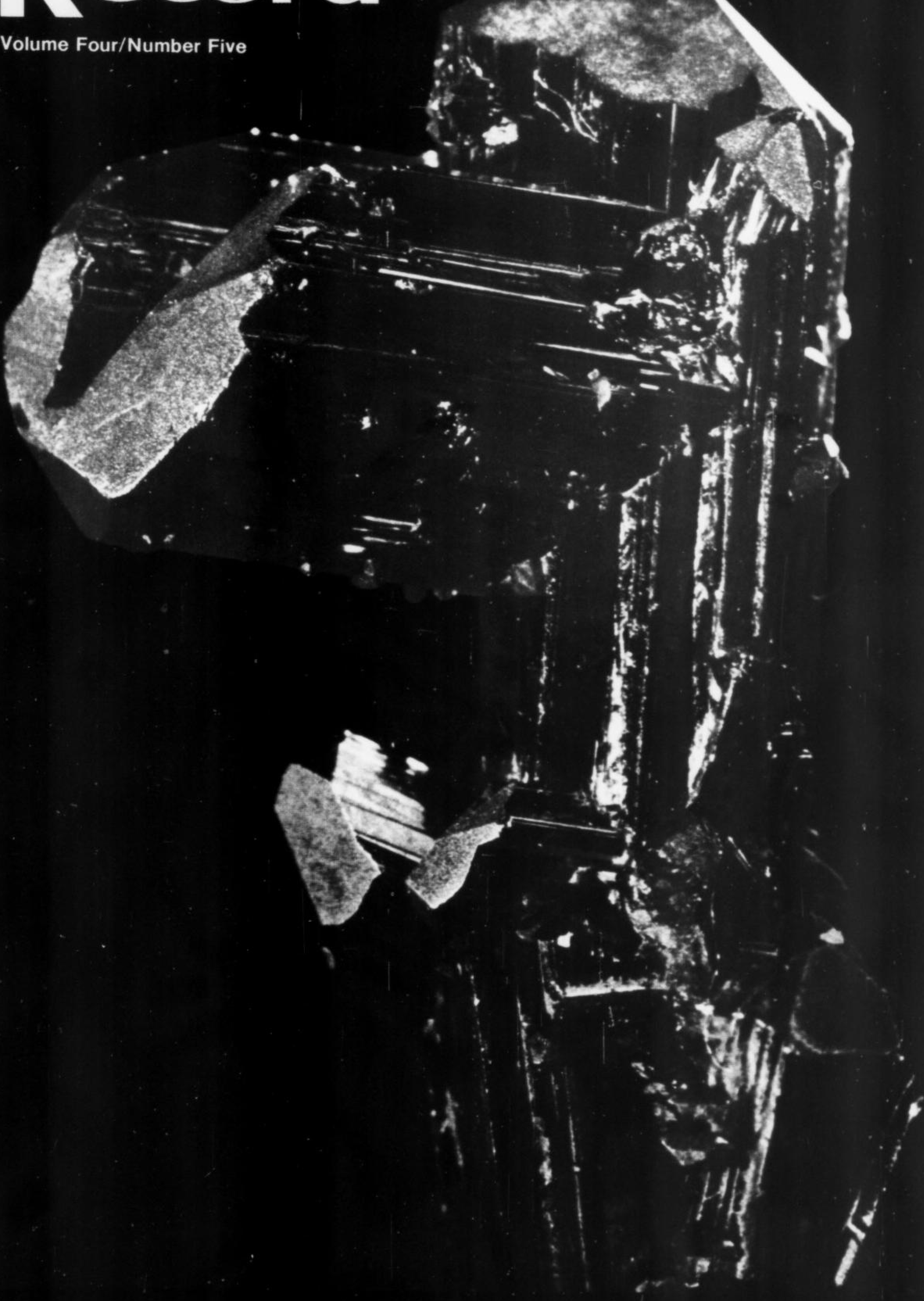
the Mineralogical Record

Volume Four/Number Five



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This fine crystal group of proustite from Niederschlemma, Germany, is in the Smithsonian's miniature collection. It was originally acquired by Martin Ehrmann and is noteworthy in that it was mined in relatively recent times. The photograph won the third annual *Mineralogical Record* cover photo contest at Tucson, Arizona, and is by Joel E. Arem,© 1973.

design & composition

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editorial matter

Contributed manuscripts and news items are welcomed, but acceptance is subject to the approval of the editorial board. They should be mailed to the editor at the aforementioned address, and should be accompanied by a stamped, self-addressed envelope. No responsibility can be assumed for unsolicited material.

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Division of Mineralogy
The Smithsonian Institution

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Editorial

On Nomenclature

Mineral nomenclature is a fascinating subject, yet it does not appear to have been given a great deal of attention in the literature. Newer collectors of minerals are often very surprised when they discover that the objects we collect and study are not *fixed* in number, that is, new species are constantly being described and named. We also lose some old ones from time to time as the application of new research tools permits definitive studies of materials formerly considered too impure or too small for accurate characterization. Probably because the subject of mineral nomenclature has been effectively "buried" (it rarely is even mentioned in formal mineralogy courses) a rather naive attitude has evolved among collectors when the rules of competitive exhibiting bring them face to face with the many nomenclatural problems. Several leading textbooks of mineralogy have been adopted as "authorities" in determining the correctness of the nomenclature that is permitted collectors when entering an exhibit in Federation competition. In spite of the fact that there is wide disagreement among the authors in the use of certain mineral names, the collectors have come to revere these authors as being so knowledgeable that whatever any of them writes must be worthy of acceptance. There is a tendency to assume that the men who wrote the textbooks were deeply concerned about the mineral names they gave preference to in the cases of synonomy and varietal designations. There is the tacit belief that these men researched the evolution of the troublesome names, arriving at a decision to use one name rather than another for good and rational reasons. There is the blind faith that the authors were dedicated to the long-range goal of simplifying nomenclature by eliminating ambiguities, synonomies and undesirable varieties. There is the idea that all of these authors have worked with major mineral collections, thus they are well aware of the importance of a nomenclature that lends itself to mineral systematics, that is, it compliments the systematization of a mineral collection.

The sad truth is that this reverence, this assumption, belief, faith and idea are not well-earned by most of the textbook writers. In some instances, at least, it is obvious that the author tried to sidestep nomenclature difficulties. Others have allowed themselves to be influenced by national considerations. Many do not even appear to recognize that problems exist, they merely continued the nomenclature they learned as students, never questioning its validity. The task of writing a major textbook is so great that one may readily believe that an author could not have investigated in the literature the history of every name to determine priority or legitimacy. There is no doubt that a contributing factor to this lack of concern over nomenclature was that there was no pressure coming from any corner urging standardization and simplification.

Today there are far more people concerned about nomenclature than ever before. These fall into two main groups: (1) curators of major collections and (2) exhibitors in Federation sponsored competition. The increase in size of the former group has probably not been too great in the last 100 years but the latter group, which didn't exist 10 years ago, has swollen in size to many thousands. So finally, in the history of mineral collecting, there is a group large enough to exert influence upon the nature of the reference works that are to be adopted by them. However, before this can happen they must be awakened from the hypnotic trance that allowed misconceptions as outlined above to prevail. They must realize that the textbook, and even system, writers never had the problems of the competitive exhibitor in mind when they wrote their books. They must be made to know what course to follow in pursuit of the best interests of the hobby, as well as the science. Even though they possess great potential lobbying force, the force cannot be utilized until a better understanding of what is needed is more widespread among those who would hope to benefit from future changes in the literature.

John S. White Jr.

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FLUOR-RICHTERITE xls. Wilberforce, Ontario, Canada. Terminated xls of this recently named amphibole in calcite. 10 x 10cm **$12.50**

INESITE xls. Trinity Co., Calif. Sharp xls of good color. 2 x 3cm **$15.00**

MANGANITE xls. Ilfeld, Germany. A fine miniature of 1cm terminated lusterous xls. 6.0 x 4.5 cm (fits a 2" competition cube space) **$160.00**

MILARITE xls. Valencia Mine, Guanajuato, Mex. Well exposed green xls on adularia xls and quartz xls. 3 x 5cm **$15.00**

NARSARSUKITE. Mt. St. Hilaire, Quebec, Can. Large xl sections in hornfels. 5.5 x 5.5cm **$5.00**

NEPTUNITE xls. San Benito Co., Calif. A nice miniature with several terminated xls of 2cm in length on natrolite matrix. 2 x 3.5 cm **$25.00**

PYRITE xl. Trabzon, Turkey. Good thumbnail of the simple octrahedron xl form. 1.5cm **$10.00**

RENARDITE. Ruggles Mine, Grafton, New Hampshire. Microxline secondary uranium mineral. 3.5 x 5cm **$20.00**

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A. 5.0 x 4.5cm **$20.00**
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TOPAZ xl. Urals. A nice single xl. Pale blue. 1.7cm **$15.00**

UVAROVITE (Garnet) xls. Outokumpu, Finland. Many small xls on matrix. 4.5 x 6cm **$15.00**

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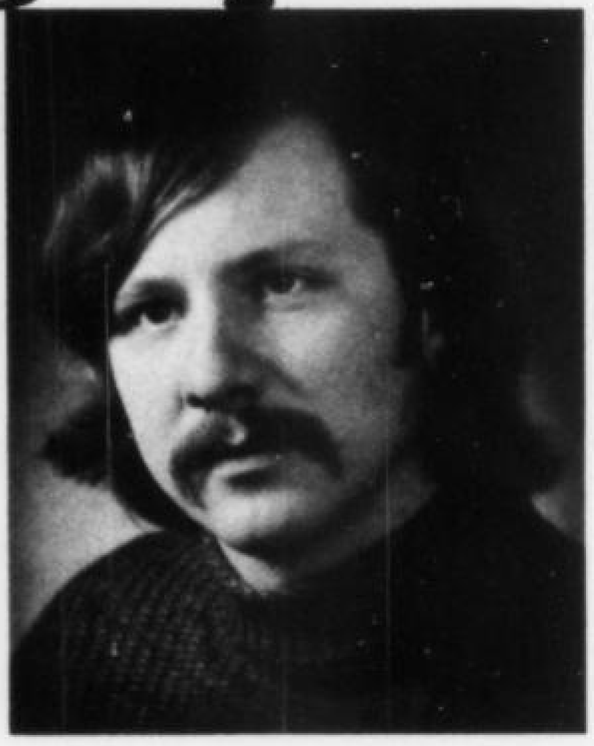


by Wendell E. Wilson

It would be impractical to run photos with this column to illustrate every point I wish to make (especially if color is a factor), so in many cases I shall refer to photos by page number in Desautel's *Mineral Kingdom* (abbreviated MK), Desautel's *Gem Kingdom* (GK), Hurlbut's *Minerals and Man* (MM), and back issues of the *Record* (MR). Probably more interested readers own these works than anything else I could refer to. This is not to say that I won't be printing some here from time to time anyway.

Backgrounds are crucial in mineral photography. Most people agree that a textured background is usually bad because it draws attention away from the specimen. There can be exceptions though; Lee Boltin has used common sand to advantage (GK, 91, 115, 118) and the effect is an enhancing contrast between the dull grainy sand and the sharp, clear, colorful crystals. It might be interesting to experiment with some other colors of sand besides the light gray used by Mr. Boltin. But texturally I would avoid all cloth except velvet, and anything else that is not smooth and featureless. Occasionally a texture can be used to show transparency of the specimen (MK, 93).

Velvet does make a nice background for some specimens (MR **3**, 6, 268, MK, 97), although many colors are so dark that they appear nearly black in the finished photo. Other colors (e.g. yellow) are so bright that they are rarely of use. In general, bright colors should be used when the specimen is drab and needs a contrast of some sort to make it more visually appealing (MK, 27, 187). Brightly colored minerals on brightly colored backgrounds may have visual impact but are almost a strain to look at (MK, 159, 162), and do not impress me as being a particularly sophisticated treatment. Others may disagree on this. Contrast is nice, so avoid using dark backgrounds with dark specimens and light backgrounds with light specimens.

Natural colors such as limonite yellow and muted greens, browns and blues are easier on the eye and do not draw attention away from the specimen. If a bright color *is* used, it sometimes helps to have much of the background in shadow so the color is not so overpowering. Of course the best test is simply to set the specimen on a variety of colored backgrounds and choose the combination you find most pleasing. Some surprises are inevitable and there are exceptions to every rule.

Many art supply stores carry matt-finished colored papers, called Color-aid and other names, which make excellent backgrounds. A great many photographers use these papers although they are hard to obtain in certain areas. Much of Lee Boltin's recent work has been done on this type of paper (MK, GK).

Probably the most popular background is coal-black, and with good reason. Black is very dramatic and yet does not detract from the specimen. The black recedes in an almost three-dimensional effect, leaving the specimen seemingly suspended in a void. Black velvet is so non-reflective and richly black that it makes a perfect black background, and is one of my favorites. But remember to keep it clean by frequently brushing it with a loop of masking tape, sticky-side out. Keep a tweezer handy to pick off large particles, hairs, cotton fibers, etc.

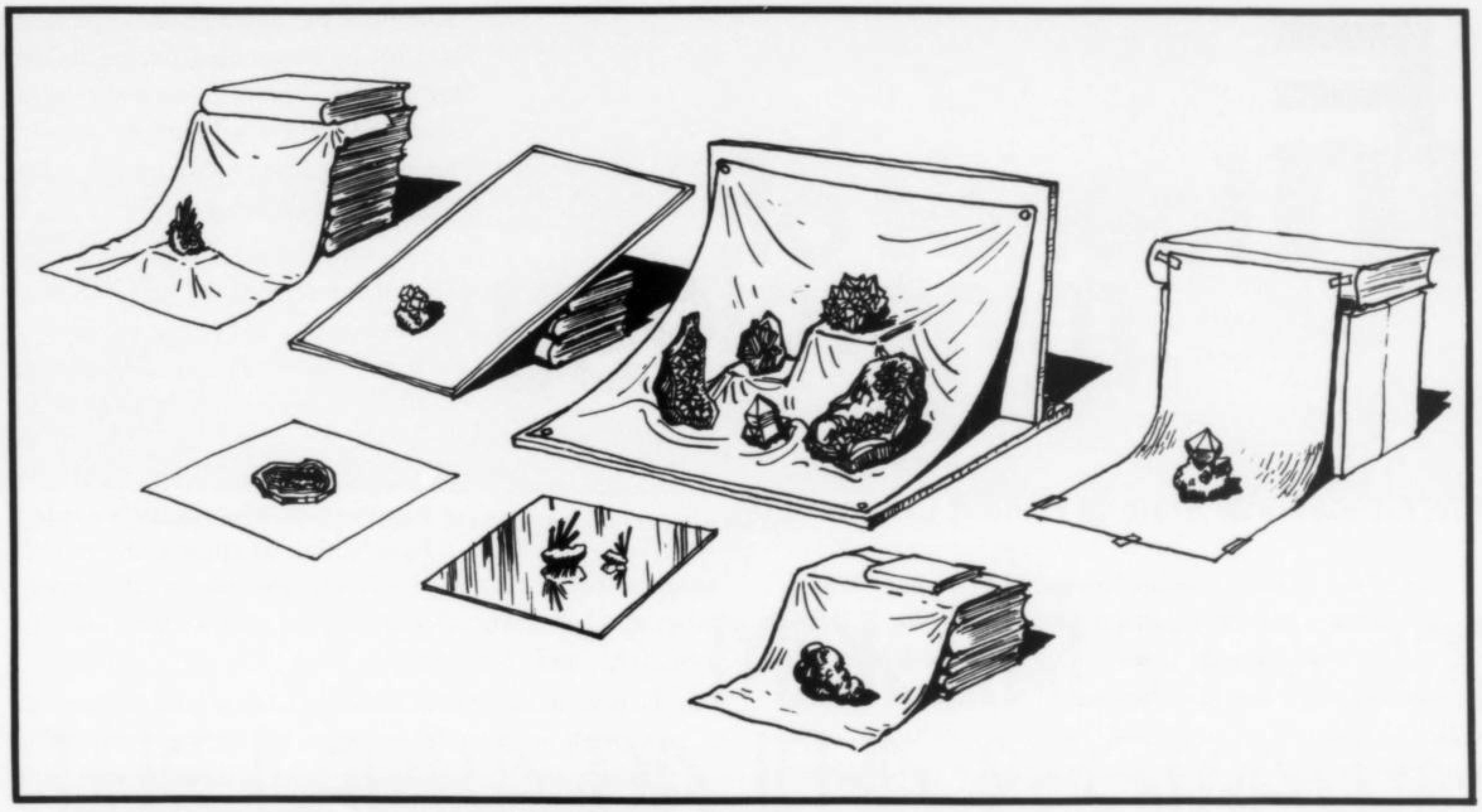
Once the background is selected you have to make a stage for the specimen. The background material should curve up behind the specimen. I usually just stack up some books on a table, drape the velvet over the books and down on the table, then set the specimen on the cloth in front of the stack of books. If paper is used you'll probably have to tape the edges down to the table and the top of the books to keep the paper in place. Be sure not to get any folds or smudges on the paper that might show up on the photograph. With the velvet you can put artistic folds and draping around the specimen, as long as you're discreet about it (MK, 152-153).

Of course the other alternative is to set the specimen flat on a table top and arrange your camera directly above it so that you can shoot straight down or at a steep angle. This can be cumbersome without a copying stand to hold your camera instead of the tripod.

A method successfully used by Lee Boltin with faceted stones (GK) is to place the specimens on a mirror. This method rarely works with crystal specimens, but it's good to know about for special cases.

Multiple staging for several specimens in one photo (MK, 152-153) usually requires cloth for a backdrop. Books, blocks or boxes are arranged on the stage so that the specimens will rest on them in a pleasing arrangement. Then the cloth is gently draped over the whole thing, and the specimens put in place.

I usually use a dab of clay to hold the specimens in place while they are being photographed ... very few specimens naturally sit right by themselves. Unfortunately the clay stains the paper, so I use up a lot of paper sometimes, but



Stage and Background Arrangements for Cloth, Paper, Mirror.

I think it's worth it. The clay should be placed so that it will not show on the photo.

Every month a variety of photography magazines hits the stands. These contain columns and articles of interest to every photographer including mineral specialists. I always page through as many as I can and buy the ones with especially interesting or useful contents. There is so much to photography and there are so many new developments that I could never cover it all in this column; I stongly recommend building a small library of magazine articles, clippings and books on photography. The more you can learn, the better your technique, abilities and photos will be.

Wendell Wilson
8042 Bryand Ave. So.
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SCAWTITE FROM JAVA

by Peter V. Newman
ARCO, P.O. Box 63/DKT, Djakarta, Indonesia

Abstract

Scawtite, calcite, analcite, and a probably new zeolite (?) occur in a veinlet cutting the bedrock beneath the Java Sea off Java.

Scawtite, $Ca_7Si_6O_{18}(CO_3)\bullet 2H_2O$, and other minerals occur in crystalline bedrock at the bottom of a well drilled in the floor of the Java Sea off Java. The occurrence is in a vertical veinlet averaging 6 mm thick in the K-1 well of Atlantic Richfield Indonesia, Inc., at a depth of 6,150 feet. The well tapped a new offshore oil field. It is about 25 km north of the Java shore, and about 95 km east of Djakarta.

The minerals in the vuggy veinlet are 1 to 4 mm crystals of calcite, analcite, scawtite, and an unidentified, probably new zeolite(?). The enclosing rock is a gabbroic gneiss, showing faint horizontal banding and made up of 40 percent augite, 30-35 percent albite, 15 percent chlorite, 5 percent reddish biotite, and 5 percent opaques; calcite or dolomite present; apatite, a trace. The minerals were identified by optical, X-ray, and chemical properties. The unidentified zeolite(?) has $\beta = 1.528$, $\alpha = 1.524$ approximately, and $\gamma = 1.533$ approximately. It seems to be orthorhombic, with two cleavages at right angles, parallel extinction, and ± elongation; many cleavage fragments give a centered positive acute bisectrix figure, 2V 50°±10°. X-ray powder diffraction shows d = 2.84Å strongest, 4.60Å second, 2.66Å third, also 2.17Å, 4.11A, and 6.44Ă.

I thank A. O. Woodford of Pomona College for the optical data and A. K. Baird of Pomona College for the X-ray data.

friends of mineralogy

FM Educational Mineral Exhibit Competition

One of the finest accomplishments of Friends of Mineralogy has been the development of Guidelines and Rules for Educational Mineral Exhibit Competition. It may not be widely known that one person in FM achieved this. He is Bob (Robert W.) Jones, teacher, writer and ardent amateur mineralogist of Scottsdale, Arizona, a prime mover in the beginnings and affairs of FM and one of its early directors.

He not only largely singlehandedly thought out and developed the whole project; but also preached and urged upon others, especially those in positions of influence, the vital educational importance of such rules and guidelines to make practical, encourge and reward mineral exhibits of intellectual and scientific meaning at the big shows. His work went on for more than two years, culminating during 1972 with the acceptance and official adoption of his FM Rules and Guidelines by the American Federation of Mineralogical Societies. Much credit goes also to the Tucson Gem and Mineral Society for its very strong encouragement of the project when started and arranging for the first try-out of the Competition at the 1970 Tucson Show. It has been suggested that the FM Rules and Guidelines for Educational Mineral Exhibit Competition be printed in *The Mineralogical Record* for all to see, and it is fitting to present them here as given in the announcement and application circular of the Tucson Society in connection with its coming show on Feb. 8, 9, 10, 1974.

FM Educational Mineral Competition offers you an opportunity to develop an educational mineral theme with the possibility of winning an award and recognition from other collectors. The host society will provide display case, lighting, tables. You must supply your own lining materials and risers. Attached is information and suggestions and the criteria for judging that will be used.

Awards will consist of plaques and specimens of excellent display quality and value. Minimum scores to earn eligibility for awards are as follows:

Adult Division: First place 90 points, runner-up 80 points.
Junior Division: First place 80 points, runner-up 70 points.
Specimens will be provided by Friends of Mineralogy and will be on display during the show.

Complete the application below and send to the designated person in the host society. Completion of the application indicates a willingness on your part to accept and abide by the rules.

AIMS AND GOALS

1. To stimulate a higher level of educational interest in minerals and mineralogy while encouraging higher standards of educational effort in mineral exhibit competition.
2. To give minerals or mineral localities greater educational meaning by selecting an appropriate mineralogical theme, such as a scientific principle or valid mineralogical relationship, and developing such a theme clearly, concisely, and accurately.
3. To present the chosen theme in a thoughtful, attractive, and well organized manner so the viewer's interest is challenged. This should be done artistically and with originality while giving the theme sufficient depth of treatment.
4. To develop unity of the chosen theme through the use of mineral specimens (personally collected when appropriate or possible), hand made materials, and othier visual aids.

SUGGESTIONS FOR COMPETITION

Selection of an appropriate theme may be achieved in many ways. Study mineral displays in museums, educational institutions, and at shows may help. Looking into the literature is important. Any activity which will broaden understanding of mineralogy and collecting will be useful. The following examples may help exemplify valid themes, although they may be beyond the scope of some exhibitors:

A. Illustrating and interpreting the sequential deposition of minerals in an ore deposit.
B. Clarifying crystal shapes with reference to their internal atomic structure.
C. Explaining chemical relationships between host rocks and their associated minerals.
D. Explaining properties of minerals in terms of their chemistry and/or atomic structure.

The use of beautifully crystallized minerals and exceptionally fine ore specimens may mislead the viewer since such material may not be typical of the occurrence. Personally collected materials are preferable whenever possible. The use of diagrams, three dimensional shapes, drawings, and photographs help reduce the need for lengthy explanations.

The mineralogical theme should be clearly spelled out in title form with the exhibit developed with originality so as to unify all materials used to support the theme. Depth of treatment and simplicity should both be sought, the

continued on page 238

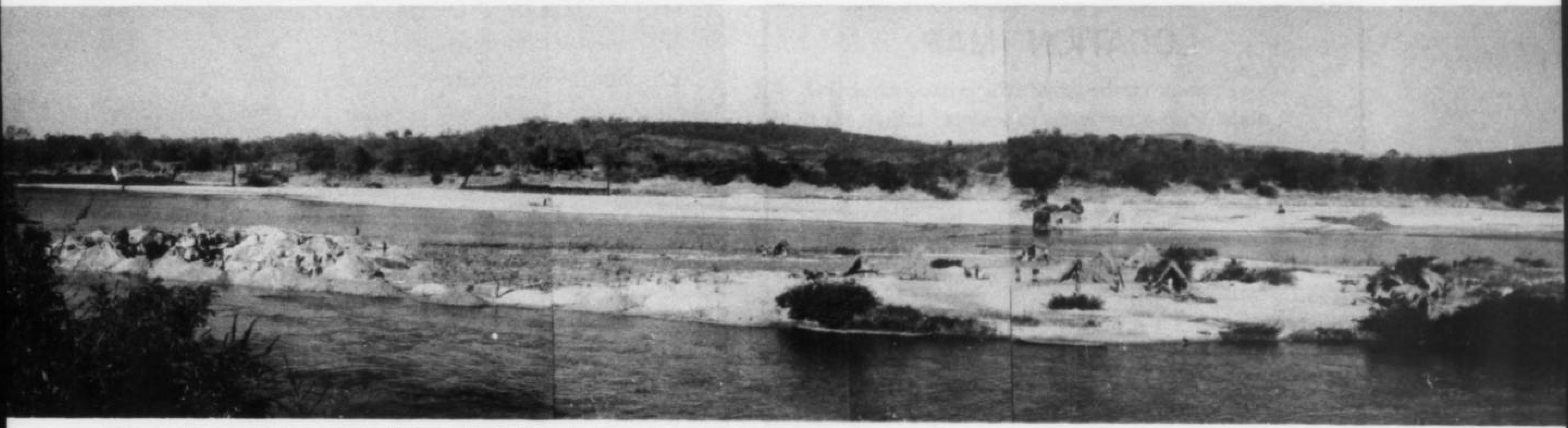

Fig. 1. **General view of the "Ilha". Workings (= lavra) are on left.**

MINERALS FROM THE LAVRA DA ILHA PEGMATITE, BRAZIL

by Jacques P. & Jeannine O. Cassedanne

Federal University of Rio de Janeiro & National Research Council (C. N. Pq.)

Today the bulk of the crystallized rose quartz, eosphorite, roscherite and wardite proceeding from Brazil comes from a single pegmatite called Lavra da Ilha. Consequently we will briefly describe and quote the main collectable minerals that may be found in this locality.

LOCATION AND ACCESS

The only name of the pegmatite presently studied is Lavra da Ilha (= Island workings) but, frequently, specimens are labelled as Taquaral, from a nearby hamlet. The mine belongs to the Itinga township (= municipio). It is located in the northeast of Minas Gerais state, 40 km WSW from Itaobim and 25 NE from Aracuai, in the heart of a famous tourmaline bearing zone (See map of location).

Access is by way of Itaobim (km 846.5 - elevation 220 m), on the paved road that joins Rio de Janeiro to Salvador. From Itaobim a good sandy road goes toward Diamantina by way of Aracuai, passing Itinga (31 km from the highway) and Taquaral (47 km from the same). At 4.7 km before Taquaral, a jeep road leads in 3 km to the Jequitinhonha River, to the houses of the Fazenda das Laranjeiras (= Orange Farm) at an elevation of 190 meters. From this locality a footpath runs along the river with a 15 minute walk to the mine. It is located on one island, dry only during low-water stage, that is to say from June to October.

The region is gently undulated, with a low bush vegetation (= caatinga) dominated by granite inselbergs.

Algonkian metamorphic rocks are the basement of this part of the Jequitinhonha Valley.

DESCRIPTION OF THE PROSPECT

It is a heterogenous pegmatite partially covered by unsorted alluvium where diamonds are rarely recovered. The island, located on the right side of the river is about 500 meters long at an elevation of 175 meters.

The workings have uncovered the pegmatite for about 40 x 10 meters extension. It strikes N40°E, dips vertically, and extends to the right side of the river where it outcrops sporadically through alluvium, about 300 meters in length. Another branch strikes N80°E and crosses the Rio Jequitinhonha.

About forty men (= garimperos) work this pegmatite with rudimentary methods to obtain only mineral specimens. They struggle against water trying to invade the excavations which are all below the river level. Work is only possible in these conditions during the few dry years (Figs. 1 & 2).

The pegmatite, of medium grain size, is constituted essentially of muscovite and feldspar on both sides of a quartz core, with small vugs in the vicinity, some crystallized rose quartz, and patches of metallic minerals.

Eosphorite and other phosphates are almost always associated with rose quartz, or growing on the quartz crystals, or included in irregular sheared muscovite and feldspar rich zones. These are scattered in the pegmatite mass with some vugs which are always small (= caldeiroes).

Besides muscovite, in lozenge shaped greenish crystals (3 cm), there also may be found: a little cassiterite, nio-

J.C.

botantalite, brown sphalerite, beryl, amblygonite and quartz in prisms of several decimeters, milky or more rarely transparent.

From a regional viewpoint it must be noted that in the Lavra da Ilha, in comparison with the nearest pegmatites worked in the region, there is a lack of pink or green tourmaline and lepidolite (very abundant in the Lavra do Urubu for instance), of petalite (a nearly monomineral pegmatite of Serrinha) and of spodumene (pegmatites of the Rio Piaui area - J. Cassedanne, 1969).

On the other hand eosphorite is lacking in all these other mines whose wallrocks are also mica-schist in roof-pendants between granite hills.

PRINCIPAL MINERALS FROM LAVRA DA ILHA

Only minerals of interest to collectors will be described. *EOSPHORITE* is the Mn-rich end of a series which extends from (Fe",Mn)Al(PO_4)$(OH)_2$•H_2O (childrenite) to (Mn,Fe") Al(PO_4)$(OH)_2$•H_2O (eosphorite).

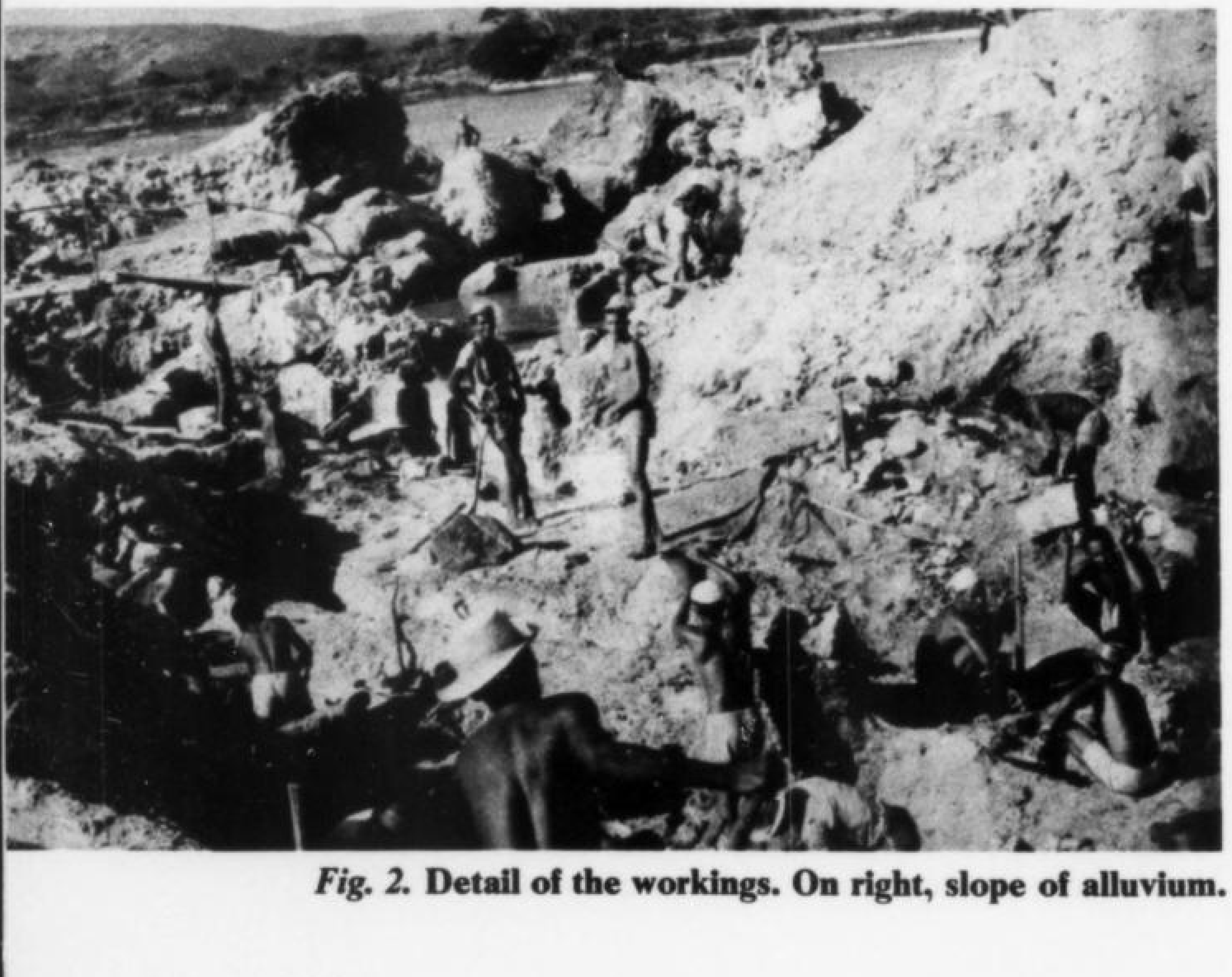

Fig. 2. **Detail of the workings. On right, slope of alluvium.**

Eosphorite is the more common phosphate from Lavra da Ilha where it is called "cabeludo" (= long-haired) and is always encountered upon quartz. This latter, almost always associated with chalcedony, belongs to a late stage formation of the pegmatite. Frequently there also occur prisms of milky quartz covered by a thin film of chalcedony, which is coated by rose quartz on which are scattered crystals of eosphorite (Fig. 3).

The eosphorite is always in radial clusters of variable size and density or in small elongated crystals terminated by a four-face pyramid, frequently translucent. Colour is from light brown to orange for unaltered samples (Fig. 4). Sometimes it forms perfect spheres having a deep orange-brown colour and bright luster.

Exceptionally, a thin film of chalcedony coats the crystals of eosphorite whose greater dimension does not exceed 20 mm. Generally the needles range in size from 5 to 8 mm.

The eosphorite seems stable in the presence of water. On the other hand, samples from the surface of the island, that is to say, in direct contact with the air during various months of the year, turn dull and greyish or brownish.

Some nodules were sporadically found. They have a radial structure and a coarse exterior with albite and manganese oxide fragments (Fig. 5).

Optical properties of the eosphorite are given for the needles and pieces from the nodules:

$n\alpha = 1.636$	1.636
$n\beta = 1.662$	1.663
$n\gamma = 1.669$	1.670
$2V = 10°$ (-)	

Three diffraction powder patterns of eosphorite made from the needles and from the nodules from Lavra da Ilha, and one of childro-eosphorite from Hagendorf, show very small variations in the parameters.

A spectrographic analysis indicates a greater amount of Mn than Fe. This fact, according to the I. M. A. recommendations, justifies the name of eosphorite given to the mineral (J. Cassedanne & Cl. Guillemin, 1971). The denomination of "childrenite", sometimes used, is incorrect.

It is always easy to differentiate Lavra da Ilha eosphorite from the same mineral coming from other Brazilian localities. In the other pegmatites, crystals are generally brown, much larger and frequently coated with limonite or manganese oxides. Specimens of this type can reach up to 20 kg! Some pink crystals are mined also near Governador Valadares.

ROSCHERITE has the composition (Ca,Mn,Fe)$_3$Be$_3$(PO_4)$_3$ $(OH)_3$•$2H_2O$ and it is monoclinic.

In Lavra da Ilha roscherite, frequently coating eosphorite, occurs as small clusters or in greenish globules. They are coated sometimes by needles of translucent, honey or

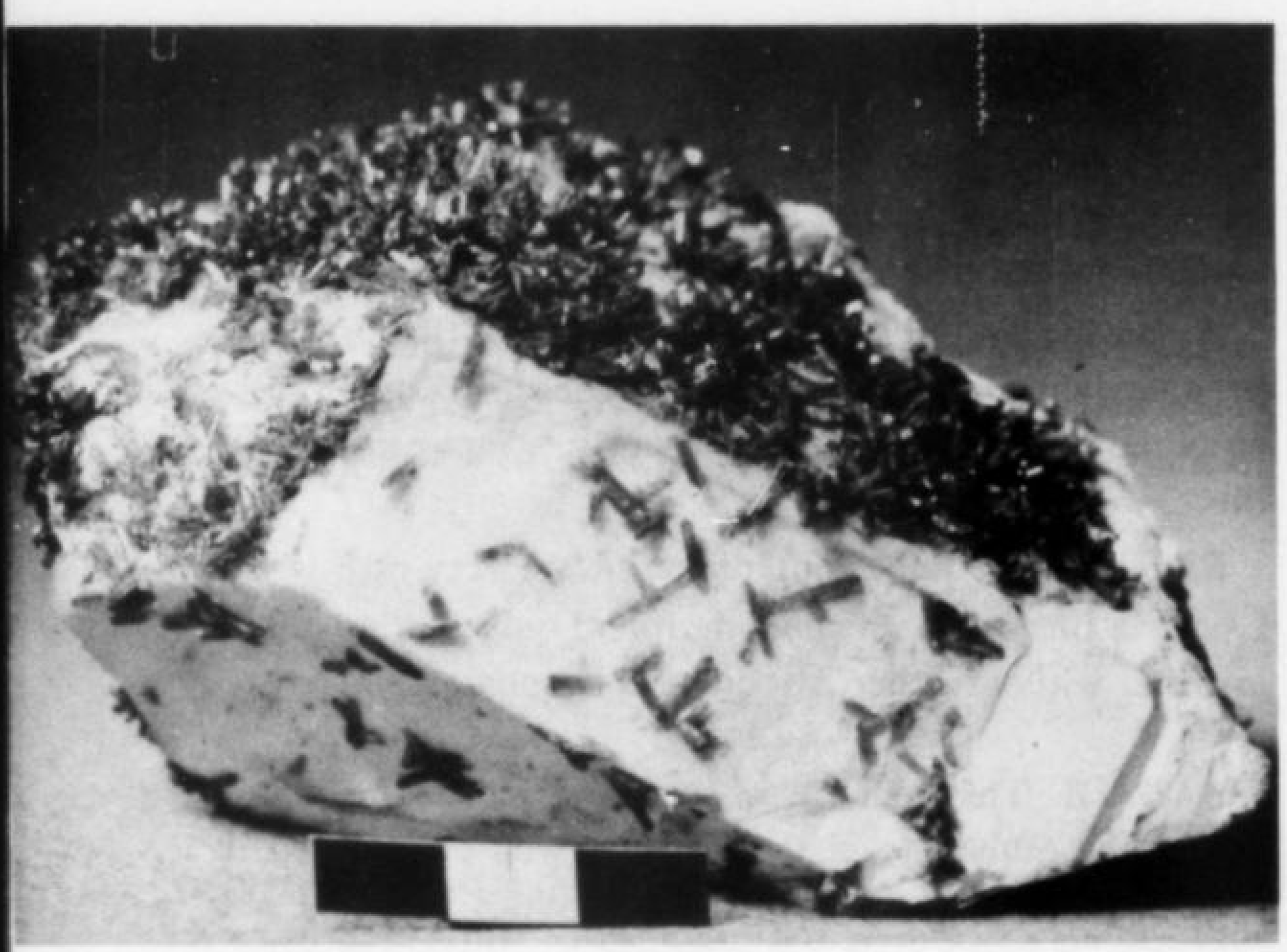

Fig. 3.* Quartz coated with chalcedony upon which are radial clusters of eosphorite. The scale is 3 cm in length.** ***All specimens and photographs from J. P. Cassedanne.

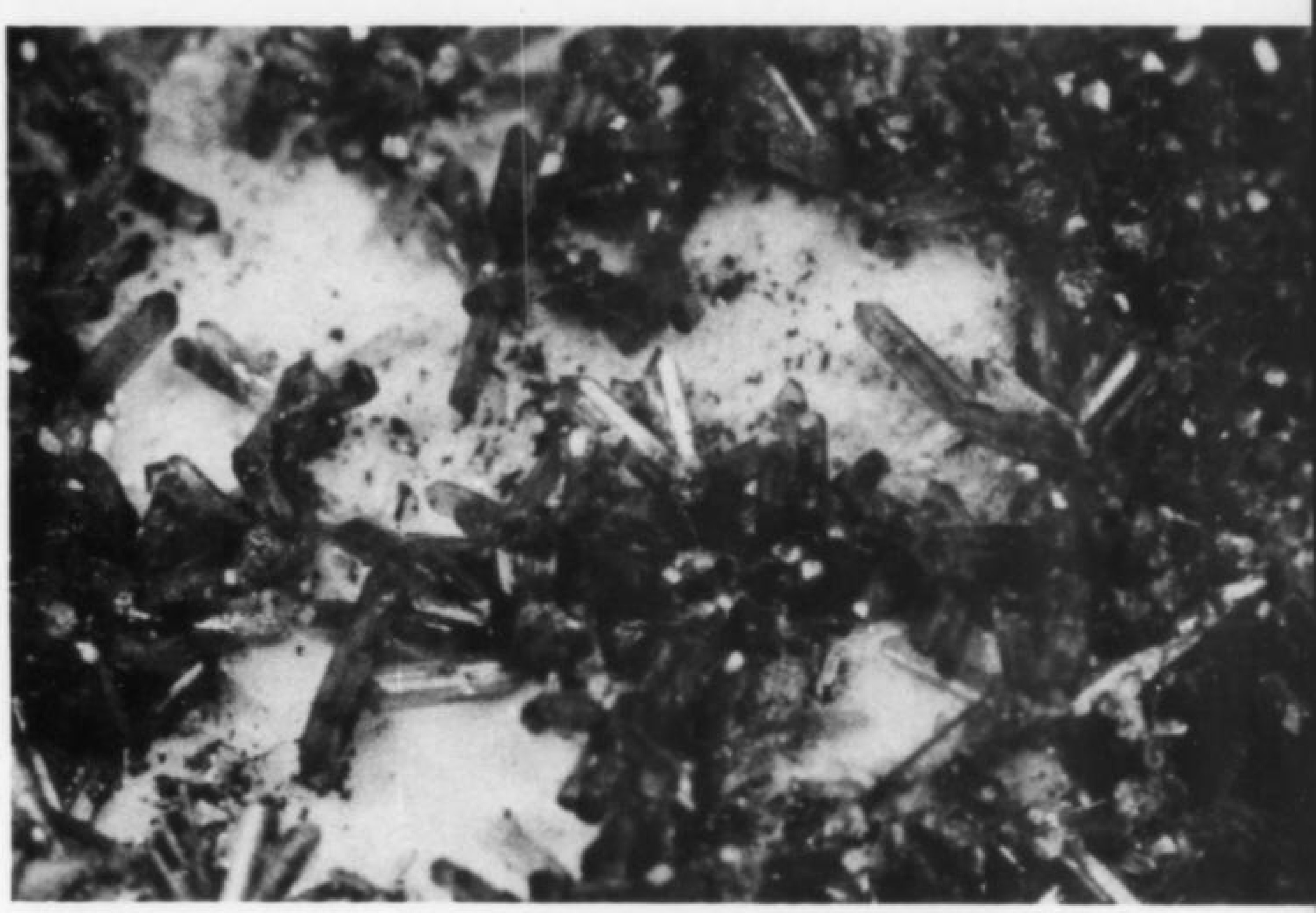

***Fig. 4.* Eosphorite clusters. Needles are 4 mm in length.**

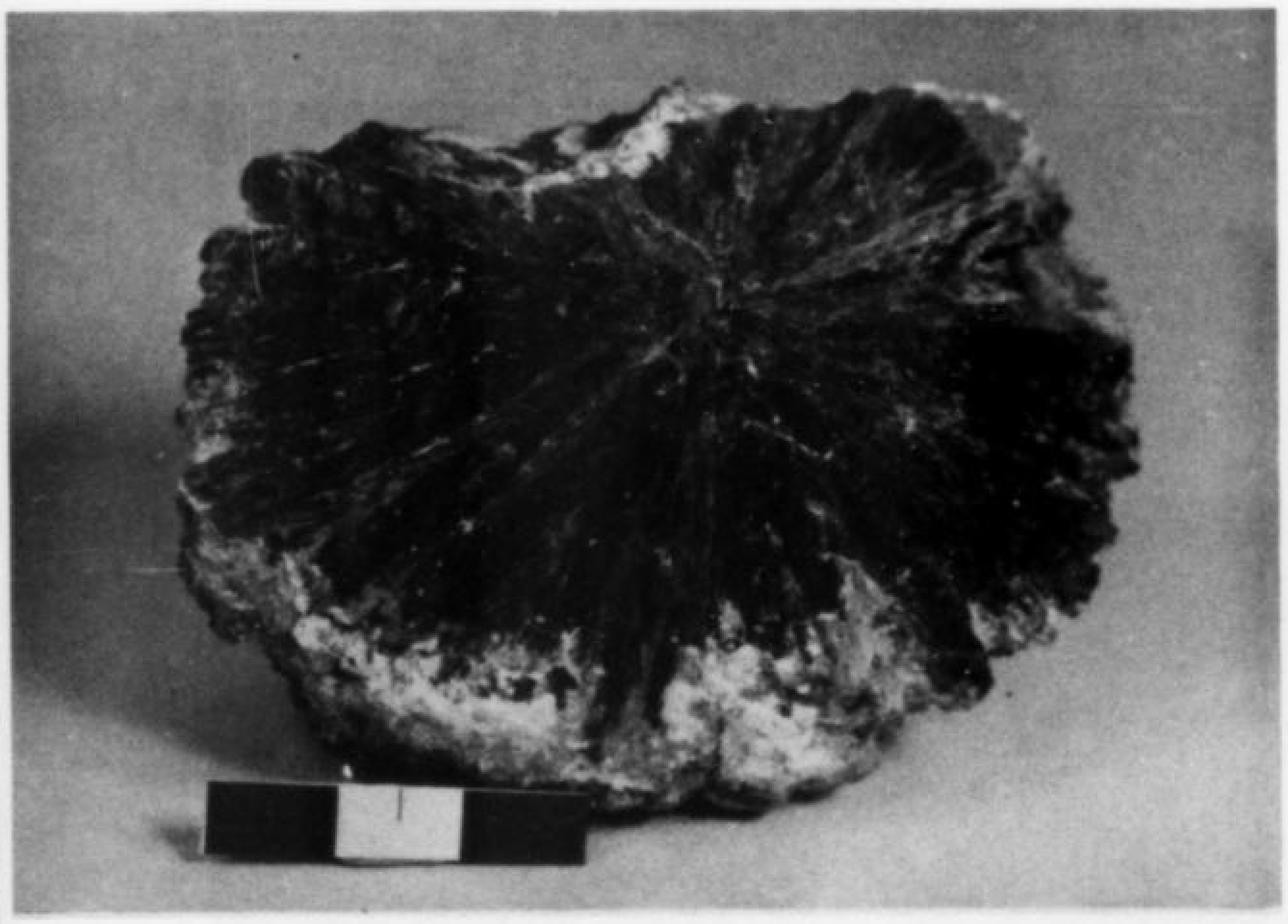

***Fig. 5.* Nodule of eosphorite.**

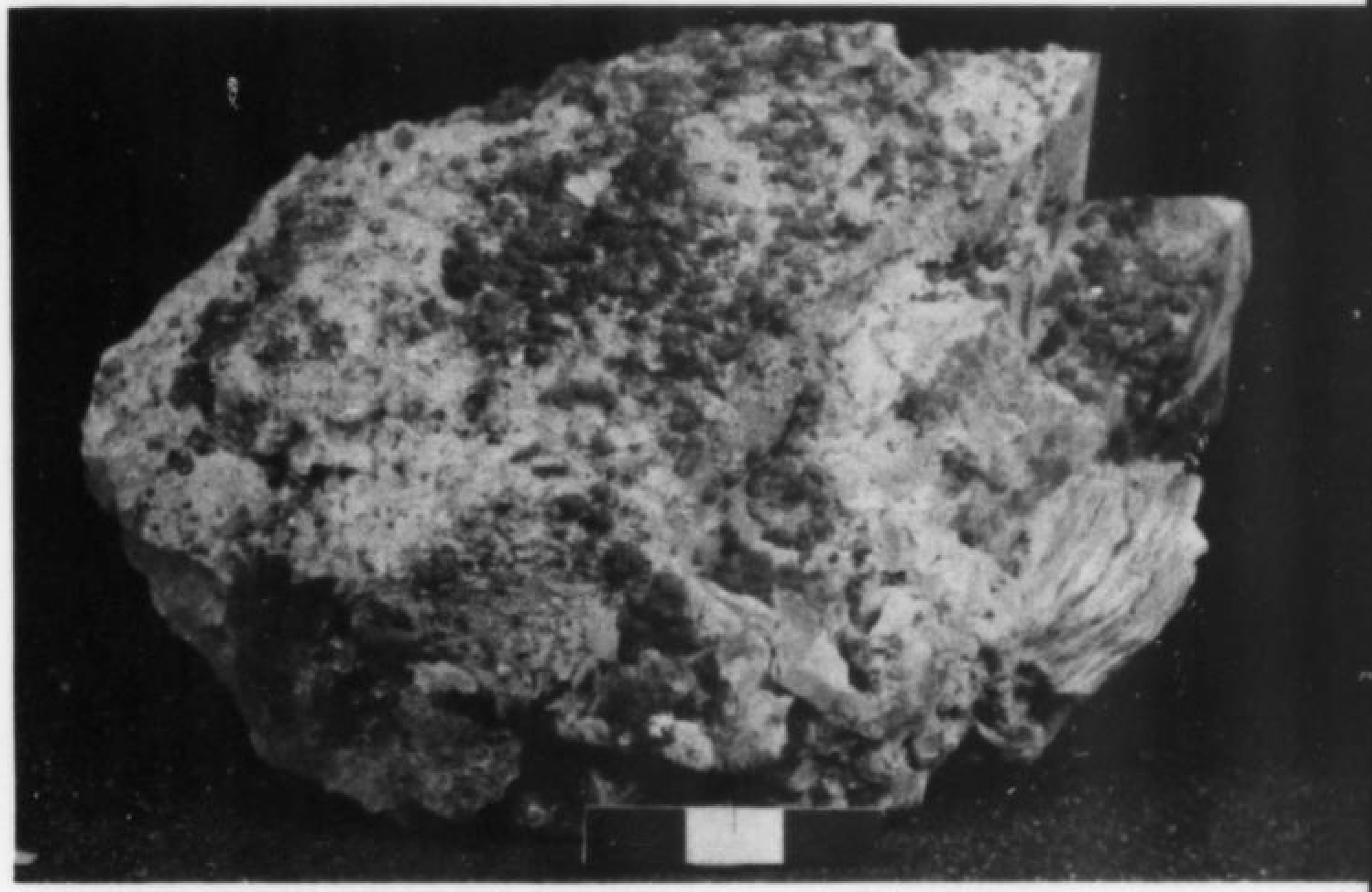

***Fig. 6.* Quartz group with some mica and many hemispherical clusters of roscherite.**

light brown, eosphorite, more rarely by manganese oxides (Figs. 6 & 7).

Single crystals, reaching up to 3 mm long, frequently associated or partially included in rose quartz, and groups of translucent apple green, pseudohexagonal crystals also occur. They then remind one of the pyromorphite habit.

Determination of the mineral was made by X-Rays (J. Cassedanne, Cl. Guillemin & Z. Johan - 1971). The powder pattern shows d-values smaller than those obtained for the roscherite from Newry quoted by M. L. Lindberg (1958). With this author's indices it is possible to calculate the following parameters for the sample and for the reference specimen:

Fig. 7. **Closeup of specimen 6. Each cluster is 3 mm in diameter.**

	Cassedanne & al.	Lindberg		
	Lavra da Ilha	Sapucaia	Greifenstein	Newry
a =	15.76Å	15.95	15.88	15.89
b =	11.76	11.95	11.90	11.90
c =	6.82	6.62	6.66	6.59
β =	90°37'	94°50'	94°42'	94°50'

These changes of parameters reflect a variation of the chemical composition of the sample from Lavra da Ilha and this is corroborated by the refractive indices which are lower than those of M. L. Lindberg:

	Lavra da Ilha (Cassedanne)	Sapucaia (Lindberg)
$n\alpha$ =	1.615	1.636
$n\beta$ =	1.604	1.641
$n\gamma$ =		1.651

Spectrochemical analysis gives the following elements:

major: Ca, Al, Be, P, Fe, Mn.

minor: Mg, K, Li, Si.

Roscherite is less abundant than eosphorite. However it is relatively easy to find it in many samples of the latter phosphate.

ROCKBRIDGEITE AND MONTGOMERYITE. These two minerals were observed as an irregular mixture at the surface of some automorphic quartz crystals which have a porcelain appearance and are irregularly coated with a brownish to greenish film. The underlying quartz has a translucent to transparent core covered by a milky millimetric envelope of several concentric layers.

Under a microscope, powder of the coating film appears to be constituted of a mixture of two minerals. One, always predominant, is in small clusters or in elongated needles with a light brown to green colour. Its pleochroism is strong in the greens, but difficult to observe because of the presence of hydrous iron oxides. It has a strong birefringence and refractive indices up to 1.86.

The second mineral, without perceptible pleochroism. is in single colourless grains and is biaxial negative. Its refractive indices are less than those of the first mineral, varying around 1.58.

One powder pattern suggests the mixture of the two minerals: Rockbridgeite $Fe^{II}Fe_6^{III}(PO_4)_4(OH)_8$ orthorhombic and Montgomeryite $Ca_2Al_3(PO_4)_3(OH)\bullet 7H_2O$ monoclinic

A powder pattern from another specimen (Fig. 8) shows predominant rockbridgeite with d-values nearer than those obtained for the rockbridgeite from the Sapucaia pegmatite.

Rockbridgeite and montgomeryite are very rare in the Lavra da Ilha pegmatite and are found only coating quartz crystals, without other associated phosphates.

WARDITE. This mineral is scattered in the pegmatite among the other phosphates. Always well crystallized, it is in simple tetragonal dipyramidal crystals reaching one cm in length and growing upon rose or milky quartz or in platy aggregates of smaller crystals (2 - 5 mm). These aggregates are isolated or growing upon milky quartz, chalcedony, mica or albite (Figs. 9 & 10).

In all crystals, the pyramid faces are striated by horizontal rulings giving a dull appearance in contrast with the brilliant small face of the pinacoid (Fig. 11).

Colour varies from white translucent to milky or very light yellow with, sporadically, a surficial film of iron hydroxides. Some crystals are coated by patches or partially covered by botryoidal manganese oxides.

Fig. 8. **Quartz crystal coated with chalcedony and rockbridgeite.**

Wardite is more recent than the bulk of eosphorite on which it grows, while roscherite crystallizes on the wardite faces. Wardite is also more recent than the milky quartz of the second stage formation which is associated always with the rose quartz.

Determination of the mineral was carried out two years ago by the X-ray powder diffraction method. The constant habit of the crystals, always typical, makes the recognition easy.

Generally the platy specimens are essentially made up of wardite, while single crystals show, on the matrix, other secondary phosphates like eosphorite, roscherite or, more rarely, apatite.

Wardite is not too rare at Lavra da Ilha. In the light of our observations at the "mineral dealers" (!) of the Taquaral area, it is possible to estimate the proportion of wardite samples to those of rose quartz and/or eosphorite, from 300 to 500:1, that is to say, a proportion much larger than for rockbridgeite and montgomeryite.

The composition of wardite is: $NaAl_3(PO_4)_2(OH)_4 \cdot 2H_2O$.

APATITE occurs sporadically in small brownish or greenish, dull radial clusters growing upon eosphorite or roscherite. No large specimens were recovered.

The determination of the mineral was confirmed by an X-ray powder pattern. No investigation was carried out on its true composition.

VIVIANITE. It occurs in blue-lavender powdery patches of several square centimeters scattered in the fine-crystallized albite which lies on both sides of the core of quartz.

Vivianite comes from the alteration of primary phosphates like amblygonite. No well-crystallized specimens were recovered. Determination of the mineral was made by the X-ray powder method.

The composition of vivianite is: $Fe^{II}_3(PO_4)_2 \cdot 8H_2O$.

Note: All the preceeding phosphates described are of secondary origin. They are formed during a late phase characterized by the deposition of chalcedony and the crystallization of the rose quartz which follows a light shearing of the primary milky or translucent quartz.

Amblygonite and sphalerite which will be described now belong, on the contrary, to the primary constituents of the pegmatite, or at least, to the end of this first phase (amblygonite from the vugs).

AMBLYGONITE. Large masses of amblygonite occur in the pegmatite, which sometimes include elongated crystals up to 15 cm. These are translucent, frequently with dull, corroded or longitudinally striated faces. Terminations are scarce and always incomplete. Tabular twinnings are common. Frequently radiated clusters of eosphorite appear on the faces, covered like amblygonite, by opal (hyalite) which fluoresces yellow.

In the vugs of the pegmatite short amblygonite crystals, perfectly terminated and reaching 11 cm, are infrequently recovered. They are translucent with a grey-greenish to yellowish colour. Faces are brilliant or dull, sometimes with growth figures. Parting is always present and well-marked, and interpenetration twins are common. A small portion of the crystals is of gem-quality, mainly in yellow specimens (Figs. 12 & 13).

Some crystals are penetrated by needles of rutile, while others show scattered doubly terminated rose quartz crystals associated with eosphorite on some faces.

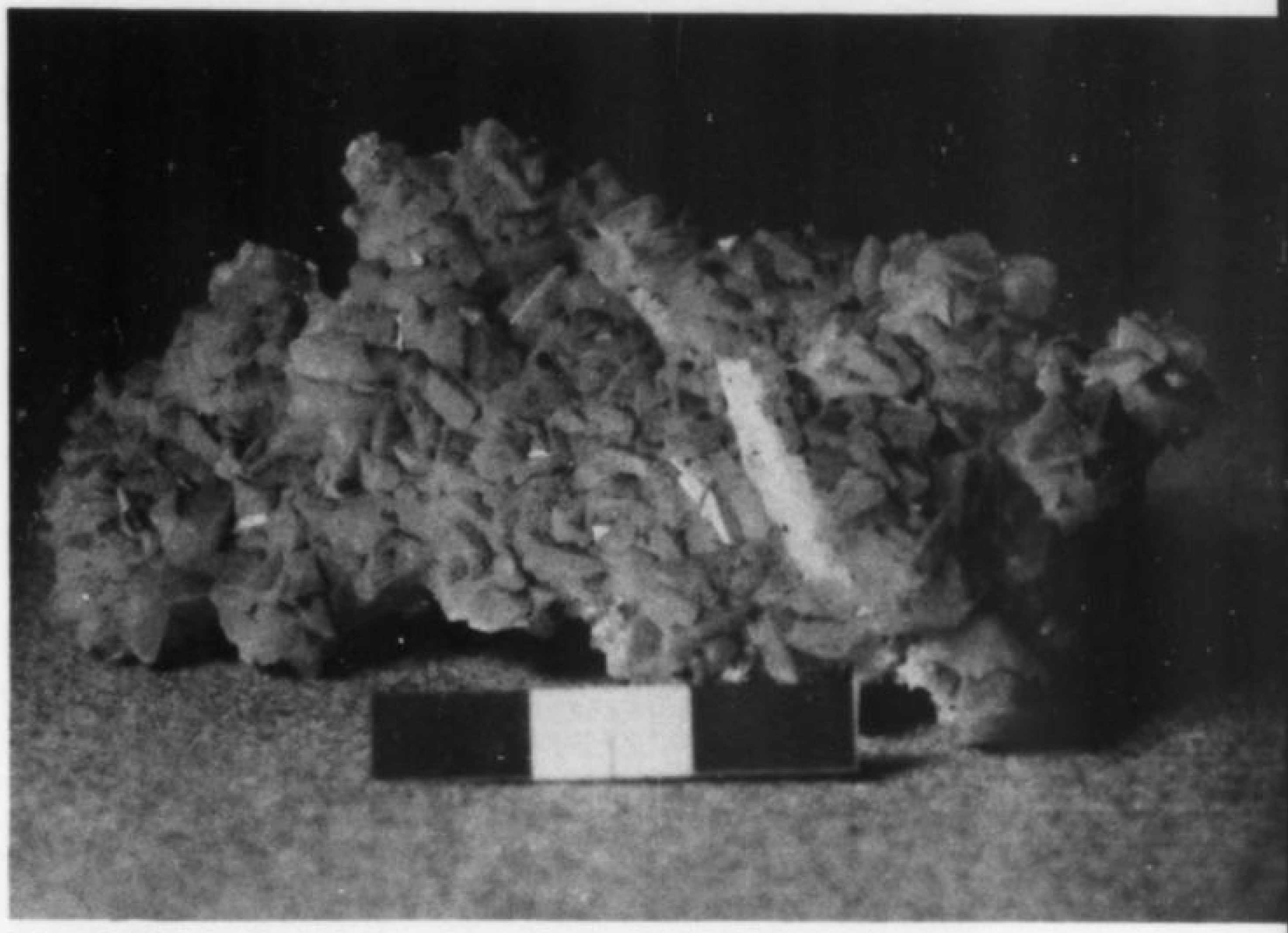

***Fig. 9.* Platy aggregate of crystallized wardite specimen.**

***Fig. 10.* Closeup of specimen 9. Large crystals are 6 mm in length.**

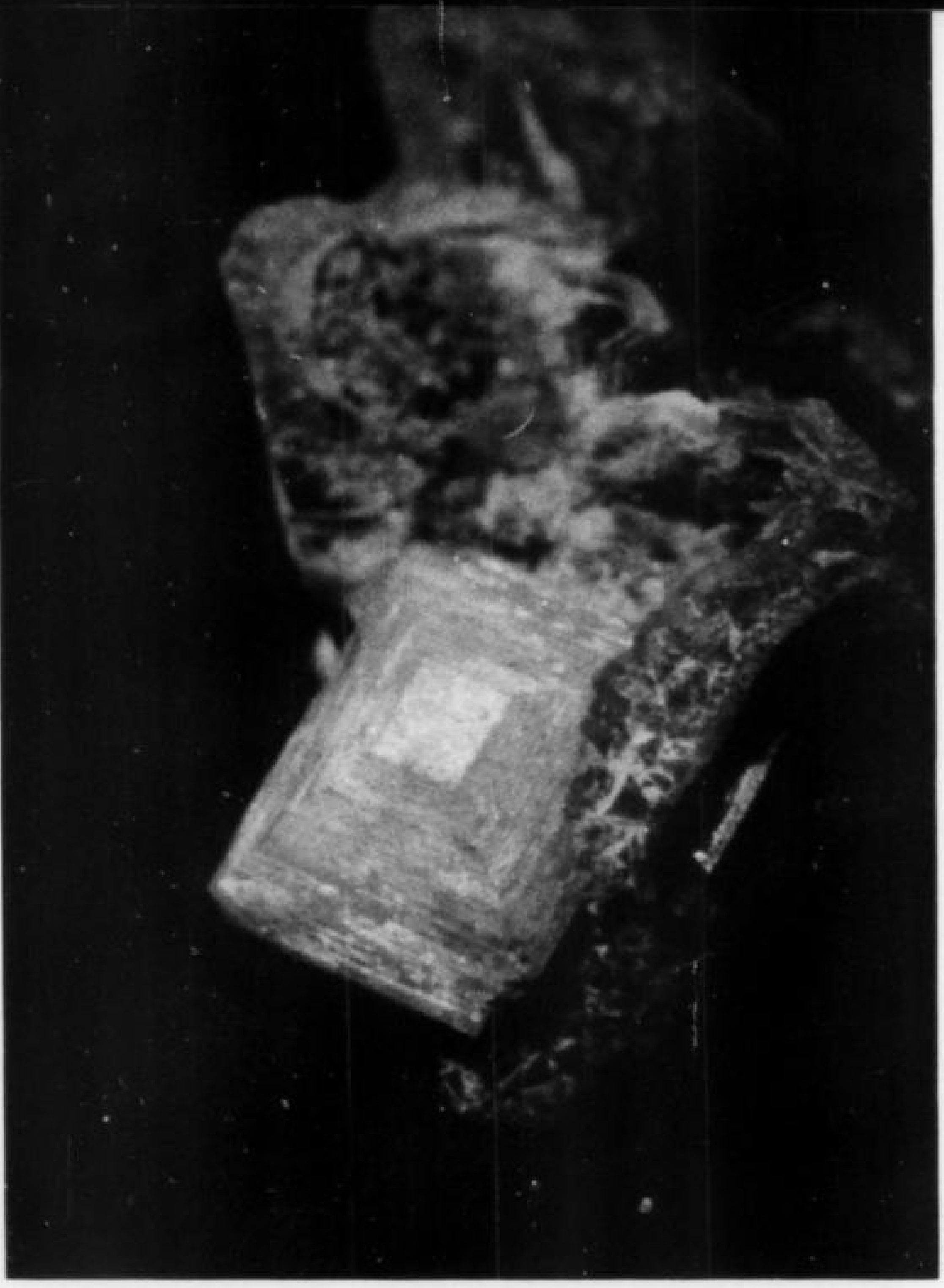

Fig. 11. **Wardite crystal with striated pyramidal faces. Length of the specimen is 1 cm.**

An X-ray powder pattern has confirmed the identity of the mineral. Its composition is: $(Li,Na)Al(PO_4)(F,OH)$. The optical properties have shown that the axial angle is smaller than that indicated by the literature (J. Cassedanne, *et al.*, 1971).

SPHALERITE. Four or five years ago a pocket of sphalerite was discovered in the feldspathic part of the pegmatite. Production may range from 500 to 1,000 kg of crude material, almost totally sold and smelted as cassiterite as a mistake of the garimperos and the metallic-mineral purchasers!!

Sphalerite from Lavra da Ilha is dark brown to black, always well crystallized in single tetrahedrons or more frequently, in platy dendritic aggregates. Faces are brilliant with growth lines parallel to the edges which are always sharp.

Sphalerite does not fluoresce at room temperature. Samples are 5 to 7 cm in length with crystal edges generally less than 1 cm. Sometimes the specimens are partially coated by a white film of albite, quartz and/or mica on which are scattered some little clusters of eosphorite and patches of manganese oxides (Fig. 14).

Today it is very difficult to obtain sphalerite from the Lavra da Ilha.

ROSE QUARTZ. It is the most popular mineral from this pegmatite and has made it famous. Although less abundant than the eosphorite, it always belongs to a late stage of the pegmatite and always crystallizes on primary minerals.

Colour ranges from light pink-white to light purple-pink. The crystals vary from translucent to quite transparent or opalescent. Variation of shade in one crystal is very rare. Faces are occasionally striated or show growth figures.

The matrix of the rose quartz crystals is generally milky or translucent automorphic or sheared quartz of the first stage. Less frequently the matrix is of other minerals, sometimes altered, of the pegmatite. A thin film of chalcedony is common between the two types of quartz.

The rose quartz lies as a quite irregular coating upon the matrix or, more generally, in radial clusters and parallel or interpenetrated aggregate crystals passing through transparent to rose colour.

The most spectacular specimens are in a crown of doubly terminated individuals around a white or translucent quartz crystal of decimeter size (Fig. 15).

Locally opal (hyalite) coats the thin aggregates of rose quartz and fluoresces magnificently. Other specimens are covered by very small milky quartz crystals (1/10 mm), yellow fine grained pyrite, iron or manganese oxides.

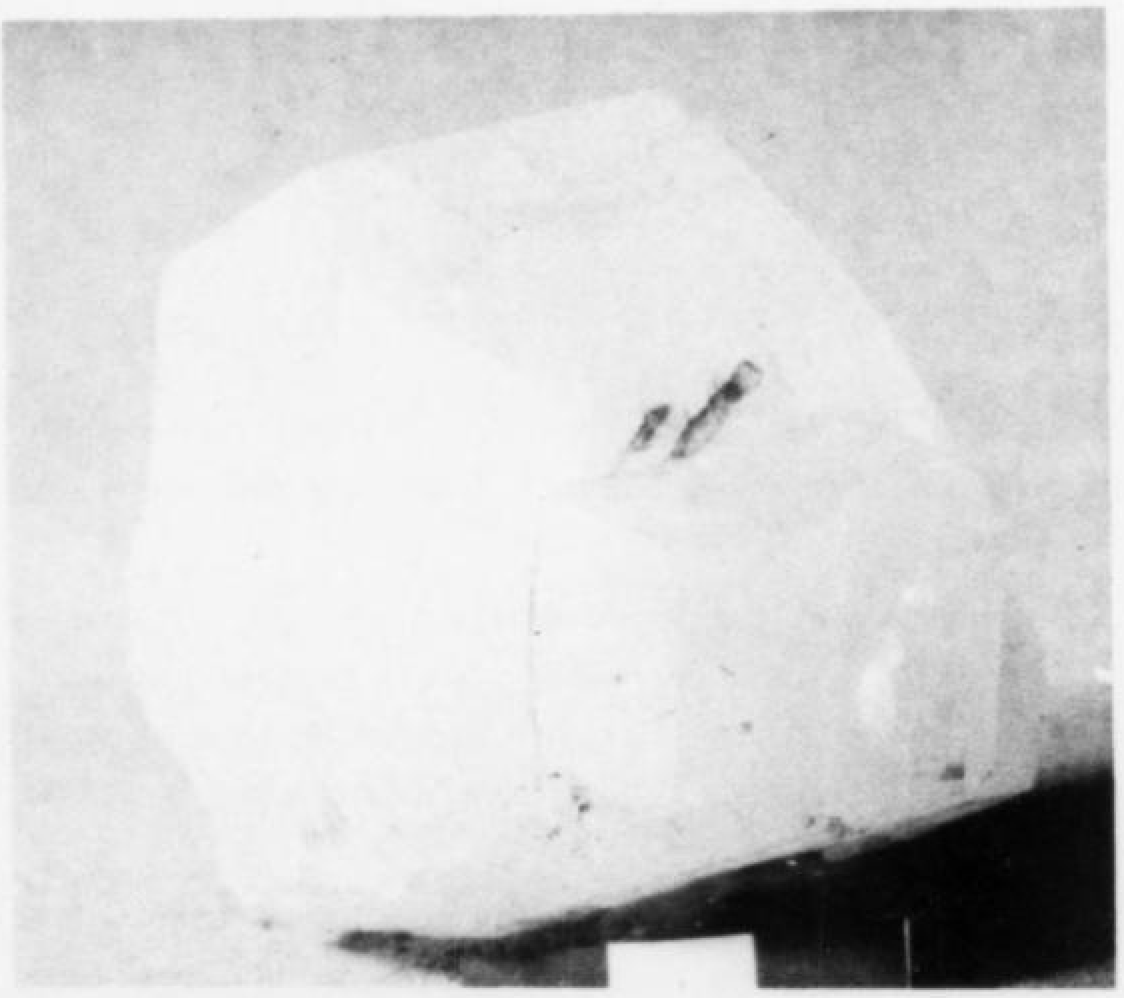

Fig. 12. **Yellowish translucent amblygonite crystal.**

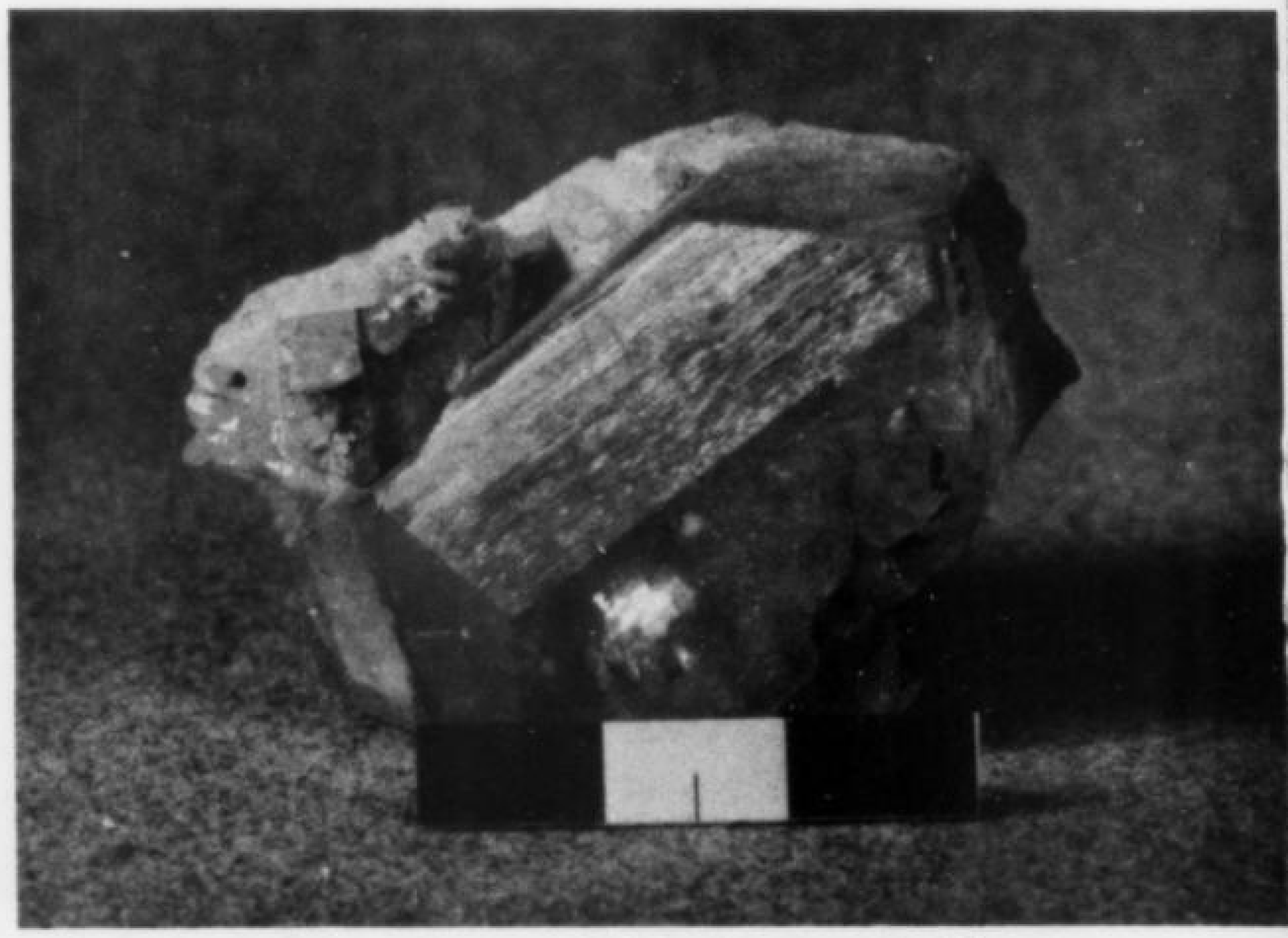

Fig. 13. **Greyish translucent amblygonite crystal with some quartz.**

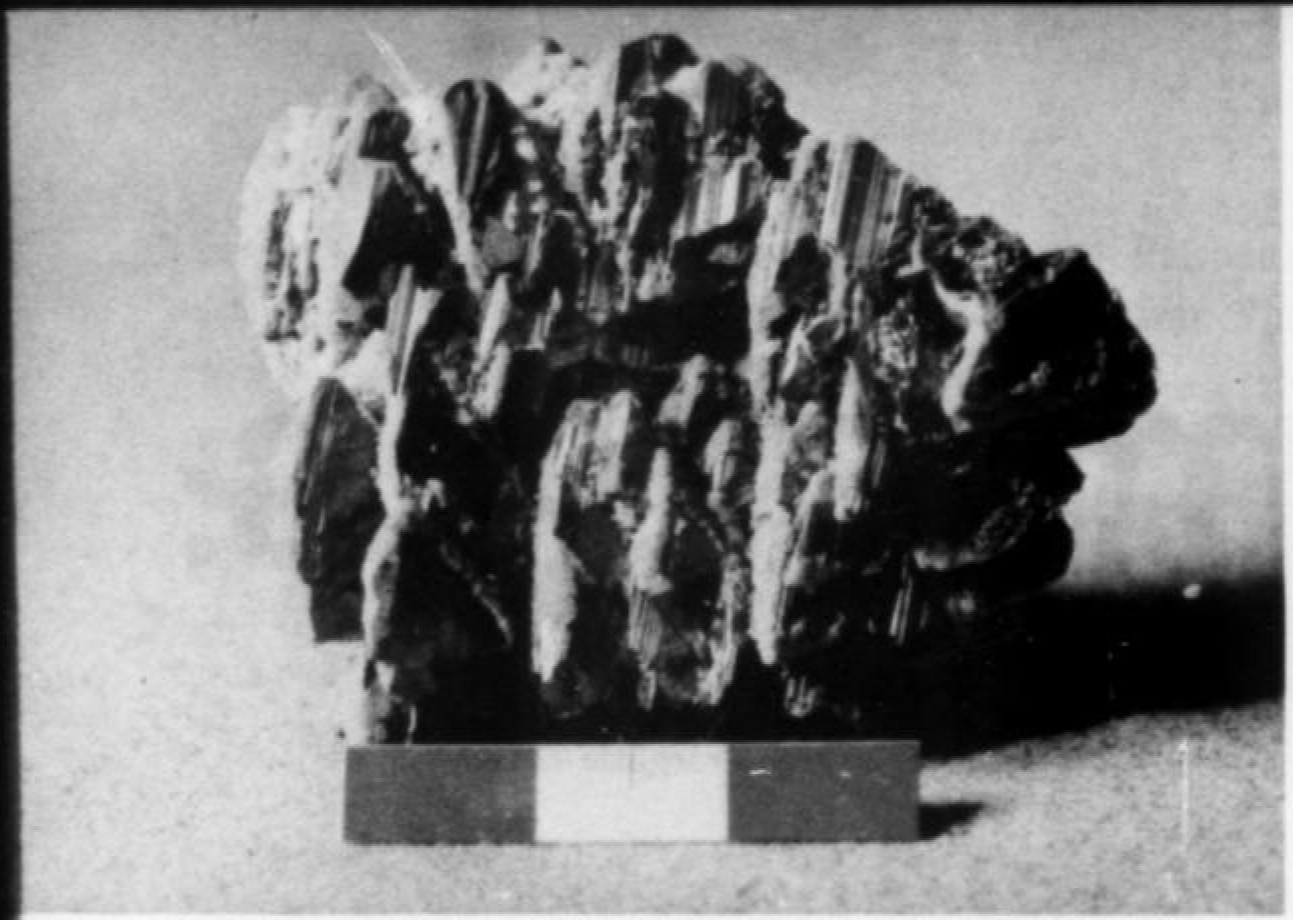

Fig. 14. **Aggregate of parallel-growing sphalerite crystals.**

Fig. 15. **Crown of rose quartz surrounding translucent quartz crystal.**

Eosphorite, roscherite, apatite and wardite are scattered in clusters or single crystals upon the rose quartz as seen before.

Today it is easy to find rose quartz from Lavra da Ilha in all the mineral shops. However its colour is weaker and the specimens are not so beautiful as those recovered years ago in the Sapucaia pegmatite near Divino de Larangeiras in the vicinity of Governador Valadares.

ACKNOWLEDGEMENT

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METAMICT MINERALS: A REVIEW

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PART II. ORIGIN OF METAMICTIZATION, METHODS OF ANALYSIS, MISCELLANEOUS TOPICS.

INTRODUCTION

In Part I of this review the term metamict was applied to those minerals which, although originally crystalline, have become partly or wholly amorphous through structural damage from bombardment by alpha particles. These radioactive emanations are from U or Th which generally forms part of the composition of the mineral. With the change from a crystalline to amorphous state there are accompanying changes in many properties of these minerals. Properties which characterize metamict minerals were outlined in Part I of this work. All the metamict minerals known are oxides, phosphates, and silicates. Of these the isodesmic[1] multiple oxides and neso- and sorosilicates are the most common. The largest number of metamict minerals occur in pegmatites. Others occur as minor accessory minerals in igneous and metamorphic rocks and some are found in detrital deposits.

ORIGIN OF METAMICTIZATION

Most investigators now agree that metamictization results from the effects of irradiation by alpha particles originating in the decay of the radioisotopes of the U and/or Th series present in the natural crystal. Because some of the hypotheses introduced earlier to explain the metamict state are interesting, and have some bearing upon current ideas, they will be summarized before the present theory is discussed.

1. *Dimorphous forms.* Des Cloizeaux and Damour (1860) and Damour (1864) considered that isotropic (metamict) and anisotropic forms of gadolinite, allanite, and zircon correspond to dimorphs in the same general sense that calcite and aragonite, or graphite and diamond are dimorphs.

2. *Unspecified external influences.* Broegger (1893) attributed metamictization to unspecified external influences. He suggested that minerals which are candidates for metamictization are especially sensitive to these influences because of their lesser stability and their complex crystal structures.

3. *Relief of pressure.* That minerals might become metamict as a result of pressure changes was considered by Vegard (1927) and George (1949). Vegard (1927) observed that minerals like xenotime and thorite are formed under very high pressure. When they come to the surface, at ordinary pressure, he suggested their structures might become unstable, and gradually transform into a metamict arrangement.

4. *Alteration involving hydration.* Other authors, like Dana (1892) and Lacroix (1922), implied that these minerals pass into the amorphous state as a result of alteration, especially hydration. Likewise Holmes (1931) did not believe that alpha particle irradiation is the main cause of metamictization, but considered that once the glassy state began to form it could take up water easily. The presence of water possibly would accelerate the change to the metamict state by splitting ionic bonds by internal hydrolysis. The water either could be meteoric, or from late stage hydrothermal activity.

5. *Alteration involving autoxidation.* Tomkeieff (1946) and Hutton (1950) proposed that metamictization might result from changes in the ionic radius of uranium attending its oxidation from U^4 (0.97Å) to U^6 (0.80Å). Their ideas are based on observations made for uraninite by Ellsworth (1925, 1932). Newly crystallized uraninite is essentially UO_2 containing small amounts of ThO_2 and rare-earth oxides. With passing time the disintegration of U gives rise, in addition to helium and the daughter isotopes of the U series, to two oxygen atoms that immediately oxidize neighboring U^4 ions to the U^6 state. Since the rate of oxidation depends on the rate of radioactive disintegration, Ellsworth (1925) proposed that oxidation could be used as an indicator of geological age. The process, however, is accompanied by the action of circulating gases and solutions which consequently penetrate the mineral more freely. This of course would cause further oxidation, hydration, and physical changes. At the present time the mechanism is not considered to adequately explain the metamict state (Pabst, 1952; Orcel, 1956). It may shed light on the amorphous condition which obtains for some uraninite specimens (Kirsch, 1925; Conybeare and Ferguson, 1950). However, Brooker and Nuffield (1952) have presented evidence to show that amorphous uraninite is not truly

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[1] Ionic crystals are called isodesmic when the bonds between all of the ions in the crystal structure are of approximately equal strength; there are no discrete radicals in the structure.

metamict, but is simply altered. Hurley and Fairbairn (1953) and Ueda (1957) agreed with this conclusion. The uraninite problem is discussed later in this review.

6. *Radiation damage from radioactive isotopes.* That metamictization could result from radiation damage by alpha particles originating from the decay of radioactive isotopes was suggested first by Hamberg (1914). The theory has been supported by Mügge (1922), Goldschmidt (1924), Faessler (1942), and numerous other authors, especially in recent years.

One way the nuclei of U, Th, and other radioactive isotopes decay is by emitting alpha particles (Fig. 1) (essentially the same as helium atoms which have lost two electrons and move at high velocity). With each alpha emission the emitting nucleus recoils, displacing lattice atoms. In fact many of the atoms displaced as a result of the emission of an alpha particle are believed to be from the action of the recoil atom. As the emitted alpha particle moves into the crystal structure it is slowed down, and its energy is transformed by possibly three modes. Initially, at highest velocities, it produces ionization and electron excitation, perhaps involving the formation of color centers. As the particle moves through the crystal it loses its energy by colliding with lattice atoms. If a collision is sufficiently energetic the atom is not only displaced but can itself proceed to cause further displacements of numerous atoms (a cascade). More often than not the collisions are not so energetic, and may only cause the hit atom to vibrate about a mean position, transferring energy to neighboring atoms. A useful way to regard this effect is in terms of a sudden delivery of heat to a restricted volume of the lattice. A similar high-temperature spot would also form at places where displaced, as well as recoil, atoms come to rest. More detailed considerations of these effects are given by Seitz (1949), Orcel (1956), and Chadderton (1965). Hurley (1971) has pointed out that the resulting damaged regions, for each alpha-particle event in a metamict mineral, would cause a dumbell shaped pair of damaged regions, involving the order of 10 atom dislocations, and is equivalent to a local source of intense heat forming the structure of glass. In addition to alpha particle damage another less important source of damage to the structure of the mineral is from rare spontaneous nuclear fission of radioactive elements. The nature of the damage arising when fast heavy charged fission fragments pass through a crystal is similar to those discussed above. Fission tracks have been discussed by Fleischer *et al.* (1969).

The minimum intensities of radioactivity (measured on a planar surface) necessary to modify a crystalline structure into an optically amorphous (metamict) structure have been given by Pellas (1951) and Orcel (1956) for the following minerals:

Allanite	2.3×10^{17}	a/cm^2	±20%
Fergusonite	11.6×10^{17}	a/cm^2	±20%
Zircon	8.3×10^{17}	a/cm^2	±20%
Thorite	1.0×10^{19}	a/cm^2	±10%

Pellas (1954) calculated that zircon would become x-ray amorphous when 20% of the atoms have been displaced. In close agreement, Holland and Gottfried (1955) calculated that zircon structures are completely destroyed after approximately 30% of the atoms in the structure have been displaced by alpha particles and recoil nuclei. They also envisioned the break-down of the zircon structure to take displacements; the saturated structure then breaks down into crystallites of ordered zircon; finally there is a breakdown into glass. Some earlier observers suggested that zircon may break down into an aggregate of crystalline ZrO_2 and amorphous SiO_2 (von Stackelberg and Chudoba, 1937; Bauer, 1939). Likewise Goldschmidt (1924) suggested that fergusonite might become a finely dispersed mixture of Y_2O_3 and Nb_2O_5. Barsanov (1964) did not agree that metamict minerals are composed of specific oxides, but proposed they are composed of a subdispersed crystalline system with many discrete indivisible particles in the order of about 50Å, generally in agreement with Holland and Gottfried (1955).

The fact that radiation damage is involved in the process of metamictization does not explain why alpha bombardment is effective in some cases and not in others. Many radioactive rare-earth bearing minerals (Table 2), and secondary uranium minerals (e.g., carnotite, tyuyamunite, autunite), have never been found in the metamict state. Broegger (1893) felt that candidates for metamictization must have a special predisposition to it, perhaps possessing complex and unstable crystal structures. Concluding his considerations of the metamict state, Goldschmidt (1924) suggested three conditions necessary for metamictization, (a) the original crystal structure must be a *weak* ionic structure in order for the rearrangement and eventual hydrolysis to be affable, (b) the structure must contain one or more kinds of ions which are readily susceptible to *changes* in the state of ionization, especially the ions of the rare earths, (c) in many cases it may be necessary for the crystal to be subjected to relatively *strong* radiation, either from within the mineral, or from outside sources. Many subsequent workers have agreed with these conclusions, although additional factors also have been suggested involving such things as the importance of extensive isomorphous replacements in the structures (Hutton, 1950; Pabst, 1952), large holes in the anion structure from deficiency of oxygen (Pyatenko, 1960), relatively open structures (Heinrich, 1958), the different ionic radii of rare-earth elements present (Y unstabilizing, Ce stabilizing) (Holmes, 1931), and radius ratios and coordination numbers (Machatschki, 1941).

Povarennykh (1956) has measured the electronegativities of the cations in nineteen radioactive and rare earth minerals. He found that only those are metamict which have differences less than 130 to 150 kcal./g.-atom between the electronegativities of their principal cations. Those with larger differences include nonmetamict bastnaesite, uraninite, and thorianite.

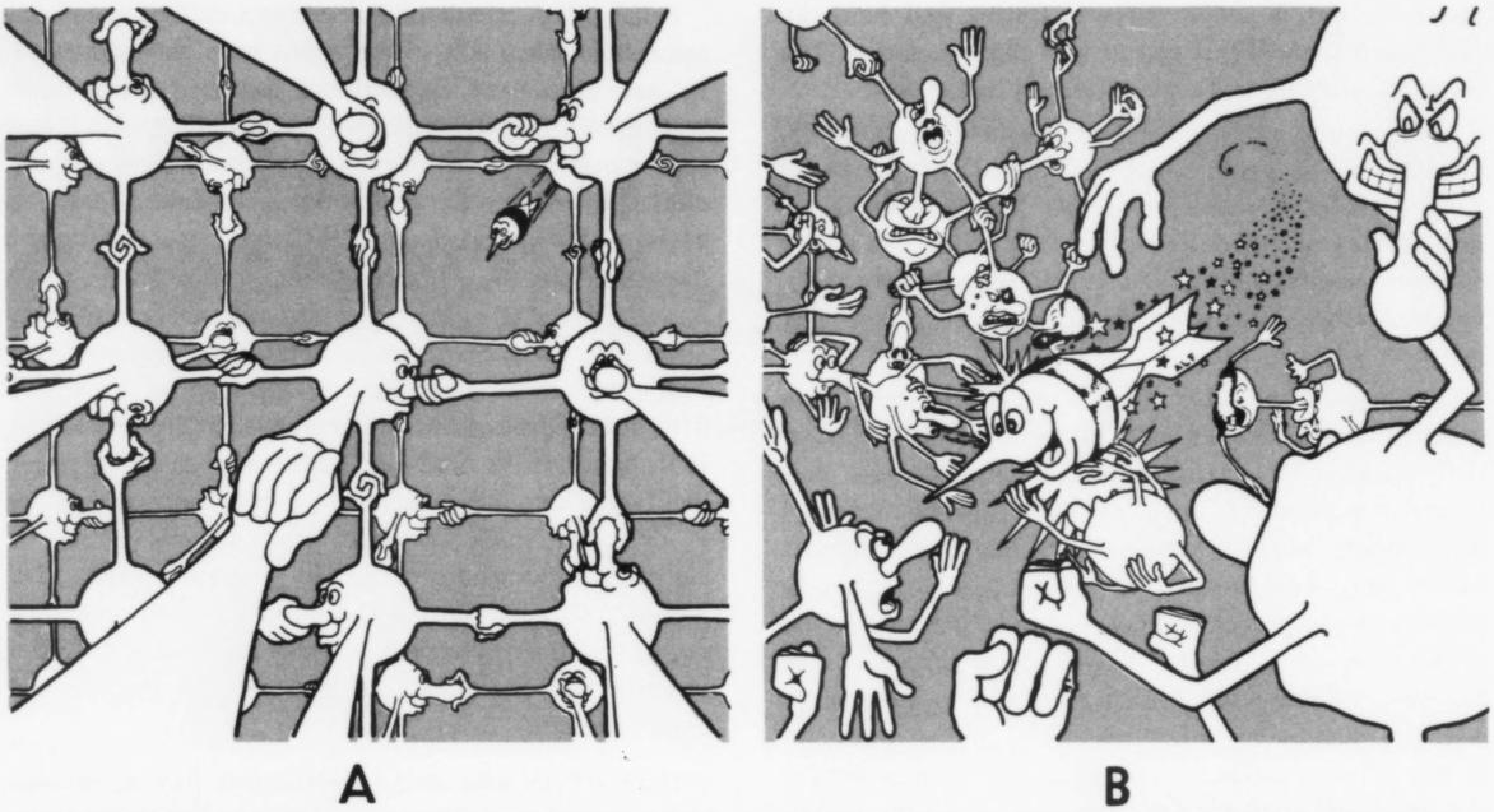

Fig. 1. A. **An alpha particle formed from the spontaneous decay of U or Th approaches a stable portion of a mineral crystal where atoms of various elements are bonded together.** ***B.*** **The energetic alpha particle collides with atoms of the structure causing displacements and structural damage.**

Recognizing that radiation damage produces local areas of high temperature and that the later stages of metamictization may consist mainly of melted or fused material, Ueda (1957) studied the effects of artificial melting and quenching of radioactive minerals. In his experiments he showed that specimens of allanite, gadolinite, and zircon, when melted at high temperatures and cooled in air, do not crystallize as the original mineral but decompose into oxides and unidentified phases. On the other hand monazite and xenotime, which only rarely show slight metamictness, recrystallize to their original structures. He cites data which suggest that thorianite and huttonite will also behave as in this latter case. He concludes that in nonmetamict radioactive minerals like these, after local fusion due to alpha-particle activity, there is annealing or a recrystallization of the original structure without metamictization. A similar view of self-annealing was suggested by Holland and Gottfried (1955).

DIFFERENCES BETWEEN SPECIMENS OF THE SAME MINERAL

Variations in the degree of metamictness of different specimens of the same mineral species may be attributed to several factors. In the first place the relative content of radioactive elements has a strong influence. In cases where common metamict minerals also occur in the nonmetamict state, e.g., fergusonite and euxenite (Nefedov, 1956), radioactive elements often are not detected. A direct correlation between the metamictness of zircon and content of radioactive elements has been made by von Stackelberg and Rottenbach (1940), Morgan and Auer (1941), and Holland and Gottfried (1955). Secondly, the degree of metamictness depends on the time elapsed since the formation of the mineral. Hutton (1950) suggested that some thorites are nonmetamict because they are not old enough, and Mügge (1922) implied that artificial uranium and thorium salts and some zircons and allanites are too young to be metamict. Thirdly, the inherent stability of the structure of a given specimen affects the degree of metamictness. The influence of this factor is not well-known, but it seems that the quantity and nature of ions substituting isomorphously for the essential ions in a specific mineral specimen affect its stability.

Several serious attempts have been made to see if it is possible to measure quantitatively the degree of metamictness. Bauer (1939), who correlated specific gravity, hardness, optical properties, and solubility with heat treatment of a number of zircons, concluded that solubility in acids is the best way to measure degree of metamictness. The metamictness of zircon was correlated with optical properties by Morgan and Auer (1941). Chudoba and Lange (1949) estimated the degree of metamictness on gadolinite, samarskite, and euxenite from specific gravity. Holland and Kulp (1950) and Kulp *et al.* (1952) showed that the degree of metamictness could be measured by determining the energy of recrystallization on heating. The latter was determined by differential thermal analysis. They also suggested that the degree of metamictness could be determined by intensity of thermoluminescence. Hurley (1952) determined that the helium content of zircon increases with degree of metamictness. Later Hurley and Fairbairn (1953) indicated the degree of metamictness of zircon could be determined by changes in the x-ray diffraction angle of the (112) plane. Ueda and Korekawa (1954) observed that interplanar spacings for allanite increase with degree of metamictness, and they also considered the shapes of x-ray diffractogram peaks. Quantitative measurements of the degree of metamictness, based on x-ray diffraction and optical data, also have been given by Holland and Gottfried (1955) for zircon, and by Pellas (1962) for allanite.

THE METAMICT STATE AND THE DETERMINATION OF GEOLOGICAL AGE

The possibility of using the metamict state to determine the geological age of rocks and minerals was initially considered by Holland and Kulp (1950) and Kulp *et al.* (1952). They assumed that metamictization results from the breaking of chemical bonds and disorganization of the structure by internal alpha bombardment. From this it follows that the amount of metamictness would depend upon the (a) total alpha-activity of the mineral, (b) time elapsed since the formation of the mineral, (c) inherent stability of a given mineral (for a given species, they assumed this would be nearly constant). The alpha activity can be measured by direct counting procedures, and, as stated above, the amount of metamictness can be determined from the energy of recrystallization upon heating. This is measured by differential thermal analysis, the area under the exothermal curve being proportional to the amount of heat generated as the specimen crystallizes, and this being proportional to time for a fixed alpha activity. In their exploratory study, especially of zircon and samarskite (Kulp *et al.*, 1952), the ages were not determined with great accuracy. Some complicating factors influencing the results involve the crystallite size (affects differential thermal analysis curves), the nature of isomorphous substitutions (affect inherent stability of mineral), the possibility of weathering influences on samples, and the possibility of natural external temperature effects (annealing) influencing the mineral during course of metamictization. Also Pabst (1952) has questioned the assumption that the entire energy from radioactive decay is spent in the disruption of the crystal structure.

Hurley and Fairbairn (1953) have also considered the use of metamictness in the age determination of zircons. They likewise considered that metamictization is a function of the total alpha particle irradiation, and that total irradiation is represented by geological age times alpha activity. They used the x-ray diffraction 2Θ angle of the (112) plane to determine the degree of metamictness of the zircon. The angle is 35.635° for nonmetamict zircon, and approaches 35.1° asymptotically as zircon becomes more metamict. Pellas (1962), following similar procedures, also determined geological ages for metamict allanite. In addition to using interplanar spacings to evaluate the amount of metamictness, he also determined this by measuring birefringence and pleochroism. Of course some of the problems outlined above also apply to these studies.

Geologically metamict minerals are very old. No doubt the majority of them will be shown to be Pre-Cambrian in age (over 600 million years). However, studies of metamict species have shown ages as young as 150 m.y. (Jurassic). The studies of zircon and samarskite, by Kulp *et al.* (1952), indicated ages ranging from 250 to 1000 m.y. Holland and Gottfried (1955) dated metamict zircon at approximately 570 m.y. Pellas (1962) found that allanite ranges from 150 to 1200 m.y. Although the youngest of these allanites is Jurassic, most of them are Paleozoic and older.

DIFFERENTIAL THERMAL ANALYSIS AND METAMICT MINERALS

From their initial work on the differential thermal analyses of about a dozen metamict minerals, Kerr and Holland (1951) suggested the method might be applicable to the identification of these amorphous materials. Subsequent work, especially by Orcel (1953, 1956, 1966), showed serious limitations when it comes to characterizing these minerals by differential thermal analysis. From a comparison of several analyses, he observed that different specimens of the same mineral species, of nearly the same chemical composition and crystal form, showed notable differences in their thermograms, having endothermic and exothermic peaks at different positions and of different shapes and amplitudes. Secondly, he observed analogous thermograms for species having different chemical compositions and apparently different crystalline forms. Some of these inconsistencies can be explained by different isomorphous substitutions, by chemical changes following metamictization, by differences in particle size, by differences in degree of metamictness, or by physical-chemical differences between environments yielding the minerals.

Numerous differential thermal analyses of various metamict minerals have been published. Data on the more common species can be found in papers by Kerr and Holland (1951), Kulp *et al.* (1952), Orcel (1953, 1956, 1966), and Adler and Puig (1961), to mention a few.

In general most differential thermal analyses show an endothermic peak between about 100° to 300°C due to the release of water. Then there is a strong exothermic peak, usually in the interval of 500°C to 900°C, corresponding to the crystallization of the mineral. Of course many variations of this heating history occur depending upon the mineral and specific specimen under investigation.

The application of differential thermal analysis to the determination of the absolute age of metamict minerals has already been discussed. Sabatier (1954) used differential thermal analysis to determine the heats of transformation for compounds, especially the heat of crystallization for metamict gadolinite. The liberation of heat from metamict minerals was explored earlier by Rose (1843), Liebish (1910), and Faessler (1942).

X-RAY DIFFRACTION DATA FOR METAMICT MINERALS

The fact that metamict minerals are amorphous (or in some cases only partially amorphous) to x-ray diffraction techniques has been known since early studies by Rinne (1915) on gadolinite and Vegard (1916) on thorite. Unlike most minerals which are well crystallized, these minerals cannot be identified in a direct manner simply by sorting data obtained from x-ray diffraction films or diffractograms. Following an early observation of Küstner (1922), that the structure of gadolinite is restored by heating, numerous investigators have published x-ray diffraction data for heated specimens of various metamict minerals. The most comprehensive data of this kind have been given by Berman (1955) and Lima-de-Faria (1964). Unfortunately, the full significance of many of the published x-ray data is not known. Initially it was assumed that the data represent the original crystalline phase of the mineral before metamictization, but recent studies have shown that this is usually not true and the actual situation is much more complex. For example, the x-ray data obtained after heat treatment (at various temperatures and in different atmospheres) might be either for the original phase, for a polymoprhic form, for a mixture of new phases, especially oxides, or for a combination of these. In many of the original studies, the specimens were simply heated in air at unknown temperatures by using Meker or Bunsen burners. More recently refinements in methods have been made, especially with the use of temperature regulated electric furnaces and occasionally the use of special environments involving hydrogen (Bannister and Horne, 1950), helium (Berman, 1955), water (Frondel and Collete, 1957), nitrogen (Lima-de-Faria, 1964), charcoal (Adams and Sharp, 1970), and vacuum (Peacor and Simmons, 1972).

Owing to the cryptocrystalline nature of the phases which develop through heat treatment, the x-ray diffraction powder methods are usually employed rather than single-crystal techniques. Apparently single crystals can be reconstituted only when metamictness has not progressed very far and there are substantial remnants of the original structure (Pabst, 1952). Single crystal techniques have been applied in only a few cases, e.g., zircon (von Stackelberg and Rottenbach, 1940; Pabst, 1952), polycrase (Pyatenko and Aleksandrov, 1960), davidite (Pabst, 1961), griphite (Peacor and Simmons, 1972).

As mentioned earlier, heat treatment studies of numerous specimens of a single mineral species often show wide differences, especially with respect to temperatures at which recrystallization, polymorphic transformation, and chemical decomposition occur. Factors which apparently influence these differences include the following: degree of metamictness; amount of chemical change accompanying metamictization; original composition of specific specimen studied (variation with isomorphism); polymorphic phase of original specimen when several phases can occur in nature; and physical-chemical factors of original deposit. Generally each metamict mineral species follows a characteristic history of change when heat treated, in spite of variations in the temperatures at which these changes occur. The time factor in heat treatment seems to be rather minor, the major crystallization occurring in periods of one hour or less. Discussions for some of the more common metamict species follow.

1. *Pyrochlore-microlite series.* For metamict specimens in the pyrochlore-microlite series, Mitchell and Zulkiewicz (1970) found that crystallization began between 400°C and 500°C. The dominant phase formed at all temperatures through 1000°C (in air, one hour) was isometric pyrochlore-microlite. Accompanying phases were $Ca(Ta,Nb)_4O_{11}$ from 800°C to 900°C, and $Ca(Ta,Nb)_2O_6$ plus $(Ta,Nb)O_2F$ from 900°C to 1000°C. In some specimens minor $(Ta,Nb)O_2$ formed at 900°C and above.

2. *Euxenite.* Although heat treatment studies of euxenite follow a fairly constant trend, there are some differences between specimens, apparently related to slight differences in composition. Mitchell (1972) found that specimens from the Amelia-Powhatan Counties area, Virginia, began to crystallize in air as low as 200°C (one hour) as the priorite dimorph. This phase persisted in decreasing amounts until 1000°C. The euxenite phase formed at approximately 800°C and generally was dominant at higher temperatures. In specimens from the Bedford County, Virginia, area a weak priorite phase, accompanied by a dominant betafite-like phase, was characteristic of lower temperatures. Euxenite began to form at 800°C and dominated at higher temperatures, where it was accompanied by a betafite-like phase, priorite, rutile, and/or brannerite-like phase. Apparently metamict specimens of original euxenite or original priorite each show similar heat treatment results, so in order to determine the original polymorph the morphology of the specimen must be determined.

3. *Samarskite.* Compared to most of the common metamict minerals the x-ray diffraction data for samarskite have been the most difficult to interpret. This is because the crystal structure and chemical formula were not known until recently (Komkov, 1965), and x-ray patterns usually represent a mixture of phases whose nature and number depend upon complex compositional variations in the mineral and upon temperatures of treatment. Mitchell (1970) found, for specimens heated in air, that the samarskite phase, $(Y,U,Fe)NbO_4$, generally formed at lower temperatures (ca. 600°C) and persisted as a major phase through 900°C. In this range it was often accompanied by UNb_2O_8 and rarely by tapiolite-like and betafite-like phases. Monoclinic $FeNbO_4$ and monoclinic $YNbO_4$ also often begin to crystallize at 900°C. At 1000°C (one hour) the samarskite phase generally completely disappeared, leaving well-developed UNb_2O_8 and monoclinic $YNbO_4$, with very minor monoclinic $FeNbO_4$, betafite-like, and tapiolite-like phases. In some rare specimens Mitchell (1970) observed that the samarskite phase never developed, even at lower temperatures, but in its place were either dominant UNb_2O_8 or dominant betafite-like phases. In these cases the samarskites were uranium rich, and the latter one also had high calcium.

***Table 1. Minerals known to occur in the metamict state.**

A. Multiple Oxides

Davidite, $(La,Ce,U)x(U,Fe^{2})(Ti,Fe^{3})_6O_{13}$-x
Loparite, $(Na,Ce,Ca)TiO_3$ The thorian variety irinite is metamict.
Zirkelite, $(Ca,Ce,Y,Fe)(Ti,Zr,Th)_3O_7$
Pyrochlore, $(Ca,Na)_2(Nb,Ta)_2O_6(O,OH,F)$ Many of the related minerals of the pyrochlore series may also be metamict.
Betafite, $(U,Ca)_2(Ti,Nb,Ta)_2O_6(O,OH,F)$
Microlite, $(Ca,Na)_2(Ta,Nb)_2O_6(O,OH,F)$ Many of the related minerals of the microlite series may also be metamict.
Zirconolite, $CaZrTi_2O_7$
Niobozirconolite, $Ca(Zr,Fe)(Ti,Nb,Zr)_2O_7$
Columbite-tantalite, $(Fe,Mn)(Nb,Ta)_2O_6$ - $(Fe,Mn)(Ta,Nb)_2O_6$ Rarely metamict.
Euxenite, $(Y,Ce,U,Pb,Ca)(Nb,Ta)Ti(O,OH)_6$ Only one nonmetamict euxenite known to date.
Tanteuxenite, $(Y,Ce,U,Pb,Ca)(Ta,Nb)Ti(O,OH)_6$
Polycrase, $(Y,Ce,Ca,U,Th)(Ti,Nb,Ta)_2(O,OH)_6$
Tantalpolycrase, $(Y,Ce,Ca,U,Th)(Ti,Ta,Nb)_2(O,OH)_6$
Samarskite, $(Y,U,Fe)NbO_4$ Always metamict.
Yttrotantalite. $(Y,Er,Fe,U)(Ta,Nb,Zr)O_4$
Kobeite, $(Y,U,Ca)(Ti,Fe)_2(O,OH)_6$
Fersmite, $(Ca,Ce,Na)(Nb,Ti,Fe)_2(O,OH,F)_6$ Metamict in part.
Yttrocrasite, $(Y,Th)Ti_2(O,OH)_6$ (?) Metamict in part.
Priorite, $(Y,Er,Th,Ca,Na,U)Ti(Nb,Ta)O_6$
Aeschynite, $(Ce,Th,Ca)Ti(Nb,Ta)O_6$
Polymignyte, $(Ce,La,Y,Th,Mn,Ca)(Zr,Ti,Nb,Ta)_2O_6$
Brannerite, $(U,Ca,Th,Y)(Ti,Fe)_2O_6$ Usually completely metamict.
Thorutite, $ThTi_2O_5 \bullet 1/2H_2O$
Fergusonite (alpha and beta), $YNbO_4$ Rare nonmetamict occurrences known.
Formanite, $YTaO_4$

B. Phosphates

Griphite, $(Na,Al,Ca,Fe)_3Mn_2(PO_4)_{2\cdot5}(OH)_2$ Not always completely metamict.
Xenotime, YPO_4 Only rarely is it slightly metamict (Vegard, 1927).
Monazite, $CePO_4$ Only rarely is it slightly metamict (Ueda, 1957).
Britholite, $(Ca,Al,Fe,Ca,Th)_5[(Si,P,Al)O_4]_3(F,OH)$ Sometimes metamict, especially the aluminian variety.

C. Silicates

Zircon, $ZrSiO_4$ Crystalline to completely metamict.
Thorite, $ThSiO_4$ Crystalline to completely metamict.
Uranothorite, $(Th,U)SiO_4$ The variety wisaksonite is usually metamict.
Coffinite, $USiO_4$
Steenstrupine, $Na_2Ce(Mn,Ta,Fe)H_2[(Si,P)O_4]_3$ Some varieties are metamict.
Thorosteenstrupine, $(Ca,Th,Mn)_3Si_4(O,F)_{12\cdot2} \bullet 5.6H_2O$ (?) Usually metamict.
Tritomite, $(Ce,La,Y,Th)_5(Si,B)_3(O,OH,F)_{13}$ (?)
Spencite, $(Ca,Fe)_2(Y,La)_3(B_3Si_{4\cdot3}Al_{0\cdot7})_8(O,OH,F,Cl)_{20}$
Rowlandite, $(Y,Fe,Ce)_3(SiO_4)_2(F,OH)$
Cappelenite, $(Ba,Ca,Ce,Na)(Y,Ce,La)_2(B_2O_5)(SiO_4)$
Gadolinite, $Y_2FeBe_2O_2(SiO_4)_2$ Commonly metamict; crystalline examples known.
Melanocerite, $Na_4Ca_{16}(Y,La)_3(Zr,Ce)_6F_{12}(BO_3)_3(SiO_4)_{12}$ Metamict in part.
Yttrialite, $Y_2Si_2O_7$ Strongly radioactive types are metamict.
Thalenite, $Y_2Si_2O_7$ Strongly radioactive types are metamict.
Hellandite, $Ca_3(Y,Yb)_4B_4O_3(OH)_6(Si_2O_7)_3$ Usually metamict.
Rinkite, $Na_2Ca(Ca,Ce)_4(Ti,Nb)(F,O)_4(Si_2O_7)_2$
Mosandrite, $(Ca,Na,Y)_3(Ti,Zr,Ce)(F,OH,O)_2Si_2O_7$
Allanite, $(Ca,Ce)_2(Fe^{2},Fe^{3})Al_2O(OH)(SiO_4)(Si_2O_7)$ Crystalline to completely metamict.
Perrierite, $(Ce,La,Ca,Na)_4Fe^{2}(Ti,Fe^{3})_2Ti_2O_8(Si_2O_7)_2$ Crystalline to completely metamict.
Chevkinite, $(Ce,La,Ca,Na)_4Fe^{2}(Ti,Fe^{3})_2Ti_2O_8(Si_2O_7)_2$ Crystalline to completely metamict.
Ilimaussite, $Na_2Ba(Ce,Fe)NbSi_4O_{14} \bullet 2\text{-}1/2H_2O$ Metamict in part.
Eudialyte, $(Na,Ca,Fe)_6Zr(OH,Cl)(Si_3O_9)_2$ Some varieties are metamict.
Ekanite, $K(Ca,Na)_2ThSi_8O_{20}$

4. *Fergusonite.* For fergusonite, Mitchell (1967) found that metamict specimens began to crystallize in air at 400°C as the tetragonal fergusonite phase. At temperatures up to 700°C the structure increasingly improved. Treated at 800°C a mixture of tetragonal and monoclinic fergusonite formed. At 1000°C only monoclinic fergusonite crystallized. These observations are based on heating for one hour. The morphology of a specimen would have to be determined in order to tell if the original mineral was alpha-fergusonite (tetragonal) or beta-fergusonite (monoclinic), both of which occur in nature.

5. *Zircon.* Lima-de-Faria (1964) found that partially metamict specimens of zircon heated in air at 700°C crystallized as a pure phase. The zircon structure persisted at higher temperatures, but at 1000°C was often accompanied by isometric ZrO_2 and at 1300°C, especially in a nitrogen atmosphere, was accompanied by isometric ZrO_2 and monoclinic ZrO_2.

6. *Thorite.* Although specimens vary widely, Pabst (1952) found the following general heating history in air for thorite from Brevig, Norway. Crystallization began at 640°C with the formation of isometric ThO_2 and tetragonal $ThSiO_4$.

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*Table 1, above, was inadvertantly omitted from part 1 of this series.

Table 2. Radioactive rare-earth bearing minerals generally not considered to be candidates for metamictization.

Gagarinite, $NaCaYF_6$
Tysonite, $(Ce,La)F_3$
*Columbite-tantalite, $(Fe,Mn)(Nb,Ta)_2O_6$ - $(Fe,Mn)(Ta,Nb)_2O_6$
Cerianite, $(Ce,Th)O_2$
Thorianite, ThO_2
**Uraninite, UO_2
Bastnaesite, $CeFCO_3$
*Xenotime, YPO_4
*Monazite, $CePO_4$
*Sphene, $CaTiOSiO_4$
Thortveitite, $Sc_2Si_2O_7$

*Although usually not metamict, metamict to slightly metamict specimens have been reported.

**Amorphous varieties are known; probably not metamict. See text.

At higher temperatures (above ca. 950°C) monoclinic $ThSiO_4$ was the major phase. The monoclinic $ThSiO_4$ is identical to huttonite. No doubt a fully metamict huttonite would have a similar heating history; a knowledge of the morphology of the original specimen would be necessary in order to differentiate between the two minerals when naturally metamict.

7. *Gadolinite.* Heat treatment studies of gadolinite from Texas were made by Gibson and Ehlmann (1970). No recrystallization in air occurred at 680°C (even after a week). An unidentified "gamma" compound formed along with minor gadolinite at 730°C. At 880°C only traces of the "gamma" compound remained and gadolinite was well developed. Above 1000°C gadolinite was essentially pure. Lima-de-Faria (1964) reported the "gamma" compound at higher temperatures. This unknown phase may be $YFeO_3$, but this is inconclusive. Gibson and Ehlmann (1970) found that the degree of recrystallization is more influenced by temperature than by heating time.

8. *Allanite.* Mitchell (1966a) found that metamict allanite can recrystallize in air in the range of about 600°C to 900°C, with 750°C being the best temperature for pure reliable x-ray data. At higher temperatures, especially 1000°C, the mineral decomposed to form a mixture of three phases: a spinel-like mineral close to magnetite, a silicate with the apatite structure (like Ce-britholite), and anorthite-like plagioclase. In some cases heating, especially for long periods at 800°C to 900°C, also formed a CeO_2 phase.

9. *Chevkinite and perrierite.* Chevkinite from Virginia, studied by Mitchell (1966b), was not very metamict. For all temperatures of heat treatment in air (one hour) through 600°C the chevkinite pattern remained essentially unchanged except for a slight shrinkage of the unit cell. A perrierite polymorph began to form at 700°C and dominated specimens after heating at 900°C and 1000°C. The 1000°C specimen also contained CeO_2 and minor chevkinite phase.

Virginian perrierite (Mitchell, 1966b) varied from metamict to slightly metamict. Heating to 600°C usually was sufficient to crystallize metamict specimens. Heating at higher temperatures produced a sharpening of x-ray reflections and a slight decrease in interplanar spacings. At temperatures approaching 1000°C CeO_2 also often developed.

X-ray data for heat treatment studies of numerous other metamict minerals have been published. The most comprehensive work of this type was by Lima-de-Faria (1964), who not only contributed important data for the minerals just summarized, but also considered the following: yttrialite, columbite-tantalite, formanite, yttrotantalite, betafite, polycrase, aeschynite, polymignite, brannerite, and davidite.

ELECTRON DIFFRACTION

Christ *et al.* (1954) have shown that some metamict minerals which are x-ray amorphous, give sharp electron diffraction patterns. The relict crystallinity is sufficient to interact with electron waves, which are considerably shorter than x-rays. Minerals which showed electron diffraction patterns are zircon, samarskite, and polycrase. Barsanov (1964) also obtained similar electron diffraction effects from unheated metamict minerals.

THE URANINITE PROBLEM

Although most uraninite is crystalline, Conybeare and Ferguson (1950) found some amorphous, and presumably metamict, specimens in Canada. Similar amorphous uraninite had been observed earlier by Kirsch (1925). Likewise Brooker and Nuffield (1952) found that some Canadian specimens give very poor or amorphous x-ray diffraction patterns before heat treatment. They found that the quality of the pattern decreased as the UO_3 content increased, and that such specimens themselves assumed an ever increasing weathered appearance. Therefore, they concluded that their uraninite is not metamict, but amorphous from oxidation. Some of their specific observations regarding this are (a) surface oxidation affects the state of aggregation by reducing the grain size, (b) chemical analyses of different zones of a uraninite crystal clearly show that the U^6 content increases outward from the core, (c) as oxidation proceeds, more oxygen is introduced into the interstices of the UO_2 structure, with possible distortion, and finally loss of definition of the x-ray powder pattern. Brooker and Nuffield (1952) indicated that metamict uraninite may exist, but they felt caution would be necessary to determine it. Perhaps truly metamict uraninite would have a glassy conchoidal fracture typical of most metamict minerals. Metamictization, with subsequent or concurrent oxidation, would be virtually impossible to separate from straight oxidation. Hurley and Fairbairn (1953) and Ueda (1957) also attributed the disordering of the structure of uraninite to oxidation rather than metamictization. The process of oxidation of uraninite was discussed earlier by Ellsworth (1925).

ARTIFICIAL METAMICTIZATION

Several early attempts were made to produce the metamict state artificially. Mügge (1922) was not successful in his experiment to change the optical properties of allanite by exposure of the mineral to radium emanations for one year. Von Stackelberg and Rottenbach (1940) claimed to have formed metamict zircon by exposing a thin plate of the mineral to radon for four months. Berman *et al.* (1950), Wittels (1953), and in recent years numerous other investigators, have formed amorphous silica from crystalline quartz by using neutron radiation. Now that powerful sources of artificial radiation are more readily available, studies of the effects of alpha radiation, neutron radiation, ion radiation, etc., on crystalline substances have greatly proliferated. The possibility of producing artificial metamictization in synthetic crystals (especially of minerals which are usually metamict in nature), in which variations in chemistry, temperature, irradiation, etc., can be controlled, opens many avenues of potential research.

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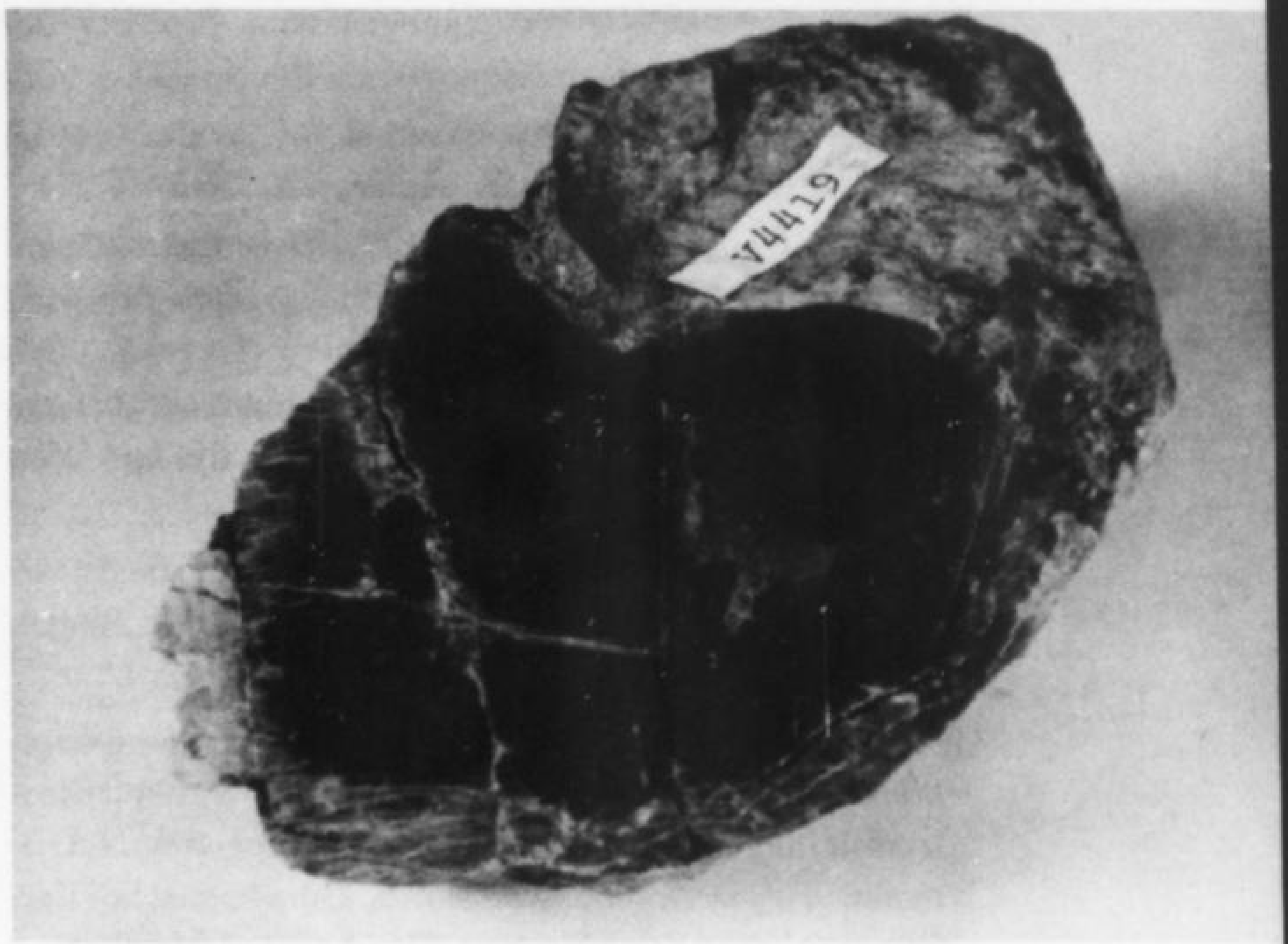

***Fig. 2.* Sawed section of metamict allanite mass with thick alteration rind (surface 9 cm across). From near Lynchburg Reservoir, Amherst County, Virginia.**

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Fig. 1.* Albite on dolomite. The albite crystal is 2.3 cm across. Gaines specimen, *photo by Julius Weber.

The Min of the M Brazil

by A. Lucio **P. O. Box 1286, Belo Horizo**
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INTRODUCTION

The Morro Velho gold mine has, in recent years, become widely known among mineralogists for the profusion and beauty of the minerals found there. The mine is located in Nova Lima (county), Minas Gerais, Brazil. The city of Nova Lima grew surrounding the mine, and its population today is over 30,000 inhabitants. Nova Lima is only 12 km from Belo Horizonte to the southeast. Today it belongs to the so-called "Greater Belo Horizonte".

HISTORY

Mining began in 1834 as an open pit operation by the St. John del Rey Mining Company. By 1867 the lode, which in its upper part plunges about 45° eastward, had been followed downward to a depth of about 360 meters. The pit was some 275 meters long in an eastward direction and 4.5 to 13.5 meters wide. The walls of the stopes were supported by timbers. In 1867 fire destroyed an important part of the mine, and from then until 1873 production almost ceased. When it started again it was an underground operation. Since then a series of shafts were sunk and tunnels were driven in order to reach the orebody. The deepest point in the mine was reached in 1934, at the bottom of a winze sunk from level 29 to level 30; 2,483 m. below the surface. The rock temperature at this level is 55°C (130°F). For several years the mine was the deepest in the world. High rock temperatures, as well as the low grade of the ore, precluded deeper mining.

The mine was owned by the St. John del Rey Mining Company (British) from 1830 to 1958; from 1958 to 1960 it was owned by the Hanna Mining Company (American). In 1960 the mine was bought by a Brazilian group, and the name changed to Minerãcao Morro Velho S. A.

It is interesting to mention that in 1938 one gram of gold was enough to pay two miners. Today it requires 1.6 grams to pay one miner. The present production is 700 metric tons/day of ore carrying 13 grams/ton of gold.

GEOLOGIC SETTING

Most of the data about geology, mineralogy and textures of the ore presented here have been taken from private reports to the company by Prof. L. C. Graton and G. N. Bjorge, and by A. F. Matheson.

The ore bodies of the Morro Velho mine are located in massive thick to thin bedded quartz-dolomite or quartz-ankerite rock (lapa seca). The lapa seca is lenticular and is interbedded with schist (mainly quartz-carbonate-sericite-chlorite or quartz-sericite-schists; locally some schist is graphitic). The dominant structure of the schists is a northward to northeastward striking, eastward to southeastward dipping schistosity. Bedding is not commonly seen.

Nova Lima is located in the so-called "Brazilian Quadrilatero Ferrifero". The Quadrilatero Ferrifero occupies a part of the Brazilian shield and consists almost entirely of rocks of Precambrian age. The Morro Velho mine, geologically, is placed in the Rio das Velhas series, Nova Lima group. It is believed that the mineralization of the main ore body occurred in lapa seca adjacent to the contact between lapa seca and schist on the north limb of an eastward-plunging synclinal fold. The locus of mineralization evidently was along the keel or along the north side of the keel, and extended upward onto the north limb of the fold as much as 150 meters from the axial region.

Graton and Bjorge noted that the main lode had the form of a ribbon set on edge and plunging S85°E at about

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Morro Velho Gold Mine,

orizonte, Minas Gerais, Brazil

R. D. #1, Pottstown, Pennsylvania 19464

45° in the upper part and 15° in the lower part of the mine. The "ribbon" is about 150 meters wide, averages 4.5 meters in thickness. Due to the 45° dip, which reduces to 15° at 2,000 meters, it constitutes a plunge length of more than 4,000 meters.

Graton and Bjorge considered the ore of Morro Velho as an outstanding example of a deep-seated high temperature deposit. This is evidenced by the association of arsenopyrite, pyrrhotite, chalcopyrite, quartz and gold, the occurrence of scheelite and wolframite, and the remarkable uniformity in texture, mineralogy, and chemical composition of the ore from the top to near the bottom of the mine.

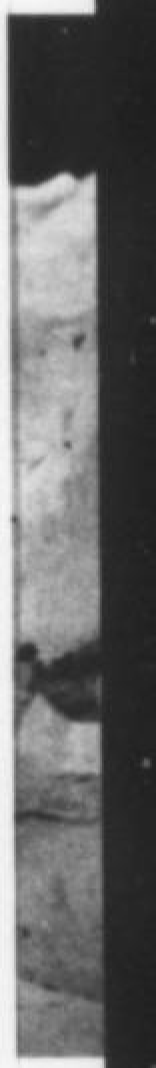
Pyrrhotite has long been considered an indicator of high temperature mineralization in the range, 300-500°C. Recent work at the Geophysical Laboratory of the Carnegie Institution, Washington, D. C., on a sample of ore from the Morro Velho mine, using the pyrrhotite-pyrite geothermometer, showed the minimum temperature for crystallization of the sulfides at the Morro Velho mine to be 325°C. The typical low temperature assemblages of chlorite, sericite, and sodic plagioclase in wallrock near the ore evidently were not affected by the temperature of the ore solutions.

THE ORE

The ore of the Morro Velho mine consists of replacement of sulfides with gold and silver in a gangue containing mainly quartz and dolomite or ankerite. The term "gold" should be understood to include silver values. Siderite, chlorite, sericite, and sodic plagioclase are generally minor gangue minerals, and calcite is rare. Other minor or rare minerals reported in the ore are galena, sphalerite, scheelite, wolframite, cubanite, tetrahedrite, bornite, rhodochrosite and magnetite. The principal sulfides in the ore are pyrrhotite, arsenopyrite, pyrite and chalcopyrite. The gangue minerals are believed to represent either relicts from the lapa seca, or secondary minerals derived in part or entirely by mobilization and recrystallization of material from lapa seca during mineralization. The sulfides are in scattered grains, in stringers parallel to bedding of the lapa seca, or are concentrated into irregular-shaped island-like patches of massive granular mineral surrounded by lapa seca. In some places sulfides and secondary quartz-carbonate fill tension joints trending across bedding of the lapa seca. The contact between ore and lapa seca is generally sharp. Small percentages of pyrite are commonly distributed throughout both lapa seca and schist in the vicinity of ore bodies.

Gold is in very fine grains and is rather uniformly distributed throughout the ore. The grains increase in size with depth. Almost invariably it is localized in fractures in arsenopyrite or pyrrhotite. In places on level 26 (about 2,250 m) gold replaces pyrrhotite enclosed within crystals of arsenopyrite, or replaces veinlets of chalcopyrite crossing arsenopyrite. The gold is probably everywhere in actual contact with sulfide. There is no consistent variation in gold content with depth. The persistence of the paragenesis to a depth as great as 2,500 meters is remarkable.

The Morro Velho mine is not the only gold mine operated by Mineracão Morro Velho S. A. There are six mines in operation, all located near Nova Lima: Morro Velho (also called Mina Grande), Mina Velha, Raposos, Honorio Bicalho, Mina do Faria and Bela Fama. The mineralization of all these mines appears to be identical with that in the



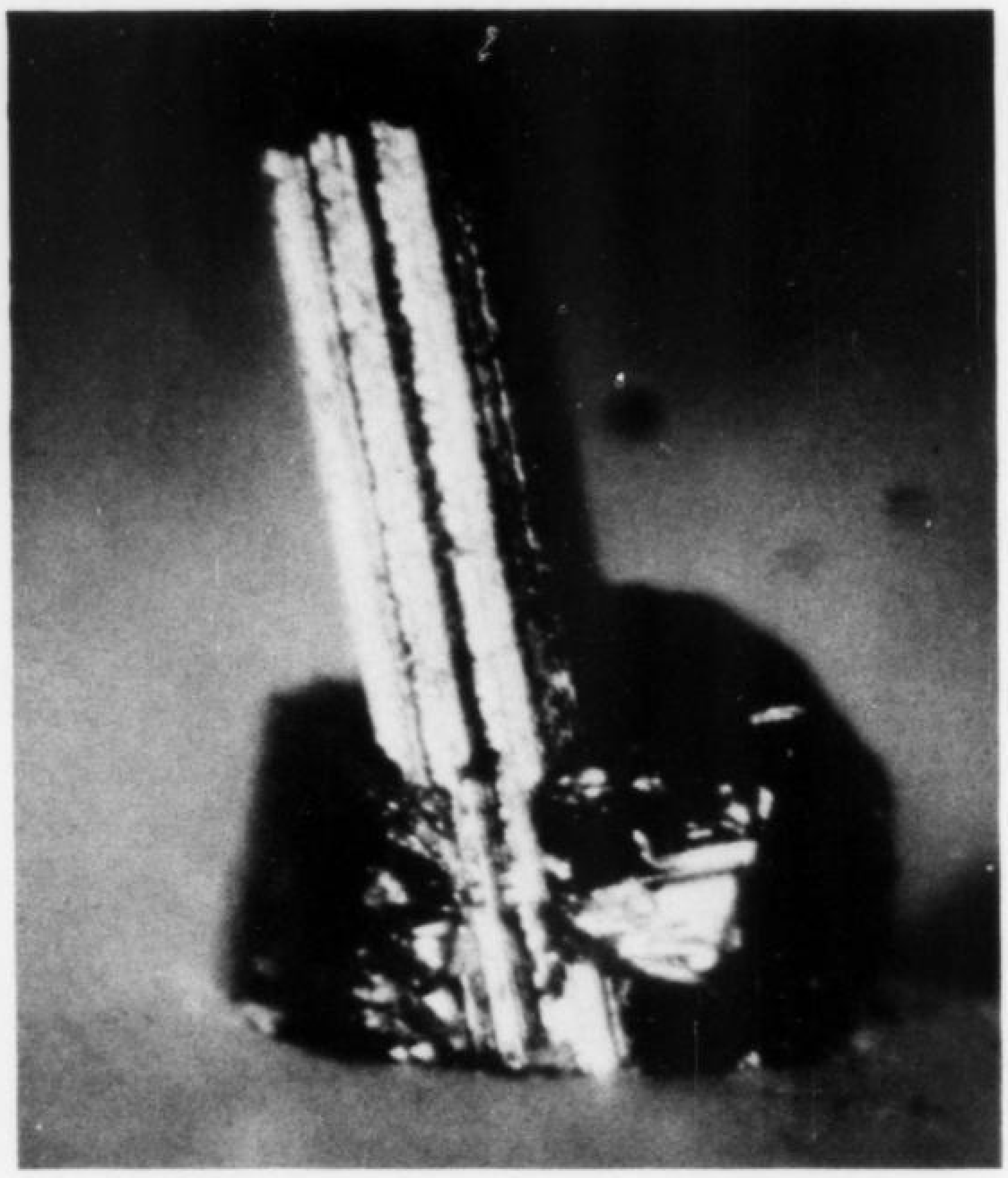


Fig. 2. **Cubanite growing through chalcopyrite crystal. Length of cubanite crystal is 4 mm. Gaines specimen,** ***photo by Julis Weber.***

Morro Velho mine. Most of the specimens come from Morro Velho.

THE MINERALS

From the viewpoint of the collector and mineralogist, Morro Velho is remarkable for the quality of the crystallized minerals and the beauty of the groupings found there. The groups generally consist of two to five different species, sometimes in very attractive arrangements. A complete list of the twenty-three minerals found to date, in approximate order of abundance, follows. Those marked with an asterisk (*) are rare, but sometimes found in fine crystals; those marked with a cross are uncommon, or may have been observed only once or twice, and not in crystals.

Fig. 3. **Cubanite on dolomite. American Museum of Natural History specimen,** ***photo by Julis Weber.***

Elements	**Sulfides**	**Sulfosalts**	**Oxides**
Gold	Pyrrhotite	†Tetrahedrite	Quartz
†Copper	Arsenopyrite		†Magnetite
	Pyrite		
	Chalcopyrite		
	Galena		
	*Cubanite		
	*Ullmanite		
	†Sphalerite		
	Bornite		

Carbonates	**Phosphates**	**Sulfates**	**Tungstates**
Dolomite	*Apatite	*Gypsum	*Scheelite
Siderite			†Wolframite
*Calcite			
*Ankerite			
†Rhodochrosite			

There are twelve minerals, most of them common species, found at Nova Lima in outstanding specimens.

Albite
Apatite
Chalcopyrite
Cubanite
Dolomite
Gold
Gypsum
Pyrrhotite
Quartz
Scheelite
Siderite
Ullmanite

A description of the mode of occurrence of these minerals follows:

Albite — This mineral is remarkable at Morro Velho for its sharpness and transparency. The habit is tabular, and the average size is 2 x 2 cm, but exceptionally to 5 x 5 cm showing the same sharpness and transparency. Dominant forms are {010} , {001} , and {110} . The albite is frequently twinned, showing the polysynthetic plagioclase law like a textbook drawing. This is a mineral which is widespread and common, but which occurs at Morro Velho in unequalled specimens.

Apatite — The groups containing apatite are always outstanding for their beauty and appeal. The apatite may be colorless, or in shades of delicate pink or light green, and usually transparent. Rarely completely euhedral crystals, nearly free of matrix, are found. In size the crystals range from 1 x 1 to 5 x 5 cm, always in tabular hexagonal crystals. The morphology is commonly complex, including the pinacoid {0001} , and prisms $\{11\bar{2}0\}$ and $\{10\bar{1}0\}$. As is common with tabular crystals, the apatite is very rich in pyramidal faces: besides $\{10\bar{1}1\}$, $\{11\bar{2}1\}$ and others, third order forms are ordinarily present in small but sharp faces. The most desirable specimens are those of an exceptional rose-red color. This mineral is also brightly fluorescent pinkish white under short and long-wave ultraviolet radiation. Apatite is a rare mineral at Morro Velho, and is found in druses with quartz, albite, pyrrhotite, dolomite, siderite, etc.

Chalcopyrite — Although the chalcopyrite crystals from Morro Velho are of exceptional beauty and brilliance they are invariably of micro size, seldom reaching 3 mm. The common crystal habit is of pseudo-octahedrons or distorted pseudo-octahedrons, often elongated [110] to form prismatic and even acicular crystals. In this habit it has often been mistaken for cubanite, but can be distinguished from the latter by the much brighter brass yellow color of chalcopyrite and the presence of striations at an angle of nearly 45° to the length.

Cubanite — Crystallized cubanite is a very rare mineral, and even at Morro Velho it is far from common. Typically it is found as inconspicuous micro crystals thinly scattered in druses of pyrrhotite and chalcopyrite crystals on dolomite. The usual size is 1 mm - 3 mm in length, although one of the authors has an exceptional specimen containing a 25 mm long crystal. The habit is slender prismatic, the color brass yellow to dark bronze, and the longitudinal striations of the crystals are very characteristic. Twinning on (110) is sometimes seen. In searching for the hard-to-see cubanite crystals in the pyrrhotite druses, it is well to note that in the absence of chalcopyrite, cubanite is seldom if ever present.

Dolomite — Dolomite is probably the most abundant crystallized mineral in the cavities, and forms the background for most of the other minerals. The color is white, translucent, and the habit simple, usually showing $\{10\bar{1}1\}$ only, although sometimes in step-like growth. Size may range up to 8 cm on edge. Unlike dolomite from lower-temperature deposits as in the Tri-State lead-zinc mines, the saddle-shaped curved crystal habit is absent. Often the dolomite crystals are covered with a light druse of small pyrrhotite crystals, some of which may be completely imbedded. Until the recent discovery of the remarkable dolomite from Eugui, Navarre (Spain), the dolomites from Morro Velho were equal or superior to those found anywhere else.

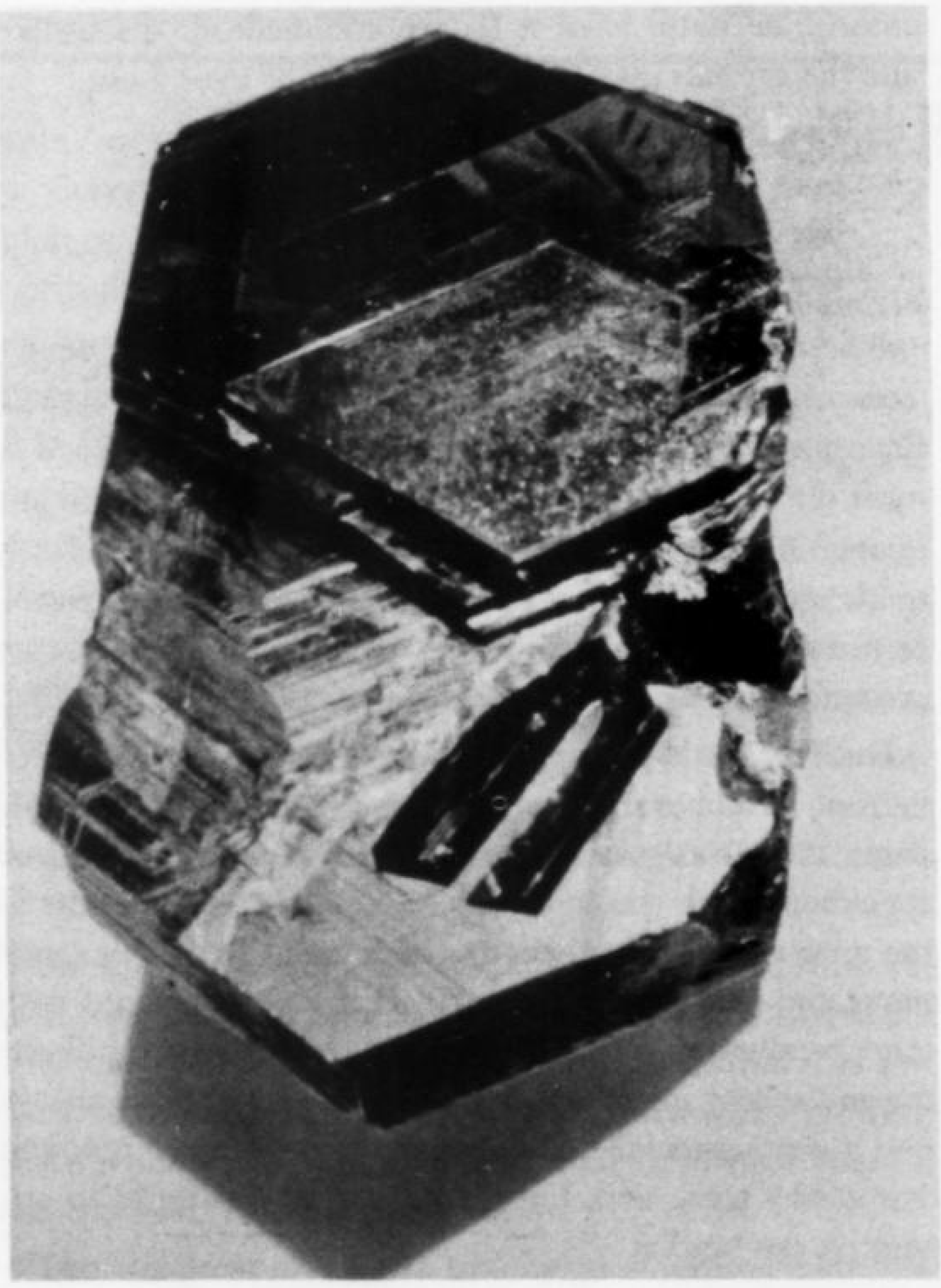


Fig. 5. Pyrrhotite crystals about 5 cm across. *Lucio specimen and photo.*

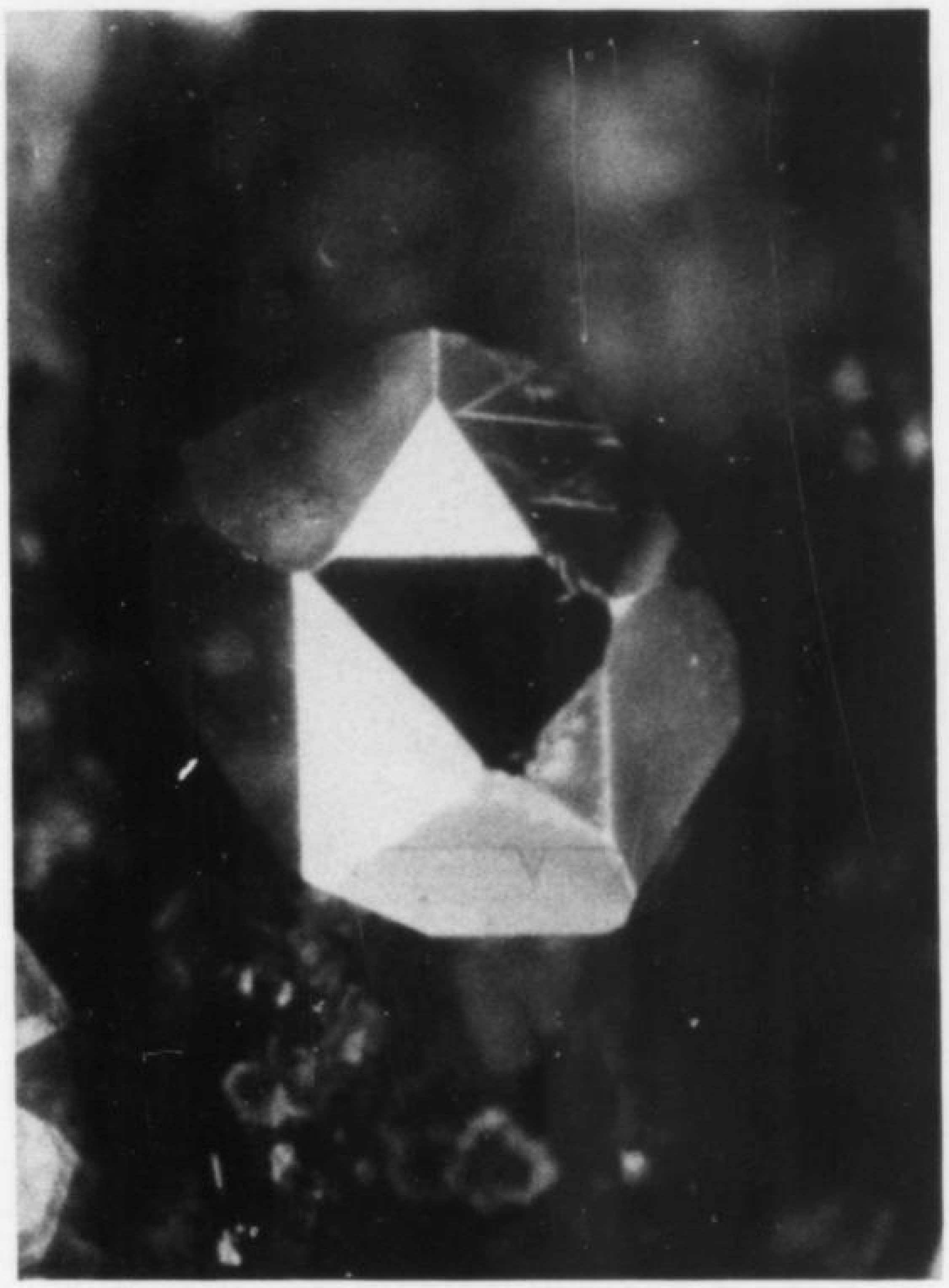


Fig. 4.* Gold on quartz. Crystal is 1 mm across. Gaines specimen, *photo by Julis Weber.

Fig. 6.* Pyrrhotite with quartz and dolomite. The pyrrhotite crystal is 1.5 cm across. Smithsonian Institution specimen, *photo by Joel E. Arem.

Fig. 7. **Siderite with quartz and minor pyrrhotite. The specimen is 13 cm high. Smithsonian Institution specimen,** ***photo by Joel E. Arem.***

Gold — Visible, free gold is rare at Morro Velho, but when it occurs the specimens are remarkable. The gold always contains silver in variable proportion, the normal ratio being 1:3 Ag:Au, and the color varies from pale yellow (electrum) to rich golden yellow. One habit is as thin, pale yellow plates (leaf gold), and the best specimen of this type, a plate 2 x 3 cm., is in the collection of the Departmento Nacional da Producão Minero in Rio de Janeiro. The most beautiful specimens, although usually micro in size, are where the gold forms scattered isolated crystals, invariably in contact with a pyrrhotite crystal. Here the habit is a combination of trapezohedron and octahedron, with extremely bright, sharp crystal faces.

Gypsum — The selenite variety of gypsum is found occasionally, and always occurs in a group of columns, like a Greek colonnade. The individual crystals are flexible, 2 - 3 cm. long and 3 - 5 mm in cross section. They resemble selenites from Rumania.

Pyrrhotite — Perfect hexagonal crystals of this mineral are not uncommon at Morro Velho. Typically they are thin tabular crystals 5 mm - 1.0 cm in diameter, thickly scattered on the dolomite matrix, but sometimes they may be as large as 10 cm on an edge by 3 cm thick. The thin tabular crystals are usually markedly curved, perhaps the most distinctive feature of Morro Velho pyrrhotite. The color is a dark bronze brown, but may be iridescent or tarnished to yellow bronze or indigo blue like covellite scales. In such cases it can be mistaken for other minerals; however its strong magnetic susceptibility is usually diagnostic. Often single crystals up to 2 x 2 cm are complete and lightly attached to the matrix by the basal plane or by a prism face. Larger crystals tend to be in parallel or subparallel groupings. Rarely complete euhedral crystals can be found completely enclosed in transparent quartz crystals, as though suspended in air.

Quartz — Generally in groups, very brilliant, showy arrangements. It is difficult to find a locality producing more beautiful quartz groups than Morro Velho. The habit is prismatic and the crystals often bi-terminated, and water clear. Rarely there may be inclusions of perfect, euhedral pyrrhotite crystals. The most beautiful groups are those which are accompanied by minerals of contrasting color, such as siderite, apatite, or pyrrhotite.

Scheelite — This is a rare mineral in the mine, but when found it is remarkable for the deep orange-red color and the sharpness of the crystals. Crystal size ranges from 0.5 to 2.5 cm., exceptionally larger, and the {011} form is dominant.

Siderite — This mineral is responsible for much of the appeal of the Morro Velho groups, due to its honey yellow color. The habit is of a flat rhombohedron, discus-like, and the crystals may attain a diameter of over 5 cm.

Ullmanite — While a very rare mineral at Morro Velho, ullmanite forms brilliant sharp dodecahedral crystals up to 2 mm diameter, in small clumps of individuals on dolomite druses with pyrrhotite, chalcopyrite, and cubanite.

The commonest association in the groups from Morro Velho is dolomite-quartz-pyrrhotite or any two of these minerals. Siderite and albite frequently join them also. The most attractive crystal groups are those with siderite and quartz, due to their brilliance and color contrast. It is easy to understand how beautiful the group is when rose apatite, or red-orange scheelite, is added, which unfortunately for collectors, very rarely happens.

Until 1970, the company didn't object to miners bringing out specimens. With increasing prices and demand, many collectors and dealers went to Nova Lima to buy specimens from the miners. This resulted in accidents in the mine when miners became too anxious to collect specimens and took unnecessary risks; it also interfered with mine production. The mine management forbade collecting and selling specimens from 1970 on; but miners always find a way, especially if specimens are not too large, and that is why some very fine new material continues to appear on the market.

The mineral assemblage and geologic environment at Morro Velho is very similar to that at Panasqueira, Portugal, the main differences in mineralogy being due to the fact that Panasqueira is rich in tungsten, tin, and phosphorous, whereas Morro Velho is richer in iron with tungsten and phosphorous low and tin absent. Genetically both deposits are prime examples of high temperature, deep seated mineral deposition of the hypothermal type. The enclosing rocks are similar, and the greater productivity of specimens at Panasqueira is due largely to the greater mining rate, and to the fact that the individual orebodies are small and scattered so that tight supervision is a more difficult problem.

Fig. 8. **Ullmanite on dolomite, with siderite and pyrrhotite. Largest ullmanite is 3 mm in diameter. Gaines specimen, *photo by Julis Weber.***

BALTIMORE MINERAL SOCIETY MAKES DONATION

The *Mineralogical Record* was the grateful recipient of a generous donation made by the Baltimore Mineral Society following their Micromount Symposium in September 1973. The statement that appeared in the Societie's Newsletter follows:

"At the last regular meeting of our society, it was decided that in lieu of personal honoraria for the four speakers at the Seventeenth Annual Micromount Symposium it would be appropriate for the Baltimore Mineral Society to donate one hundred and fifty dollars ($150.00) to the *Mineralogical Record* in appreciation of the lectures which were given by Dr. Joel E. Arem, Mr. Paul E. Desautels, Mr. Wayne C. Leicht, and Mr. Lou Perloff. In this way, all of us, i.e., the lecturers, the participants in the symposium, and every member, past and present, of our society will share in the support of a worthwhile periodical publication of significant educational value that is of benefit to thousands of interested persons throughout the world."

'GEMS', A JOURNAL IN BRITAIN

GEMS, The British lapidary magazine, is the English equivalent of the *Lapidary Journal, Gems and Minerals* and other American periodicals which cater for the amateur lapidary and mineralogist. Now in its fifth year, it is approaching a circulation of 8,000, and, as the only journal of its kind in Britian, is read by the great majority of people interested in any aspect of the subject.

Mineral collecting was a passion in Victorian England. There are many fine private collections dating from those days, some of which—like that of the Duke of Northumberland's in 1970—have come under the hammer at Sotheby's.

The public collections in the Geological and Natural History Museums in South Kensington are without parallel in the world, and there are many fine regional collections also.

During the first half of this century, however, mineral collecting suffered an eclipse. It did not really revive till after the War, when interest began to spread across the Atlantic from the United States. Now it is rapidly growing and the number of mineral and lapidary clubs has risen in the four years from less than a dozen to over 50.

There is great interest in finding good cutting materials but fine mineral specimens are not neglected. Three dealers who cater specially for this field are Dr. Gordon Harker of Lythe Minerals, Leicester (British specimens). Mr. John Weller of Truro (Cornish specimens) and Mr. Brian Lloyd, London (world specimens).

Britian is not of course especially rich in fine mineral specimens, and many of the best locations have been worked over so much that little is left. On the other hand, the recent increase in commerial mining, especially Cornish tin mining, has brought new material to the surface.

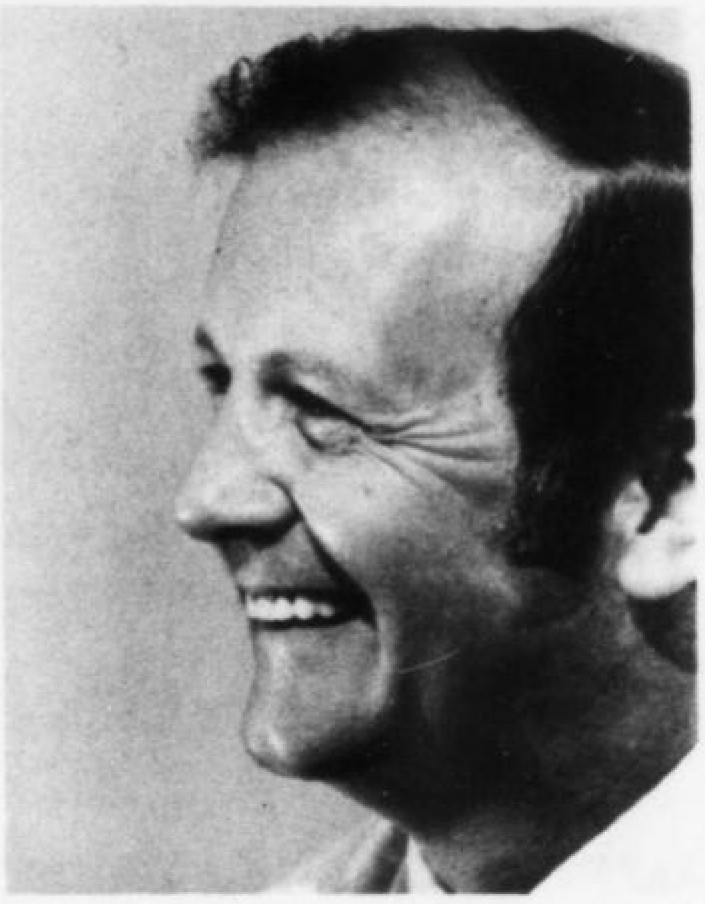
World demand for British specimens, especially calcite from Cumberland is increasing. The Blue John mines at Castleton, only source of this material, are of course world famous. Cornwall is now producing excellent cassiterite and other tin specimens and an interesting marble, with little landscaped pictures like Montana Agates, has been found in Skye.

Each issue of *GEMS* includes material on mineral locations, and a special summer issue each year is devoted to this subject. The June issue in 1973 dealt in some depth with collecting minerals in Western Europe.

GEMS is available direct from the publishers at 84 High Street, Broadstairs, Kent at 5 dollars for eight issues (airmail $11.65). The firm also publishes a little book called *Finding Britain's Gems* at $1.00 and a map called *Gemstone Sites of the British Isles* listing over 200 locations at $1.30.

The Museum Record

by Paul E. Desautels



Mike Ridding has sent along a copy of an editorial entitled "The Culture of Chefs-d'oeuvre" which appeared in the *ICOM News*. ICOM is the International Commission on Museums. Normally, this publication contains little of interest to either the mineral collector or curator. However the author of the editorial directed it at museums in general and the contents made me so irate that I was immediately thrown on the defensive and goaded into writing this column. Later, more sober thought and more careful reading suggests that the editorial was written "tongue-in-cheek" and the author doesn't seriously mean what he says. Not taking any chances, I feel obliged to jump into the fray and attack the general ideas.

The editorial is written in the form of a statement of principle followed by two corollaries and then a discussion. In my mind the first principle is erroneous and therefore the whole discussion falls apart.

"PRINCIPLE: The Museum is a building in which are exhibited objects of exceptional value, chosen for their rarity and beauty.

COROLLARY I. The criteria for the choice of objects to be acquired and exhibited are: the value of the object expressed in dollars, and the personal preferences of the curator.

COROLLARY II. The museum value of an object is directly proportionate to its dollar value."

I don't want to get bogged down at this point in searching out a definition of what a Museum is. I'd just like to meet that stated Principle head-on in its own terms. It is true that many private mineral collectors adhere to the philosophy that a mineral specimen is no good and not worthy of owning or displaying unless it is expensive. Thus they equate collection value of a specimen with dollars. And yet, I don't know of a single mineral museum of any account in the world that even considers the cost of a specimen any criterion at all for its acquisition except that if it costs too much it can't be purchased. Perhaps this is only because no mineral museum has any money to speak of. I prefer to think that there are other reasons why curators do not value their specimens in dollars. From what I have seen also, the personal preferences of the curator play some part in specimen selection but with maturity and experience his preferences are increasingly suppressed. With an experienced curator selections are almost always based on what is needed to remedy deficiencies in the collection. Experience is required not only to know the collection itself but to recognize the deficiencies and to be alert to appropriate specimens when they appear.

The trouble with the stated Principle is perhaps twofold. First there is a problem with the word "value". Specimens have values which may be totally unrelated to a market place price. In other columns I have written of the archival, educational, illustrative, documentary, research, and numerous and sundry other values of specimens. Sometimes these values are determinants for prices in the current market but most often they are not. Private collectors have established their own set of criteria for specimen prices but these collectors also generally have a different set of objectives from the museums. Thus, a curator frequently finds no competition in acquiring specimens he needs for some purpose and thus no escalation in prices brought about by competition. Of course, when he is shopping for the same specimens as collectors and for the same purposes he had better be prepared for hot, price-inflating competition.

The other problem with the stated Principle is that it has the objects "chosen for their rarity and beauty". All I can say is that any mineral museum limiting its choice of exhibits under these criteria is mineralogically bankrupt. Beauty and rarity are desirable criteria and, of course, any exhibit made of ugly and common blobs of rock is destined for disaster. Mineralogy, however, is an enormous lot more than just beauty and rarity. I always get a little ill when some trophy-winner collector urges me to get rid of that junk in the display. We should apparently exhibit only those specimens which agree with the hallucinatory point system under the famous "Uniform Rules"—so many points for quality, so many points for rarity, so many for labeling and none for mineralogy. A mineral museum cannot do this or else it is abandoning mineralogy for art. Fortunately, I haven't seen any major mineral museum doing it.

To be absolutely fair, I must admit that the editorial under discussion does address most of its comments to art museums where the situation is somewhat different. However, rising specimen prices and the pressures of private collectors and their organizations could eventually force the mineral museums into a position where curator and private collector are competing for the same specimens for the same purposes. Then, as the editorial says, "the curator of a major museum is a private collector disposing of public funds, disposing also of discretionary powers, an arbitrator of taste, imposing his preferences on an ignorant public" - - - "the museum represents nothing but the total purchase price of the objects it encloses." Is it possible that already we can see some private mineral collections that represent nothing but the total purchase price of the specimens?

What I am trying to point out as clearly as I can, making use of the ICOM editorial, is that mineral museums differ from art museums. Private mineral collectors and mineral museums are not the same thing either. In today's world of specimen mineralogy they have different objectives. Neither should ever lose sight of the fact.

SHUTTERBUGS TAKE NOTE!

The *Mineralogical Record* will sponsor another contest in conjunction with the Tucson Show. Anyone (except professional photographers) may enter two 35 mm color transparencies and compete for the $25 cash prize and the pleasure of seeing his photograph used on the cover of a future issue of the *Record.* Last year's winner, by Joel Arem, is on the cover of this issue.

HOW TO ENTER – mail your two transparencies, carefully packed and adequately identified, to: Richard A. Bideaux, 1242 W. Pelaar, Tucson, Arizona 85705. Please include return postage. Do not fail to label the slides with the mineral names and localities.

The Society welcomes as members individuals who are interested in mineralogy, crystallography, petrology, or related sciences. Membership applications can be obtained from the business office at the address below. Membership is for the calendar year, and the annual dues are $20 for all except students, who pay only $6. All members receive two journals, **The American Mineralogist,** and **Geotimes,** and are also entitled to a reduced rate for subscription to **Mineralogical Abstracts. The American Mineralogist** is a bimonthly, technical publication of the Society and emphasizes the latest scientific aspects of modern mineralogy, crystallography, and petrology. **Geotimes** is the monthly news magazine for earth sciences published by the American Geological Institute. A price list for other publications of the Society may be obtained from the business office.

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What's New in Minerals?

PALERMO, NEW HAMPSHIRE

A note of interest from Paul B. Moore, University of Chicago ...

It is always a great joy when serious collectors and investigators of minerals witness a reopening of some classic locality and the possibility of uncovering fresh specimens of unusual species and associations. What better locality could there be than the Palermo No. 1 pegmatite near North Groton, New Hampshire, a past source of a practically unrivalled array of peculiar species, especially the phosphates! Mr. Peter Samuelson of Warren, New Hampshire, a diligent and devoted collector of pegmatite gem minerals, is operating the pegmatite, not just for scrap mica and feldspar, but for specimens.

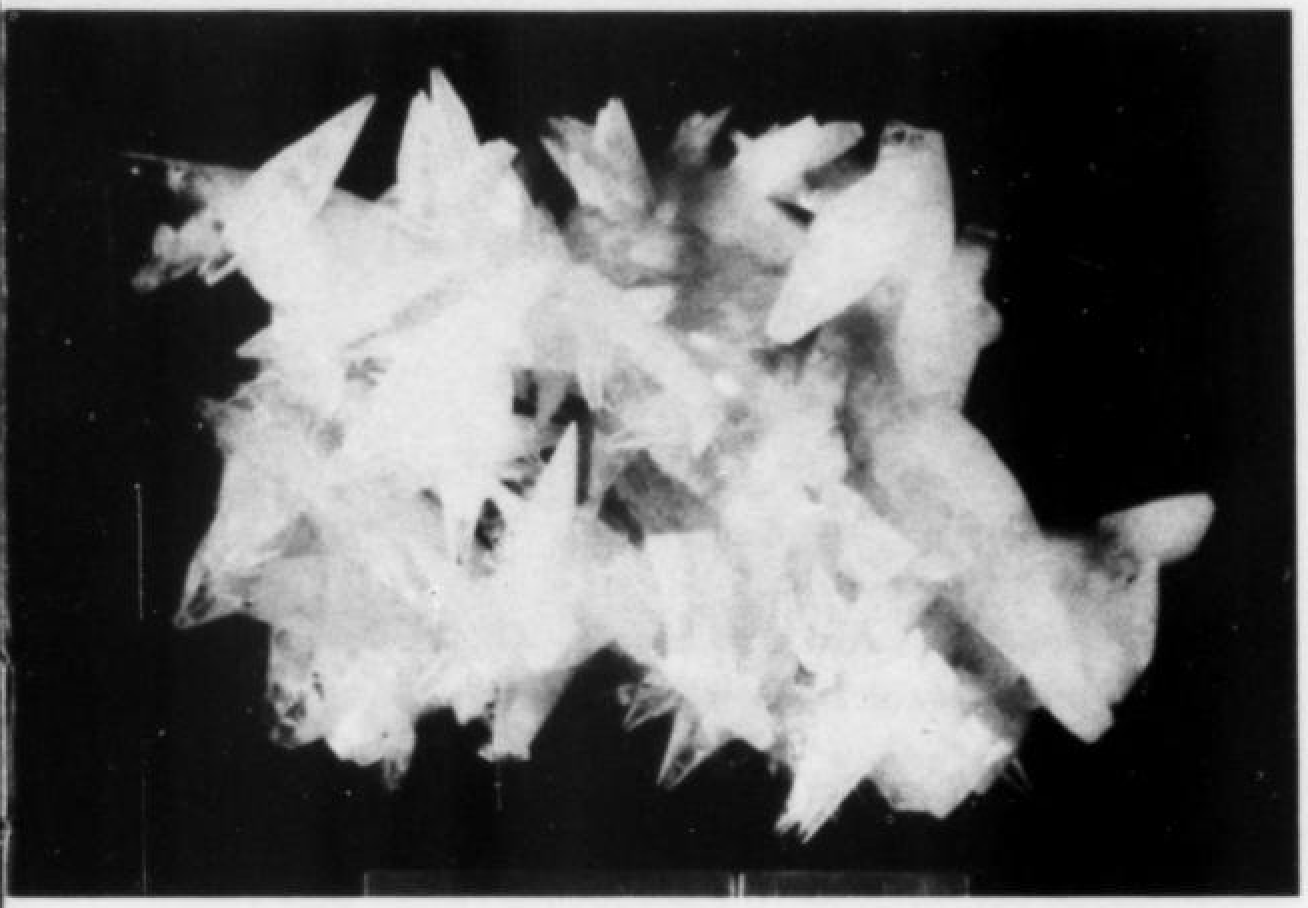
On June 23, my colleague Dr. V. L. Goedken and I visited this magnificent pegmatite and were pleased to discover that Mr. Samuelson had just exposed a triphylite pod two days earlier by a well-placed blast. Palermo triphylites have attained enormous dimensions, up to twenty feet in length and the portions of these giant crystals which lie close to the core have often suffered retrograde metasomatic exchange reactions. Unlike the Black Hills pegmatites, where such reactions involve Na-metasomatism and the formation of alluaudites, the Palermo materials are extensively robbed of phosphate anions, with the formation of carbonates, particularly siderite and rhodochrosite. Ca-metasomatism led to the formation of whitlockite in some instances.

We noted a great abundance of whitlockite, ca. *$Ca_8Mg[PO_4]_6$ and siderite. The whitlockite is greasy white in color and contains vuggy cavities in which are implanted crystals of the same: carbonate-apatite, occurring as white hexagonal prisms; and colorless quartz. Most interesting was the unusual abundance of erstwhile rare species, which occur in druses upon the carbonate apatite, quartz and whitlockite. Crystals of these range from 0.1 to 1.0 mm and provide excellent micromount material. Childrenite, $(Fe,Mn)^{2+}Al(H_2O)(OH)_2[PO_4]$, occurs as brown to tan sprays and individual elongate prisms with fine pyramidal terminations. Palermoite, $SrLi_2Al_4(OH)_4[PO_4]_4$, is rather abundant as individual and grouped aggregates of colorless striated prisms with a rectangular cross-section. Occasional terminations lead to a chisel-shaped appearance. The most pleasant surprise was the rather frequent occurrence of the new species bjarebyite, $Ba(Mn,Fe)_2^{2+}Al_2(OH)_3[PO_4]_3$, appearing as dull bluish-green fibrous to granular masses which, upon closer examination, prove to be etched complex crystals in parallel growth. Bjarebyite was named in honor of the late Mr. Gunnar Bjareby of Boston, a specialist in the Palermo paragenesis. It occurs upon the whitlockite, usually in close association with palermoite. In the siderite-rich portion of the pod, cavities reveal fine small crystals of strunzite, laueite, beraunite (rich green needles), stewartite, metastrengite, jahnsite, hureaulite, vivianite, messelite, xanthoxenite (of Frondel) and rockbridgeite. In addition, at least six unknown species await further study. A good opportunity to find species new to science is always possible at Palermo, particularly in the palermoite-bjarebyite paragenesis. Finally, I remark that a wall was exposed which contains small crystals of uranyl phosphates, derived from primary uraninite. All of these will require further study.*

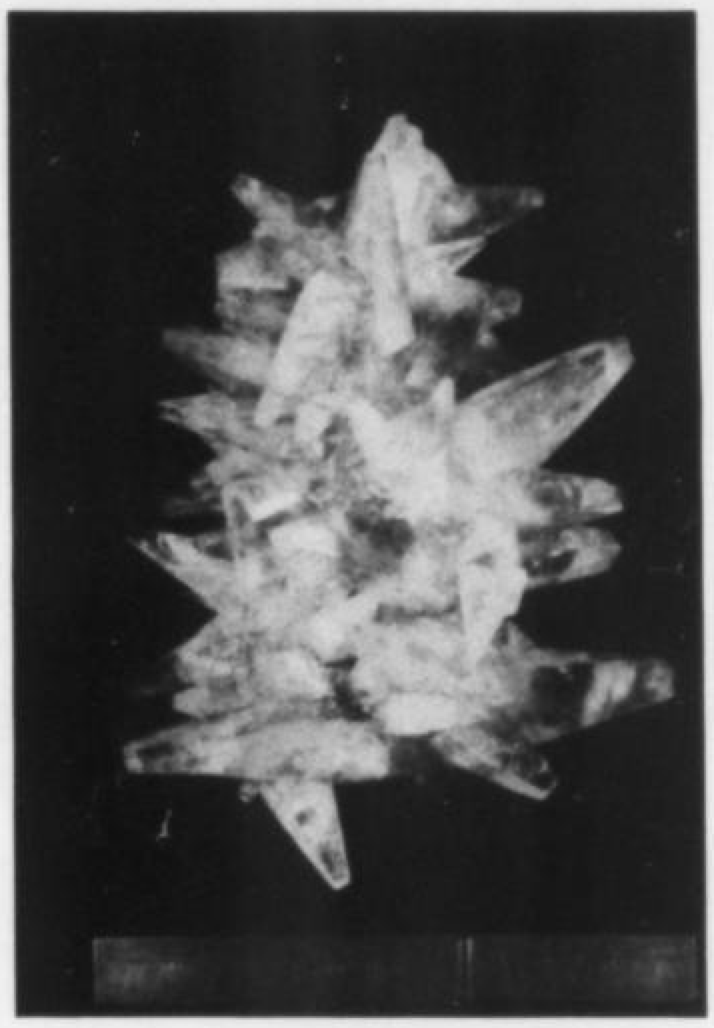
Mr. Samuelson plans to continue removal of the phosphates which are concentrated as a ring around the quartz core and certainly many magnificent micromounts shall continue to be uncovered. Collecting is permitted on Friday, Saturday and Sunday and the daily fee is $4.00 per person. This is very generous when the availability of good micromounts and the freshness of specimens are kept in mind. Mr. Samuelson renders a valuable service to professional and amateur scientists alike and we should give him every encouragement.

PREHNITE – QUEBEC

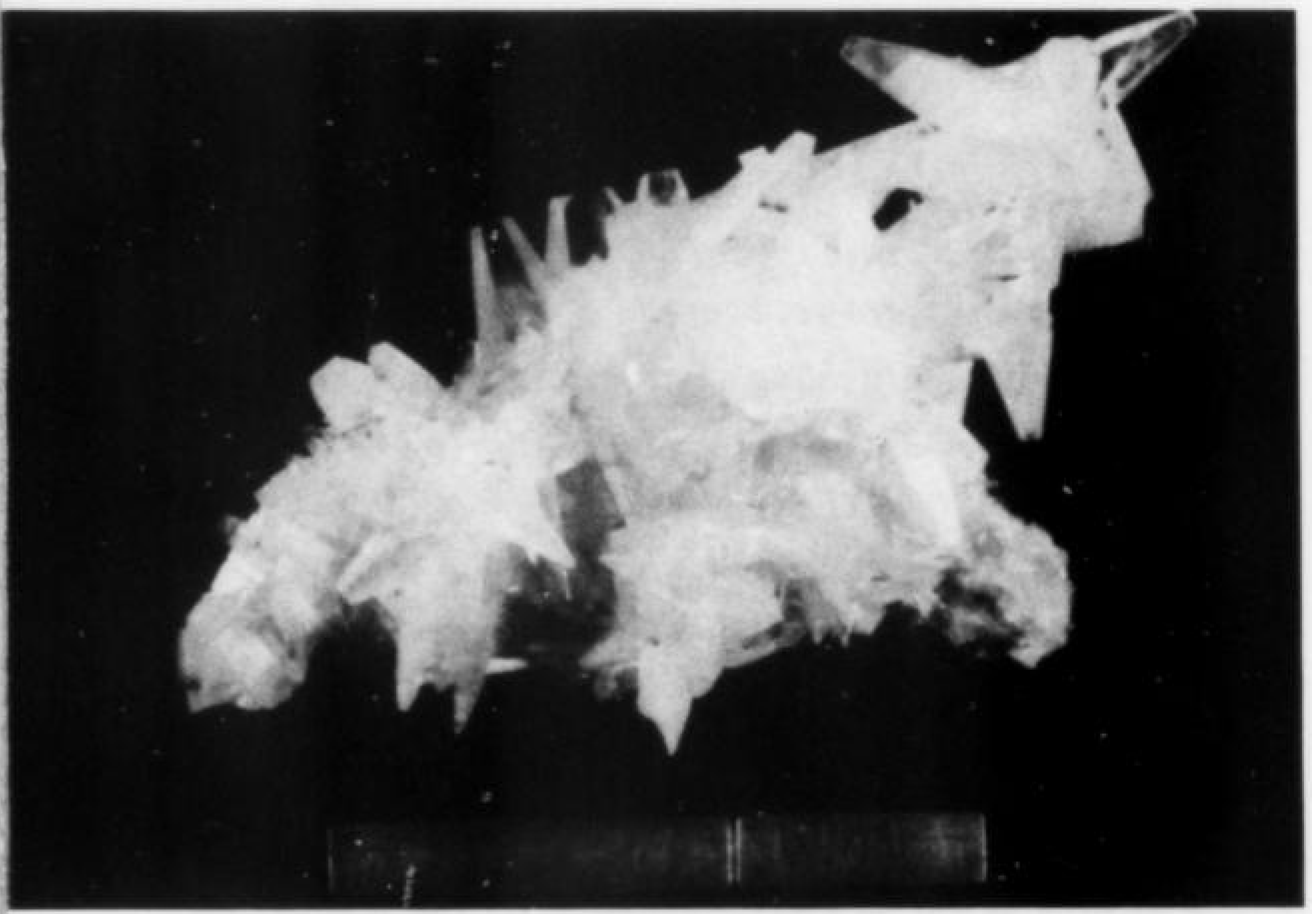
Prehnite has been recognized as a mineral species for almost 200 years, and has been found at numerous localities. It is generally dark to pale green in color, and crystals are usually intergrown and indistinct, or in simple groups of subparallel platy crystals. Recently, at the Jeffery asbestos mine, at Asbestos, Quebec, in a zoned albitite, a remarkable new discovery of prehnite crystals was made. Although prehnite has been found at this locality for many years, the new specimens are unique because of their size, sharpness, and the fact that they are true single crystals. The crystals are very sharp, steep, four-sided bipyramids and are white translucent to colorless. They range in size to 1-1/2 inches, but most are smaller, in the 1/4 to 1/2 inch category. These were found in association with amber colored needlelike crystals of diopside in which some of the best single crystals and small clusters were found to be "floating." The find was made in November of 1972 and involved only one pocket. Thus far, no other material of this



"Prehnite—Jeffery Mine, Asbestos, Quebec, Canada (actual size)."



"Prehnite—Jeffery Mine, Asbestos, Quebec, Canada (actual size)."



"Prehnite—Jeffery Mine, Asbestos, Quebec, Canada (actual size)."

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type has been found. About 300 thumbnail, 60 miniature and 20 cabinet sized specimens of note were recovered. One exceptional specimen consists of a slender bipyramid about 1-1/2 inches long by about 1/4 inch in diameter with a few other minor crystals attached. This is perhaps the best prehnite ever found.

OKENITE FROM INDIA

Recently, in a large shipment of zeolite mineral specimens to a mineral dealer in the U. S., a number of fine okenite specimens have come to light. The locality is thought to be a quarry near Bombay rather than the often mentioned "Poona" locality. The species is found as white puffballs of extremely delicate hairlike crystals. These puffballs measure to 1-1/2 inches on and off matrix and as isolated, as well as intergrown, spherical tufts. They were commonly seen growing on pale intergrown spheres of gyrolite and drusy quartz (more rarely a dirty amethyst). On some specimens the okenite appears to be growing directly on laumontite. A few laumontite prisms to two inches were coated with copious loose hairy mats of okenite. On other specimens, glassy white apophyllite crystals and spherical balls of stilbite to one inch were associated

"Okenite—Bombay, India"

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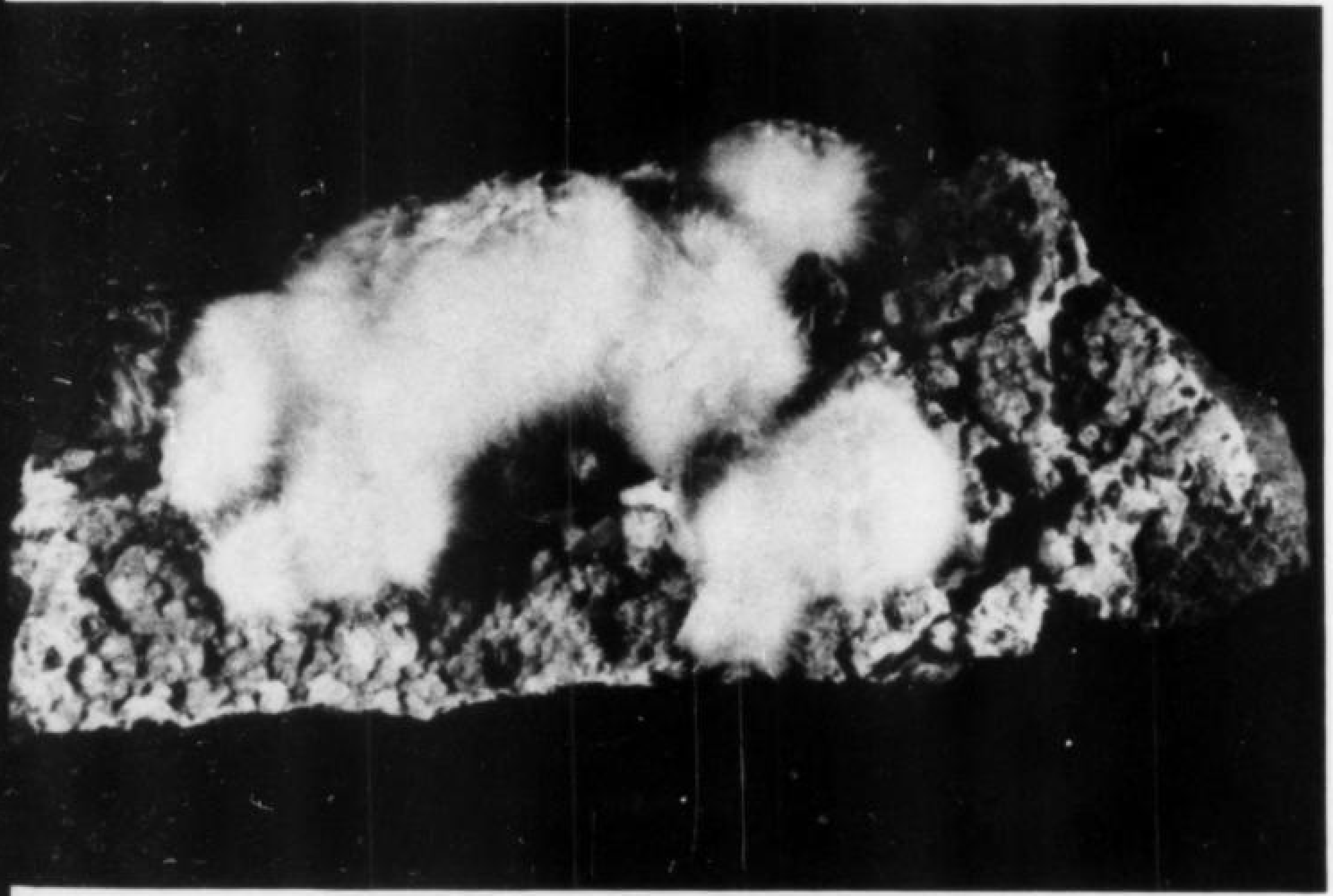


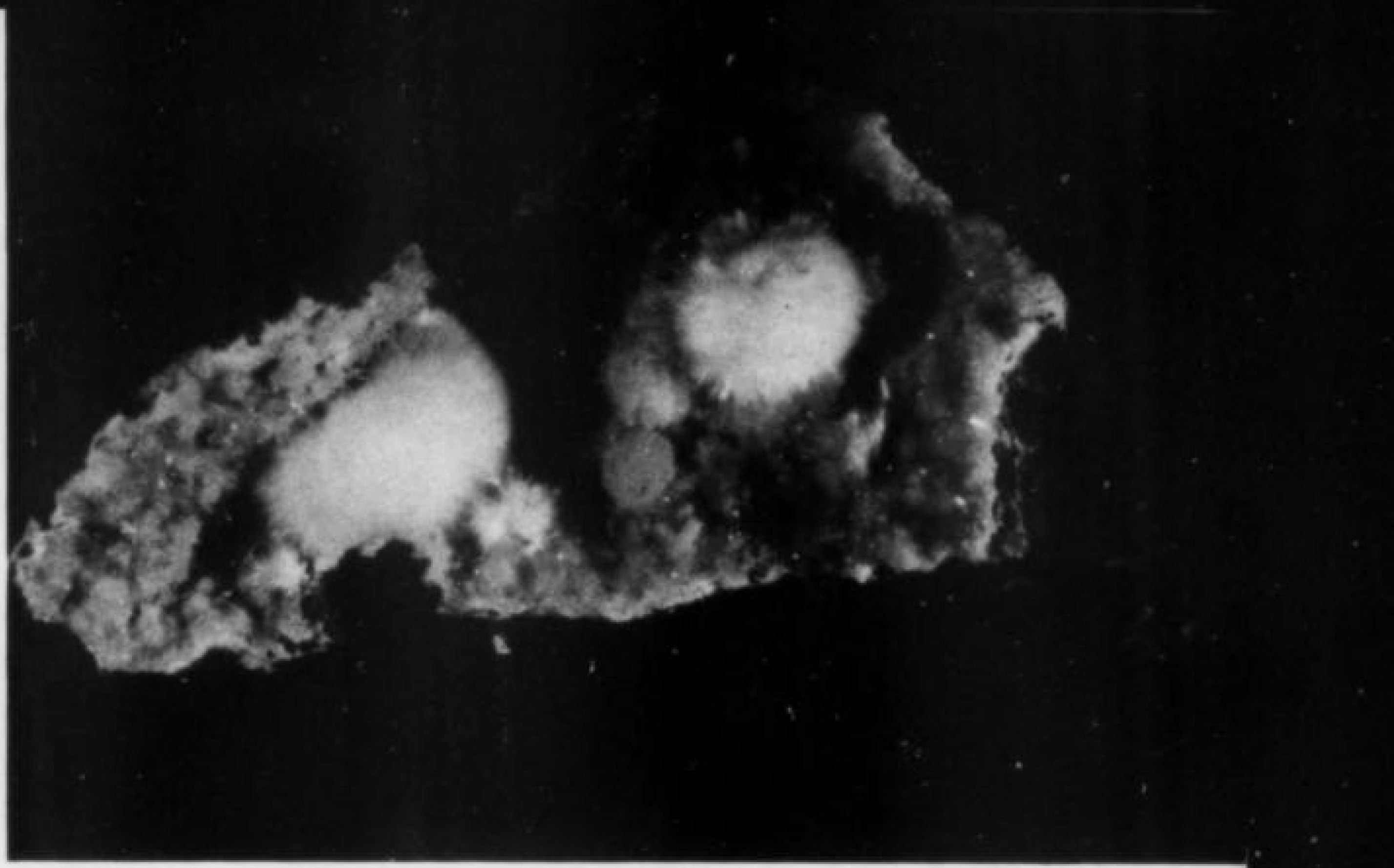
"Okenite—Bombay, India"

with okenite. The individual crystals of okenite are so thin that in most cases a cross section is not distinct even under 400x magnification. Because of the extreme thinness of the crystals the puffballs may be "petted" (with care) without damaging them. The crystals just bend and then spring back into place once the finger has passed over. One remarkable specimen measured 8 x 9 inches with a shallow vug covering most of its surface, lined with intergrown tufts and knobs of okenite.

NEWS FROM NEW JERSEY

The following note was received from Joe Rothstein, New York City ...

For the last two months there has been a flurry of activity in zeolite collecting where some blasting has taken place on new Route 278 and Shunpike Road, in Summit, New Jersey, adjacent to the Houdaille quarry. Anything in your collection labelled Summit comes from this spot. Grading has just about finished the collecting, but for a while it was interesting. The spot is about a quarter mile north of where the last blasting occurred several years ago for the initial stages of Interstate 278 and where the greenockite on prehnite was found.



"Okenite—Bombay, India"

For historical purposes here's what came out this time. Brown stilbite and heulandite by the bucketfull while it lasted. Never saw so many tiny gas pockets filled with heulandite before from this area. Occurred in a dark green to light green weathered basalt which made digging easy. Some orange stilbite came out on calcite too. The part-time dealers loaded up on the heulandite and it should be fanning out soon. The same stilbite-heulandite combination came out on massive thomsonite matrix. The American Museum has my best specimen. Not too many museum quality specimens were recovered.

As for the rest, smidgeons of everything: poor prehnite, same for datolite, amygdules of quartz, little chalcedony, pumpellyite, calcite, chrysocolla in specks, the same for chalcopyrite and malachite.

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Yedlin on Micromounting

The annual two day meeting of the Capital Mineral Club of Concord, New Hampshire, held again at Sunapee State Park on August 18th and 19th, was notable for the fact that a new micromount group, an offshoot of the Capital Club, set up shop at one end of the exchange area, (the whole second floor of the winter ski lodge) exhibited, exchanged micromount material, and gave away some notable specimens.

The arrangements at this mineral festival were excellent. The lodge was two floors. The first was devoted to dealers and their sales; the upper area to exchanges. (The New York Stock Exchange might have observed the operation and profited.) Notable among those in the "swaps" area were Peg Marble (material from St. Hilaire, the southeastern states), Jenny and Lee Areson (Franklin, New Jersey and world wide), Ralph Areson (domestic and foreign minerals), Bob Lambert (assorted minerals recently brought from Europe), the Capital Mineral Club micro section (Palermo, St. Hilaire and other New England areas), Les Zakarin (minerals and books) and David B. Hardman, of Leicester, England (mendipite and brewsterite from Scotland, and pyromorphite in long green needle crystals from Wales). Exchangers set up shop, did their "thing", and left. A constant turnover, so that we were not able to list everyone attending this phase of the meeting.

We were most interested in some new Palermo mine material. We spoke at length with Bob Whitmore, Route 2, Weare, New Hampshire 03281, and visited him the day following the show. Bob's been visiting Palermo regularly and the result of his labors includes palermoite in minute loose crystals and on quartz matrix; bjarebyite in complex, minute, green crystals, monoclinic; (See the *Mineralogical Record,* Vol. 4/No. 3.) whitlockite; goyazite; laueite; apatite; green needles of beraunite; strengite; rockbridgeite; and much else. Bob has available a great many palermoites, loose crystals, minute, clear and terminated. If you have none of this mineral, or but a few, now's the time to get them.

Palermo's been leased, and the operation until now has been for the blue scorzalite (Not lapis, which is a lighter blue.) and beryl, with the "gunky" phosphate material cast aside. "Gunky" at first glance but the 'scope at about 24 power brings forth an astounding array. Dr. Paul Moore's fine article in the *Record*, cited above, describes all of these minerals. (And if you seek Christmas gifts for a deserving friend, why a subscription to the *Record* is inevitable. Get the whole year, for what was news mineralogically in January is still news to-day. And it will include the May—June issue, which is about all pegmatite phosphates.)

The lessee at Palermo charges a fee for collecting, and what with inflation, stage IV, the shortage of beef and the conditions of the times this fee is four dollars per day per person. If you're a micromounter the fees's well spent.

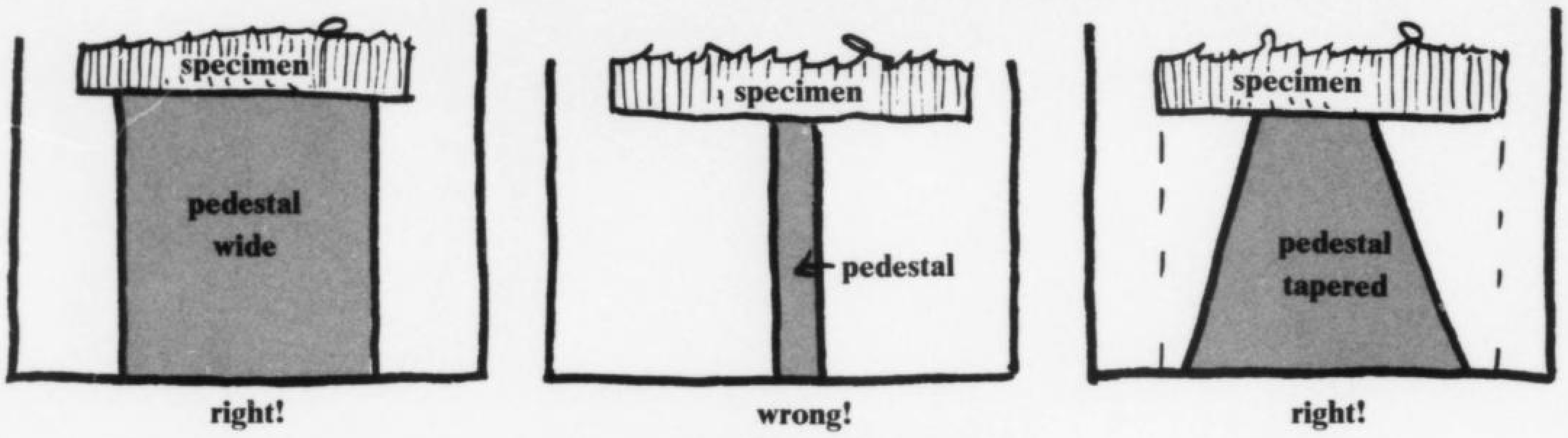
We received through the mail four completed micromounts, and three of the four had broken loose at the point where the pedestal was cemented to the plastic box. This is not unusual where the box has been painted black with dull enamel, and then the pedestal cemented to this surface. The paint comes loose, sticks to the wood or cork, and often the specimen takes a beating and is ruined.

We examined the four mounts carefully and discovered that the unbroken one was considerable larger at the base than the others. Hence it had more contact and less vibration than the others.

Micromounters like to make things as small as possible to assure that no cementing material is visible when the specimen is observed. The tendency, then, is to have everything small, including a narrow upright, and this is a contributing cause of breakdown. The ratio of support to the size of the mineral should not be such as to cause such instability. Fine for single crystals and other minuti, but for normal matrix specimens covering perhaps one quarter or more of the area of the enclosing container a different approach is disireable. The sketches outline the procedure.

After the Eastern Federation and American Federation meeting at Charlotte, North Carolina, we visited our old friend Louis Perloff, and spent five days at his apartment in Tryon. Beautiful, spacious, secluded, with one of the two bedrooms converted to a mineral laboratory, we reviewed old acquisitions and visually determined identities of unknowns by logic, eliminations, recognitions and instinct, using, as tools, the 'scope, Dana and Strunz, a needle, and a wry, squinting look at the walls and ceiling of the room, eventually saying: "It can't be that; it just has to be...", and surprisingly getting things right, as subsequent checking proved.

On Monday Betty Williams, columnist for *Rocks and Minerals* magazine drove over from Asheville and we sat around a hot microscope reviewing our findings. A couple of days later Miles Hudson and Carter Hudgins came by,



A TECHNIQUE FOR MOUNTING

with 'scopes and specimens, so that among the four of us there were three instruments, and the fourth man going to the books for verification. The discussions centered on the Foote Quarry at Kings Mountain, and the newer Lithium Corporation of America's working nearby. We looked at the following: apatite, bavenite, bertrandite, brannockite, eakerite, pyrite, switzerite, fairfieldite-collinsite, and tourmaline. Hudson had babingtonite and xenotime duplicates, from North Carolina, and we were the lucky recipient. These were fine sessions. We regetted having to return to Connecticut.

A letter from Herb Corbett, of Baltimore. "Dear Neal: A specimen of cubic magnetite herewith from Partridge Island, Nova Scotia. Please excuse the minute sample as I must dole out my meagre supply. Paul Desautels (National Museum of Natural History) collected the cubic crystal form of magnetite near the Gem mine, (one mile, approximately) San Benito County, California, in 1967, and gave the specimens to members of the Baltimore Mineral Society. At the time he said that as far as he knew this was the only locality on this side of the Atlantic Ocean. In 1970 I collected the cubic magnetite on Partridge Island. Its identity was confirmed at the Smithsonian. In 1972 Mel Watson, of the Ottawa Club, supplied matrix specimens from a road cut at Shawville, Quebec, about 25 miles from Ottawa. Verification from the Canadian Museum. This makes three localities for this rare habit of magnetite in the short span of six years. How about that?" (Ed. note: How about that indeed! Where would this mineral science be without the able assist of the micromounter?)

In early 1971 two visitors from Australia attended the Pacific Micromount meetings at Santa Monica, California, and the convention at Tucson, Arizona. They visited many collections of minerals, stayed for a time with Mike and Eileen Kokonos, studied museums and their collections throughout the United States, and left behind them a trail of fine Australian specimens.

Albert and Dorie Chapman have, perhaps, the best collection of minerals in Australia, rich in specimens from Dundas, Broken Hill, Northern Territory, Queensland, and elsewhere. A short time ago a package arrived from them, and it proved to contain fine micro crocoite, pyromorphite and gibbsite from Dundas: pyrargyrite, siderite, cerargyrite and cerussite from Broken Hill, New South Wales; radioactives from Northern Territory; scholzite from Flinders, South Australia; and others.

The Chapmans are not micromount collectors, but have the good judgment and good taste to preserve minute things that come to them with other acquisitions. They will, perhaps, attend the same meetings in 1974 as they did previously, with, perhaps a supply of macro and micro material. Lie in wait for them.

We had not known about the pyromorphite-crocoite combination from Dundas. We do have such specimens from Beresov, Urals, with sometimes vauquelinite, though not all three together; usually the crocoite with either of the green minerals, but not the pyromorphite and vauquelinite together. Whether this is an invariable condition we cannot tell. It may be that it is a situation existing only in our own collection. We'd like some information in the matter.

At this point we'd like to digress and editorialize a bit anent a lack of judgment, conduct, good manners - call it what you will. The New York Mineralogical Club has never had difficulty in obtaining speakers and lecturers. A procedure that has been followed has been to make three or four contacts with the proposed guest, the last of which is a letter immediately after his talk, from the club president, thanking the speaker for his efforts. Financial arrangements can be consummated at this time if they have not already been done.

We've given perhaps 100 talks to various groups in the last decade, and about half the time have not received that last letter. It is evident that good manners is not the norm in these cases. When the guest had delivered his message to the club the members were no longer interested in him, and as a result the converse became true.

The New Jersey Mineralogical Society does the ultimate. It has as guests, at its annual banquet in December, all those who have been speakers at its meetings during the preceding year. A gracious thing, and truly commendable.

One other thing. Please advise the sender of minerals, books, - anything, that you've received them. It is most embarrassing for him to inquire about the stuff. He does not want to be considered eager or overly zealous. Yet if it has not been received he must set in motion action to trace the material or claim insurance. So invest in a stamp and say in effect:"Package received. Thank you." Anything else you add is frosting on the cake.

Neal Yedlin
129 Englewood Drive
New Haven, Connecticut 06515

GEO—VENTURE '73

GEO-VENTURE '73 was the second show of the Central Canadian Federation of Mineralogical Societies, hosted this year at Brock University, St. Catharines, Ontario, Canada, by the Niagara Peninsula Geological Society. The show occupied 40,000 square feet of the newly opened Geology Building at the University. The building itself was a fantastic asset to the show as it is very attractively decorated with huge walls of glass looking out over the countryside and a magnificent dining room done in red carpeting.

The ground floor lobby was occupied by a dozen club exhibits from various parts of Ontario. The remainder of this floor consisted of a registration and information area, a swap area and two theatres, one devoted to a series of seven speakers and the other to a continuous program of films. The second level had two lounges occupied by twelve dealers and two large rooms containing forty-three competitive exhibits. The remainder of this level consisted of a group of five seminar rooms containing noncompetitive exhibits and a large comfortable lounge for visiting and resting. The upper level was devoted to special exhibits, by invitation of the host society and contained exhibits from such institutions as the Royal Ontario Museum and the National Museum of Canada. There were fine exhibits and demonstration of stone carving by Marg Clark, Sandy Cline and Wilson Grau; the superb fossil exhibit of Paul and Hedy Hobberlin and a demonstration of sphere making by W. S. Hutchines of Memphis, Tennessee. In addition were many fine exhibits of minerals and lapidary and a room devoted to micromounters.

The annual general meeting of the Central Canadian Federation of Mineralogical Societies also took place at the show and three new clubs were admitted to membership. Election of officers were held and Denis Thorn resigned his position to the incoming president Reg Fisher.

The host society and the staff of GEO-VENTURE '73 wish to thank all who participated to make this occasion the success that it was.

Friends of Mineralogy, continued from page 206

skill and planning of the exhibitor bringing about a balance which will appeal to and challenge the viewer.

CRITERIA FOR JUDGING

1. PRESENTATION (40 points)
   - A. Is a single theme identified?
   - B. Is it presented clearly and logically to a conclusion?
   - C. Is the sequence of presentation easily followed and is it instructive?
   - D. Does the display have sufficient impact to catch the eye and hold even a casual viewer?
2. ORGANIZATION AND CREATIVE EFFORT (30 points)
   - A. Is the display neat and attractive?
   - B. Is the display artistic, well thought out, and well executed? (Consider lighting, cloth, labels, etc.)
   - C. Is effective use made of visual aids such as: photos, graphs, maps, drawings, etc.?
3. ACCURACY AND MESSAGE (30 points)
   - A. Is the presentation accurate?
   - B. Is the level of presentation appropriate to instruct the lay audience, not too superficial or too complex?
   - C. Is the point clear and understandable, being accurately supported by materials of the display?

These criteria are developed so that a judge may follow the questions step by step as he views the display. The same questions serve the competitor, or in preparing his display. Knowing just what questions the judges will have in mind as they work should be a considerable aid to the competitor. These same questions lend some consistency to judging of educational displays regardless of who judges or where the show is held.

RULES:

1. Individuals, families, or groups are eligible to enter.
2. Cases provided by TGMS are to be used unless special permission is requested and granted by the Entries Chairman for use of personally owned cases. TGMS cases are 46 1/2" wide x 20 5/8" deep x 21 3/4" inside height. One or two of these cases may be used. Diagrams of the TGMS cases will be provided with acknowledgement of the entry. If exhibitor wishes to provide own case, full information of dimenisions, electrical requirements, and appearance of case must be provided on entry form.
3. All entries must be received by Jan. 1, 1974.
4. Entries may be placed beginning Thursday, Feb. 7th, from 1:00 PM until 10:00 PM, or by special arrangement and consent of Entries Chairman, before 9:00 AM on Friday, Feb. 8th.
5. Exhibits may not be removed before 6:00 PM, Sunday, Feb. 10th, and must be removed by 8:00 PM of that same date.
6. The Tucson Gem & Mineral Society, Inc., and the Show Committee are unable to assume any responsibility for loss or damage to exhibitor's property, materials, or specimens. Each exhibitor must provide his own insurance or assume his own risks. Locks are provided for each case and the Exhibition Hall will be under 24—hour armed guard surveillance throughout the show.

Mail entries to: Mrs. Mildred Schupp,
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Arizona 85713

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Copy entry form and mail to above address.

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Name ______________________ Phone ________

Address ____________________ Zip code ______

TITLE or THEME of Exhibit: ________________

Division: Adult ______ Junior ______ Please give age if junior

I will need ____ (1 or 2) of the TGMS cases described above

I prefer to use my own case/s because ____________

Outside dimensions of my case/s are: __________ " wide x __________ " deep x __________ " high

Electrical wattage required ________________

NOTE: All electrical equipment must comply with the Tucson code and meet rigid inspection.

Please sketch or describe case if using your own:

All news and material relating to FM, for Record publication, should be sent to Dr. Arthur Montgomery at: Dept. of Geology, Lafayette College, Easton, Penna. 18042.

Note on The Collector from Volume Four/Number Four

I regret having overlooked crediting Charles Baines for producing the fine photographs of the specimen labels in the last issue, page 193.

The Record Bookshelf

***Exploring Minerals and Crystals* by Robert I. Gait (Associate Curator, Mineralogy, Royal Ontario Museum), photographs by Arthur Williams, published by McGraw-Hill Ryerson Ltd., 119 pp., 38 color plates, hardcover, printed in Hong Kong (1972). ($7.95)**

In his preface, Robert I. Gait describes his latest book as an attempt "to answer the apparently simple, yet rather difficult question: What is a mineral?" The emphasis is on the kinds and arrangements of atoms in minerals, and their effects upon physical properties. The more complex areas of this topic, such as symmetry, x-ray methods, crystal classes, and instrumental and chemical testing are omitted, suggesting that the intended audience is in the 12-16 year-old range. Gait takes the trouble to carefully explain basic concepts so that readers starting from ground-zero in mineralogy can understand easily. Subjects covered include atoms and crystals, crystal systems, unit cells, twins, aggregates, pseudomorphs, crystal growth, physical properties and tests, mineral classification, and the relationship between crystal chemistry and physical properties. Silicate structures are discussed in some detail.

To illustrate topics in the text, 66 black and white photographs and 38 color plates have been included. With only a few exceptions, the color plates show attractive, well-crystallized specimens from the Royal Ontario Museum. Truly *exceptional* specimens are few, though, and include a gemmy, red Vermont grossular and an excellent zoisite (tanzanite). This lack of mineral masterpieces is not really a defect since the thrust of the book is toward education rather than pure entertainment or specimen documentation. Photographic and print quality is uniformly good. Plate size ranges from 2-1/2 x 3 inches to full-page size (8 x 11 inches), with most on the smaller side. There is a subject index and a list of 12 references to which readers are directed for more information.

The author devotes himself to an important aspect of beginning mineralogy and covers it well at the chosen level of technicality. Any greater detail or complexity would probably be lost on the newcomer. The style is rather dryly explanatory, without reference to interesting anecdotes or in-depth information, but reads easily. Data on physical, chemical, and crystallographic properties and terms are presented in orderly fashion.

The layout is attractive and striking. Usually one column of a page is devoted to text leaving the other column for diagrams and figures. Large blank areas, some black, some white, are used for dramatic effect, almost to excess. Color plates are segregated into two sections. Every plate is accompanied by species, locality and size data... a rarity these days.

The only obvious error in the text is the granting of mineral status to *lechatelierite* (sand fused by lightning). This clearly cannot be, since sand (melted or unmelted) has no specific composition, as any sand collector knows. I (and others) strongly disagree with Gait's assertion that natural glasses are minerals. Surely obsidian, a common natural glass, will never officially be considered a mineral by any stretch of the definition. And yet in the absence of any nationally or internationally accepted definition of *mineral,* it seems everyone is entitled to his own opinion. A comparatively minor correction is that Hassan (1972, *Min. Rec.* **3,** 5, 221) has recently proved amethystine purple to be due to iron rather than titanium and manganese as Gait states.

The careful explanations and the abundant, well-done illustrations and plates, which serve well to elucidate the text, make this book an excellent first exposure to crystal chemistry and physical properties. The potential audience will be people around 12 years and older with no previous exposure to mineralogy, chemistry or physics. I suspect *Exploring Minerals and Crystals* will receive wide distribution, mostly in the form of gifts, and deservedly so.

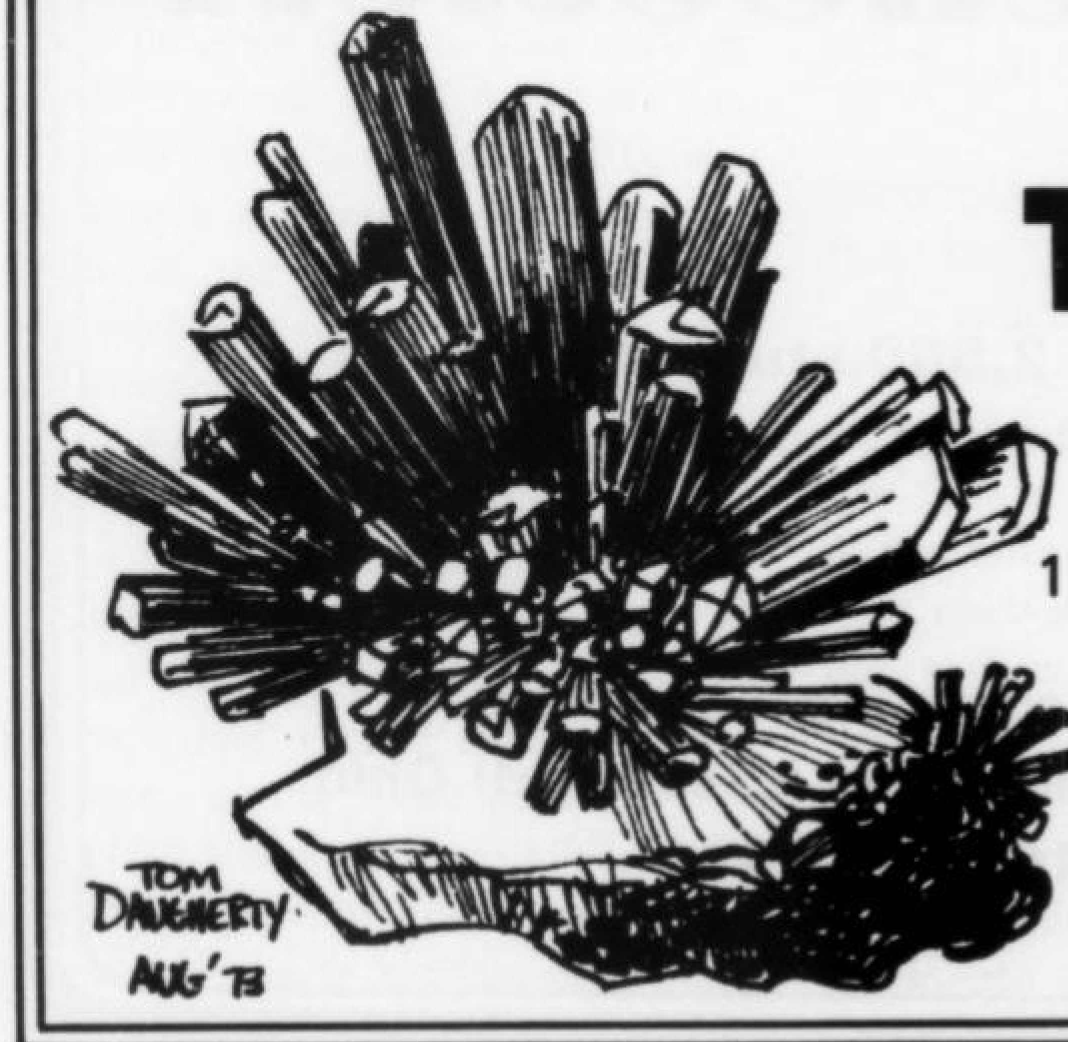
Wendell Wilson

***The American Mineralogical Journal*, ed. by Archibald Bruce, M.D., Vol. 1 —Facsimile of the 1814 edition. Hafner Pub. Co., New York, 1968, 272 pp. ($18.00).**

The American Mineralogical Journal was the first geological publication produced in the United States. Although its existence terminated after only four years, with the untimely death of its editor in 1818 (at the age of 41), it paved the way for another journal which was to gain considerable prominence. Benjamin Silliman, a close friend of Bruce, was entreated to take on the chore of continuing Bruce's work. He did so, and *Silliman's Journal* was eventually to evolve into the *American Journal of Science*.

This facsimile edition by Hafner makes it possible for contemporary geologists to get the flavor of science in the early days of U.S. geology and mineralogy. An extensive introduction by John C. Greene puts the *Journal* in historical perspective, with a lively account of the life, times and associations of Archibald Bruce. Those were the days when fine mineral cabinets were few and well known to all mineralogists, days when the medical doctor was the "general savant" expected to pursue all manner of investigations in natural science. Bruce's travels led to friendships with such men as the Count de Bournon (bournonite) in London, Heinrich Struve (struvite) in Lausanne, George Gibbs (gibbsite) of Rhode Island, George Brush (brushite) of Yale University and Benjamin Silliman (sillimanite) of New Haven. Bruce knew and corresponded with Abbe Hauy in Paris who, with his contemporaries Francois Gillet-Laumont (laumonite) and Andre Brochant (brochantite) brought out the *Journal des Mines*, a leading mineralogical publication.

The historical importance of Bruce's *Journal* is matched by the interesting table of contents and the delightful style of writing it contains. We find such articles as "Chilton's Description and analysis of Heavy Spar from New Jersey". "Mitchill on the Geology of Long Island", "Akerly on the Geology



and Mineralogy of the Island of New York" and many others. Gibbs reported a visit he made to a supposedly volcanic peak in Connecticut, and the West River Mountain. He writes:

This mountain having been announced in the American Geography and in the Annals of the American Academy, as volcanic, I had the curiosity to visit it. As the neighbourhood is granite, and the mountain itself craggy, my expectations were not very sanguine.

The "lava rock" reported from the locality turned out to be hematite.

This book is worth reading, not only because it is simply enjoyable, but because it is a rare insight into the state of American science in its infancy. Moreover, it provides a glimpse into the type of information drawn upon by such men as Dana in compiling the reference works of their time. One often wonders where, for example, Dana acquired his locality information, since many of these occurrences have long since been obscured. Here we find original articles, written by some of the foremost mineralogists in America of their time. An original copy of this rare edition would be difficult to procure, and somewhat expensive when found. This relatively inexpensive facsimile brings *The American Mineralogical Journal* into the range of any book budget.

Joel E. Arem

To the Editor

INTEREST IN "INTEREST SURVEY"

Dear Sir:

The article in Vol. 4, #1 *re* Interest Survey (Wilson) is of great interest also. We own a serious gem and mineral shop and will benefit by the survey report — if we have enough sense to take advantage of the information in relation to our business.

Like almost *all* of your articles (the highly technical ones bore me but still have interest!) and sure wish you each and every one well. Someday we might be rich enough (Ha!) to toss a donation your way. All we can do now is subscribe and verbally boost the *MR*.

Lolette P. Dalbec
Ridgecrest, California

EDUCATIONAL EXHIBITS

Dear Sir:

Your editorial concerning educational exhibits in the March-April issue was most interesting, and I agree with the majority of the points you made. Our junior members have been presenting just the kind of exhibit you favor for the past three years at the Tucson show.

However, I do not go along with your proposal that the local club determine a single theme for all the educational exhibits in a show. I believe that such a group of exhibits would turn off the very audience we are attempting to reach (and despite what I have been told by some knowledgeable people, I still think most people attending a show, even the Tucson show, know next to nothing about minerals). Wouldn't such people be bored by repetitive displays on the same theme, even if each one were unique in its presentation? And wouldn't the prospective mineral collector learn more from a number of clear and simple exhibits on various subjects?

I further believe that your "one theme" proposal would inflict certain hardships on exhibitors, particularly junior members, and stifle creativity. Exhibitors would have to make an effort to learn specifically what they need to know for the exhibit, one in which they may have little interest, instead of being able to utilize knowledge they already have to put up an exhibit on a topic in which they are really interested. When our juniors decide on a theme for their exhibit for the Tucson show, it is an outgrowth of what they have learned from their classes, workshops and field trips. They can then spend the frantic weeks before the show planning and preparing their exhibit instead of having to take a cram course on esthetics, paragenesis, or whatever topic the host club has dreamed up. The present system certainly makes our job easier in planning the total educational program for our juniors.

I really think the only parties who would benefit at all from your proposal are the judges, whose task would definitely be simpler. Since you are a judge, perhaps that's what you had in mind.

Harris M. Richard
Junior Explorer Advisor
Tucson Gem and Mineral Society
Tucson, Arizona

MINERALS AND MINERALOIDS

Dear Sir:

The lack of an accepted definition of *mineral* is an embarrassment to us all. It has been 136 years since Dana's first *System of Mineralogy* and still no agreement. This matter should have been resolved a long time ago; I feel the various national mineralogical societies should do their job and agree on exactly what it is we are all studing.

Of course I have my own comments on the definition which I would like to throw into the pot. For one thing, the practice of giving various substances mineral status on an individual, arbitrary basis, without applying rigid rules, is unacceptably imprecise and unscientific. The "inorganic rule" is ignored frequently; crystallized sulfur produced in salt domes through the digestive process of gypsum-consuming bacteria is called a mineral, presumably because it is pretty, whereas asphalt is *not* a mineral, presumably because it is *not* pretty. Asphalt may not be a crystalline solid, but then neither is chrysocolla or mercury. Some people wish to see the Jerome mine fire crystals and Laurium slag crystals declared minerals, presumably because *they* are pretty, however the same people would balk at giving mineral status to the rust on old mine rails or the products of decomposed shoring and oxidized paint. Are we developing a science based on PRETTINESS?

I believe a rigid definition should be accepted and adhered to, but I cannot sympathize with those who struggle to come up with a definition which will include their own favorite quasi minerals. I propose the following:

1. MINERAL: A solid, mono-phase, crystalline, inorganically-produced element or compound whose composition varies only within narrow given limits.
2. MINERALOID: (I propose expanding the definition of this term to resolve the controversy) Any substance of interest to mineralogists, for whatever reason, but which fails to meet one or more of the criteria for a *mineral*, and which is not intention-

ally man-made. (At present, *mineraloid* refers only to amorphous substances which otherwise would be called minerals.) Included under *mineraloid* could be all the border-line substances such as chrysocolla, mine-wall melanterite and chalcanthite, butlerite, laurionite, water, mercury, hydrocarbon resins, etc. Individual specimens of recognized mineral species which are not exactly "kosher" in their origin could be prefaced. Example: rust on auto bodies could be referred to as "mineraloid goethite" if someone so desired. The term *mineral* could then be preserved and applied with scientific accuracy, and there would never again be exceptions to the rule or "controversial" minerals.

Wendell Wilson
Bloomington, Minnesota

SUGGESTION: In order to avoid having to cut out pages of your copies of the *Mineralogical Record,* we urge that you have these revisions copied (Xerox, etc.), trim the copies along the dotted lines, and insert the copies in your GLOSSARY OF MINERAL SPECIES, 1971, by M. Fleischer.

Corrections and Additions to Glossary of Mineral Species, 1971

By Michael Fleischer*

*Publication authorized by the Director, U. S. Geological Survey

Since publication of a list of additions and corrections in *Mineralogical Record,* **3,** 140-142 (1972), descriptions have been published of 50 new minerals and many minerals have been restudied. The present list reflects this new work plus the efforts of many persons who have kindly pointed out errors. I thank all those who have helped, and especially E. M. Kupletskaya of Moscow.

Special attention is called to the new mineral Kafehydrocyanite, which is the first ferrocyanide reported in Nature; compare julienite, the only reported thiocyanate.

The page numbers refer to the 1971 Glossary.

1	Acanthite, monoclinic Ag_2S, dimorphous with Argentite.
1	Agrinierite, $K_2CaU_6O_{20} \cdot 9H_2O$
2	Aktashite, $Cu_6Hg_3As_5S_{12}$
4	Apatite. Formula should be $A_5(PO_4)_3(F,OH,Cl)$
5	Armstrongite, $CaZrSi_6O_{15} \cdot 2.5H_2O$
5	Arseniosiderite. Formula should be $Ca_3Fe_4(AsO_4)_4(OH)_6 \cdot 4H_2O$
7	Balkanite, $Cu_9Ag_5HgS_9$
7	Bambollaite. Formula should be $Cu(Se,Te)_2$
8	Barkevikite, add $(OH, F)_2$ at the end of the formula
8	Bauranoite, $BaU_2O_7 \cdot 4\text{-}5H_2O$
10	Biphosphammite, $(NH_4,K)H_2PO_4$ recently validated
11	Bloedite. Formula should be $Na_2Mg(SO_4)_2 \cdot 4H_2O$
12	Brannockite, $KSn_2Li_3Si_{12}O_{30}$, osumilite group
13	Brüggenite, $Ca(IO_3)_2 \cdot H_2O$
13	Brunogeierite, $(Ge,Fe)Fe_2O_4$
16	Cavansite, $Ca(VO)Si_4O_{10} \cdot 4H_2O$ (new data)
17	Chalcokyanite, $CuSO_4$
18	Chernykhite, $(Ba,Na)(V,Al)_2(Si,Al)_4O_{10}(OH)_2$
20	Congolite, rhombohedral, $(Fe,Mg,Mn)_3B_7O_{13}Cl$, compare Ericaite
22	Cuprobismutite, $Cu_{10}Bi_{12}S_{23}$ (new data)
22	Cuprospinel, $(Cu,Mg)Fe_2O_4$
25	Cyclowollastonite, $CaSiO_3$, dimorph of Wollastonite
27	Embreyite, $Pb_5(CrO_4)_2(PO_4)_2 \cdot H_2O$
28	Eylettersite, $(Th,Pb)_{1-x}Al_3(PO_4,SiO_4)_2(OH)_6$ (?)

SIMPLY GREAT

Dear Sir:

One has to read Wendell E. Wilson's review of Joel Arem's new book *Rocks and Minerals* twice to believe it; it is so totally lacking in objectivity.

Verbose, picayune and carping, Mr. Wilson's effort points up the old adage that the severest critics are those who have either never attempted or who have failed in their own original compositions.

It takes this particular critic four valuable columns of *The Mineralogical Record,* and over 1000 words, to disparage Dr. Arem's new book and I cannot but help wonder why?

After reading the review and in spite of it, I went out and bought Joel Arem's little book and I must confess it's simply great!

Ervan F. Kushner
Paterson, New Jersey

AMUSED

Dear Sir:

Was amused by the letter from Maxine Schmidt. Obviously, she will never make it as a collector. I have yet to find a decent collector of *anything* who isn't a snob to some degree. In fact, that is at least a part of what any hobby is all about. Here's to snobs, may they proliferate and devour the Maxine Schmidts of the world.

Also amused at the fuss over melanterite. As the "King of Borax," I must confess to a bit of a bias. I have also observed that those who defend the "grey area minerals" are frequently those who have collected them. Those most down on them are most apt not to have a source. They can afford to be down on them. I sure can't, a big chunk of our collection came as a direct result of borax in old mine sumps.

Jim Minette
Boron, California

ON PEGMATITE PHOSPHATES

Dear Sir:

Mentioning Palermo mine not far from here, and other New England pegmatites as it does, the article on pegmatite phosphates (Vol. 4, #3) was of considerable interest to many of our Club members (Capital Mineral Club, Concord, N. H.). As a group and individually some of us have done considerable collecting at these New England localities. I think that the article stimulated, or at least facilitated, the willingness to carry some copies for sale.

W. Seward Mariner
New London, New Hampshire

SATISFIED READER

Dear Sir:

I just want to let you know that in my humble opinion the *Record* is getting better all the time. The article by Moore in the recent issue dealing with pegmatite phosphates was extremely informative thanks to Moore's highly readable method of dealing with a difficult topic.

I have visited several of the locations in the New England area and as micromounters my wife and I have collected a good many phosphate mineral. Unfortunately several of these specimens are still unlabeled simply because we lack the knowledge or testing facilities to properly identify these specimens. Moore's article has added considerable to our knowledge and we will keep it within easy reach so that it can serve us as a quick reference source. Thanks again for a fine issue.

If you accept suggestions or requests from your readers, may I file my request for an in-depth article on the various quarries in Mont St. Hilaire?

William P. Lindeyer
Windsor, Connecticut

Yours is not the first such request. We have vague promises of such an article but we must wait for it to come in. Part of the problem is that all the various species (many new ones) have not yet been described individually. Ed.

Corrections and Additions to Glossary (continued)

29	Fernandinite misspelled
30	Ferrihydrite, $HFe_5O_8 \bullet 4H_2O$
31	Freieslebenite, $PbAgSbS_3$ (new data)
32	Galkhaite, $(Hg,Cu,Zn)(As,Sb)S_2$
33	Garrelsite, $Ba_3NaSi_2B_6O_{13}(OH)_7$ (new data)
33	Gaudefroyite. Formula should be $Ca_4Mn^{3+}_{3-x}(BO_3)_3(CO_3)(O,OH)_3$
36	Haapalaite, $2(Fe,Ni)S \bullet 1.6(Mg,Fe)(OH)_2$, valleriite group
36	Hägggite. Formula should be $V_2O_2(OH)_3$
38	Heyite, $Pb_5Fe_2(VO_4)_2O_4$
41	Hydromagnesite, $Mg_5(CO_3)_4(OH)_2 \bullet 4H_2O$
41	Hydroromarchite, $Sn_3O_2(OH)_2$ (new data)
42	Iimoriite, $Y_5(SiO_4)_3(OH)_3$
43	Insizwaite, $Pt(Bi,Sb)_2$
43	Irhtemite, $Ca_4MgH_2(AsO_4)_4$
44	Jennite, $Na_2Ca_8(SiO_3)_3Si_2O_7(OH)_6 \bullet 8H_2O$
45	Kafehydrocyanite, $K_4Fe(CN)_6 \bullet 3H_2O$ (potassium ferrocyanide)
46	Kanemite, $NaHSi_2O_4(OH)_2 \bullet 2H_2O$
48	Krutaite, $CuSe_2$
49	Larosite, $(Cu,Ag)_{21}PbBiS_{13}$
49	Lacroixite, $NaAl(PO_4)(OH,F)$ (new data)
51	Leucophosphite, formula should be $KFe_2(PO_4)_2(OH) \bullet 2H_2O$
53	Mackelveyite, $(Na,Ca)(Ba,Y,U)_2(CO_3)_3 \bullet 1\text{-}2H_2O$
55	Manganese - shadlunite, $(Fe,Cu)_8(Mn,Pb)S_8$ (pentlandite group)
56	Mattagamite, $(Co,Fe)Te_2$
56	Mboziite, $Na_2CaFe^{+2}_3Fe^{+3}_2(Al_2Si)_6O_{22}(OH)_2$, Amphibole group
57	Mertieite, $Pd_5(Sb,As)_2$
58	Metacaltsuranoite, $(Ca,Na,Ba)U_2O_7 \bullet 1\text{-}2H_2O$
58	Delete Metajennite, not a mineral
58	Metalodevite, $Zn(UO_2)_2(AsO_4)_2 \bullet 10H_2O$
58	Metastibnite, Sb_2S_3 (recently validated)
59	Minasragrite, $VOSO_4 \bullet 5H_2O$ (new data)
60	Montgomeryite, $Ca_2Al_2(PO_4)_3(OH) \bullet 7H_2O$
61	Mossite. Formula $Fe(Nb,Ta)_2O_6$
61	Mountainite. Formula $(Ca,Na_2,K_2)_2Si_4O_{10} \bullet 3H_2O$

ADDRESSES WANTED

Dear Sir:

Would it be possible for...reviewers to include a more complete address of the publishers of the book reviewed? I have found that books ordered through book stores take a considerably longer time in arriving than when ordered directly. For those of us impatient ones, a complete address of the publishers of each book reviewed would certainly be a great favor. I, for one, will appreciate your consideration of this suggestion.

Mrs. Marge Mills
Irving, Texas

We will try to comply with this worthy suggestion. Ed.

ON AZURITE

Dear Sir:

I found the article by Mr. Bideaux on azurite (Vol. 4, No. 1) most enjoyable. I'm sure others would like to see more articles which review the occurrence of a single significant mineral on a world basis.

However, if azurite is to be considered "a cornerstone mineral of any collection", readers (including Richard Bideaux) may be interested to learn that this mineral is probably more abundant at the Chingola mine (formerly Nchanga) on Zambia's Copperbelt than at any other mine in the world. This has likely always been true, although mining did not start as early as at some of the other classic localities. This mine's enormous open pits and an underground operation produce approximately 250,000 tons of copper per year - (1/3 of Zambia's total). Chingola high grade oxide concentrate contains about 1 percent of azurite. If we add to this the smaller but significant percents of azurite in other concentrator products, the yearly weight of mined azurite exceeds 5,000 tons.

Corrections and Additions to Glossary (continued)

61	Mpororoite, $(Al,Fe)_2W_2O_9 \bullet 6H_2O$
62	Nambulite, $NaLiMn_8Si_{10}O_{28}(OH)_2$
63	Neyite, $Pb_7(Cu,Ag)_2Bi_6S_{17}$
64	Nimesite, $(Ni,Mg,Fe,Al)_{5-6}(Si,Al)_4O_{10}(OH)_8$ (septechlorite group) (dimorph of nimite)
66	Osarsite, $(Os,Ru)AsS$
67	Pandaite. Formula $(Ba,Sr)_2(Nb,Ti)_2(O,OH)_7$
68	Paraschachnerite, orthorhombic Ag_3Hg_2
68	Pellyite, $Ba_2Ca(Fe,Mg)_2Si_6O_{17}$
69	Pentagonite, $Ca(VO)Si_4O_{10} \bullet 4H_2O$
72	Potash Alum, $KAl(SO_4)_2 \bullet 12H_2O$
74	Raite, $(Na,Ca)_4(Mn,Fe,Ti)_3Si_8O_{16}(OH)_{12} \bullet 5H_2O$
75	Rameauite, $K_2CaU_6O_{20} \bullet 9H_2O$
75	Reyerite, $(Na,K)_4Ca_{14}(Si,Al)_{24}O_{60}(OH)_5 \bullet 5H_2O$ (new data)
79	Santanaite, $9PbO \bullet 2PbO_2 \bullet CrO_3$
80	Schachnerite, hexagonal $Ag_{1\cdot 1}Hg_{0\cdot 9}$
80	Schirmerite, $AgPb_2Bi_3S_7$ (new data)
80	Schoenfliesite, $MgSn(OH)_6$, compare Stottite
81	Semenovite, $(Na,Ce,Ca)_{12}(Be,Si)Si_{12}O_{40}(F,OH)_8 \bullet H_2O$
82	Shadlunite, $(Fe,Cu)_8(Pb,Cd)S_8$ (pentlandite group)
82	Shcherbinaite, V_2O_5
82	Sicklerite, $Li(Mn^{+2}, Fe^{+3})PO_4$
82	Silhydrite, $3SiO_2 \bullet H_2O$
83	Smythite, $(Fe,Ni)_9S_{11}$ (new data)
86	Stumpflite, $Pt(Sb,Bi)$
89	Tellurantimony, Sb_2Te_3
89	Tetrawickmanite, $(Mn,Fe)Sn(OH)_6$
91	Tranquillityite, $Fe_8(Zr,Y)_2Ti_3Si_3O_{24}$
92	Tulameenite, Pt_2FeCu
92	Tungstenite—3R, WS_2
99	Wyllieite, $(Na, Ca, Mn)_2(Fe, Mg)_2A1(PO_4)_3$
100	Yttrotungstite, $YW_2O_6(OH)_3$
101	Zircophyllite, $(K,Na,Ca)_3(Mn,Fe)_7(Zr,Nb,Ti)_2Si_8O_{24}(O,OH)_7$ astrophyllite group
101	Zorite, $(Na,K,Ca)_3(Ti,Al,Nb)_2Si_4(O,OH)_{14} \bullet 4H_2O$

The preceding is good news. Now the bad news, which many serious collectors and dealers must already know. Although nature kindly provided one of the world's richest copper deposits for this country, a sacrifice was made in the lack of good and the absence of outstanding mineral specimens in crystal form.

The great bulk of the azurite is present as layered granular material intergrown with malachite, Fe oxide, and gangue silicates within the ore formations. The mineral occurs mainly in an arkose which is mined from underground and from one of the open pits.

The forms which attract some interest are balls, lenticular discs and, of course, good sized crystals. Azurite balls are relatively abundant. They average 1 - 2 inches in diameter and have been found as large as 8 inches across. The smaller balls occasionally display a surface of closely packed divergent blades, as a result of radial either solid or partially hollow and may contain perfect 1 - 2mm crystals. Very rarely, larger balls contain a core of well developed crystals pseudomorphed partly to malachite. These are the most prized specimens of any mineral to be found at Chingola. The discs have been common in the Chingola open pit and occur in thin clay beds. They come in all sizes and may display columnar growth normal to the circular plane.

The vast majority of discs and balls contain so much clay, mica, quartz and Fe oxide as to make them unattractive to the discriminating person and sadly find their best purpose as food for the concentrator.

Azurite crystals 2 inches in length and probably longer have been obtained from quartz veins in the underground mine. These crystals, while well developed, are usually intergrown with smaller crystals and quartz. In several years of close conact with the Chingola mine I have not seen or heard of a really outstanding azurite crystal specimen.

There is little likelihood that mining operations on the Copperbelt will uncover azurite of the type that collectors might dream. The stratiform orebodies are very consistent in their nature of mineralization.

S. P. Korowski,
Mineralogist, Research & Development
N. C. C. M., Kitwe, Zambia

STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION

(Act of August 12, 1970: Section 3685. Title 39. United States Code):

1. Title of publication: Mineralogical Record.
2. Date of filing: October 1, 1973
3. Frequency of issue: Bimonthly.
4. Location of known office of publication: 12304 Welling Lane, Bowie, Maryland 20715.
5. Location of the headquarters or general business offices of the publishers: Suite 703, 1825 K Street Northwest, Washington, D. C. 20006.
6. Names and addresses of publisher, editor, and managing editor: Publisher, John S. White, Jr., 12304 Welling Lane, Bowie, Md. 20715; editor, John S. White, Jr., 12304 Welling Lane, Bowie, Md. 20715; managing editor, John S. White, Jr., 12304 Welling Lane, Bowie, Md. 20715.
7. Owner (if owned by a corporation, its name and address must be stated and also immediately thereunder the names and addresses of stockholders owning or holding 1 percent or more to total stock.): The Mineralogical Record, Suite 703, 1825 K Street Northwest, Washington, D. C. 20006.
8. Known bondholders, mortgages, and other security holders owning or holding 1 percent or more of total amount of bonds, mortgages or other securities: None.
9. For optional completion by publishers mailing at regular rates (Section 132. 121, Postal Service Manual) 39 U.S.C. 3626 provides in pertinent part: "No person who would have been entitled to mail matter under former section 4359 of this title shall mail such matter at the rates provided under this subsection unless he files annually with the Postal Service a written request for permission to mail matter at such rates." In accordance with the provisions of this statute, I hereby request permission to mail the publication named in Item 1 at the reduced postage rates presently authorized by 39 U.S.C. 3626: John S. White, Jr., publisher.
10. Not applicable.
11. Extent and nature of circulation:

	Average No. Copies Each Issue During Preceding 12 Months	Actual No. Copies of Single Issue Published Nearest to Filing Date
a) Total No. Copies Printed (Net Press Run)	5166	5000
b) Paid Circulation		
1. Sales through dealers and carriers, street vendors and counter sales	253	246
2. Mail subscriptions	3553	3846
c) Total Paid Circulation	3806	4092
d) Free Distribution by Mail, Carrier or other means	65	59
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I certify that the statements made by me above are correct and complete.

JOHN S. WHITE, JR.
Publisher

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