

THE PICKING TABLE

JOURNAL OF THE FRANKLIN-OGDENSBURG MINERALOGICAL SOCIETY, INC.



VOLUME 33 NUMBER 2

AUTUMN/WINTER 1992

\$5

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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 available publication information 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.



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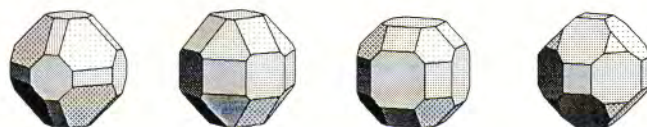
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ABOUT THE COVER PHOTOGRAPH

SEM photomicrograph of a cluster of cianciulliite crystals (on right), and water-clear cannite disphenoids (on left). Field width is approximately 0.5 mm.

FROM THE PAST EDITOR'S DESK

Omer S. Dean
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THE GOOD NEWS

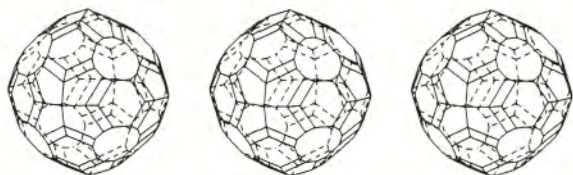
It was in the Spring issue for 1989 that I first requested replacement as Editor. Upon my return from Tucson and other points south in early March, I was pleased to find that my request had finally been fulfilled. Your new Editor, in case you haven't heard, is Herb Yeates. I am positive that you will be pleased with both his work and dedication. Herb is young, knowledgeable, computerwise, and a lover of Franklin-Sterling Hill minerals. Those are great qualifications! As for me, I plan to continue as a member of the Editorial Board.

I want to thank everyone who submitted articles for publication, whether they were ultimately used or not, during my tenure as Editor. Also, I want to thank the members of the Editorial Board for their supportive role during those seven years. Finally but equally important, I want to thank my wife, Betty; first, for tolerating all the complications and schedule changes brought about by my editorial duties, and secondly, for all those hours she spent doing last-minute proof reading for fourteen individual issues of *The Picking Table* prior to their being mailed to the printer.

1992 TUCSON SHOW

Many FOMS members are interested in where to obtain specimens from other parts of the world of species appearing on the Franklin-Sterling Hill list. The differences in the species from the various occurrences can be most fascinating and sometimes puzzling. The following are the most noteworthy encountered while in Tucson. Luis Leite at the Executive Inn had some nice specimens from N'Chwaning Mine, Kuruman, Cape Province, South Africa (one assemblage included gageite, rhodochrosite, and groutite; another assemblage was bultfonteinite and oyelite; hausmannite was present in several assemblages). Specimens from the Wessels Mine, Kalahari Manganese Fields, Cape Province, South Africa were also available. The leucophoenicites and hausmannites were very attractive. These Wessels Mine minerals were available from both C. S. Quiet (Executive Inn Ballroom) and Luis Leite.

In the past I have mentioned numerous FOMS members encountered at the show. This time the list is just too long to include here. Possibly, this is one of the best indicators of how serious our members are as mineral collectors!



Franklinite. Crystal habit adapted from Palache (1935), figure 47.

FROM THE EDITOR'S DESK

Herb Yeates
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THANKS

Greetings! This issue begins my term as editor of *The Picking Table*, and I hope to serve the readership well. On behalf of all readers of *The Picking Table* I wish to thank Mr. Omer S. Dean for his superb, high-quality work during the past seven years. During his editorial career we have enjoyed a marked improvement in the quality of *The Picking Table*, and we are all in his debt. Thank you Omer!

I would also like to thank the members of the Editorial Board for their assistance and guidance over the past few months in getting acquainted with the production of our journal. The open and helpful discussions I have enjoyed with all of them have allowed me to assume the job with a minimum of difficulty, and I am grateful for their help. Finally, a special thanks to those who have recently chosen to write for this journal.

CHANGES

This issue features several changes. First, the FOMS now owns a personal computer (an IBM-compatible PC), printer and software allowing the journal to be "typeset" on computer (It does not, however, do it by itself). This should allow a bit more flexibility in the way our journal is prepared for printing. Second, the layout has been changed around a bit using this new tool, and I hope it meets with your approval. Otherwise unattributed crystal drawings were made using the program SHAPE, and are used to fill empty spaces. Comments, complaints and ideas are all most welcome.

TO PROSPECTIVE AUTHORS

You have heard it before, and it is still true: this is *your* journal. Write for it. Pick up a pen or keyboard and put together a note to share with the readership. The basic format for all manuscripts submitted should be either:

- 1). As ASCII text, WordPerfect, Wordstar, or MSWord, files on DOS-formatted floppy diskette (3.5 or 5.25").
- 2). **Double-spaced** typed copy, with 1-1/2" margin all around, in a simple font with no justification or proportional spacing enabled (*i.e.* just plain ordinary double-spaced text). Please, *do not* send single-spaced copy.

These are the *preferred* formats; hand-written manuscripts, old articles, Zinc Company records etc. are all welcome as well. The formats listed above, however, will make your new editor's life considerably easier.

Also, please provide, if at all possible, photographic material in *black-and-white* format and as a print without need of return. The black-and-white print should be of a size suitable for publication "as is," *i.e.* without need of further enlargement or reduction. The FOMS will otherwise need to spend extra moneys to change or duplicate a black-and-white photo, or convert a color slide to black-and-white print. This can, of course, be done — but the less of it the better. Please help out by keeping to these suggestions, and **write!**

HY 8/92

LOCAL NOTES

NEWS FROM THE FRANKLIN MINERAL MUSEUM

John L. Baum
Curator, the Franklin Mineral Museum, Inc.

Trustees of the Museum have voted to accord paid-up members of the Franklin-Ogdensburg Mineralogical Society unlimited free visits to the museum. This does not include collecting nor free visits by relatives and friends, however. Donations and memberships will still be accepted. The museum is most grateful to members and friends who have recently made available by sale or donation an impressive volume of mineral specimens from both the local area and elsewhere. Although accepted primarily for sale, these have included material since selected for retention in the Museum's collections. Among the most recent collections acquired are those of Paul Solberg, Fred Howell, Al Smith and Adam Szenai. Donations involving selected specimens have been received from William Kroth, from the collection of Bob White; George Elling, from the collection of John Sebastian; and Gerry Shulman, from the collection of Will Shulman. The Museum is most grateful to all those who have made this material available. Also voted was a new seven-day-a-week schedule from March 1 through December 1.

NEWS FROM STERLING HILL

Gary Grenier
Editor, the *Sterling Hill Newsletter*

The Sterling Hill Mining Museum, Inc. is now in its second full year of providing underground tours and museum displays of mining equipment and minerals to the public. Last year's attendance reached 15,000 and this year is showing strong growth in attendance and interest. Recently, the New Jersey Association of Science Teachers took the tour and were favorably impressed with the facility, displays, and wealth of information about Sterling Hill's mining past.

Several events have occurred that will provide for the continued health of the project. They include changing the corporate structure to that of a not-for-profit foundation as well as being named to the National Register of Historic Places and the New Jersey Historic Trust. The formal certification of non-profit status was completed only this month (June). Also, the final certificate of Occupancy is in the last stages of the approval process with the Borough of Ogdensburg. A membership drive that was initiated last fall has attracted over 200 contributing members. New volunteers are continually contacting Sterling Hill to find out how they can be a part of the many projects that are ongoing. Several projects are nearing completion underground. The rising water in the mine has claimed the 430 foot

Level and made the 340 foot Level inaccessible. However, the mining equipment, ore cars, salvageable materials, and mineral specimens have been recovered from those levels. A large research collection of mineral specimens has been assembled that represents geologically significant locales down to the 1100 foot Level.

Mineral discoveries continue to occur as older material is examined and dry areas of the mine are explored. A very rich sulfide occurrence was encountered 70' below the 700 foot Level. On the 700 foot Level fluorescent barite and a stilbite-like mineral that has not yet been studied were found. Other areas of the mine have yielded a black tourmaline-group mineral, wollastonite, fluorapophyllite, titanite, actinolite, feldspars, green mica, black mica, pyroxenes and amphiboles, mcgovernite, realgar, zinkenite, stibnite, tennantite, fluorite, copper sulfides and complex assemblages all requiring much study in detail; the complexities of which will be reported in future issues of *The Picking Table*.

The Sterling Hill Mining Museum Foundation is producing a quarterly newsletter in which you may find stories of current events at Sterling Hill, reports of mineral occurrences, reports of projects in progress, historical accounts of the mine, and membership news to name but a few topics.

The future looks bright for Sterling Hill. New tunnels are being engineered to improve the tour route. New museum displays of mining equipment and minerals are being planned and acquired. More intense academic interest from universities by professors and graduate level students is being focused on the mine, its geology and mineralogy. If you are a student of earth sciences, a mineral collector or just wondered what it was like to be a miner underground there is something for you at Sterling Hill.

IN MEMORIAM

Will Shulman, aged 74, passed away this past November. Will was a retired English teacher, an ardent mineral collector, micro-mineral enthusiast, and long-time member of the FOMS. He is survived by his wife, Gerry, and a sister, Lillian Ostrin, of Livingston New Jersey.

Will was born in New York City in 1917, and lived in Newark before moving to Livingston, New Jersey in 1957. He discovered minerals at the age of 12, while taking a class in mineral identification at the Newark Museum. Will obtained a B.S. from Arizona State University and an M.A. and professional diploma from Columbia University. His career as a teacher spanned 31 years.

His collection of many thousands of specimens includes some 6,000 micromounts; a particular interest of Will's. In over 60 years of collecting, he was dedicated to the principal of acquiring a first-class mineral collection without ever purchasing a specimen. He will be missed by all who had the pleasure to know him.

THE CHECK LIST OF FRANKLIN-STERLING HILL FLUORESCENT MINERALS: --- --- DISCUSSION AND UPDATE

Richard C. Bostwick
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INTRODUCTION

This check list is an alphabetical listing of all mineral species from the Franklin-Sterling Hill area which are known to fluoresce. The species nomenclature used here follows that of the complete list of Franklin-Sterling Hill minerals compiled and regularly revised by John L. Baum with the assistance of Dr. Pete J. Dunn. In other respects the check list of fluorescent minerals is a product of my own direct observations, with assistance and guidance over the years from many fellow collectors and a few sympathetic scientists.

The check list of fluorescent mineral is no more a static document than the species list: it can (and should) change with the discovery of new fluorescent species, newly observed fluorescences, and the discreditation of either. Anyone with observations or objections which would contribute to the improvement and updating of the list is welcome to write to me; additional information would be much appreciated.

This is not the first check list of local fluorescent minerals nor is it likely to be the last. The earliest listing appears in Charles Palache's 1928 article "The phosphorescence and fluorescence of Franklin minerals" (*American Mineralogist*, vol. 13, pp. 330-333), which describes ten Franklin minerals as seen under the iron arc. Since then many other descriptions of the local fluorescent minerals have appeared. The most elaborate treatment of the subject is Robert W. Jones, Jr.'s *Nature's*

Hidden Rainbows (published by UVP, Inc., 1964, revised 1970), which describes the fluorescence of 30 local minerals.

My check list, which has appeared in the annual program of the Franklin-Sterling Mineral Exhibit since 1982, is an outgrowth of my article "The Fluorescent Minerals of Franklin and Sterling Hill, New Jersey: A Progress Report for 1977," which appeared in that year's *Picking Table* and *Journal of the Fluorescent Mineral Society*. Forty-nine fluorescent species were listed there; by 1991 the total had risen to eighty. This is to my knowledge the highest total for any mineral locality, and there is no reason why it should not eventually become much higher.

TERMINOLOGY

The descriptions of fluorescent color in this version of the check list are more detailed than those which have appeared annually in the Franklin-Sterling Mineral Exhibit program, and require some introduction.

Two abbreviations are retained from the program check list: "SW" for shortwave ultraviolet radiation, and "LW" for longwave ultraviolet radiation. Where the two abbreviations appear together separated by a slash (SW/LW or LW/SW) it means that the described fluorescence is of similar character during exposure to either shortwave or longwave ultraviolet radiation, but is somewhat brighter or more noticeable in response to the wavelength range listed first.

Beyond this the descriptions now include basic information about three qualities of fluorescent color, in this order: intensity, saturation, and hue. The terms used in describing them are intended to be intuitively obvious but will take some getting used to. Once learned, they can be used to describe mineral fluorescence with reasonable precision; the increase in accuracy is worth the wordiness.

Intensity

Intensity is the brightness of a fluorescence. The scale goes from very weak to very bright, and the terms as used here mean the following:

- very weak*: luminescence so feeble that it can be seen only by the dark-adapted eye.
- weak*: visible under average conditions, but just barely.
- moderate*: easily visible but not really suitable for display.
- bright*: obviously visible and suitable for display.
- very bright*: the brightest of fluorescent minerals, e.g. esperite.

I have also used "moderately weak," to describe a fluorescence of an intensity between weak and moderate, and "moderately bright" to describe a fluorescence of an intensity between moderate and bright.

Saturation

Saturation is perhaps best understood as the degree of white mixed with a chromatic color. In blending paint colors the only difference between a vivid emerald green and an extremely pale green may be the addition of white; the green pigment has not changed, but our perception of the color certainly has. In describing mineral fluorescence, the basic scale of saturation goes from *pale* (heavily diluted with white) to *medium* (somewhat diluted with white) to *deep* (a color with no white in it). Toward the upward limits of dilution there is a point when a fluorescence starts appearing basically white. For example, an extremely pale blue color would be called bluish-white, or white with a bluish tint. Fluorescent colors of low intensity and high saturation can be difficult to describe, particularly in the yellow to orange range; to the eye they can appear tan or brown. Saturation levels used here are:

- pale*: large amount of white present
- medium*: some white present
- deep*: a "pure" color; no white present

Hue

Hue is the color itself: red, orange, yellow, green, blue, violet, purple, and the gradations between them. The transition from yellow to green, for example, would be:

- Yellow
- Greenish-yellow
- Yellow-green
- Yellowish-green
- Green

Examples

In these descriptions I am following the format of intensity, saturation, and hue, in that order. Take two examples, one simple and the other less so:

Chabazite: Fluoresces moderate medium green SW. Often nonfluorescent.

This means that some chabazite from the Franklin-Sterling Hill area, when exposed to shortwave ultraviolet radiation, fluoresces with *moderate intensity* (it is neither bright nor weak), *medium saturation* (there is some white in the color, but it is not a pale green or greenish-white), and a *green hue* (neither a bluish-green nor a yellowish-green).

Aragonite: Fluoresces and phosphoresces weak to moderate white to pale yellow SW/LW. Rarely fluoresces moderate pale green SW, with typical LW fluorescence and SW-LW phosphorescence.

This tells us that Franklin-Sterling Hill aragonite can fluoresce and phosphoresce with an intensity that varies from barely visible to quite visible but not bright. The white and pale yellow fluorescences are seen under both shortwave and longwave ultraviolet radiation; as white is not a chromatic hue it requires no description of its saturation, but the yellow fluorescence in this case has a lot of white in it and is termed pale. The rare green-fluorescing variety of aragonite fluoresces pale green only under shortwave ultraviolet radiation; however, this variety fluoresces like other aragonite under longwave ultraviolet radiation, and phosphoresces like other aragonite under shortwave or longwave ultraviolet radiation.

Perhaps the easiest way to understand these descriptions is to go to the minerals themselves. The meanings of intensity, saturation, and hue will become increasingly obvious as specimens are placed next to each other and studied. The use of these terms in color descriptions may be new to many collectors of Franklin-Sterling Hill minerals, but they are part of the basic vocabulary for discussing color in general. For those interested in pursuing the subject further, there are excellent discussions of color perception and terminology in Manny Robbin's *The Collectors Guide to Fluorescent Minerals* (1983, Van Nostrand Reinhold). Some of the information and attitudes in this article are derived from that book.

The untutored human eye routinely discriminates between a thousand or so reflected colors, and in theory a trained observer could distinguish more than a million. The study of reflected and transmitted colors is highly advanced, with well-developed standards for hue, saturation, reflectance, luminance, etc. At present there are no standards for fluorescent, emitted colors, although the Fluorescent Mineral Society has formed a committee to develop them.

The difficulties of describing mineral fluorescence in the absence of standards have been experienced by everyone who has attempted it. There is a pointed discussion in the introduction to *The Henkel Glossary of Fluorescent Minerals* (Journal of the Fluorescent Mineral Society, vol. 15, 1988-89, edited by Earl R. Verbeek and Peter J. Modreski) under the heading "Colors and intensities of fluorescence." Without standards, it is certain that not everyone will use color terms in exactly the same way; my reddish-orange, for example, could be someone else's orangeish-red. Nevertheless there is bound to be value in trying to make the descriptions we have more accurate, and such differences as exist in color perception among people with normal vision are sufficiently minor that one can certainly go beyond describing the fluorescence of Franklin-Sterling Hill calcite and willemite as merely "red and green."

When applying the information in this check list to your own minerals, please remember that there is a great deal of information missing. The check list includes those species from the Franklin-Sterling Hill area which have been found to fluoresce;

this does not mean *all* specimens of the listed species fluoresce, and indeed in some cases the mineral is often nonfluorescent. The check list also says nothing about which minerals are rare and which are abundant. It certainly does not tell you how mineral "x" looks in white light, or whether it is found in the ore or the marble, or which other minerals might be found with it. Fluorescence is only one property of a mineral, and a highly variable one at that; it is unwise to identify a species solely on that basis. Still, checking a specimen under an ultraviolet lamp remains one of the simplest of all diagnostic tests, and when used in conjunction with other observations it can be a powerful aid to mineral identification.

CRITERIA

The criteria for additions to this check list are simple: the mineral must fluoresce, its species identity must be certain, and it must be from the Franklin-Sterling Hill area. On the face of it nothing could be simpler, but all three criteria require some explanation.

The mineral must fluoresce

Mineral fluorescence is not necessarily obvious, and when a fluorescence can be seen clearly it may be a mineral other than the one it is thought to be, or it may not be a mineral at all.

Mistakes in mineral identification may result from the fluorescence of mineral mixtures. An example is the fine-grained mixture of non-fluorescing leucophoenicite and red-fluorescing calcite reported by Frank Edwards ("Fluorescent Mineral Notes," *The Picking Table*, vol. 15, no. 1, pp. 6-8). Jones (*Nature's Hidden Rainbows*, pp. 87-100) mentions green-fluorescing mixtures of willemite with bementite, hancockite, hardystonite, hodgkinsonite, manganophyllite, and tephroite; each of the six had been reported earlier as a green-fluorescing mineral. In every case the fluorescence was clearly that of calcite or willemite, and the initial reports of fluorescent leucophoenicite, bementite etc. were due to a failure to recognize which mineral was fluorescing

Mixtures of more than one fluorescing species may cause additional confusion. When two fluorescing minerals are intimately intergrown, or one is a thin coating on another, a new fluorescent color may be perceived which is characteristic of neither mineral. Transmitted colors, such as those emitted by fluorescing minerals, combine or add together differently than do reflected colors. Where a mixture of red, blue and yellow paint would appear brown, the same combination of fluorescing minerals is seen as white. A finely ground mixture of willemite and calcite will fluoresce pale yellow. At Franklin and Sterling Hill there are many fluorescent species and microscopic intergrowths, and so this possibility of mistaken color attribution exists. When anomalous fluorescence responses are found, samples should be checked for the possibility of intimate mixture.

Coatings can cause similar problems. One type is the thin films which have formed on specimens from dumps, mines, and quarries as a result of surface alteration. These coatings often fluoresce white to pale yellow and are particularly noticeable under longwave ultraviolet radiation. Rarely the coating may develop selectively on one mineral, which can give an observer the impression that the fluorescence is coming from the mineral underlying the coating. Thin coatings such as these can be difficult to analyze and are of limited interest to many mineralogists; consequently their species identities often remain unknown. Another deceptive coating is the dust of fluorescent minerals: pulverized willemite is astonishingly persistent and

ubiquitous in any collection or accumulation of minerals rich in Franklin material, particularly when the minerals were stored without thorough cleaning and careful packing. Willemite dust clings to specimen trays, wrapping paper, dynamite boxes, etc., and readily transfers to otherwise clean specimens without regard for their location or identity.

Synthetic minerals can also form fluorescent coatings. Films of Portland cement can be found on some specimens from Sterling Hill, where cement was used as part of the fill process. Franklin dump material was often used in stone walls, fireplaces, and the like, and may be similarly coated. Exposure to moisture, chemicals, etc., whether in damp basements or on mineral dumps, can result in a variety of mineral or mineral-like coatings. Furthermore, a very small minority of collectors is capable of deliberately experimenting in this medium. If there is a question whether a certain fluorescence is due to a coating, the specimen may be broken to obtain a fresh surface for examination. Keep in mind, however, that a heavily cracked, weathered specimen will generally break along another weathered surface.

Many fluorescent coatings are not minerals. Thousands of organic substances fluoresce, and it is not uncommon for some of these to come into contact with specimens: oil, grease, paint, dye, wax, glue, etc. Drill oil is particularly deceptive, as it often appears on freshly mined specimens and does not wash off easily, if at all. When new, drill oil fluoresces moderately bright blue-white; as it ages the fluorescence weakens and turns yellow. Automotive oils and greases are often kept in areas where minerals are stored, and in one way or another these can contaminate specimens too. Paint can fluoresce: some of the calcite collected near the fence around the Buckwheat open pit is coated with blue-fluorescing dots of fence paint. Dyes can transfer to specimens from contact with dyed cloth or paper; specimens wrapped in newspaper often have blue-fluorescing spots at points of contact. (For this reason I recommend that specimens be wrapped in clear plastic film like Handi-Wrap or Saran Wrap before being wrapped in paper.) Optical brighteners, colorless dyes that fluoresce bright blue-white, are used to make paper and fabric appear whiter. They are commonly found in laundry detergent as well, hence the necessity of thoroughly rinsing specimens washed with detergent. Because laundry brighteners are intended to adhere to textile fibers and not wash out, they can adhere to fibrous minerals as well. I recommend washing minerals with a nonfluorescent soap such as Ivory. Many glues fluoresce; repaired and restored specimens often show evidence of this. Glue, varnish, shellac, etc. are often used to attach numbers or labels to specimens, and can remain when the labels or numbers are gone. Specimens can also be contaminated with cosmetics, insect eggs and egg cases, food, and so forth.

Coatings of various origins, except those due to the alterations of specific minerals, are generally identifiable because their distribution on the specimen does not correspond to that of the underlying minerals. In addition, many organic materials (e.g. paint, wax) are obviously coatings with uniform color and smooth texture. A hand-lens is generally sufficient to distinguish them. Removing coatings can be difficult, and a full treatment is outside the scope of this article. Oil stains, which often form films invisible except under ultraviolet radiation, can be removed by organic solvents such as xylene. I mention this because specimens of common minerals contaminated with drill oil have been sold locally as unknown fluorescent minerals, and the use of a strong organic solvent is one way of detecting them.

The species identity must be certain

Here again, this is not a simple matter. Although a good many Franklin-Sterling Hill species have distinctive visual characteristics, fluorescence, or associations which make them easily identifiable on sight, many more do not. Examples are members of the amphibole, apatite, calcite, dolomite, feldspar, garnet, humite, kaolinite-serpentine, mica, and pyroxene groups, to name a few. Within each group there are several Franklin-Sterling species which cannot necessarily be distinguished from one another by color, hardness, streak, associations, etc. Take the feldspar group; the Baum/Dunn species list includes albite, anorthite, anorthoclase, celsian, hyalophane, microcline, and orthoclase. Of these seven, only albite, hyalophane, and microcline are currently included in the fluorescent species list, even though the other four are known to fluoresce from *other* localities. Those four are not listed either because I have never examined an analyzed sample of the species from the Franklin-Sterling Hill area, or because when I was able to examine one, I couldn't see any fluorescence.

As most of us are well aware, a label is no guarantee of species identity, even when an "authority" is invoked. In the first place, as the science of mineralogy grows and changes, so do mineral definitions and names change; Lawson Bauer's svabite is today's turneaureite. Also, to be gruesomely blunt, some authorities are more reliable than others, even when their opinions about a specimen's identity are correctly presented by the owner. Mineral identification at Franklin among the collector/dealer community is largely a matter of sight-identification, based on memories of specimens presumed to have been correctly identified. This method and its foundation are treacherous enough, but in practice the results are sometimes skewed by memory flaws, ignorance, wishful thinking, the profit motive, and the understandable desire to appear more knowledgeable than one may actually be. Suffice it to say that when adding a new species to the check list of fluorescent minerals, I try to be cautious about the species identification. Who identified the mineral? When? With what methods? How is the identification documented? Can it be cross-referenced, or linked to a published description of the mineral? If there is any doubt, the species isn't added.

The mineral must be from the Franklin-Sterling Hill area

When a specimen has mineral "x" prominently displayed on a matrix of willemite, franklinite, zincite, and calcite, this is easy. Not all Franklin-Sterling Hill specimens are this visually distinctive. For example, without a specific connection to a local quarry within the defined boundaries (to refresh your memory, see "Definition of the Franklin-Sterling Hill Area" in *The Picking Table*, vol. 28, no. 1, page 4), it is virtually impossible to assign responsibly a specimen of norbergite/chondrodite or other marble-hosted minerals to the Franklin-Sterling Hill area. Not only does the Franklin Marble extend outside the area boundaries, with locally active quarries (*e.g.* the Lime Crest Quarry in Sparta) yielding similar material, but marbles of similar age and composition are found in upper New York State and Canada. Other examples can be cited of material from the Franklin-Sterling Hill area which is similar in appearance to specimens found elsewhere. Trotter mine nickel minerals come to mind, as do specimens from the Ball's Hill iron mines and some of the material from the oxidized zones at both orebodies. Now is an

appropriate time to make a plea for accurate labeling of material each of you may have collected. It is assured that your rocks will outlive you; please make sure that the locality of each is carefully recorded. Failure to do this will unquestionably result in confusion down the line.

More confusion has been sown by specimens which are in fact not from the Franklin-Sterling Hill area, but have wound up safely ensconced in Franklin-Sterling Hill collections (This rather complex subject, which may be described as the contamination of the Franklin-Sterling Hill specimen base, will be discussed at length in an article now in preparation, but certainly merits a brief discussion here.) These often enter Franklin collections without labels, but quickly acquire them. It is as if Franklin-Sterling Hill minerals are so strange, wonderful, and mysterious that any unusual specimen might have come from there, and therefore probably did. It is also the case that responsible Franklin-Sterling Hill collectors can specialize so completely in the local minerals that they may not be familiar with visually similar material found elsewhere. I have seen alien specimens masquerading as natives in many Franklin-Sterling Hill collections, including my own: willemite/calcite from Arizona and Zambia, Canadian "wernerite," Michigan copper, and many others, their authenticity attested to by miners and their wives, among others. Much of this material seems to have been introduced into the area by rockhounds and others who either threw non-Franklin specimens away on the Franklin dumps, or traded them with miners and local collectors. Another source is the residue of unlabeled material found in most large collections, institutional and private; when it is marketed speculative localities are often assigned, in preference to providing none. The reasons that alien specimens become naturalized range from innocent ignorance and wishful thinking to prankishness, assumptions of superior knowledge, and the desires for prestige and profit.

ADDITIONAL FLUORESCENT SPECIES

While it is not easy to increase the species total of Franklin-Sterling Hill fluorescent minerals, it is extremely likely that more will be found. As a starting point for the search, let me share another list with you. It contains forty-four species which are included in *The Henkel Glossary of Fluorescent Minerals* and in the current Franklin-Sterling Hill species list, but not in the Franklin-Sterling Hill check list of fluorescent minerals. These minerals have all been reported as fluorescent from somewhere in the world. They are found at Franklin and/or Sterling Hill, and some may be fluorescent from these localities. All the same, I have never seen specimens or received correspondence which satisfied the three criteria for additions to the check list. Anyone who has access to specimens of these minerals from the Franklin-Sterling Hill area is asked to examine them under ultraviolet lamps, preferably as described below under "viewing techniques," and to let me know the results.

VIEWING TECHNIQUES

Anyone with normal vision and color perception is quite capable of making competent observations of fluorescent minerals, as long as he or she has decent ultraviolet lamps and a genuinely dark place in which to use them. However, so many collectors are accustomed to observing fluorescent minerals in high ambient light, often along with other distractions, that it is easy to overlook some common-sense basics. Obviously the

Adamite	Clintonite	Muscovite
Analcime	Descloizite	Natrolite
Anglesite	Dolomite	Orthoclase
Anhydrite	Edenite	Otavite
Anorthite	Forsterite	Pharmacolite
Anorthoclase	Ganomalite	Sepiolite
Austinite	Grossular	Sillimanite
Bakerite	Greenockite	Spinel
Barysilite	Heulandite	Stilbite
Biotite	Kaolinite	Strontianite
Brucite	Larsenite	Thorite
Bastnäsité-group mineral	Laumontite	Tirodite
Celsian	Legrandite	Uranophane
Clinzoisite	Mimetite	Wulfenite
		Wurtzite

Minerals found at Franklin-Sterling Hill which are listed in *The Henkel Glossary of Fluorescent Minerals* as fluorescent from other localities.

following are suggestions which do not have to be rigorously enforced during casual examination of fluorescent minerals, but which in the long run will greatly enhance your awareness and enjoyment of mineral fluorescence.

Achieve darkness

Find or create a truly dark place to observe fluorescence. This is not always easy: few mineral dealers, dumps, museums, or general collectors are likely to provide one. The ideal is something on the order of a photographic darkroom. Areas with light leaks can make it difficult to accomplish the next suggestion.

Adapt your eyes to darkness

Take the time to allow your eyes to become dark-adapted. This can take ten minutes or more, but it is worth the wait. Otherwise you are unlikely to be able to see very weak fluorescences and phosphorescences, such as the phosphorescence of esperite. (If in the middle of an observing session you have to turn on the light, keep one eye shut. Don't let Mom in with milk and cookies.)

Avoid fluorescent distractions

Avoid brightly fluorescing clothing or background materials. Long-sleeved white shirts (as an example) fluoresce more brightly than most minerals and can be a serious distraction. The same is true of white sheets, if as it happens the only place in your bedroom to lay out minerals is your bed. Mineral labels and boxes often fluoresce; the cotton padding supplied with these boxes invariably does. Specimens should be removed from their boxes and placed on a nonfluorescent and nonreflective background before observations are made. Black cloth is fairly effective as a background but tends to accumulate fluorescent lint; perhaps a better solution is cardboard or wood which has been painted flat black. Black construction paper is also used for this purpose.

Use a good ultraviolet lamp

For shortwave lamps this means one whose filter is not heavily solarized. Pre-1980 shortwave lamps all have the old Corning filter, which although advertised as having 500 hours of life was in very poor shape in a tenth that time. The newer filters are reputed to have lives measured in thousands of hours and can be obtained in sizes to fit older shortwave lamps. It is also important to have a fairly powerful lamp, as up to a point mineral fluorescence is proportional to the strength of the exciting ultraviolet radiation. I prefer separate longwave and shortwave 6-watt line-powered hand lamps. It is possible to do well with 4-watt lamps, but they often must be held close to the specimen. Combination longwave/shortwave lamps require care on the part of the observer in distinguishing between the effects of longwave and shortwave ultraviolet radiation.

Use ultraviolet-blocking goggles

These protect the eyes from ultraviolet radiation, and allow careful observation of mineral fluorescence by preventing eyes, eyeglasses, and contact lenses from fluorescing. Such goggles are available from scientific supply houses and dealers in ultraviolet lamps.

Longwave ultraviolet radiation (often called "black-light") is relatively harmless in the wavelength range emitted by conventional longwave lamps. It is, however, very effective in causing eyes, skin, and teeth to fluoresce, along with many other organic materials. Shortwave ultraviolet is in fact harmful to human body tissue, duplicating the effects of sunburn but without the accompanying tan. The eyes are more sensitive to exposure than the skin; at low doses they will simply feel irritated. Higher doses cause a sensation not unlike that of having sand in the eyes, accompanied by copious tears and the formation of crusts: severe conjunctivitis, in short. A very few minutes of direct exposure are sufficient to cause several days of severe discomfort. And as with longwave ultraviolet radiation, eyes, skin, etc., will fluoresce.

Glass and coated plastic eyeglass lenses will block shortwave ultraviolet radiation but do not protect the eyes completely. Furthermore, such lenses generally fluoresce under longwave and shortwave ultraviolet radiation. Whether the eye itself or the lens protecting it is fluorescing, the effect is to interpose a fluorescent haze between the retina and the object being observed. This haze can mask weak mineral fluorescence very effectively. Ultraviolet-blocking goggles are the only form of eye covering which will both protect the eyes completely and allow unobscured viewing of fluorescing minerals.

Beware of light from any source

It will always interfere with your ability to see fluorescence clearly. We have discussed stray light in the observing area, the fluorescence of clothing, mineral boxes, and other background materials, and the fluorescence of eyes and lenses.

Another source of light is the fluorescence of the minerals themselves. When a weakly fluorescing mineral is next to or intergrown with a brightly fluorescing mineral, the weaker fluorescence will be obscured, sometimes so effectively that the only noticeable sign of any response is a weak phosphorescence after the UV lamp is switched off. When a weak fluorescence is sought or suspected, an effective approach is to mask nearby brightly fluorescing minerals; this can be done with black electrical tape, black-painted aluminum foil, or some other dark, nonfluorescent material which will neither damage the specimen nor shift during handling.

A source of light which is more pernicious, because it is always there, is the visible light emitted by the ultraviolet lamp (keep in mind that if the filters were completely efficient in blocking visible light, you would be unable to tell that the ultraviolet lamp was on by looking at the filter). While the amount of visible light passing these filters is a very small percentage of the output of the lamps, it is enough to obscure some weak fluorescences and distort one's perception of others. White and pale-colored minerals are likely to reflect the violet and blue light emitted by the lamp, and this reflection can be mistaken for fluorescence, or make a weak white fluorescence appear blue or violet. A technique for distinguishing reflection from shortwave-induced fluorescence is to place ultraviolet-blocking goggles (or a sheet of ultraviolet-blocking material) between the ultraviolet lamp and the mineral, and note the change in the apparent fluorescence. This technique blocks only the shortwave emissions of the lamp, not the longwave ultraviolet radiation or visible light also emitted, and as a result is ineffective for longwave ultraviolet lamps.

Use microscopes cautiously

When a microscope is being used to observe the fluorescence of very small minerals, it is well to remember that the degree of magnification proportionately decreases the amount of light reaching the eye. In other words, a pinpoint of fluorescence which seems quite bright in a micromount held a foot away can be very difficult to find under a microscope. Often it is necessary to switch back and forth several times from unaided light vision to microscope illuminator and to ultraviolet radiation before a small crystal can be singled out and its fluorescence confirmed. To be certain the spot you are viewing is actually fluorescing, it is better to alternate between white light and ultraviolet light illumination while keeping the sample stationary and maintaining one's view through the microscope. A useful method is to connect the power for the white light to a foot pedal or other "hands-free" switch. Switching the white light on and off can then be done without taking one's eyes off the subject under microscopic view. This greatly reduces the chance of misattributing the fluorescence. Keep in mind also that small fragments of fluorescent minerals (e.g. willemite dust) are as capable of contaminating micromounts as they are of coating cabinet specimens.

Suggestions for note taking

If you write down your observations, record at least the fluorescent hue and the intensity: bright green, moderate yellow,

weak purplish-red, etc. The difference between moderate and deep saturation is harder to perceive and describe, but if a fluorescence is distinctly pale, this should be recorded. If you choose to adopt the descriptive approach used here, remember to use *weak, pale, moderate, medium*, etc., in their restricted senses. As an example, in common usage pale can imply *weakness*, so that someone might describe a barely visible fluorescence as "pale." This is the risk of having common words in a specialized vocabulary. Some discipline must be employed in their use. Try to avoid ambiguous or decorator color names (e.g. "spring green," or "federal blue"). If stuck for a description, compare a fluorescent mineral with others, as in "fluoresces a more reddish-orange color than clinohedrite." Always record the exciting wavelength (SW or LW) and whether there is any phosphorescence. It is very important to write down the catalog number of the specimen (and the collection, if it is not your own), so that anyone coming after you can confirm or amplify your observations.

Again, I welcome correspondence dealing with any of the topics raised in this article, particularly those of new fluorescent species for the check list, and the matter of the contamination of the Franklin-Sterling Hill specimen base. Any assistance will be most appreciated.

ACKNOWLEDGMENTS

Much of the credit (and none of the blame) for this reworking of the check list of fluorescent minerals belongs to the editors, past and present, of *The Picking Table*, who thought it possible when I did not. The stimulus to approach the three-headed hydra of intensity, saturation and hue came from the work and conversation of Manny Robbins, Don Newsome, and most particularly Earl Verbeek, who is using this approach in his own work and who encouraged me to use it here.



Fluorescent Mineral Society

The Fluorescent Mineral Society is devoted to increasing the knowledge of its members in the luminescence of minerals with emphasis on fluorescence and phosphorescence. The Society is international in its membership. It promotes increased knowledge in this interesting hobby with emphasis on collecting, displaying and understanding. To help all members, it publishes an interesting bi-monthly newsletter called the *UV WAVES* and an annual, *THE JOURNAL OF THE FLUORESCENT MINERAL SOCIETY*. This stresses the scientific side of the hobby while the *UV WAVES* highlights the usual and ordinary applications of common interest to you. Membership information may be obtained by writing:

The Fluorescent Mineral Society
P.O. Box 2694
Sepulveda, CA 91343

THE CHECK LIST OF FRANKLIN-STERLING HILL FLUORESCENT MINERALS

*The format used here is: species, typical fluorescence response, and any less common responses.
Each response is described in terms of intensity, saturation and hue, in that order.*

Albite: Fluoresces moderate deep purplish-red SW.

Aragonite: Fluoresces and phosphoresces weak to moderate white to pale yellow SW/LW. Rarely fluoresces moderate pale green SW, with the usual LW fluorescence and SW/LW phosphorescence.

Barite: Typically fluoresces moderate to very bright yellowish-white SW, with occasional weak phosphorescence. Also fluoresces and phosphoresces moderate to bright medium yellow to pale yellow SW/LW. Rarely fluoresces moderate white SW, with moderate very pale green fluorescence LW.

Barylite: Fluoresces moderate deep violet SW. Appears bright blue violet when viewed using the iron arc.

Bassanite: Fluoresces and phosphoresces moderate pale violet SW/LW.

Bustamite: Fluoresces moderately bright deep pinkish-red LW/SW. Often nonfluorescent.

Cahnite: Fluoresces and phosphoresces weak to moderate white to pale yellow SW/LW. Often nonfluorescent.

Calcite: Typically fluoresces moderate to very bright deep orangeish-red SW, with a brief but bright deep orangeish-red phosphorescence. Longwave fluorescence and phosphorescence are similar but generally weaker. Calcite can also fluoresce a full range of reds from orange-red to purplish-red, as well as various hues of yellow, orange, green, blue, violet, and white. Most of these varieties also phosphoresce.

Canavesite: Fluoresces and phosphoresces moderate medium violet LW. Shortwave fluorescence (if any) is obscured by the fluorescence of associated willemite.

Celestine: Fluoresces and phosphoresces moderately bright pale blue SW, moderately weak white LW. Rarely fluoresces and phosphoresces moderately weak deep violet SW and weak medium violet LW. Often nonfluorescent.

Cerussite: Fluoresces moderate medium yellow LW, weak very pale orange SW.

Chabazite: Fluoresces moderate medium green SW. Often nonfluorescent.

Charlesite: Reported to fluoresce moderate pale blue SW when freshly broken, but generally coated with gypsum which is fluorescent and phosphoresces moderate white SW/LW.

Chondrodite: Fluoresces weak to moderate medium orangeish-yellow to orange-yellow SW.

Clinohedrite: Fluoresces and phosphoresces moderate to very bright yellowish-orange SW. Longwave fluorescence and phosphorescence much weaker.

Corundum: Fluoresces weak to moderate deep purplish-red LW. Shortwave fluorescence much weaker.

Cuspidine: Fluoresces moderately bright medium-orange yellow SW with brief reddish-orange phosphorescence.

Datolite: Fluoresces moderate white to pale violet SW.

Diopside: Fluoresces bright medium blue SW, and moderately weak medium yellow LW.

Dypingite: Fluoresces and phosphoresces moderate very pale blue LW/SW.

Epsomite: Fluoresces moderate very pale yellow LW, weaker response SW.

Esperite: Fluoresces very bright deep greenish-yellow SW, much weaker response LW; very weak phosphorescence SW.

Fluorborite: Fluoresces bright very pale yellow SW.

Fluorapatite: Fluoresces weak to bright deep orange to pinkish-orange SW. Also fluoresces weak to moderately weak pale violet-blue SW.

Fluorapophyllite: Fluoresces and phosphoresces weak white SW.

Fluorite: Typically fluoresces and phosphoresces weak to moderate medium bluish-green SW/LW. Also fluoresces and phosphoresces moderate pale yellow SW and weak deep violet LW; fluoresces moderate deep violet SW/LW with weak phosphorescence; and fluoresces and phosphoresces moderately bright white SW with moderately weak pale green fluorescence and phosphorescence LW. Much bluish-green-fluorescent fluorite is also thermoluminescent with the same color. This property (as well as the fluorescence) disappears on repeated heating. Additionally, the bluish-green fluorescence is diminished or extinguished by exposure to light. As a general rule, all Franklin-Sterling Hill fluorite should be protected from light to preserve its luminescent properties.

Guerinite: Fluoresces and phosphoresces weak white SW/LW.

Gypsum: Fluoresces and phosphoresces moderate pale blue, pale violet, or pale yellow SW. Weaker fluorescence and phosphorescence LW. Also fluoresces and phosphoresces weak to moderate white SW/LW. Often nonfluorescent.

Hardystonite: Fluoresces moderately weak to bright purple of medium to deep saturation, with weak phosphorescence. Longwave fluorescence is similar but generally weaker.

Hedyphane: Fluoresces weak reddish-orange or yellowish-orange SW.

Hemimorphite: Fluoresces and phosphoresces moderately weak white to pale yellow SW, weaker response LW. Also fluoresces moderately weak pale blue or green SW.

Hodgkinsonite: Fluoresces weak deep purplish-red SW. LW

Hyalophane: Fluoresces weak to moderate deep purplish-red SW.

- Hydrocalcite:** Fluoresces moderate pale yellow LW. Shortwave fluorescence (if any) is obscured by the fluorescence of associated willemite.
- Hydroxyapophyllite:** Fluoresces and phosphoresces weak white SW.
- Hydrozincite:** Fluoresces moderate to bright medium blue to pale blue SW. Varied, ambiguous LW fluorescence (probable mixtures with other minerals).
- Johnbaumite:** Fluoresces moderate to bright deep orange SW.
- Junitoite:** Fluoresces moderately weak pale yellow LW.
- Magnesiohornblende:** Fluoresces moderate pale greenish-blue SW.
- Manganaxinite:** Fluoresces moderately weak to very bright deep orangeish-red SW with very weak phosphorescence. Longwave fluorescence similar but weaker.
- Margarite:** Fluoresces weak to moderately weak very pale yellow SW/LW.
- Margarosanite:** Typically fluoresces moderately bright to very bright pale to very pale blue SW; often mixed with areas which fluoresce bright pale to medium red SW, and moderate to weak medium purplish-red LW. Rarely fluoresces weak medium orange LW.
- Marialite:** Fluoresces moderately weak yellow SW and moderately weak pink LW.
- Mcallisterite:** Fluoresces moderately weak yellowish-white SW.
- Meionite:** Typically fluoresces weak to moderate deep purplish-red SW, but can also fluoresce varied shades of orange, pink, and yellow, often brighter LW than SW.
- Meta-ankoleite:** Fluoresces moderate medium green SW.
- Metaldevite:** Fluoresces moderate medium green SW.
- Microcline:** Fluoresces moderate to bright pale blue SW, weaker response LW, with weak phosphorescence. Also fluoresces moderately weak deep purplish-red SW.
- Minehillite:** Fluoresces weak to moderate medium violet SW, weaker response LW.
- Monohydrocalcite:** Fluoresces moderately bright medium green SW/LW with white phosphorescence.
- Nasonite:** Fluoresces weak to moderately bright pale yellow SW, weaker response LW.
- Newberyite:** Fluoresces weak yellowish-white LW/SW.
- Norbergite:** Fluoresces moderate to bright medium yellow to orange-yellow SW, weaker LW.
- Oyelite-like mineral:** Fluoresces moderate medium violet and white SW/LW.
- Pargasite:** Fluoresces moderate pale greenish-blue SW.
- Pectolite:** Fluoresces and phosphoresces moderately bright yellowish-orange SW/LW.
- Phlogopite:** Fluoresces weak to moderate, medium to deep orangeish-yellow SW.
- Picropharmacolite:** Fluoresces and phosphoresces moderate white, pale blue, pale yellow SW/LW.
- Powellite:** Fluoresces bright to very bright pale yellow SW/LW.
- Prehnite:** Fluoresces moderately weak to moderately bright medium orangeish-pink SW.
- Quartz:** Fluoresces weak to moderately bright pale yellow or pale green SW. Also fluoresces moderate orange-yellow SW/LW.
- Roebblingite:** Fluoresces weak to moderately bright medium to deep orangeish-red SW with brief phosphorescence, the same as typical calcite. Some specimens fluoresce weak pale pinkish-yellow LW.
- Scheelite:** Fluoresces moderate to bright pale yellow through yellowish-white and pale blue SW. Yellow-fluorescing types also fluoresce weakly LW.
- Smithsonite:** Fluoresces and phosphoresces moderate white SW/LW. Often nonfluorescent.
- Sphalerite:** Typically fluoresces and phosphoresces moderate to bright orange of varying saturation LW, weaker response SW. Sphalerite with a medium blue fluorescence and phosphorescence of comparable intensity is often associated with this, but is seldom found separately. More rarely fluoresces and phosphoresces shades of yellowish-orange and orange-yellow. Specimens which fluoresce are also characteristically triboluminescent moderate pale orange.
- Svabite:** Fluoresces moderately bright pale yellowish-orange SW.
- Talc:** Fluoresces moderately weak yellowish-white LW/SW.
- Thomsonite:** Fluoresces moderately weak yellowish-white SW/LW.
- Tilasite:** Fluoresces moderate pale yellow SW/LW. Does not always fluoresce.
- Titanite:** Fluoresces weak medium yellowish-orange SW. Often nonfluorescent.
- Tremolite:** Fluoresces moderate to bright very pale to pale blue SW, much weaker response LW.
- Turneaureite:** Fluoresces bright yellowish-orange SW.
- Uranospinite:** Fluoresces moderate medium green SW.
- Uvite:** Fluoresces moderate medium to deep yellow SW, weaker response LW.
- Willemite:** Typically fluoresces bright to very bright deep yellowish-green SW, generally weaker response LW. Also fluoresces medium orange through yellowish-orange, orange-yellow, yellow and pale yellow to greenish-yellow. Rarely fluoresces bright pale blue. All varieties may phosphoresce, some quite persistently.
- Wollastonite:** Fluoresces a continuum from weak to very bright pale yellow to deep orange SW, with brief conspicuous phosphorescence which is usually more reddish than the fluorescence. Similar but weaker fluorescence LW.
- Xonotlite:** Fluoresces moderate to bright medium violet SW.
- Zincite:** Fluoresces weak to moderately bright pale greenish-yellow, medium yellow, and medium yellowish-orange LW/SW. Generally nonfluorescent.
- Zircon:** Fluoresces weak to moderate orange of medium to deep saturation SW; much weaker fluorescence LW.
- Znucalite:** Fluoresces moderate medium green SW/LW.

RCB 8/92

ORTHOSERPIERITE AT STERLING HILL, NEW JERSEY

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The occurrence at the Sterling mine of the rare mineral, orthoserpierite, $\text{Ca}(\text{Cu}^{+2}, \text{Zn})_4(\text{SO}_4)_2(\text{OH})_6 \cdot 3\text{H}_2\text{O}$, was first reported by Dunn (1986). The exact provenance for the material was not known. This note therefore records geologic and mineralogic information, pertaining to a second find of orthoserpierite in the south wall of the 1060 Pillar, 430 Level, at approximate mine coordinates 1060N, 1210W. Several kilograms of the assemblage containing orthoserpierite were collected, but the species was confirmed on only a single specimen. The collecting site is now flooded.

The orthoserpierite occurrence is located near the junction of the Crossmember with the East Branch of the West Vein, where high grade Brown Ore to the west is in contact with lean Black Ore to the east. The contact strikes about N30W and dips 45 degrees NE. It is transitional over a thickness of about 0.3 m.

Lithologic descriptions of Sterling ore types are found elsewhere (Metsger *et al.*, 1958), but it is necessary to this discussion to note features of local Black Ore. At the site Black Ore consists of disseminations in about equal proportions of medium to coarse grained, anhedral to subhedral franklinite and black willemite in bands, averaging about 10 cm in thickness, hosted by very coarse grained white calcite. Ore minerals constitute about 20% by volume of the assemblage in each band. Individual ore mineral bands are separated by intervals of barren calcite, as much as 0.8 m in thickness. Banding is subparallel to the contact between ore types.

In one ore mineral band about 0.6 m east of the contact, chalcocite forms rinds on franklinite grains and patches in calcite. Irregular solution cavities are also developed in the calcite of the band, surfaces of which are partially coated with secondary rhombic calcite, an iron oxide mineral, and malachite. Cutting both ore types in the contact area is a single fracture, which strikes about N20E and dips 60 degrees SE. Within Brown Ore on the south wall of the drift the fracture is filled with



Figure 1. Friedelite veinlet with oxidized copper minerals cutting Brown Ore in south wall, lense cap is 5 cm in diameter.

friedelite and oxidized copper minerals (Figure 1). The veinlet filling averages about 5 mm in thickness and is vuggy in part. The fracture continues across the ceiling and into the north wall in Black Ore. Friedelite filling is absent in the Black Ore, but oxidized copper minerals appear again in solution cavities in calcite in the ceiling (Figure 2), where the fracture cuts the ore mineral band containing chalcocite.

Orthoserpierite is restricted to the friedelite veinlet in Brown Ore of the south wall. Samples of the assemblage were collected about 1 m above the floor of the drift and 0.2 m west of the contact. Orthoserpierite occurs as bright green-blue, rectangular prisms, often bent or kinked, as much as 0.5 x 1.0 mm in cross-section, but averaging about 0.15 x 0.4 mm (Figure 3). The phase is associated with abundant fibrous aurichalcite on the single specimen, the two species occurring in vugs in friedelite. Other samples from the same veinlet contain malachite and hemimorphite in addition to aurichalcite. These three minerals also occur in the area of oxidized copper minerals in the ceiling. All species were verified by X-Ray powder photography and X-Ray energy-



Figure 2. Oxidized copper minerals in porous Black ore in ceiling, field of view is about 0.5 m across.

dispersive chemical analysis at the Central Research-Experimental Station laboratories of E.I. DuPont de Nemours & Company. The author wishes to acknowledge Chip Michel and Ellen Ervin for assistance in use of instruments and Nadir L. Jenkins for preparation of the typed manuscript.



Figure 3. Secondary electron image of bent and kinked blades of orthoserpierite in vug in porous friedelite, specimen from collection of author (#9420). Field width is about 0.15 mm.

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Ed. Note: figures 1 and 2 were left-right reversed in production.

FRANKLIN-STERLING HILL MINING TERMS: A PRIMER FOR THE NOVICE

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Mining jargon and mine maps sooner or later find their way into the lives of all true aficionados of Franklin and Sterling Hill minerals. Through a series of illustrative diagrams and discussion, the reader is given a clear path through some of this maze of mining terminology.

For those of you who have been reading *The Picking Table* through the years, or for those newcomers who read back issues, it is inevitable that you run across numerous terms and phrases that recall the hundred-some years of zinc mining in Sussex County. This article was written to help explain some of these terms. Procedures such as slushing, roof bolting and tramping, as well as place designations like 1220 Pillar and 935 Stope will be considered. Now, in the space of a few pages it is impossible to exhaust the mining lexicon, for it took a sharp fellow about five years to learn enough to be considered a 'finish' (*i.e.*, experienced) miner, so we will stick to often-heard terminology in this primer.

To begin with, let's talk about the way the Sterling Hill orebody was mapped by the New Jersey Zinc Company (NJZ). Because distances were measured in feet within the mine, we will employ feet in this discussion as well. To provide a single, consistent method of referring to locations within the mine the New Jersey Zinc Company set up their own coordinate system.

Locations are then referenced by using a set of numbers such as "1220N, 500W, -1410." These numbers are distances in feet north of, west of, and below a point selected as zero/zero/zero, or "000." At Sterling Hill this point was selected some distance off to the southeast of the orebody, and approximately 1000 feet above the surface. As a result, all locations within the mine can be simply expressed as a negative elevation, a positive distance north, and a positive distance west. It should be noted, however, that measurements using this system do not follow geographic north or west. Instead, the company chose to align mine north with the predominant strike of the orebody. As a result, mine north is some nineteen degrees *east* of true north (at Franklin mine north is approximately 23 degrees east of true north). This poses some potential for confusion, so it is best to keep the distinction clear. Unless stated otherwise, in this discussion we will use the NJZ system of orientation. At Sterling Hill place designations such as crosscut, pillar and stope numbers are all made using this coordinate system. This said, we are now ready to view some maps and discuss some of the mining operations.

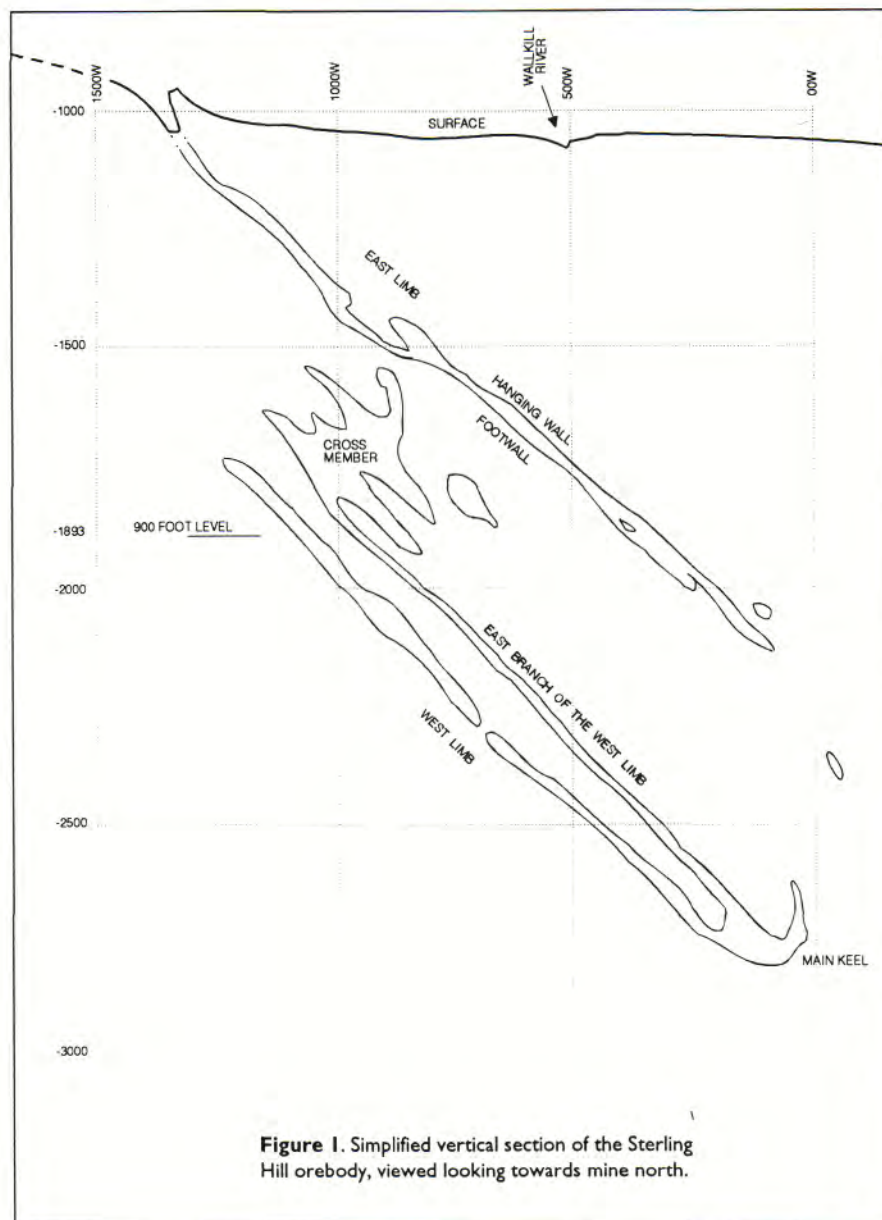


Figure 1. Simplified vertical section of the Sterling Hill orebody, viewed looking towards mine north.

Let's look at the way the ore lay in the earth. Figure 1 shows a cross section of the Sterling Hill orebody. Several major faults offset the ore but they have been omitted to simplify the diagram. This is a vertical plane (or "section") oriented east-west on the mine coordinate system (geographically N74W). This cross section is approximately perpendicular to the length of the orebody, and the land surface appears at the top of the figure. The view is mine north or looking some 19 degrees east of *true* north, and eastwards is to the right. The uppermost band of ore to the right at any given depth is called the East Limb; West Limb ore is to the left. The East Branch of the West Limb connects the mass of the Cross Member to the West Limb. There were several keels to the orebody; the Main Keel is the major fold where East Limb becomes West. Because the Sterling Hill orebody is inclined from the vertical, each limb has a "hanging wall" and a "footwall." The hanging wall is the body of country rock

hanging over the miners' heads after the valuable ores have been removed (in this view it lies to the right). The footwall is to the left of the ore here and is *underfoot* when the orebody has been mined.

The accompanying numbers such as -1000 and -2000 are New Jersey Zinc Company elevation coordinates. An example included in Figure 1 is "-1893," which corresponds to about 893 feet below the surface or the 900 foot Level. In practice, however, the elevations of most mineral finds are referenced by the number of feet above or below the nearest mine level; *e.g.* "30 feet below the 1200 foot Level." Each level is made up of extensive horizontal workings, tracks for ore haulage, and a shaft station for transport of ore, men, and equipment to the surface. The levels are roughly analogous to the floors in an office building, and at both the Franklin and Sterling mine are generally placed at intervals of 100 feet vertically.

Coming around to Figure 2, a segment of the Franklin orebody is represented. This view is a plan, or map view of ore in the central portion of the West Limb on the 700 foot Level. Note the Palmer, or main Shaft. The orebody at Franklin, like that at Sterling Hill, is inclined; the hanging wall in this figure is to the right and the footwall is to the left. The ore, the shaft and their enclosing rocks all dip to the right. Cross-hatched areas are stopes already mined when this map was drawn. These are separated from one another by pillars, or units of ore left in place for support; these were to be mined later. Now notice unmined ore divided into numbered segments nearest the Palmer Shaft. This area is part of what is known as the Palmer Shaft Pillar. It lies above the Palmer shaft and was not mined until the end of the Franklin mine's operation in order to protect the shaft from collapse. When the Palmer Shaft Pillar was removed during the last stages of mining at Franklin, the famed lead silicate assemblage was rediscovered (some 50 years following the original find at the Parker dump). The numbers are pillar numbers by which the working places were known. The coordinates shown were used by and known only to the engineering department of the New Jersey Zinc Company.

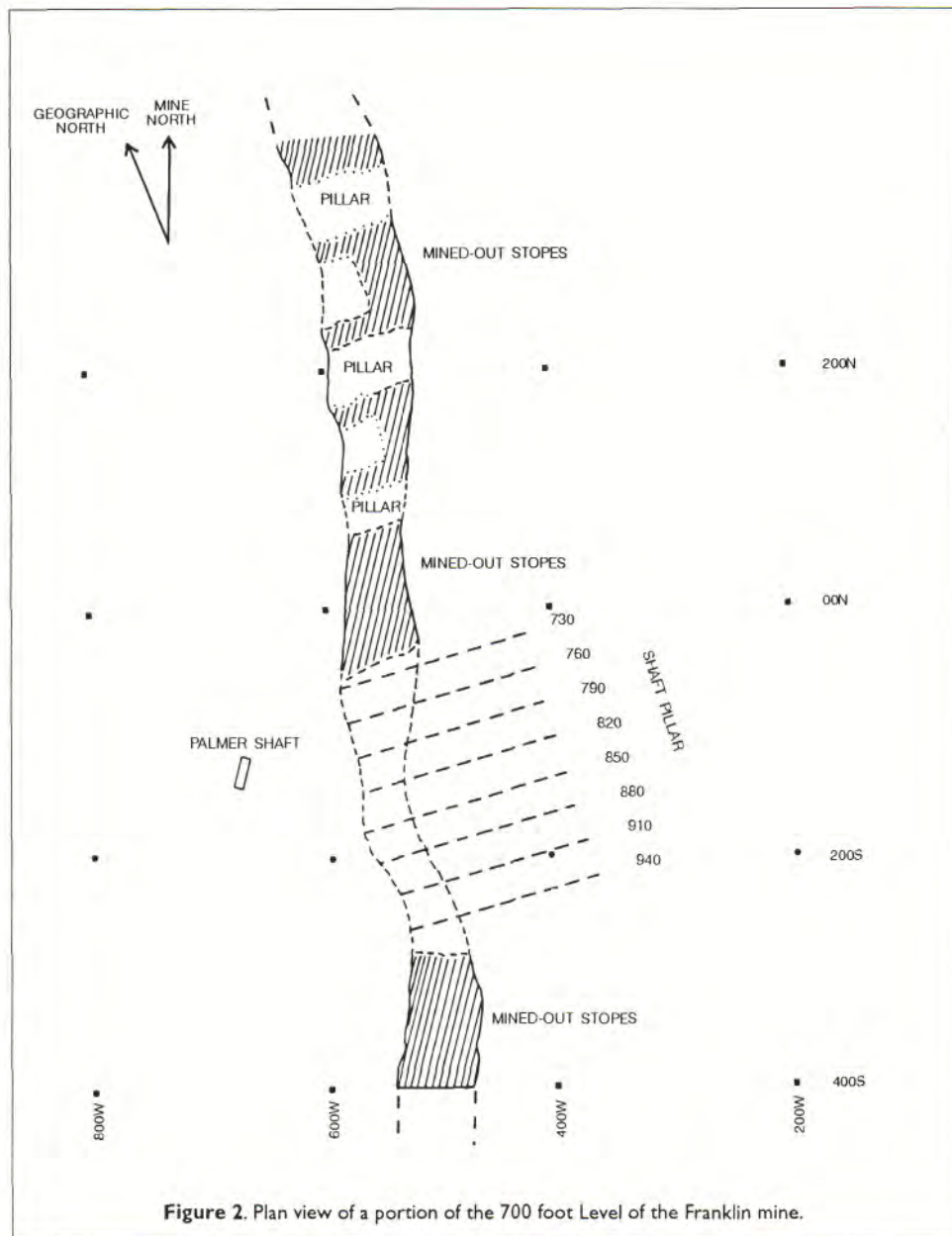
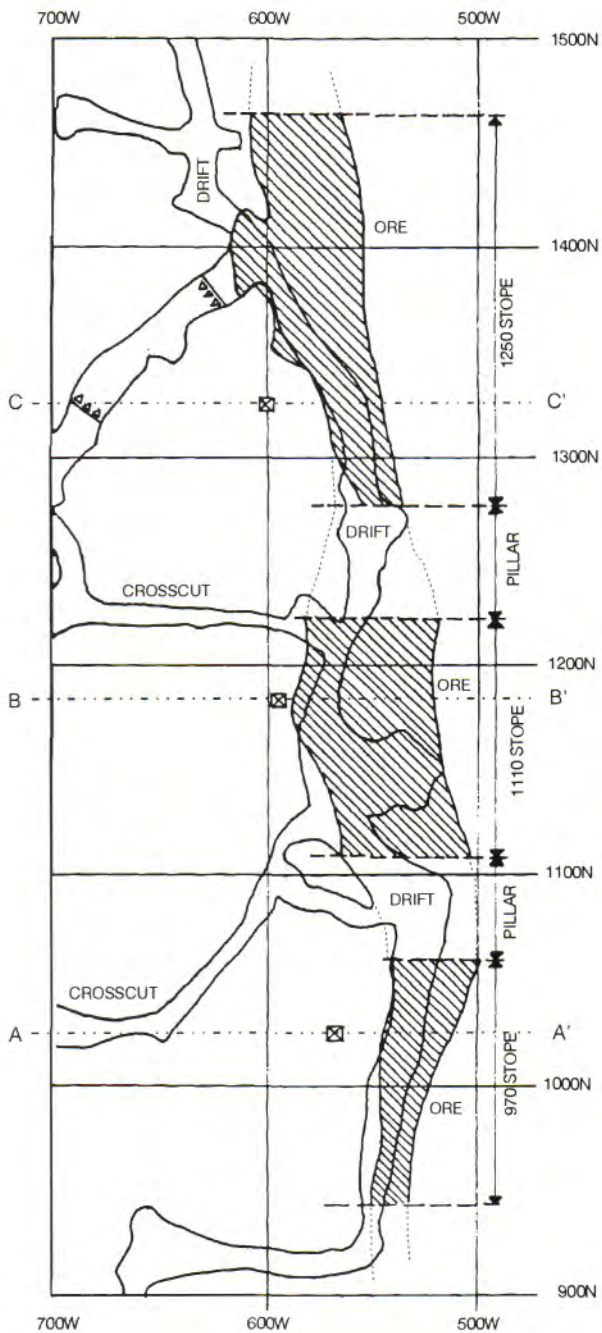


Figure 2. Plan view of a portion of the 700 foot Level of the Franklin mine.

Now let's move on to Figure 3. This shows several views of a segment of Sterling Hill's East Limb. On the left side of the opposite page is another plan (map) view or horizontal sheet view of part of the 900 foot Level. North is to the top of the page. Note the north and west mine coordinates. The numbers are distances in feet based on the mine coordinate system. The narrow tunnels are called drifts and crosscuts, and are in and near the limb of ore. The crosscuts slice across the ore, while the drifts parallel it. Cross-hatched areas are "to-be-mined ore." Three stopes shown here as to-be-developed are the 970, the 1110, and the 1250. Each number indicates feet north from the 00 mark of the mine to the southernmost point in the stope on the specific level at which it was first opened. In other words, the 970 Stope is a stope which, on the level it was begun, had a southernmost opening some 970 feet north of mine coordinate 00. These stopes are separated by

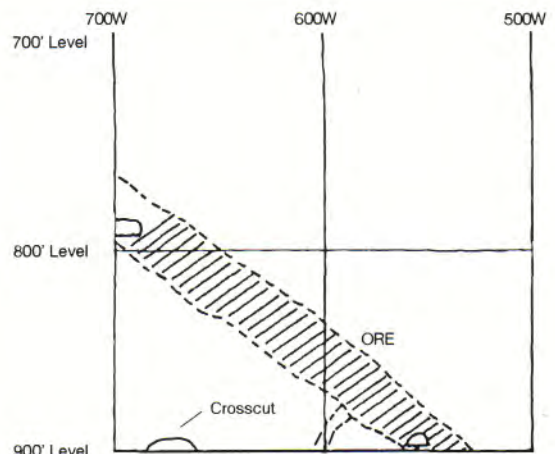
small pillars; commonly these are numbered in the same manner. Note also that in this plan view the hanging wall is at the right of the page, while the footwall is towards the left.

At the right side of the page are three cross sections or vertical sheets looking north, and showing cross-hatched ore cut by ovoid drifts. These three vertical sections intersect the plan view roughly along lines A-A', B-B' and C-C.' The correspondence between the sketches isn't exactly precise, but take some time to view the relationship between them. Raises, or inclined up-down passages, are seen in the sections as diagonal extensions from the drifts to the ore, and are shown in the plan view as small boxes with "x" marks. If you are able to visualize the correspondence between the sections and the plan view in Figure 3, you are well on your way to understanding mining maps.

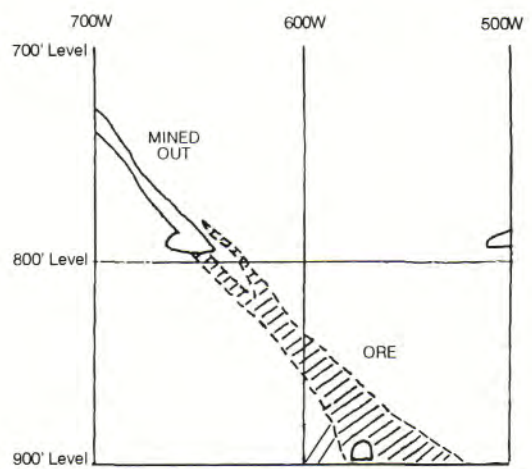


PLAN, OR MAP VIEW OF A PORTION OF THE 900 FOOT LEVEL

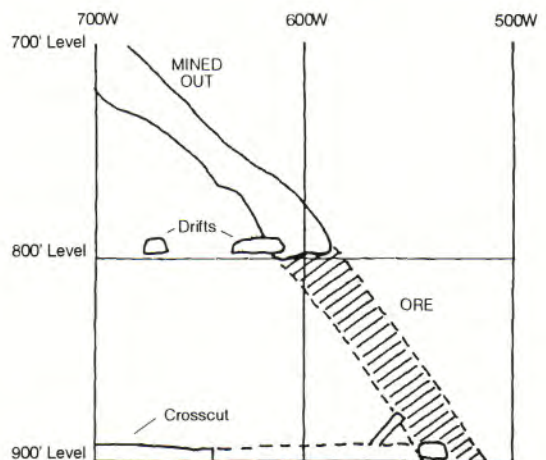
Figure 3. Plan view and related vertical sections of an area in the Sterling mine. Raises on the plan view are shown as boxed "x" symbols.



SECTION C-C' THROUGH CENTERLINE OF 1320 NORTH



SECTION B-B' THROUGH CENTERLINE OF 1180 NORTH



SECTION A-A' THROUGH CENTERLINE OF 1020 NORTH

VERTICAL SECTIONS A-A', B-B' AND C-C'

Figures 4-7 show several aspects of the mine as well as mining technique as practiced in later years at the Sterling mine. Figure 4 is a vertical section of a drift showing its "ribs" and "back" the mining equivalents of the walls and top, respectively, of a tunnel. The light-gauge rail used underground rests on "ties," or blocks made of wood or cement for support. Figure 5 is a plan view and illustrates the difference between a drift and a cross-cut. The drift can be seen to follow the ore while the crosscut slices across the orebody.

Figure 6 is a vertical section of an ore vein looking North, and shows a stope in the process of being mined from an 800 foot Level drift up to an unseen 700 foot Level passage or drift. In this sketch it has progressed about halfway. Below, the stope is mined out and filled with concrete (in earlier times tailings and waste rock were used) down to the 800 foot Level. Above is unmined ore. Broken ore in the stope, known as "muck," is passed down an inclined passage through the fill known as a "crib," and into a chute for loading into tram cars. It is then carried by rail to the ore pass. The latter is a large raise or steeply inclined passage for storing ore and conveying it to the underground crushers, which are located on the 1100 and 1920 foot Levels. There it is broken up further so as to increase the hauling efficiency of the "skips." Skips are ore cars with a seven-ton capacity (at Sterling Hill) that haul ore up the shaft from the crusher's loading pocket to the surface. Another passage through fill is the manway pipe (not shown in the diagram), which is used for access by workers from below. This matches a raise (or two) above the stope through solid ore up to the level above. Both passageways have ladders.

Figure 7 illustrates a stope in operation. Broken ore forms the muck pile, usually 10 to 20 feet in height. The fresh surface above the ceiling of the open stope is scaled for "loose" with a pry bar to knock down chunks and is then roof-bolted. This process consists of inserting three-, six-, or eight-foot long steel

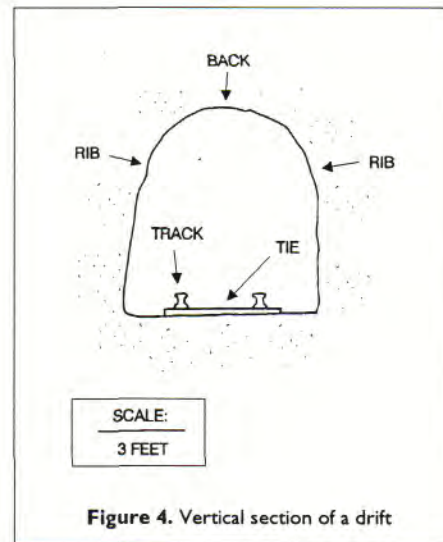


Figure 4. Vertical section of a drift

bolts and plates into a specially drilled hole. The bolt is then tightened against the plate and the rock face beneath. This minimizes rock falls. At the other end of the stope a scraper (Franklin parlance) or slusher (Sterling-speak) motor pulls alternately on two or three cables, thereby moving a heavy steel bucket back and forth over the muck to pull ore into the crib leading to the chute below. Here again, ore cars and an electric motor (locomotive) carry or "tram" it to the ore pass. The muck falls to a crusher, is dumped into a skip and is hoisted quickly up the shaft to the mill on the surface.

This then has been a whirlwind tour of "mining jargon." It is cursory, of course, but an in-depth study isn't necessary to understand most mining terms commonly encountered by a mineral collector. Since there were many different types of mining at Franklin and Sterling Hill over the years, only the most

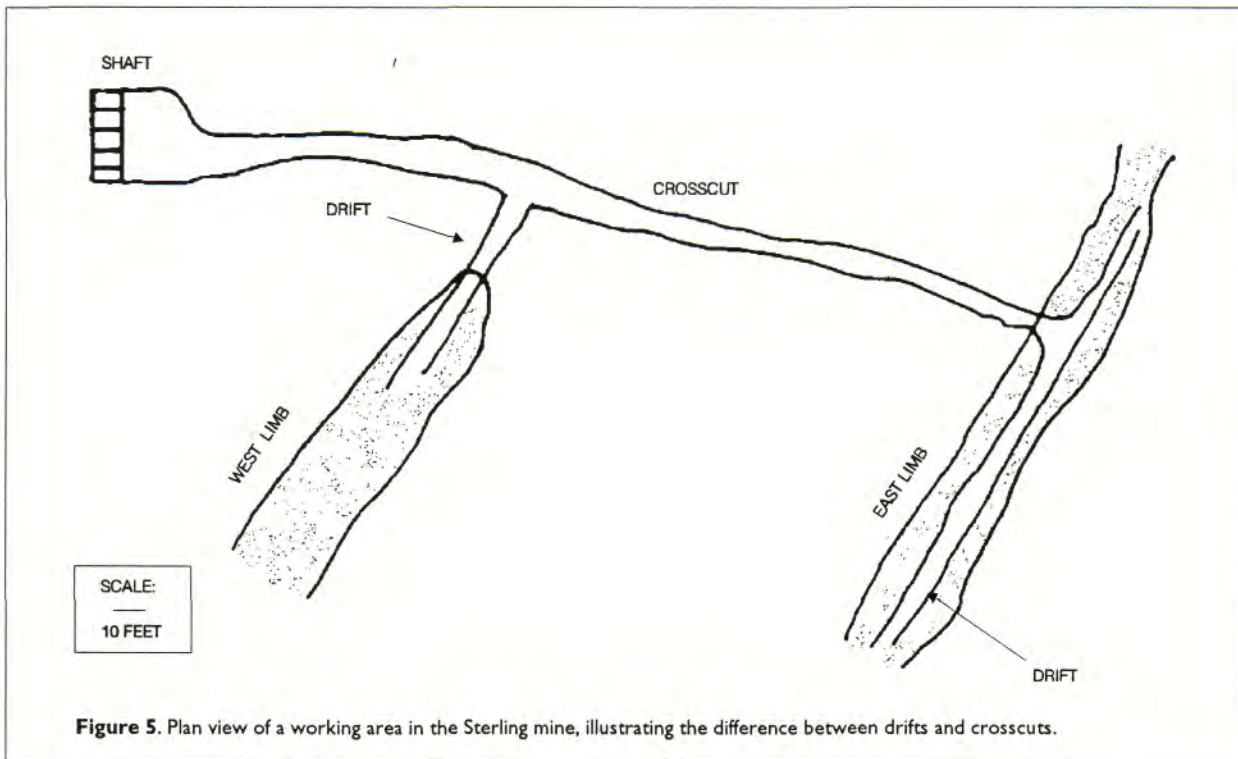


Figure 5. Plan view of a working area in the Sterling mine, illustrating the difference between drifts and crosscuts.

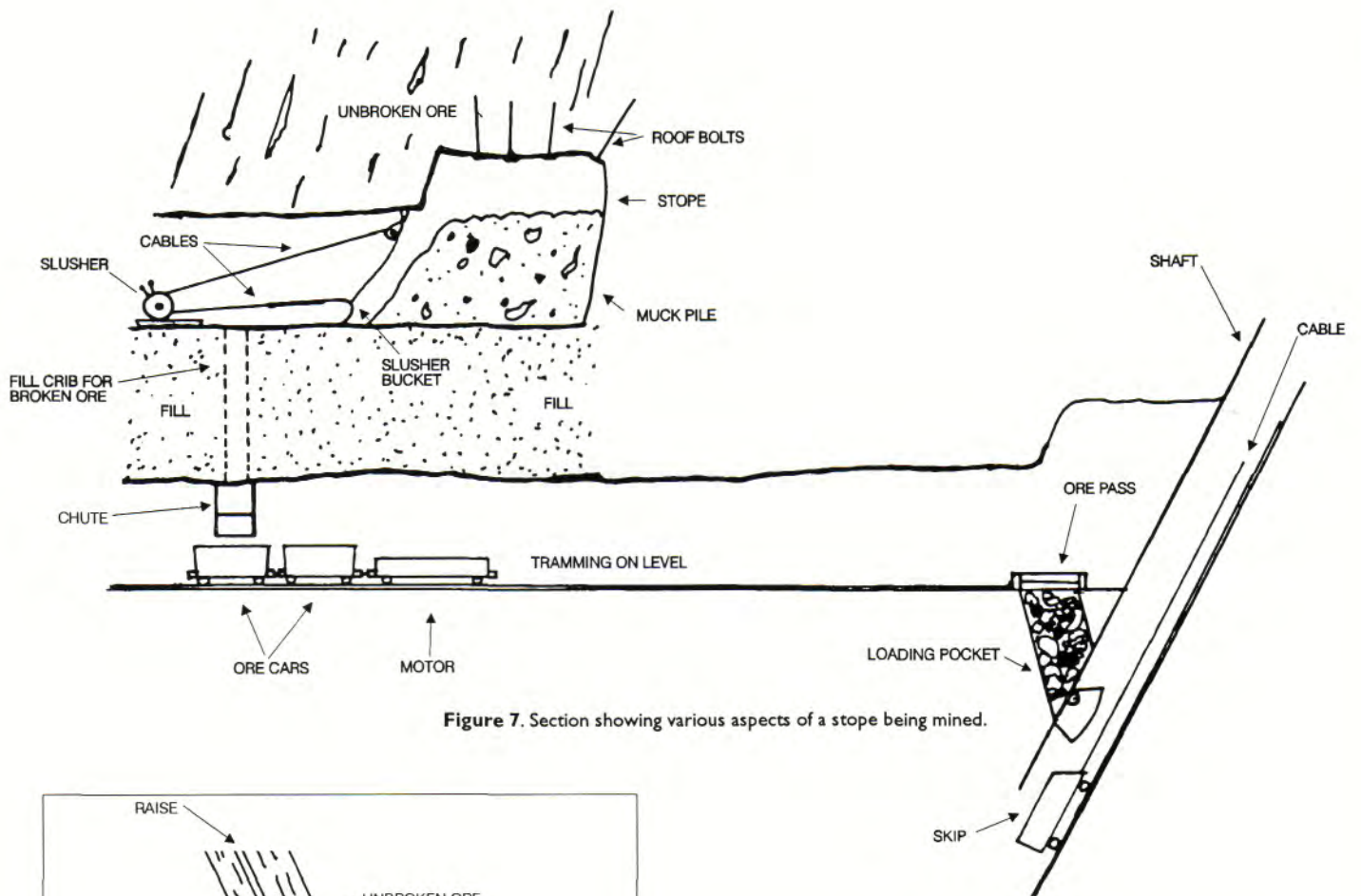


Figure 7. Section showing various aspects of a stope being mined.

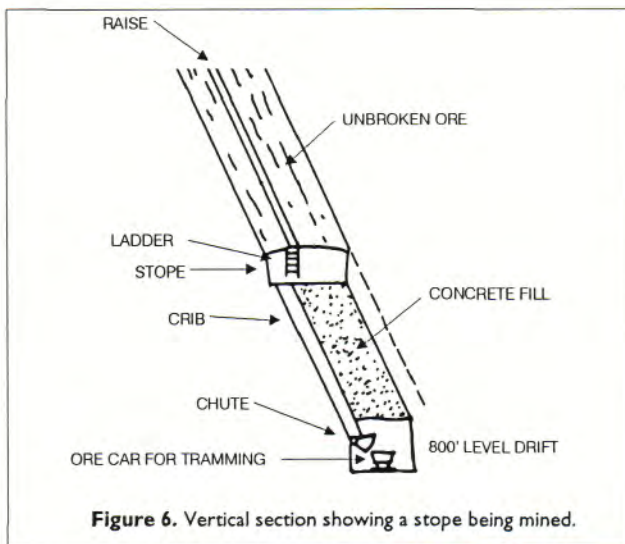
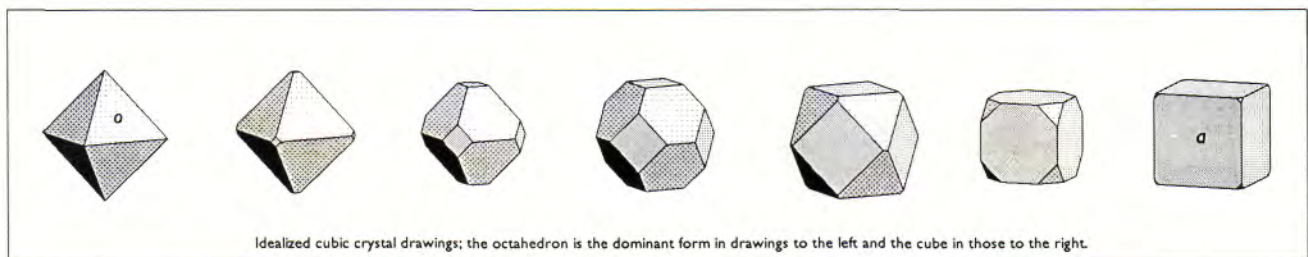


Figure 6. Vertical section showing a stope being mined.

recent were considered. However, a general feel for the miners' phrases can be gleaned.

ACKNOWLEDGMENTS

Inspiration for this article comes from Dr. Pete J. Dunn. Figures 1-3 are based on diagrams taken from New Jersey Zinc Company records in the archives of the Franklin Mineral Museum. My thanks to John L. Baum, FMM Curator, for providing access to the archives. Line drawings for Figures 1, 2, and 4 are the work of Steve Misiur. Also, the author wishes to thank Earl Verbeek, Dick Bostwick, and Omer Dean for their valued suggestions and help.



Idealized cubic crystal drawings; the octahedron is the dominant form in drawings to the left and the cube in those to the right.



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THE RESURRECTION OF STERLING HILL

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Locality preservation, only a conceptual ideal for many, is in vigorous practice at Sterling Hill in Ogdensburg, New Jersey. Private investment and inspiration, legions of volunteers, and dedicated leadership are preserving a famous locality. The Sterling Hill Mining Museum is operational.

INTRODUCTION

Located in the New Jersey Highlands, some 45 miles from New York City, are the two most unusual and enigmatic mineral deposits on our planet. The closely related Franklin and Sterling Hill orebodies are located in the boroughs of Franklin and Ogdensburg, respectively, in Sussex County, New Jersey. These orebodies are exotic in many ways; foremost among these is the abundance and unique association of the primary ore minerals: willemite, franklinite and zincite. The deposits are host to more than 330 minerals (a mineralogical record), which is approximately 10% of all known species; Franklin and Sterling Hill are the type localities for 67 species (also a record), about half of which are found nowhere else. These include species with names drawn from the local area, such as ogdensburgite, minehillite, franklinfurnaceite, kittatinnyite, sussexite, wallkilldellite, sterlinghillite, hardystonite and others. The deposits are renowned for their fluorescent minerals; over 70 species found there exhibit fluorescence under ultraviolet radiation. The deposits' reputation for well-crystallized specimens, unique assemblages, brightly fluorescent minerals, giant crystals, rare and exotic species, and a very colorful mining history, ranks them first among the mineral localities most interesting to the very serious collector.

This article is a partial reprint from the Mineralogical Record, vol. 22, Sept.-Oct. 1991, pp. 367-376. All of the text and figure 1 appear here. Please refer to the original article for all other figures.

The Franklin mine closed in 1954 and only scattered structures remain of operations there. The Sterling mine closed in 1986, and might have suffered the same demise. However, herculean efforts have been made and are still underway to preserve as much of the mine as can be saved, and the property has been converted into a mining museum.

It is not the purpose of this paper to provide detailed descriptions of the history, geology or mineralogy of the Sterling Hill deposit, but rather to provide a general framework for understanding the importance of the Sterling mine's preservation and the tour offered there. Historical aspects are still being researched; the given information is based on what is presently published, and may be changed as new information is developed. Because there are very few large, deep mines in the East, and no deposits like those at Sterling Hill and Franklin elsewhere on our planet, the preservation of Sterling Hill is a very important undertaking to scientists, collectors and historians alike.

EARLY HISTORY

The Sterling Hill and Franklin deposits have an extensive and colorful history, only a very small part of which is related here. Much of the local history pertains to both deposits, and Franklin was clearly dominant until 1954, but the following partial historical summary is written with an intentional focus on Sterling Hill.

The earliest discovery of the Sterling Hill orebody is shrouded in speculation. The orebody had been exposed by erosion, probably during the late Precambrian (there is proof of

this at the neighboring Franklin deposit) and was again denuded by Pleistocene glaciation. The massive east limb of the deposit was boldly exposed on the wall of the beautiful Wallkill Valley, and must have been obvious to any passersby. The local Indians, a tribe of the Lenni Lenape, visited the valley and were most likely aware of the deposit, which had colorful rocks on the surface unlike those found anywhere else in their domain (indeed, in the world!). The Lenni Lenape might well have been the first human discoverers, and the first local mineral collectors as well; lennilenapeite is named in their honor.

It has been suggested by Farrington (1852) that the Sterling Hill deposit might have been found, tried, and found lacking by Dutch miners who were sent as prospectors by their Governor in 1624, and who had entered the nearby Minisink Valley by 1640. Presumably they might have found the Sterling Hill deposit while wending their way up each river valley as they moved inland from the Hudson River, and up the connecting Wallkill River which drains both the Franklin and Sterling Hill deposits. The Dutch mined copper ore at Pahaquarry, near the Delaware Water Gap, and might also have tried the Sterling Hill ore for copper (Farrington, 1852). Although no records remain of the probable Indian or Dutch efforts, speculations regarding them are reasonable conjecture and consistent with local legends and folklore.

Although early 18th century land records reportedly refer to a "Copper Tract" in or near the area now known as Sterling Hill, copper was not economically recovered here. The abundant, then-unnamed zincite, however, could well have been mistaken for cuprite. Also, there are some secondary copper minerals exposed locally at the surface, and these might have been more abundant in historical times. A 1749 survey mentioned "old mine holes," later described by Alger (1845) as crude shafts some 5 or 6 meters into the marble; Farrington (1852) also reported old shafts and mining galleries there. Dendrochronological studies of a red cedar tree growing in the ancient pits dated the pits to *not later than* 1739 (Jackson, 1852; Farrington, 1852). Lord Stirling (William Alexander) owned or leased part of what is now Sterling Hill between 1761 and 1776, and attempted in vain to use the ores. In 1772 several tons of "red ore" (later named zincite) were shipped to Swansea in Wales for smelting, but this effort was unsuccessful as well.

The true nature of all three of the abundant primary ore minerals at Sterling Hill was then wholly unknown to science. The chemical composition of zincite was determined in 1810, and those of franklinite and willemite in 1819 and 1822, respectively. It is important to realize that the exploitation of the ores here went hand-in-hand with the development of the sciences of mineralogy, petrology and economic geology; with the development of the zinc and zinc-based paint industries; and with the growth of the United States as a nation.

THE STERLING HILL ORE DEPOSIT

The orebody at Sterling Hill is completely encased in the Precambrian Franklin Marble, as is its sister-deposit at Franklin, some 3 miles north. The deposits were strongly metamorphosed approximately 1 billion years ago, and the original mineralogy is unknown. The orebody is chemically and mineralogically zoned, but its detailed geology has not been described; only general relations appear in the literature (Metsger *et al.*, 1958). The ore, while deeply buried, is inferred to have sunk through the less-dense marble (Metsger *et al.*, 1969), and to have been strongly folded during the sinking process.

The orebody is shown in Figure 1. It has a hook-like surface expression and at depth has the general form of a syncline,

plunging 45° to the east-northeast. According to Metsger *et al.* (1969), the orebody is:

a complex series of attenuated isoclinal folds, which modify the west limb of a larger, but similarly attenuated, isoclinal syncline. Structures in both the ore and the infolded wallrock demonstrate extreme plastic deformation during folding. The structural complexity of the ore body is much greater than that of the surrounding region.

It is not our intent to describe the geology of the deposit in detail; its structural complexity precludes any simple description.

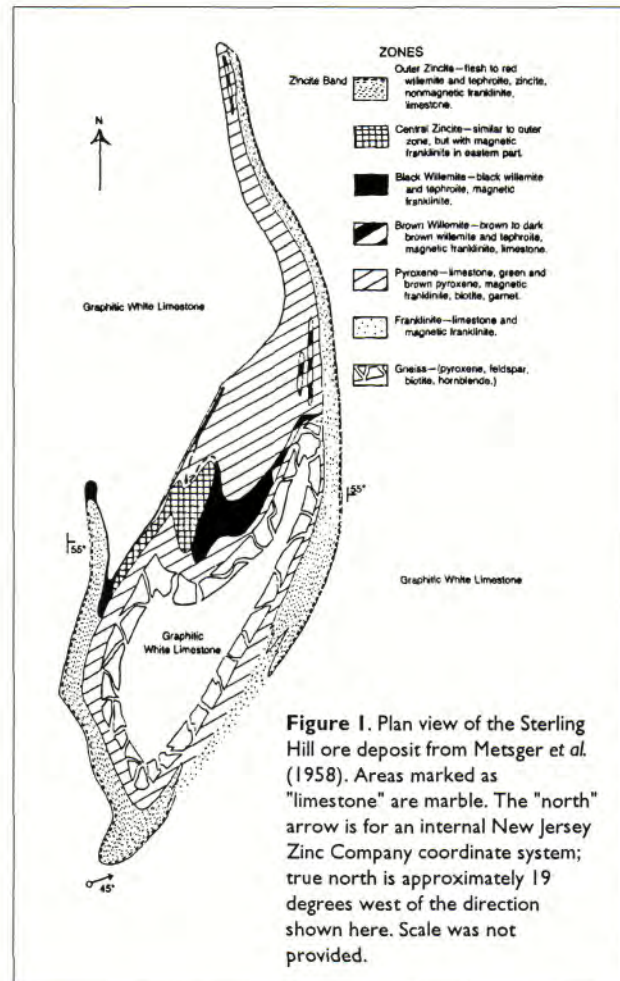


Figure 1. Plan view of the Sterling Hill ore deposit from Metsger *et al.* (1958). Areas marked as "limestone" are marble. The "north" arrow is for an internal New Jersey Zinc Company coordinate system; true north is approximately 19 degrees west of the direction shown here. Scale was not provided.

The surface manifestations of the orebody, as encountered by a visitor, are a long east limb, a shorter west limb, and a cross-member nearly connecting both limbs. Much of the geology of the orebody is still discernible at the surface; in part, it can be studied in place, even today. It is a spectacular resource for scientists and collectors alike.

MINING AT STERLING HILL

As Sterling Hill, as well as at the nearby Franklin deposit, there has been a long history of numerous small, uncoordinated mining operations; many passed into obscurity without a trace. For the purposes of this limited discussion, it is convenient to consider Sterling Hill mining in three distinct phases which overlapped in time. These are: mining of iron ore; mining of

secondary, mostly surficial zinc deposits; and mining of the primary zinc ores.

Mining of Iron Ore

Although Sterling Hill is a zinc deposit with franklinite, willemite and zincite as the primary ore minerals, there was a period of iron mining. The franklinite ore at the extreme southern end of the deposit is anomalous; it is zinc-poor and iron-rich, and was mined as an iron ore from about 1877 to 1882. Approximately 45,000 tons were mined in the first two years. The ore was obtained from the deposit at the east side of its southernmost keel, near where the two limbs of the deposit join, and near the Noble mine which was worked for hemimorphite (locally called calamine), as discussed below. The iron ore was removed in part through a 97-meter haulage tunnel through the east side of the hill; the opening of this tunnel is still visible from Plant Street. The ore, although low in zinc, was still franklinite (not easily smeltable then in pure form), and could only be simply processed if mixed with other iron ore (such as locally abundant magnetite) in a proportion not exceeding one-fifth of the total furnace charge. As mining progressed, however, the ore became increasingly zinc-rich and thus (at the time) unusable; iron-mining operations were then permanently suspended.

Mining of the Secondary Zinc Deposits

Deposits of hemimorphite overlying the orebody, and mined from open pits, were known to Dr. George Cook, the State Geologist, prior to 1864; but nothing is known of their discovery. The smaller of these pits was between the orebody limbs, over the southernmost bend in the orebody, and was called the Noble pit or Noble mine. It was worked from 1860 to 1870 for hemimorphite and later, as noted, for iron-rich franklinite.

The larger pit, north of the Noble mine, was also situated between the east and west limbs of the orebody, and south of the cross-member. It was called the Passaic pit or Passaic mine and was worked by the Passaic Zinc Company. Hemimorphite was mined in great abundance here and was washed free of mud in a primitive, on-site log-washer. Specimens of this white, lustrous, rough-surfaced hemimorphite have been distributed worldwide, and were referred to as "calamine" and "maggot-ore." The name "Passaic mine" was also applied to the concurrent mining activities of the Passaic Zinc Company in primary ore.

Sterling Hill is well known for enormous crystals (tens of centimeters) of augite (jeffersonite), fayalite (roeperite), gahnite, franklinite and other minerals. These were first found at the surface, in the weathered material in the open pits, and have since made their way into collections around the world.

Mining of the Primary Zinc Ores

Early efforts

Organized mining of the primary zinc orebody was undertaken prior to the exploitation of the calamine pits, by the Sussex Zinc and Copper Mining and Manufacturing Company and the New Jersey Exploring and Mining Company. These firms merged and were acquired by the New Jersey Zinc Company in 1852; in 1880 the name of the company was changed to the New Jersey Zinc and Iron Company. These companies operated the first underground workings to be known as the Sterling mine, located in primary ore on the northern part of the east limb of the orebody. Mining continued sporadically, possibly until 1896; the published record of operations is incomplete (Shuster, 1927).

In the same general area, a shaft referred to as the Pierce shaft was in place by 1868 and, like the Passaic Zinc Company's

operation, had its own engine-house and blacksmith shop. It was likely operated by the New Jersey Zinc Company.

Early holdings of the Consolidated Exploring and Mining Company were acquired by the Passaic Mining and Manufacturing Company (later renamed the Passaic Zinc Company), which mined primary ore both at the southern end of the east limb and along the west limb; they also mined hemimorphite in the Passaic pit. Later, the Passaic Zinc Company sunk a 152-meter shaft, known as the Marshall shaft, in the primary ore of the east limb, and operated small crushing mills.

Thus we find that there were periods when three separate mining companies operated here simultaneously. For example, in 1868 the New Jersey Zinc Company was mining primary ore along about 150 meters on the north end of the east vein; the Passaic Mining and Manufacturing Company was mining primary ore on an equal portion at the southern part of the east vein; and a Mr. Noble was mining secondary ore at the bend at the convergence of the veins. There were numerous other shafts and openings, but they were unnamed for the most part. On-site transportation of ores was by company-owned cable and rail trams.

The Sterling Hill properties, together with those at Franklin, were unified in what was called The Great Consolidation in 1897. This ended an extended 40-year period of litigation and resulted in the unification of the competing mining interests at Franklin and Sterling Hill under one umbrella company, the second New Jersey Zinc Company. Henceforth all the former operations at Sterling Hill were referred to collectively as the Sterling mine, a term that had previously been of more restricted use, as noted above.

Post-consolidation mining

After the 1897 consolidation of the various mines and entities, attention turned to the larger deposit at Franklin. There, after a period of deliberation by the new company, a new shaft (the Palmer shaft) replaced the Parker Shaft, and a new mill (Mill #2, or the Palmer Mill) replaced the Parker Mill (Mill #1). Both were completed by the end of 1910.

There was apparently very little activity at Sterling Hill during this period (1896-1910), and the mine was full of water in 1901. Once the Franklin operations were well underway, however, organized activity returned to Sterling Hill, and exploratory drilling commenced in 1910. A new shaft was developed and a new concentrating mill, was constructed between 1913 and 1915. This new shaft, which reached a depth of more than 564 meters, was known by several names (Operating shaft, East shaft, and later, the Old shaft). The concentrating mill, known as the Sterling Mill, was modeled after the new mill at Franklin. The Sterling Mill processed 450 tons of ore per day to produce ore concentrates, which were then shipped by rail to Palmerton, Pennsylvania, to be processed into zinc metal (spelter), zinc oxide and other products.

Mining in the last 40 years

Franklin was the larger deposit, and was more easily worked; thus it continued to draw most of the local attention and resources of the New Jersey Zinc Company until the mine was exhausted and closed in 1954. As the demise of the great Franklin mine approached, increasing attention was focused on the Sterling Hill deposit.

Starting in the late 1940's, and continuing until the late 1950's, the New Jersey Zinc Company refurbished the Sterling mine, adding a new crushing mill, shops, headframe, hoist-house, conveyor, loading and shipping equipment, and a new five-compartment shaft (the West shaft, or the New shaft). The

West shaft was accessible not only at the surface (headframe area) but also through an adit driven 137 meters west into Sterling Hill. Additionally, another shaft was developed underground (the North shaft), which operated from the 564-meter (1850-foot) level to a depth of 830 meters, well below the bottom mining level (785 meters), to exploit a deep northward extension of the orebody, called the north orebody.

Economic factors, including a drop in the price of zinc, resulted in a slowdown, and the mine was shut from 1958 to 1961. During this time, much planning was done and the method of mining was changed. The new facilities became fully operational in 1961, and the mine continued in operation until its eventual closing in 1986.

After these improvements in the facilities, the Sterling mine's ore was subjected only to on-site bulk-crushing and pulverizing, and then shipped unsorted to the New Jersey Zinc Company's processing facilities at Palmerton, Pennsylvania. The East shaft was abandoned and used only for ventilation, and the old Sterling Mill was subsequently demolished.

CLOSING

The Sterling mine was operated at a near skeleton-staff level in its last years, in part due to the low price of zinc and in part due to numerous other economic and mining factors. The mine was closed on the eve of Good Friday, in March of 1986. The workings were dismantled in late 1987, and the shafts were capped in early 1988.

The company had been embroiled in ongoing property-tax disputes with the Borough of Ogdensburg for years and this legal activity played a pivotal role in the mine's closing well before it was exhausted. The story has been partially told from the perspective of the Borough's mayor (Horuzy, 1990). The details of the dispute need not be described here, but it can be said that misjudgments were made. In April of 1988 the Borough took title to the property by foreclosure and entered into a period of deliberation as to the disposition of the property. After lengthy consideration, it was decided to sell the property at auction.

ACQUISITION BY THE HAUCK BROTHERS

On March 7, 1989, the Borough of Ogdensburg auctioned off the approximately 70-acre lot, having partitioned it into a nearly 40-acre undeveloped woodland parcel and an approximately 30-acre parcel containing the Sterling mine. The undeveloped non-mining area was purchased by Ahmed Elbarki for \$665,000, and the Sterling mine and its various above-ground facilities were purchased for \$750,000 jointly by Richard Hauck and Phillips Enterprises. Subsequently, the Sterling mine parcel was partitioned further, part being divided off to Phillips Enterprises, Ltd., which now owns the top of the hill, including the former hoist-house, crushing building, and various shops. The Hauck brothers, Richard and Robert, who formally took title to the mine property on June 16, 1989, have retained the mine workings, adits, shafts, open-pits, ore-loading bins, core-shed, mine office, the administration building and change-house on Plant Street, and the headframe structure on top of the hill. In 1989, the Sterling Hill Mining Company was formed, and a massive and vigorous effort to preserve this mineral locality commenced.

RESURRECTION

At first there was euphoria, a surge of joy in the mineral community seldom experienced in the local area as uniformly as it was then; the whole local *mineralculture* celebrated. At last there was real hope that the same fate would not befall Sterling

Hill as happened at Franklin, only a few miles north, where only remnants remain of a once-great mining and milling operation. After the well-deserved celebrations, the work began.

All was not sweetness and light. The New Jersey Zinc Company had recovered some of their capital by selling off many salvageable assets. At the surface much of the mining equipment was gone, but some would be recovered later underground. The physical plant that remained was in poor condition; the immediate challenges were daunting and great efforts were needed just to preserve the infrastructure and basic necessities. The capital improvements needed immediately included new roofs on half the structures, new heating systems for surface buildings, and a totally new electrical service to the mine site itself, with much rewiring to provide full electrification of the facilities. Also needed were new connections to the local water system, new septic systems and septic fields, and even new roads. All this had to be given priority, ahead of the principal goals of locality preservation. These basic but very costly needs were attended to promptly; full attention and energy were then turned to the more important, awesome, and challenging tasks of redevelopment and the creation of the Sterling Hill Mining Museum.

Like with the physical facilities, the mine was also in need of attention. The entrance to the main adit had been sealed with 20 cubic meters of concrete which had to be painstakingly chopped out, inasmuch as blasting would have damaged the surrounding structures. After much back-breaking labor, the Haucks were in the mine within a week of taking title to the property, and its repair and renovation began immediately.

A COMMUNITY EFFORT

Although it was the motivation, inspiration, hard work and investment risks of Richard and Robert Hauck that led to the successful preservation of Sterling Hill, they did not do it alone, and they are both very emphatic on this point. The credit is widely shared. A great many people stepped forward to help, to work for free, to donate their time, talent and equipment, to prepare exhibits and to assist in funding. The helpers came from near and far, and from all vocations: ex-miners (young and old), geologists, mineral collectors, professionals, business-people, electricians, plumbers, mechanics, mineralogists, community leaders, memorabilia collectors, aficionados of all kinds and, in particular, former zinc company employees, all proud that something of their heritage was to be saved.

This great assemblage of helpers did not merely applaud, wave their arms, or cheer; they dug dirt, smashed concrete, removed debris by the thousands of cubic meters, and they did it together, in unison. They were often knee-deep in rock, mud, muck and grease; they went wherever hard work was needed. They scraped, painted, restored and recovered whole areas previously left to rot and rust away, and they did all sorts of things one would never think of doing for mere money. Together, inspired by the dedicated leadership of the Hauck brothers, they shoved, pulled and energetically wrested the Sterling Hill Mining Museum into existence. Less than 15 months after taking title, the Sterling Hill Mining Museum was opened to the public. When you go there, find some of these helpers (it's easy) and thank them. It's a heritage we can all share.

At present (April, 1991), the pumps have been restarted and the rate of rising of groundwater has been appreciably slowed. The operation is State-certified to discharge pumped water. Present pumping is from a reservoir on the 500-foot level to which the surface inflow is directed. Plans are to use sump pumps to raise water from below the 600-foot level to the 500-foot level reservoir, from where it will be pumped to the surface, thus keeping the mine dewatered to below the 600-foot level. Much

of the geology of Sterling Hill can be studied on and above this level. With pumping, the potential for continued scientific research here is unlimited.

THE MILL RUINS

Earth-moving was needed on a large scale to make this former industrial site accessible to the public and to make the property safe for visitors, as well as to enhance the tour. In the extensive process of earth moving, a long-forgotten basement in the foundation of the original Sterling Mill (built in 1913-1915) was uncovered, along with the top station for the old East shaft. The mill had been razed in the 1960's, covered with rubble, soil and tailings; it had been largely forgotten. The discovery of the mill's basement provided the Hauck brothers with 5 immense rooms, each approximately 5 x 24 meters, totalling over 560 square meters. It was a wholly unexpected bonus! This space and the connected old-shaft station are intended for future development.

THE RAINBOW TUNNEL AND THE RAINBOW ROOM

The main adit, 137 meters in length, ended at the large shaft-station of the West shaft. To provide a greater experience for the visitor, a new 73-meter drift (The Rainbow Tunnel) was driven from a point near the shaft, southward toward the open cut. This effort consumed 2 tons of dynamite fired in 49 shots, and was completed on June 6, 1990. Just inside the egress from this long, new tunnel, a smaller heading was driven westward to intersect the west limb of the orebody. At this point, a small stope or room has been developed within the ore itself. Because the ore (willemite) and its host rock (calcite) are fluorescent, the west limb of the orebody gives a brilliant and colorful response to ultraviolet light. Visitors stand within the mountain, in the midst of the orebody, surrounded by the great vein of red and green-fluorescing minerals and by great boulders of multi-colored fluorescent ore brought here from deeper levels. The effect is truly spectacular on each and every visit.

THE STERLING HILL EXHIBIT HALL

The miners' change-house for showering and changing into street-clothes is located on the lower street-level, on Plant Street. This massive brick structure contains a great cathedral-ceilinged room, 15 by 30 meters, which was totally cleared; its walls and ceilings were sandblasted with over 8 tons of grit to expose the original brick and wood, and it was refurbished. Of over 6 tons of lockers once in place, only a few rows remain, newly adorned with the names of some of those who have helped to make this project happen.

This former change-house is now a fine exhibit hall with over 60 displays of mining memorabilia (local and otherwise), mining technology, minerals, blasting equipment, ultraviolet generators, mining-safety equipment, mining tools, antiques, and equipment for surveying, mineralogy and analysis. There are special exhibits on The New Jersey Zinc Company, the nearby Edison iron mines (an important part of local history) and many more subjects. Mineral specimens have a principal and special place in this exhibit hall. They vary from cabinet-specimens collected long ago at Franklin and Sterling Hill to recently mined boulder-sized ore specimens which will delight geologists and collectors alike.

MINERALOGICAL ACTIVITIES

Not only is the surface level of the mine being restored, but sub-surface levels are being studied by qualified staff and by approved scientific investigators. Research on the deposit, its

structure, geochemistry, genesis, and its minerals is being conducted at the mine and in numerous distant laboratories. Sterling Hill has long been recognized by scientists as a geologically important site, and much work is underway there.

Mineral-specimen preservation operations are conducted by experienced staff familiar with the mine geology. Such operations since the mine was reopened have resulted in the recovery of many hundreds of significant specimens of barite, franklinite, mcgovernite, realgar, zinkenite, stilbite, wollastonite and other minerals, some of them the best of their kind ever recovered from Sterling Hill. Enormous geologic specimens, too, are being collected, permitting the preservation of whole assemblages.

THE TOUR

The tour of Sterling Hill actually begins as one approaches on local routes. The headframe, conveyors and other structures all attract attention from a distance. Upon entering the main gate on Passaic Avenue, one passes an electric tram complete with locomotive and ore cars, which appropriately sets the theme for the museum. High overhead hangs the huge ore-conveyor; to the left stand four 8-story-high loading tanks once full of pulverized ore awaiting shipment.

After parking, one enters the mine-office building atop the site of the old Pierce shaft's blacksmith shop, which has been converted into public-use facilities. It now houses the ticket-office, a food concessionaire (week-ends and peak periods) and a museum-shop. The shop contains, in addition to books and educational materials, souvenirs promoting the deposit and museum, and various tourist items. Most importantly, the mineral collector is not forgotten and ten full vertical cases of mineral specimens are available for purchase from such dealers as Lawrence Conklin, Excalibur, Jim's Gems, Kristalle, Herbert Obodda, and the Sterling Hill Mining Company. The available specimens are from worldwide localities, and especially from the local zinc deposits.

Leaving the museum shop under the direction of a tour guide, one notes that there are also many exhibits outside. Nearby, where the footwall of the east limb of the orebody is in full view, one can see the East (a.k.a. Old shaft), the old mill ruins, and the more recent conveyor and ore-loading facilities, together with over 112 pieces of huge mining equipment.

The tour proceeds underground by entering the well-lit main adit, then passes the old safety exit (an old, now-defunct miners' emergency ladderway to the 1850-foot level), and proceeds to the West shaft. Along the way one passes the lamp-room which houses mining cap lamps, recharging equipment, maintenance facilities and other equipment used by the current staff. Then one arrives at the shaft-station, an immense chamber the size of a barn, and an important focal point of the tour. Here one experiences the scale of the mining operation while observing the immense machinery of the shaft-operations. The visitor is immediately aware that not all exhibits are in the formal exhibit hall; many are on the route, carefully perched and placed for educational and instructive effect. Moving toward the new southward-driven tunnel, one encounters an area where small objects can be tossed through a grizzly (a heavy steel screen for sizing ore), below which they fall with resounding clatter down a huge ore-pass to about the 600-foot level. Further along, one passes a large historical exhibit of approximately 30 large mining drills, dating from 1905 to the present, and the "cap room," once used to store fuses and blasting caps; near this room is a core-drilling exhibit, complete with drill cores, showing how to "read-the-rocks."

The visitor then enters the newly-driven Rainbow Tunnel, which passes through white Franklin Marble, and observes fresh exposures of faults and joints. A bit further along, one enters the magnificent Rainbow Room described above. Dark at first, it soon becomes aglow with brilliant fluorescent colors. Here, most visitors stand in awe. It is difficult to depart. Another new adit, opposite the Rainbow Room, was driven to the east in the winter of 1990-1991 in an attempt to expose more of the orebody. It is 36 meters in length and will be used to illustrate drilling and excavation methods, and provide a darkened area for the examination of specimens which fluoresce in ultraviolet, and which are available for acquisition.

Leaving this fascinating underground walk, one emerges from underground and passes the foundations and ruins of the old mill, leading to the exhibit hall described above. After enjoying all the exhibits, visitors can wend their way back upstairs to the museum-shop and parking area. The tour may start at different places along the way, due to weather or other local conditions, but will cover the same ground and exhibits.

The tour takes approximately 90 minutes; depending on how long one lingers with the exhibits, this can stretch to two hours. Group tours are available and can be geared to special interests: historical societies, schools, scouts, and mineral societies all have differing emphases and the tour guides can accommodate these. Restroom facilities are more than adequate, and access for the handicapped is available. Parking is abundant and free, busses can be accommodated, and a picnic area is provided with ten tables. Visitors are advised to bring sturdy walking-shoes, secure child-restraints, and protection from the elements since part of the tour is in open-air. The mine is cool (56°F) year-round so a sweater or jacket is suggested. The length of the tour is less than a half-mile of very easy walking; half the distance is outdoors. Tours are given as needed, 7 days a week (the last tour is at 3:30 p.m.), and the facility is staffed from 10 a.m. to 5 p.m. The museum is open from March 1 through November 30 and has reduced rates for groups (10 or more) and for children. The mailing address is: Sterling Hill Mining Company, 30 Plant Street, Ogdensburg, New Jersey 07439; the telephone number is (201) 209-7212.

AMENITIES AND DIRECTIONS

The Sterling Hill Mining Museum is located at the intersection of Plant Street and Passaic Avenue (enter from Passaic Avenue) in Ogdensburg, Sussex County, New Jersey. It is just a few miles south of Franklin, and about 45 miles from New York City in distance (and a million miles from it in all other respects). Motels are present in the area, but not listed in quality guides (for cause); campgrounds are available. There are many other local tourist attractions. While in the area, the mineral enthusiast might also wish to visit the fine and newly expanded Franklin Mineral Museum and the famous Buckwheat dump, only three miles distant in Franklin, and open from April 15 to November 15. It is located on Mine Hill, at 6 Evans Street in Franklin, NJ 07416; the telephone number is (201) 827-3481; call for schedule before coming. The Paterson Museum is less than an hour away, and the Rutgers University Museum just a bit further. One can also venture into New York City to visit the American Museum of Natural History.

Once in the area, from Franklin, take Route 517 South three miles to Ogdensburg (toward Sparta). In the center of Ogdensburg, turn right on Passaic Avenue, cross through the intersection with Plant Street/Cork Hill Road at the bottom of the hill, proceed a few hundred feet uphill on Passaic Avenue, under the railroad trestle, and immediately turn left at the entrance to the Museum. Alternatively, follow Route 517 North from Sparta to Ogdensburg,

turn left on Passaic Avenue and continue as above. Upon entering the property, drive straight ahead and follow directional and parking signs carefully; they are there for your safety.

EPILOGUE

The Sterling mine is alive and well, the museum is well designed and interesting, and the walk-in tour is a great and exciting experience. Hundreds of years after mining was first tried here, this famous place is available to all. Stop in and enjoy!

ACKNOWLEDGMENTS

The views expressed herein are those of the authors and do not imply any endorsement by the Smithsonian Institution. We are indebted to the following persons for critical readings: John L. Baum, Richard C. Erd, Jr., Elna Hauck, Richard Hauck, Robert Hauck, Robert Metsger, Steve Misiur, Steven Morehead, Daniel Russell, Earl Verbeek, and Herb Yeates. Henry Van Lenten and Ron Cedar were of special assistance in photographing the Rainbow Room under ultraviolet illumination, and have our deep gratitude.

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- SHUSTER, E. D. (1927) Historical notes of the iron and zinc mining industry in Sussex County, New Jersey. Privately published by the Franklin Kiwanis Club.
- Recent research on the deposits was the subject of a Symposium at Lehigh University in May of 1990. The Proceedings volume (118 pages) is available postpaid for \$15 from (payee): Franklin - Ogdensburg Mineralogical Society, P. O. Box 146, Franklin, NJ 07416.

THE FRANKLIN-STERLING HILL AREA MINERAL SPECIES LIST

The list of species from the deposits is unchanged from last year and thus there is no "Notes from the Laboratory" column in this issue. Procedures for adding species to the list are given in *The Picking Table*, 28, number 1, pages 4-5 (1987).

Compiled from various sources by Pete J. Dunn of the Smithsonian Institution and John L. Baum, Curator of the Franklin Mineral Museum, July 1992, following the nomenclature of the *Glossary of Mineral Species* (Fleischer, 1991).

ACANTHITE	BERTHIERITE	COVELLITE	GAGEITE-2M
ACTINOLITE	BIOTITE	CRYPTOMELANE	GAHNITE
ADAMITE	BIRNESSITE	CUPRITE	GALENA
ADELITE	BORNITE	CUPROSTIBITE	GANOMALITE
AEGIRINE	BOSTWICKITE	CUSPIDINE	GANOPHYLLITE
AKROCHORDITE	BRANDTITE		GENTHELVITE
ALBITE	BREITHAAPTITE	DATOLITE	GERSDORFFITE
ALLACTITE	BROCHANTITE	DESCLOIZITE	GERSTMANNITE
ALLANITE-(Ce)	BROOKITE	DEVILLINE	GLAUOCOCHROITE
ALLEGHANYITE	BRUCITE	DIGENITE	GOETHITE
ALMANDINE	BULTFONTEINITE	DIOPSIDE	GOLD
ANALCIME	BUSTAMITE	DJURLEITE	GOLDMANITE
ANANDITE		DOLOMITE	GRAPHITE
ANATASE	CAHNITE	DOMEYKITE	GREENOCKITE
ANDRADITE	CALCITE	DRAVITE	GROSSULAR
ANGLESITE	CANAVESITE	DYPINGITE	GROUTITE
ANHYDRITE	CARROLLITE		GUERINITE
ANNABERGITE	CARYOPILITE	EDENITE	GYPSUM
ANORTHITE	CELESTINE	EPIDOTE	
ANORTHOCLASE	CELSIAN	EPSOMITE	HADINGERITE
ANTLERITE	CERUSSITE	ERYTHRITE	HALOTRICHITE
ARAGONITE	CHABAZITE	ESPERITE	HANCOCKITE
ARSENIC	CHALCOCITE	EUCHROITE	HARDYSTONITE
ARSENOSIDERITE	CHALCOPHANITE	EVEITE	HASTINGSITE
ARSENOPYRITE	CHALCOPYRITE		HAUCKITE
ATACAMITE	CHAMOSITE	FAYALITE	HAUSMANNITE
AUGITE	CHARLESITE	FEITKNECHTITE	HAWLEYITE
AURICHALCITE	CHLOROPHOENICITE	FERRIMOLYBDITE	HEDENBERGITE
AURORITE	CHONDRODITE	FERRISTILPNOMELANE	HEDYPHANE
AUSTINITE	CHRYSOCOLLA	FERROAXINITE	HEMATITE
AZURITE	CIANCIULLITE	FLINKITE	HEMATOLITE-LIKE-MINERAL
	CLINOCHLORE	FLUCKITE	HEMIMORPHITE
BAKERITE	CLINOCHRYSSOTILE	FLUOBORITE	HENDRICKSITE
BANNISTERITE	CLINOCLASE	FLUORAPATITE	HERCYNITE
BARITE	CLINOHEDRITE	FLUORAPOPHYLLITE	HETAEROLITE
BARIUM-PHARMACOSIDERITE	CLINOHUMITE	FLUORITE	HEULANDITE
BARYLITE	CLINOZOISITE	FORSTERITE	HEXAHYDRITE
BARYSILITE	CLINTONITE	FRANKLINFURNACEITE	HODGKINSONITE
BASSANITE	CONICALCITE	FRANKLINITE	HOLDENITE
BASTNAESITE-GROUP MINERAL	CONNELLITE	FRIEDELITE	HUEBNERITE
BAUMHAUERITE	COPPER		HUMITE
BEMENTITE	CORUNDUM	GAGEITE-1Tc	HYALOPHANE

HYDROHETAEROLITE	METAZEUNERITE	ROWEITE	WENDWILSONITE
HYDROTALCITE	MICROCLINE	RUTILE	WILLEMITE
HYDROXYAPOPHYLLITE	MIMETITE		WOLLASTONITE
HYDROZINCITE	MINEHILLITE	SAFFLORITE	WOODRUFFITE
	MOLYBDENITE	SARKINITE	WULFENITE
ILLITE	MONOHYDROCALCITE	SAUCONITE	WURTZITE
ILMENITE	MOOREITE	SCHALLERITE	
	MUSCOVITE	SCHEELITE	XONOTLITE
JACOBSITE		SCHORL	
JAROSEWICHITE	NASONITE	SCLARITE	YEATMANITE
JERRYGIBBSITE	NATROLITE	SCORODITE	YUKONITE
JOHANNSENITE	NELENITE	SELIGMANNITE	
JOHNBAUMITE	NEOTOCITE	SEPIOLITE	ZINALSITE
JUNITOITE	NAHITE	SERPIERITE	ZINCITE
	NEWBERYITE	SIDERITE	ZINKENITE
KAOLINITE	NICKELINE	SILLIMANITE	ZIRCON
KENTROLITE	NONTRONITE	SILVER	ZNUCALITE
KITTATINNYITE	NORBERGITE	SJOGRENITE	
KOETTIGITE	OGDENSBURGITE	SKUTTERUDITE	
KOLICITE	OJUELAITE	SMITHSONITE	
KRAISSLITE	ORTHOCHRYSSOTILE	SONOLITE	
KUTNOHORITE	ORTHOCLASE	SPESSARTINE	
	ORTHOSERPIERITE	SPHALERITE	
LARSENITE	OTAVITE	SPINEL	
LAUMONTITE	OYELITE-LIKE MINERAL	STARKEYITE	
LAWSONBAUERITE		STERLINGHILLITE	
LEAD	PARABRANDTITE	STIBNITE	
LEGRANDITE	PARARAMMELSBURGITE	STILBITE	
LENNILENAPEITE	PARASYMPLESITE	STILPNOMELANE	
LEUCOPHOENICITE	PARGASITE	STILPNOMELANE (Mn-	
LINARITE	PECTOLITE	DOMINANT)	
LIROCONITE	PENNANTITE	STRONTIANITE	
LIZARDITE	PETEDUNNITE	SULFUR	
LOELLINGITE	PHARMACOLITE	SUSSEXITE	
LOSEYITE	PHARMACOSIDERITE	SVABITE	
	PHLOGOPITE	SYNADELPHITE	
MAGNESIOHORNBLLENDE	PICROPHARMACOLITE		
MAGNESIORIEBECKITE	PIMELITE	TALC	
MAGNESIUM-	POWELLITE	TENNANTITE	
CHLOROPHOENICITE	PREHNITE	TEPHROITE	
MAGNETITE	PUMPELLYITE-(Mg)	THOMSONITE	
MAGNUSSONITE	PYRITE	THORITE	
MALACHITE	PYROAURITE	THORTVEITITE	
MANGANAXINITE	PYROBELONITE	TILASITE	
MANGANBERZELIITE	PYROCHROITE	TIRODITE	
MANGANESE-HOERNESITE	PYROPHANITE	TITANITE	
MANGANHUMITE	PYROXMANGITE	TODOROKITE	
MANGANITE	PYRRHOTITE	TORREYITE	
MANGANOSITE		TREMOLITE	
MANGANPYROSMALITE	QUARTZ	TURNEAUREITE	
MARCASITE			
MARGARITE	RAMMELSBURGITE	URANINITE	
MARGAROSANITE	REALGAR	URANOPHANE	
MARIALITE	RETZIAN - (La)	URANOSPINITE	
MARSTURITE	RETZIAN - (Nd)	UVITE	
MCALLISTERITE	RHODOCHROSITE		
MCGOVERNITE	RHODONITE	VESUVIANITE	
MEIONITE	RIEBECKITE	VILLYAELLENITE	
MELANTERITE*	ROEBLINGITE		
META-ANKOLEITE	ROMEITE	WALLKILLDELLITE	
METALODEVITE	ROSASITE*	WAWAYANDAITE	

* Reported but not confirmed with certainty.

There are 340 total confirmed species from the Franklin-Sterling Hill area

MINERALS UNIQUE TO FRANKLIN AND STERLING HILL, NEW JERSEY

BOSTWICKITE $\text{CaMn}^{3+}_6\text{Si}_3\text{O}_{16}\cdot 7\text{H}_2\text{O}$	LAWSONBAUERITE $(\text{Mn},\text{Mg})_9\text{Zn}_4(\text{SO}_4)_2(\text{OH})_{22}\cdot 8\text{H}_2\text{O}$
CHARLESITE $\text{Ca}_6(\text{Al},\text{Si})_2(\text{SO}_4)_2[\text{B}(\text{OH})_4](\text{OH})_{12}\cdot 26\text{H}_2\text{O}$	LENNILENAPEITE $\text{K}_{6-7}(\text{Mg},\text{Mn},\text{Zn},\text{Fe})_{48}(\text{Si},\text{Al})_{72}(\text{O},\text{OH})_{216}\cdot 16\text{H}_2\text{O}$
CHLOROPHOENICITE $\text{Mn}_3\text{Zn}_2(\text{OH})_6[\text{As}_{0.5}\text{H}_{0.5}(\text{O},\text{OH})_3]_2$	MAGNESIUM-CHLOROPHOENICITE $(\text{Mg},\text{Mn})_3\text{Zn}_2(\text{OH})_6[\text{As}_{0.5}\text{H}_{0.5}(\text{O},\text{OH})_3]_2$
CIANCIULLIITE $\text{Mn}(\text{Mg},\text{Mn})_2\text{Zn}_2(\text{OH})_{10}\cdot 2\cdot 4\text{H}_2\text{O}$	MCGOVERNITE $(\text{Mn},\text{Mg},\text{Zn})_{273}\text{As}^{3+}_{-12}\text{As}^{5+}_{-30}\text{Si}_{-42}\text{O}_{324}(\text{OH})_{252}$
FRANKLINFURNACEITE $\text{Ca}_2\text{Fe}^{3+}\text{Mn}^{2+}_3\text{Mn}^{3+}\text{Zn}_2\text{Si}_2\text{O}_{10}(\text{OH})_8$	MINEHILLITE $\text{K}_{2-3}\text{Ca}_{28}[\text{Zn}_4\text{Al}_4\text{Si}_{40}\text{O}_{112}(\text{OH})_4](\text{OH})_{12}$
GERSTMANNITE $(\text{Mg},\text{Mn})_2\text{ZnSiO}_4(\text{OH})_2$	MOOREITE $\text{Mg}_9\text{Mn}_2\text{Zn}_4(\text{SO}_4)_2(\text{OH})_{26}\cdot 8\text{H}_2\text{O}$
HANCOCKITE $(\text{Pb},\text{Ca},\text{Sr})_2(\text{Al},\text{Fe}^{3+})_3(\text{SiO}_4)_3(\text{OH})$	NELENITE $\text{Mn}_{16}\text{Si}_{12}\text{O}_{30}(\text{OH})_{14}[\text{As}^{3+}_3\text{O}_6(\text{OH})_3]$
HARDYSTONITE $\text{Ca}_2\text{ZnSi}_2\text{O}_7$	PARABRANDTITE $\text{Ca}_2\text{Mg}(\text{AsO}_4)_2\cdot 2\text{H}_2\text{O}$
HAUCKITE $(\text{Mn},\text{Mg})_{24}\text{Zn}_{18}\text{Fe}^{3+}_3(\text{SO}_4)_4(\text{CO}_3)_2(\text{OH})_{81}$	PETEDUNNITE $\text{CaZnSi}_2\text{O}_6$
HENDRICKSITE $\text{K}(\text{Zn},\text{Mg})_3\text{Si}_3\text{AlO}_{10}(\text{OH})_2$	RETZIAN - (La) $\text{Mn}_2\text{La}(\text{AsO}_4)(\text{OH})_4$
HODGKINSONITE $\text{Zn}_2\text{Mn}(\text{SiO}_4)(\text{OH})_2$	RETZIAN - (Nd) $\text{Mn}_2\text{Nd}(\text{AsO}_4)(\text{OH})_4$
HOLDENITE $(\text{Mn},\text{Mg})_6\text{Zn}_3(\text{OH})_8(\text{AsO}_4)_2(\text{SiO}_4)$	SCLARITE $(\text{Zn},\text{Mn},\text{Mg})_4\text{Zn}_3(\text{CO}_3)_2(\text{OH})_{10}$
JAROSEWICHITE $\text{Mn}_2\text{Mn}^{3+}(\text{AsO}_4)(\text{OH})_6$	STERLINGHILLITE $\text{Mn}_3(\text{AsO}_4)_2\cdot 4\text{H}_2\text{O}$
JOHNBAUMITE $\text{Ca}_5(\text{AsO}_4)_3(\text{OH})$	TORREYITE $(\text{Mg},\text{Mn})_9\text{Zn}_4(\text{SO}_4)_2(\text{OH})_{22}\cdot 8\text{H}_2\text{O}$
KITTATINNYITE $\text{Ca}_4\text{Mn}^{3+}_4\text{Mn}^{2+}_2\text{Si}_4\text{O}_{16}(\text{OH})_8\cdot 18\text{H}_2\text{O}$	WALLKILLDELLITE $\text{Ca}_4\text{Mn}^{2+}_6\text{As}^{5+}_4\text{O}_{16}(\text{OH})_8\cdot 18\text{H}_2\text{O}$
KOLICITE $\text{Mn}_7\text{Zn}_4(\text{AsO}_4)_2(\text{SiO}_4)_2(\text{OH})_8$	WAWAYANDAITE $\text{Ca}_{12}\text{Mn}_4\text{Be}_2\text{Si}_{12}\text{O}_{46}(\text{OH},\text{Cl})_{30}$
KRAISSLITE $\text{Fe}^{3+}_2\text{Mg}_4\text{Mn}_{44}\text{Zn}_6(\text{AsO}_4)_6(\text{AsO}_3)_4(\text{SiO}_4)_{12}(\text{OH})_{36}$	YEATMANITE $[\text{Mn}_5\text{Sb}_2][\text{Mn}_2\text{Zn}_8\text{Si}_4]\text{O}_{28}$

List provided by Pete J. Dunn and John L. Baum

RESEARCH REPORTS

New-to-the-Science:

CIANCIULLITE (DESCRIPTION)

Reference

Dunn, P.J., Grice, J.D., Criddle, Alan, and Stanley, Chris, 1991, **Cianciullite, a new magnesium manganese zinc hydroxide from Franklin, New Jersey**: *American Mineralogist*, **76**, p. 1708-1710.

Introduction

Cianciullite, $\text{Mn}(\text{Mg}, \text{Mn})_2\text{Zn}_2(\text{OH})_{10} \cdot 2-4\text{H}_2\text{O}$, is a newly recognized mineral from Franklin, New Jersey and is named in honor of John Cianciulli of Sussex, New Jersey "in recognition of the substantial assistance he has provided to scientists studying the minerals of Franklin and Sterling Hill and to the Franklin Mineral Museum." The sole known specimen of cianciullite is a micromount in the collection of the Smithsonian Institution; crystals from the holotype specimen have been deposited in the Canadian Museum of Natural History.

Appearance

"Cianciullite occurs as lustrous, euhedral crystals up to 0.6 mm in length, but most are considerably smaller. Many of the crystal faces appear to be curved to varying degrees. Cianciullite crystals, tabular on {100}, are so darkly colored and highly reflective that they appear opaque in all but one direction, normal to the perfect {100} cleavage. The cleavage has a markedly different appearance from the other surfaces; the effect is striking and is the most diagnostic feature of the mineral. The luster of this pinacoid is dull to pearly and noticeably distinct; incipient cleavages are copiously developed and give this pinacoid the appearance of a mica cleavage. The luster of freshly broken surfaces and other crystal faces of cianciullite is adamantine to vitreous." The mineral is dark reddish brown, but only the thinnest fragments transmit light; crystal exteriors appear opaque dark brown. No fluorescence was observed under ultraviolet radiation.

Properties

Density (calculated) is 2.87 g/cm^3 [for 4 H_2O per unit cell; see following abstract]. Hardness not measurable but very soft, estimated at 2 (Mohs'). Indices of refraction between 1.76 and 1.92, but optical properties in transmitted light are difficult to determine because of the near-opacity of the mineral. Cianciullite in plane-polarized reflected light is gray, very weakly birefractant, and not observably pleochroic. When immersed in oil ($n_d = 1.515$) it becomes slightly darker and bluer gray in color. Refractive indices calculated from the reflectance data are 1.79-1.80, in agreement with values obtained in transmitted light.

Chemical composition

Microprobe analysis yielded MgO 9.2, MnO 27.8, ZnO 31.1, total = 68.1 wt%, H_2O (by difference) 31.9. Cianciullite is markedly unstable under the electron beam, precluding accurate determination of the H_2O content by difference; more-

over, insufficient material exists for the determination of H_2O by any other available chemical analytical procedure. The metal ratios, however, remain unaffected by this uncertainty. Crystal structure analysis (see next abstract) was thus used to determine the amounts of OH and H_2O per unit cell. Recalculation of the microprobe analysis in accordance with the structure determination yields (for $2\text{H}_2\text{O}$ and $4\text{H}_2\text{O}$, respectively) MgO 9.86, 9.15, MnO 29.7, 27.56, ZnO 33.36, 30.97; H_2O 27.08, 32.32, giving the chemical formula $\text{Mn}(\text{Mg}, \text{Zn})_2\text{Zn}_2(\text{OH})_{10} \cdot 2-4\text{H}_2\text{O}$, with cation site assignments from the crystal-structure determination.

Occurrence

Cianciullite occurs as sparse crystals with abundant, colorless disphenoids of cahnite [see photomicrograph on cover] and thin films of a black material resembling manganese oxides on an orange, fine-grained matrix of willemite and zincite that have replaced coarse crystals of some other, unknown species. Nothing is known of its geologic occurrence in the mine.

Discussion

Divalent Mn at Franklin and Sterling Hill occurs mostly in the primary ore minerals, carbonates, and the numerous associated silicates. In secondary assemblages divalent Mn occurs in many anionic groups, particularly in silicates and in more than 20 manganese arsenate minerals. Cianciullite and pyrochroite, however, are the only two known secondary, divalent-manganese hydroxide species known from these localities. Secondary trivalent manganese species (e.g. feichtknechtite, groutite, hausmannite, manganite) are rare and known principally from Franklin, with the significant exception of hetaerolite, known from both localities [and hardly rare from Franklin]. Secondary, hydrated, tetravalent manganese minerals (aurorite, birnessite, chalcophanite, todorokite, woodruffite) are known principally from Sterling Hill but are restricted mostly to the extensively oxidized saprolite of the "mud zone".

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CIANCIULLITE (STRUCTURE)

Reference

Grice, J.D., and Dunn, P.J., 1991, **The crystal structure of cianciullite, $\text{Mn}(\text{Mg}, \text{Mn})_2\text{Zn}_2(\text{OH})_{10} \cdot 2-4\text{H}_2\text{O}$** : *American Mineralogist*, **76**, p. 1711-1714. [Note: See preceding abstract for general information on the appearance, composition, prop-

erties, and occurrence of ciangiulliite. The mineral was described as a new species in late 1991]

Introduction

Metal ratios of the major cations Mn, Mg, and Zn in ciangiulliite were known from microprobe analysis, but the marked instability of the mineral under the electron beam precluded accurate determination of their absolute amounts. Moreover, insufficient material was available for determination of water by any available chemical method (the mineral is known from only a single micromount specimen). Accordingly, crystal structure determination was performed to determine the valence state of Mn, the amounts of OH and H₂O, and the number of formula units per unit cell.

X-ray precession photographs and crystal structure determination show ciangiulliite to be monoclinic with space group *C2/m*. Unit-cell parameters refined from the diffraction data are $a = 15.405(3)$, $b = 6.344(1)$, $c = 5.562(2)$ Å, and $\beta = 101.23(2)^\circ$, with $V = 533.2$ Å³ and $Z = 2$.

Structure description

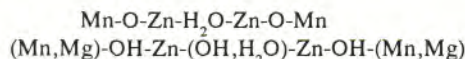
The most striking feature of the ciangiulliite structure is that it consists of two discrete layers, a brucite-type layer and an H₂O layer, parallel to the dominant cleavage plane (100). The brucite-type cation layer consists of a sheet of edge-sharing Mn and (Mg,Mn) octahedra with one-quarter of the octahedral sites vacant. These octahedral holes are capped on either side by Zn tetrahedra to complete the cation sheet. The cation sheets are interleaved with and weakly H-bonded to the H₂O layers.

Because of the rather poor quality of the crystals and the tendency of the H₂O layer to volatilize during X-ray analysis, the X-ray data were not sufficient to locate H atoms in the structure. A model with disordered H₂O and half occupancy of the H₂O sites, yielding four H₂O per unit cell, resulted in the most

satisfactory refinement of the data. However, it is very possible that fully hydrated ciangiulliite contains eight H₂O per unit cell [corresponding to the formula $Mn_2(Mg,Mn)_4Zn_4(OH)_{20} \cdot 8H_2O$] and that one-half of the weakly bonded H₂O molecules are lost under laboratory conditions. In support of this proposed formula is the observed volatilization of the mineral during microprobe analysis [see previous abstract] and the collapse of the structure along the *a* axis during X-ray analysis. The authors conclude that the H₂O molecular layer in ciangiulliite is only weakly H-bonded to the cation layer and hence partially lost in sample preparation and analytical procedures. They propose the general formula $Mn(Mg,Mn)_2Zn_2(OH)_{10} \cdot 2-4H_2O$ for ciangiulliite, the variable water content reflecting the expected range for the mineral under normal laboratory conditions.

Discussion

Several other manganese oxide minerals, notably birnessite, manganite, and buserite [the latter not known from Franklin or Sterling Hill], have layered structures. The layered manganese minerals have been studied in great detail because they are a major component of marine nodules. Of the two species having the closest *chemical* relationship to ciangiulliite—chalcophanite and woodruffite—only the former is closely related structurally. Layer sequences in the direction perpendicular to layering for chalcophanite and ciangiulliite, respectively, are:



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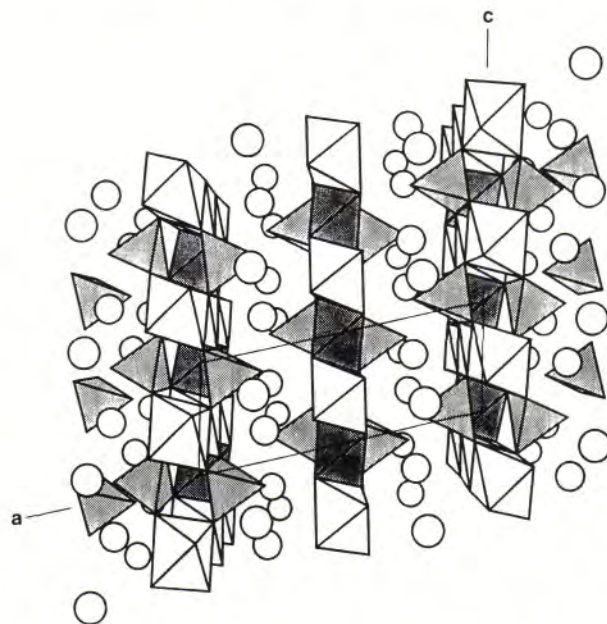


Fig. 1. A perspective view down the *b* axis of the ciangiulliite structure. The Mn octahedra are darkly shaded, (Mg,Mn) octahedra are lightly shaded, Zn tetrahedra are ruled, and H₂O molecules (O5) are large open circles. The lower face of the unit cell is outlined.

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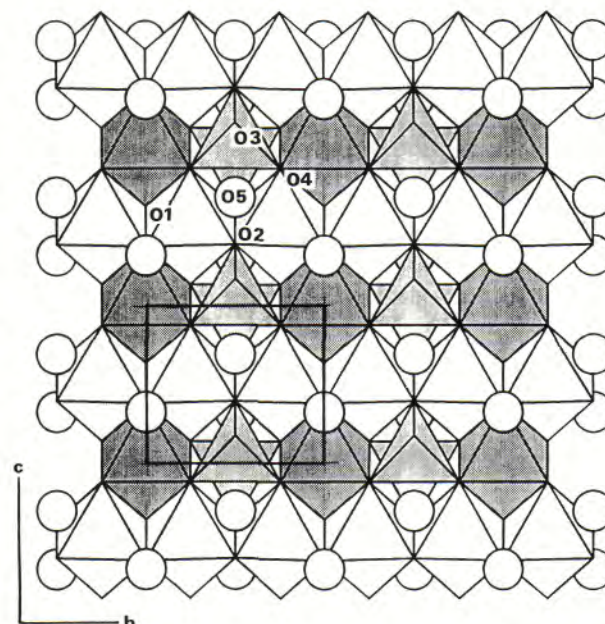


Fig. 2. A projection of the ciangiulliite structure on (100). Mn octahedra are darkly shaded, (Mg,Mn) octahedra are lightly shaded, Zn tetrahedra are ruled, and H₂O molecules (O5) are large open circles. The unit cell is outlined.

AUTUMN 1992 ACTIVITY SCHEDULE

Saturday, September 19th, 1992

9AM - Noon -- *Field Trip* -- Collecting on the Sterling Hill Mining Company Dump.
1:30 - 3:30 -- *Lecture* -- "The Long Pond Ironworks at Hewitt, New Jersey," by Martin Deeks,
The Friends of Long Pond Ironworks.

Saturday and Sunday, October 3rd & 4th, 1992

The 36th Annual Franklin-Sterling Mineral Exhibit and Show. The *Annual Banquet* will be held on Saturday evening, October 3rd.

Saturday, October 17th, 1992

9AM - Noon -- *Field Trip* -- Collecting at the Old Andover Iron Mine, Andover, New Jersey.
1:30 - 3:30 -- *Lecture* -- "The Edison Mine," by Carl Anderson, Rancocas Nature Center.

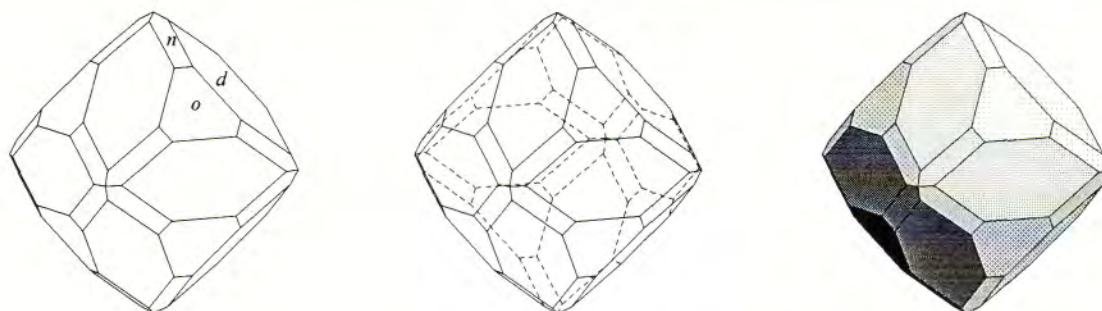
Sunday October 18th, 1992

9AM - Noon -- *Field Trip* -- Collecting at the Lime Crest Quarry, Sparta, New Jersey.

Saturday, November 21st, 1992

9AM - Noon -- *Field Trip* -- Collecting at the Franklin Quarry, Franklin, New Jersey.
1:30 - 3:30 -- *Lecture* -- "Clarence S. Bement: the consummate collector," by Joseph J. Peters,
The American Museum of Natural History.

Scheduled activities 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. Field trips are generally held to correspond with the weekend of a meeting/lecture program, and may be held on a Saturday or Sunday. Unless otherwise specified, business meetings will follow the lecture programs listed. The March and November meetings/lecture programs are held at the Hardyston Township School, on route 23 in Franklin, New Jersey. All others are held in Kraissl Hall of the Franklin Mineral Museum, Evans Road, Franklin, New Jersey.



Franklinite crystal. Habit adapted from Palache (1935), figure 42. Drawing at the left is similar to the original figure; forms present are $d\{110\}$, $o\{111\}$, and $n\{211\}$. The middle figure shows the "back edges" of this crystal as well, and the figure at the right is shaded as though illuminated from the upper right.

HY



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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)

Fron del, 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 Delos (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).

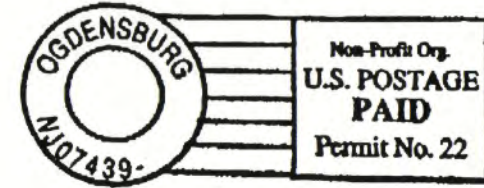
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