the Mineralogical Record

Volume 2/Number 6
November/December 1971

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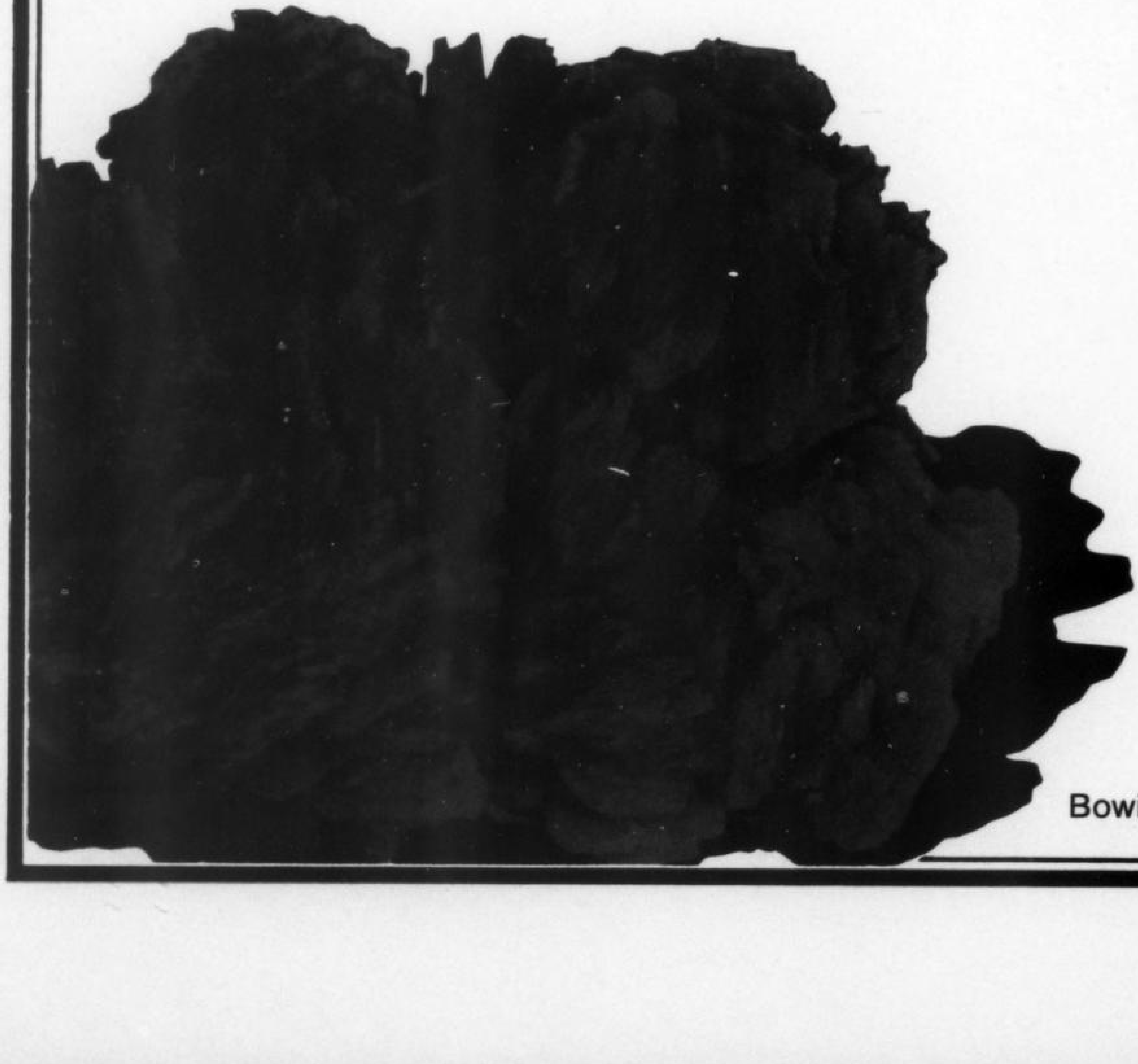

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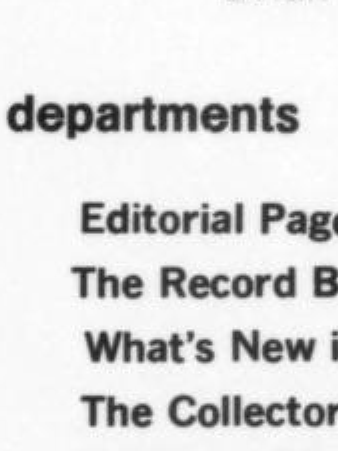

VANADINITE from the Apache Mine, Gila County, Arizona. The largest crystals in the group are about 4 mm in diameter. Smithsonian Institution specimen. Photo by Joel E. Arem.

Editorial

Mineral Dealers

Without mineral dealers the hobby, as we know it, could never have evolved the way it has in this country. The wealth of specimen material available to collectors would not exist. It is disturbing to hear collectors, commonly newer ones, vow that they will never *buy* a mineral specimen. In their minds they have assumed the posture of a. purist. The only specimens worth having are those personally collected. Of course some are not as "pure" as others and will accept specimens as gifts or will trade for them.

Without a doubt the nasty old profit motive stimulates the search for important mineral finds. It drives the mineral "diggers" back again and again to the sources of specimens. Dealers move vast quantities of this material and, as it is shuffled about, the finer specimens seem to fall into the hands of advanced collectors, and lesser pieces become the treasures of novices. As novices become more knowledgeable they gradually replace these lesser pieces with better and more costly ones. Hence the dealer is able to stock both expensive and inexpensive material and hope to sell it all.

One need only to visit a country where there is little non-professional mineral collecting in order to appreciate the role of dealers. In some countries the only specimens are in university and state collections. A mineralogist in one part of the country finds it very difficult to obtain needed specimens from other parts of the country. He must contact the mineralogist who has studied and described the mineral he wants. The describer may have collected only what he needed plus a few specimens for the collection of his school or museum so he may not be able to supply samples. Without dealers the deposits are not exploited and the specimens either remain in the ground or are lost in the ore crusher.

Another important role of the dealer is that of publicizing the discovery of new mineral finds so that samples are widely and rapidly disseminated. Thus the material finds its way into most major collections and its chances of being preserved are greatly enhanced.

One phenomenon which may be more or less unique to the mineral hobby is that of the mineral dealer who knows NOTHING about minerals. New dealers of this type pop up like weeds in a garden, especially around western tourist traps situated near mining areas. Most give fair warning to the wary by putting up signs which read ROCK SHOP, a term nearly synonymous with *rock junk.* There are, of course, many other signs which serve to identify the know-nothing rock seller. His specimens are not clean and are poorly organized and displayed. They rarely are labelled with mineral name and locality — clear testimony to the fact that he can't tell one mineral from another and doesn't even understand why he should. Reliable dealers usually have their material attractively displayed, clean, labelled and priced. The good dealers are the ones new collectors should patronize, for reasons other than the obvious ones such as better service, guaranteed refunds if dissatisfied, etc. Some of the less obvious reasons are:

(1) The customer can be more confident that the specimens are properly identified as to species and locality.

(2) These dealers know the market so their prices are competitive.

(3) Specimens are all priced so the dealer can't "size you up" and adjust the price at the last minute.

(4) Such dealers can usually answer questions about local collecting for those who might like to try it.

Actually all serious collectors should avoid the rock shops but even many advanced collectors are drawn to them for the same reason that knowledgeable antique collectors can't pass junk shops without looking in. This is especially so when these shops are located in areas known to have produced real "finds". They are all looking for the valuable specimen buried under years of grime and surrounded by trash. The dealer's ignorance keeps him from recognizing the one valuable specimen in his shop. The lucky collector finds a "sleeper" which probably will cost only a fraction of what it will be worth when cleaned up. The absence of a label is of no concern because the collectors who can spot "sleepers" are usually able to recognize the mineral, and its place of origin, on sight. Unfortunately many would-be sleepers are lost due to careless handling by these dealers resulting in damage to the specimens which destroys their value.

Mineral wholesalers are those who buy large lots of specimens from regular suppliers at bulk rates and sell to retailers also at bulk rates claiming a markup which is usually about 100%. The suppliers are the people who dig the specimens out of the ground. For most, this is a part-time occupation. Many are miners working at the locality, digging specimens on their own time or on the sly during company time. They possess neither the means nor the time to retail their material directly so they are happy to turn it over to a wholesaler who is set up for large volume distribution.

Actually there is a very nice system of checks and balances at work in these transactions. A supplier may find it easy to select a few of the finest pieces in his material and sell them at high retail prices. However the absence of those specimens may make the remainder of his stock of too little interest to be sold. Even more important though is the understanding that if caught in such an unethical pratice, he may discover that the wholesalers will not buy from him. Among collectors and dealers there is a very active grapevine and it is only a matter of time before everyone learns of such behavior.

The remark is heard frequently that mineral dealers' specimen stock consists largely of stolen goods. This is true to the extent that much of it, and perhaps most of it, has been taken from mines and properties without the knowledge and consent of the owners—a practice known as *highgrading*. Certainly nearly all of the spectacular specimens from Tsumeb, Southwest Africa were brought to the surface wrapped in clothing or hidden in lunchpails. There are many stories about famous localities where the specimen mining activity of highgraders at night exceeded that of the legitimate miners or quarriers during the day. Some mining ventures operated only for mineral specimens failed because of highgraders. There is no doubt that some mines and quarries have produced highgraded specimens, the total value of which was greater than that of all the ore and rock legitimately removed. Most mining officials discourage collecting by their employees, not because they can't afford the loss of potential ore or because they desire the profit from the specimens, but because they want to keep the miners mining. Once miners become aware of the prices specimens may bring they spend too much time looking for them instead of doing what they are being paid a salary to do. A lovely pocket of crystals was recently exposed in a mine in Spain. The foreman was a highgrader who realized that unless something drastic was done the crystals would be scooped up and trucked off to the crusher. He couldn't highgrade right in front of the other workers because they might have joined in. So he called a strike, closed the mine, and made off with a valuable collection of minerals.

Retailers have had a tough time in turning a profit in the past but the picture is changing as the hobby continues to grow rapidly. They find it difficult to anticipate the reaction of customers to the things they sell so it is necessary to stock a wide variety of sizes and quality in each of the minerals. Therefore they have a large investment in specimens, most of which do not move fast and many which never move at all. The sale of tumbled jewelry and cabachon-cut and faceted gem material is all that has kept many dealers in business. Today there is a far greater number of buyers, not only because the hobby is growing but also because many collectors are finding it extremely difficult to find suitable specimens themselves as the localities are so well picked over.

A relatively small percent of the dealers limit their business to selling only very fine and expensive material. They have regular customers who buy thousands of dollars worth of specimens annually. These dealers must have a good business acumen, an almost intuitive feel for what the buyers will like, and the courage and resources to invest heavily in such material when it is available.

A dealer may carry a specimen for years without being able to sell it. Discouraged he may trade it to another dealer who is able to sell it right away. Equally difficult to understand are the examples of fine specimens reasonably priced which don't sell. In some instances dealers have found that if they raise the price substantially, the specimens suddenly do sell. The psychology involved must be that many buyers feel that a specimen can't be worth having if it is inexpensive.

Many dealers prefer to avoid the problems associated with running a walk-in store. They regularly mail out lists of their stock and do all of their business by mail order. This can be very disastrous for those who offer only mediocre specimens because it is understood that the buyer may return the specimens if he is not satisfied with them. So the overhead of a store may be eliminated but he has the expenses of and must devote considerable time to preparing and mailing price lists, packing and shipping of orders, typing invoices, corresponding with and telephoning customers, all of which may end with the return of the order. Store-based businesses must cope with restricting store hours, damage to specimens by customers, thefts by shoplifters and much time lost in long conversations with visitors who buy nothing.

Dealers in all categories should be responsive to the importance of proper labelling. This is sometimes difficult for them because suppliers, chiefly those in northern Mexico, will purposely misrepresent the place of origin of their material in order to keep other suppliers away. Dealers have other problems too which plague them. When a locality becomes known and holds promise as a likely supplier of specimens for a long time, collectors inevitably will try to bypass the middleman to get right at the source. The miners have been accustomed to a price which will permit several markups as the specimens move from original supplier to wholesaler to retailer. Suddenly along comes the collector willing to pay retail prices directly to the supplier. This may totally destroy the price structure and force the dealer to cease buying from the supplier. The supplier is hurt because the relatively small number of specimens he can sell at retail prices does not bring in as much as regular sales of large lots to wholesalers.

So you can see that the lot of the mineral dealers is a difficult one. Many have been forced to give up their businesses as they cannot make a living at it. Yet when some people witness the sale of a single specimen for several thousand dollars, they assume the dealer is making a huge profit and also that such a sale is a typical business transaction for him. Actually such sales are rare for any dealer and very few, if any, mineral dealers are making a good living from the mineral business. Therefore, for the sake of the hobby, I urge you to support the mineral dealers by buying specimens. Besides, mineral specimens are a good investment!

John S. White, Jr.

Hansen's Minerals Makes Changes

Dr. and Mrs. Gary R. Hansen of St. Louis, Missouri are pleased to announce the reorganization of their business presently called *Hansen's Hut*. Dr. Hansen, after finishing his Ph.D. work at the University of Iowa, taught in a graduate college of the University of Idaho for two years and then joined Monsanto Chemical Company as a Senior Research Chemist. He resigned from this position in August 1971 to enter the mineral business on a full-time basis. The newly incorporated business will now be called *Hansen's Minerals*. Gary and his wife Maurine are well known to collectors throughout the United States and Europe as they have operated their mineral specimen business for eight years.

The new business will be entirely devoted to the acquisition of new minerals and gemstones from a variety of sources. Dr. Hansen has already purchased several classic mineral properties and mining will begin next Spring. They will continue to purchase collections and will travel directly to mining areas to purchase fine minerals on a national and worldwide basis. This program will be complimented by mineral exchanges with leading geological museums.

One of the mining properties, the Kitty No. 1 lode which adjoins the Bull Moose mines, famous for its rose quartz and phosphate mineralization, is a classic pegmatite located near Custer, South Dakota. This mine will be opened to mineral collectors next Summer. A large number of minerals have been found in this mine including rose quartz, schorl, muscovite, columbite, beryl, feldspar, spodumene, and barbosalite. A map of the location and descriptive data will be published in the next issue of the *Mineralogical Record.*

The Hansens will also publish a quarterly individual specimen price list — a four-page list dated 12/19/71 is currently available on request. They will attend a limited number of mineral shows including Detroit, Tucson, American Federation, and other regional federation shows. An attempt will be made to feature a mineral specialty at each show. This program will begin with the Tucson Show where the Hansen's are reserving for this show a limited selection of fine blue barite on calcite specimens from an isolated pocket in the fluorite mines of Southern Illinois.

The Hansens will also open a new mineral display gallery in St. Louis during the early part of 1972 and invite any collector traveling in this area to call for directions — phone (314) 432-2882.

"Mineral Classics" Relocates in Colorado

Richard A. Kosnar has recently moved his "Mineral Classics" business to the Denver, Colorado area in order to more centralize his operation.

There is presently in stock, a wide variety of fine mineral specimens. These include fine Wardite xls. associated with eosphorite, roscherite, rose quartz, and a new (not yet identified) mineral. Also a fine selection of old classic material, such as, Cumberland, England fluorites, Cleator Moor, England Hematite & Quartz combinations, Bisbee and Morenci, Arizona azurites, and many other fine specimens for the collector and museum.

Most material is made available on "approval" to collectors, as well as dealers (wholesale). All inquiries to be made to: Richard A. Kosnar, "Mineral Classics", 11260 E. Center, Aurora, Colorado, 80010

The Record Bookshelf

by Joel E. Arem

Introduction to Crystal Geometry, by Martin J. Buerger, McGraw Hill, New York, 1971, 204 pp., ($12.50)

When the author of half a dozen authoritative books in his chosen field decides to write yet another, one obvious question that may arise is: what new contributions are to be made? Prof. Buerger answers this question candidly and lucidly in the preface to this new book, by pointing out the very real literature gap that it is designed to fill. Crystallography is gradually gaining recognition as one of the most basic of sciences. Its concepts are used in chemistry, physics, metallurgy, mineralogy and even biology; yet most introductory texts in these fields do not present authoritative treatments of crystallographic principles that will form valuable background later on. *Introduction to Crystal Geometry* is intended as an introduction to the college student, but one that requires no college-level background. It thus automatically qualifies as an ideal sourcebook for the serious collector of minerals who wants more rigor than is usually provided in introductory mineralogy texts.

Chapter designations include: order in patterns, translational order, rotational order, point groups, lattice types and coordinate systems, application of point group symmetries to crystals, characteristics of space groups, the space groups, equipoints, and the development of crystal geometry. The text is almost entirely nonmathematical. The essentials of crystallographic theory are developed logically and very convincingly, and in proper sequence for better understanding. This is not a text in metallurgy, mineralogy or any of the other specific fields mentioned above. It is pure crystallography, and no rationale is given to explain inclusion of any of the topics selected for discussion — they naturally all form parts of a unified and coherent whole. Several misconceptions that have bothered novice crystallographers and mineral collectors endlessly are dispelled neatly by Buerger. One argument especially appreciated by this reviewer is the justification for placing all point groups with one 6-fold or 3-fold axis in a single crystal system called the hexagonal system. In several instances similar problems are treated almost conversationally, as if Prof. Buerger were presenting his case in person. The book is readable throughout, though compact.

Introduction to Crystal Geometry is an ideal preface to more advanced study, yet it is sufficiently rigorous and complete to stand alone as a source book for basic information. For this reason it will be appreciated by the student who needs a solid foundation in theory, as preparation for further study, and by the serious amateur who is not satisfied with many of the non-rigorous or oversimplified treatments of crystallography normally available to him. Both types of readers will be pleased by the scope and clarity of the book, and will find it continually useful for many years to come.

Joel E. Arem

The Growth of Single Crystals, by Robert A. Laudise, Prentice-Hall, Inc., 1970, 352 pp., ($14.50)

Crystal growing is one of the most important technologies in our modern civilization. Without techniques for making large perfect crystals of such formerly esoteric materials as silicon and germanium, we would never have known the advantages of transistors, semiconductors, lasers and the countless consumer products and services that these devices make possible. It is probably safe to state that crystal growing is a critical aspect of nearly every major industry, since all solids are crystalline. Crystallization is used in purifying chemicals, refining metals, and even in many areas of biological and pharmaceutical research.

The literature of crystal growth is enormous. No one book can hope to cover it all, and Laudise makes this quite clear. But a general survey of the current field of crystal growing is both possible and needed. *The Growth of Single Crystals* provides welcome and adequate coverage of commercially important crystal growing procedures. The preface to the book outlines the areas of its utility: as a textbook in materials science, as a guide to the professional crystal grower, and as a source book on crystal growth methods currently in popular use. But there is so much valuable information in its pages that the work could be profitably skimmed by almost anyone who is interested in crystals *per se*. One cannot clearly separate aspects of science that are inherently closely related. The processes used to grow crystals in the laboratory are, in large part, duplicated on a grand scale by nature (seen especially clearly in the case of hydrothermal growth). Laudise's book is therefore an excellent source of material on crystals in general, and *how* they grow. The opening chapter, on single crystals, is compact and readable, although slanted towards the "solid-state" oriented reader (space is devoted to a discussion of vacancies, dislocations, grain boundaries,

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What's New in Minerals?

Photos by Joel E. Arem

ARSENOPYRITE

I hope it never ends! Another stunner from Mexico; this time arsenopyrite. These are not the smaller (up to about ½ inch) simple, prismatic crystals growing epitaxially on pyrite from Noche Buena, Zacatecas (Fig. 1). The new crystals are large (3/4 to 1 inch) tabular beauties having a brilliant luster and come in uncomplicated groups or as superb singles (Figs. 2, 3). As is typical of arsenopyrite the vertical prism zone is striated and the striae are divergent from the center.

When this material first appeared an attempt was made to conceal the true locality by crediting it to a false locality—the famous old arsenopyrite occurrence at Parral in Chihuahua. It is now generally agreed that the proper source is Santa Eulalia, Chihuahua. By way of verification, I have seen one specimen of the arsenopyrite associated with typical Santa Eulalia pyrrhotite and galena.

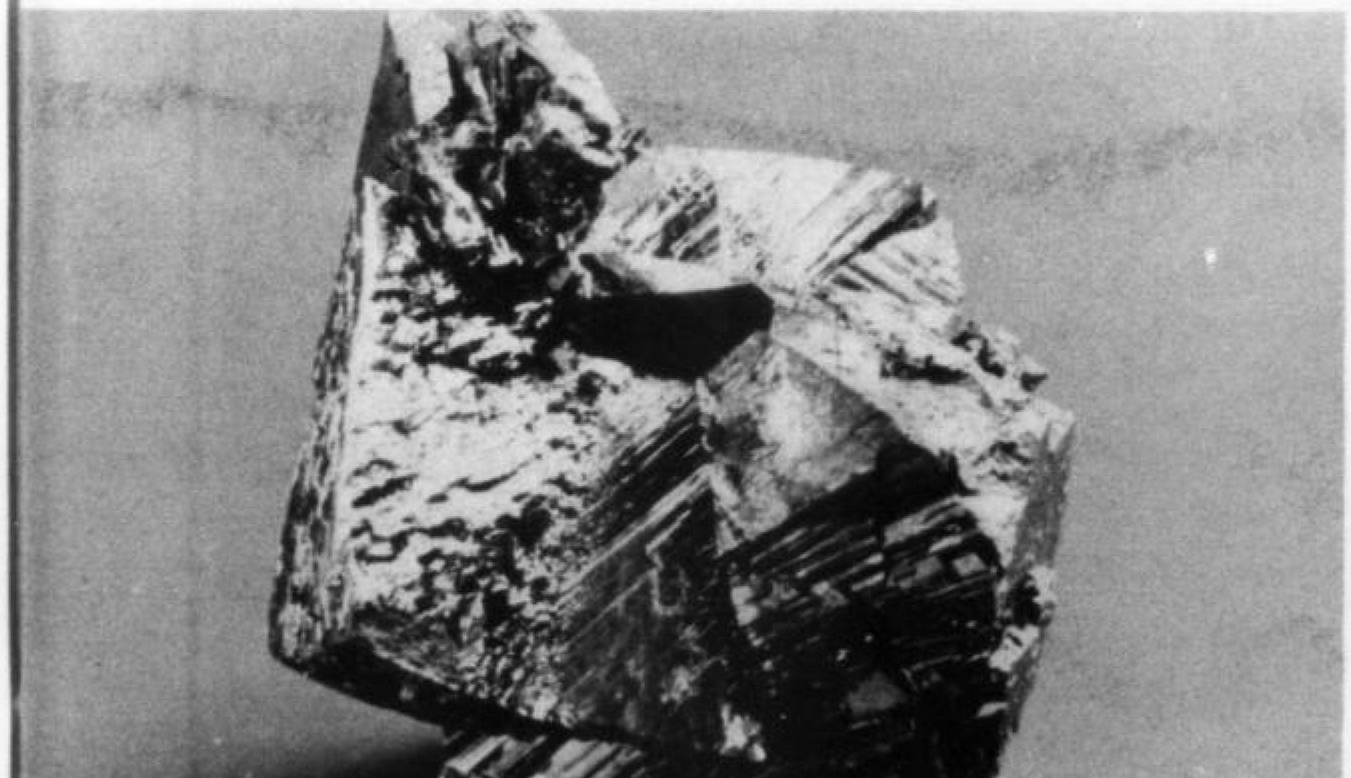
Of particular interest is that these crystals show what certainly is epitaxial pyrite (Fig. 4). Rather than scattered crystals of pyrite over the surface (as one sees the arsenopyrite when epitaxial on pyrite) the overgrowth is a continuous blanket less than 1 mm thick, sometimes covering the arsenopyrite crystals entirely. The identification of pyritohedral forms rules out the possibility of the overgrowth being marcasite, an iron sulfide mineral one might expect before pyrite since the structures of marcasite and arsenopyrite are so similar. Specimens with epitaxial pyrite appear to be rare.

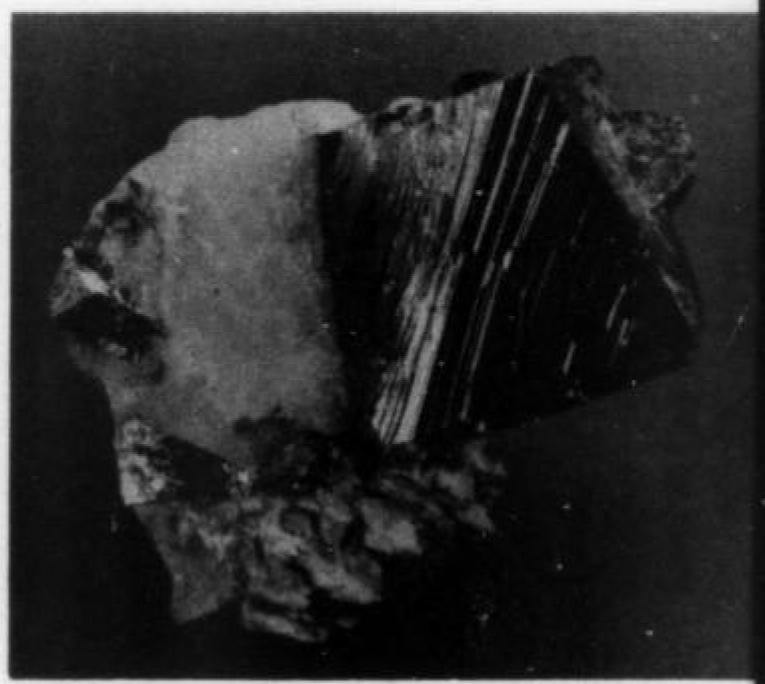
White quartz and calcite crystals are the only other common associated minerals.

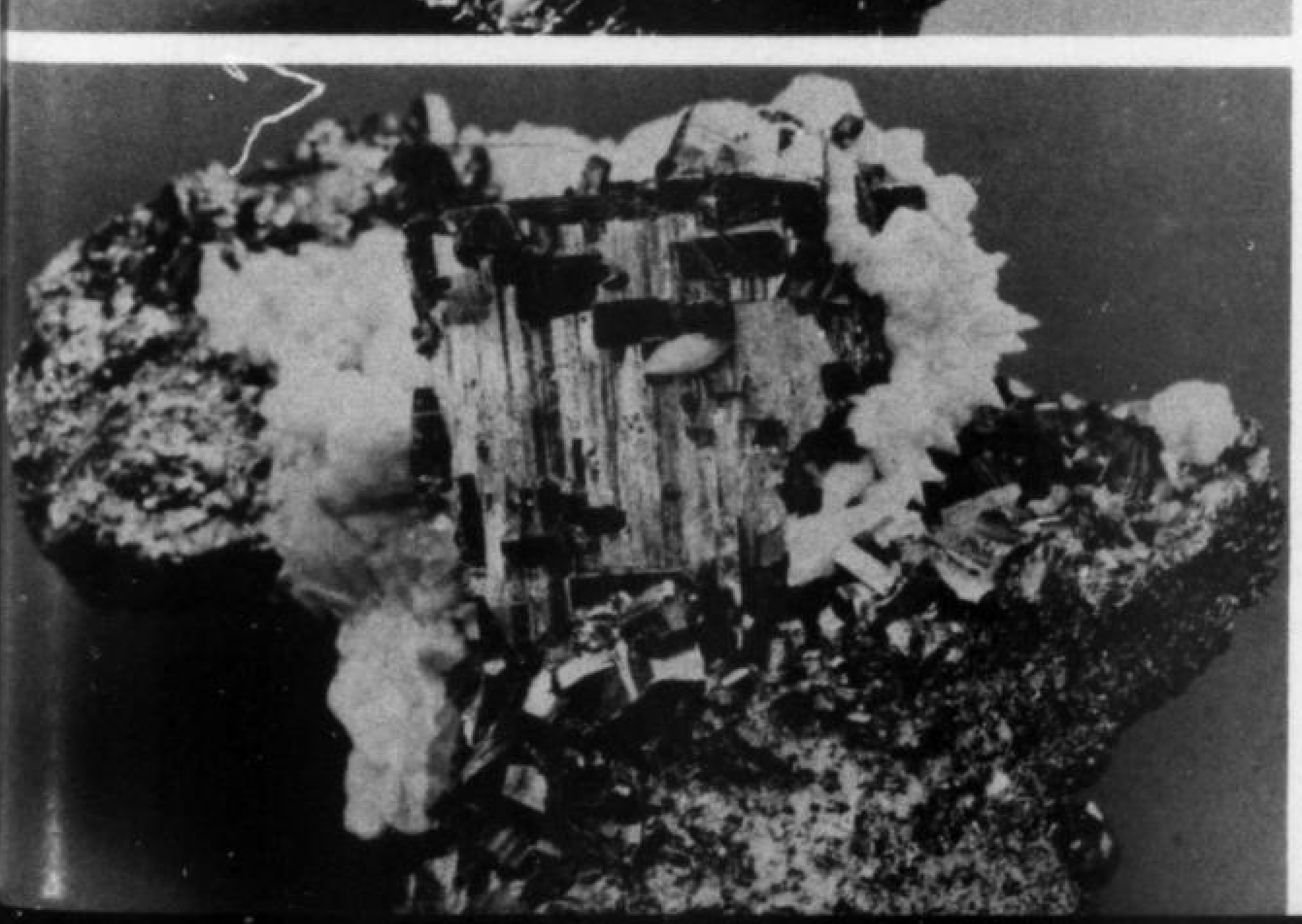
MARCASITE

Wisconsin marcasite delights the eye and challenges the imagination. How were these weird-shaped formations grown? The variety is incredible—from knobby stalagmitic growths to hollow shells shaped like, and the size of, a soldier's helmet. These strange growths tend to come in very large specimens, often at least a foot in one dimension. They are ideal for the "decorator piece" trade. Most of the specimens consist of flat plates of marcasite and sphalerite out of which rise the balls, shells, fingers and stumps of marcasite in bizarre forms and combinations. The helmet-like forms are often thin and hollow. When broken open they are usually found to contain colorless to white calcite crystals partly filling them. One characteristic of this marcasite is that it appears to be quite stable, even in the presence of marcasite from other localities that is decomposing. The marcasite-sphalerite undersides of the specimens do experience decay.

While at the Detroit Show this year (a fantastic show in all respects) my eye was drawn to some of this marcasite.







1. **Arsenopyrite in oriented overgrowth on pyrite. Noche Buena, Zacatecas, Mexico. Smithsonian Institution specimen.**

2. **Cluster of arsenopyrite. Santa Eulalia, Chihuahua, Mexico. Smithsonian Institution specimen.**

3. **Arsenopyrite, Santa Eulalia, Chihuahua, Mexico. Smithsonian Institution specimen.**

4. **Pyrite in oriented overgrowth on arsenopyrite (left side of large arsenopyrite crystal). Santa Eulalia, Chihuahua, Mexico. Smithsonian Institution specimen.**

It was part of the special display provided by Bill Howe (of Howe's Lapidary, Kinosha, Wisconsin), who very graciously allowed me to borrow two pieces to be photographed. The growths on Mr. Howe's specimens actually had hooks on the tips and a textured surface giving them the appearance of some sort of appendage from an aquatic animal. Photographs of the two specimens are shown in Figs. 5&6.

Very little information has ever crossed my desk about this material and the area (or areas) that produced it. About half of the specimens I have seen are labeled Shullsburg, which is in Lafayette County, southern Wisconsin,

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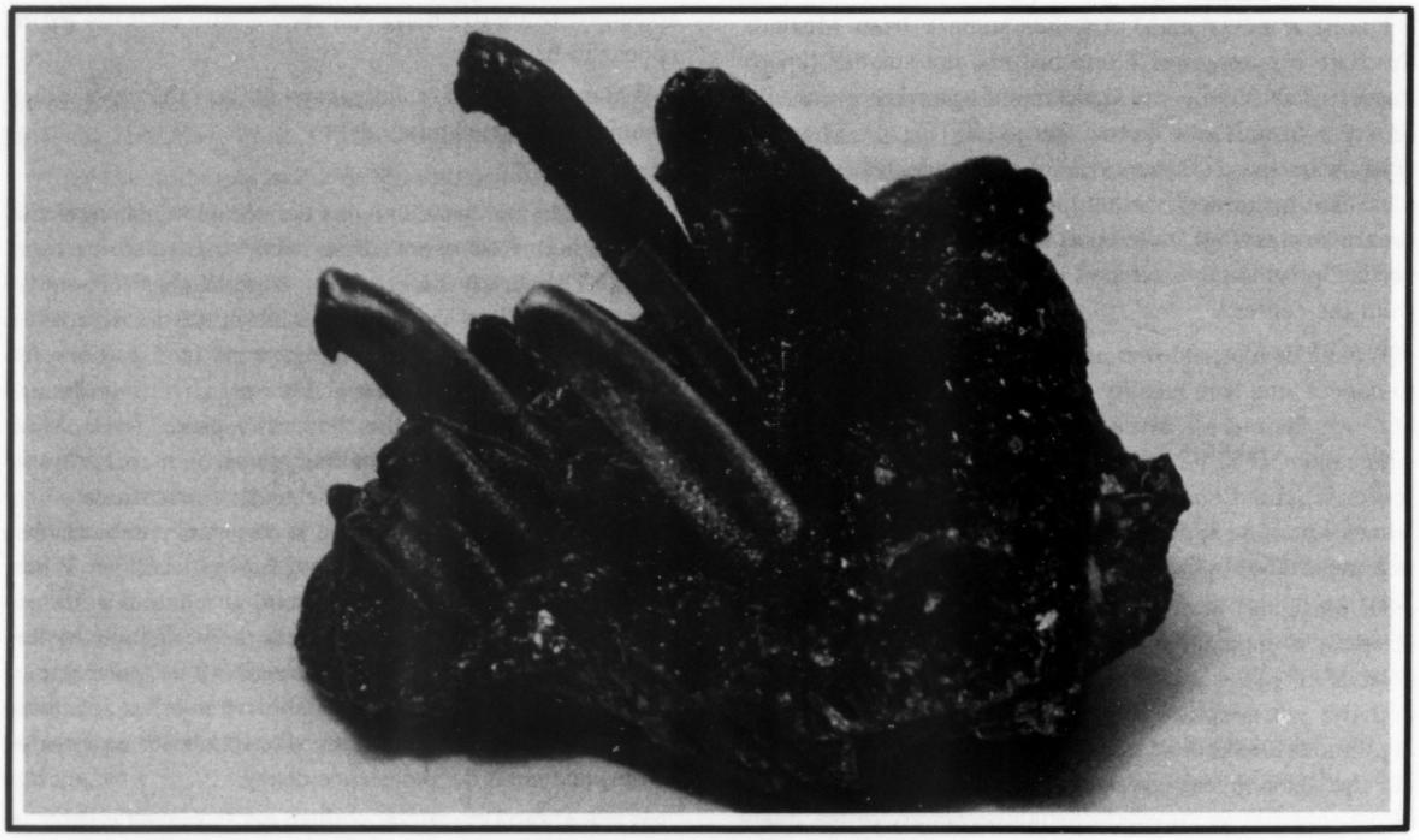
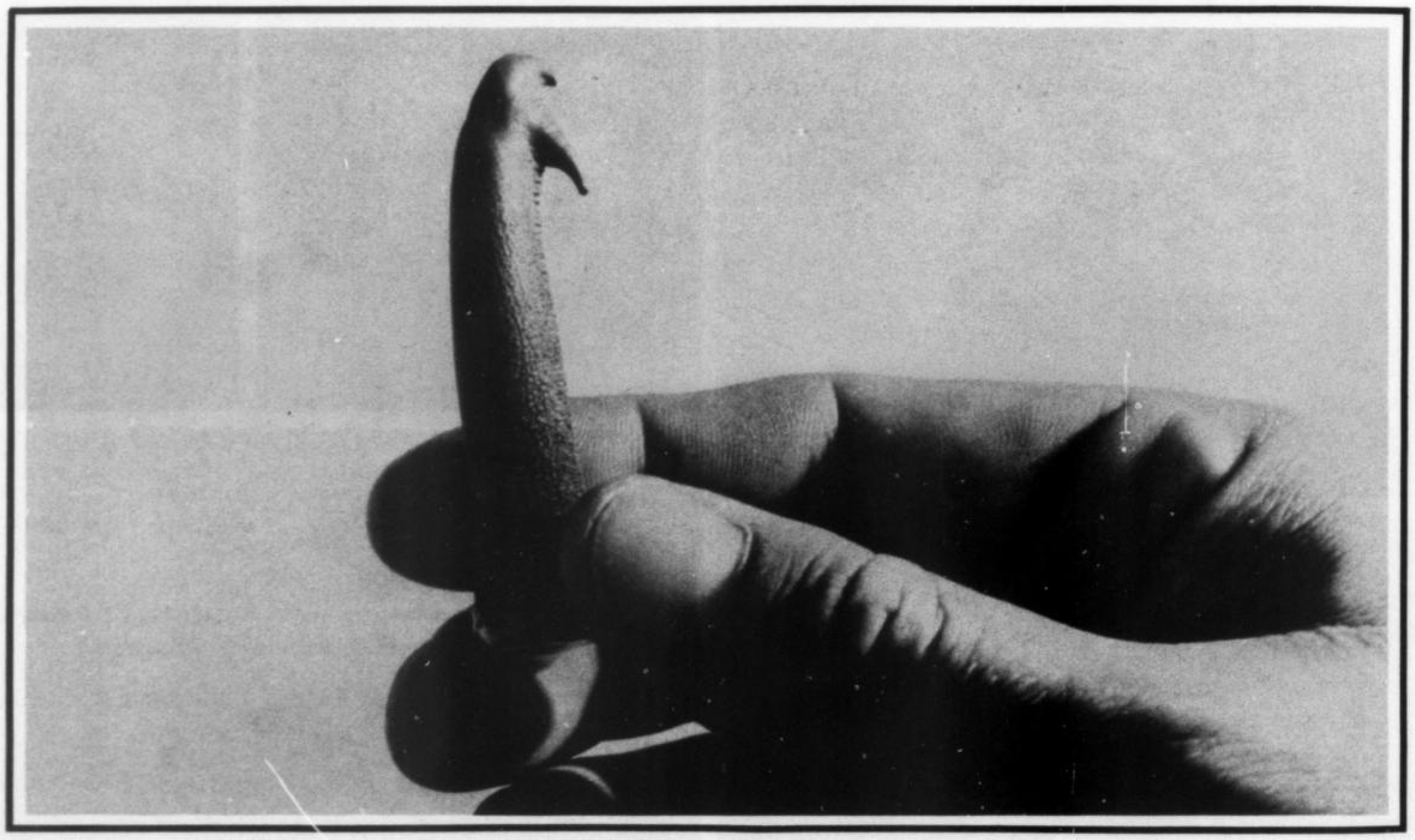
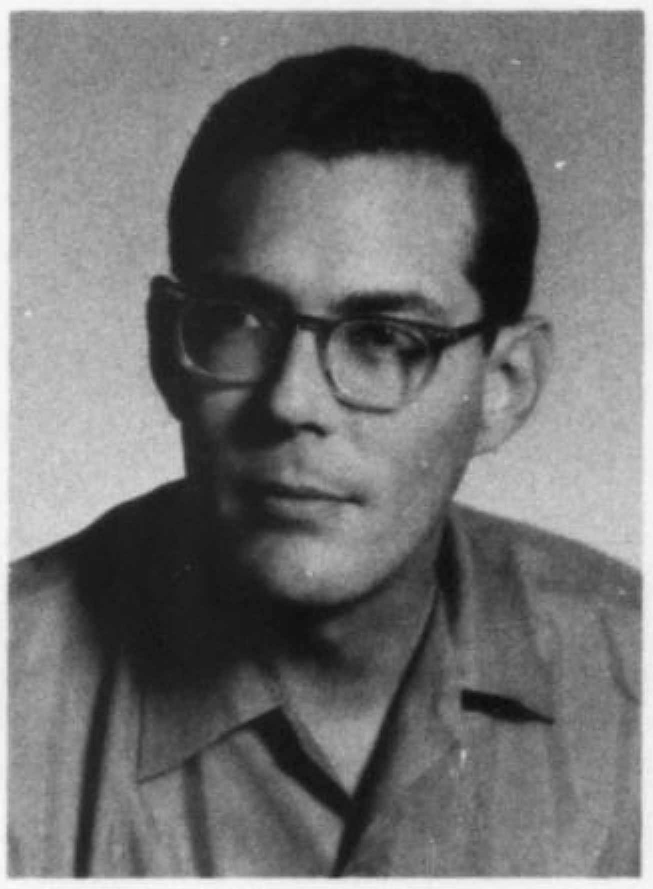


5. **Marcasite, Shullsburg, Lafayette County, Wisconsin. William Howe specimen.**



6. **Marcasite, Shullsburg, Lafayette County, Wisconsin. William Howe specimen.**



THE COLLECTOR

by Richard A. Bideaux

Accompanying this issue's column is a note by Jack Halpern, of San Francisco, on the use of typing correction fluid as an aid in specimen cataloging. I can attest that this beats any other method that I've seen and can even be readily used in the field. The method probably in widest use currently involves lacquer or "dope" manufactured primarily for modeling enthusiasts; this is the long drying material to which Jack refers. Little pieces of paper glued to the specimen, and bearing handwritten or printed numbers are commonly found on older collections. I once tried typewritten numbers on strips of adhesive tape, but this proved impractical as the adhesion was lost in only a few years.

There are a few cautions — Jack mentions that the spot should be put on the "least important surface." Specifically, this means out of sight, usually on the back or undisplayed side of the specimen. This may seem apparent, but all too often disfiguring numbers are unnecessarily evident on a specimen as it is displayed. For example, the Carl Bosch collection, now at the National Museum, once was gone over in preparation for numbering by untrained students, who laid on yellow daubs of paint almost without discrimination.

A broken or partly exposed flat crystal surface, if large enough, will take the paint most surely and smoothly. If such is not available, rougher matrix must be used. Generally two coats should be applied to give the smoothness required for accurate numeral formation with India ink.

Finding a smooth spot on most specimens presents little problem, but a few may require substantial effort. Sometimes the matrix is porous, or depressions must be filled in. Multiple thin coats are a necessity here. If too much typing correction fluid is applied at one time, a skin will form and the material underneath can take hours to dry.

Try not to fill in little pockets containing microcrystals, as these often provide material for study as important as that on the display side. Many micromount collections are made up in large part from material garnered from the sides and backs of cabinet specimens. These tiny but perfect crystals are more sought by professionals for serious crystallographic work than are the macrocrystals commonly displayed.

Poorly consolidated, friable material, such as the limonite and wad matrix of many of the highly oxidized minerals, presents another problem. Even though there is ample surface for application of the fluid, it tends to curl on thorough drying, sometimes even falling off, taking the number and part of the matrix with it. Since this type of matrix commonly soils the fingers during handling, and continually spalls residue about the specimen when on display, it is often best to stabilize the entire specimen before numbering. This can usually be done without detriment to the piece by application of one or more coats of an acrylic spray such as Krylon, being careful not to coat any of the crystals on the display side. In extreme cases the entire specimen may have to be soaked in diluted acrylic or glue before stabilization is achieved.

What is this specimen number, and why are we going to this trouble to put it on anyway? All of the pertinent information, such as species names, compositions, locality, etc., that one should associate with the specimen, cannot be put directly on the piece. This information must then be maintained separately, on labels and catalog cards, keyed to the specimen by a unique number in common.

Such a system prevents major problems in losing the identity of a specimen when it passes into other hands. Take the following instance — late in WW II, it seems that a major German collection had been packed into barrels by Russian troops for shipment back to Russia. This was blocked by advancing American forces, and the collection was found sitting on a railroad siding; over a dozen boxcars of specimens, and one boxcar of labels!

This important number can take a variety of forms, the simplest being a serially assigned number. More complex systems can be based on the numbering schemes in Dana's *System of Mineralogy*, Strunz's *Mineralogische Tabellen*, or Hey's *Chemical Index of Minerals*. These longer numbers contain information on the species and its classification, when used in conjunction with the proper text. They must be made even longer when used for cataloging purposes, as an additional number, serial within species, must be added to provide the necessary unique specimen number.

These systems break down when the species being catalogued is not represented in the source text, usually be cause it is new since the last revision. *Dana's System*, VII Ed., is missing the silicates but this can be alleviated somewhat by ordering a copy of *A Dana-type Classification of the Silicates*, Mineralogical Society of Southern California Special Publication No. 1, from R.E. Pedersen, 645 Maryanna Lane, Monrovia, California, 91016, for $1.50.

Several numbering methods have been tried on our own collection, but currently simple serial numbers are being used. If these are reused as duplicates or disposed of, an added advantage is knowledge of how many specimens are cataloged.

Some collectors incorporate the date of acquisition as part of the number, while other times a collector's initials are added as a means of personalization. Stamp collectors sometimes use special marks, as a tiny crescent moon for example, to provide this personalization less conspicuously. Some of the stamp marks are world famous, yet the collector prefers to remain anonymous.

Many pieces in the American Museum of Natural History collection have a little dart (v) inked directly onto the bottom of the specimen, showing the direction of the best display face in the opinion of an early curator. Among the best collectors and curators however, there is rarely even slight disagreement as to the best way to turn a specimen for display (and there is usually only one best way!): this is an acquired skill.

Peter Embrey, curator of the British Museum collections, quite correctly once pointed out to me that there is one paramount item of information about a specimen that should be placed on it if anything is to be; this is the locality. Nearly all else of importance can be determined from the specimen itself. There are a few other intangibles, sometimes even of scientific importance, such as the history of the piece, that many like to record, so maintenance of a separate catalog is still desirable.

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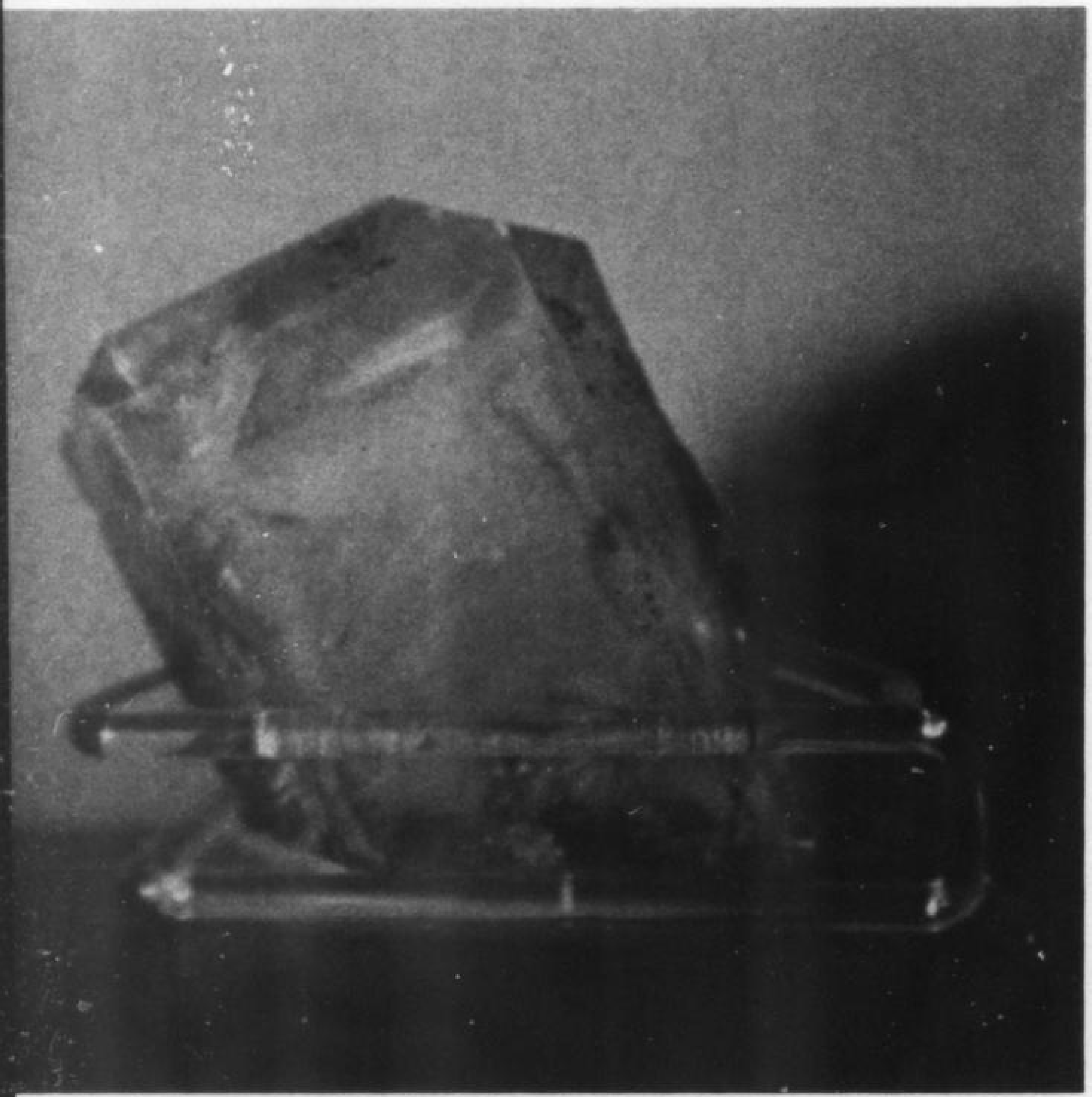
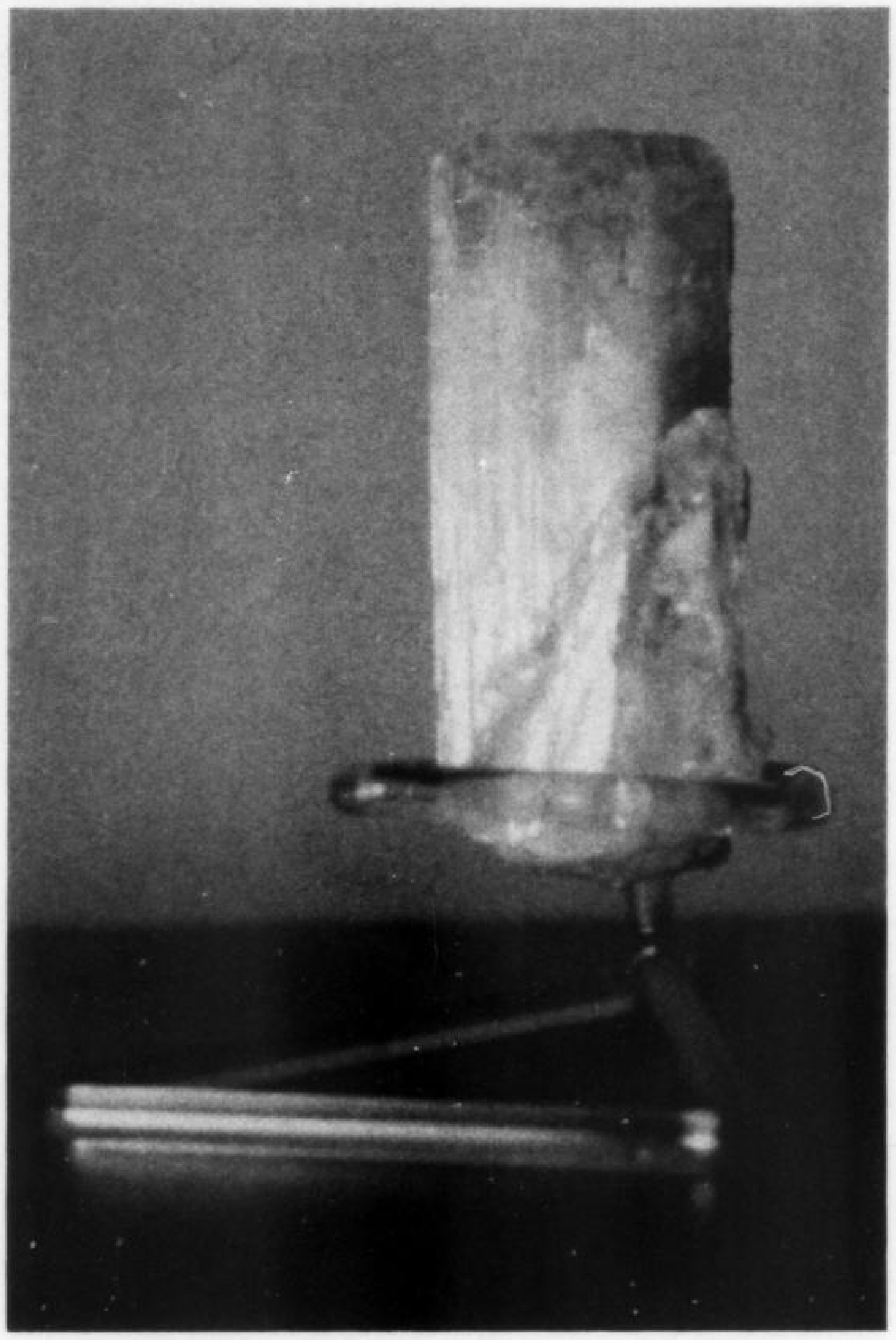


Barite. Knoch, Westmoorland, England



Danburite, Charcas, San Luis Potosi, Mexico

The pictures with this column are contributed by Malcolm Smith of Walnut Creek, Calif. He writes "The enclosed pictures illustrate stands or mounts I have constructed for a number of single crystals and mineral specimens to replace the dust collecting styrofoam blocks which often obscured a good part of the specimen.

I took some ordinary laboratory glass rod (5 mm. in diameter) and fashioned each mount in less than one minute. The cost figures to about 3½ - 4 cents each. The only tools needed are a glass cutter or file and a propane torch, available at any hardware store. Scientific supply houses carry glass rod in four foot lengths, sold by the pound. The material I used was a dollar a pound and there are thirty feet to the pound.

Each stand is made from one piece cut to about a twelve inch length. a triangle is made by torching the rod at 2 — 2½ inch intervals and bending while fairly hot, bringing the third side around to the starting point. The rod is then bent perpendicular to the plane of the triangle. At a height of about an inch another similar but smaller triangle is fashioned directly over the base. With only a small amount of practice, the judgement of the distances involved allows ending up with no excess. It is sometimes desirable to bend the top triangle down a bit to lower the center of gravity.

Although this kind of stand will support many specimens and crystals it is easy to fashion a custom-made stand for the specimens with a different set of dimensions." Note custom modeling of the barite crystal's base.

Glass rod is cut by filing a notch, then snapping. Firepolish the cut ends with the torch until melted into a rounded form. Wear gloves when bending — hot glass sticks to fingers!

I would be interested in hearing from readers about the most effective display techniques they have seen, preferably accompanied by high contrast black and white photographs.

****

IN, BLESSED SPOT — Jack Halpern

Numbering is a key step in cataloging a collection of minerals. Crystal collectors have long sought to learn the simplest way to produce a light-colored spot on the back of a mineral specimen for subsequent use in numbering the specimen.

This light-colored spot is the daub of paint, usually white, which you apply on the least important surface of a specimen to create a background field. Later, with India ink of a boldly contrasting shade, you inscribe on it the specimen number you assign to this particular sample.

The Problem — Painting the white mark used to be an awkward nuisance. Most paints available used to be slow-drying, making it nearly impossible to complete the cataloging of a batch of specimens in the same session as that in which the task was begun. The light background field must be absolutely dry before the India ink number can be properly overwritten, and to wait for complete drying made cataloging operations seem interminable.

Then too, the paint brush used in applying the white daub would need to be cleaned following its use; one rarely faced this somewhat messy operation with relish.

Still, in taking a professional view when cataloging a specimen, the perspective is of the long term and you want to make sure your specimen number will be legible centuries hence. As a result, the use of glued-on paper numbers is to be avoided because with the passage of sufficient decades, such attachments are likely to lose their adhesion and fall off. Instead the painstaking and patience-taxing procedures already described are followed. Pardon if a profane word forms occasionally on your lips.

The Solution — Now contemporary technology permits one to create the white spot easily and conveniently, and within a matter of seconds to achieve a dry surface ready to receive an India-inked number. Make use of the same materials employed by office typists to cover over the inevitable occasional typing mis-stroke which mars the perfection of a typewritten letter: use *typing correction fluid* to produce the white spot needed on the back of a mineral specimen.

Advantages:

(1) Typing correction fluid is very quickly and easily applied by means of a small brush which is an integral part of the container cap.

(2) It dries completely within a few seconds of application.

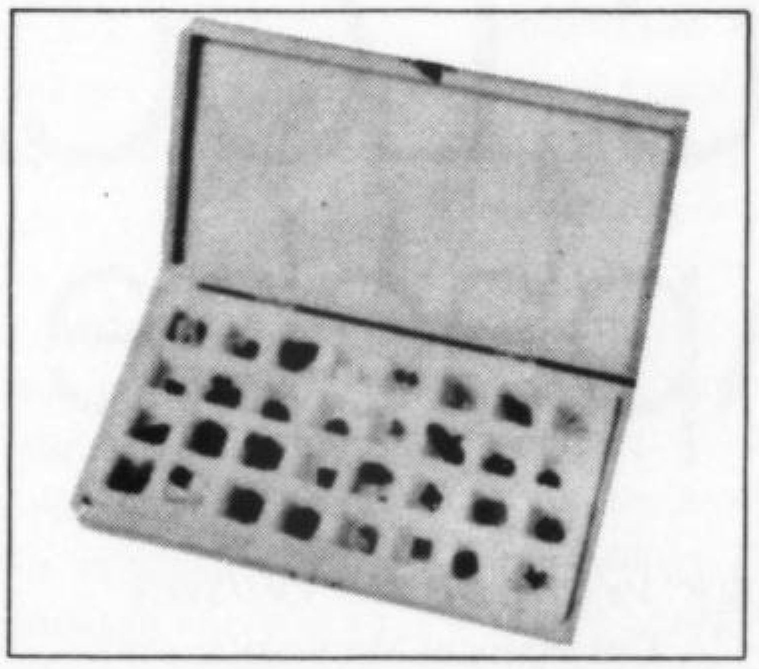
(3) The brush, which should be promptly placed in the container after use, needs no cleaning.

A small bottle of white correction material, available at most stationery stores costs about one dollar. It will provide sufficient quick-drying enamel-type paint for daubs on at least several hundred mineral specimens. Brands such as "Liquid Paper" and "Snopake" have proven excellent.

When you have made a neat white mark on the back of a specimen (just large enough for your number), and you have entered upon it your specimen number with contrasting permanent India ink, underscore the number to show the orientation in which it is to be read. Otherwise, sixes and nines may be mistaken for one another with resulting confusion. When India ink is dry (a matter of perhaps forty seconds), protect your number with a coating of clear finger nail polish and it will be ready for the ages.

To Lady Macbeth, certain spots, hematitic in hue, may have caused a measure of concern, but no astute mineral collector armed with a suitable white shield need any longer be awed by problems surrounding the creation of the pristine spot.

A debt of gratitude is acknowledged to mineralogist Dr. William B. Sanborn of Newport Beach, California for sharing his world of crystals and for his lessons on cataloging a mineral collection.



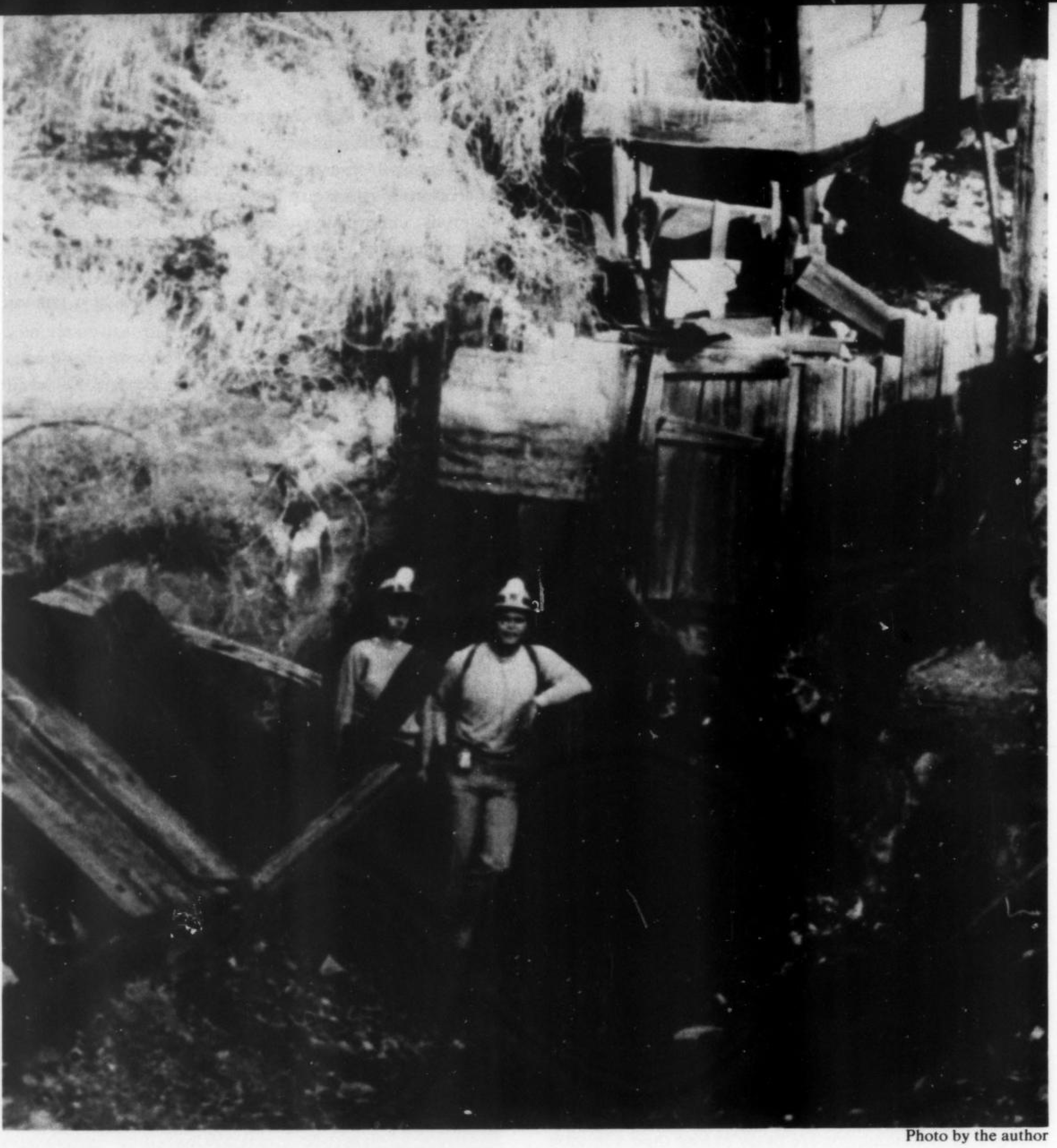


Photo by the author

Fig. 1. **Main entrance to the mine. A couple of Eastern collectors, Rick and Lynne Stinchfield, found the mine quite a pleasant change from working pegmatites.**

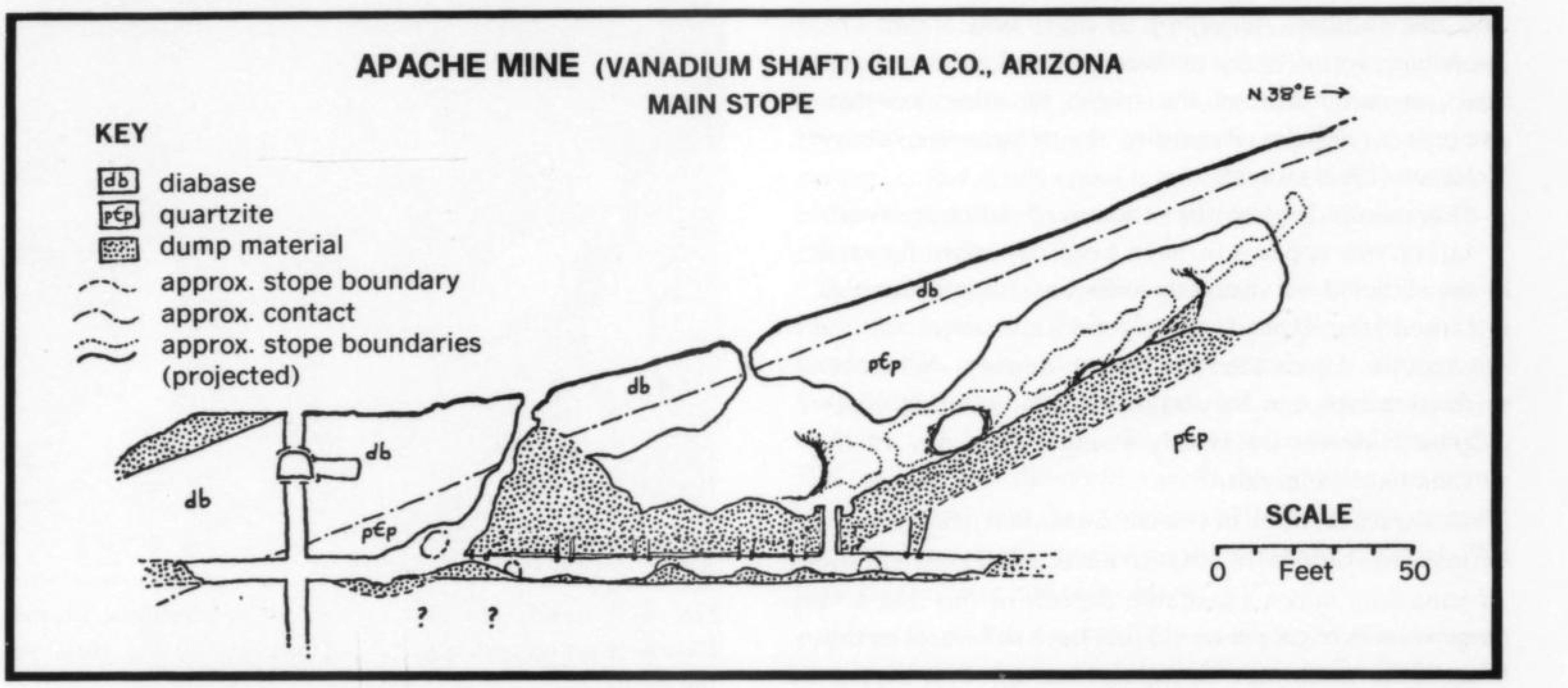
CLASSIC LOCALITY:
The Apache Mine

by Wendell E. Wilson
University of Minnesota
Bloomington, Minnesota 55420

ABSTRACT

The Apache mine, Gila county, Arizona, has produced fine specimens of vanadinite since 1930 and is still yielding specimens to this day. Since 1930 twenty tons of vanadium concentrate and thirteen hundred tons of oxidized lead ore have been mined. The deposit is the oxidized zone of a fault breccia lead vein and may have been influenced by externally-derived vanadium-bearing solutions. Minerals present include vanadinite, descloizite, mottramite, calcite, quartz, cerussite, anglesite, willemite and galena. The mine consists of a fault vein stoped continuously for over 450 feet and accompanied by shafts and drifts. Although the mine is quite hazardous many collectors are drawn by the abundant, sometimes exquisitely beautiful, vanadinite specimens found there.

The Apache mine, Gila County, Arizona, is familiar to most collectors as one of the two most productive localities in the United States for fine vanadinite. The other locality, the Old Yuma mine, has produced very little vanadinite since the main stope caved in a few years ago (although many fine wulfenites have lately merged). Regardless of the volume and variety of vanadinite that has been produced from Mexico, Morrocco and elsewhere, an experienced collector can always recognize an Apache specimen by the blood-red color of the crystals, stocky habit, frequent background of rich, black mottramite, and charac teristic mottled, meta-sediment matrix. For decades the Apache mine has provided fine specimens in amazing quantities, and specimens are still being produced to this day.



LOCATION

The mine is located about five miles north of Globe by road from the highway 60-80 intersection. In the past the Apache mine has also been known as the Defiance mine and is designated as the Vanadium shaft on the Globe, Arizona, quadrangle, sec 2, R15E, T1N. A new trailer camp blocks the old road to the mine but fortunately there is an alternate road a few hundred feet to the west. The low hills of the area can all look alike, and the roads on the quadrangle map must be followed very carefully. Several other abandoned shafts and diggings are present in the immediate area, and a profusion of old mines are present in the quadrangle. Most of these have not been thoroughly explored by collectors.

HISTORY

Visible across the valley from the Apache mine are the Inspiration smelter and mountains of tailings from the huge open-pit copper mines for which the Globe-Miami area is most famous. The discovery of ore in the area can be indirectly attributed to the murder in 1836 of Chief Juan Jose of the Apache Indians, by white men. This diplomatic *faux pas* caused the Apaches to reassess their friendly attitude toward the European Americans, and by 1866 a full-scale Indian war had developed. In 1871 the Federal Government sent large numbers of troops into the area in a determined effort to end the Apache problem. It was during one of the first attack missions conducted by Army cavalry in 1871 that promising mineralization was discovered. How the troopers had time to prospect while fighting Indians is still a mystery. Civilian prospectors entered the area a year later and by 1874 Globe had become a booming silver camp. Commercial production and smelting began in 1881, and the Apache conflict ended, finally, with the surrender of Geronimo in 1886. Copper production began around the turn of the century.

A prospect pit is indicated on the Apache vein on a U.S.G.S. map of the area made in 1902, indicating that the actual discovery may well have been made by some obscure prospector in the late 1800's. The first known production from the deposit was not until 1930 when Edward C. O'Brian and Co. produced and shipped 20 tons of vanadium concentrate. (Collectors shudder at the thought that this 20 tons was mostly vanadinite crystals.) Dana's Textbook of Mineralogy, 1932, mentions a locality for vanadinite "...near Globe, Gila County (Arizona)" which almost certainly refers to the Apache mine. From 1936 to 1948 the mine was worked sporadically by the owner, D. S. McDonald, and various lessees. During this time about 1300 tons of lead ore was produced which also contained small amounts of gold and silver. The ore was hand-sorted and probably comprised no more than 20 percent of the rock broken in the stope. The owner in 1953 was the Mercer-King Consolidated Mines Ltd. of Globe, Arizona (Wells and Mead, 1953).

In a time when it is normally so important to get permission from a property owner before collecting, it is curious that after much inquiry and research I have as yet been unable to establish the current ownership of the Apache mine. A title search may be necessary. However, because the mine has been unproductive (from a mining standpoint) for so long, it may well be that ownership has reverted to the State of Arizona through non-payment of taxes, but this is only a guess.

GEOLOGY

The deposit at the Apache mine appears to be the oxidized zone of a deposit containing galena and minor copper and zinc sulfides. According to Berry and Mason (1959) vanadinite forms in the surface oxidized zone and represents an enrichment of the sparse vanadium content of the primary sulfides. Regarding the paragenesis, however, Peterson (1962) writes:

> "Vanadinite formed after the quartz-sulfide mineralization, but appears to have been deposited by solutions that were distinctly different from those that caused the typical supergene alteration of the [Apache, Albert Lea, and Irene] deposits. Wherever relationships can be established the common supergene minerals are clearly younger than any of the vanadium minerals."

This sequence does not seem consistent with a normal series of alterations. In order to distill small concentrations of vanadium into a vanadinite deposit of this size a very large volume of galena would first have to be broken down. Vanadinite would not be expected as the first supergene mineral to form. An alternative is that the vanadinite was deposited in part from a vanadium-bearing solution not derived from the primary sulfides. Vanadium-uranium solutions transported long distances by ground water are thought by some to be the source of the Colorado Plateau deposits of these elements. Perhaps a similar solution depleted in uranium encountered the Apache lead vein and reacted to form the vanadium minerals. Under certain Eh-pH conditions vanadium can precipitate while uranium remains in solution or vice versa (Garrels and Christ, 1963). Because these reactions can occur below the water table in a reducing environment, other secondary minerals may not yet have formed. Torbernite, a copper-uranium phosphate, is found elsewhere in the district (Peterson, 1962), whereas the uranium-vanadium minerals carnotite and tyuyamunite are largely absent.

The ore body is in the Precambrian Pioneer formation, which here is a hard, fine-grained quartzite overlain by


Photo by the author

***Fig. 2.* The Apache Mine and dump. Headframe is visible above the dump.**

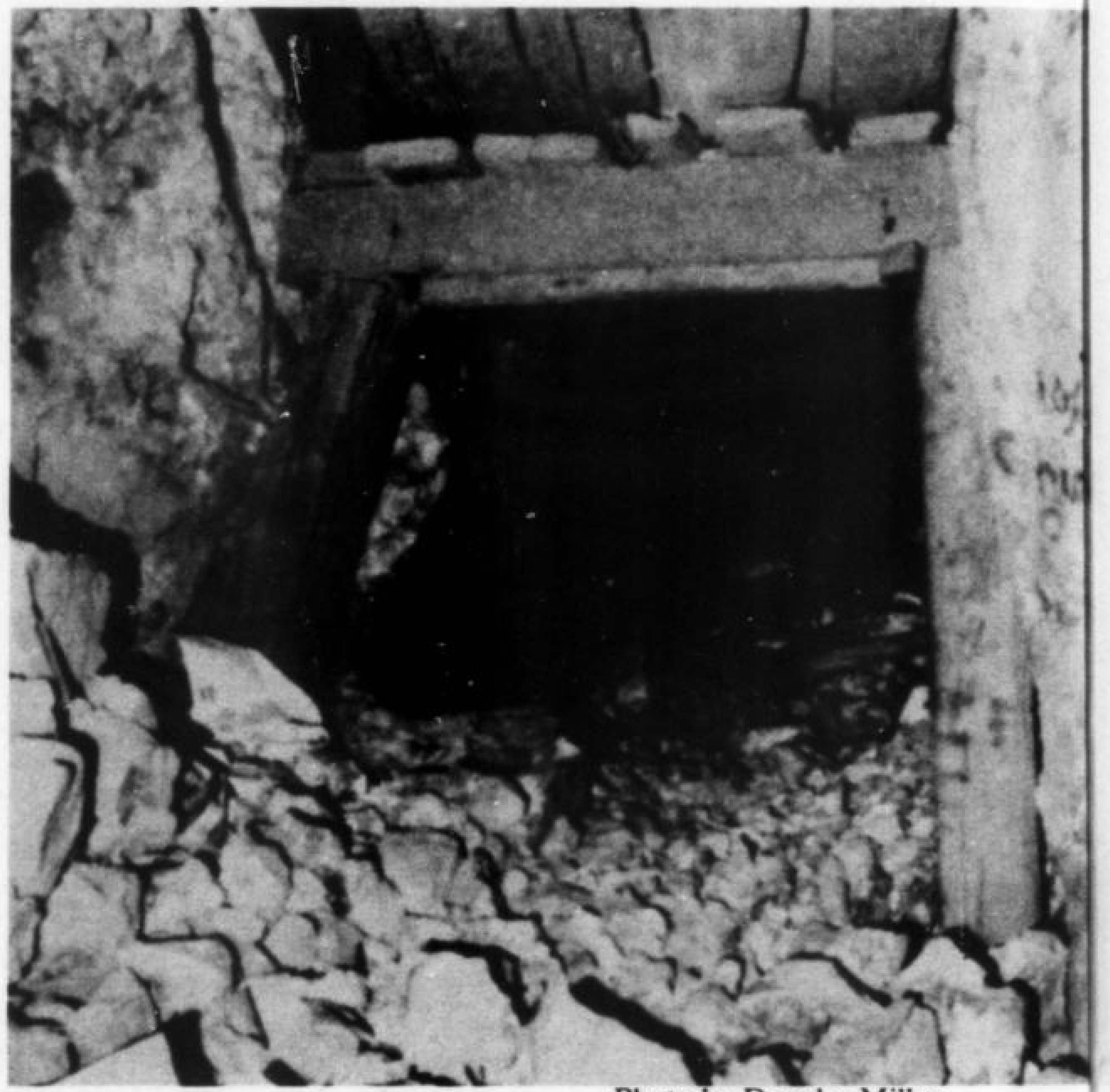


Photo by Douglas Miller

***Fig. 3.* A nearly blocked section of the haulage tunnel. Debris is entering from a filled opening to the stope on the right.**

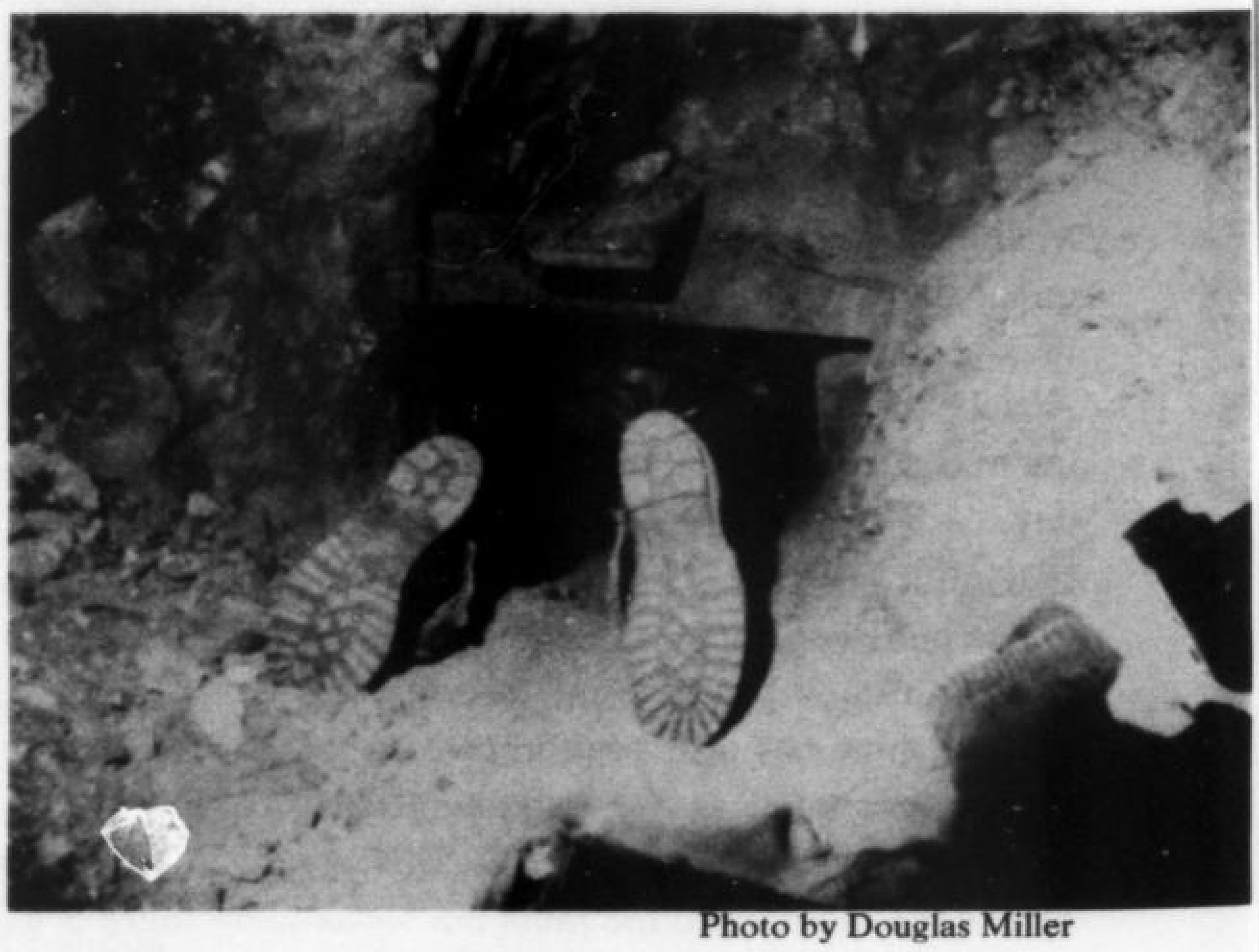


Photo by Douglas Miller

***Fig. 4.* One of the tighter squeezes in the haulage tunnel.**

Photo by Douglas Miller

***Fig. 5.* The author standing in the haulage tunnel near the manway to the stope, which is above the section of ladder. The best mottramite exposure is immediately around the corner to the left. As in this area, most shoring is in good condition.**

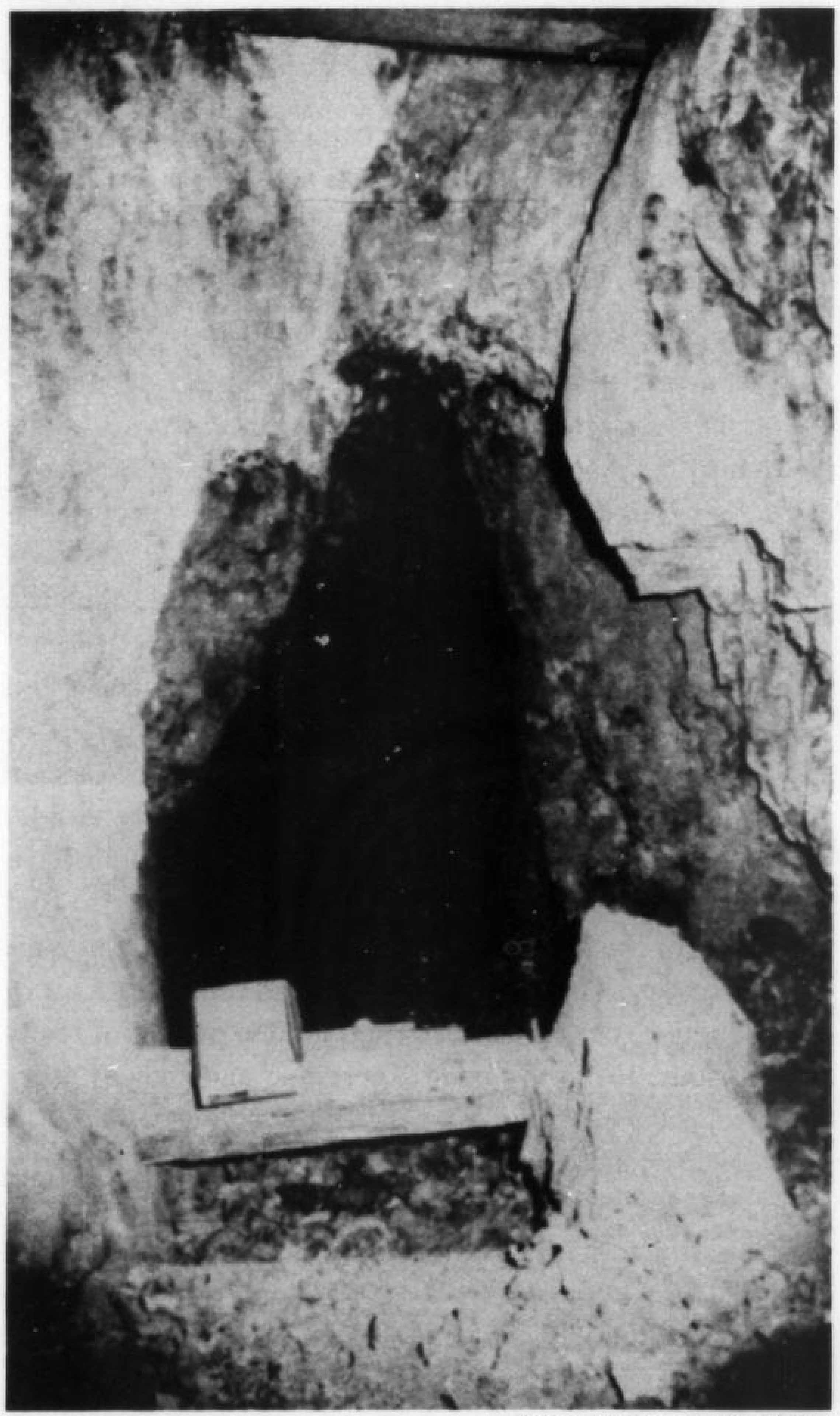


Photo by Douglas K. Miller

***Fig. 6.* A portion of the main stope, looking downward toward the manway. Best collecting areas are in the rooms through the wall to the right and in the lower section of the "chimney", which is behind the photographer.**

diabase. The dip of the beds is 30-40° south, which roughly parallels the hillside and the trend of the underground stopes. The vein strikes N30°E and is nearly vertical. It is bounded on the top by a diabase flow and on the bottom by a bedding-plane fault (Peterson, 1962).

MINERALIZATION

Much lead was once present as masses of cerussite and anglesite, often surrounding a small remnant core of galena. Willemite occurred as granular aggregates of small hexagonal prisms interspersed with fine-grained vanadinite and descloizite. Other than vanadinite and descloizite these minerals are rarely encountered in the mine now.

Vanadinite is fairly common in crusts of 3mm crystals, and crystals 1 to 2 mm or less are abundant in the extreme. Most of the best specimens have ruby-red crystals up to 6 or 7 mm in diameter which are flat and lustrous on all sides. A few extremely rare crystals over a centimeter in size have also been found, and rumor has it that some 2 to 3 cm crystals were seen when the mine was operating. The basal pinacoid is often frosty, however, and cavities can be present in the sides of many of the larger crystals. Cavernous or hopper crystals with pyramidal modifications are occasionally collected. As might be expected, specimens with crystals measuring 6 mm or more are highly coveted by collectors and rarely make it into the commercial market. Most are jealously hoarded or privately sold or traded to other collectors.

Also present in good specimens are rich black druses of mottramite ranging from sooty to sparkling. Rarely this mineral has been found as free-standing, arborescent-botryoidal formations. When present as a background for brilliant red vanadinite, the contrast is truly beautiful. Hollow molds of dissolved vanadinite crystals can sometimes be found, and the specimens with the largest crystals, about 0.2 mm, make interesting micromount material. The crystals are sharp and shiny black.

Brown to reddish descloizite in poorly crystallized masses and coatings is often associated with vanadinite in the main vein, and quartz in druses of 1 mm crystals tipped with other minerals is also present.

The only other common mineral in the mine is calcite, which sometimes completely coats specimens, but can add an attractive and contrasting white to the color scheme of samples when artistically and sparingly grouped. The blocky to platy, milky white crystals with trigonal (rhombohedral) truncations are distinctive.

MINE PLAN

It should be emphasized here that this is a dangerous mine. Inexperienced collectors have no business here, and in fact it has been argued that the mine is too dangerous for anyone at all. I have been hit by more falling rocks in this mine than anywhere else. An acquaintance who used to favor collecting alone and without a hard hat (both cardinal sins) was once knocked unconscious for several hours in this mine by a falling rock. Needless to say, he has since changed his policy, at least regarding the hard hat!

Photo by the author

Fig. 7. **The "chimney". Rick is removing part of a fine pocket. Fresh air periodically had to be blown into the working area by waving beer flats.**

Regardless of the dangers the characteristic drive of mineral collectors still compels many to collect here. During two years in Arizona I met only one collector who had not been to the Apache mine.

Basically the accessible portion of the mine consists of two shafts, a haulage drift with many jammed ore chutes emptying into it, and several tabular stopes occupying at least 450 feet of the original vein. The fault breccia zone is normally 5 to 10 feet wide with numerous off-shoot faults and fracture zones extending into the wall rock on the northwest side of the main fault. The best collecting area is this zone of off-shoot faults parallel to the main stope. The surface dump is relatively small because much of the underground workings were used for the disposal of waste rock and are now inaccessible.

The main shaft is a few steps into a adit under a collapsed headframe. A rather rickety ladder descends about 40 feet down to a landing at the haulage drift. The shaft continues down but is barren of specimens below this level. From the shaft the tunnel ends quickly in one direction and continues past several ore chutes in the other direction. Cave-ins and rock slides from the chutes nearly block the tunnel in two places and great care should be taken not to aggravate the situation. Near the end of the tunnel, about 150 feet from the shaft, is a manway around a corner to the right that ascends about 20 feet into the stope. Further down the tunnel, in the short distance before it ends, a number of fine specimens have been collected. The area near the base of the manway is where the best mottramite is found.

Air enters the stope through a small manway in the ceiling about 75 feet above the floor. Some collectors have entered the mine through this hole from the surface using a long rope ladder, thus avoiding the hazards of the haulage tunnel.

Shaft no. 2 is located 160 feet to the southwest of the main shaft. The woodwork and ladder are badly deteriorated and make entry even more hazardous than the main shaft. In a brief exploration of this shaft and a small accompanying stope I found no collectable material of any kind.

Photo by Douglas Miller

Fig. 8. **Shoring in the stope consists solely of a few beams wedged between walls of the fault.**

COLLECTING

What most surprises the average collector on his first visit to the mine is that, once in the main stope, vanadinite is literally everywhere! The walls are coated with crystals, the talus underfoot is coated with crystals, the ceiling is even coated in many places, and dense nests of red, sparkling crystals peer out from almost every crack and vein. A preliminary investigation soon shows, however, that the crystals are quite small and often badly damaged. Many rocks with good crystals are astonishingly tenaceous, and will not break until every crystal has been vibrated off by the shock from hammer blows. Deep cracks look more promising but fine material is rarely immediately visible. The key to remember is that hundreds of people have probably scoured these obvious outcrops. In order to find the best Apache has to offer each collector must make his own discovery. This requires digging and removing a lot of unproductive rock in search of that hidden pocket of really fine crystals. From my own experience and that of other collectors it seems that the big strikes are usually in the form of irregular, volleyball-sized zones in the breccia in which breccia fragments are thickly coated with large crystals. A treasure pocket like this will usually yield enough outstanding specimens to cover the bottom of three to five beer flats! (Beer flats, which make handy collecting containers, measure about 30 X 40 cm. One is visible in Figure 7.) These are not discovered every day, unfortunately. As with most collecting elsewhere, it takes hard work and luck, and few collectors have made more than one or two such strikes. On an average day just a flat or so of fair to good specimens can be collected here and there, and occasion-

Photo by Douglas Miller

Fig. 9. **A cabinet specimen of vanadinite from the collection of the author.**

Photo by the author

Fig. 10. **The commonest forms of vanadinite crystals: the 6-sided prism and basal pinocoid. Crystals are about 3mm.**

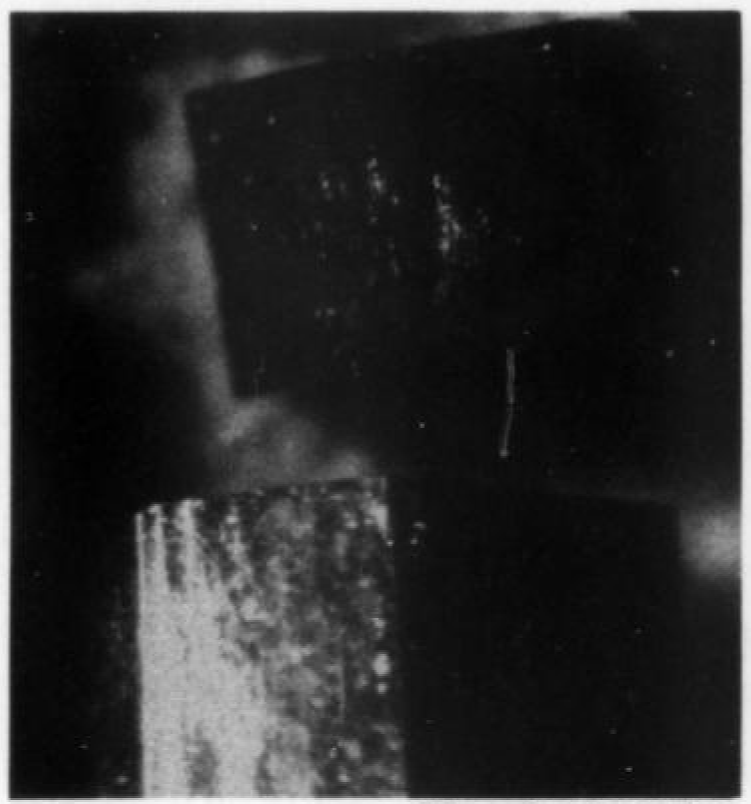


Photo by the author

Fig. 11. **Side view of vanadinite crystals showing growth lines parallel to the basal pinocoid, and attractive internal reflections. Crystals are about 4mm in diameter.**

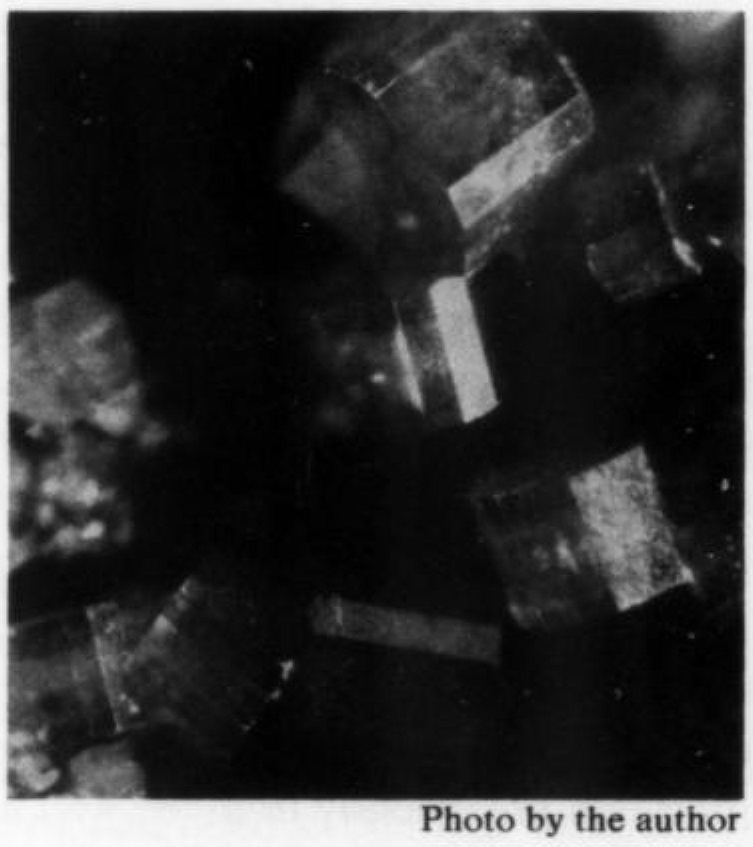


Photo by the author

Fig. 12. **A group of vanadinite crystals in rare 12-sided prisms. Crystals are about 1mm.**

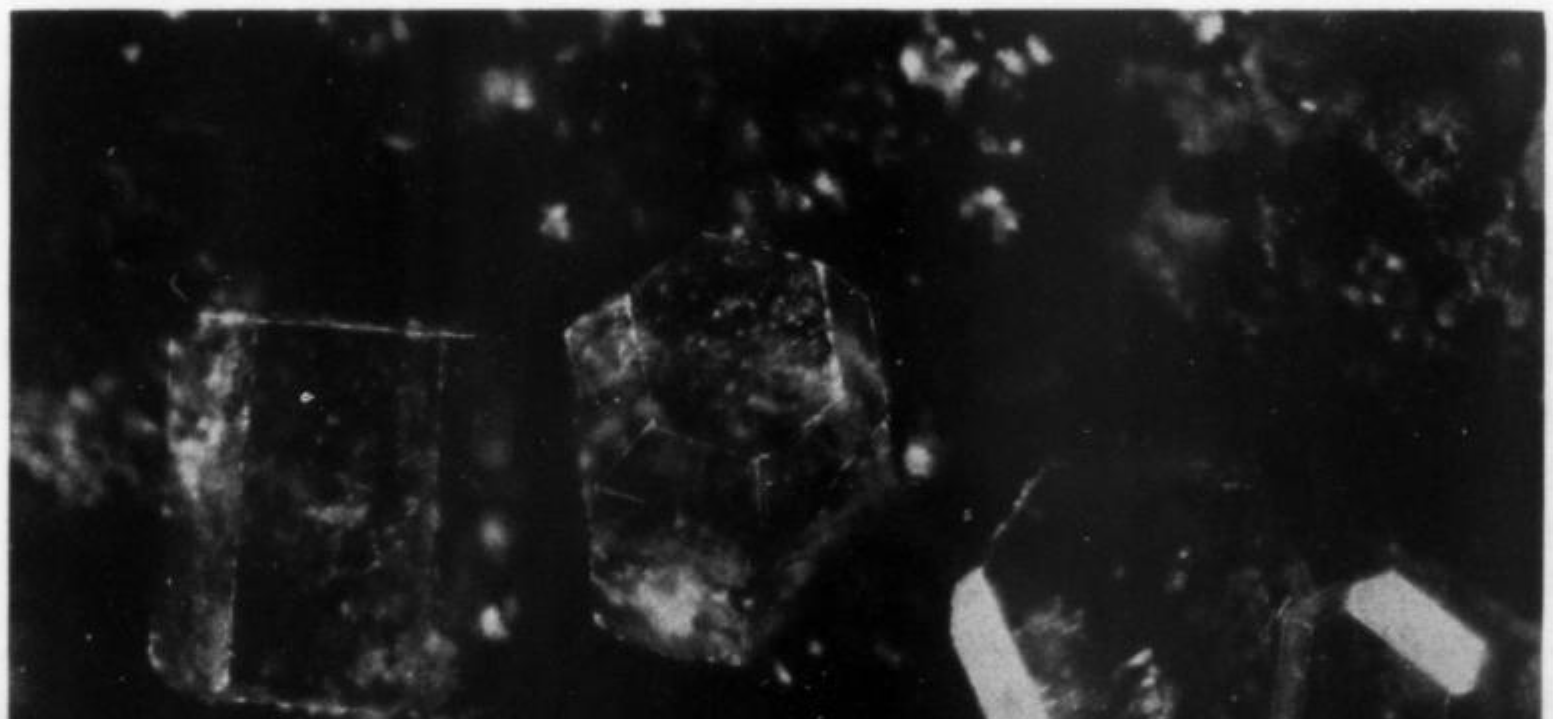


Fig. 13. **Water-clear vanadinite crystals with hexagonal pyramid faces. Crystals are about 1mm.**

Photo by the author

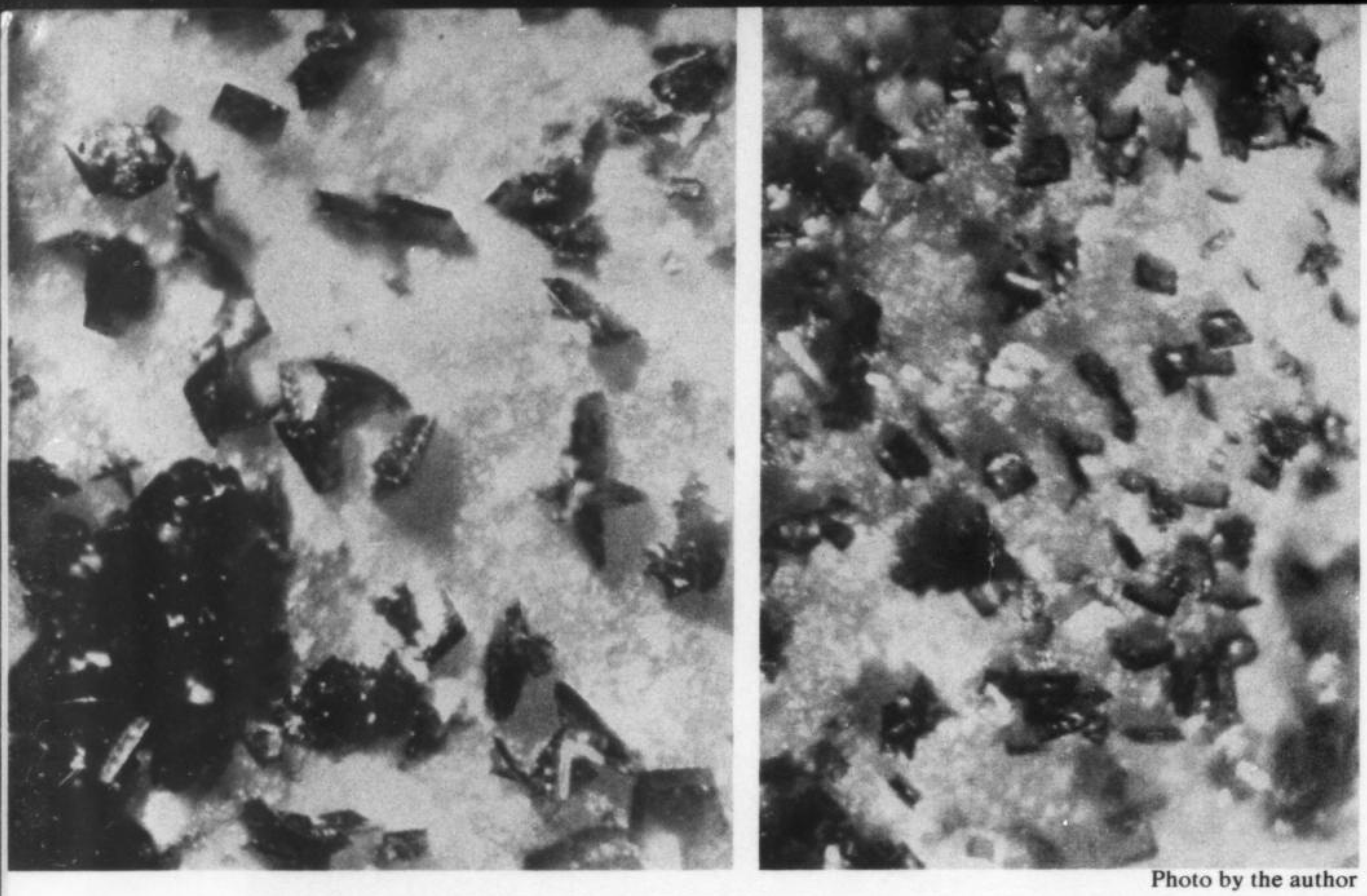


Fig. 14. **Mottramite crystal plates about .4mm in diameter.**

Photo by the author

ally people do come out empty-handed. It depends partially on how discriminating one is. I have seen dealers come into the mine bringing 40 or 50 beer flats with the intention of filling them *all* with anything that has a crystal on it. This, of course, is easy.

The breccia in this mine, by its very nature, is highly susceptible to caving in small quantities so prudence must always be exercised when working under or near overhanging areas.

During the last two years much excellent material has been removed from a small, collector-dug tunnel near the upper end of the main stope, referred to by some as the "chimney". This tunnel is very narrow and cramped, and extends upward at an angle of about 30° for about 50 feet. Air circulation is poor, and at the top of the chimney is a small room which is actually a giant "mouse trap" for collectors! A large rock weighing several hundred pounds protrudes precariously from the wall and is held in place only by breccia. Should it come loose and fall to the sloping floor it would quickly slide into the small opening to the room like a giant cork, sealing the fate of any unlucky collector who might be working in there at the time. NO ONE should enter this room!

Surface outcrops of vanadinite exist in a few places along the trace of the vein but weathering has destroyed the color of the specimens.

CLEANING AND TRIMMING

Careful cleaning and trimming can improve many specimens. If unwanted calcite is present on specimens a soaking in acetic acid is usually sufficient to remove it without destroying the vanadinite underneath. Soaking for several MORE days in pure water is usually necessary to remove the acetic acid smell. (Some specimens are held together only by calcite and will, of course, crumble in acid.) Although the crystals are quite firmly attached, the matrix rock is so hard that many specimens can be destroyed in the trimming process. For really fine specimens in which you'd like to invest some time, the crystals may be secured more firmly by dipping the crystal-coated area in melted paraffin. The paraffin should first be allowed to sit until it begins to solidify slightly on the sides of the container. This will insure that it is at the lowest possible temperature to guard against cracking the crystals. The specimen may then be broken on an hydraulic trimmer, for instance, and the paraffin can be dissolved off in a few minutes in carbon-tetrachloride or some other organic solvent. Bear in mind that fumes from organic solvents are highly toxic. After this process any unwanted calcite may be removed. Calcite can help secure the vanadinite crystals during trimming.

Vanadinite tends to darken and lose a little of its fire after prolonged exposure to light. Some collectors may therefore wish to store their specimens in light-tight containers when not on display.

The Apache mine has at times in the past appeared to be running dry of fine specimens, but undaunted collectors have always succeeded in discovering new veins and pockets of high-quality specimens. Periodic "booms" at the mine have occasionally kept it inhabited by collectors 24 hours a day for long periods of time. Many friendships have been formed through coincidental meetings of collectors on busy days underground. With luck and care, years of productive collecting may still be in store at this classic locality.

NOTE ADDED IN PROOF: The author was unaware until recently of an article by Thomssen, 1957, Micromounts from the Apache mine, *The Mineral Explorer*, v.1, no.1, in which it is reported that small amounts of wulfenite, boleite, brochantite, malachite, chrysocolla, and covellite were also found at one time in the Apache mine. Dick Bideaux (personal communication) has reported the presence of another rare mineral, matlockite.

Yedlin on Micromounting

Some of the side benefits of collecting micromounts are the little gatherings of the aficianados — the sessions devoted to the what, where, when and how of mineralogy. We'll touch on one such meeting as a by-product of our talk at Montreal in October. Another took place at the home of Dr. Bill Henderson (a frequent contributor to the *RECORD*) at Stamford, Connecticut. Bill plays host at such gatherings the last Thursday of the month, and more scientific chitchat goes on than at most major conventions. At the last session, on Oct. 28th, there were 7 in attendance, including Bill, Elmore Easter, Russ Buckingham, George Jellenik, Mildred Watson, Marcelle Weber and Neal Yedlin (that's me) were there, and a tally showed that the Stamford Mineral Society, the New Haven Mineral Society, and the New York Mineralogical Club were represented. There were 6 microscopes. Jellenik had just returned from an European trip and was fortunate in having been able to visit and collect at the Lengenbach quarry at Binnental, Switzerland. He'd mounted dozens of crystals of the rare sulfosalts and others from this locality, for identification and study. A casual inventory disclosed such things as golden goyazite in thin rhombohedra; green platy fuchsite crystals; brilliant red realgar, associated with yellow sphalerite and distorted pyrite; clear rhombs of dolomite; and what may to be baumhauerite, sartorite, binnite and others needing detailed study. We've said this before. We'll repeat it. If you see available some of the sugary, friable dolomite from this famous quarry, acquire it. The dolomite can be scratched away with a needle point, and if you're lucky you'll expose a vug with a black lustrous prismatic crystal, occurring in but few other places in the world.

St. Hilaire material was shown, and some of the superb essonite from Eden Mills, Vermont. Henderson had been trading with a collector in Germany and, as a result, showed and distributed complex clear apatite, with epidote, from Untersulzbachtal, Austria as well as anatase and brookite from the Tyrol.

A tray of minerals from the Francon quarry at Montreal was passed around, and specimens of weloganite, dresserite and dawsonite were up for "grabs". Yedlin showed some mounts prior to photographing them — an erythrite from Morocco: arborescent friedelite, hetaerolite, twinned sphalerite, brookite on dolomite, lavender tephroite, rhodonite on yellow garnet, and minute gemmy golden crystals of chondrodite, perched on dolomite rhombs, all from Franklin, New Jersey.

It started out to be a ten o'clock session. At midnight the meeting broke up, when scopes, lights, specimens and; books were put away. Yes, many books, for references were made to reddingite, goyazite, the sulfosalts and others. Even so, there were at least a dozen things that defied visual determination, and are yet unidentifed. A fine, fine meeting. Go thou and do likewise.

For the first time we missed the Baltimore Symposium. The first in 15 years. But we did address the members of the Montreal Gem and Mineral Club and had a fine time with this hospitable and knowledgeable group. Milt Stitt, long time member of the society, and Mrs. E.O. Freedman, president, were our hosts. The first order of business was a meeting of the micromounters of the group at Stitt's house. Present: Pete Tarassoff, Henry Budgen, Quint Wight, the host, and the "visiting fireman", us. There was a kitchen table bearing scopes and lights, around which we sat, peered, discussed and drank fine tea. There were superb micromounts — primarily of the minerals of St. Hilaire, with a few others to vary the interest.

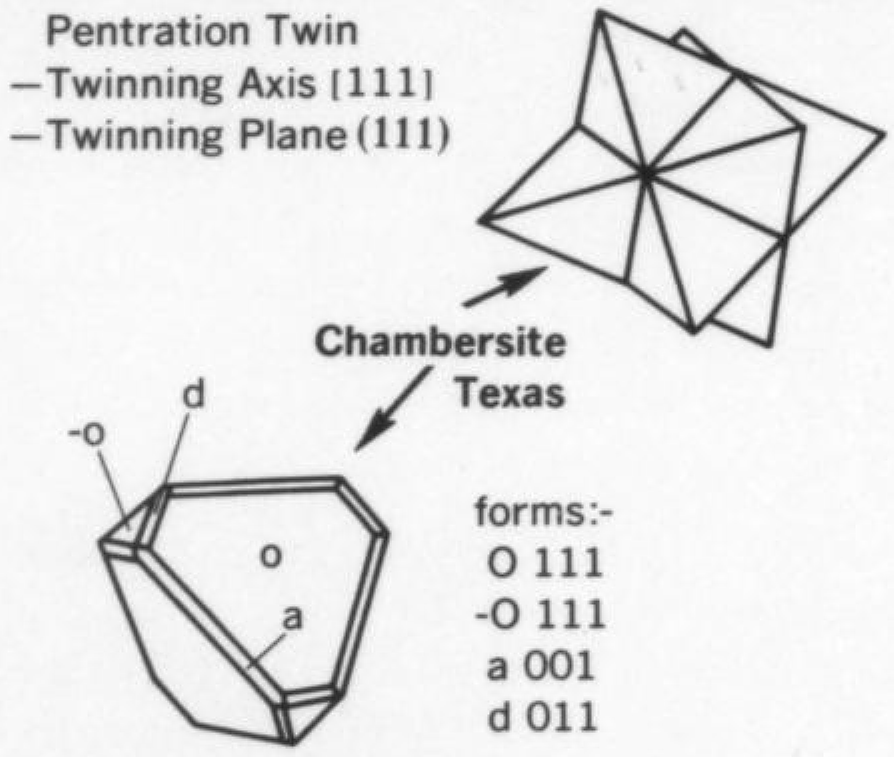
We looked at labuntsovite, orange-pink needle crystals, (previously labelled U.K. No. 5.) and at narsarsukite in yellowish tabular forms, tetragonal in crystallization, but pseudo-hexagonal in habit. We studied burbankite and possible nenadkivichite, described as one end member of the series, of which labuntsovite is the other. we looked at micros of genthelvite, catapleiite, serandite, ancylite, enormous clear terminated pectolites, neptunite, ekanite, eudialite, leifite (karpinskyite?) lemoynite, synchisite, and many others. All rare minerals. All from St. Hilaire. What a locality!

We revised our thoughts about another phase of micromounting. Anent the item "workmanship", we've always said "The mineral's the thing: all else is incidental. Neat mounts, yes but do not become so involved in the carpentry of the art that the specimen is lost sight of." This is still our basic tenet, but with a softening of attitude. With perhaps one exception, notably H.A. Mitchell, whose technique includes machine printing of individual labels, Pete Tarassoff's mounts are the best. Suberb workmanship, machine printing of each label — just about as fine mounting as we've ever seen. And Pete does *not neglect the contents of the box.* His minerals are superb, unique, and his forte is making the quality of the mount come up to that of the specimen, neglecting neither. We bow, humbly.

We visited the Dimix quarry at St. Hilaire and met Dr. Guy Perrault — (pronounced by him "Gee Perro") of Ecole Polytechnique of Montreal. He had a geology class at the workings and was doing active on-the-spot teaching, in the form of instant lectures of the terrain and of mineral specimens brought to him for identification. He, among others, has done remarkable work on the mineralogy of Mt. St. Hilaire, most of which appeared in the *Canadian Mineralogist*, and most of which was published in French. We exacted a promise from him to write for the *MINERALOGICAL RECORD*, in English. So renew your subscription and wait.

Art Smith, 9118 Concho, Houston, Texas, 77036 sends us a note and specimens. He specializes in the minerals of the gulf coast salt domes and, in the May and June, 1970 issues of *Rocks and Minerals*, he describes them and the areas in which they occur. Read them. He sent us alabandite, hauerite, pyrrhotite, aragonite twins, anhydrite and barite, all in loose crystals, and all from this area.

Speaking of H. A. Mitchell reminds us of his coming up with a mason jar full of crystals of chambersite and hilgardite in 1965. He waded into the brine pools, scooping up bucketsfull of the sand residues, and then spent hours hand picking the minerals. We've sketched them from *Dana* and the *American Mineralologist*.



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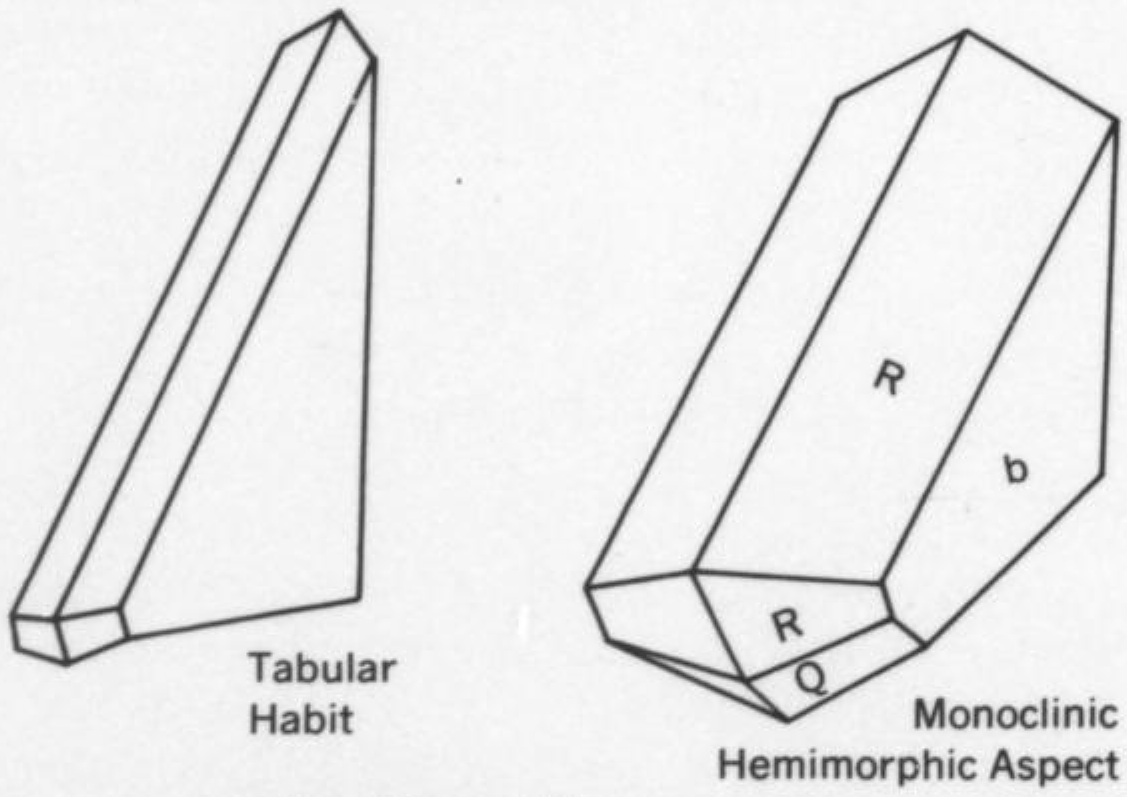

Hilgardite-Louisiana
(Dana-System, 7 Ed. Vol. 2. P. 382)

Chambersite is a manganese chlorborate and is the manganese analogue of boracite, which it resembles morphologically. Hilgardite is a hydrated chlorborate of calcium, monoclinic, colorless and transparent, with 2 perfect cleavages. So far all the crystals we've seen have been very small, best viewed at about 36X. Smith's article lists a great many of these insoluble minerals in the brines. These and drill core minerals from Green River, Wyoming could well provide some sort of specialized collection.

November 7th was the opening of Bentley's Minerals, successors to the Schortmanns. By now you should have seen their advertisements. Open house was in order, and a mob of friends turned out to see the new showroom, acquire specimens, and wish good furtune to the Bentleys. The displays were really fine, and the prices most reasonable. We couldn't resist a couple of things — hardly micros, but unusual. We bought a 5" X 6" thick slab of granite, in which were embedded several flat twinned chrysoberyls — from Greenfield, near Saratoga, New York, a *Dana* locality. Another was a 7" X 8" mass, surfaced on both sides with small calcites, on and in which were several dozen small clusters of chalcocite crystals. Locality — another famous *Dana* one — Bristol, Connecticut.

Need we say more? The specimens are there. Take Rte I-91 to exit to Rte 178, six miles north of Hartford. Left on 178 (Park Ave.) 1 long block to traffic light (Matianuck Ave.). Right on Matianuck 1 1/2 blocks to No. 1090, the Bentleys. (203 — 688 1627). A 'scope is ready and available for those of you think big and mount small.

We're off on another crusade. We've seen, too many times, fine old mineral specimens, without labels, massed together in boxes, or in cabinets for display, or packed by unknowing heirs for disposal. Sometimes old loose identifying tabs can be matched up. Most times not. The late O. Ivan Lee did something that we're now advocating for everyone. PASTE A LABEL ON THE SPECIMEN. Yep, a paper label, giving name and exact locality. Most specimens have poor or "dead" sides — the parts on which they rest in your cabinet. This is where the label should go. Duco cement the label, and in a few minutes, when it's dry, a smear of the clear cement on the face of the paper. This will last and last, and your heirs, successors and assigns will be thankful. If the mineral surface is too rough, 2 or 3 dabs of the Duco, one after the other, wll build up the surface. For micromounters, get an identifying mark on the cover AND the box. Mixups are so prone to occur. One of the fine exhibits at a national show lost points because the cover of a Katanga kasolite inadvertently got put on a fine curite specimen, and was entered as a kasolite.

So now it's "Buy and use a good mineral book", and "Affix a label to the specimen"

Neal Yedlin

The Microstructure of PRECIOUS OPAL

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Gem opal has been known for many centuries and the reason for its spectacular appearance has been the subject of much conjecture. A great number of observations have been recorded in the past, but only with the advent of modern scientific techniques has the full story begun to unfold.

Opal, a form of hydrated silica, is common in most parts of the world, but opal showing brilliant spectral colours (gem opal) is rare, although the two are very similar, chemically and physically. Spectrographic analysis has shown little or no difference in composition between common and gem opal from the same area (Bayliss 1965). This eliminates the possibility of the colour being caused by allochromatic elements present as impurities.

Both common and gem opal are found to be amorphous or show a poorly crystalline pattern by X-ray analysis (Jones et al. 1963), and if anything, gem opal is less crystalline than common opal. None of these observations provides a clue to the mechanism of formation of the spectral colours associated with gem opal.

Examinations of thin sections of gem opal with a petrographic microscope have shown spectral colours by reflection even from sections 30mμ thick, and the complementary colours by transmitted light. This is further evidence that the colours are not produced by selective adsorption. Even though the opal may be regarded as amorphous, some anomalous polarisation effects have been observed, but these do not account for the brilliant spectral colours.

Optical investigations by Sir David Brewster (1854), E. Baier (1932) and Sir C. V. Raman (1953) failed to produce a correct explanation for the production and play of colour, although in principle it should have been possible to work out the problem from Baier's measurements. Because the structures which produce the colours cannot be resolved by optical microscopy, the missing clue had to be provided by electron microscopy, a technique which was not available at the time of Baier's optical measurements.

Electron Microscopy of Fracture Surfaces

Scanning electron microscopy can be used with a minimum of specimen preparation to examine the structure of gem opals (Greer 1969, Segnit *et al.* 1970). However, greater resolution is obtainable from transmission electron microscopy, but in order to use this technique, a thin replica of the surface must be made. The surface is first vacuum coated with a very thin layer of platinum metal, deposited at an angle of about 20° to the surface (a process called shadowing) and then this is covered with a layer of carbon, also deposited in vacuum. The opal is dissolved away in a solution of hydrofluoric acid (HF), the replica washed with water and collected onto a small grid which is placed inside the electron microscope. When one of these replicas of a gem opal is examined at a magnification of about 20,000x, one sees a geometric array of small holes (Fig. 1). The pattern of the array and the shapes of the holes (Fig. 2) vary from specimen to specimen, but in opals exhibiting colour there is always a regularity in the arrangement. Because the holes appear in *every* fracture surface, it can be concluded that they extend throughout the body of the opal, in a regular way.

These holes are the naturally occurring cavities between spherical particles, and it has been found that all gem opals are made up of particles cemented together. Although too small to be visible by optical means, these particles can be easily seen in an electron microscope if

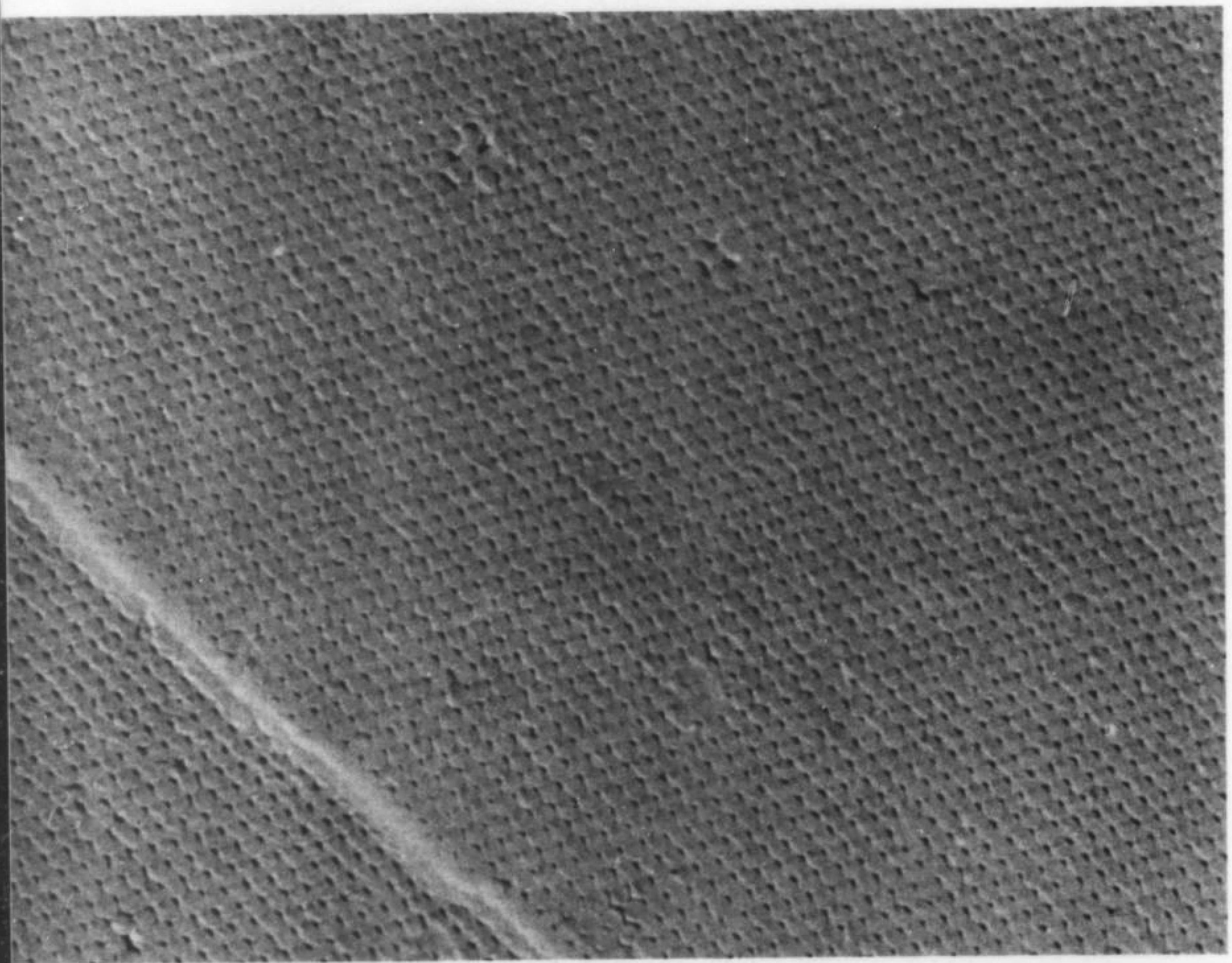


***Fig. 1* Electron micrograph (x 12,000) of a replica of the surface of a gem opal from Lightning Ridge. The black dots are small holes in a regular array.**

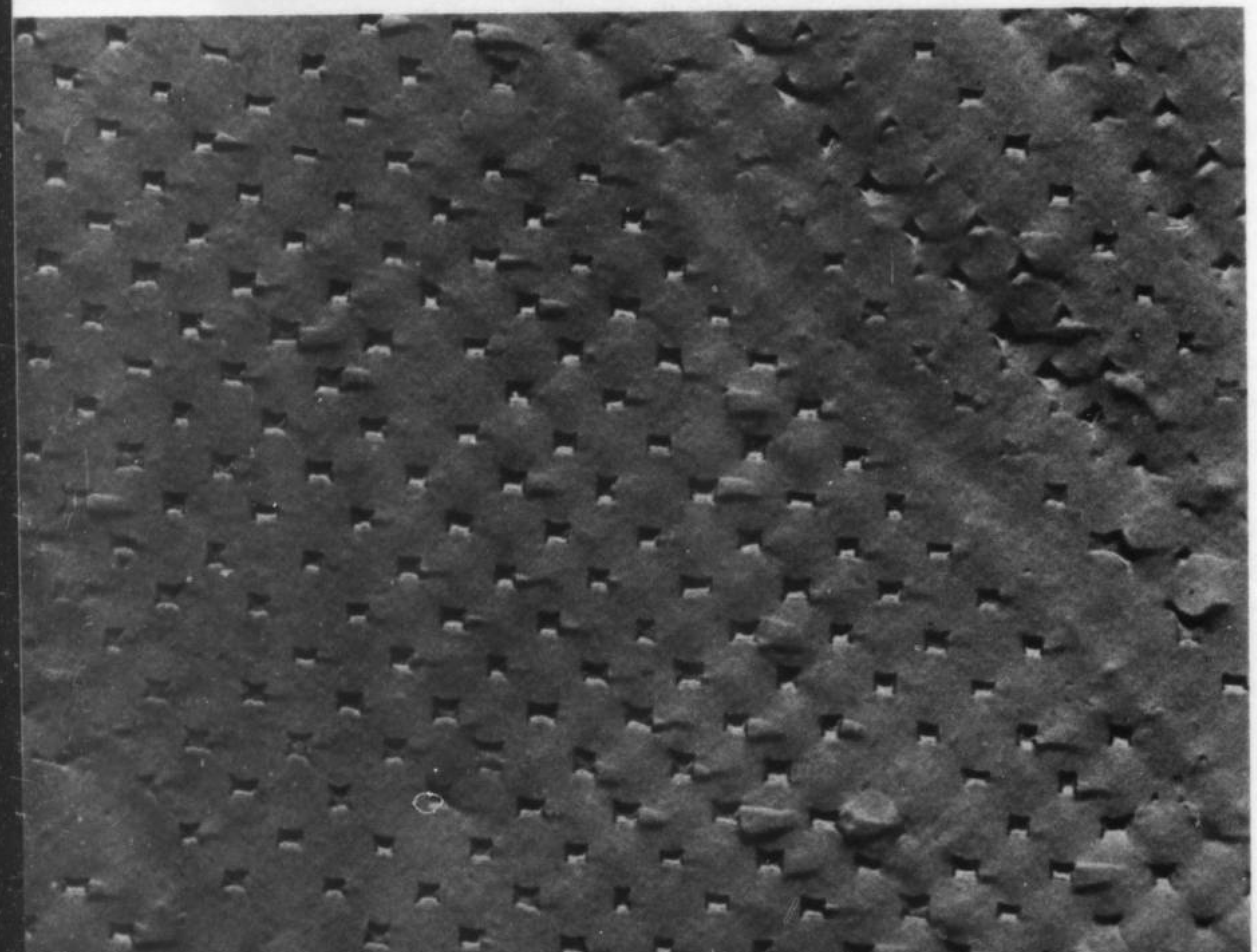


***Fig. 2* Geometrically arranged holes in a fracture surface of a gem opal from Coober Pedy. Electron micrograph of a replica x 22,000.**

the opal is etched with HF solution before the replica is made (Fig. 3). In an opal of gem quality the particles are remarkably uniform in size and hence they have been able to pack together in a very regular manner. Thus the holes between the particles (Fig. 1) are also arranged in a regular way in three dimensions.

Generally the spheres are so strongly cemented together that the fracture passes through the particles rather than between them, so that the holes are seen in section (Fig. 4). The shapes of the holes, and their arrangement depends upon the angle at which the fracture surface passes through the array.

Optical Properties

This arrangement of an orderly array of cavities in a transparent medium immediately suggests that opal is a type of optical diffraction grating for visible light. The diameters of the particles are just of an appropriate size for this process to occur. We argue that the silica particles are optically transparent, and there is a change in refractive index at the surface of the spheres so that they scatter light. Because the spheres are arranged regularly as a three dimensional grating, various wavelengths in the scattered light reinforce at different angles and so the incident white light is split up into its spectral colours. The geometry of this diffraction condition is very similar to that of X-rays diffracted from atoms in simple crystals.

The theory of diffraction predicts how the colours should change with angle of incidence of the illumination (Darragh and Sanders 1965) and this has been checked by optical measurements in the laboratory. By examining in detail the patterns of white light diffracted from a single grain of opal, it is possible to deduce the arrangement in which the silica particles are packed together. Apart from a very few exceptions this is an arrangement called a randomly-faulted, close-packed structure (Sanders 1968, Monroe *et al.* 1969). The faulting is an important factor in this structure and is the main reason for so many grains appearing coloured at any particular angle of viewing. This faulted structure produces sets of very fine, parallel straight lines which can just be seen in patches of colour when they are viewed with a hand lens. They are quite clear at the higher magnifications available with an optical microscope. These lines are an inherent feature of the structure and have no effect on the strength of the opal; they are not a sign of weakness, as sometimes thought.

The few gems which have been found in which there is little or no faulting are much less attractive. They are generally transparent and colourless, but at certain specific angles of viewing a colour suddenly flashes out.

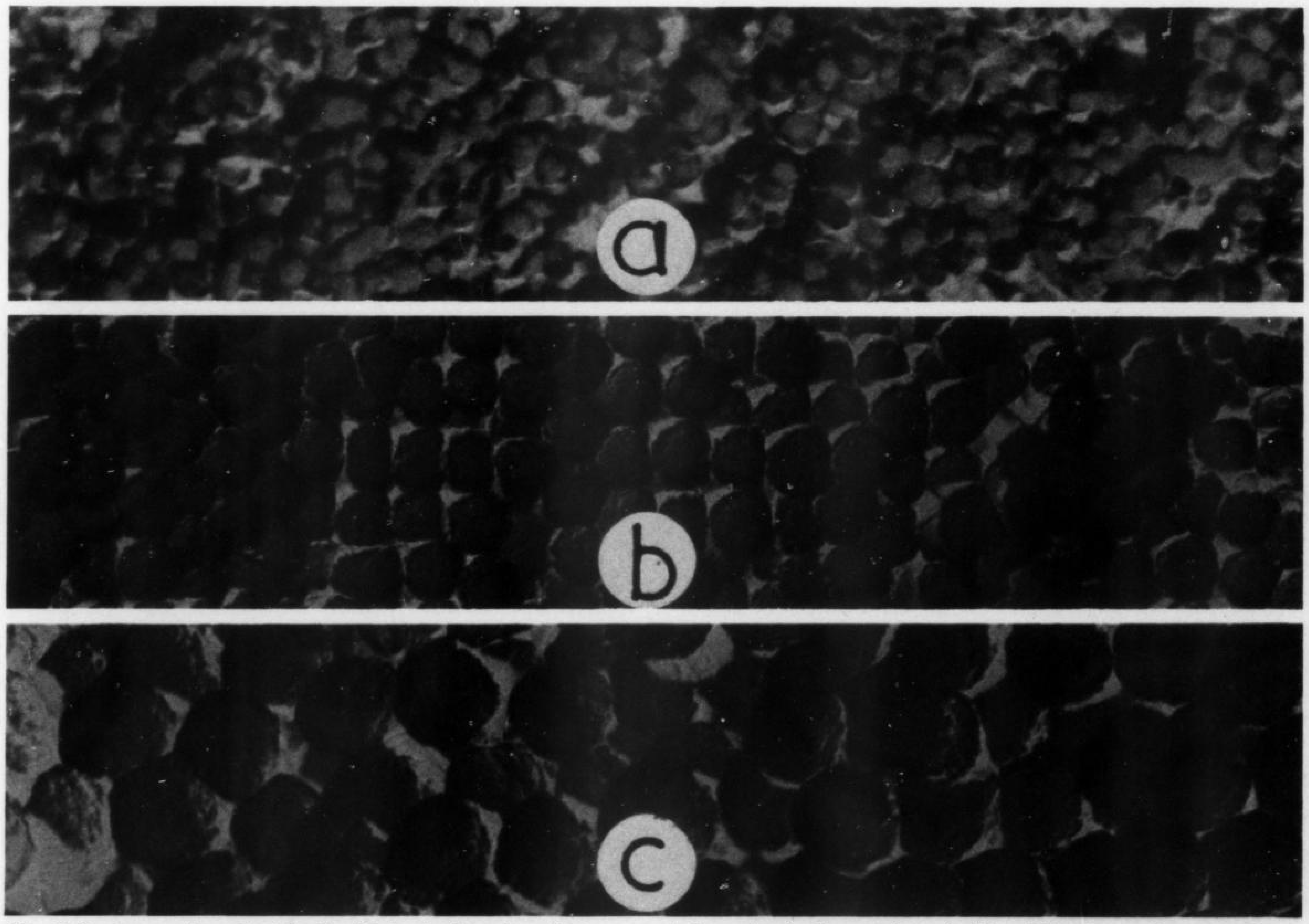


***Fig. 3* Surfaces of opal etched with hydrofluoric acid to reveal the spherical particles of silica. The three electron micrographs, all at the same magnification (x 30,000), indicate the range of sizes of the particles found in different specimens of gem opal.**

Particle Size

Generally, in any single gem stone the particles of silica of which the opal is composed are all of the same size (Figs. 3, 4). The various grains appear in different colours because their orientation varies, just as in an etched metal surface the various grains show up because the reflectivity is different from grain to grain.

The size of the particles in an opal specimen can be quickly estimated by eye. One tilts the stone around and looks for the colour of maximum wavelength (λmax) which can be seen. (The visible spectrum can be divided into the colours, violet, indigo, blue, green, yellow, orange, red, in increasing wavelength from 0.3-0.7mμ). Then the radius of the particles (r) is just one fifth of this, i.e. λ max = 5.02 r (Sanders 1968). Thus the smallest particles which give visible colours are in opals which appear violet: i.e. λ max = 0.4mμ, and their radius is 0.08mμ (r = 0.4/5 = 0.08mμ). With increasing size of the particles colours of longer wavelength become visible systematically, and the whole spectrum from red (λ = 0.7mμ) to violet can only be seen from opals with a particle size greater than about 0.14mμ radius. This range of sizes is shown in the micrographs in Fig. 3, of samples selected by their appearance from the rules formulated above. The specimen used for Fig. 3a was transparent potch opal, exhibiting no colours to the eye; the particles are about 0.05mμ in radius, which is too small to give diffraction colours in the visible wavelengths, but could give diffraction colours in the ultraviolet. The specimen in Fig. 3b gave only blue-green colours. That in Fig. 3c gave red and all the other colours of the visible spectrum, and of course has the largest particles (r = 0.15mμ) because red has the longest wavelength in the visible spectrum.

Systematic variations of particle size, when they occur, can easily be recognized by a gradation of range of colour. Such gradations are sometimes found in polished gem stones, but are not very common; however they occur more often in the ground along a seam of opal, and frequently in "painted-ladies". These are formed by opal filling nearly vertical fissures, often about 1 mm. wide in a boulder, in the opal level. The rock can easily be broken open along this fissure, and splits into two parts, each of which has a thin skin of opal on the fracture face. They are found in iron-stone concretions from Queensland (Australia) deposits, and also among the boulders in the opal level at Andamooka (South Australia). The colour grading in these opals is in a vertical direction and sometimes there are in addition, horizontal bands (1-2 cm wide) each containing a repetition of the colour gradings, suggesting that the opal was deposited sequentially on a number of separate occasions.

Generally, in the best gem quality opal the particle size is at least 0.25mμ diameter so that all the spectral colours can be seen. Occasional specimens exhibit a "second-order" red, i.e. a cerise colour which is a combination of red and violet, indicative of even larger particles. It is important to note that these diffraction colours are formed by back-diffraction, i.e. the light is sent back into the direction from which it came. This is a further result of the particles being just this size.

If the particles are not uniform in size, they cannot pack together in a regular way and cannot form a grating. This results in the commonly occurring potch opal. A micrograph of potch produced in this way in Fig. 5 shows this disordered arrangement of particles.

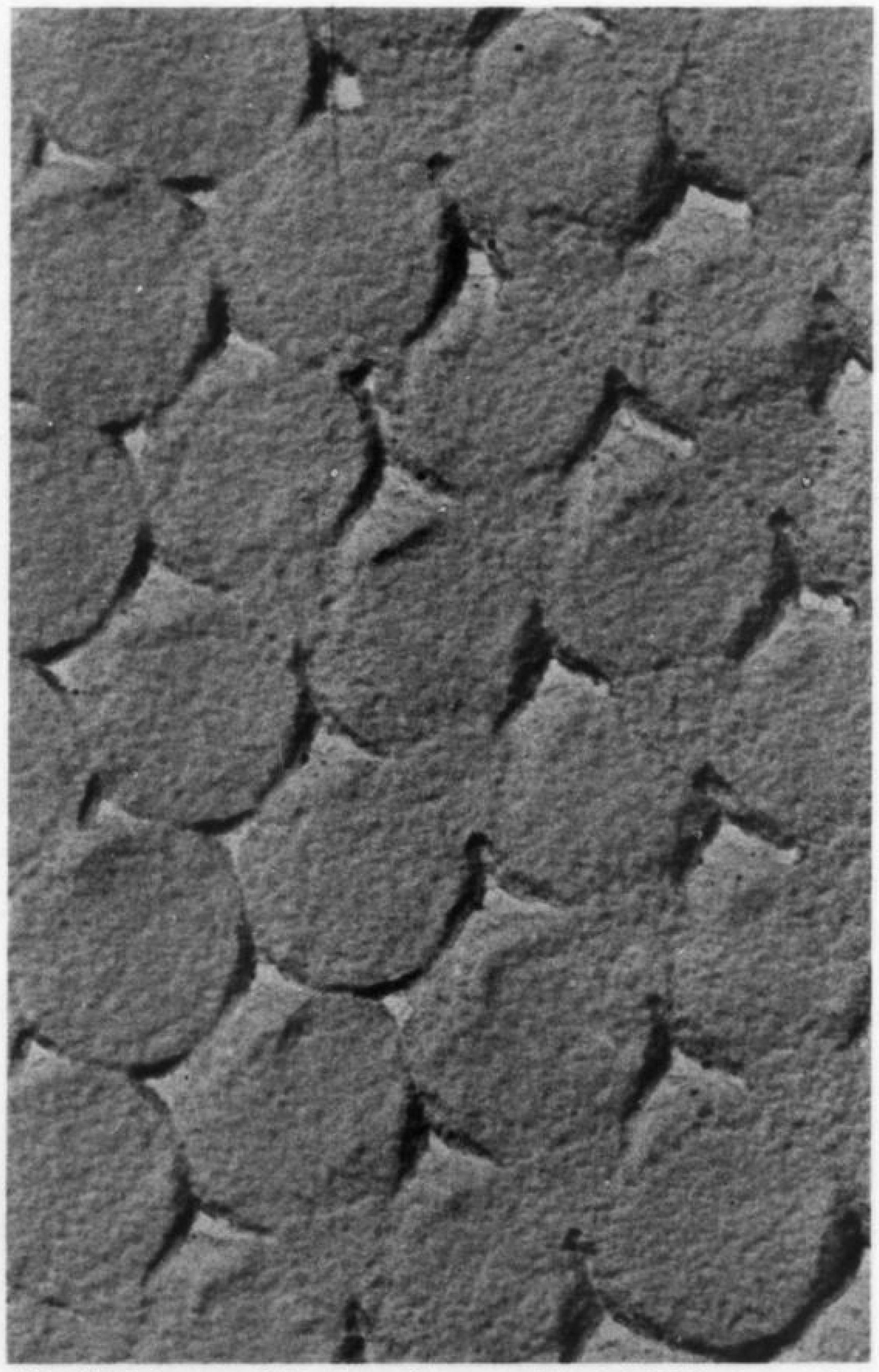


Fig. 4 **High magnification micrograph (x 80,000) of a replica of gem opal, as in Fig. 1. The circular outlines are the edges of silica particles, close-packed in a hexagonal array and sectioned by the fracture passing through them. There are cusp shaped cavities between the particles.**

Particle Structure

When an opal is fractured, the break nearly always passes through the silica particles (Fig. 4) and not between them, so that sections of the individual particles, and the holes between them are exposed on the surface. Internal structure can therefore be revealed if the surface is chemically etched. In opals from the central Australian fields,

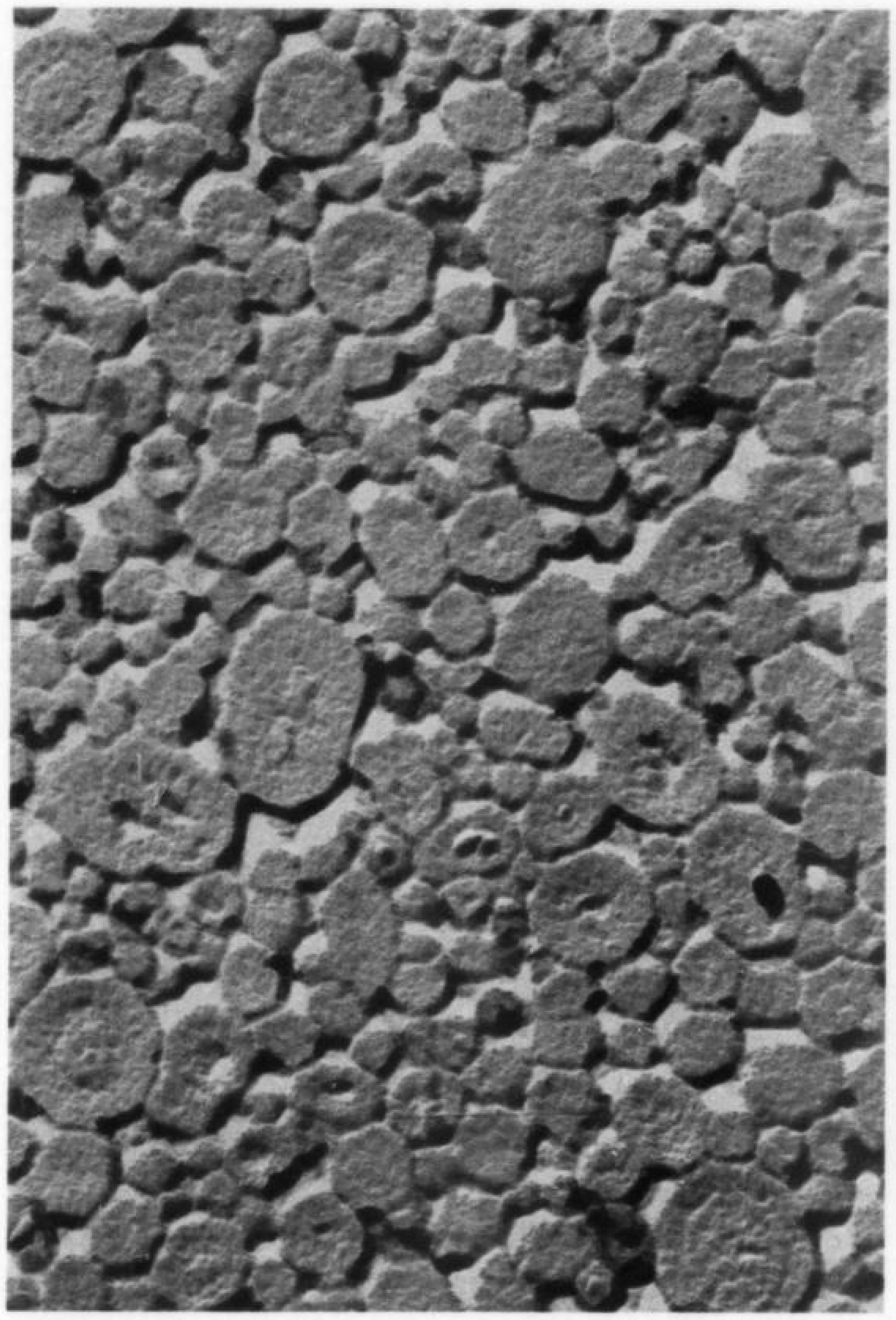


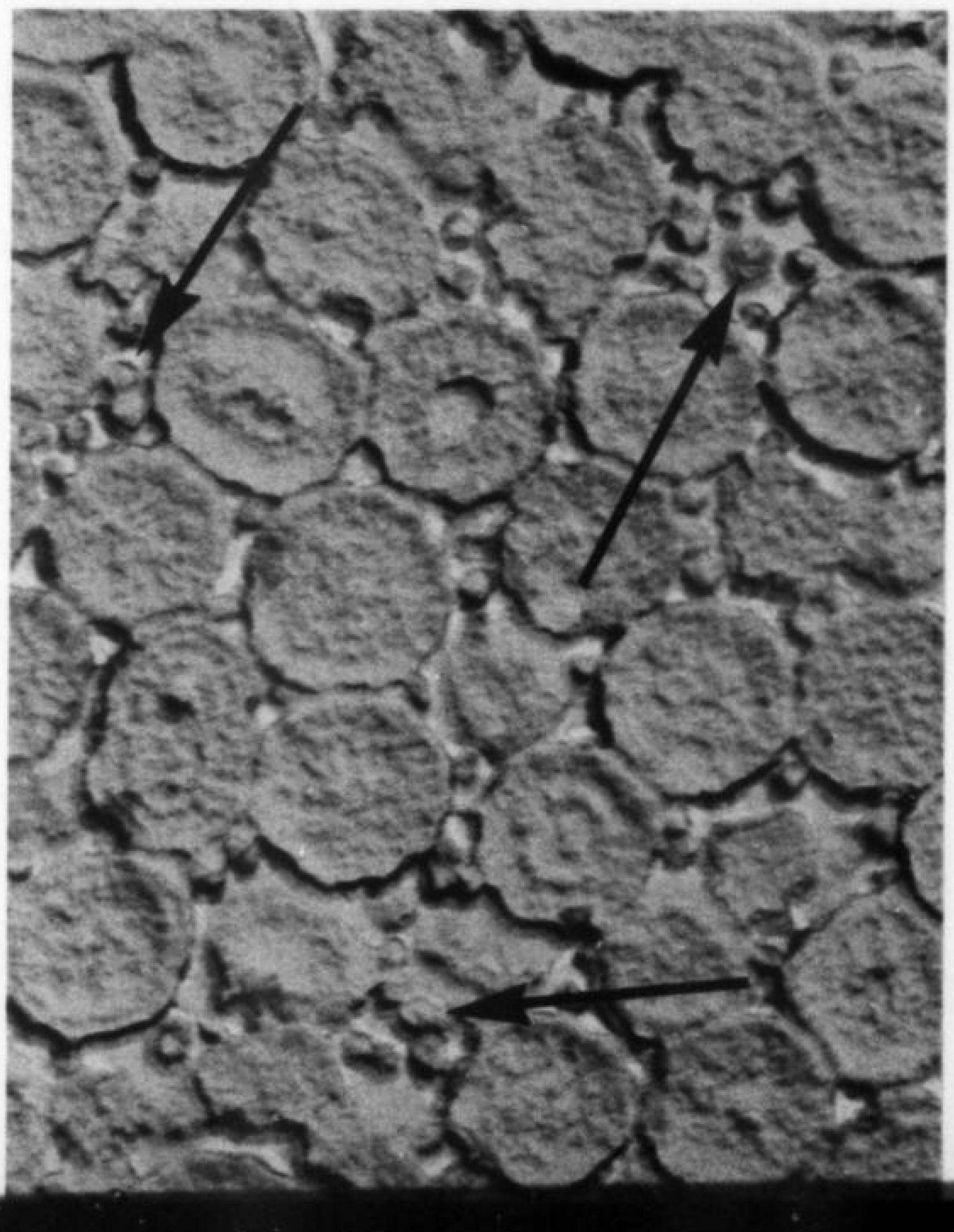
Fig. 5 **Electron micrograph (x 50,000) of potch opal in which the particles vary in size from 0.06 to 0.3mμ diameter, and therefore have not packed regularly.**

Fig. 6 **Lightly etched surface of opal showing the internal structure of shells within the particles. In the two biggest sections at the top and bottom the outer three shells only can be seen. The inner ones have not been etched. Shadowed replica, x 70,000.**

examined in this way, each particle is found to contain a set of concentric shells. By examining numerous samples, it has been established that the bigger particles contain more shells. Each shell is about 500Å thick, so that the smallest particles which can give colour consist of a central nucleus and one shell. In green opals the particles have two shells and in red opals they have three or more. The greatest number of shells that we have detected up to now is shown in Fig. 6, where the particles are 0.5mμ diameter, and some of the five layers in them have been made visible by etching.

The shells consist of aggregates of primary silica particles (Darragh *et al.* 1968) which also seem to be very uniform in size in any given gem stone. On rare occasions some of the primary particles have been trapped between the big silica spheres, and can be seen in the etched surfaces (arrows, Fig. 7).

Fig. 7 **Electron micrograph x 50,00 of the etched surface of potch opal, showing primary particles 40 nm diameter (arrows) trapped between the large spherical particles. Some of the internal structure can be seen in the large particles.**



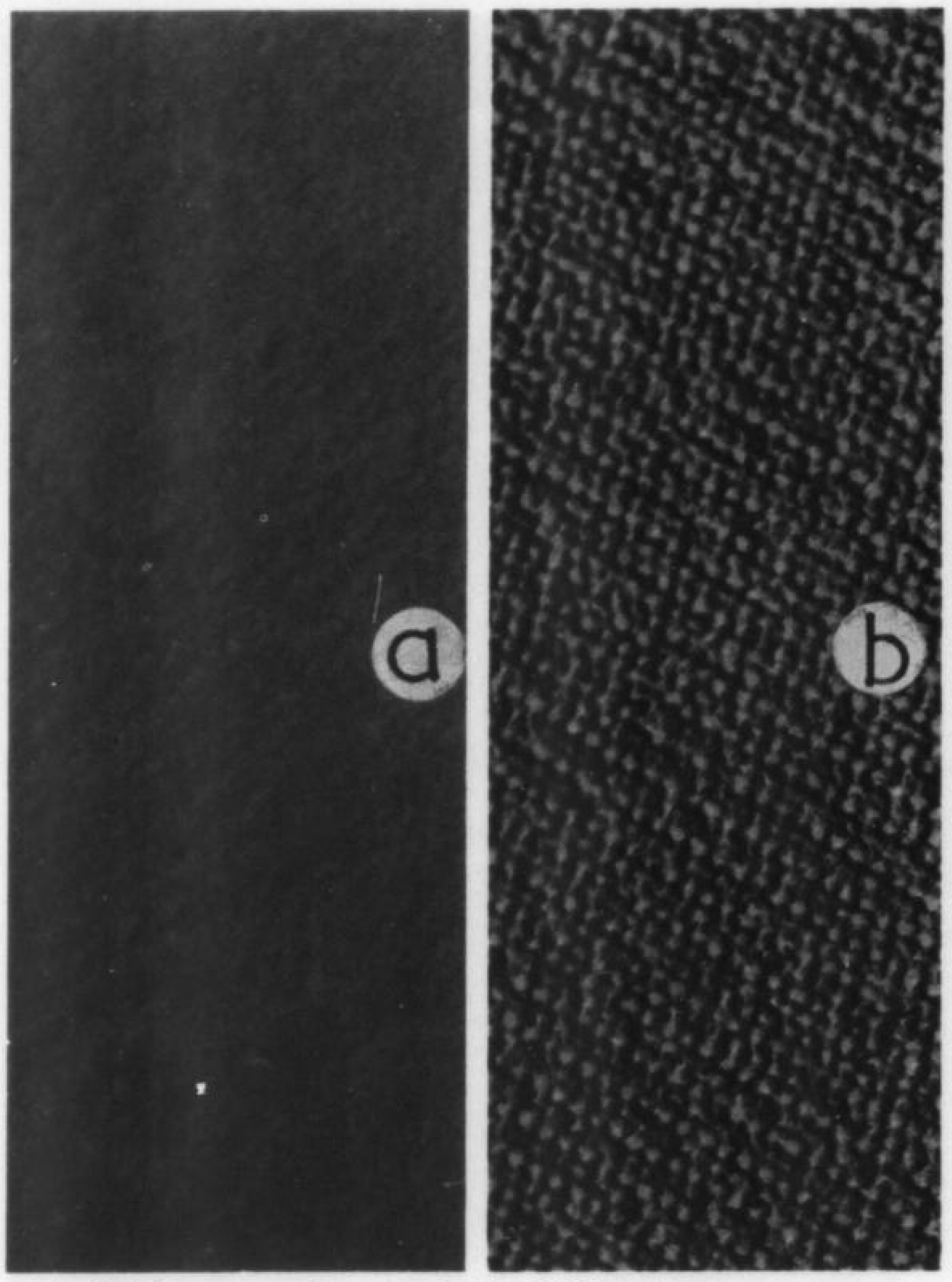


Fig. 8 **Electron micrographs (x 8,000) of the surfaces of Mexican fire opal, (a) fracture surface, with no evidence of cavities (compare Figs. 1, 2), (b) etched surface revealing regular lines of particles.**

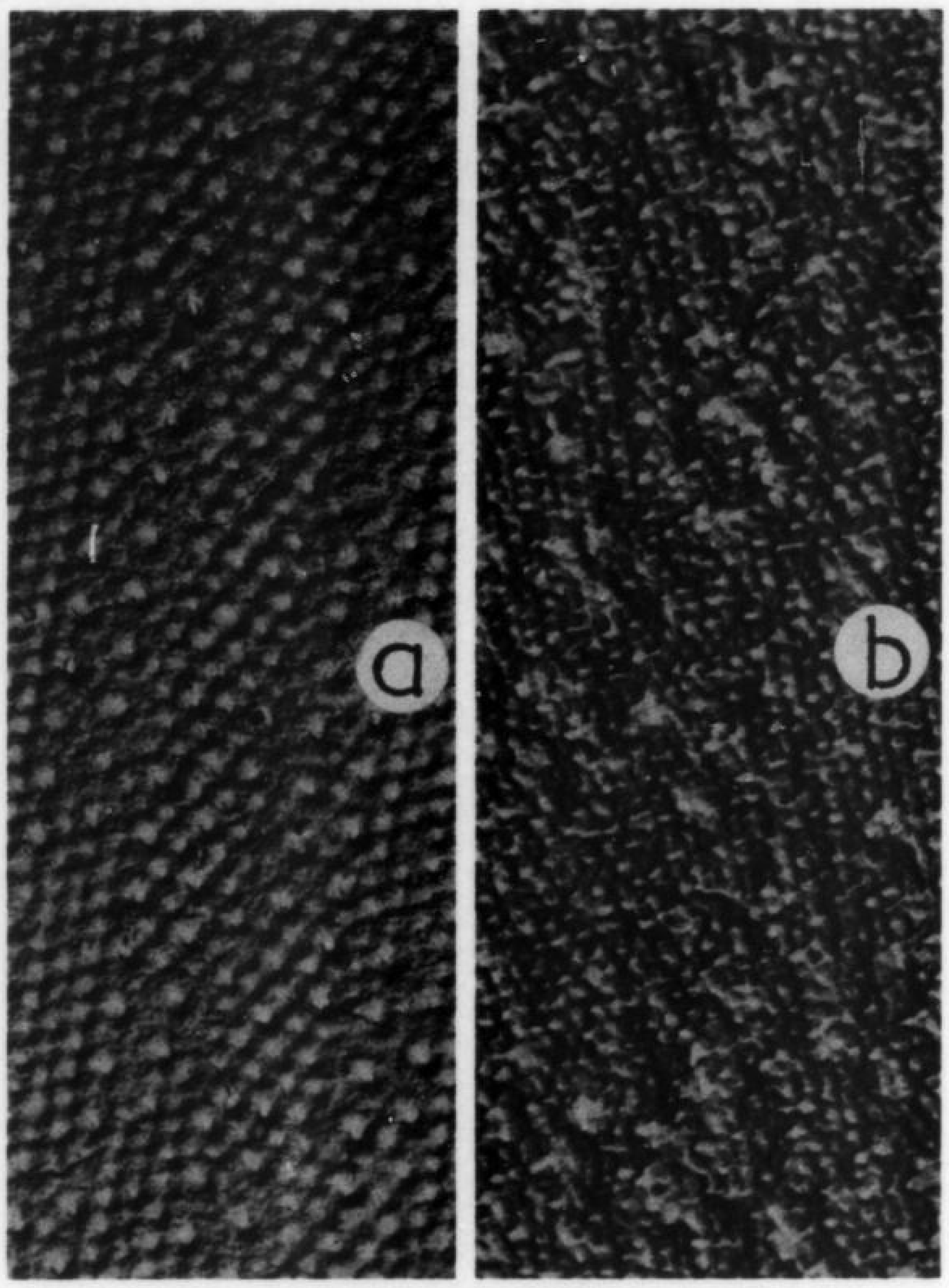


Fig. 9 **Electron micrographs (x 5,000) of etched surfaces of volcanic gem opal, showing lines of particles (a) sample from east coast of Australia, (b) sample from Nevada, U.S.A. The lines of particles are less distinct than in (a) because the surface is rougher.**

This structure of clearly defined shells is a feature characteristic of the Australian opals from sedimentary host rocks, and by contrast, cannot be distinguished in American and similar opals. These are, however, also made up from primary particles but in this case their aggregation into shells is not apparent. Fracture surfaces of these opals show the primary particles as a surface texture, but there is no evidence of regular agglomeration or of cavities (Fig. 8a). Etching, however, shows up a regular arrangement of lines of particles (Figs. 8b, 9a, 9b) because the centres of the particles are more soluble, and they show up as an array of lines of depressions. The complete absence of cavities in this material is surprising and accounts for the diffraction colours in American opal having less intensity than most of those from Australia. It is necessary to postulate that there is nevertheless a variation of refractive index across or between particles which is sufficient to scatter some light, and the regular repetition of this change produces the colours by diffraction.

Particle Shape

It is not immediately clear, from replicas of fracture surfaces where the particles are seen in section, that they have a spherical shape. It can be inferred from the circular appearance of the shells in etched surfaces, or better still can be seen directly in a rare sample from Yowah (Queensland) (Figs. 10, 11). In this case, the particles were apparently only weakly cemented together, and the fracture therefore passed through the places of contact, rather than through the particles. This neck where individual particles were joined can be clearly seen in Fig. 11 as small flat areas on otherwise spherical particles. The surfaces of the individual particles have a rough texture, corresponding with the protruding primary particles, as can be seen in Fig. 12 where some loosely packed spheres lie in a cavity in some opalised bone fossil from White Cliffs (N.S.W., Australia).

As discussed previously, the more common potch opal will be formed if the particles are non-uniform in size. It is also produced if the particle shape is irregular, and samples of potch may reveal a wide variety of non-circular shapes (Fig. 13). In other cases, sets of rods in parallel bundles have been found (Fig. 14). The thickness of the rods is obviously about the same size as the particles but it is not clear why this form is adopted in this case.

It was fortunate that the earliest investigations with the electron microscope were made on Australian opal

Fig. 10 **Electron micrographs (x 6,000) of a fracture surface of gem opal from Queensland (Australia) where the fracture has passed between rather than through the particles. Their regular size and packing is immediately clear.**

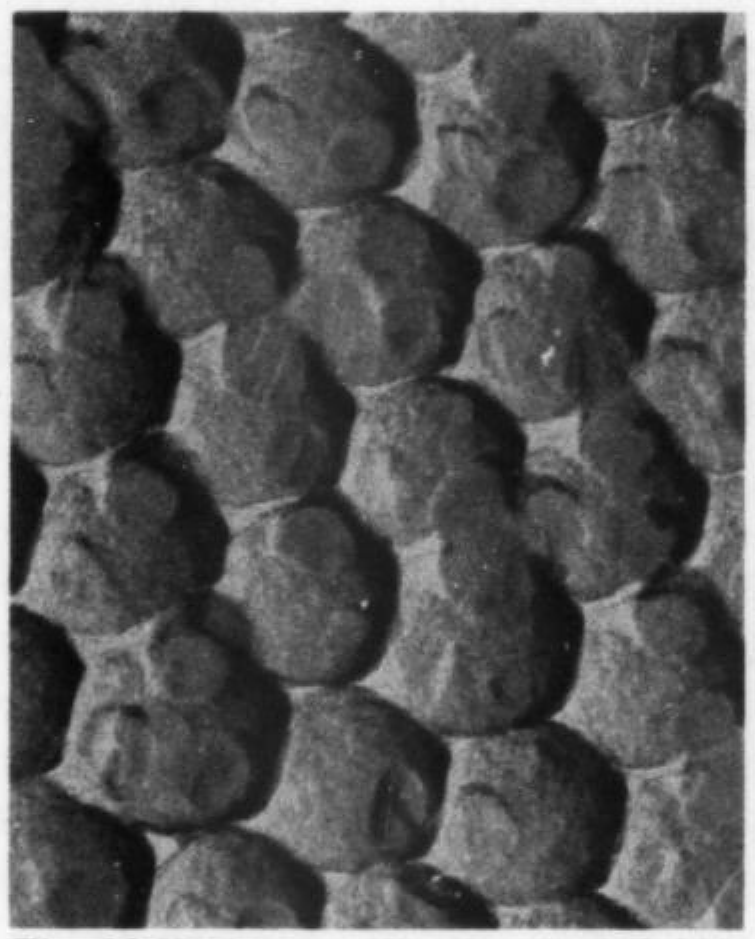
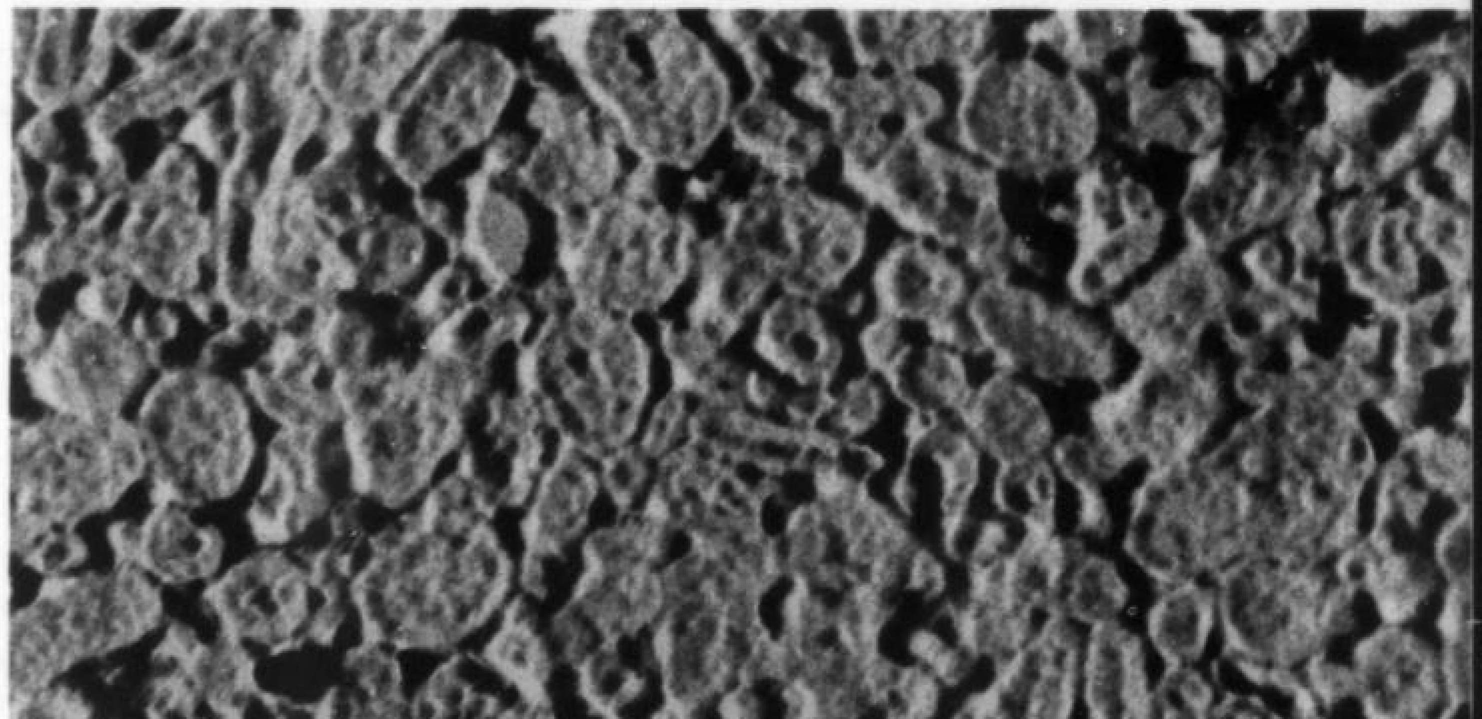


Fig. 11 **High magnification (x 100,000) electron micrograph of sample as in Fig. 10 showing spherical shape of particles on which there are small flat areas where the particles in the next layer were attached before fracture.**

Fig. 12 **Loosely packed, unattached particles in a sample of opal in fossilised bone from White Cliffs (Australia). Electron micrograph x 30,000.**

Fig. 13 **Electron micrographs (x 45,000) of the etched surface of potch opal showing irregular shapes of silica particles and their internal structure.**



in which the structure was immediately obvious. Our later investigation of Mexican opal showed that it had a much less clearly defined structure (Figs. 8, 9), which was revealed only by etching. We therefore consider that there are differences in the genesis between these two types of gem opal.

Genesis

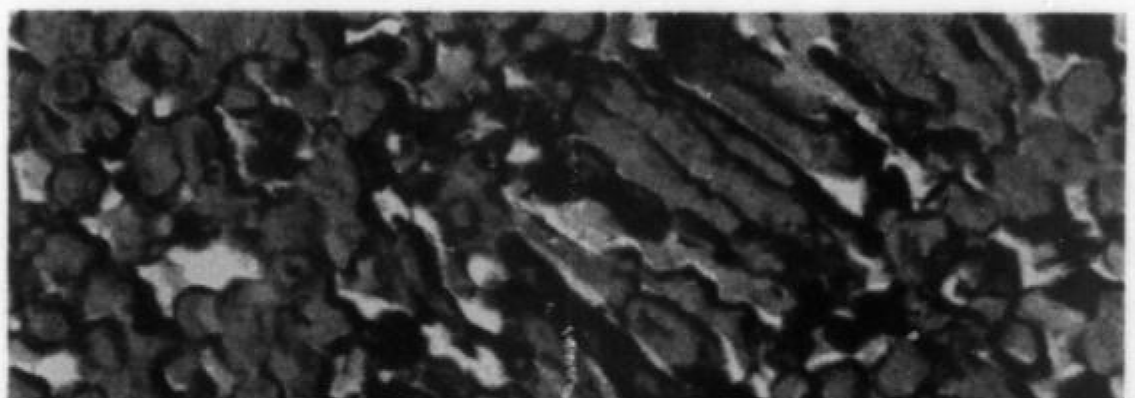
The geological conditions under which opal may occur require a source of silica and space in which the opal may accumulate by evaporation from solution. These simple requirements may be met in both sedimentary and volcanic environments; however, the opal and its microstructure are usually recognizable as belonging to one or the other environment.

Sedimentary Environment

The occurrence of opal in cretaceous sediments has been recorded from a number of localities of inland Australia. These localities have a number of significant features in common. The opal lies under a bed of claystone, which seems to have been formed by the leaching of silica from feldspar by ground water. There is no reason to believe that silica concentrations have at any stage been higher than the 100-120 ppm which occur in the ground water on some fields today. The opals occur just above or actually in a bentonitic horizon. This means that even though the rainfall is low (140-250 mm/annum) water is trapped in formational dams formed by the bentonite beds. These seem to be the key to the situation for the production of gem opal because in other areas drying out has occurred to much greater depths.

The space in which precipitation of silica occurs is provided in a number of ways: it may be between particles in

Fig. 14 **Electron micrograph (x 12,000) of the etched surface of potch opal from Lightning Ridge (Australia) showing irregular particles and a bundle of parallel rods of**



a poorly sorted coarse conglomerate; or cavities left after minor faulting; or holes left by the dissolution of shells, bones, wood, or inorganic crystals, e.g. gypsum, glauberite, calcite etc; or the hollow cores of iron-stone concretions. The cavities occur in one or more horizontal levels, 10—40 metres below the surface. This enables the opal horizon to be readily recognized on any particular field, but does not guarantee the occurrence of gem opal.

We suggest that the silica solution was concentrated by evaporation through the porous overlying claystone. As concentration proceeded, discrete particles appeared and in this environment it is rare to find particles less than 0.05 mμ in diameter. However, in the laboratory, in solutions of higher concentrations and with more rapid evaporation rates, particles as small as 0.01 mμ can form. Laboratory work has also shown that if a dilute silica solution containing primary particles of 0.05 mμ is allowed to stand for some months, particles up to 0.15 mμ diameter may form without any increase in silica concentration. The particles aggregate by collision, and as imbalance cannot be tolerated, spherical aggregates result. Similar processes could occur in nature, and once the spherical aggregates have reached the same size, sedimentation will produce ordered masses with the larger particles at the bottom.

The difference between potch and opal showing a play of colours is very small and is probably due to minor disturbances to the slow and steady concentration of silica, producing particles of non-uniform size or shape which cannot form into regular arrays when they settle. As far as field conditions are concerned, it is obviously easier to achieve constancy in small rather than large cavities; hence it follows that the larger cavities generally contain poorer quality opal. The occurrence of gem opal in sedimentary rocks appears to be unique to Australia.

Volcanic Environment

In other parts of the world, gem opal is associated with volcanic rocks, and opal of this type is also found in Australia, at Tintenbar and Mullumbimby. The host rocks of this type of deposit are listed in Table 1. The Nevada opal probably had its source in volcanic tuffs or associated magmatic waters, although space for the opal was provided by replacement of wood fragments. Bentonite is also associated with the Nevada opal, but is formed by the alteration of a volcanic tuff, whereas the bentonite associated with Australian deposits has no obvious volcanic associations.

TABLE 1

Source	*Host rock*
Honduras	trachyte
Mexico	trachyte
Hungary	andesite
California	basalt rhyolite obsidian
Nevada	fossil wood
Tintenbar	basalt
Mullumbimby	rhyolite

Hot springs with water rich in silica are not uncommon in the late stages of volcanic activity. The source of silica may be magmatic or derived from the hydrothermal alteration of silicate minerals, as is shown by the occurrence of kaolinite in the Mexican trachyte. Field measurements in hot spring areas show concentrations of silica of 300-500 ppm and temperatures close to 100° C, and a value as high as 700 ppm has been recorded (Krauskopf 1965). This means that opal in volcanic rocks was derived from solutions of higher concentration and temperature than the "sedimentary" opal. Another factor in which the two processes appear to differ is that many of these volcanic deposits are on, or very close to the surface, so that rapid evaporation and concentration of the silica have taken place. A generally greater rate of evaporation means that the silica solution is concentrated more rapidly and the concentric shells are less perfectly formed. Any sedimentation will be affected by the close association of the particles and smaller particles may be trapped between the larger ones. Hence, when opal formed under these conditions is examined, the larger aggregated spheres are not obvious, and this type of opal generally has a greater transparency.

Hungarian (Cervenica) opal, although associated with andesite, does show aggregated spheres, and its microstructure is very similar to that of Australian opal of sedimentation origin. This apparent anomaly may be explained by the depth below the surface at which the opal occurs in Hungary and the consequent retardation of evaporation due to the overlying rock.

Silica in its many forms is one of the most common minerals, and even ordinary opal is very common and occurs in a wide range of environments. However, precious opal is much more restricted and this supports the laboratory findings that the conditions required for the formation of gem opal are very specialised.

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''New Minerals from Mont St. Hilaire, Quebec''

A DISCUSSION

by J.A. Mandarino and Guy Perrault

Royal Ontario Museum, Toronto **Ecole Polytechnique, Montreal**

We read with interest the recent article by Agos, Richerson and Regis (*Min. Record, 2,* 141-142 (1971)). Unfortunately, this interest rapidly changed to incredulity and dismay. We feel most strongly that the majority of the minerals listed in Table 1 of the article represent misidentifications and should be thrown out for various reasons. Before discussing each of these minerals, we would like to make some general statements.

First, both of us have been convinced for many years that amateur mineralogists (as opposed to "rockhounds") can make significant contributions to our science. Indeed, many have done so. In recent years, more and more amateurs have obtained access to modern mineralogical tools such as x-ray diffraction equipment. The proper use of such tools can solve many mineralogical problems. However, all tools and techniques have their limitations and both the professional and amateur must recognize this fact and work within these limitations.

For many years, the amateur has heard about x-ray diffraction and he has come to think of it as the ultimate answer in identification. X-ray diffraction is, without doubt, the most frequently used technique for identifying minerals, but *by itself* it cannot give unique answers to every specimen subjected to it. Many chemically different species give essentially identical x-ray patterns. Therefore, chemical, optical, and other physical data must be used together with x-ray before a species can be identified properly.

With these statements made, let us proceed to the paper under discussion. Our first objection is in the title. "New Minerals. . ." conveys to most mineralogists *new* minerals, not simply minerals previously unreported from a locality. True, the authors correct this in the text, but why didn't they use a more appropriate title?

A much more important objection is the means by which the authors "identified" the thirteen species listed. They state in the second paragraph: ". . .extensive x-ray diffraction studies. . .have revealed a number of previously unreported species from Mont St. Hilaire." No mention is made of any other data resulting from chemical, optical, or other physical tests. We must assume that the authors mean what they say—namely, that they identified all these minerals by x-ray diffraction only. For *eight* out of *thirteen* of the minerals this is impossible.

The eight "species", together with our comments, are listed below:

Brockite. . . This mineral gives an x-ray powder pattern almost identical to that of rhabdophane.

Fluoredenite. . . As a member of the Amphibole Group, this substance could not be distinguished from most other amphiboles by x-ray diffraction alone. We refer to fluoredenite as a "substance" rather than a mineral because to the best of our knowledge no description of a natural fluoredenite has been published. The only x-ray data for fluoredenite are for the synthetic substance.

Hedenbergite, var. Salite. . . Hedenbergite is a member of the Pyroxene Group. All other clinopyroxenes give x-ray patterns practically identical to that of hedenbergite.

Heikolite. . . This is a discredited amphibole considered identical to arfvedsonite by some authorities and intermediate between riebeckite and glaucophane by others. In any case, comment under fluoredenite applies here also.

Hibschite. . . This is one of the OH-bearing members of the Garnet Group. No garnet can be identified solely by x-ray diffraction.

Lessingite. . . While the authorities seem to disagree on the status of this mineral, it is clearly isostructural with the Apatite Group. Its cell dimensions preclude any differentiation from other "apatites" or structurally similar minerals.

Ripidolite. . .X-ray diffraction cannot distinguish between this and other members of the Chlorite Group.

Strontian-apatite. . . Here we have a case of incorrect nomenclature. The name implies an "apatite" with some strontium replacing the dominant calcium. The chemical formula, however, shows all strontium. In either case, x-ray diffraction could not distinguish this from any other apatite.

In the case of certain other minerals we must raise objections on the grounds of paragenetic relationships and/or mineral association. For example, minnesotaite is restricted to metamorphosed "iron formation" and hydrothermally altered volcanics. There are no rocks at Mont St. Hilaire which even remotely resemble these categories of rocks. In a similar way, tobermorite is found in metamorphosed siliceous limestones. Although such rocks occur as xenoliths at Mont St. Hilaire, the authors clearly state that the minerals associated with "tobermorite" are albite, aegirine, and mangan-neptunite. These three minerals are not constituents of the xenoliths but occur in the igneous rocks.

Of the original thirteen minerals, three have not been discussed: anglesite, malachite and talc. Talc is sometimes difficult to identify strictly by x-rays. Anglesite and malachite shouldn't present any difficulties.

We feel compelled to make one further criticism of the paper. This is in regard to the chemical formulae given in Table 1 of the paper. Many of the formulae are incorrect. Since we have indicated that we consider most of the identifications incorrect, we do not feel that it is necessary to list corrections to the formulae in this paper.

In conclusion we would like to stress again that the amateur (or professional!) who has the good fortune to use some of the more sophisticated techniques should be fully aware of the limitations of the techniques. Also, while "gold is where you find it", many other minerals do not have universal occurrences. Study the types of minerals that can and *cannot* occur in certain rocks.

A REPLY TO THE DISCUSSION

by A.J. Regis
Shrewsbury, Mass.
and David Richerson
Auburn, Mass.

We wish to reply to the criticism by Mandarino and Perrault of our paper "New Minerals from Mont. St. Hilaire, Quebec" which was co-authored with Ted Agos.

The article "New Minerals from Mont. St. Hilaire, Quebec" was submitted to the *Mineralogical Record* as a preliminary article to inform interested collectors of some new mineral occurrences we have found at St. Hilaire. It was our intention at the time to submit a more detailed paper listing all the data, x-ray, optical, spectrographic, etc. for each of the minerals at a later date. This intention was passed on to the editors of the *Mineralogical Record* in our cover letter submitted with the article under discussion.

It is unfortunate that Mandarino and Perrault made many erroneous and premature judgements of our article, and thus left the impression to many readers that they are the sole authorities on mineral identification and minerals from Mont. St. Hilaire, Quebec. We wish to dispel some of these beliefs.

To begin with, we are not all amateurs as Mandarino and Perrault would lead you to believe. Mr. Agos has one of the most extensive St. Hilaire collections known, and has specialized only in St. Hilaire minerals for the past five years. His reference collection now numbers over 500 minerals and associations from this location. Mr. Richerson, a ceramic engineer by profession, is also an established St. Hilaire collector. In addition, Richerson has had academic training and experience in crystal chemistry and in x-ray diffraction techniques. Mr. Regis is a professional mineralogist, and is in charge of the X-ray Diffraction Laboratory at Norton Company, Worcester, Mass. Regis, also is a St. Hilaire collector and is currently in the process of mapping and studying the geology — geochemistry of the locality.

The x-ray work reported in our article was performed on a Norelco-Phillips X-ray Diffraction Unit. Because of the very small specimen size usually available, the x-ray analysis was performed by two methods, (1) by carefully powdering the sample and forming a slurry on a glass side with alcohol and obtaining a diffractiongram for preliminary identification, and (2) by obtaining a film record of the x-ray pattern by the Debye-Scherrer method. With the Debye-Scherrer technique, we used fluorite or quartz as internal standards in order to eliminate errors in reading the individual x-ray lines. In addition to the x-ray examinations, each mineral was examined under a petrographic microscope for its optical properties, and analyzed for its chemical components on a B & L Dual Grating Emission Spectrograph.

We now wish to substantiate the identity of the minerals reported from St. Hilaire in our original paper.

Brockite. . .We were well aware of the similarity in the x-ray pattern between brockite and rhabdophane, as we are with all the other similar x-ray patterns for minerals occurring at St. Hillaire. Rhabdophane, however contains essential cerium and yttrium whereas brockite is a calcium, thorium hydrated phosphate. Emission spectrographic analysis on our sample showed the following:

major: Ca, Th, P
minor: Y, Sr, Ba

The mean refractive index was 1.685, and the brockite occurred as light yellow, flat rounded hexagonal-like crystals. These properties are very much like the ones reported for brockite by Fisher and Meyrowitz (1962).

Fluoredenite. . .The presence of fluorine is the real problem in this identification. The mineral from St. Hilaire has a low iron content, approximately 3.0 - 5.0% and also low refractive indices which places it as edenite.

All edenite contains some fluorine, and preliminary work on edenite from Wilberforce. Ontario shows a fluorine content high enough to properly be called fluoredenite.

Hedenbergite var Salite. . . At first this mineral was believed to be diopside, however, after optical and spectrographic examination, it was determined to be closest to the salite composition of hedenbergite. The properties for this mineral are:

Total Iron 6%
Optical - $\alpha = 1.691$
$\beta = 1.699$
$\delta = 1.710$

This data corresponds to descriptions of hedenbergite var salite as described by Deer, Howie and Zussman (1963).

Heikalite. . . If this species is descredited as claimed by Mandarino and Perrault, then this should be "thrown out".

Hibschite. . . This is a very rare hydrated calcium garnet. It occurred as very small isolated, colorless octahedral crystals. Its refractive index is 1.670. Emission spectrographic analysis showed only calcium, aluminum and silicon. The only other garnet of this composition is grossularite, however, the refractive index of grossularite is approximately 1.730±, which is far too high for the mineral we have described. What other garnet could it be?

Lessingite . . . The problem here is partly one of nomenclature. The mineral we identified as lessingite showed by emission spectrographic analysis to contain the following:

major: Si, Ce, La, Ca
minor: Fe, P, Mn

Based upon the high amount of silicon present, we felt it was closest to lessingite as described by Gay, (1956). According to Gay, britholite contains a much higher amount of phosphorous.

Ripidolite . . . Based on careful observation of relative line intensities, chlorite minerals can be divided into what is known as 14Å and 7Å chlorites. By use of this data and the fact that this chlorite contains a high iron content, corresponding to a β refractive index of approximately 1.65, and its mode of occurrence, this chlorite falls into the prochlorite group. We admit, however, that assigning the name ripidolite is questionable at this stage.

Strontian-Apatite ... The primary basis for this identification was the high strontium content as proven by emission spectrographic analysis. Calcium was also present.

Minnesotaite ... We agree that minnesotaite, an iron bearing talc, has been confined in occurrence to the metamorphosed "iron formations". The sample from St. Hilaire was a highly altered siderite bearing rock consisting primarily of "limonite". The minnesotaite occurred as greenish-gray silky, radiating, fibrous coatings on this "limonite" rock. The refractive indices,$y\alpha = 1.578$ and $\gamma = 1.620$ are far too high for talc. Also, a contamination free sample of this mineral showed a high iron content by spectrographic analysis, and only 4-6% magnesium. Approximately 1-2% of aluminum is also present.

Tobermorite ... One of the authors (Regis) has had considerable experience with tobermorite type minerals. He has synthesized virtually all the various tobermorite compositions (Regis, 1963) so this mineral posed no problem in its identification. Spectrographic and optical analyses confirmed its presence. We agree, however, that the mineral associations reported occurring with the tobermorite were in error.

The compositions we gave for the new mineral occurrences at St. Hilaire in our article were not meant to be "ideal" formulas, but only to convey to the reader the general composition of these minerals. For example, without a complete chemical analysis, the correct formula for brockite is impossible to write; the same is true for lessingite, fluoredenite, hedenbergite, minnesotaite and chlorite (ripidolite-prochlorite). All of these minerals can have considerable substitution of one element for another in their structures. We are currently in the process of getting detailed chemical analyses on many of these minerals by electron probe.

It is indeed unfortunate that such a misunderstanding must arise on a mineralogical paradise such as St. Hilaire. The theme for all mineralogists, professional and amateur alike, should be one of cooperation.

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FURTHER DISCUSSION

by J. A. Mandarino

I am moved to make some comments on the reply by Regis and Richerson. The basic fact which prompted the writing of the discussion is that we criticised what was *stated*; namely, that the identifications were based on ". . .extensive x-ray diffraction studies. . .". It would have been unnecessary to have written the discussion if Agos, *et al*, had mentioned other work performed by them. All this aside, Regis and Richerson still do not make good cases for some of their minerals.

Heikolite they are willing to have "thrown out". Please note that Guy and I are not "claiming" it should be discredited; it plainly has been discredited.

They now seem to feel that the name ripidolite is "questionable at this stage." I agree. Most mineralogists would have simply called it a "chlorite" unless they had *complete* data on the mineral.

Strontian apatite is still in doubt. What does "high strontium" and "calcium was also present" mean? Strontian apatite is *not* a mineral species. If they think they have a strontium analogue of apatite, they should say so.

I do not agree with the statement that the presence of fluorine is the real problem in the case of fluor-edenite. The *real* problem is whether you can distinguish an "edenite" from other amphiboles. For some reason, we are switched from St. Hilaire to Wilberforce. The Wilberforce "edenite" which Regis and Richerson feel could be called "fluoredenite" has been under study here at the Royal Ontario Museum for several months. The study is almost completed and it is neither edenite nor fluor-edenite. I hope to submit a full description of this mineral to the *Mineralogical Record* by Spring.

I am quite content to believe that Mr. Regis is competent to identify tobermorite, but how could the authors have been in error on the associated minerals reported originally? What are the associated minerals?

A "semi-quantitative" spectrographic analysis is not sufficient grounds to assign the name lessingite. In fact, the "major" designation for the Si content really doesn't pin down to lessingite (SiO_2= 19.85); beckelite (SiO_2= 17.13), or britholite (SiO_2 = 16.77). The figures are taken from Guy's paper referred to by Regis and Richerson. One might note also that Hey and others think that lessingite may be identical to or a variety of beckelite.

Brockite, hedenbergite, hibschite, and minnesotaite, in view of the other data now given seem reasonable. Again, it is unfortunate that these data were not included in the original paper.

What Regis and Richerson are saying in their reply is "How can anybody dispute what we said if they had known what we didn't say?"

"RREST" BIBLIOGRAPHIES

The ROCK AND MINERAL EXCHANGE SERVICE (RMES) is compiling a monthly bibliography of relevant materials for earth science teachers entitled, "Resources and References for Earth Science Teachers" (RREST). To receive copies of this one-page bibliography, send *stamped, self-addressed envelopes* (business-size, please) to: Charles A. Wall, Department of Science Education, The University of Georgia, Athens, Georgia 30601. You will receive on or about the first of each month a copy of the "RREST" biblographies for as long as your supply of envelopes lasts. Due to the free, voluntary nature of the RMES, *only* those inquiries accompanied by *stamped, self-addressed envelopes* will be processed.

To the Editor

Dear Sir:

Not surprising is my statement that I cannot agree completely with all of your criticism of the AFMS Uniform Rules. However, we here in Springfield have our own criticisms and have a committee working on a list of suggested revisions and changes. Several years ago, in conjunction with a couple of other nearby Societies, we adopted for our own use a modified code of rules. Now, several of those variants are part of the latest edition of the Rules. We have hopes our current suggestions will also be helpful to the hobby.

Harold M. Dunn
Springfield, Oregon

Dear Sir:

Greetings from Colorado. This is to let you know that there are some people who agree with your editorial in Vol. 2, no. 4 on "Variety Selenite."

I used to judge minerals but quit several years ago because of what I considered "nit-picking" by judges, and I know of at least three other ex-judges who quit for the same reason. Rock clubs all over the country have problems getting judges and exhibitors — this situation is going to get worse unless there are some rule changes which will eliminate some of these pretty irritations.

A rock show is put on for the public and it is hoped that the public will support it to the point where the clubs won't go in the red. The public couldn't care less that a label should read "Gypsum variety Selenite." So keep up the good work. Maybe some day the rules will be changed to the point where labels will not be such a point of irritation to exhibitors — and to some of us ex-judges.

C.W. Withers
Lakewood, Colorado

Dear Sir:

Some comments on some of the things I have read so far. On the subject of showing minerals at shows, I noticed that you commented on the rules, etc. There is another aspect of this that I think a lot of people do not realize. Over the years and after many shows, I am of the opinion that this is sort of an affluent collectors game, as from the past experiences I have noticed and people I have talked to, it seems that the winner is always a person who has the best minerals, BUT they have been purchased at a great price, which most collectors cannot ever touch. And this goes even down to thumbnails. People in the lower and middle income bracket such as me, do not have the money to buy the best and therefore the most expensive minerals for our collections and therefore we refrain from even attempting to enter these shows. It seems that there are a few dozen people across the country who have the means and time to attend all the big shows and these people enter the shows in hopes of beating one of the other fellows of the lodge and so on. It is a shame that there cannot be a way for the average collector to compete in this show of minerals, as I feel that many people do not enter shows just for this reason and many collectors miss seeing excellent minerals for this reason. I can only give a personal opinion on this, but being a collector of some 12 years which does not put me in any way in a superior category, but does seem to put me in a place to voice an opinion, I will say that I have refrained from the shows mainly for this reason, but also because I am not in an area where there are very many shows that are in convenient range to be able to attend them. Here in Kansas, I am off the so-called beaten path and being perhaps the only mineral collector for a distance of many miles, puts me off to myself and not too much in connection with other collectors, although I do have one or two friends with whom I am able to get together frequently and we very much enjoy sharing our minerals when we get new ones and have gone on some profitable field trips in the past. The way that I have built up my collection of some 2000 (+) specimens, is by doing a lot of trading and field trips every chance I can. I have traded with people in many foreign countries and all over the U.S. and find that 99 percent of the mineral collectors are great people and very nice to know, even if only by letter, and the real treat is when I get to meet personally the people I trade with. This is the ultimate time in a mineral collector's life as he can share the collection with a mutual friend and compare minerals and views on this subject. Even my wife says that the best part of the hobby is the nice friends we have acquired and visited with.

Robert P. Bates
McPherson, Kansas

What you say is not unique to mineral collecting, the same may be said about coins, stamps, antiques autos, art, etc. Would you expect to be able to find a horse that could compete with those of the Rockefellers and DuPonts? In minerals the truth is, however, that very few wealthy people are competing with their collections. Most *that I know of have but average incomes. Therefore the sacrifices these people are making to acquire the specimens they show are extreme and I suspect that few of them derive the satisfaction from the hobby that you seem to. Ed.*

Dear Sir:

Congratulations on your extremely fine publication. I have enjoyed all of the articles and columns immensely. I did notice, however, a slip in the article by Clarkson, Roberts and Lingard in the Sept.-Oct. (Vol. II, no. 5). In the appendix they mentioned the reduction of arsenic to the trivalent state by the addition of stannic chloride. One would have an exceptionally difficult time reducing anything with stannic chloride; the reagent in question should be stannous chloride ($Sn(II)Cl_2$) which is routinely used for such a reduction.

I am sure that this was just a slip of either tongue or pen on the part of the authors.

Best wishes for continued success in your fine publication.

Laurence W. Littau
Assistant Professor
Monmouth College
West Long Branch, New Jersey

Thank you for bringing the slip to our attention. Ed.

Dear Sir:

I would hope that you could overcome the financial crisis outlined in your September-October issue. The magazine has proved itself to be very worthwhile.

You refer to your attempt to reach the average collector. As to that attempt I venture some criticism. Thus, in a number of issues there have been references to the Tucson Show. There has been no reference to the National Show at Seattle, and I have reason to believe that show was deliberately passed up by the editorial staff of the *Record* and the Smithsonian. Yet the attendance at the National Show has been estimated to have been over 60,000, hundreds, perhaps thousands of rockhounds attended, there were hundreds of exhibits, and the special exhibits were outstanding in quality and in number. If you were there it would have been easy to get someone who was there to write about that show. In ignoring it I think you did ignore the "average collector." I gather that at the Tucson Show there is a dealer's Mecca. I do not know how the dealers at the National Show compare although there were many and they did a land office business, but I strongly suspect the Tucson Show on an overall basis does not compare with the National Show.

I am not a lapidarist, but a great many rockhounds are and your magazine has had little to offer them.

Desautels' column, The Museum Record, seems directed to other museum personnel with little concern for the "average collector." Thus, in referring to mineral museums in Paris, I think the average collector would be interested to know that these museums are accessible only at certain times which are important to know beforehand. As to "the obvious state of decay in the collection of the Natural History Museum", it was not obvious to my wife and I, two average (perhaps subaverage) collectors when we were there this Spring. We found it very worthwhile and were especially impressed with it's new accessions in special cases as one entered the building.

I enjoy your magazine but it must be difficult to appeal to the average collector when all of the editorial personnel are so far above the "average."

Philip Marcus
Wheaton, Maryland

Mr. Marcus' letter touches on so many important points that we feel it should be replied to in detail. We have often alluded to the "average collector" but we are very much aware that he is hard to define. However, there is one trait that characterizes all of those we envision as belonging in this category — a desire to learn *about minerals. This is what separates collectors from "rockhounds", the latter appear to have little if any genuine desire to advance the state of their understanding of minerals. I do not intend this to be derogatory. It is a fact that a very large segment of the Federation-affiliated mineral club members has absolutely no interest in taking the hobby seriously. This is their right and no one should look down his nose at them for it. At the same time, we have no interest in steering the content of the* Mineralogical Record *in the "rockhound" direction. There are several other publications doing this, another isn't needed. The same is true for lapidarists. Several publications are loaded with lapidary articles, there* *is no need for another. We stated at the outset that we would not carry lapidary articles and columns.*

The staff of this magazine does feel partial toward the Tucson Show. It has been the one major show to place a long-time, heavy emphasis upon minerals as minerals, not as lapidary materials. Now there is another, the Greater Detroit Show. The Pasadena Show is still another but it is not as large as the others. We did not purposely ignore the National Show. I and others at the Smithsonian would have been delighted to attend that one but we could not afford to go. Our travel budgets and time are severely taxed so we can attend only a small number of shows and are forced to pass up many that would be excellent.

So we return to the matter of the "average collector." The members of the editorial staff have been mineral collectors for most of their lives. Those of us who are now professionals have been collectors longer than we have been professionals. We have been active in mineral clubs as members, officers, lecturers and even founders, and we participate frequently in mineral shows as exhibitors, lecturers and judges. We think we have a good picture of what a cross-section of mineral enthusiasts likes to find in a mineral publication. We do not claim infallibility, and we are learning. We have set reasonably high objectives for the Record *in the belief that we can stimulate a keener interest, among collectors in general, in some of the more rewarding aspects of the hobby. We also feel that the general reaction to the* Record *has been favorable and we are encouraged. The hobby, after all, is not stagnant. It is growing and it is changing and we hope to be able to influence the changes for the betterment of all concerned.*

It is not possible to spell out in detail here the current state of decay of the collections in the Natural History Museum in Paris. Mr. Desautels was not implying that it isn't a good collection. The point is that it was once great and is not now. Many of the fine specimens once there are gone. A discerning eye can quickly see the poor quality of the bulk of the specimens on display. Even a non-discerning eye can see the thick coat of dust and grime on most specimens, crumbling specimens, aging and illegible labels and many specimens showing the abrasive wear and tear of careless handling, etc. We must sharply disagree that there is anything exceptional about the new accessions cases at the entrance. They look good as a whole but most of the specimens would not grace a private collection — let alone that of a great museum. To my knowledge they don't even have a mineralogist as curator there days.

It would be nice to publish a schedule of times when foreign mineral museums are open. Many are available by appointment only and few have regular hours. When there is a regular schedule it is often subject to change with the seasons or for some other reason. Any published list and schedule would quickly be outdated. Mr. Desautels reports that the International Mineralogical Association is still struggling to produce a world list of mineral museum collections, their contents, hours, etc., but seems to be making little progress. Ed.

FRIENDS OF MINERALOGY

One of the goals of the Minerals Preservation Committee of the Friends of Mineralogy is to maintain classic collecting localities for the collector and researcher, — localities that otherwise might be abandoned at the cessation of mining operations or 'lost' as waste disposal or road-aggregate trucking sites. Many such are now gone, but one of the classic localities in North America has been preserved, the Buckwheat dump from the New Jersey Zinc Company's Franklin mine. Not only has collecting been maintained at a nominal fee, but display specimens have been preserved in a museum, educational tours and exhibits are provided, and research activities concerning the mineralogy proceed concurrently. Surely, this is a happy combination for all the various aspects of mineralogy: for the hobby of collecting, from an aesthetic viewpoint, and for the science.

The following story by John L. Baum, curator and researcher at the Franklin Museum, describes the means by which this locality has been preserved for our edification and enjoyment. Obviously, a great many people collaborated to make this venture a success, from the understanding cooperation of the New Jersey Zinc Company to locally enterprising Kiwanians and the enthusiastic support of many individuals. However, the moral of the story is that preservation can be accomplished. John Baum's article illustrates one method; we hope his example will spawn other and similar efforts.

D. M. Lapham

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The Franklin Mineral Museum Inc. was created by the Franklin, N.J. Kiwanis Club as a service to the town, which was in poor shape following the closing (in 1954) of the Franklin mine of the New Jersey Zinc Company. Initially, the Kiwanis Club requested, and was given by the Zinc Company, an old brick building at the end of the mine open cut, and also the Company's mine mock-up, formerly used for training miners in rescue work. The mine replica was expanded to two levels; a small mineral collection and a 10 foot-long display of fluorescent minerals were incorporated. Tours were conducted by appointment and the guides were Club volunteers.

Starting in 1957 the Kiwanis Club staged an annual mineral show to attract visitors to the town and to raise funds for charitable purposes. Success of this venture indicated that there was need for a larger display than contained in the old building, and in 1965 the Franklin Mineral Museum, Inc. opened its doors to visitors after two years of planning and construction. The land was a gift of the New Jersey Zinc Company. Money was solicited and a mortgage obtained; a sympathetic builder and a generous architect gave more than full value, and a young refugee cabinet maker was given a new start building cabinets to the design of the head of the building committee (later the Curator).

Mineral speciments and even entire collections were loaned for display purposes. The success of the venture enabled additional improvements, particularly a 35 foot square display room featuring the minerals and mining relics of the Franklin-Ogdensburg New Jersey zinc belt, a Curator's office for record keeping, archives, and study purposes, a combination furnace and specimen preparation room, a sales facility and a 35 foot-long dark room, one entire side of which is terraced behind glass. This houses a striking fluorescent display consisting entirely of local specimens, some mineral powder art work, and spheres cut from local material. The museum building is connected to the mine replica by a covered passageway featuring the uses of zinc, a flow sheet of the former ore milling process, and an enormous American flag that last flew over the Zinc Company's Franklin plant.

Adjacent to the museum complex is the noted Buckwheat dump, where lean ore and waste rock were discarded during mining of the south end of the Franklin orebody. Here a knowledgeable collector can pick up twenty different mineral species in half an hour (approximately 200 species have been described from the area). Fascinating micromount material occurs in vuggy dolomite and there are numerous other mineralogical attractions. New material is uncovered annually by bulldozing, and children have found one-inch franklinite crystals on matrix (much to the chagrin of the collecting adults). The fenced dump belongs to Franklin Borough and is currently leased to the Franklin Mineral Museum, Inc.

The staff of the Museum is headed by a Manager (currently Mrs. Florence Hansen) who is employed full-time and who attends to the booking of tours, the personnel, the sales shop, and maintenance. The sales force, guides, Buckwheat dump attendant and Manager are all salaried. The Curator attends to the displays, acquires additional specimens and undertakes such mineral studies as are possible

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Merrillite and Whitlockite or What's in a Name?

by Brian Mason
Smithsonian Institution, Washington, D.C.

Introduction

Many mineralogists, both amateur and professional, are occasionally troubled or confused by mineral names. The principal source of the trouble is the use of the same name for specifically different minerals, or two or more names for the same mineral. Some are inclined to shrug off the problem as either trivial or mere hair-splitting, but this is not the case; the progress of science demands precision in nomenclature. The best discussion of this problem known to me is that in the Introduction to the Sixth Edition (1892) of *Dana's System of Mineralogy*. This states that the Law of Priority has the same claim to recognition in mineralogy as in other sciences, but notes several reasons for amending this law; among these are: (a) when the name is identical with the accepted name of another mineral of earlier date; (b) when it is put forward without description; (c) when it is published with a description so incorrect that a recognition of the mineral by means of it is impossible; (d) when a name has been lost sight of and has found no one to assert its claim for a period of more than fifty years.

These problems are remarkably well illustrated in the merrillite-whitlockite dilemma, and are of current interest, because of the identification of whitlockite in the lunar rocks.

Merrillite

Tschermak (1883) gave a careful description of the optical properties of an unknown mineral which he observed as microscopic grains in thin sections of several meteorites; he believed it was a silicate and referred to it as "Monticellit-ähnlich Mineral". Merrill (1915) showed it was a calcium phosphate, and Wherry (1917) named it merrillite in his honor. Shannon and Larsen (1925), after tedious and time-consuming work, succeeded in extracting samples weighing 40 to 60 mg from kilogram quantities of the New Concord and Allegan meteorites. Two separate fractions, identified by their different refractive indices and densities, were obtained from New Concord. One of these was found to be chlorapatite; the other, merrillite, with about the same composition. Merrillite was described as being uniaxial negative, $\omega = 1.623$, $\epsilon = 1.620$, with density $= 3.10$. No x-ray data were provided, since x-ray procedures were not in general use at that time. Students of meteorites have continued to identify merrillite in meteorities since that time, usually on the basis of its optical properties in thin sections. These properties are so similar to those of apatite, however, that certain identification is extremely difficult.

Whitlockite

In 1941 Frondel published a paper entitled "Whitlockite: a new calcium phosphate, $Ca_3(PO_4)_2$". This mineral was found in a granite pegmatite at the Palermo quarry, near North Groton, New Hampshire. An interesting coincidence is that the name was in honor of Herbert P. Whitlock, Curator of Minerals and Gems in the American Museum of National History; G. P. Merrill had held the corresponding position in the Smithsonian Institution.

Frondel provided a very detailed description, including x-ray data. He noted, however, that the space group, $R3c$, was inconsistent with the theoretical cell contents, 7 $Ca_3(PO_4)_2$, since an odd number of cations is present and only equivalent positions occurring in pairs are available in this space group; Frondel favored an explanation that sufficient positions are vacant in the structure to satisfy the symmetry requirements. He evidently considered the possibility that whitlockite might be related to merrillite, since he writes: "A sample of alleged merrillite from the Waconda meteorite was found to have a powder pattern different from both whitlockite and apatite, but these is no certainty as to the validity of the specimen". With the advantage of hindsight it can be seen that the latter part of this sentence is highly significant; the "alleged merrillite" was not, in fact, merrillite.

Two years later Frondel (1943) published an extensive paper on the mineralogy of phosphate rock. He reexamined, by x-ray and optical techniques, a number of previously-described calcium phosphate minerals from phosphate rock, and showed that the following were identical with whitlockite: zeugite, described by Julien in 1865; pyrophosphorite, described by C. U. Shepard, Jr. in 1878, and martinite, described by Kloos in 1888. Of these, zeugite and pyrophosphorite were poorly described and these names could well be abandoned under the fifty-year rule of Dana. Martinite was in a somewhat different category, since it was included as a valid species in the Sixth Edition of *Dana's System of Mineralogy*. Fleischer (1944) pointed this out, and suggested the name martinite be retained; however, this has not been generally accepted — Strunz, in his *Mineralogische Tabellen* (1970) lists martinite as a variety of whitlockite.

During the following years, whitlockite was identified from several additional localities, and was also found as a constituent of slags, of calculus on human teeth, and of kidney and bladder stones. It can evidently form over a wide range of temperatures, from that of the human body to those of metallurgical furnaces.

Recent Developments

In 1962 Fuchs provided the first examination using x-ray techniques of the meteoritic phosphates described by Shannon and Larsen in 1925. He showed that the phosphate mineral in the Allegan chondrite has an x-ray diffraction pattern identical with that of whitlockite from the Palermo quarry, and he identified the same mineral in the New Concord and Waconda meteorites. From spectrographic analyses he arrived at a formula $2.5CaO.0.3MgO.0.1FeO.0.1Na_2O.P_2O_5$ for this mineral, i.e., a partly substituted $Ca_3(PO_4)_2$. He wrote: "The evidence presented here suggests that the previously recognized meteoritic mineral merrillite is actually whitlockite. In addition, the formula for merrillite ($3\ CaO.Na_2O.P_2O_5$) is in disagreement with the findings of Franck, Bredig, and Frank, who report that the only ternary compound found in the system $CaO\text{-}Na_2O\text{-}P_2O_5$ is $CaO.Na_2O.P_2O_5$." He thus rejects the name merrillite on the basis of the erroneous analysis. It is questionable, however, if this is sufficent to invoke Dana's rule "(a) description so incorrect that a recognition of the mineral by means of it is impossible", since merrillite can be recognized by its optical properties. However, since the publication of Fuch's paper, the use of the name whitlockite for this meteoritic phosphate seems to have gained ground; in the latest (1970) edition of *Mineralogische Tabellen* Strunz comments: "Merrillit = Whitlockit aus Meteoriten". It must be admitted, therefore, that in spite of the claims of priority, common usage is likely to validate the acceptance of whitlockite and the relegation of merrillite to the synonmy.

A Whitlockite Group?

Unsuspected complications have further bedevilled the situation. Keppler (1965) resolved the inconsistency between space group and formula of whitlockite noted by Frondel by showing that the formula should be written $Ca_9MgH(PO_4)_7$, and postulated that the whitlockite structure requires the presence of at least one Mg or similar-sized cation to nine atoms of calcium. This seems to be borne out by published analyses, as shown in Table 2.

These analyses show clearly that magnesium is always present in the mineral whitlockite. Can pure $Ca_3(PO_4)_2$ crystallize with the whitlockite structure? The phase diagram for the system $Ca_3(PO_4)_2$ - $Mg_3(PO_4)_2$ as published in Fuchs (1969) shows a field for whitlockite extending from pure $Ca_3(PO_4)_2$ to about 7% $Mg_3(PO_4)_2$ (= 3.2%MgO). Mackay and Sinha (1967) find that synthetic calcium phosphate with the whitlockite structure is piezoelectric and suggest that it contains essential hydrogen, giving the formula $Ca_{20}H_2(PO_4)_{14}$. It is conceivable that combined hydrogen might be so tightly bound in the structure that it would be held even up to the melting point. However, Ito (1968) has synthesized whitlockites ranging in composition from $Ca_9(PO_4)_6$ to $Ca_7Mg_2(PO_4)_6$, and states that infrared absorption analysis shows that these are anhydrous.

While some of the natural whitlockites have compositions close to the formula $Ca_9MgH(PO_4)_7$, others show a considerable amount of iron replacing magnesium, and two (from the Shergotty meteorite and from one of the lunar samples) have more iron than magnesium. One specimen from Mexico contains an appreciable zinc content. Thus we can distinguish magnesium whitlockite and iron whitlockite, and zinc whitlockite possibly exists. Meteoritic whitlockites contain sodium, presumably replacing some of the calcium. The lunar whitlockites are especially interesting, since they contain relatively large amounts of yttrium and rare earths, and some silicon; the latter element presumably replaces phosphorus, by the coupled substitution of $Y^{3+} + Si^{4+} = C^{2+} + P^{5+}$. The certain identification of the lunar mineral with whitlockite lacks confirmation by x-ray diffraction, but the chemical compositions are consistent with the accepted formula for this mineral. This raises the question of a suitable nomenclature to indicate their special composition. Since yttrium is the most abundant element of the group, probably the most informative method would be to call the mineral from Lunar rock 12036 yttrian magnesium-whitlockite and that from Lunar rock 12032 yttrian iron-whitlockite. It certainly seems probable that additional members of the whit-

TABLE 2. Analyses of whitlockite

	CaO	MgO	FeO[1]	R_2O_3[2]	MnO	ZnO	Na_2O	P_2O_5	SiO_2	H_2O	
$Ca_9MgH(PO_4)_7$	48.00	3.84						47.30		0.86	Calculated
$Ca_9FeH(PO_4)_7$	46.63		6.64					45.90		0.83	Calculated
Palermo quarry	46.90	2.53	3.47					45.86		0.48	Frondel, 1941
Palermo quarry	46.84	1.90	2.52		0.76			45.94		0.66	Frondel, 1949
Oran, Algeria	48.15	3.53	0.05					45.87		1.79	Bannister, 1947
Sabinas Hidalgo, Mex.	46.35	2.17				1.99		44.28	2.80	1.61	Cady et al, 1952
Allegan meteorite	46.3	3.7	0.3		0.02		3.1	45.4			Fuchs, 1969
Shergotty meteorite	45.9	1.5	4.1		0.2		1.5	45.7			Fuchs, 1969
Lunar rock 12036	42.3	3.8	1.35	7.6			0.33	42.5	0.54		Keil et al, 1971
Lunar sample 12032	33.5	0.63	4.8	19.7			0.02	3.65	3.9		Keil, unpublished

1. All Fe as FeO
2. R = Yttrium and rare earths

Table 1. MERRILLITE-WHITLOCKITE CHRONOLOGY

1883	Tschermak	Unknown mineral in meteorites, "Monticellit-ahnlich Mineral"
1915	Merrill	Tschermak's unknown is Ca phosphate
1917	Wherry	Gave the name merrillite to Tschermak's unknown
1925	Shannon & Larsen	Examined meteorites: New Concord (2 fractions) chlorapatite merrillite $(CaO)_3(Na_2O)(P_2O_5)$ (Anal. by Shannon) Allegan merrillite only (Anal. by Shannon)
1941	Frondel	Described whitlockite (new), $Ca_3(PO_4)_2$ (from granite pegmatite)
1943	Frondel	Phosphate mineralogy studied $\text{whitlockite} = \left\{\begin{array}{l}\text{zeugite (Julien, 1865)}\\ \text{pyrophosphorite (Shepard, 1878)}\\ \text{martinite (Kloos, 1888)}\end{array}\right.$ whitlockite has wide range of temperature stability
1962	Fuchs	Meteoritic phosphates studied (first x-ray studies) Identified whitlockite in the Allegan, New Concord and Waconda meteorites Showed Shannon and Larsen formula wrong Rejects name merrillite on basis of erroneous analysis
1965	Keppler	Whitlockite formula should be: $Ca_9MgH(PO_4)_7$

ADDITIONAL NOTES

Yttrium-, magnesium-, iron-, and zinc-bearing whitlockites are known

Lunar whitlockites contain Y, rare earths and Si
Mg is present in all natural whitlockites
Fe can replace more than half of the Mg
Zn is sometimes present, also Na

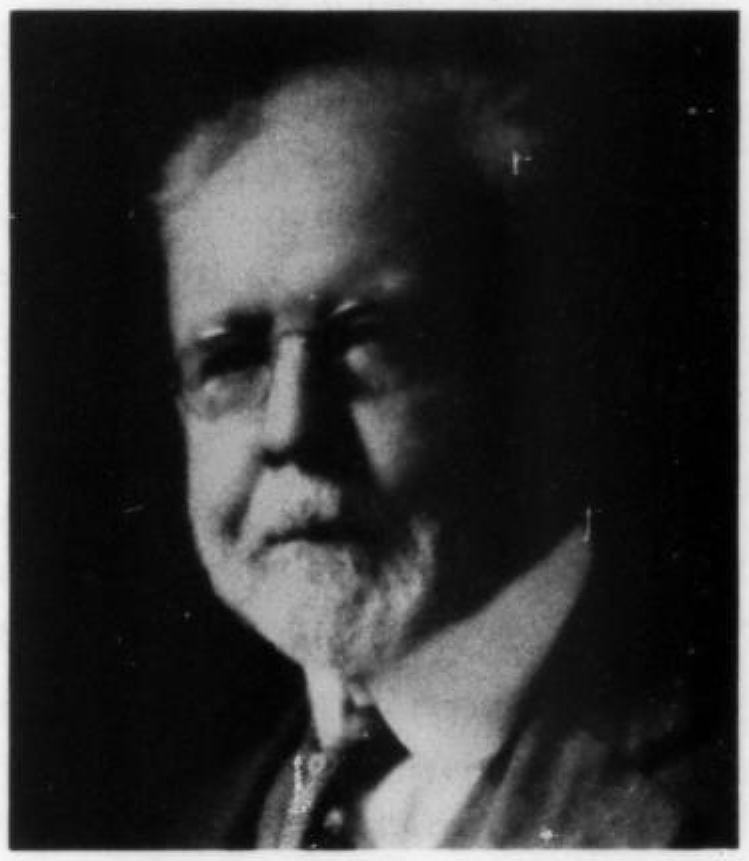

Fig. 1. **George P. Merrill. Photograph courtesy of the Smithsonian Institution.**

Fig. 2. **Herbert P. Whitlock. Photograph courtesy of the American Museum of Natural History.**

lockite group are waiting to be identified. Possibly the name merrillite can be revived for one of these.

Acknowledgements

I am indebted to Dr. K. Keil for the unpublished analysis of the whitlockite in Lunar sample 12032, and to Dr. C. Frondel, Mr. L. Fuchs, and Dr. M. Fleischer for their comments and advice on the manuscript.

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RECORD BOOKSHELF, continued from page 246

twins, stacking faults, vicinal faces and other crystal imperfections). All these features are certainly found in minerals, but the mineralogical literature lags somewhat behind that of physics in treating them. Unquestionably this is largely due to the unbelievable complexity in trying to handle them all at once, as is the case with minerals. The physicist can choose materials (or grow them) that prominently display only one or two crystalline defect types, and study these with a great variety of techniques not usually employed by the mineralogist.

Other chapters in the book cover crystal-growth equilibria, kinetics, growth by solid-solid, liquid-solid and vapor-solid equilibria and growth from solution. Not all the materials that are being grown or have been grown are mentioned, but this does not detract from the usefulness of the book. It is intended to be an introduction to the field and, in any case, the professional is strongly urged to consult the periodical literature before starting research. Laudise's text is also much more descriptive than mathematical.

The Growth of Single Crystals should find a welcome place in the library of mineralogists who hope to learn about how minerals grow in nature, for this knowledge is likely to come from the laboratories in which nature's processes are duplicated.

Principles of Crystal Structure Determination, by G. B. Carpenter, W. A. Benjamin, Inc., 1969, 237 pp., ($14.50)

Most textbooks on crystal structure analysis are either qualitative or so rigorous as to frighten off the casual reader. Carpenter's book fills the need for a lucid introduction to the principles of structural work, on a level suitable for the undergraduate or graduate student, or a review for scientists familiar with some aspects of the field of structure determination. Carpenter succeeds so well in his middle-ground approach that many parts of his book are suitable even for the serious amateur. These sections are among the most concise, perspicuous and logical passages on crystallographic topics to be found in the current literature.

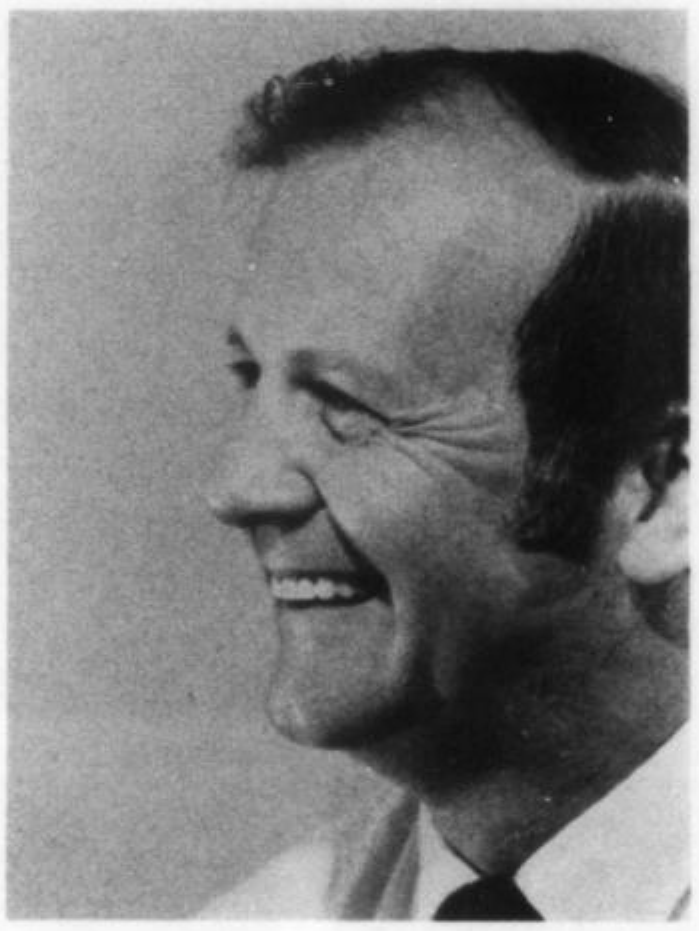
Principles of Crystal Structure Determination is, above all else, well written. Sentences are short, carefully structured and to the point. All topics are developed in a style so forthright and logical that one is amazed at the simplicity of the concepts discussed. This is the mark of a top-quality educator — the ability to make complex subjects seem transparently simple. Carpenter realizes that rhetoric lives or dies on the strength of its assumptions and premises. Consequently, definitions are worded so carefully that no doubt remains as to what is being stated. Even some of the very words used in the definitions are themselves defined (as in the case of the definitions of *crystal* and *lattice*). Yet brevity reigns, and much material is summarized in a few words that ordinarily occupies several pages in other books. One must constantly remind himself that the book is a text. An unfortunate contemporary idea among pedagogues is that students are expected to "wade" through pages of rigorous text. It is refreshing to find that the same concepts can be conveyed with a fraction of the text, but no loss of rigor.

Topics covered in the book include: Crystals, lattices and structures; Diffraction of X-rays by crystals (production and properties of X-rays, physics of diffraction, the reciprocal lattice, experimental arrangements, diffraction intensities); Crystal symmetry (concepts, groups, symmetry in diffraction); Determining and refining crystal structures. Appendices on the isotropic temperature factor and matrix notation are useful additions, and the appendix on statistical notation is a special attraction. A most noteworthy feature is a section on the variables describing a structure and the statistical treatment of errors.

Many parts of the book are quite detailed and rigorous, and the reader is expected to have a working knowledge of vectors throughout. The derivations of expressions for the atomic scattering factor and the Bragg equation (from the Laue conditions) are especially well presented. The section on the reciprocal lattice is passed over a bit quickly, in light of its underlying importance in understanding the diffraction process. An unfortunate printing error early in the text (both "grey" and "black" lines on a diagram are printed black) is a minor flaw. All such trivial sins are forgiven in light of the bounteous gift to the reader at the end of the book—an annotated bibliography. To the frustrated researcher of scientific papers whose bibliographies sometimes do not even give the titles of papers, such a directory is a rare treasure.

Carpenter's book is not for the casual reader, though scattered parts of it are easy to grasp even by the layman. The best use of the text can be made by students just learning the details of crystal structure determination. The book should certainly also be read by the laboratory-tested professional, who can but wish that such a text was available when he learned his craft.

The Museum Record



by Paul E. Desautels

A museum exists because of its collections. Any of the activities in which it is involved that are unrelated to its collections could probably be just as easily done somewhere else under other auspices. This doesn't mean, of course, that a museum is a viable institution just because it owns collections. If there is no activity in and around the collections then it differs little from a warehouse — with the usual difference that a good portion of the holdings are in open, visual storage. Assuming that the museum is alive and well, one might expect to see signs of programs in research, education and public exhibition as well as collection care and improvement.

Directing our attention to the last of these — collection care and improvement — it is almost a truism that any museum which neglects its collections, permits them to deteriorate, and abandons the struggle to make them available and useful is playing dangerous games with its fundamental charter. And yet, it is amazing how institutions, more often than not, treat mineral collections rather carelessly.

It is rather interesting that so many mineral collections have gravitated to all sorts of institutions over a long period of years. This was brought to mind sharply just recently while I was browsing through an old publication. In 1923 a booklet entitled *The Final Disposition of Some American Collections of Minerals* was published privately in a limited number by Frederick A. Canfield of Dover, New Jersey. This was just three years before Mr. Canfield's extraordinary collection was to come to the Smithsonian — the first of its great collection acquisitions. In the publication he lists some of the most important collections. Of the Clarence S. Bement collection of Philadelphia he states "This was the finest private collection of minerals ever made. It is the best public collection in America — it has but two rivals in the world (note — he was probably referring here to his own collection and that of Colonel Roebling). It contained about 16,000 specimens. In 1900 he sold it to the late J. Pierpont Morgan, who presented it to the American Museum of Natural History of New York City. The price paid was never published, but is said to have been only sixty per cent of the cost of the collection. Mr. Bement culled many of the choicest specimens from private collections, by purchase or exchange." He also lists the William S. Vaux collection also assembled in Philadelphia as "a general collection of the finest specimens that could be obtained. It absorbed the Markoe collection many years ago (note — which already contained the Fox collection). For a long time it was only surpassed, later, by the Bement collection. He bequeathed it to the Academy of Natural Sciences of Philadelphia, reserving, however, twenty-five specimens for his family. These are in the possession (note — no longer) of George Vaux, Jr. of Bryn Mawr, Pennsylvania. Mr. Vaux provided an endowment fund so that his collection continues to be active (note — barely)."

Most of these very important collections are still identifiable at least in large part in the institutions made famous by their acquisition. However, I am intrigued by the possible fate of some of the lesser collections listed by Mr. Canfield. Some, I have found, are still in existence and are relatively intact. One of the most interesting of these is in the Academy of Natural Sciences in Philadelphia where it sits as the oldest preserved collection in the United States. This is the Adam Seybert collection. Canfield says this collection "was presented to the Academy of Natural Sciences by the son, Henry Seybert, about 1825. It was a general collection of about 2000 specimens. It is kept intact, in its original cabinet, because of its historical interest." The George J. Brush collection of New Haven, Connecticut is another still identifiable and still in use. The publication tells us that Brush "presented his library and his collection of minerals to the Sheffield Scientific School, in 1904 (note — part of Yale University). It is a large collection of high quality, and contains many type specimens of rare minerals. His gift was valued at $40,000."

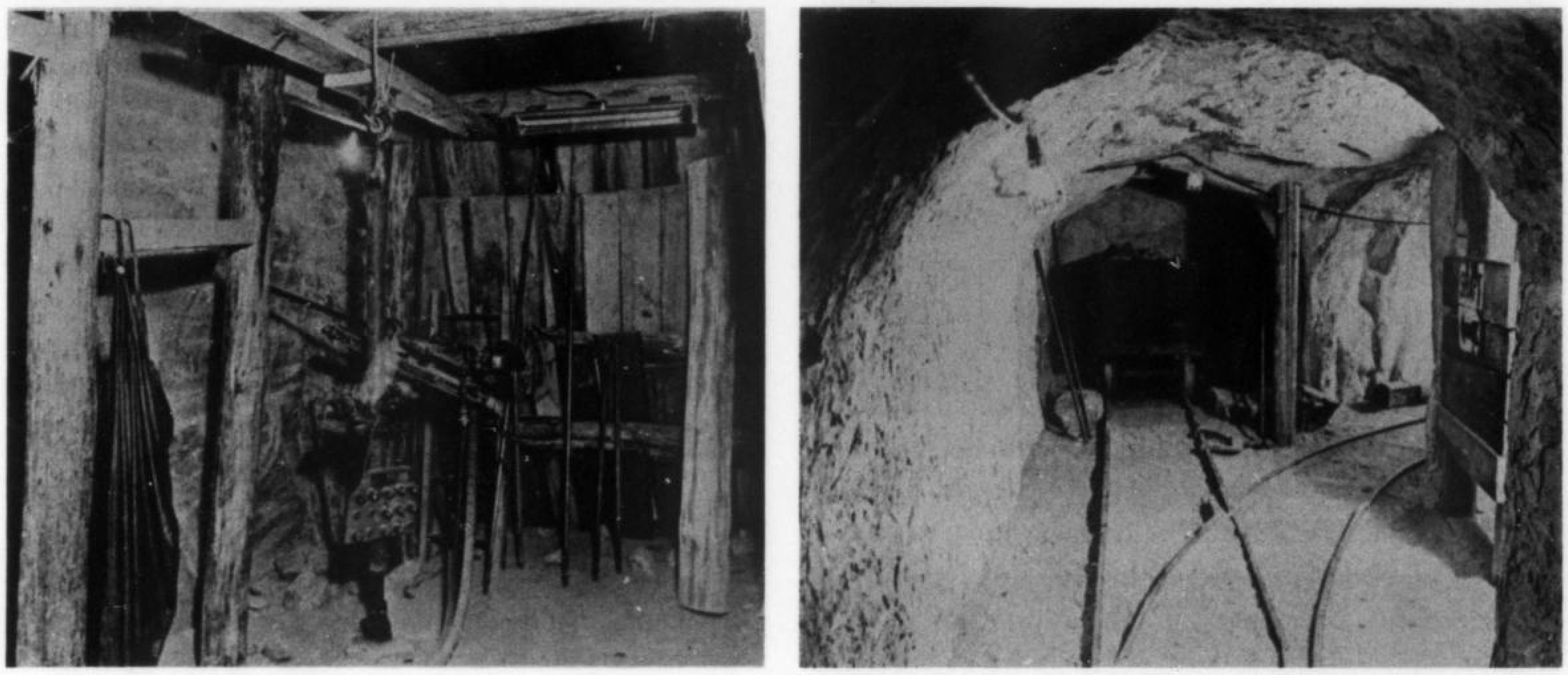
What intrigues me most are notations about collections given to institutions which I suspect are not aware that they got them. Possibly some still exist as listed but, as many collections as I have heard of and visited during my curatorial career, many have never attracted my attention. What ever happened to the E. S. F. Arnold collection which was given to the Mount Saint Vincent Academy of New York City? There was also the Thomas T. Bouve collection of Boston. "He gave most of his collection to the Boston Society of Natural History. He also gave some choice specimens to the Public Library in Hingham, Massachusetts," The Richard T. Brumby collection of Columbia, South Carolina "was sold at auction in New York City in 1869. It was acquired by Davidson College of Davidson, North Carolina." Is it still there? The Daniel Clark collection of Tyringham, Massachusetts is supposed to be "in the

Athenaeum in Pittsfield, Massachusetts." We are told quite bluntly about the Thomas Cooper collection of Columbia, South Carolina. "This very old collection was acquired many years ago by the South Carolina College, of Columbia. It received rough treatment by the soldiers during the Civil war." Has anyone in New York City ever heard of the Joseph Delafield collection? "In his will of January 16, 1869 he bequeathed his collection to the New York University about 1890, stipulating that is should be preserved separate and intact. It was a general collection of about 2500 specimens, and was reputed to be the finest collection in New York City."

Out west have any of you heard of the John Dickinson collection of Forestville, Connecticut? Dating from about 1879 it was "purchased by the University of Southern California (Los Angeles) which institution was unable to pay for it. It was acquired by Throop Institute, of Pasadena, California. It was a general collection. It contained fine specimens of the rare minerals that were found at Branchville, Connecticut." Here at home I must search the archives someday because I note that the George W. Hawes collection - of 450 specimens of American minerals - is in the National Museum. I don't recall that I have ever seen a specimen in the collection that was obviously part of the original Hawes material. However, I suspect a little catalog searching would turn up something.

I can't help thinking what fun it might be to attempt tracking down the remnants of the 172 collections listed by Canfield. Even more, I think it would be an excellent project for a group such as the Friends of Mineralogy to correct, and generally update Canfield's list. There have been hundreds of collections transferred since his time for which the records are slowly but surely vanishing. We should at least know that they have existed even if dispersed or carelessly destroyed.

The Franklin Mineral Museum, Franklin, New Jersey. ***Photo by Aladdin Business Service.***



Two views of the full scale mine replica, Franklin Mineral Museum. Photos by Aladdin Business Service.

FRIENDS OF MINERALOGY, continued from page 276

with the petrographic microscope and the carbon-arc spectroscope. There is a friendly mineral identification arrangement with Harvard University, a cooperative effort of mutual benefit. The working hours spent by the Curator, John L. Baum, and by the Associate Curator, Mrs. Fred Kraissl, are donated to the Museum.

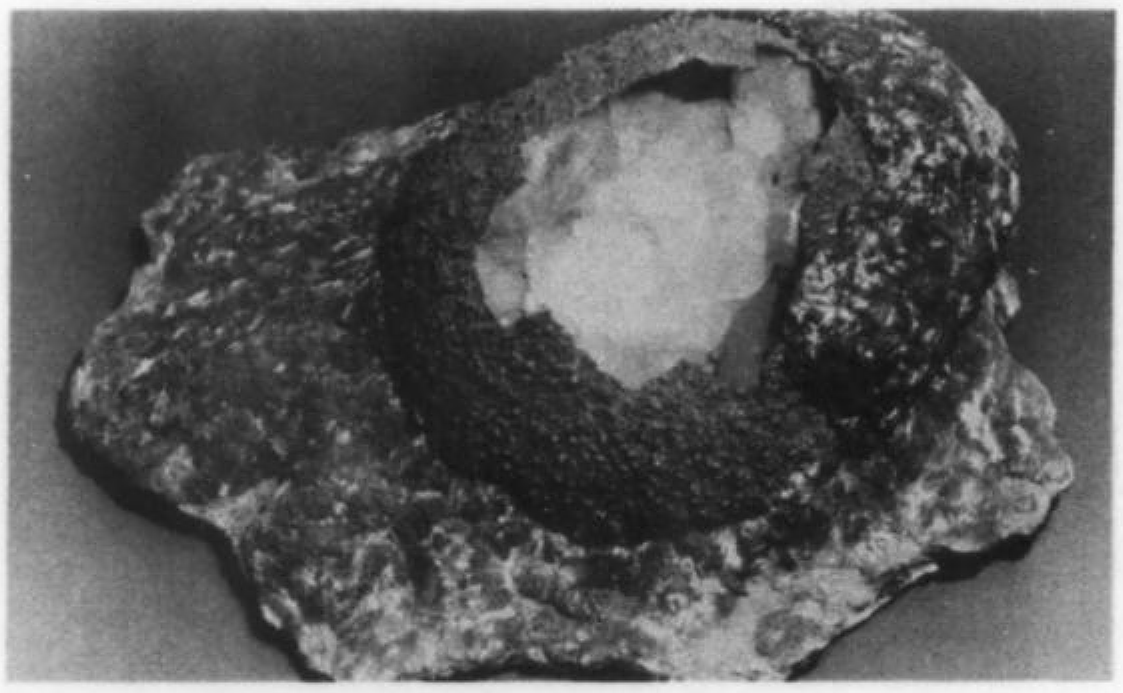
The Museum and dump are open from March 15 to December 15, Tuesday through Saturday, and Sunday afternoons. Nominal admission fees are charged, and there is a 25 pound limit on collected material. In the past, nighttime collecting for fluorescent material has been allowed on two nights per month. Most of the Museum visitors are school children, who arrive by the bus load (by appointment) during the Spring and Fall months. Teachers are admitted free, but accompanying parents must pay admission. The operation receives tax benefits as an educational institution. Band concerts are held on the grounds on occasion during the summer, and picnic tables are available to visitors. Revenue for overhead costs is obtained from proceeds of the annual mineral show, and lesser funds are donated annually (designated for specimen acquisition) by the Franklin-Ogdensburg Mineralogical Society. The Board of Trustees of the Museum Corporation is elected annually by the Franklin Kiwanis Club.

In summary, the Franklin Mineral Museum, Inc. is a successful operation that exposes young and old to mineral collecting. It gives employment to local citizens, preserves Franklin-type specimens for all to enjoy and makes surplus specimens available to students, collectors, colleges and research institutions. It records the mining history of a productive area and seeks to add to mineralogical knowledge. Such accomplishments are worthy of the highest praise and acknowledgement.

John L. Baum, Curator
Franklin Mineral Museum, Inc.
Franklin, New Jersey

Succeeding issues of MR will detail other case histories, solutions, and goals of the FM Minerals Preservation Committee. Although we can take no credit for the preservation of the Franklin area, several problems are actively being pursued. In the future, we hope to report here the success of at least some of these projects. We urge any interested readers to join our efforts and to comment upon them either by writing the editor of MR, John White Jr., or Davis M. Lapham, Pennsylvania Geological Survey, Dept. of Environmental Resources, Harrisburg, Pa. 17120 (current chairman of the MP Committee).

7. **Marcasite in bulbous growths. Shullsburg, Wisconsin. Smithsonian Institution specimen.**



8. **Marcasite "helmet" with top broken out to show calcite crystals attached to both sides of their thin walls. Smithsonian Institution specimen.**

9. **A pair of marcasite "helmets" turned upside down. Smithsonian Institution specimen. Shullsburg, Wisconsin.**

NEW MINERALS, continued from page 248

where zinc has been mined. Mr. Howe told me his specimens are from the Blackstone mine (now closed) near Shullsburg. However I have seen many other specimens labeled Montreal, which is in Iron County, northern Wisconsin, in the heart of iron mining country. Perhaps the use of the latter locality is simply a decoy to steer people away from the true source. Certainly the presence of sphalerite on most specimens would lead one to suspect that Shullsburg is the proper locality. Specimens have never been very abundant but over the last 6 years or so they have always seemed to be available in small numbers. It would seem that the miners are releasing only a limited quantity at a time. Figs. 7-9 show some of the forms of specimens in the Smithsonian's collections.

VARISCITE

In the last issue (Vol. II, no. 5, p. 231) I suggested that the variscite found in Winston-Salem, North Carolina is the product of the introduction of phosphorus into the stream by industry. Boyd Mattison, of Charlotte, N.C., did a little sleuthing and made a satisfying discovery. The aluminum foundry upstream can be "credited" with providing the phosphorus. Boyd found that they have been releasing some 340 lbs of phosphoric acid each week into the "sewer" since the 1950's. Phosphoric acid is used in the *bright-dip* process for cleaning aluminum. Boyd's efforts also revealed that a bone-button factory was located upstream around 1850, but one is compelled to believe the aluminum foundry's influence has been a far greater factor in producing the variscite.

CHLORAPATITE

From Canada comes apatite that is not apatite. In the *Canadian Mineralogist,* Vol. 10, Pt. 2, pp. 252-259, A. W. Hounslow and G. Y. Chao describe "Monoclinic Chlorapatite from Ontario." After learning that apatite is a *hexagonal* mineral this may come as a shock to many collectors. Of course we all understand that one thing most of the more widely accepted definitions of a mineral make clear is that one mineral cannot belong to two crystal systems, these are polymorphs and, as such, different minerals. There are numerous examples of dual names for polymorphs in the literature. Those where the identical chemistry relationship of the pairs is not revealed by the names include pyrite-marcasite, quartz-tridymite-cristobalite, argentite-acanthite, sphalerite-wurtzite, greenockite-hawleyite, etc. A popular practice is to attach a prefix to the name of the first recognized form thus emphasizing the polymorphic relationship. Some examples include vauxite - paravauxite - metavauxite, zoisite - clinozoisite, α, β andy γ sulfur, laueite-pseudolaueite, etc. Clearly this practice is more desirable because, without knowing anything at all about the polymorph, the name alerts you to the fact that the mineral bears some relationship to another species. Modified versions of established species names are much easier to remember than completely new names. Still another advantage is that it makes indexing so much simpler. Vauxite and its polymorphs, for example, could appear together in an index in this form:

vauxite
vauxite, meta-
vauxite, para-

Of course metavauxite could be listed under *m* and paravauxit under *p* as well.

The monoclinic apatite, then, really deserves a name and several choices are immediately obvious. However it is the right of the describer to name his mineral and this must be done through the International Mineralogical Association according to established procedure. I believe that Hounslow and Chao can be credited with the first description of natural nonhexagonal chlorapatite but synthetic monoclinic chlorapatite has been known for several years at least.

The new material was found at Bob's Lake, Oso Township, Frontenac County. It occurs in calc-silicate marbles in pinkish-white crystals with actinolite, diopside, calcite, quartz and talc. Chlorapatite from Norway (Bamle?) and Japan (Kurokura?) are hexagonal, apparently not containing enough chlorine to promote the structure change.

The authors credit D. Silver and A. Cherny with discovering the material and providing samples for the study.

J.S.W. Jr.

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Arthur Montgomery of Lafayette College and Friends of Mineralogy has prepared a series of articles on crystallography for the mineral collector. The author's aim is to simplify understanding of crystal shapes so that collectors may better recognize and enjoy their own crystallized specimens, as well as learn to classify crystals of unknown identity. A practical working knowledge of crystals is stressed, rather than theory.

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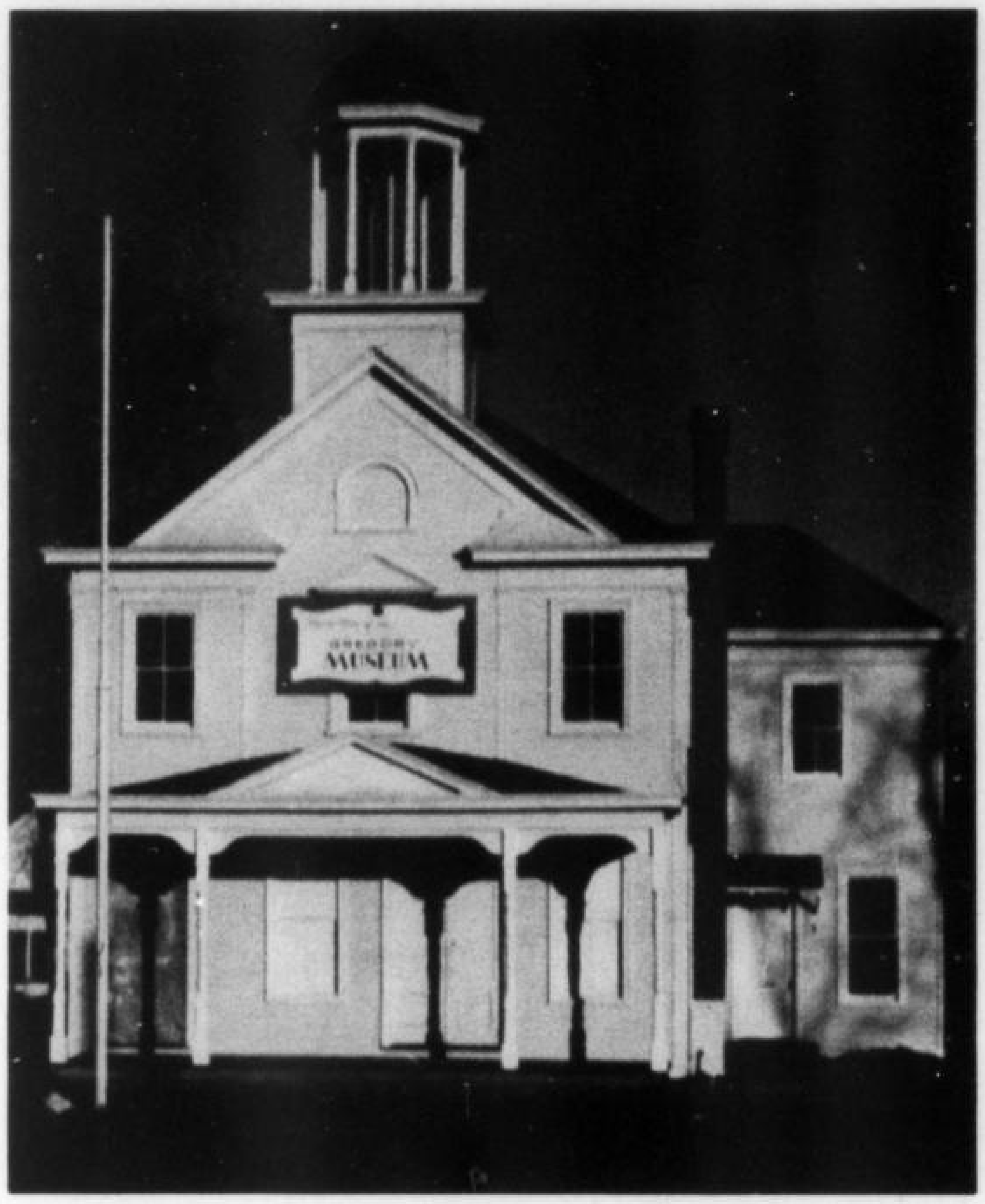
The Gregory Museum, basically an Earth Science Museum, is sponsoring a Gem & Mineral Show "Our Mineral Heritage" on April 29th and 30th, 1972 as a means of raising funds for the moving of the Museum into its new home, the Heitz Place Court House, Hicksville, built in 1895. The present premises can no longer contain all of the specimens of rocks, minerals, moths, butterflies, faceting and cabachon making equipment, nor can it accommodate the large crowds wanting to tour the Museum and attend its educational programs.

The Show will have both wholesale and retail dealers with a large variety of materials, educational exhibits, school exhibits, demonstrations of faceting, cabbing, micromounting, silversmithing, photomicrography and photomacrography. A lecture room will be available with an excellent program of many lecturers on all phases of mineralogy, geology, ecology, etc. Door prizes will be drawn every hour, and there will be grab bags for children. The curator of the Museum will identify specimens of rocks and minerals brought by the public.

For further information contact The Gregory Museum, 207 Cottage Boulevard, Hicksville, New York 11801, or phone 516-681-6041.



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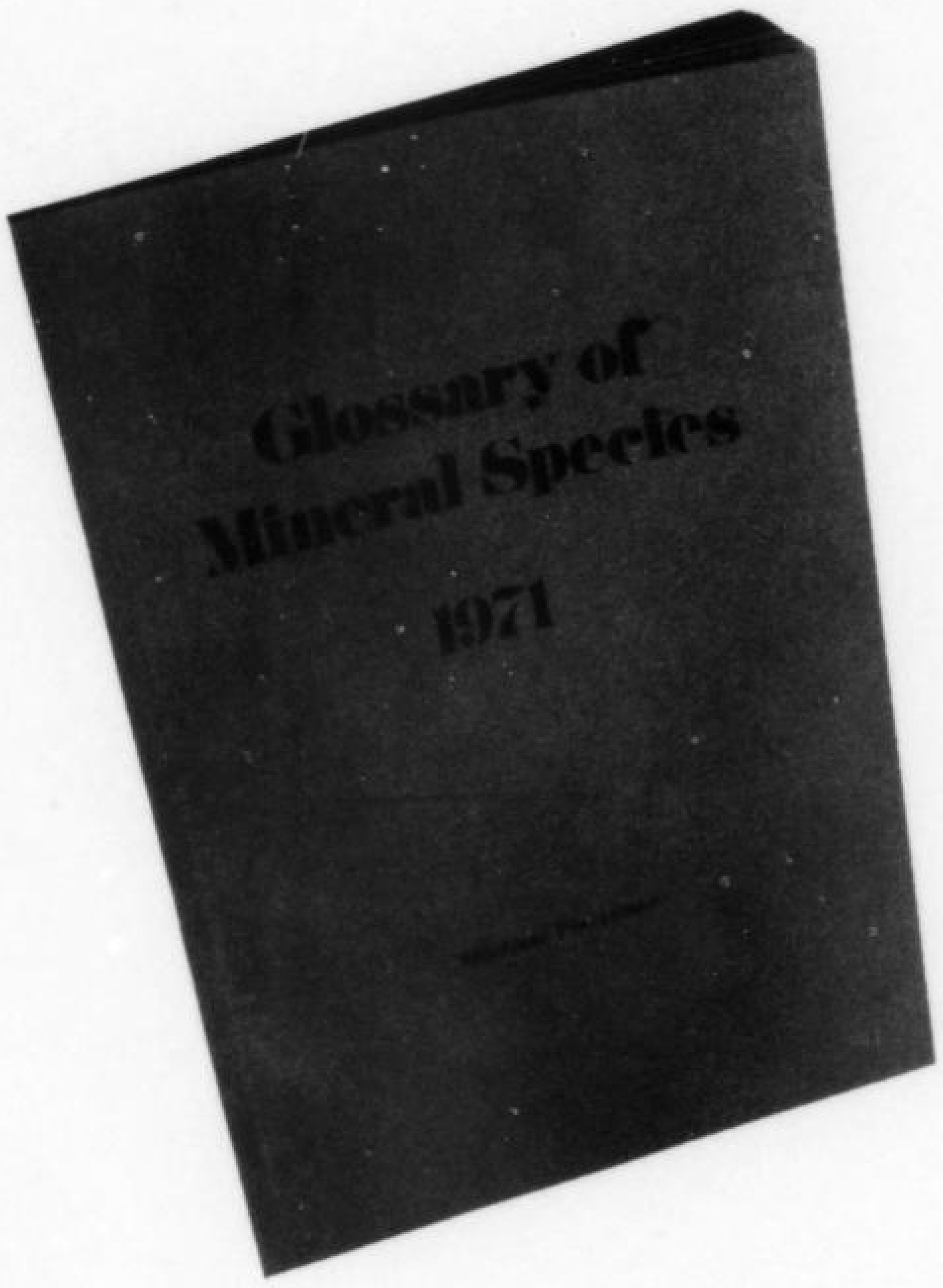
Glossary of Mineral Species
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Luzonite

- copper arsenic sulfide
- Chinkuashih mine, Keelung, Taiwan
- 4x5 $50.00, 2x3 $20.00, 2x2 $10.00, 1x5 $5.00, 1x1 $3.50, 1" $2.50
- lavender-gray, metallic luster, nearly pure

Pandaite

- hydrated barium strontium member of the pyrochlore-microlite series
- Panda Hill, Tanzania
- ref: E. Jager *et al*, Min. Mag. *32*, 10-25 (1959)
- single, loose octahedral crystals suitable for micromounts - @ $5.00 ea.

Scholzite

- hydrous calcium zinc phosphate
- 40 miles S.E. of Blinman, S. Australia
- colorless prismatic orthorhombic crystals up to 3/8" long on gossan. Most specimens show some damage
- from $4.50 to $12.50

Quartz

- Japan law twins
- Narushima, Nagasaki-ken, Kyushu, Japan
- flattened euhedral crystals 5/8" to 1" - @ $17.50 to $25.00

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