the Mineralogical Record

Volume Six/Number Three

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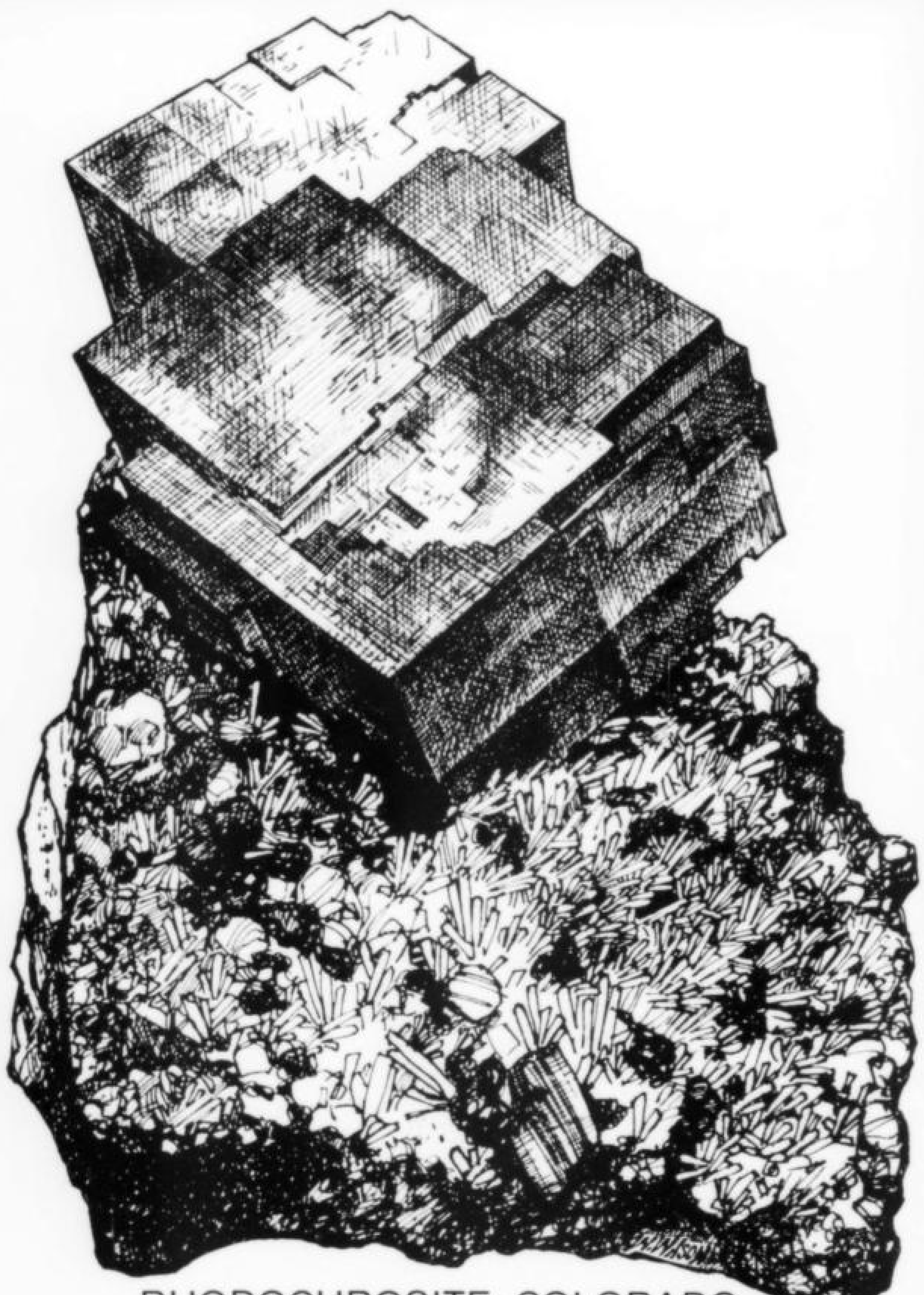

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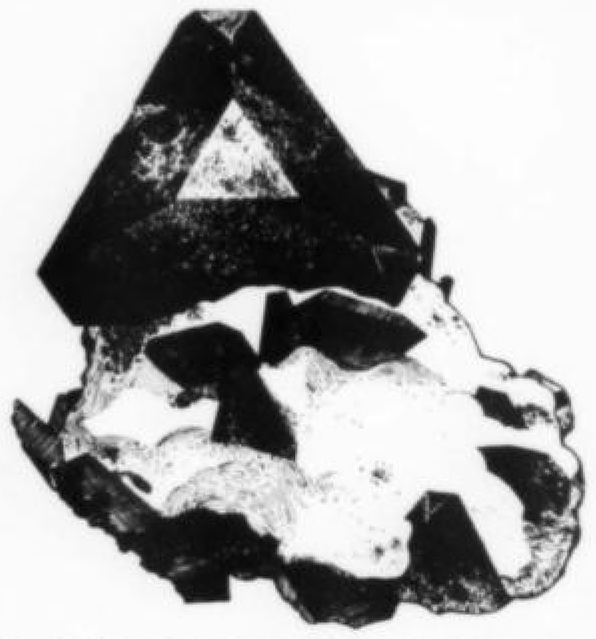

BENITOITE; CALIFORNIA

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editorial matter

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Beryl. The Hiddenite and Emerald mine, near Stony Point, Alexander County, North Carolina. Found in 1971, this group of crystals is overall 4.5 inches in length and the two large crystals are doubly terminated. The specimen is in the David P. Wilber collection. Photography by Van Pelt, Los Angeles, California.

Editorial

TRAPPED

It is disturbing to fall into a "trap" as easily as I did recently while judging competitive displays at a mineral show. I had come to believe that I understood rather well what the Federation produced uniform rules system was all about and that I was doing my duty accordingly. How unsettling, then, to learn after the fact that I had let myself participate in what I now am inclined to believe is a misjudgement.

I call this situation a "trap" but it was a self-made situation. I had allowed myself to become a part of the parade toward the idolization of sculptural and/or colorful specimens, and more or less adopted these criteria to the exclusion of all others. This practice had progressed to the point where, when examining the case of a top competitor, any specimens that did not dazzle and thrill the viewer were automatically downgraded. Unfortunately, this is a common failing these days. In the particular instance alluded to above, this happened with a specimen of bayldonite in crystals, remarkably large for the species. Nevertheless, the specimen was dark green, almost black, and rather formless overall. Occupying a case where all of its neighbors were either exquisitely colored or artistically sculptural, the bayldonite did, in fact, appear out of place. Never mind that it possibly was (and probably still is) the finest bayldonite specimen in the world and that every major museum would love to own it, it was certainly not the same type of display specimen that comprised the rest of the exhibit. It had to be examined very closely to determine just how fine it really was, an act not required to appreciate the qualities of the other specimens.

Now, the question is, was it right for the judges to downgrade this unesthetic specimen? The answer, obviously, is not a simple one. If we say "no", because it is the world's finest bayldonite, then we must ask ourselves if this response would also apply to the finest kaolinite specimen (which, at best, might resemble a lump of chalk), or the finest of any species no matter how visually unappealing it might be. If we fail to give such material its due, then we are guilty of overemphasizing the beautiful to the exclusion of the rare and exotic. Arguments that such specimens make up their points under "rarity" judgements are spurious because so few points in proportion are allotted to "rarity". Where do we draw the line? Clearly there must be a reasonable point beyond which unattractive material should not be included in a competitive and otherwise esthetic display, but is this to be determined on the basis of visual appeal alone? Are we not also trying to educate by encouraging the display of uncommon species? Is there not unattractive material that should be included simply because it represents the best of a species? At least, if we are going to make such exclusions we ought to be honest about it and say so.

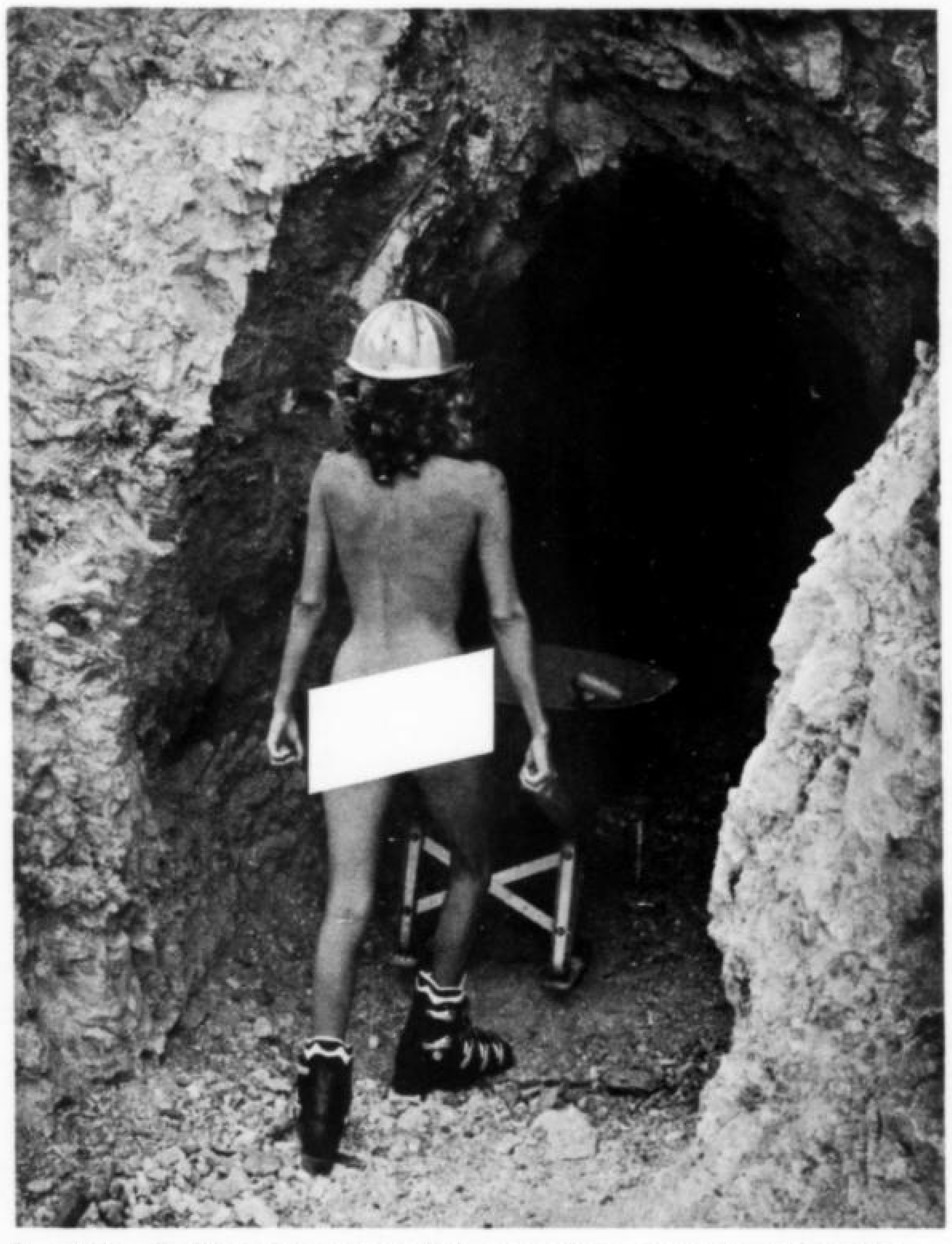
I feel that if I were to be given the opportunity to judge this same exhibit again, after some soul-searching, I probably would not react to the specimen in exactly the same way, but my judgement of its visual impact would not change at all. Furthermore, my comment on the specimen for the clerk to record, taking all of this into account, might be at least more tactful than the thoughtlessly unflattering comment made at the time.

A similar theme was put forth in an editorial by Bill Moller last year in *The Bulletin of the Mineralogical Society of Southern California* (1974). His discussion opened with a reference to a remark by a well-known (in California) mineral collector who felt she needed a bright yellow mineral to brighten up a drab part of her mineral display. Bill speculated on the possibility that the judges would have been more satisfied with a bright yellow "anything" than any rare and valuable, but dull-looking, specimen in that spot in the case. A frightening prospect, and certainly not without foundation.

There can be no doubt that we are departing drastically from pure mineralogy and entering the world of art. To what extent should the artistic skills of the exhibitor enter into the deliberating of the judges? Can we honestly believe that we can judge the specimens on their merits alone without being influenced by the way that they are presented? Even if we could disregard the latter, should we? Since we probably are influenced by the overall beauty of the exhibit case, how can we fairly differentiate between showmanship of the exhibitor and quality of the specimens?

These are questions that deserve careful consideration and I hope that the *Record's* readers will respond.

John S. White, Jr.



PERSONALITY SKETCH

FRANK PERHAM

Pegmatite Miner, Geologist and Humorist

by Pete J. Dunn
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Smithsonian Institution
Washington, D.C. 20560

Few names are as intimately associated with the pegmatite belt of Maine than that of the Perhams. Frank's grandfather, Alfred, was a farmer-turned-miner, and Frank's father was the well-known Stan Perham. Stan made his mark in a tourmaline find at the B.B. #7 mine in north Norway, Maine, and came to fame as the "mineral man at Trap Corner" in West Paris, Maine, where he operated a mineral shop until his passing on December 1, 1973. The shop is now operated by his daughter, Jane Perham Stevens, and his widow, Hazel Perham.

Frank Perham is a man well-met. A geologist with more practical field knowledge of pegmatites than most, he is also a dedicated pegmatite miner, a crack diesel engine mechanic, and is possessed of a wry, laconic humor that bubbles frequently in his conversations. Following in the footsteps of his father, Frank obtained a geology degree from Bates College in Maine, and proceeded to learn Maine's pegmatites by mining them. He has, over the years, mined commercial-grade feldspar, muscovite and beryl at the Waisanen, Nubble, and Bumpus mines, and the Newry Hill area, as well as maintaining a small drilling and blasting operation for ledge rock and cement removal. These operations provided the experience and equipment for his main love, the mining of gem-bearing pegmatites. Considering that the mining of gems is primarily a labor of love on Frank's part, his successes have been truly significant rewards. Some of the areas in Maine which Frank has worked for mineral specimens and gem materials include the Harvard mine for purple apatite, Plumbago mountain for rose quartz crystals, Mount Mica for tourmaline, the Keith and Pulsifer quarries on Mt. Apatite for tourmaline and purple apatite, the Consolidated Mining quarry in Georgetown for gem spodumene and tourmaline, the Whispering Pines mine for facet-grade rose quartz, and the Waisanen mine for smoky quartz crystals, herderite crystals, and tourmaline.

Undoubtedly, one of Frank's greatest thrills was the mining of record amounts of gem quality elbaite tourmaline at the Dunton gem mine in 1972, 1973, and 1974. Frank's description of the recovery of this gem material is one of the most fascinating and captivating experiences I have ever heard. The human side of Frank is ever-present, and he affectionately recalls the day in September of 1972 when his father was brought to the top of Newry Hill to see the gem elbaite being brought out of the pockets. Tourmaline had always been a part of the then-aged Stan Perham's life, and Frank wanted him to share in the thrills of this notable discovery. Frank's mining efforts have now come full-swing, and he is back at Mount Mica and Newry, mining for the Plumbago Mining Corporation, the discoverers of the 1972 tourmaline strike.

To watch Frank work a pegmatite with suspected pockets, and find the pockets and remove the contents with a minimum of damage, is akin to observing an expert surgeon in a complex operation. With a fine touch for drilling and blasting, perfected by years of experience, Frank is eminently well-suited to the challenges any pegmatite can offer. He has a remarkable three-dimensional memory which enables him to remember the size, contents, and position-in-space of pockets found in the past, and he utilizes this knowledge in the search for more pockets and seams of pegmatite minerals.

One is most impressed by Frank Perham in the "breaks" between drilling efforts, when the noise has ceased and the dust settled, and Frank begins to explain, over a cup of hot soup, what he is doing that day. It is at this time that the listener comes to realize that this humble and self-effacing man is indeed the complete geologist, who is daily blending theoretical and practical knowledge in the search for pegmatite minerals.

On a recent visit to the site of Frank's efforts, I had the good fortune to arrive just before lunchtime, known to Frank as the "edible hour." We were invited to join him while he ate in a converted bus-cum-camper which he hauls to the site of his mining for creature comforts (hard seats and one table!). We were informed, ever so seriously, that we were dining in what Frank calls the "Mount Mica Hilton!" Frank's narratives include colorful (and off-color) descriptions of some of his finds. Most of his analogies are quite unique; such as "lepidolite crystals stacked up like a pile of Necco wafers," and other even more eloquent efforts.

In summary, Frank Perham combines the talents of a geologist and pegmatite miner with the warmth and good rich humor of a honest Maine man. Many of Maine's treasures have been borne into our conciousness through his hands, and more will certainly come in the years ahead. He represents the best in the mineral men of Maine.

Note: The editor is anxious to have more readers submit Personality Sketches for publication in the Mineralogical Record. This will be a regular feature if only more such sketches are received. Ed.

Quenstedtite from California

by Dwight Weber
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Specimens of the rare mineral quenstedtite, $Fe_2(SO_4)_3 \bullet 10H_2O$, were identified several years ago on samples collected by one of the authors (DW) at the old locality known as the "Sulphur Hole" in the Calico Mountains, San Bernardino County, California, in 1959. The mineral occurred in a fumarole-type deposit very sparingly as well-formed, thin, tabular, pale lilac to nearly colorless, and nearly transparent triclinic crystals, generally less than one mm in length, in an assemblage of at least 11 other known minerals (Murdoch & Webb, 1966). Until fairly recently (Kravtsov, 1971) quenstedtite had not been reported from any part of the world except Chile (Palache, et al., 1951; Betechtin, 1971; Ramdohr & Strunz, 1967). Since the color and appearance of the fine-grained material superficially resembles coquimbite, which was formerly abundant at this locality, this may account for the fact that this mineral has not been previously reported here. Quenstedtite is more often associated with römerite and coquimbite than with any other minerals on the specimens observed.

The photomicrograph (Fig. 1) shows the typical habit of quenstedtite, which makes it quite distinct in appearance from any of the other minerals occuring at the Sulphur Hole. Three x-ray powder patterns, taken on different samples by one of us (DW), were confirmed by a sample sent to and x-rayed independently by G. Switzer and J. White of the Department of Mineral Sciences of the Smithsonian Institution. Both analyses assumed the correctness of the J.C.P.D.S. data (Cesbron, 1964). A number of lines observed in our study were not reported by Cesbron, and *vice versa*. Semiquantitative chemical and atomic-absorption spectroscopic analyses performed for us elsewhere supported the x-ray results[1].

Quenstedtite is apparently quite stable, when not exposed to excessive temperature, moisture, or weathering, as are most of the other sulphates with which it occurs, contrary to common misconceptions about many sulphate minerals. The fact that nearly all of the minerals from this locality have been preserved for nearly 15 years in micromount boxes, or within a layer of plastic wrap, and are still in good condition is reasonable evidence of this stability. Careful handling is essential, of course, because the various minerals often occurred in assemblages with or without matrix in a very friable condition, even when first collected.

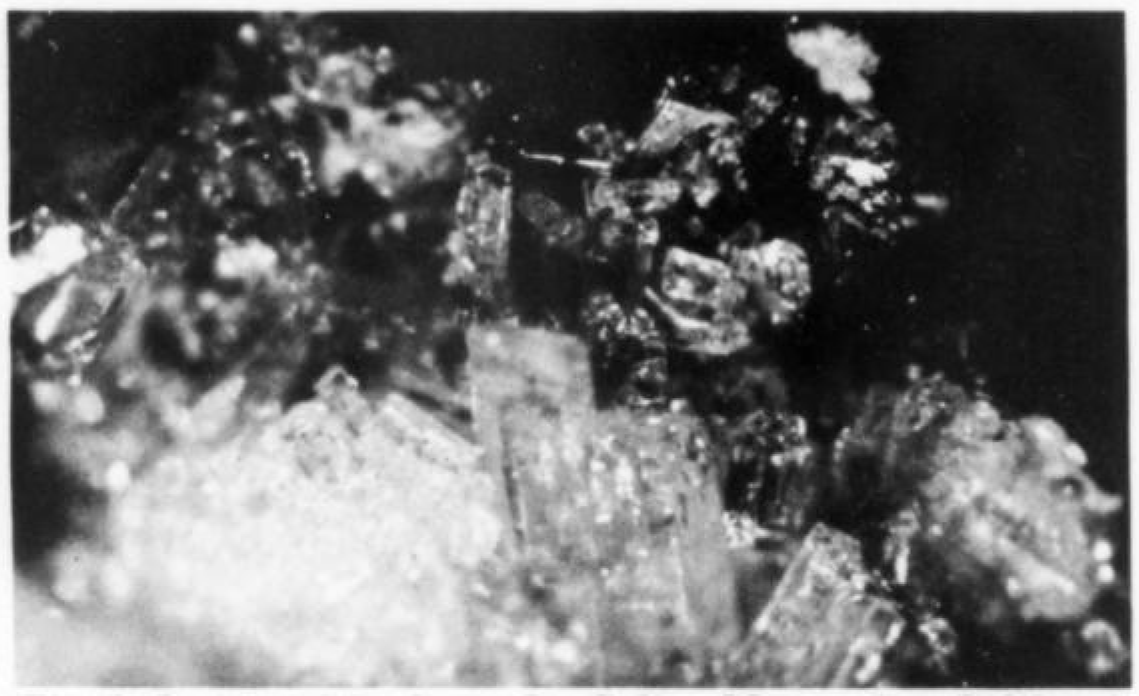

Fig. 1. **Quenstedtite from the Calico Mountains, California**

Acknowledgements are due to S. B. Alexander for assistance in the photomicrography.

REFERENCES

BETECHTIN, A. G., (1971), *Lehrbuch der speziellen Mineralogie*, translated from the Russian by Dr. H. J. Rösler, VEB Deutscher Verlag F. G., Leipzig, DDR.

CESBRON, F., (1964), "Contribution a la mineralogie des sulfates de fer hydrates," *Bull. Soc. franc. Min. Crist.* **87**, No. 2, 125-43.

KRAVTSOV, E. D., (1971), "Minerals from the permafrost oxidation zone of the D'yakhtardakl deposit," *Zap. Vses. Min. Obshch.* **100**, 282-90 (in Russian).

MURDOCH, J. & R. W. WEBB, (1966), *Minerals of California*, Bulletin **189**, Ca. Div. of Mines & Geology, San Francisco. (Although the reported minerals are noted in this reference, no locality index is included, so that one must search the whole book to locate those minerals from any one locality or look up one or more original papers. The other known minerals reported from this locality are: alunite, copiapite, coquimbite, fibroferrite, halotrichite, jarosite, krausite, metavoltine, romerite, sulphur, and voltaite.)

PALACHE, C., et al., (1951), *The system of mineralogy*, Vol. II, 7th Ed., Wiley, New York.

RAMDOHR, P. & H., STRUNZ, (1967), *Klockmann's Lehrbuch der Mineralogie*, F. Enke Verlag, Stuttgart.

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[1] Repeated analyses were made because of a greater amount of scatter in the x-ray data than usual, a phenomenon which appears more common with highly hydrated species. It had been determined previously that patterns of known materials could be duplicated with the equipment used in this study within ±.004 Å without any special effort, whereas the scatter in this data averaged ±.03 Å. Although the relative intensities differed somewhat from those reported by Cesbron, this is to be expected. In both studies the most intense line was the 4.07, and the next most intense was the 5.71 Å line, as Cesbron reported.

FM friends of mineralogy

ACTIVITIES OF REGION 5

by

Arthur Y. Johnstone

FM director and Region 5 coordinator

Late in 1973 we took a long hard look at FM in Region 5. It seemed to be going nowhere. There was little response to National projects and efforts to encourage more and better educational exhibits at the Detroit Show had failed.

As a possible solution to these problems, three of us agreed that FM members in this area should plan, build and set up at the 1974 Detroit Show an exhibit which would attract attention, be educational in Mineralogy, and could serve as an example of what could be done in this field at this and other shows.

A call went out to all FM members within a reasonable distance of Detroit. The response was very gratifying; the project was adopted with some sixteen members participating. Meetings were held, the exhibit was planned, minerals gathered and selected, and the exhibit, occupying a space 15' x 22', was built and set up. Briefly, the exhibit comprised a hexagonal pylon 8 ft. high and 8 ft. across and four pony cases containing over fifty Michigan mineral specimens. On the pylon were mounted a map of Michigan showing mineral localities and reproductions of old Michigan mining scenes. From inside the pylon, color slides of Michigan minerals were projected continuously on a screen set into one side of the pylon. Handouts were provided, giving information on mineral collecting in Michigan, keyed to the map on the pylon. Several large specimens were displayed outside of the cases for visitors to touch. A detailed report has been written by Charles N. Miller, Chairman of our Education Committee, and is available to anyone interested in our experiences in putting the display together.

The exhibit was a success but, more important, we had created a group with great potential, which had worked together with enthusiasm and genuine personal satisfaction. We have continued to meet, now regularly on the first and third Saturdays of each month at 10:00 AM at the Cranbrook Institute of Science. Our active membership has increased substantially. We discussed many ideas for group activities, some of which were borrowed from other Regions. Some were adopted for immediate implementation, others put off for futher study, and some were rejected.

Current projects of our group:

1. Planning and setting up of an educational exhibit for the 1975 Detroit Show.
2. Compilation of a bibliography of Michigan minerals and localities. In addition to listing all the literature we hope to be able to show whether and where it is available. Where gaps in the record are revealed we hope eventually to fill them.
3. Special study of Michigan celestine occurrences, forms and habits.
4. Sponsorship of programs on mineralogy for schools and local groups including providing color slides, specimens, etc.
5. Providing aid to museums and other institutions with mineral collections, in the form of money, specimens, curatorial help, etc.
6. Compilation of lists of mineral collections open to the public, reputable mineral dealers, current publications dealing with mineralogy (annotated to indicate scope, level, and where they can be obtained most cheaply).

On the back burner are plans for sponsorship of clinics on identification of minerals, and mineral and mineral locality preservation.

Our organization is simple. The Regional Coordinator presides at meetings and appoints the chairmen of the committees which handle the various projects. We have not felt the need for other office-holders; however, this will probably change as we grow and if and when "Chapters" are recognized. Our meetings, which run at least two hours, are divided into two sections: a business session in which we hear committee reports, discuss FM affairs, consider new projects, take up other matters; and a study session in which we discuss minerals, swap information, and listen to members or guests more advanced in various areas of mineralogy. We also have had and plan to have "field trips" to visit collections of minerals, laboratories and other places of interest, in or outside of our area, on other than meeting days.

We are walking a thin line, trying to realize the full potential of our group and yet not become too ambitious. We are, after all, with one or two exceptions, amateurs in mineralogy, with other interests and obligations and many commitments. It disturbs us that all members of Region 5 cannot participate in our program. Perhaps the solution there is local recruiting to provide enough members in other areas to form workable groups. We stand ready to help in any way we can.

At this point we are long on plans and short on accomplishments, but we are on the move and could go far. It looks like a happy journey. Please contact me if interested. (Arthur Y. Johnstone, 996 Larkmoor, Berkley, Michigan 48072)

All news and material relating to FM, for Record publication, should be sent to Neal Yedlin at: 129 Englewood Drive, New Haven, Connecticut 06515, U.S.A.

Descloizite from the C and B Vanadium Mine

by T. J. Trebisky
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The C and B Vanadium mine is a little-known locality which has produced some small but remarkable crystals of descloizite. The mine is in the NE¼ of Sec. 32, T.3S., R. 15E., on the north side of the Dripping Spring Mountains about 10 miles northwest of Christmas in Gila County, Arizona (USGS El Capitan 7.5' quadrangle, marked as "Vanadium Mine"). Descloizite and associated supergene Cu-Pb-Zn minerals are primarily found in a set of N10-35W, easterly dipping fracture zones in Precambrian diabase and Mescal limestone (Ross, 1925). The deposit is developed by a number of adits and one shaft, most done since the Ross report, probably during World War II.

Descloizite occurs as crystal aggregates and sharp, brown to brown-black crystals as large as 5 mm. The larger crystals and the crystals of the aggregates form tablets as shown in Fig. 1a, while most of the small, darker crystals are more equant as in Fig. 1b. The *o*{111} form appears to be a faster growing one which decreases in relative size as the crystals become larger.

Hexagonal, red-orange prisms of vanadinite, occasionally coated with yellow mimetite, occur with the descloizite. The crystals are usually simple although some smaller crystals show an interesting termination composed of a number of flat dipyramids. Calcite coats all three minerals and only rarely forms good crystals. The general paragenetic sequence is vanadinite—mimetite—descloizite—calcite.

A non-vanadate assemblage is found in one small area of the mine, consisting of mimetite, wulfenite, and cerussite developed on anglesite and galena. The mimetite and wulfenite occur as orange masses of little interest to the collector. The cerussite forms small, very sharp crystals (Fig. 2), remarkable at this locality for their complete absence of the usual twinning.

REFERENCE

ROSS, C. P. (1925). Ore deposits of the Saddle Mountain and Banner Mining Districts, Arizona, *U.S. Geol. Survey Bull.* **771**, 69.

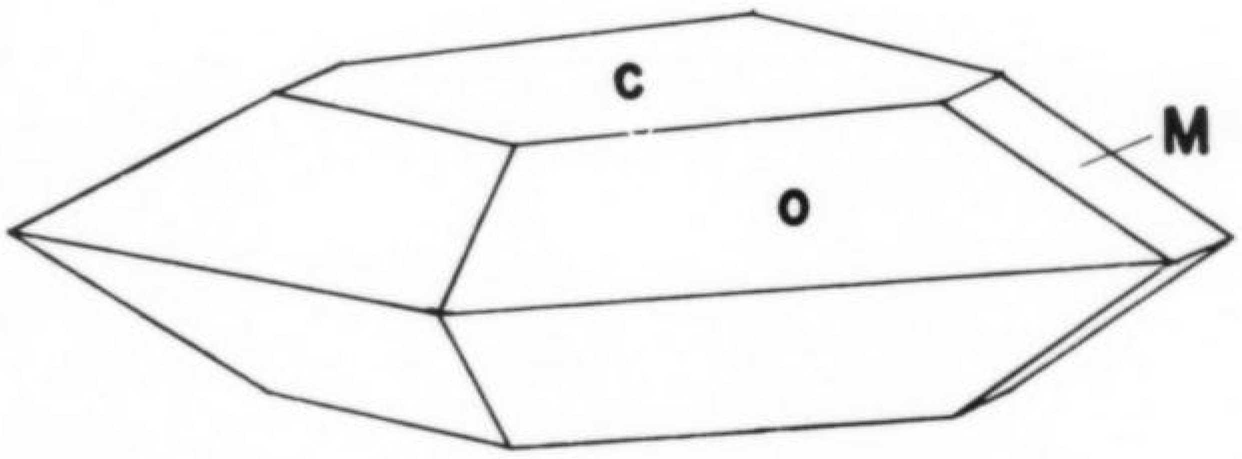
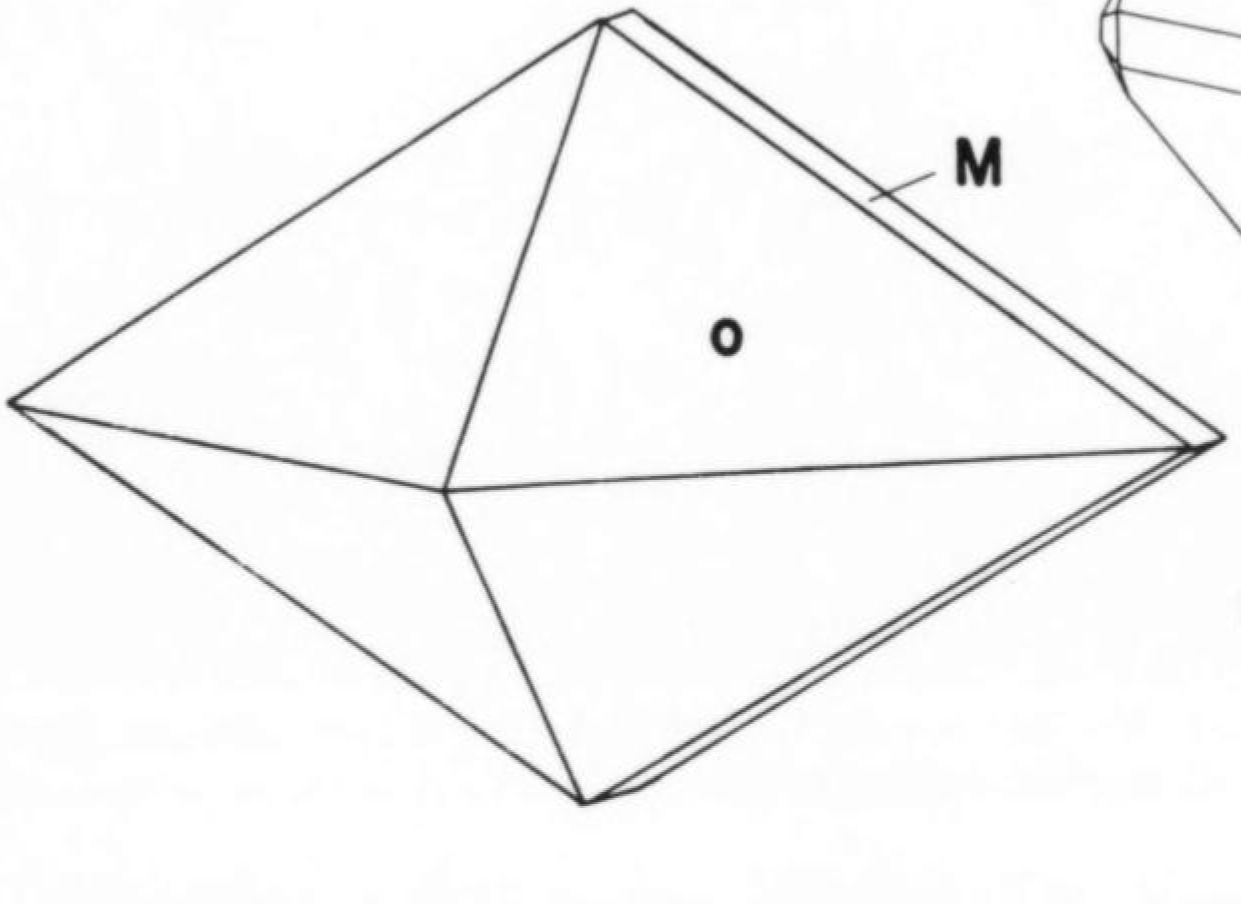


Fig. 1a & b. Two crystal developments of descloizite showing the forms *c*{001}, *M*{011}, and *o*{111}.



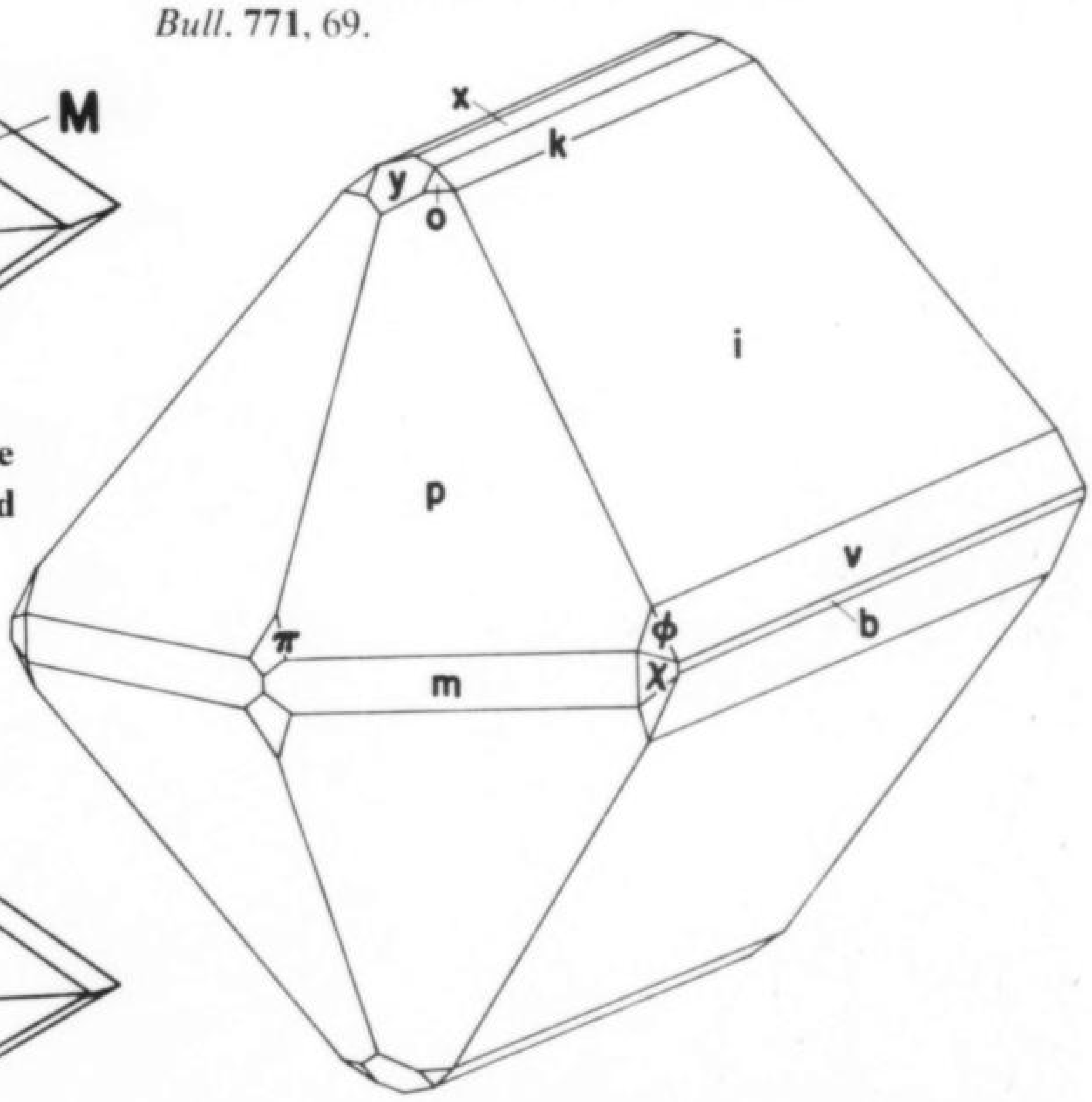


Fig. 2 **Cyrstal of cerussite showing the forms *b*{010}, *m*{110}, *x*{012}, *k*{011}, *i*{021}, *ν*{031}, *y*{102}, *o*{112}, *p*{111}, χ{120}, π{302}, and φ{131}.**

The Minerals of the Zinc Hill Mine, Inyo County, California

by *Jack A. Crowley* **4649 Solano Way, Fair Oaks, California 95628**

INTRODUCTION

The Zinc Hill mine is located in Sec. 35, T. 18 S., R. 44 E., Darwin Quadrangle, Inyo County, California. It is about 5-1/2 miles northeast of Darwin, California. The mine has not been actively worked for a number of years, although the present owners do the annual assessment work. Hall and MacKevett (1958) studied the general geology and ore deposits of the mine; however no detailed study of the mineralogy was done.

The Zinc Hill mine is composed of four sets of workings that are separate and unconnected. The workings are divided into: the upper workings, located on the south side of the deposit at an elevation of 3900 to 4000 feet; the middle workings, about 500 feet northwest at an elevation of 3700 feet; the lower workings, 200 feet further northwest at an elevation of 3,500 to 3,550 feet and the western workings some 300 feet west of the lower workings and about 50 feet lower. In addition there are some

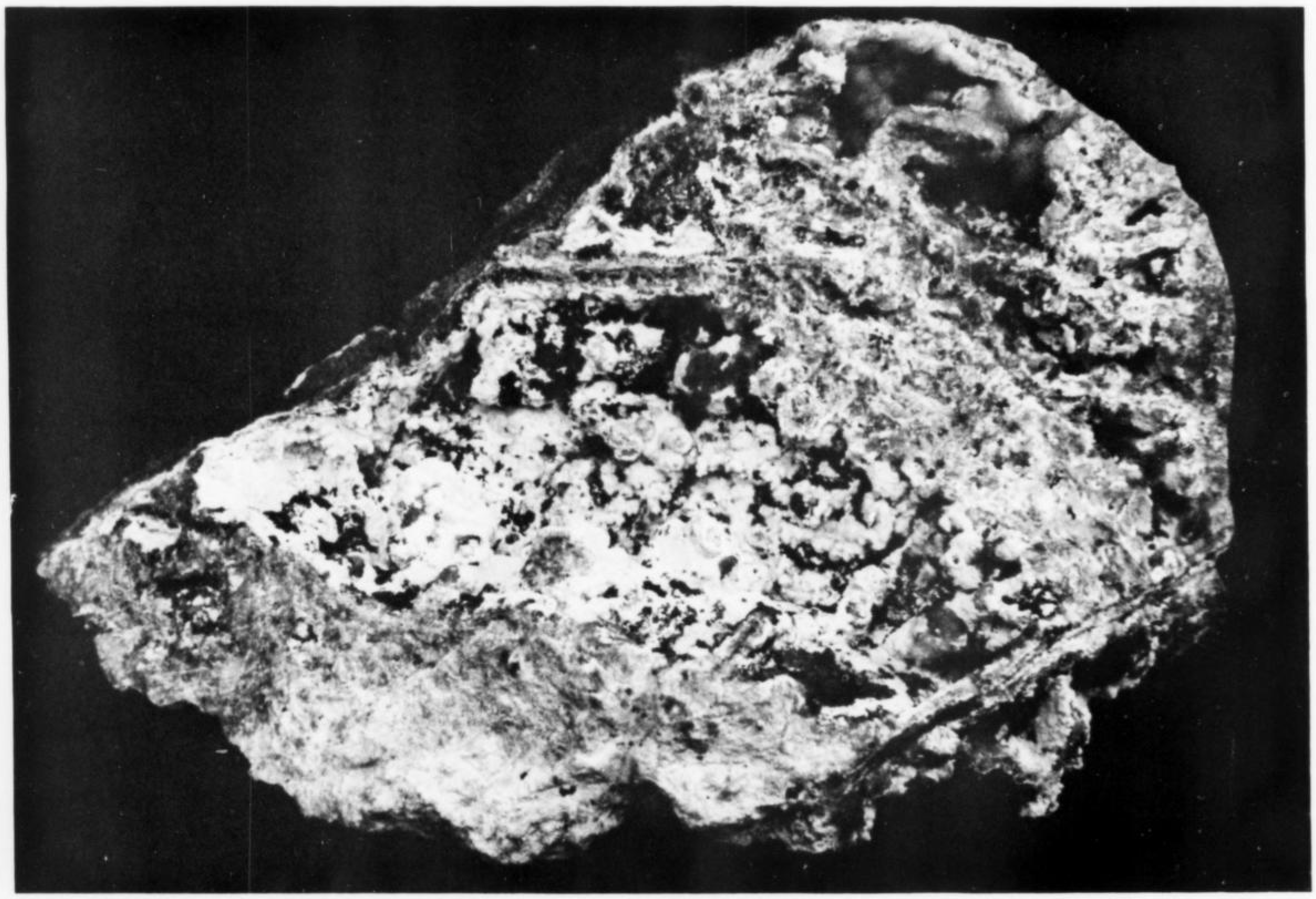


Fig. 1. **White hydrozincite, partly coated with hemimorphite. The hydrozincite is covering botryoidal pale gray and green smithsonite. The matrix is massive smithsonite. Specimen size is six by eight inches.**

small prospect pits and a few short adits scattered around the area.

DESCRIPTION OF THE DEPOSIT

The major rock type in the mine area is marble. Some limestone locally recrystallized to marble is also present. The major structural features of the mine are several faults, a few of which are mineralized. The original ore bodies appear to have been replacement deposits similar to the type presently found in the upper workings, where sphalerite, galena and chalcopyrite have replaced the marble. Oxidation has been extensive in the mine area and only the upper workings contain hypogene ore minerals. Most of the oxidized ore left in the Zinc Hill mine consists of intermixed hemimorphite and limonite. Secondary copper mineralization is common in the lower workings.

MINERALOGY

Twenty-two minerals have been identified to date from the Zinc Hill mine. Only the secondary supergene minerals are of interest. Most of the secondary crystallized material is microcrystalline. Individual crystals rarely exceed two or three millimeters in size. A complete listing of the minerals found at the Zinc Hill mine is given in Table 1. The more mineralogically interesting minerals are described below.

Smithsonite is common in the lower workings. It occurs as massive, dense, fine grained, white material; as minutely botryoidal coatings of a gray to pale green color, and as tan, up to one millimeter rhombohedral and scalenohedral crystals. The smithsonite is often coated with hemimorphite and hydrozincite (Fig. 1).

Rosasite is abundant in the lower workings in various shades of blue and green. It commonly occurs on smithsonite, as attractive sky-blue crusts coated with colorless hemimorphite crystals which in turn are partly coated with colorless to white bladed calcite crystals (Fig. 2). Rosasite is present, too, as pale green fuzzy balls and coatings on other copper minerals, and as large masses of a pale chalky green color with a botryoidal habit, similar in appearance to botryoidal malachite. The botryoidal rosasite is sprinkled with hemimorphite and calcite crystals (Fig. 2).

Malachite occurs as pseudomorphs after azurite, as coatings of brilliant green bundles a little over a millimeter in size on limonite, and as paler green velvety surfaces. Much of the malachite has been altered to rosasite.

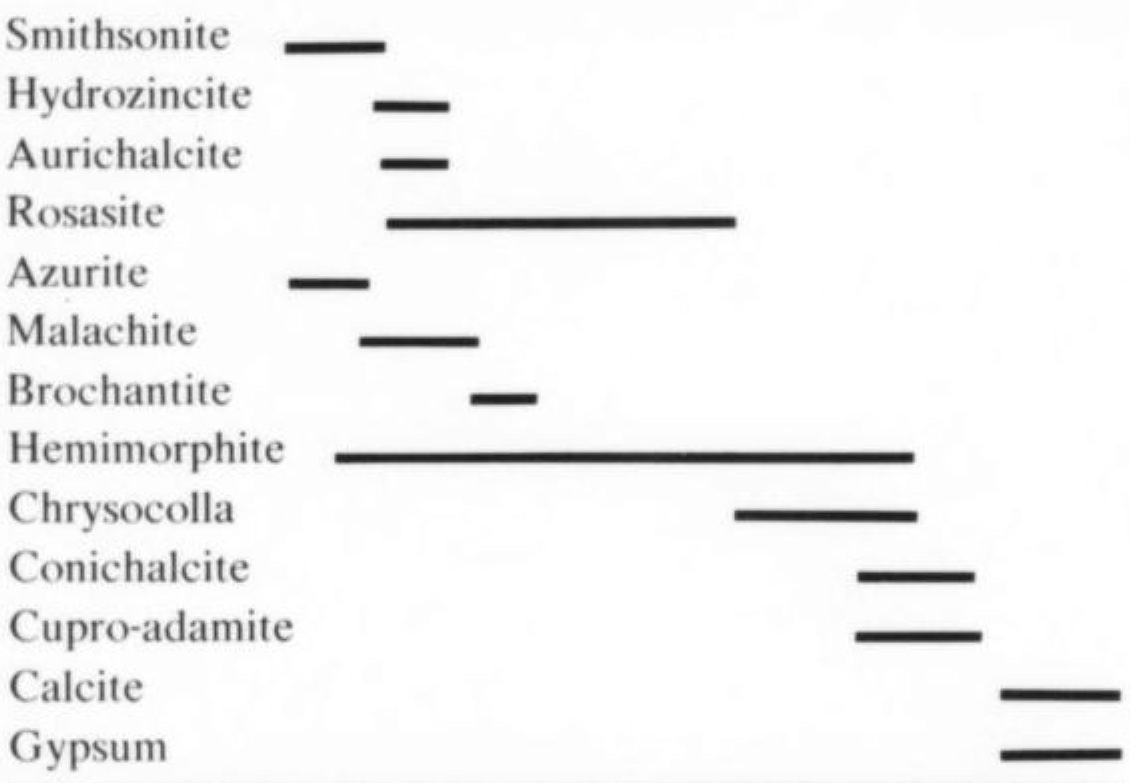
Hydrozinctie is common in all the workings adjacent to and below oxidized areas where channel-ways have been cut by descending solutions carrying zinc ions. The hydrozincite occurs as white coatings on hemimorphite and smithsonite, and in turn has sprinklings of hemimorphite crystals scattered on it (Fig. 1).

Azurite is found as deep blue drusy crusts in cavities in massive azurite and as druses on cavity surfaces in a chalky, pale blue, earthy material. Crystal size is generally less than a millimeter. Some of the azurite has tufted, pale green rosasite spheres resting on it, which make striking microspecimens.

TABLE I. Minerals found at the Zinc Hill mine.

Mineral	*Primary Location*	*Abundnace*	*Common Associates*
Sphalerite	Upper workings	Abundant	Listed sulfides
Galena	Upper workings	Common	Listed sulfides
Chalcopyrite	Upper workings	Common	Listed sulfides
Pyrite	Upper workings	Uncommon	Listed sulfides
Calcite	All workings	Abundant	All minerals
Smithsonite	Lower workings	Common	Hydrozincite, rosasite
Hydrozincite	Lower workings	Common	Smithsonite, hemimorphite
Rosasite	Lower workings	Common	Hemimorphite, smithsonite
Aurichalcite	Lower workings	Rare	Hemimorphite
Malachite	Lower workings	Common	Azurite, brochantite
Azurite	Lower workings	Common	Malachite
Cerussite	Upper workings	Rare	Galena
Anglesite	Upper workings	Rare	Galena
Brochantite	Lower workings	Common	Malachite, hemimorphite
Gypsum	Upper workings	Rare	Galena
Hemimorphite	Western workings	Abundant	All secondary minerals
Chrysocolla	Lower workings	Common	Conichalcite, brochantite
Tremolite	Rims around chert nodules	Rare	
Quartz	Upper workings	Common	Sulfides
Olivenite	Lower workings	One sample found	Limonite
Adamite	Lower workings	Uncommon	Hemimorphite
Conichalcite	Lower workings	Uncommon	Brochantite, chrysocolla

TABLE 2. Paragenetic sequence of secondary minerals in the lower workings, Zinc Hill Mine.



Aurichalcite occurs as frosty green balls, to three millimeters in diameter, forming patches up to a centimeter across, associated with hemimorphite on iron stained marble or limonite.

Hemimorphite is the prevalent mineral at the Zinc Hill mine. It is found as multiple layers of colorless or brilliant, black stained crystals forming incrustations on massive smithsonite. It is also associated with most of the secondary minerals found throughout the mine and is one of the last ore minerals to have formed.

Adamite is restricted to one small area in the lower workings. It is present as the variety cupro-adamite, and forms pale green to dark green rounded aggregates of crystals with individual groups seldom exceeding a diameter of two millimeters (Fig. 3).

Conichalcite is found associated with brochantite, azurite and chrysocolla. The conichalcite forms beadlike balls up to one-half millimeter in diameter that form aggregates up to several millimeters in diameter (Fig. 4). No other arsenates have been found directly associated with the conichalcite. This was one of the first recorded occurrences of conichalcite in California (Pemberton, 1969).

Brochantite occurs as light to dark emerald green crystals. It is found in two habits; one as acicular radiating groups of light emerald green color, and the other as darker prismatic crystals.

PARAGENESIS

In order to discuss the sequence of crystallization of the minerals at the Zinc Hill mine, two areas of good exposure in the lower workings are considered; an open stope and an open cut dug at right angles to a mineralized fault zone.

In the stope, smithsonite is the first supergene mineral to have formed, followed by aurichalcite or rosasite; if no copper was available, hydrozincite formed rather than aurichalcite or rosasite. The final metal-bearing mineral to form in the stope was hemimorphite. Local variations

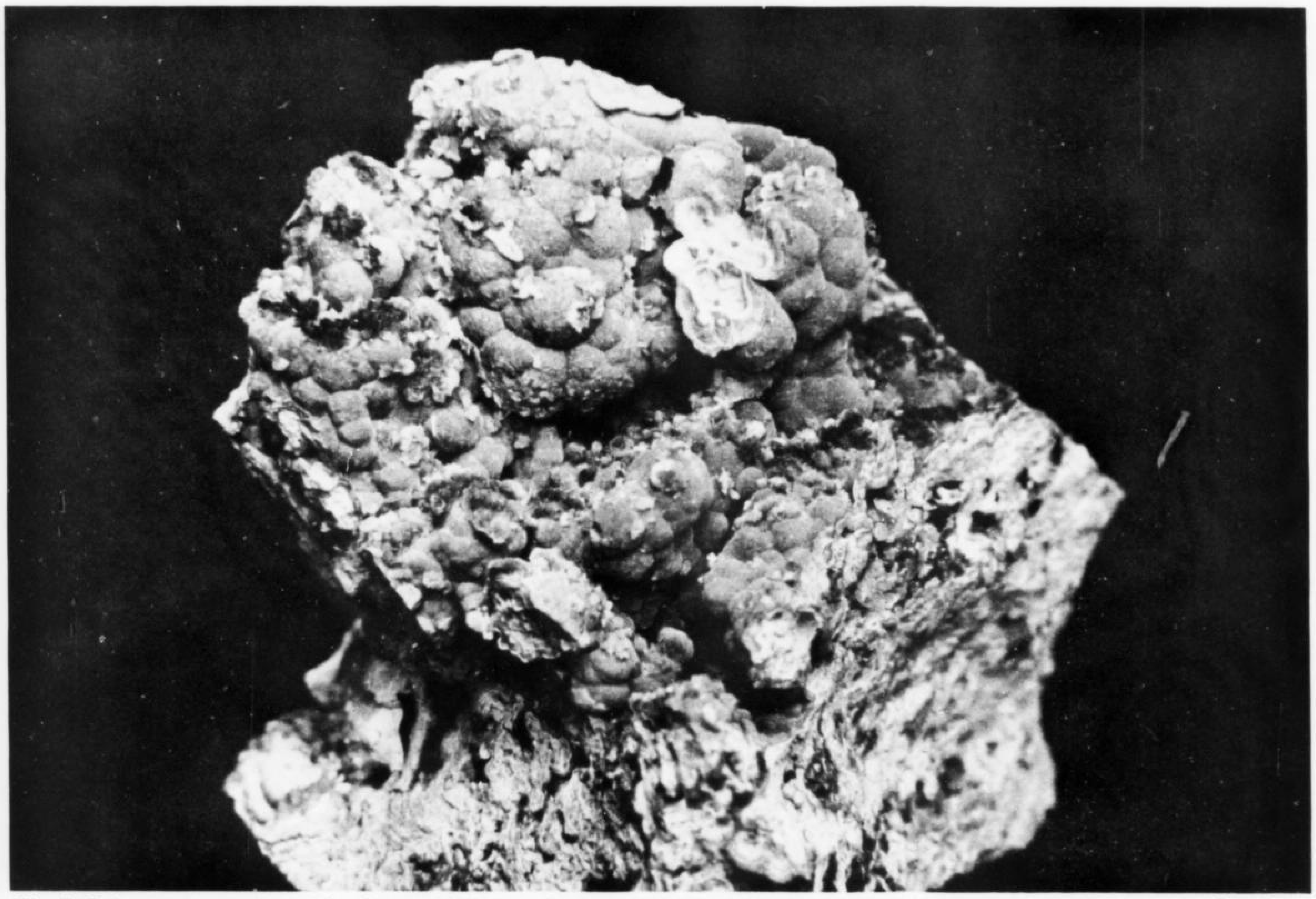


Fig. 2. **Pale green rosasite with a botryoidal form. Scattered blades of hemimorphite are present on the rosasite. Specimen size two by three inches.**

Fig. 5A.

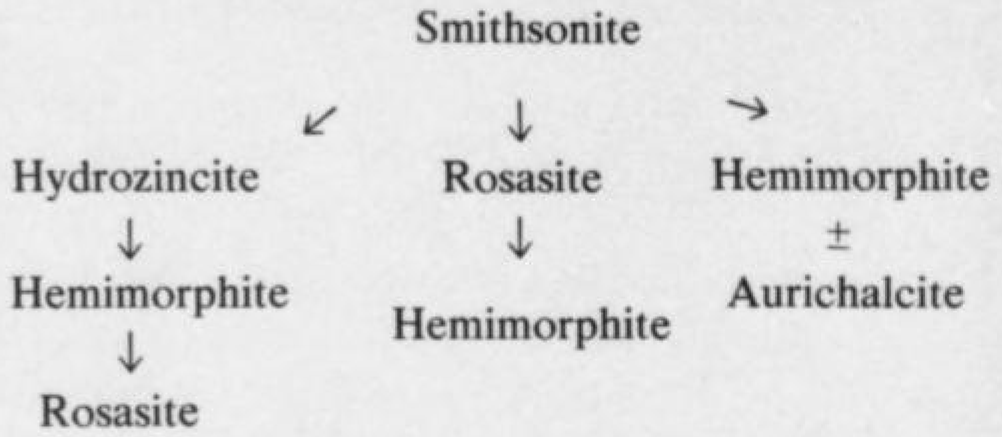


***Fig. 5A.* Diagrammatic scheme showing the order of secondary mineral crystallization in the large stope of the lower workings, Zinc Hill mine.**

Fig. 5B.

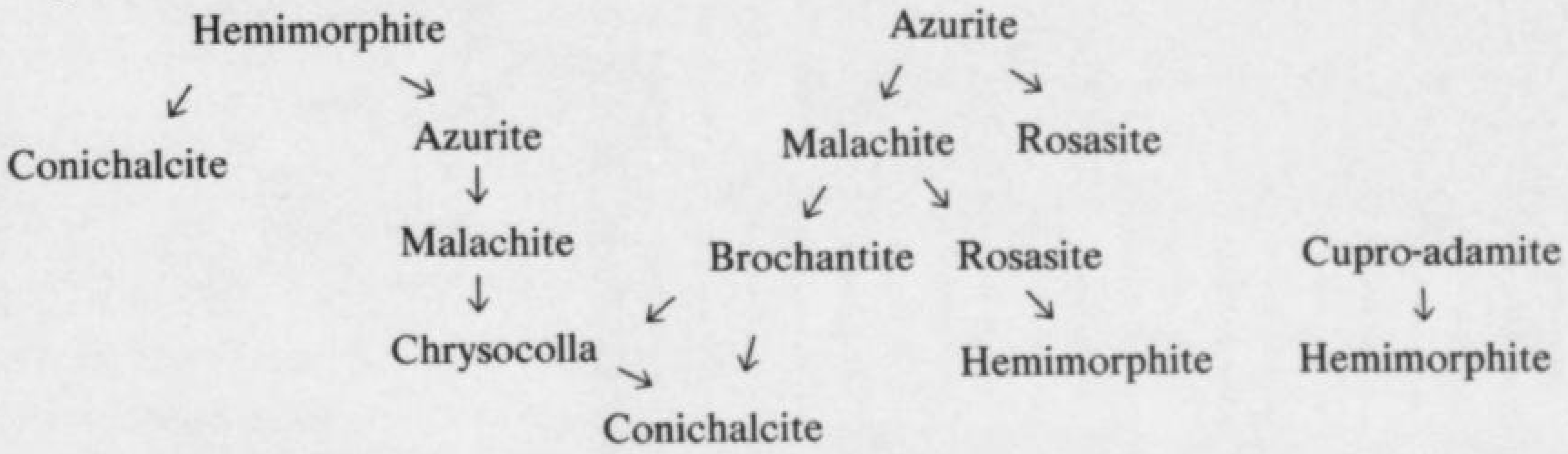


***Fig. 5B.* Diagrammatic scheme showing the order of secondary mineral crystallization in the area of the copper fault of the lower workings, Zinc Hill mine.**

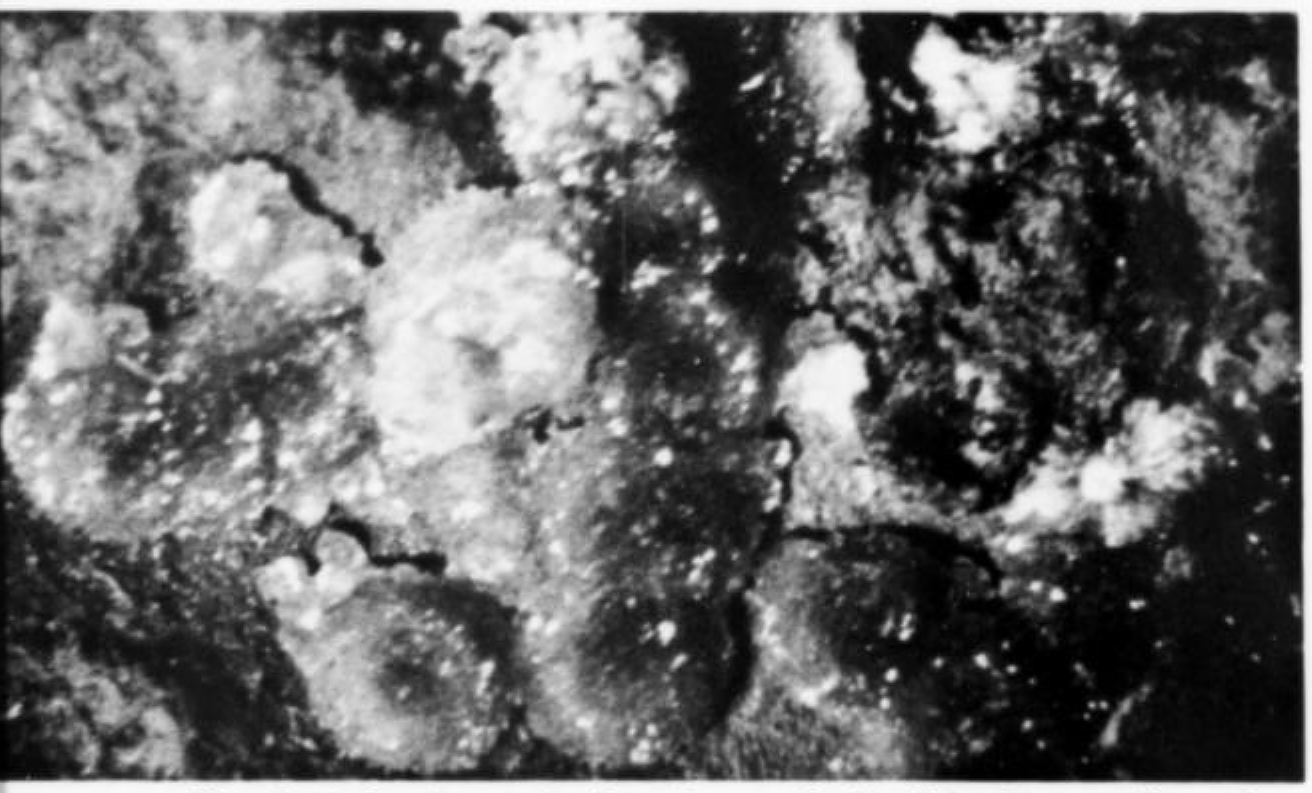


***Fig. 3.* Adamite as isolated rounded spherules on limonite. The adamite is light green. Individual spherules are two millimeters in diameter.**

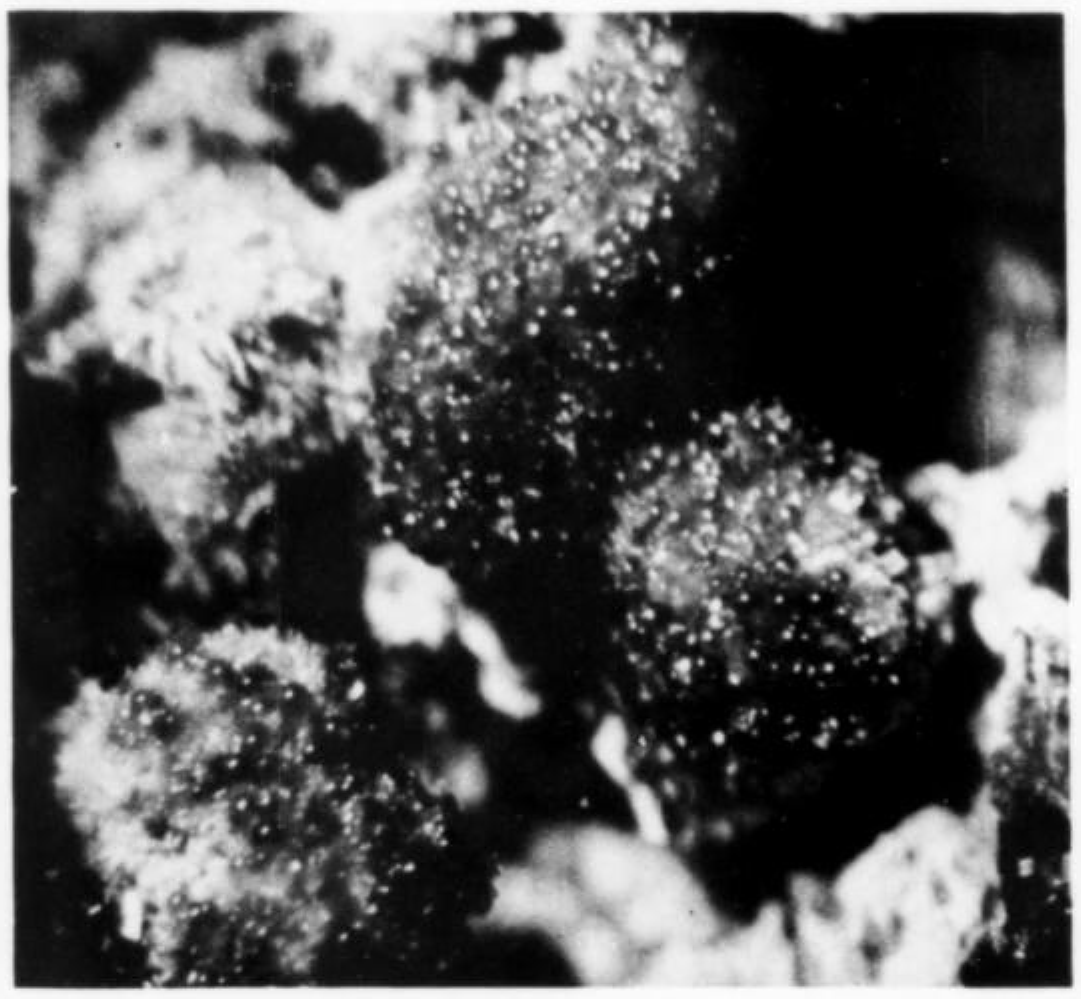


***Fig. 4.* Conichalcite in bright emerald green, globular aggregates. The matrix is brochantite. The globular aggregates are about three millimeters in diameter.**

occur, as in the entrance to the stope, where the sequence was smithsonite-hemimorphite-rosasite (Fig. 5A).

In the area of the fault the sequence of crystallization of the secondary minerals is more complex (Fig. 5B). In small vugs in the marble near the fault, hemimorphite formed first, followed by azurite and copper-zinc carbonates. In areas where oxidation was more severe, hemimorphite formed near the end of the crystallization sequence, after formation of azurite, malachite and rosasite. Brochantite formed later than malachite and often occurs as crystal coatings on massive malachite. The two arsenates conichalcite and cupro-adamite occur in the fault area, but they are not found together. Cupro-adamite is usually found with hemimorphite. Conichalcite is commonly found without any associated hemimorphite.

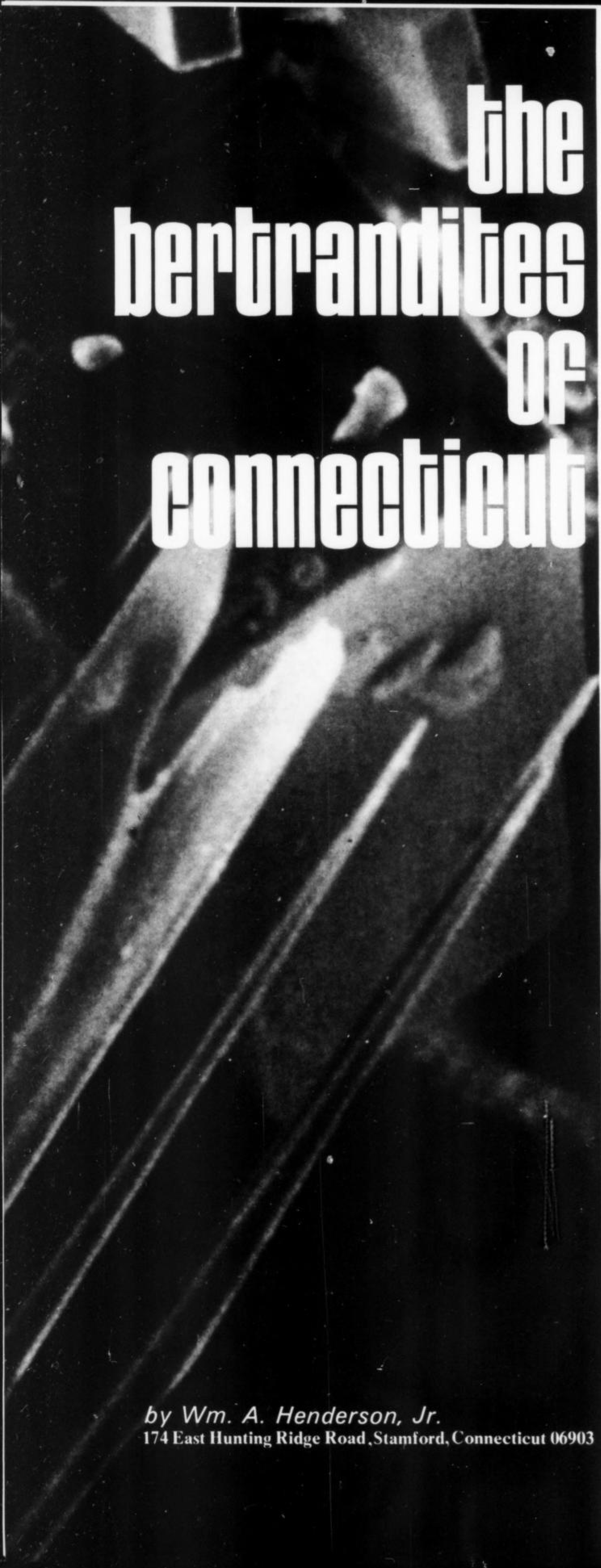
As a general trend, the first supergene minerals formed were the carbonates. They were followed by the sulfate brochantite. The brochantite was followed by the silicates, hemimorphite and chrysocolla. The arsenates formed last. The non-metal bearing minerals calcite and gypsum crystallized as the final stage.

REFERENCES

HALL, W. E. and E. M. MACKEVETT, 1958. Economic geology of the Darwin guadrangle, Inyo County, California: *Calif. Div. of Mines. Special Report* **51**, 15-18, 44-49.

PALACHE, C., H. BERMAN, and C. FRONDEL, 1951. *The system of mineralogy*, 7th Edition, Volume II. John Wiley & Sons, New York, New York, 251-252.

PEMBERTON, H., 1969. Minerals of California for 1965-1968. *The Mineral Explorer*, **3**, 18.



the bertrandites of connecticut

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My interest in bertrandite dates back to 1955, when I took an unknown collected at the Strickland quarry, Portland, Connecticut, to Neal Yedlin for identification. The specimen, found to be bertrandite, was mounted by Mr. Yedlin, and became the first micro specimen in my collection. The mineral has fascinated me ever since.

Although not brilliantly colored, bertrandite is of interest to other collectors because of its fine crystallization and its bewildering variety of crystal forms and shapes. Being rather inconspicuous, it is a bit difficult to find.

Bertrandite is found in greisens and granites, but most often in pegmatites. The formulas for beryl and its more interesting alteration products are given below.

Beryl	$Be_3Al_2Si_6O_{18}$
Bertrandite	$Be_4Si_2O_7(OH)_2$
Bavenite	$Ca_4BeAl_2Si_9O_{24}(OH)_2$
Phenakite	Be_2SiO_4

Generally speaking, non-hydrated minerals tend to be formed at higher temperatures than hydrates. This is the case with the beryllium minerals, where the primary mineral beryl lacks water. Phenakite, too, is usually primary. However, field observations (Pough, 1972) and laboratory studies (Bukin, 1967) show that it tends to form at slightly lower temperatures than beryl. It is sometimes formed as an alteration product of beryl (Orlov, 1961).

Bertrandite, a hydrated mineral, is almost always formed as a hydrothermal alteration product of beryl. In the laboratory, it is formed at temperatures as low as 300°, and in either basic or acidic solution (Bukin, 1967). Phenakite, formed at higher temperatures, is corroded and altered to bertrandite. The presence of fluoride or carbonate in solution appears to promote dissolution of beryl and migration of the beryllium-bearing solutions to reprecipitate as bertrandite elsewhere (Govorov and Stunzhas, 1963), while in their absence, beryl alters to bertrandite in place. Bavenite, as its formula suggests, appears to be formed hydrothermally also, but under conditions where higher concentrations of calcium are present.

Bertrandite is generally believed to be an uncommon mineral. In publications with general circulation, it has been reported from only one Connecticut locality; the Strickland quarry, Portland. (Zodak, 1937). In club bulletins and local guidebooks, it has been reported from the Selden and Slocum quarries, East Hampton, and the Tollgate quarry, Middletown (Schooner, 1958), as well as the Biermann quarry, Bethel, the Captain Cook quarry, Dodgingtown, the Branchville pegmatite, Branchville, and the Ridgefield pegmatite, Ridgefield (Januzzi, 1961).

It is much more likely, though, that bertrandite is merely unobtrusive rather than uncommon, as it is known to the author from no less than 19 localities in the state. These are listed in Table I and shown on the map in Figure 1. The localities fall in two areas, the Hartland formation of western Connecticut and the pegmatite area bordering the Connecticut River.

Bertrandite is by far the most common alteration product of beryl in Connecticut. Of the other alteration products, bavenite has been reported from the junction of Route 9 and Beaver Meadow Road (Henderson, 1970) and the Hewitt quarry (Schooner, 1966), both in Haddam, and is said to occur sparingly at the Slocum quarry, East Hampton (Schooner, 1966). Phenakite is believed to occur in a railroad cut in East Hampton (sight identification, Schooner, 1966).

With two possible exceptions, all the Connecticut bertrandite localities are hydrothermally altered pegmatites. The doubtful localities are Thomaston, where it occurs with chlorite and anatase in pockets in white feldspar collected from loose rock in a road cut, and Trumbull, where it occurs in another road cut in a stringer of white feldspar.

The pegmatites vary greatly in size, the Strickland quarry being at least 150 feet long. Others, such as that on Rolling Meadow Road, are pegmatite bodies only two or three feet wide with a beryllium bearing portion only a foot or so in greatest dimension and containing less than five pounds of beryl.

The mineral is best found in these bodies by looking for small, white to colorless crystals, often iron stained, easily mistaken for feldspars, and occuring in aggregates as in Figures 2 and 3. The blocky form in Figure 3 is most common. Corroded beryl or empty hexagonal cavities after beryl are good indicators that bertrandite is near. In fact, the mineral often occurs in these cavities, as in Figure 4. The crystals are typically completely hidden from view

Table I Bertrandite Localities of Connecticut

Number[a]	Town	Name or Location
1	Colebrook	Colebrook Dam
2	East Morris	Morris Dam
3	Thomaston	Route 109 road cut
4	Woodbury	Woodbury pegmatite
5	Bethel	Biermann quarry
6	Dodgingtown	Captain Cook quarry
7	Ridgefield	Ridgefield pegmatite
8	Branchville	Branchville pegmatite
9	Pound Ridge,[b] (New York)	Rolling Meadow Road
10	Trumbull	Parlor Rock Road
11	Middletown	White Rocks quarry
12	"	Toll Gate quarry
13a	Portland	Strickland quarry
13b	"	Pelton quarry
14	Cobalt or East Hampton	State Forest mine
15	East Hampton	Slocum quarry
16	"	Selden quarry
17	Haddam	Hewitt's quarry, Turkey Hill
18	"	Route 9 and Beaver Meadow Road
19	"	Connecticut Yankee Atomic Power Plant

a. Numbers correspond to those on the map, Figure 1.
b. Although in New York, the Rolling Meadow Road locality is listed as it is less than 100 feet from the Connecticut state line.

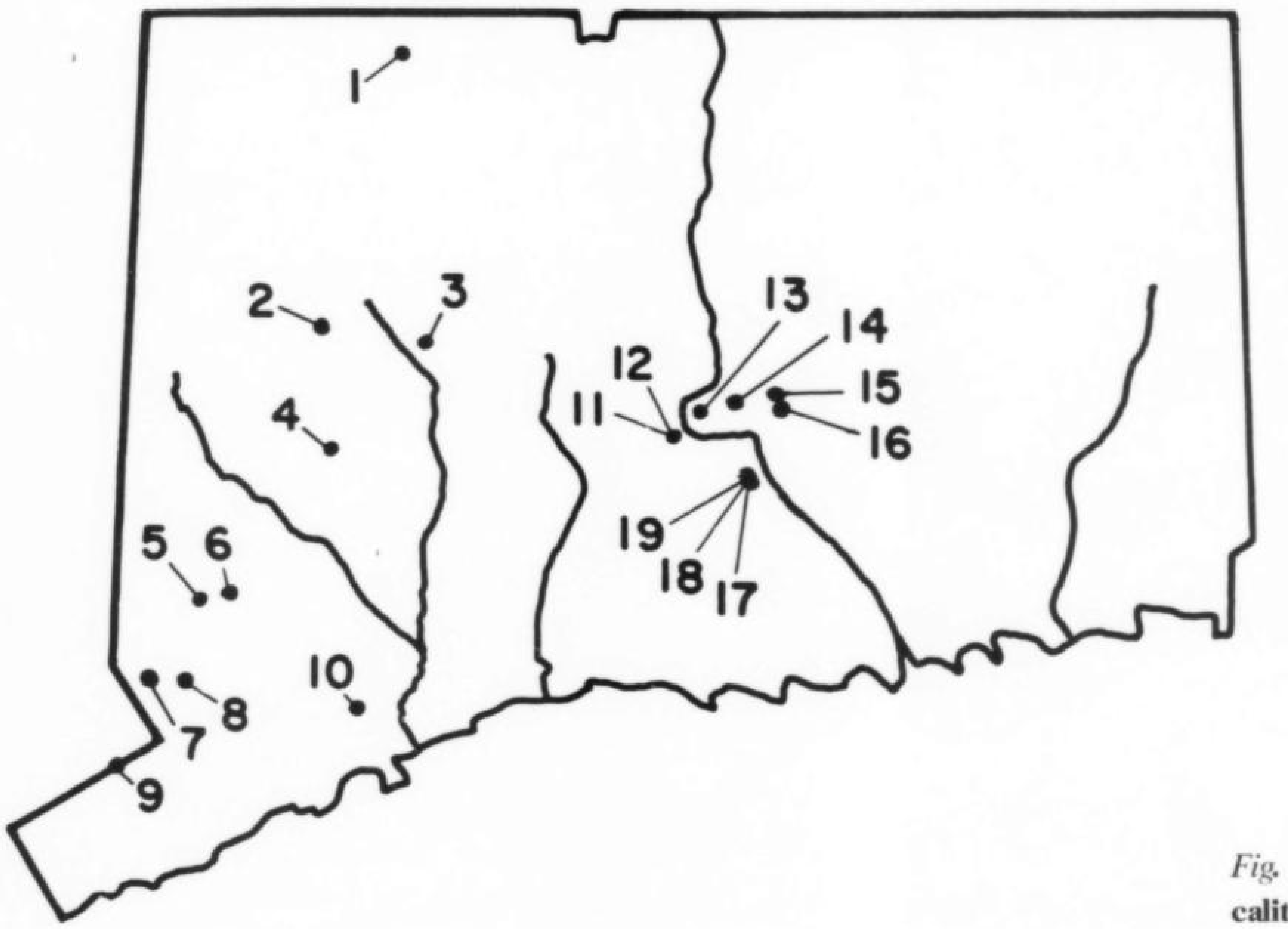


Fig. 1. **Connecticut bertrandite localities. For key to map, see Table I.**

beneath a coating of iron oxides or clays. Soaking in oxalic acid removes the former, but not the latter.

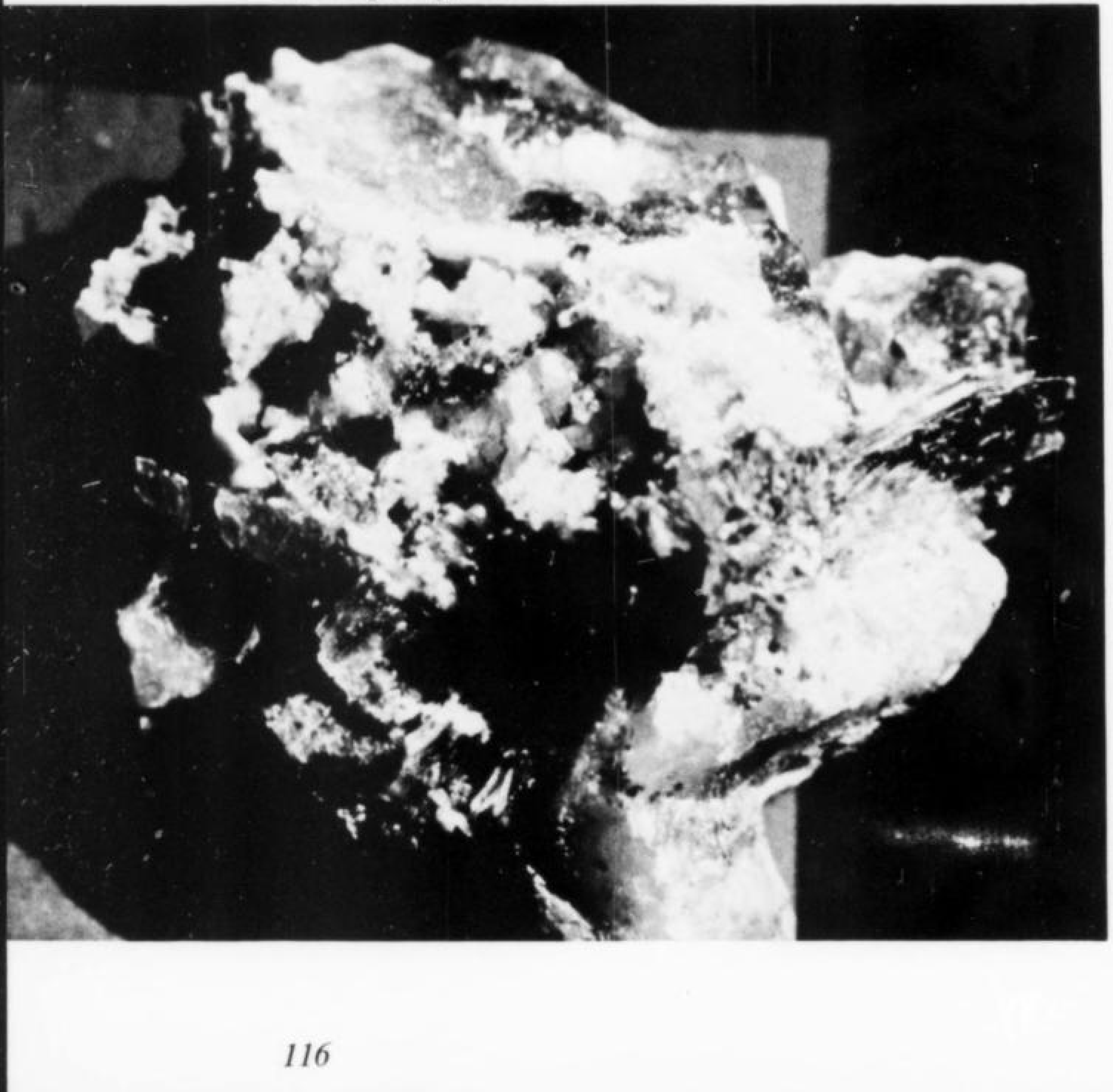
Other alteration products of beryl found associated with bertrandite in the beryl cavities in Connecticut are bavenite, quartz, albite, adularia, muscovite, chlorite and clays. In a single instance, pseudomorphs after beryl have been found composed of an inner core of deep green, subhedral torbernite crystals surrounded by an outer rim of bertrandite crystals. These pseudomorphs, from the Woodbury pegmatite, are most interesting as there is no chemical relationship whatever between the original beryl and the torbernite replacement.

Very rarely, beryl cavities are found in which relict beryl is in intimate relationship with large, well-formed bertrandite crystals. More commonly, while beryl is still present, the bertrandite is only found as very finely divided, almost clay-like particles. Figures 5 and 6 show relict beryl as parallel needles; small to large, blocky bertrandites as twins and singles; and rhomb-shaped feldspar crystals, all within hexagonal beryl cavities.

Collectors with a background in chemistry or physics might wonder why beryl and certain other minerals etch to give a completely different crystal form from that in which they grew. Why, if the etching process is the reverse of the growth process, does beryl, which grows in columnar hexagonal prisms, etch to give extremely slender needles? The answer must lie in the fact that the growth process occurs under higher temperature conditions and in contact with a different composition solution than does the etching process.

In the following pages, the Connecticut bertrandites will be described. Most were identified by sight. In the very few cases where there was any doubt as to the mineral's being bertrandite, it was checked by optical means (indices, parallel extinction, lack of twinning).

Fig. 2. **Iron stained bertrandite in cavity after beryl. Biermann quarry, Bethel.**



The crystal forms described were identified using a homemade goniometer (Henderson, 1970), those forms previously reported being indexed as shown in Table II. Because the goniometer was only accurate to 1/2°, the few forms seen which might be new are not reported.

Fig. 3. **Equant bertrandite crystals, some twins. Hewitt's quarry, Haddam. Forms a,b,c.**

Fig. 4. **Bertrandite in hexagonal cavity after beryl. Biermann quarry, Bethel.**

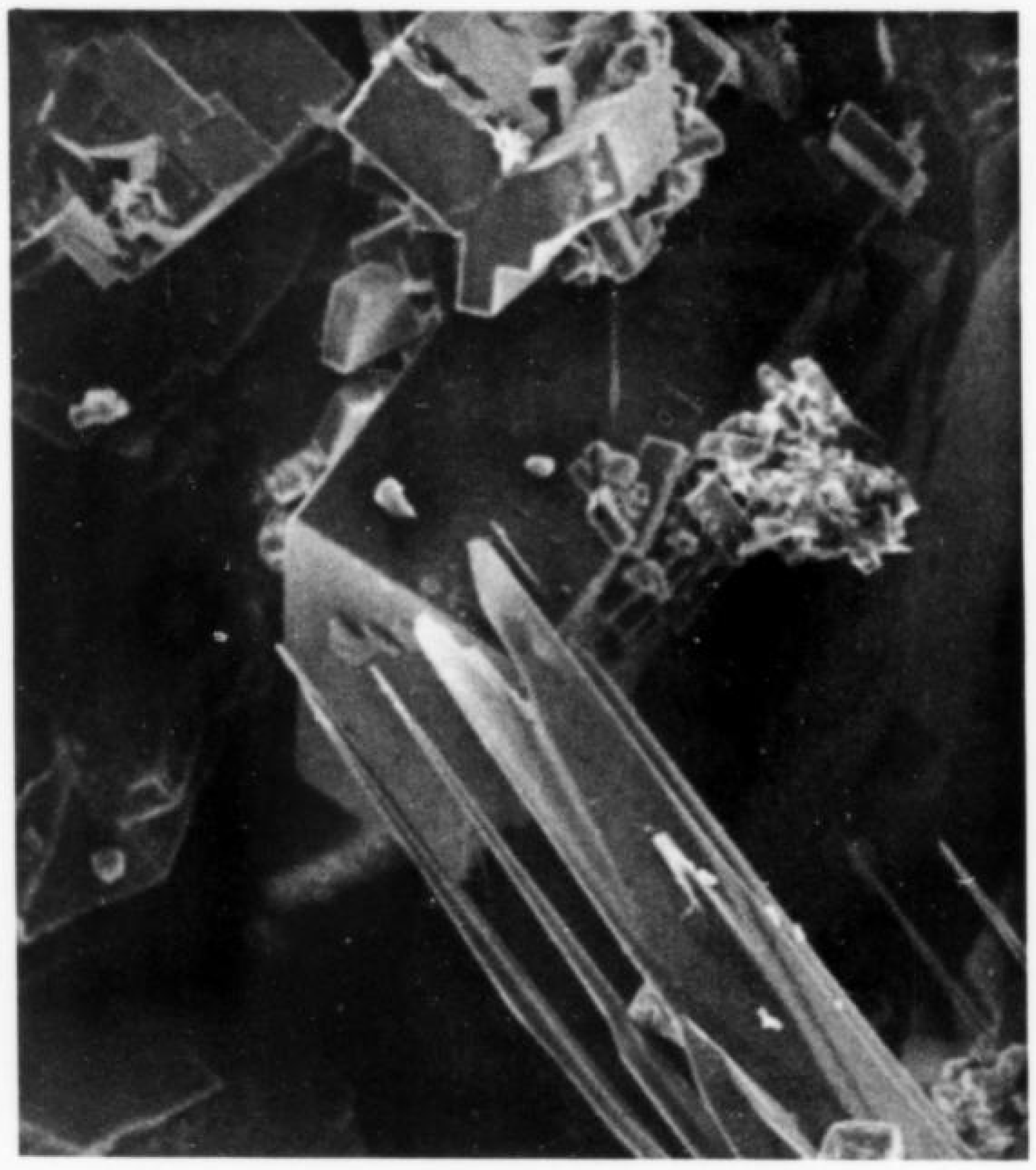


Fig. 5. **Bertrandite single crystals and trilling on feldspar with residual parallel needles of beryl. Biermann quarry, Bethel.**

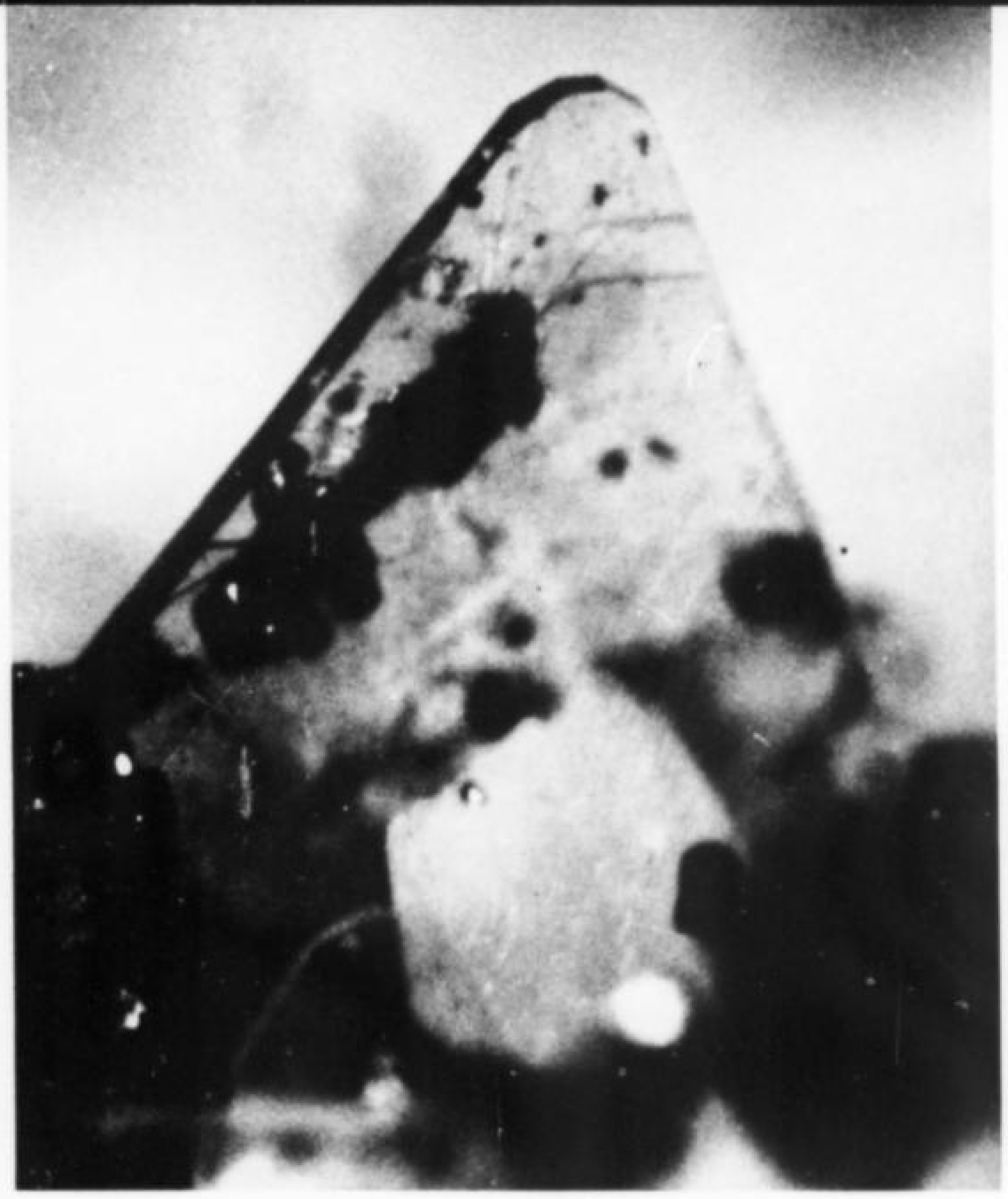


Fig. 7. **Transparent bertrandite flattened normal to the c-axis with pyrite on feldspar. Strickland quarry, Portland. Forms b,c,m,f.**

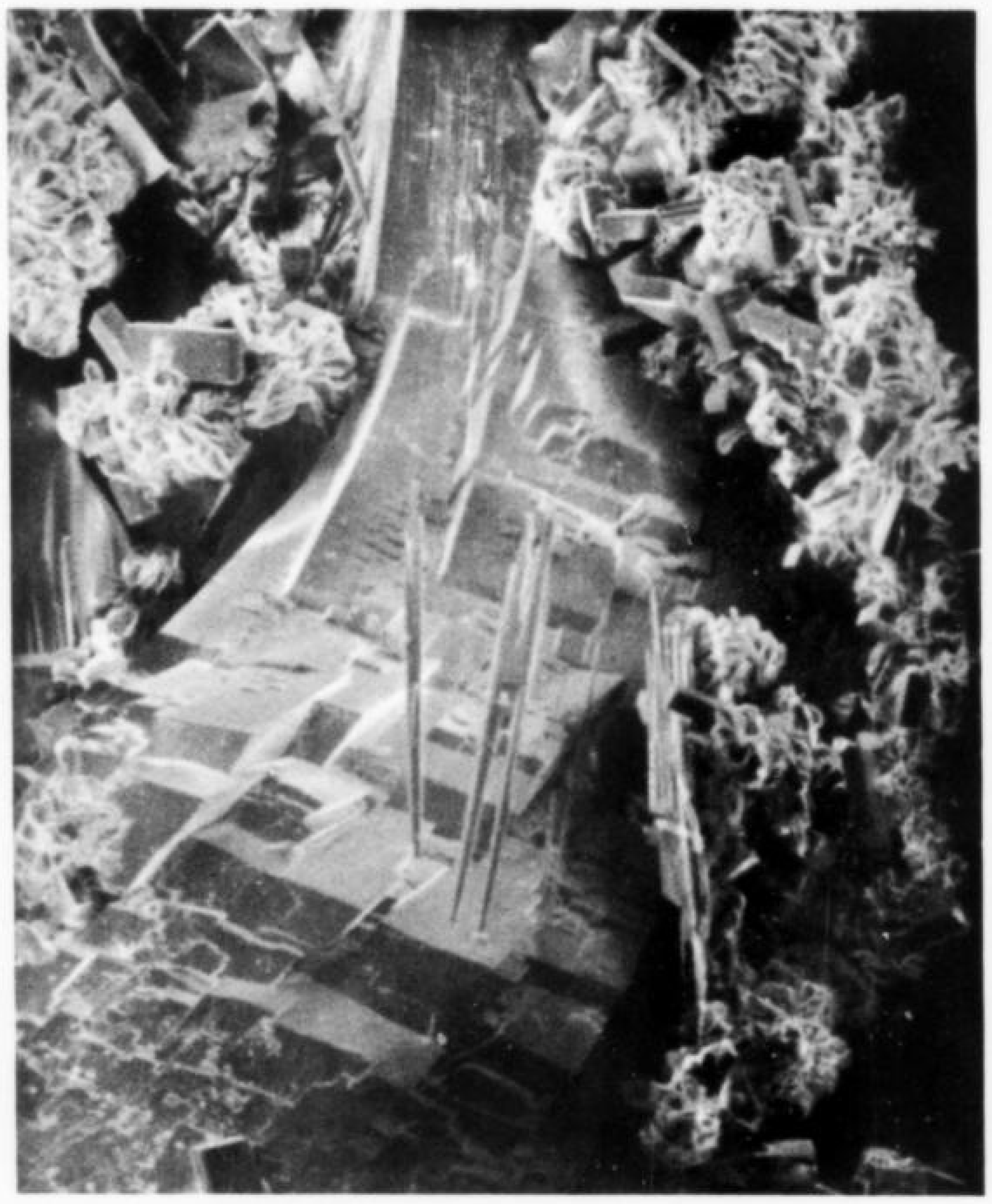


Fig. 6. **Very fine bertrandite, clay (?) and relict needles of beryl. Biermann quarry, Bethel.**

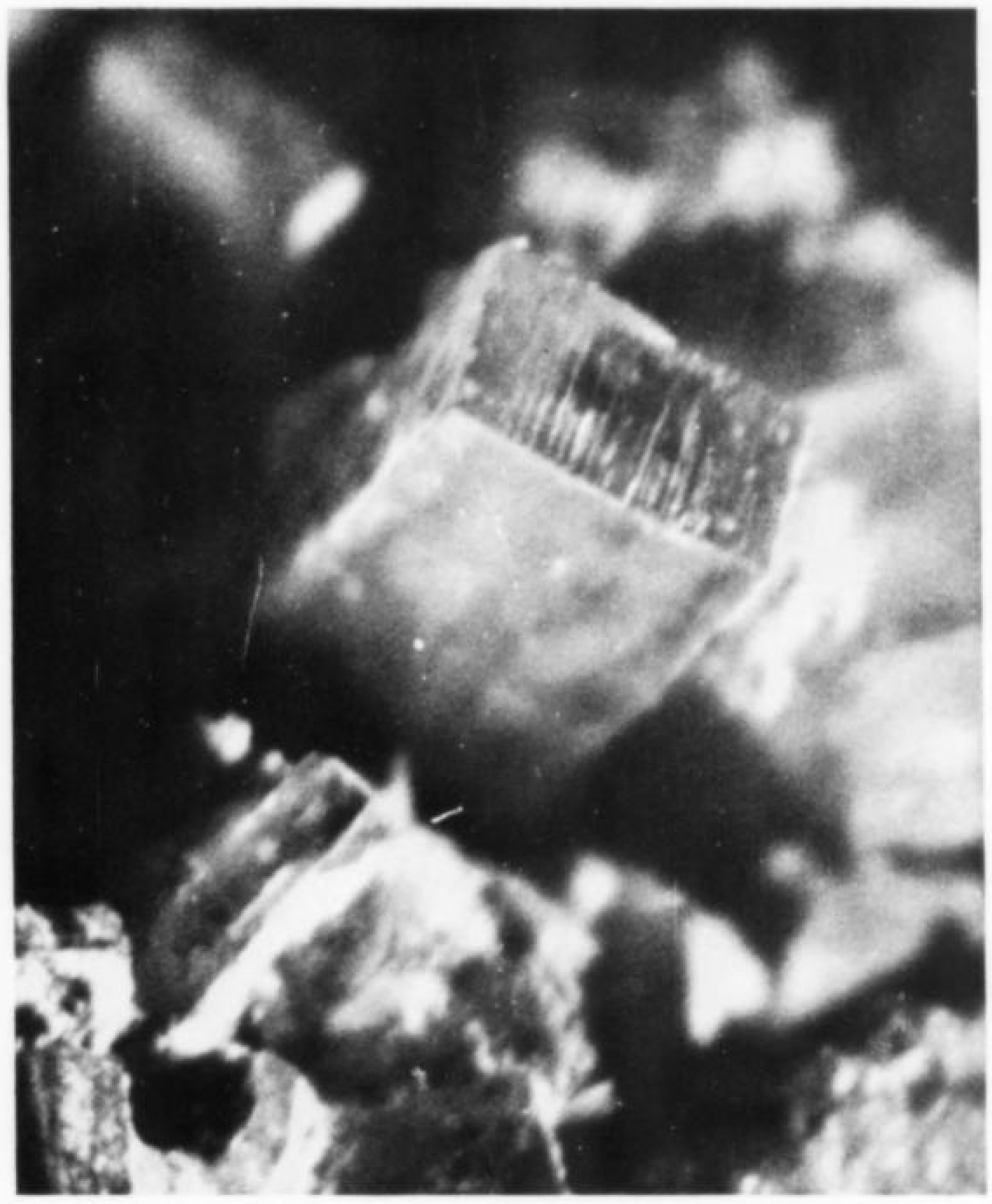


Fig. 8. **Iron stained bertrandite displaying simple form. Ridgefield pegmatite, Ridgefield. Forms a,b,c,m.**

In Figure 7 is shown a thin, transparent crystal of bertrandite, one of those on the first micro specimen of bertrandite found by the author. The crystal is associated with pyrite, and is the only one the author has seen which is colored other than by surface deposits of iron stains. Viewed on edge, it and its fellows are a distinct pink. Pale shades of yellow and blue have been reported (Schooner, 1958) for bertrandite from the Strickland quarry, and pale blue-green bertrandites are known from the Connecticut Yankee Atomic Power Plant (Weber, 1973).

Perhaps the commonest habit of bertrandite is that shown in Figure 8. This is an almost equant, blocky crystal, flattened normal to and striated parallel to the c-axis. Except for the striations, it shows only the three pinacoids, although close examination of most such simple bertrandites shows slight modification by other forms.

Figures 9 and 10 show bertrandites flattened normal to the *c*-axis and elongated parallel to the *b*-axis and *a*-axis, respectively. The latter in addition shows the hemimorphic character of bertrandite, about which more will be said later. These two rather complex crystals by chance show all the known crystal forms observed by the author on Connecticut bertrandites.

The bertrandite in Figure 11 is almost round in aspect, and is again flattened normal to the *c*-axis. The rounding results from extremely well developed alternation of faces in the zone of the *c*-axis. As is shown in Figure 12, bertrandite may also be elongated parallel to the *c*-axis. The striations allow quick orientation of the crystal.

The crystals shown in Figures 13 and 14 illustrate the great variety in habit of bertrandite from a single locality. The first crystal is so flattened normal to the *c*-axis that it is completely transparent, while the second is almost equant.

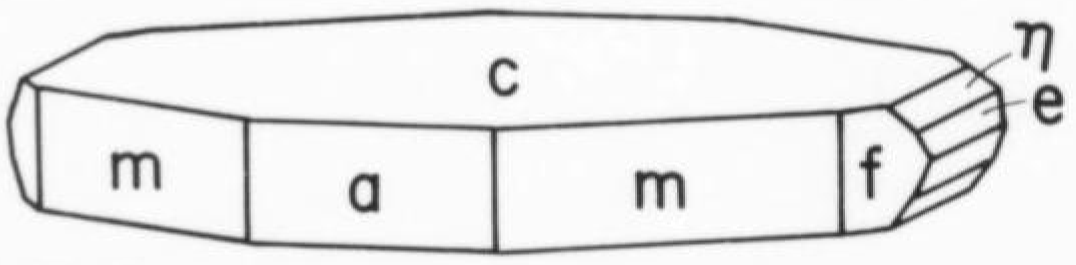


Fig. 9

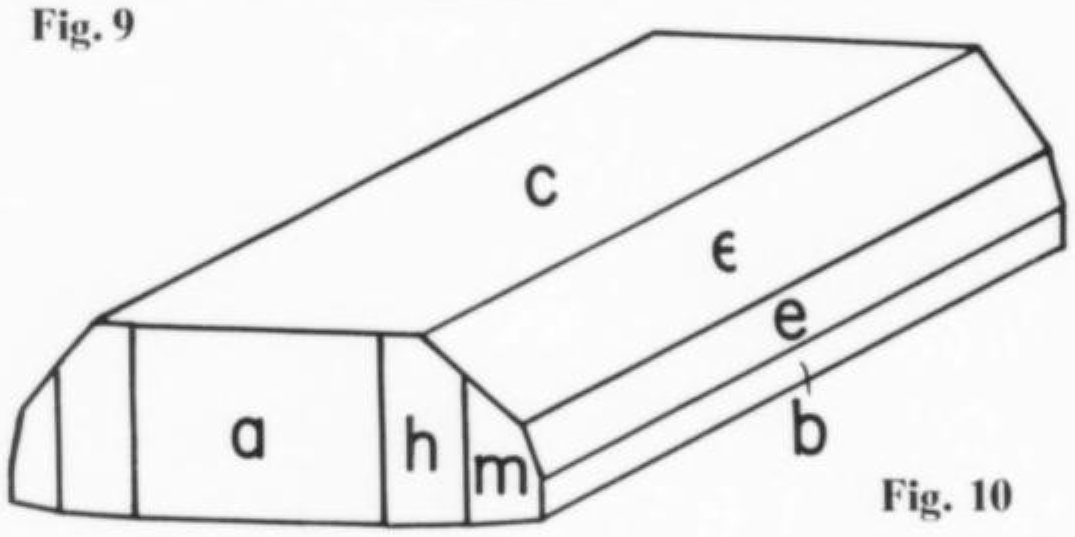


Fig. 10

Fig. 9. **Complex bertrandite crystal. Slocum quarry, East Hampton. Forms a,c,e,f,m,η.** ***Fig. 10.*** **Hemimorphic bertrandite crystal. Strickland quarry, Portland. Forms a,b,c,e,h,m,ϵ.**

Table II. Bertrandite
Orthorhombic; pyramidal - m m 2
a:b:c = 0.5688:1:0.5974

Form	Miller Index	ϕ	ρ = C
c	001		0° 00′
b	010	0° 00′	90 00
a	100	90 00	90 00
f	130	30 22	90 00
m	110	60 22	90 00
g	320	69 14	90 00
h	310	79 16	90 00
ϵ	011	0 00	30 52
η	021	0 00	50 05
e	031	0 00	60 51

Fig. 11. **Rounded bertrandite crystal flattened normal to the c-axis. Slocum quarry, East Hampton. Forms a,b,f,h,m.**

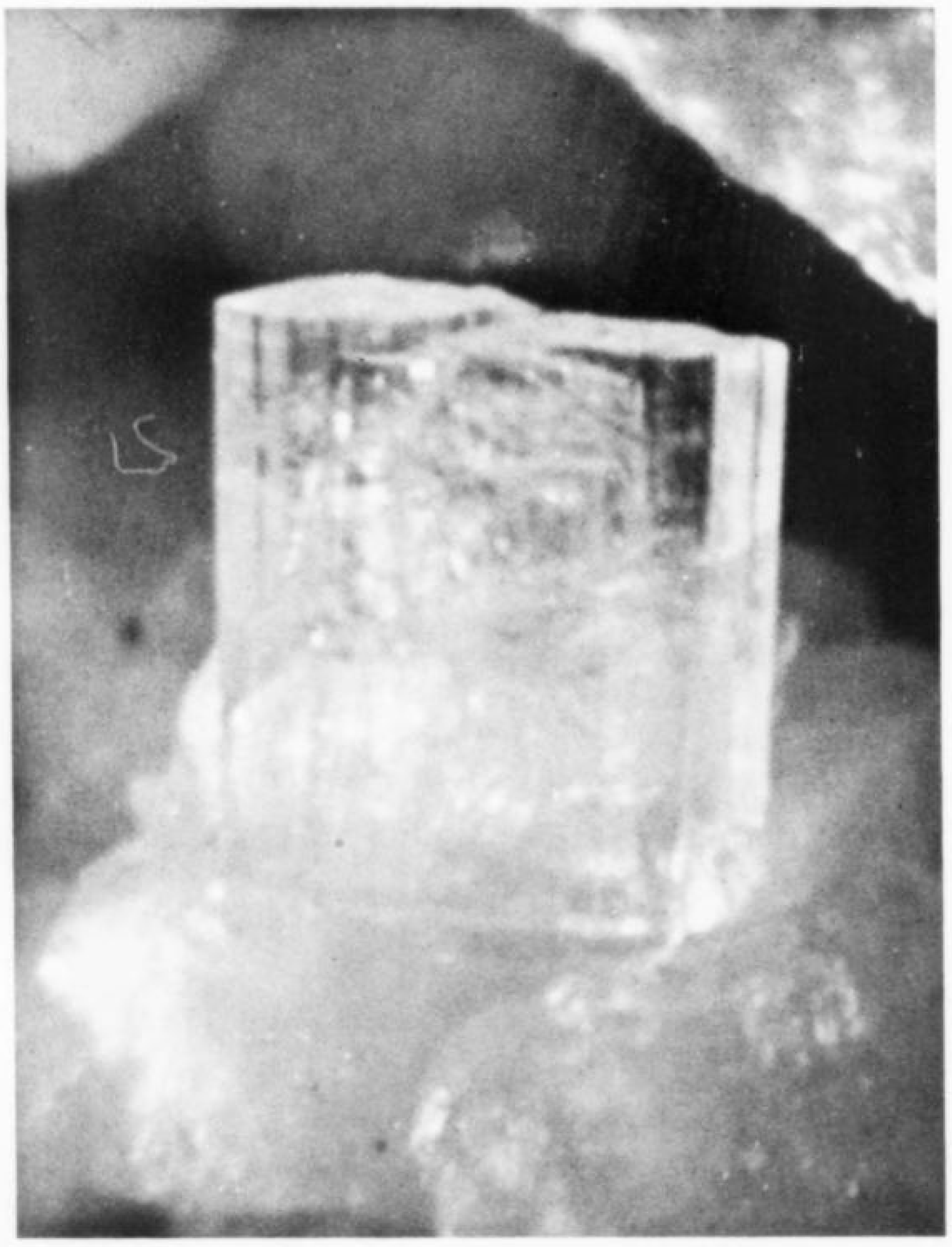


Fig. 12. **Bertrandite crystal elongated parallel to the c-axis. State Forest mine, Cobalt. Forms a,b,c,f,g,m.**

The bertrandite shown in Figure 15 is interesting for its associate, extremely small dipyramids of cassiterite identified by a positive test for tin. The cassiterite is formed directly on bertrandite, and thus must be later. Previously, it was the author's belief that cassiterite was invariably a high temperature mineral, but this specimen appears to show otherwise. Indeed, so widespread is the belief in the high temperature origin of cassiterite that the identity of one or the other of the minerals involved was challenged by one of the referees of this paper. Subsequently, the identity of the two has been proven by their x-ray powder patterns.

Other interesting and unusual associations of bertrandite are found at the Strickland quarry in addition to the above

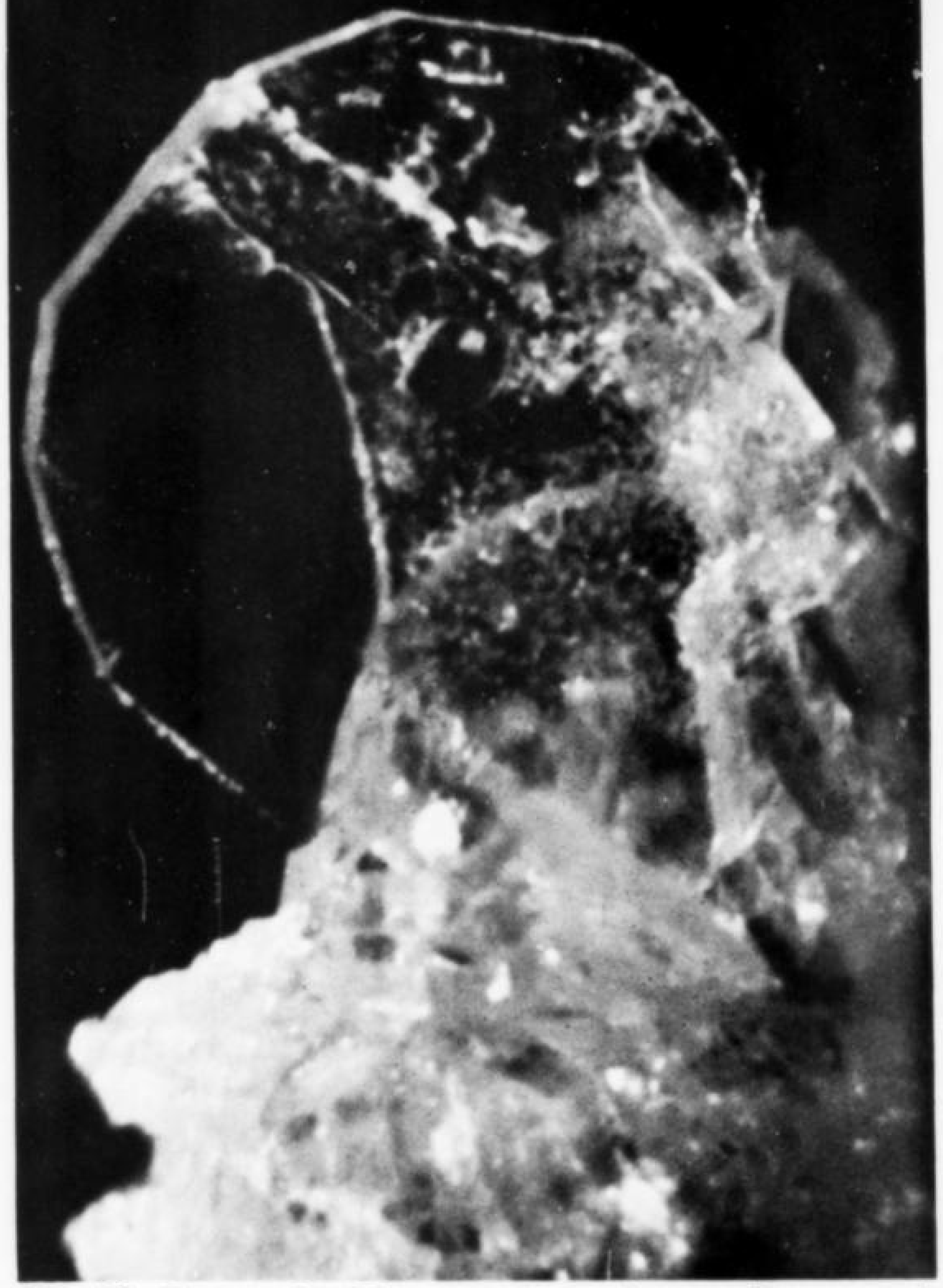


Fig. 13. **Extremely thin, transparent bertrandite crystal. Branchville pegmatite, Branchville. Forms a,b,f,m.**

Fig. 14. **Bertrandite elongated parallel to the c-axis. Branchville pegmatite, Branchville. Forms a,b,c,f,m.**

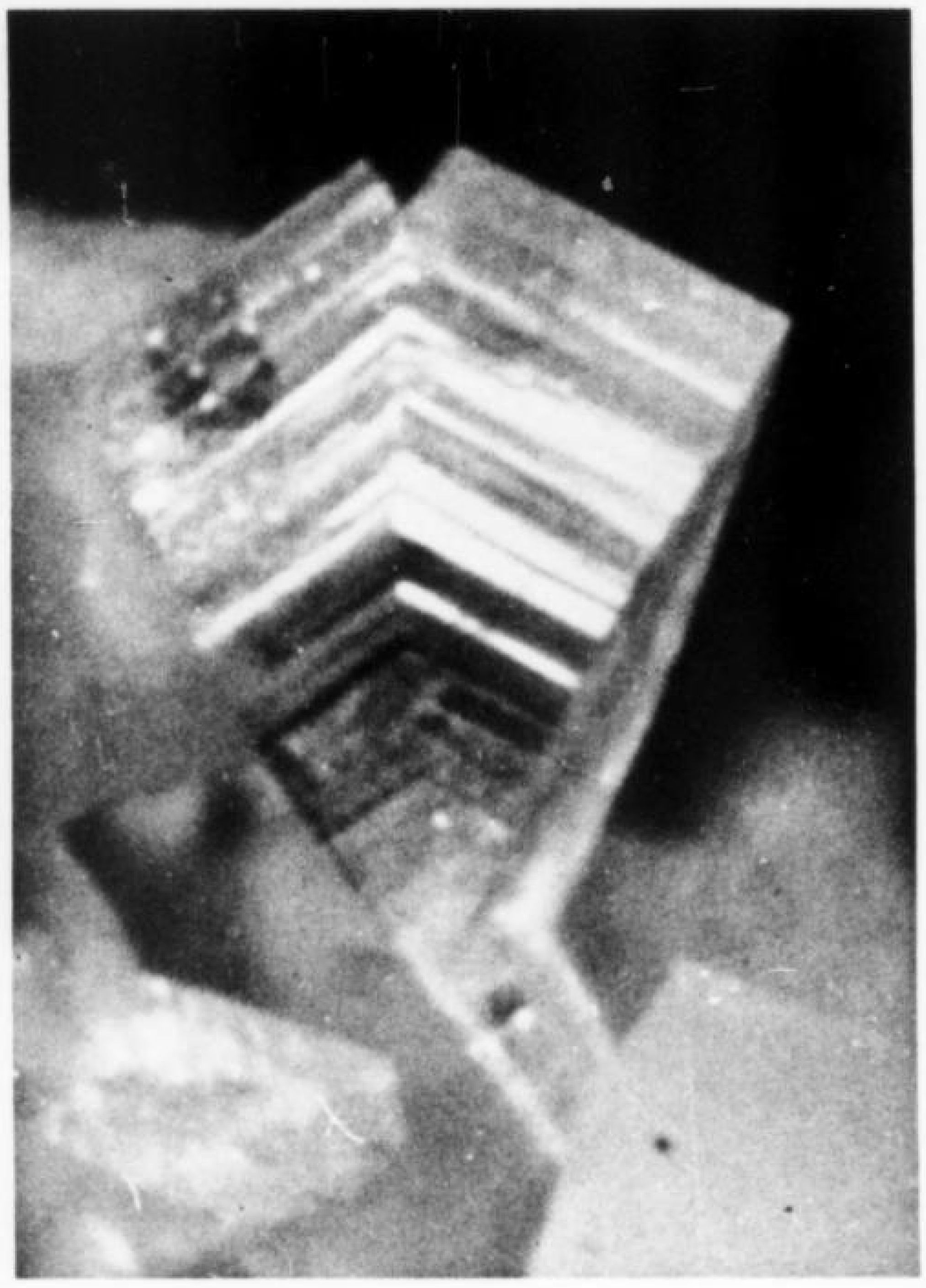
paragenetic sequence. Tabular, rhomb-shaped bertrandite is found on and with blue apatite and on columnar blue-black columbites. Contemporaneous and also later is chlorite, which is found with and on bertrandite.

At the Route 9 and Beaver Meadow Road locality in Haddam, bertrandite is found with other minerals in cavities after beryl. The paragenetic sequences bertrandite-bavenite, bertrandite-chlorite, chlorite-bertrandite, and chlorite-bavenite, all on feldspar, show that these minerals crystallized essentially simultaneously. The chlorite is in part vermiform, and is found frequently embedded in continuous, single crystals of feldspar as though the feldspar were penetrated by wormholes. Occasionally, fairly solid casts of bertrandite, chlorite and bavenite after beryl are found with dimensions up to 5 x 12 cm.

While single crystals of bertrandite are extremely varied and interesting, the mineral is frequently twinned to give other intriguing forms. The twin plane *e* with an angle of 30° 52' gives rise to twins with internal angles of approximately 62° or 118°. Repeated twinning gives trillings with a total internal angle of approximately 355°, only 5° short of and indistinguishable by eye from a whole circle. Thus, bertrandite forms twins and trillings in a manner very similar to the mineral cerussite.

In Figure 16 is shown a very simple twin of bertrandite, striated parallel to the *c*-axis and showing a nice reentrant angle. Note the small "tail". All the twins on this particular piece of matrix were quite thick, while untwinned crystals (see Figure 17) were invariably flattened parallel to *c*. It is interesting to speculate why this should be so. Other specimens from the same locality do not always follow this rule.

Fig. 15. **Bertrandite with cassiterite. Strickland quarry, Portland.**



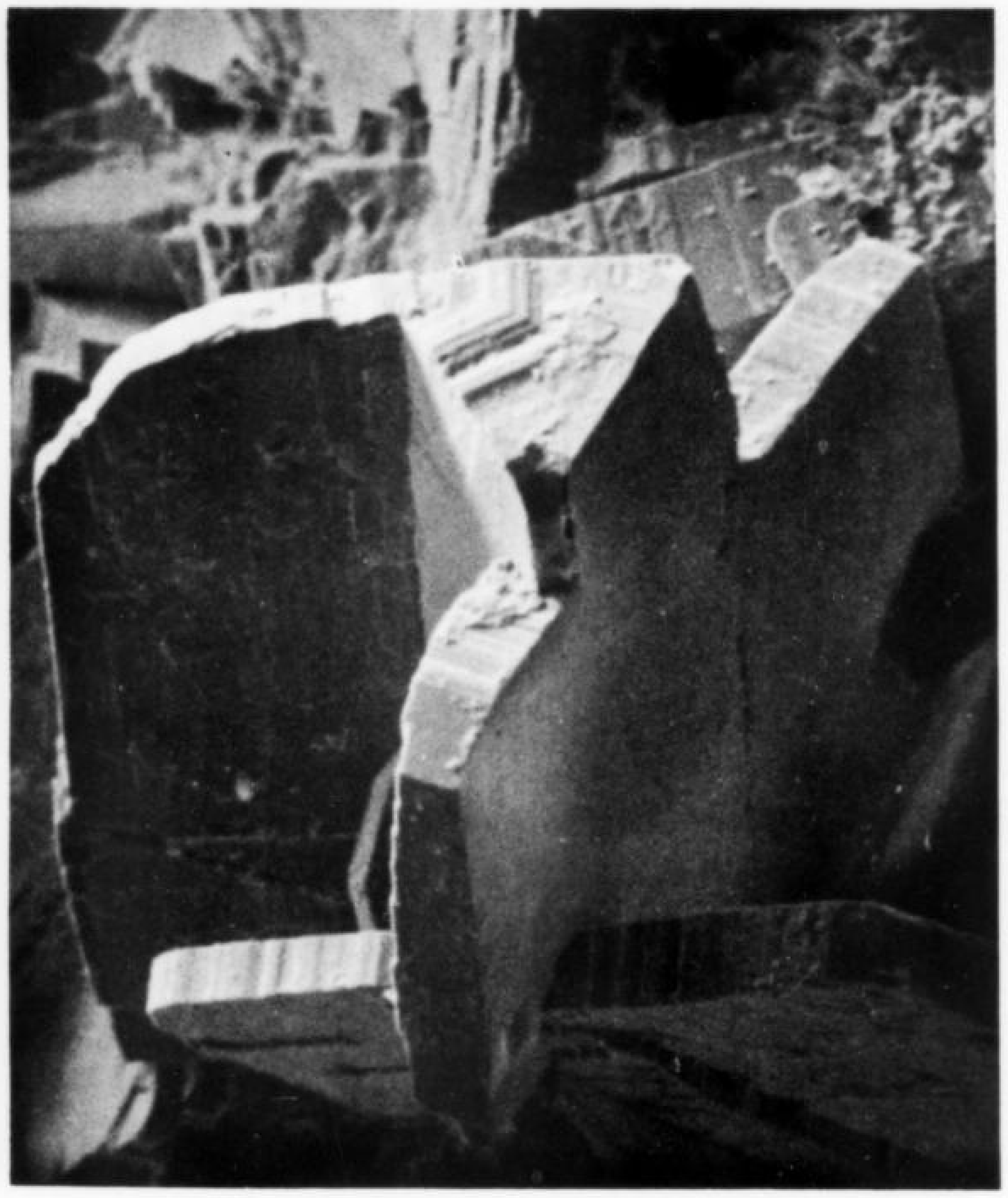
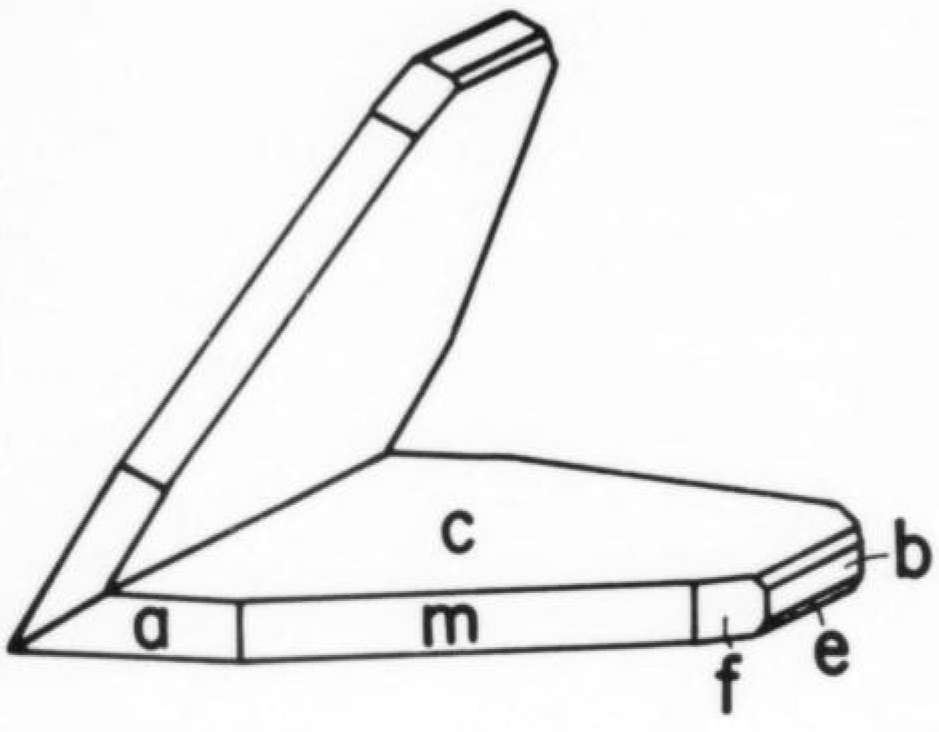


Fig. 16. **Above left, bertrandite twin. Strickland quarry, Portland. Forms a,b,c,f,m.** *Fig. 17.* **Left, tabular bertrandite. Strickland quarry, Portland. Forms a,b,c,f,m.** *Fig. 18.* **Below right, butterfly twin of bertrandite. Tollgate quarry, Middletown. Forms a,b,c,e,f,m.** *Fig. 19.* **Above right, bertrandite twin with "wing" and trace of trilling. Biermann quarry, Bethel. Forms a,b,c,f,m,ε.**



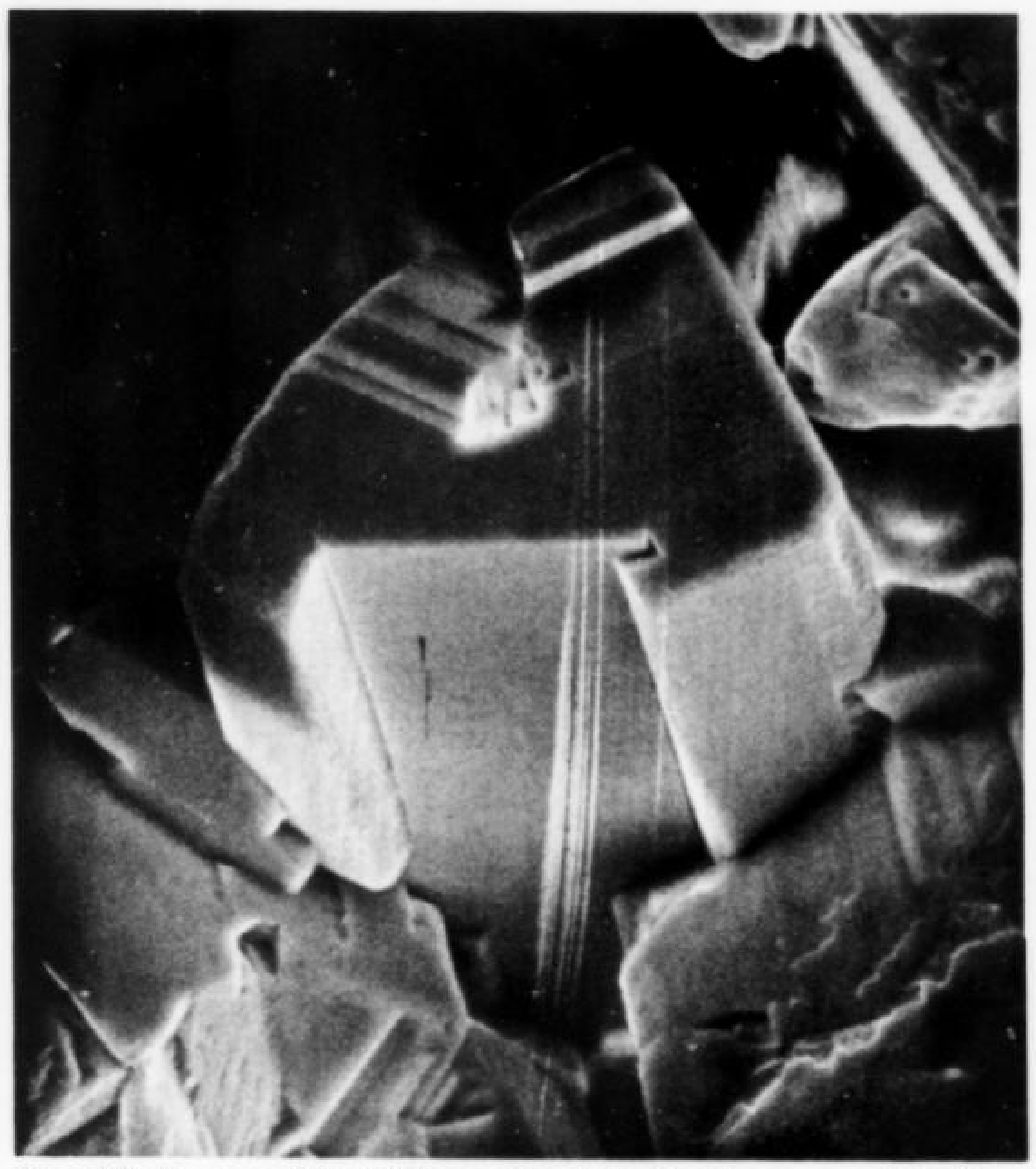


Fig. 20. **Bertrandite trilling. Captain Cook quarry, Dodingtown.**

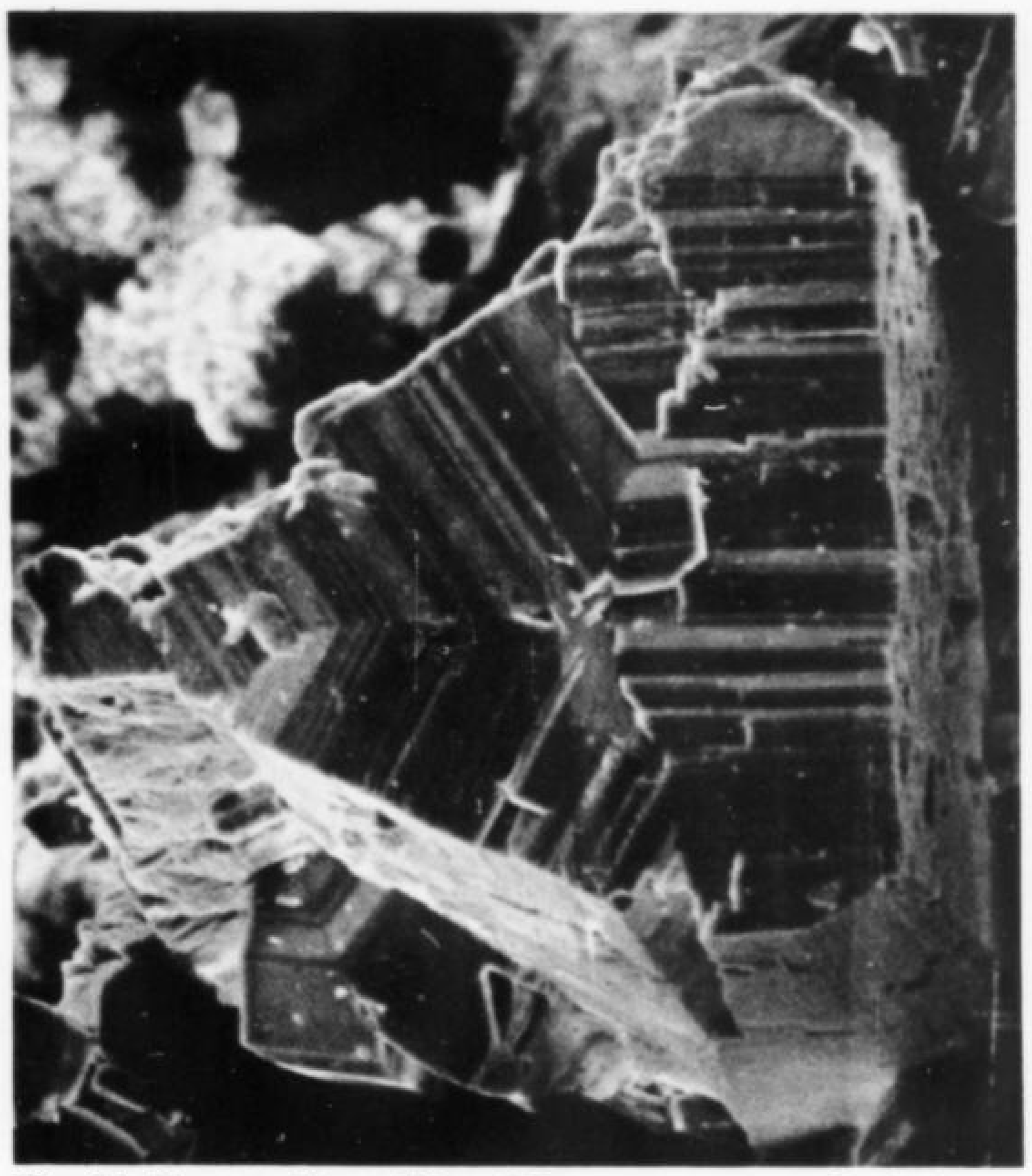


Fig. 21. **Bertrandite trilling. Biermann quarry, Bethel.**

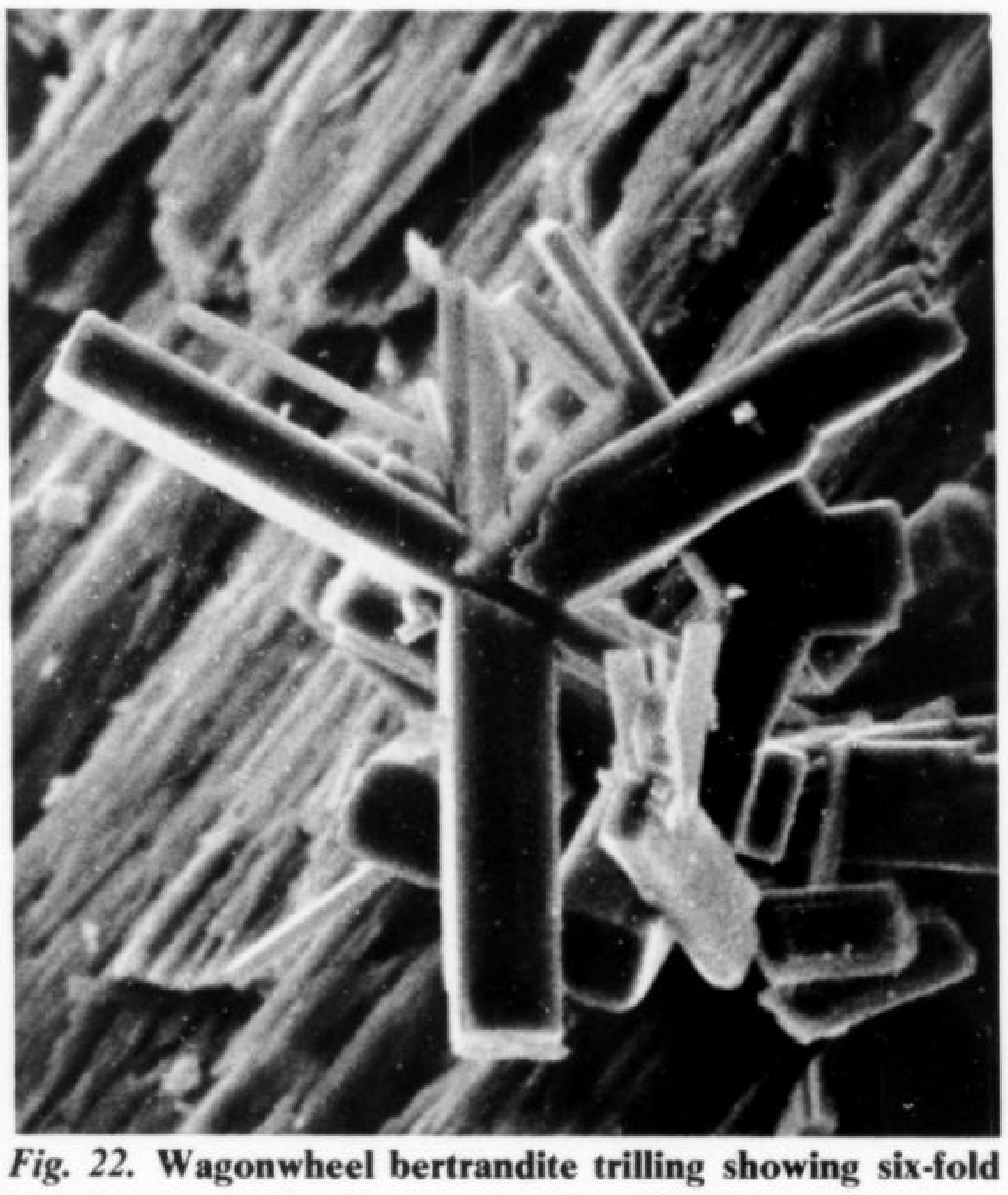


Fig. 22. **Wagonwheel bertrandite trilling showing six-fold development. Woodbury pegmatite, Woodbury. Forms a, b, c, m.**

Figure 18 shows a paper-thin butterfly twin of bertrandite, the original of which was completely transparent. Unlike the butterfly twins of other minerals, this really does mimic the insect.

Figures 19 to 21 show various trillings of bertrandite. The first appears to have wings, while all show the striae which allow orientation of the crystal as to the direction of the *c*-axis. In Figure 21, the striae make it possible to pick out the three individuals making up the trilling with some certainty.

By far the finest, rarest and smallest trillings known to the author are those shown in Figures 22 and 23. The tip to tip distance of these trillings is 0.15 mm, and it sometimes takes five minutes to relocate one on a half inch piece of matrix. These are the only crystals known to the author where the crystal development is such that it results in a wagonwheel form. Close inspection of the crystal in Figure 22 shows that it is developed in six directions at approximately 60° angles, not just three at 120°.

As shown in Figure 10 and by the three subparallel individuals in Figure 24, bertrandite is a hemimorphic mineral, i.e., the two ends of the crystal along the *c*-axis are not the same. Most orthorhombic minerals cannot twin using *c* as the twin plane, as *c* is a symmetry plane and the resultant "twin" would thus be identical to the untwinned individual. In a hemimorphic mineral, this is not the case, as the twin plane is no longer a symmetry plane. A twin can form, and it is marked by a higher pseudosymmetry, the two ends of the crystal now being the same. Such behavior is exemplified by the mineral hemimorphite.

In Figure 25 can be seen three pairs of bertrandites, apparently exhibiting parallel growth. The suspiciously

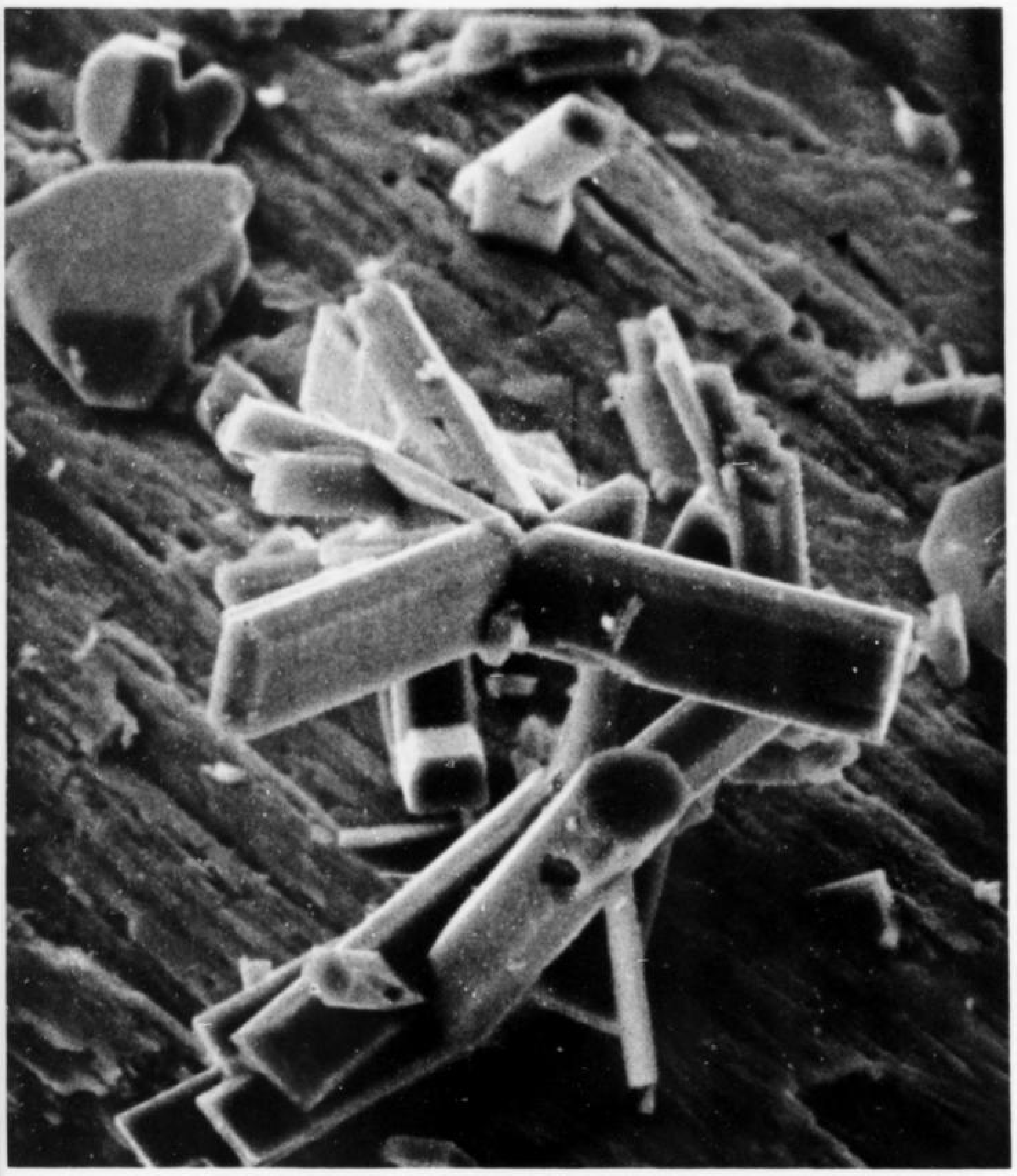
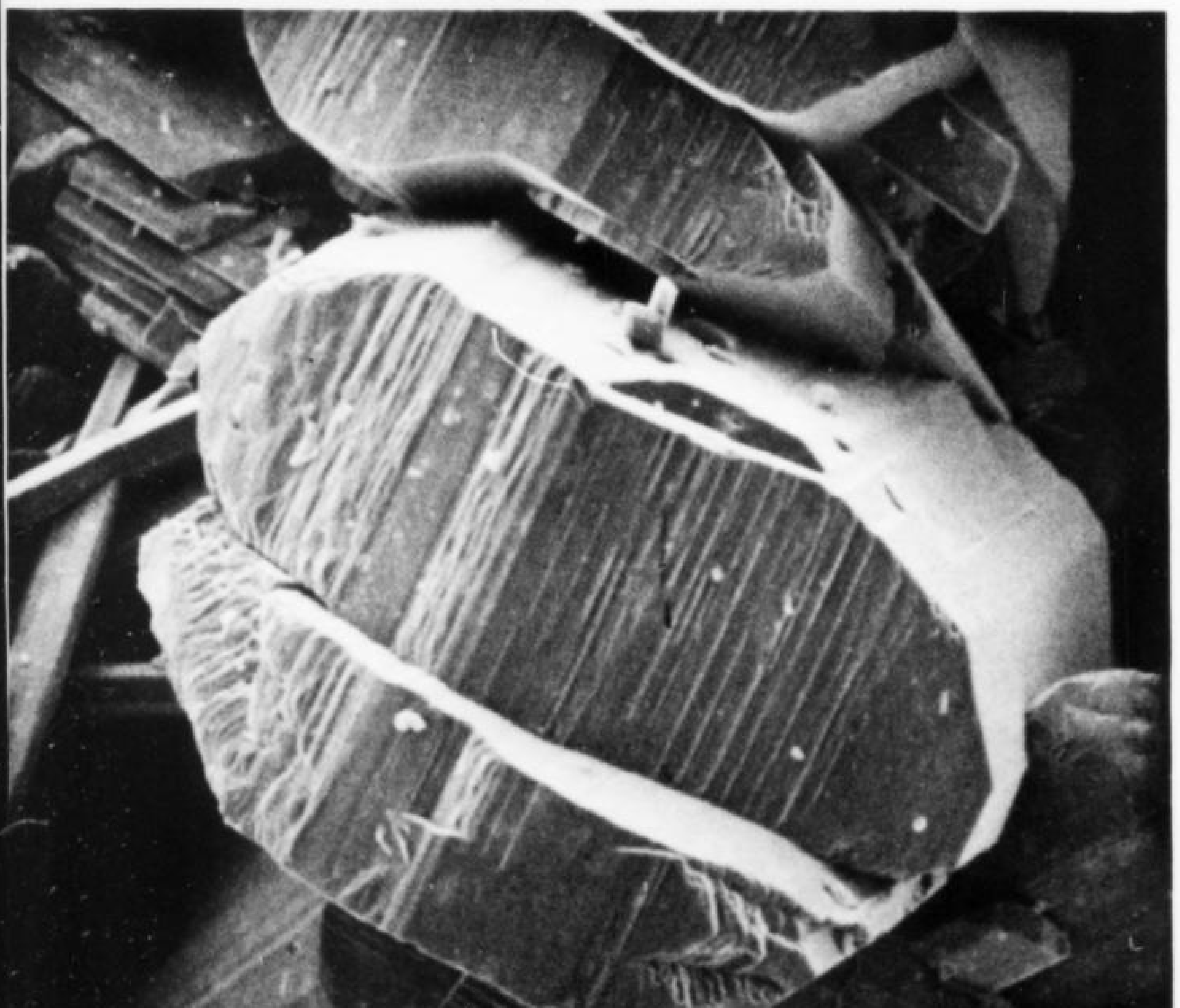


Fig. 23. **Wagonwheel bertrandite. Woodbury pegmatite, Woodbury. Forms a,b,c,m.**

Fig. 25. **Bertrandite twinned on c. Strickland quarry, Portland. Forms a,b,c,e,h,m,ϵ.**



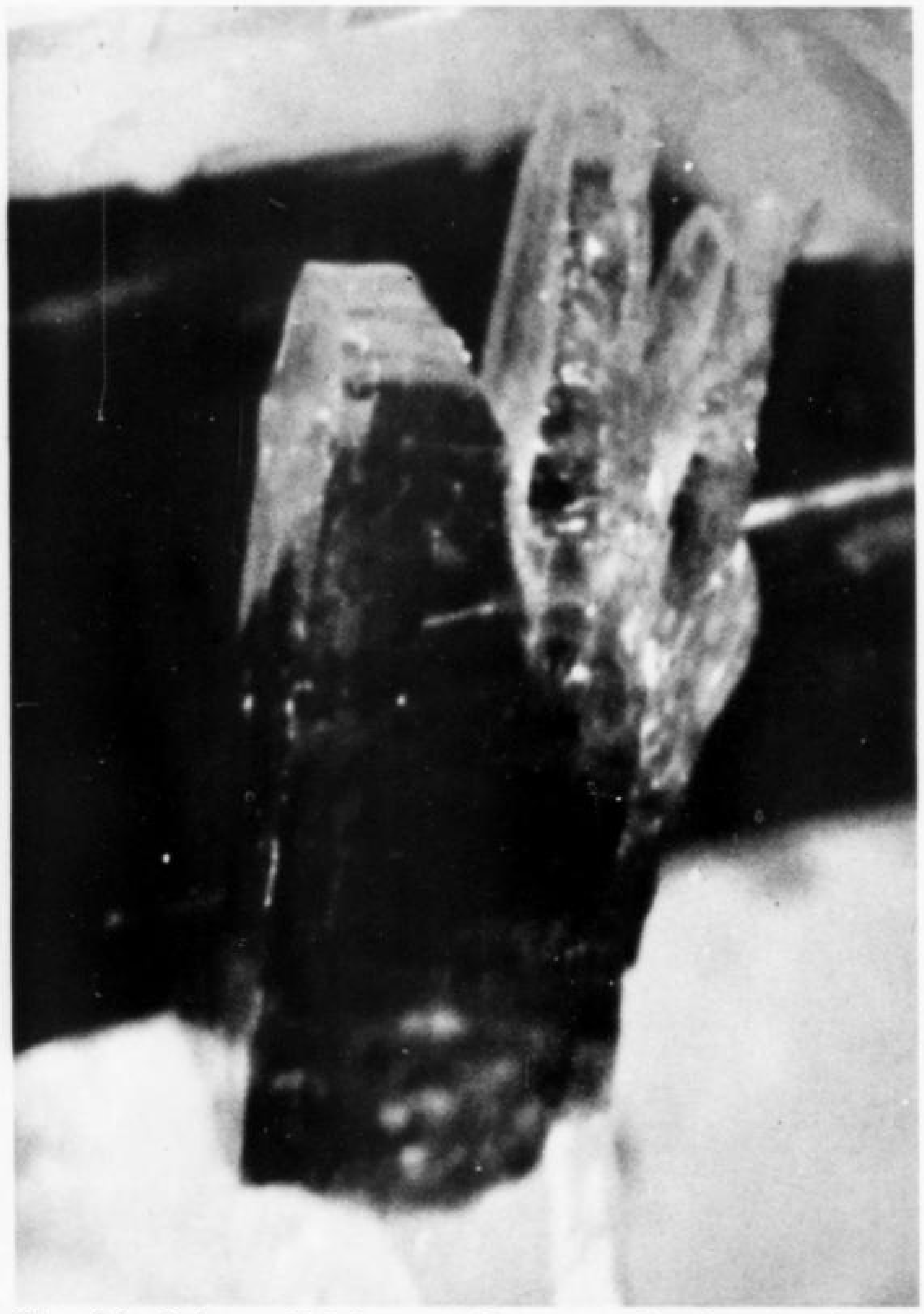


Fig. 24. **Subparallel bertrandite crystals showing hemimorphic symmetry. Route 9 and Beaver Meadow Road, Haddam. Forms a,b,c,f,m,η.**

high proportion of such pairs on the specimen (over half the 35 crystals are in pairs) led the author to believe that he was observing for the first time twinning of the mineral on *c*. Such nearly perfect twin plane sutures as that shown on the transparent crystal in Figure 26 strengthened this belief. The observation is not original, though, as Penfield (1889) reported a single crystal of bertrandite twinned on *c*.

Finally, the bertrandite shown in Figure 27 appears to be twinned on both *c* and ϵ. The more common twin on ϵ is clearly present, while the deep reentrant angle between the thin "cap" on the left and the obvious discontinuity on the right hand side of the crystal suggest twinning on *c*. The most convincing argument for twinning on *c* rather than simple parallel growth is the observation that many of the striations on the central portion of the crystal are continuous into the "caps". This is the only such twinned crystal known to the author.

Those interested in collecting Connecticut bertrandites will find the Biermann quarry a most prolific and fine source of simple twins and trillings. The Strickland quarry offers a lesser quantity of bertrandite, but the greatest variety of crystal forms.

The author would greatly appreciate word of any other localities for bertrandite in Connecticut. It is his hope that this article will stimulate others with access to hydrothermally altered pegmatites to make search for the mineral,

Fig. 26. **Bertrandite twin on c showing sharp composition plane. Strickland quarry, Portland. Forms a,b,c,e.**

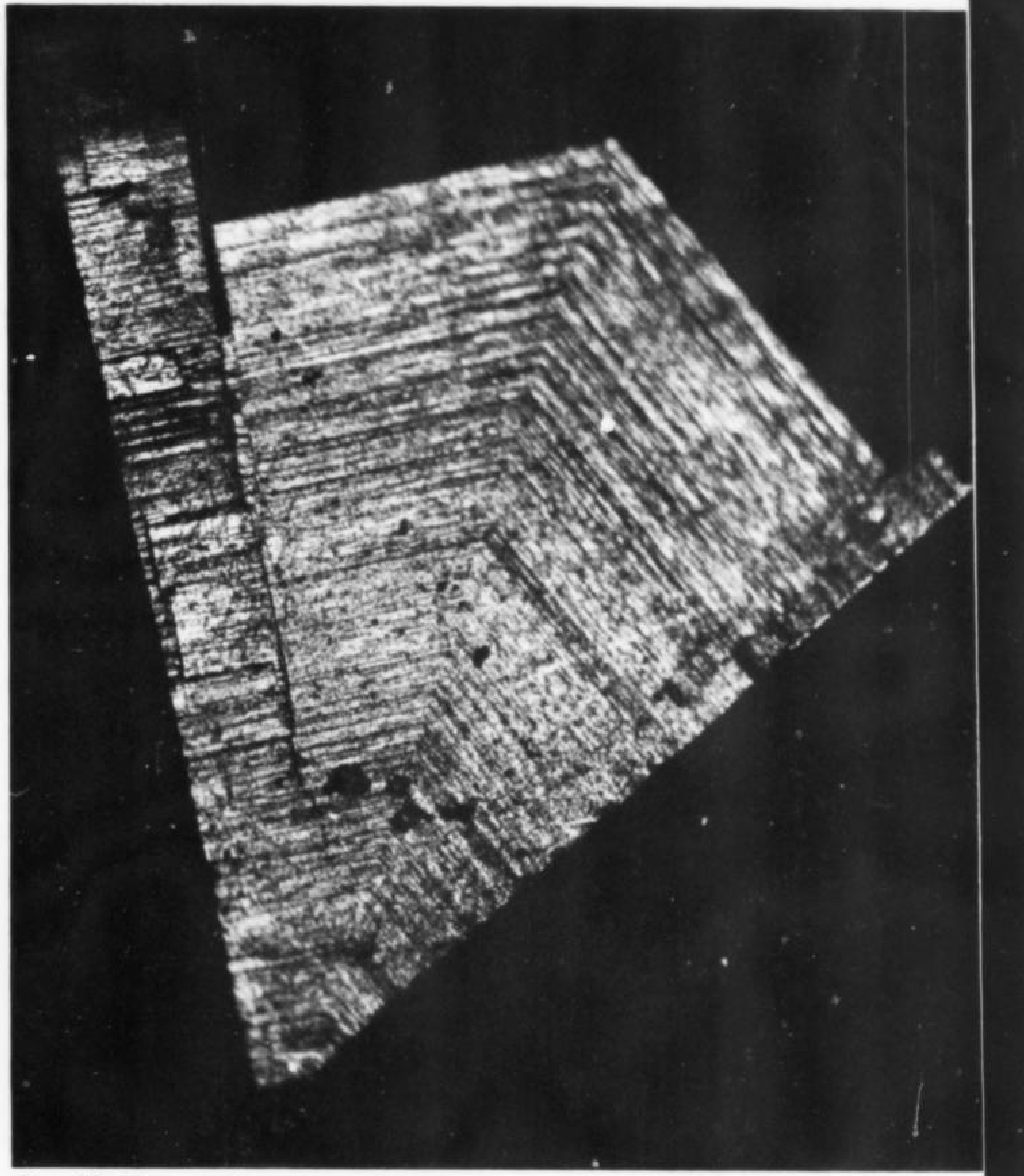


Fig. 27. **Bertrandite twinned on both c and ϵ. Strickland quarry, Portland.**

as it should be possible to add many localities in other states to the rather short list now known.

Acknowledgements

The author thanks Neal Yedlin for the photograph used in Figure 4, Julius Weber for those in Figures 7 and 15 and Edward Thomas for that in Figure 27. He is deeply indebted to john Hession and Martin Botty for the arduous task of taking the SEM photographs, and to Pete J. Dunn for the x-ray identifications. He is indebted to Frederick B. Watson and Walter J. Bagley for specimens and most especially to two extremely discerning collectors, Mr. and Mrs. Charles H. Weber, Jr., who reported several new localities to him and loaned him much material for study.

REFERENCES

BUKIN, G. V. (1967) Experimental data on the crystallization conditions of phenakite-bertrandite-quartz associations, *Dokl. Accad. Nauk SSSR*, **176**, 664-667; *Chemical Abstracts*, **68**, 493 (1968).

GOVOROV, I. N. and A. A. STUNZHAS (1963) The form of beryllium migration during alkaline metasomatism. *Geokhymiya*, 383-390; *Chemical Abstracts*, **59**, 340 (1963).

HENDERSON, W. A. JR. (1970) Building a one-circle goniometer. *Mineralogical Record*, **1**, 56-57.

HENDERSON, W. A. JR. (1970) Bavenite from Connecticut. *Mineralogical Record*, **1**, 70-71.

JANUZZI, R. E. *The mineralogy of Connecticut and southeastern New York State*; Mineralogical Press, Danbury, Conn., 1961, 257 pp.

ORLOV, Y. L., A. I. GINZBURG and N. G. PINEVICH (1961) Paragenetic interrelation of berylium minerals in some pegmatite veins. *Trudy Mineral. Muzeya, Akad. Nauk SSSR*, **11**, 103-113; *Chemical Abstracts*, **55**, 20818 (1961).

PENFIELD, S. L. (1889) Crystallized bertrandite from Stoneham, Maine and Mt. Antero, Colorado. *Amer. J. of Science*, **37**, 213-216.

POUGH, F. H. (1972) Phenakite. *Lapidary Journal*, **26**, 4-12.

SCHOONER, R. (1958) *The mineralogy of the Portland-East Hampton-Haddam area in Connecticut*; published by author, 1958, 49 pp.

SCHOONER, R. (1966) Some of the newer Connecticut minerals. *Triassic Valley Bulletin*, April, p. 5.

SCHOONER, R. (1971) Private communication.

WEBER, C. H. JR. (1973) Private communication.

ZODAC, P. (1937) Minerals of the Strickland quarry. *Rocks and Minerals*, **12**, 131-144.

Akira Kato Elected Chairman of I.M.A. Commission

At the meetings of the International Mineralogical Association in Berlin, Germany, September 12-14, 1974, Dr. Akira Kato, of Japan, was elected to the chairmanship of the Commission on New Minerals and Mineral Names of the I.M.A. He replaces Michael Fleischer who had held the position since the Commission was begun in 1959.

Dr. Akira Kato was born in Tokyo on June 19, 1931. Already in boyhood he became interested in the natural sciences, and by the age of nine he could draw a weather map from radioed weather reports. While he was a high school student he read the third (1948) edition of Wada's *Minerals of Japan* and became interested in descriptive and topographic mineralogy. After graduation from high school in 1950 he entered the university with the intention of becoming a chemist, but switched to geology and mineralogy in 1952—a fortunate switch for the progress of mineralogical science!

His first publication, in 1955, was on sedimentary rocks, but he soon specialized in mineralogy, under the guidance of Professor Takeo Watanabe. In 1955 he was studying a small molybdenum deposit near Miyako, in Iwate Prefecture. Professor Watanabe directed his attention to a dolomite-granodiorite contact near the mine, and in the contact zone they identified kotoite, $Mg_3(BO_3)_2$, first described in 1939 by Professor Watanabe, from the Hol Kol mine, North Korea. Professor Watanabe predicted that the manganese analog should occur in contact-altered manganese carbonate rocks, of which there are many occurrences in Japan. In 1963 Dr. Kato collected this mineral in the Kaso mine, Tochigi Prefecture; it was named jimboite and described by Professor Watanabe, Dr. Kato, and two of their colleagues.

I spent several months at the University of Tokyo in 1961, where I had the pleasure of a personal association with Dr. Kato both in the Mineralogical Institute of the university and on field trips to mineral localities. I learned to appreciate his keen eye for the interesting and unusual, and his remarkable power of total recall for the properties of rare and obscure minerals. In 1967-68 we renewed our earlier association, when he spent a year at the Smithsonian Institution as one of the first recipients of a Post-Doctoral Fellowship in the Department of Mineral Sciences. During that period he described the new mineral, stannoidite (a copper-iron-zinc-tin sulfide), and the first occurrence of roquesite, $CuInS_2$, in Japan. He was also a constant and reliable source of information on all aspects of mineralogy.

His present position is chief curator of minerals in the National Science Museum of Japan, and he is a part-time lecturer at the Mineralogical Institute of the University of Tokyo. He has served the International Mineralogical Association as secretary of the Japanese Commission on New Minerals and Mineral Names from 1960 to 1974, and as acting-secretary of the Commission on Mineral Data and Classification from 1972 to 1974. For many years he has been a co-worker with Dr. Kin-Ichi Sakurai, the owner of the largest and finest mineral collection in Japan, and together they have contributed greatly to the knowledge of the mineralogy of Japan.

Among his hobbies is a love of music, especially opera, and he has a remarkable collection of records of operatic arias sung by many of the great singers.

BRIAN MASON

the Mineralogy of the Department of Oruro, Bolivia

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INTRODUCTION

What does the mineralogist, both professional and amateur alike, think of when Bolivia is mentioned? Most likely it is the phosphates of Llallagua, Araca cassiterite, the fabulous wolframite of Chicote Grande, silver sulfosalts of Colquechaca, or the elusive phosphophyllite from Potosí. Because these locations have produced perhaps the finest known examples of the species for which they are famous, they have generally overshadowed other outstanding Bolivian occurrences which are inadequately described in the English literature. The purpose of this article, therefore, is to acquaint the reader with some of these lesser-known, mineralogically intriguing localities, specifically those within the Department of Oruro.

Information concerning current conditions and operations was gathered during December, 1973. Additional historical and mineralogical descriptions are translated from various works of Bolivia's noted mineralogist, Fed-

Fig. 1. **View looking east from the mountain above the San José mine showing the city of Oruro, the Altiplano, and the eastern arm of the Andean Cordillera on the horizon.**

erico Ahlfeld. All persons appreciating fine mineral specimens owe Dr. Ahlfeld a debt of gratitude, for it is this gentleman who had the foresight and energy to save from the mill and disseminate to museums and collectors surprising quantities of important Bolivian material at a time when many mines were in their specimen-producing prime.

Bolivia is a deceptively large country, approximately the size of Texas and California combined. It is exceedingly rugged topographically and very sparsely populated except around the commercial centers of LaPaz, Oruro, Cochabamba, and Santa Cruz. Transportation within the country, particularly to outlying mining districts, presents a formidable problem. For those contemplating a collecting trip, the mining districts of Bolivia are no place for those unable to accept primitive conditions and the extreme physical demands of working at elevations between 13,000 and 15,000 feet. For additional descriptive detail the reader is referred to Gordon's account of the districts discussed herein, published in a recent issue of the *Mineralogical Record* (Montgomery, 1974). Good specimens are still difficult to acquire, and those few persons that have them fully realize their value.

LOCATION

The Department of Oruro, of which the city of Oruro (pop. approx. 200,000) is the seat of provincial government and the central mining center, occupies a large area encompassing the west-central portion of the country (Figure 1). The department is traversed in a north-south direction by a generally featureless plane (Altiplano), having an average elevation of about 13,000 feet. The Altiplano is bordered on the east and west by arms of the Andean Cordillera. Most active mining districts lie within the mountains east of the Altiplano; however, several, including the district surrounding the city of Oruro, are related to isolated mountains on the Altiplano. Noted districts within the department include Oruro, Huanuni, Poopó, Antequera, Conde Auque, and Morococala. Specific locations discussed are shown on the general location map (Figure 2).

GENERAL GEOLOGY

The general geology and metallogenesis of the Bolivian Andes have been discussed adequately in the recent literature (Turneaure, 1971; Turneaure and Welker, 1947; Ljunggren, 1962). Most of the primary tin-silver, tin-tungsten, antimony, and other base- and precious-metal deposits are hydrothermal in origin, occur as veins within sediments of Ordovician through Devonian ages, and are genetically related to intrusive rocks of late Paleozoic and younger ages. Most veins are narrow, structurally complex, and exhibit mineralogical zonation with depth. Many of the bonanza-type deposits are now exhausted. However, inflated metal prices and modern mining and milling techniques are responsible for renewed activity in several districts, the mining of large tonnages of lower-grade ore, and the reworking of old dumps.

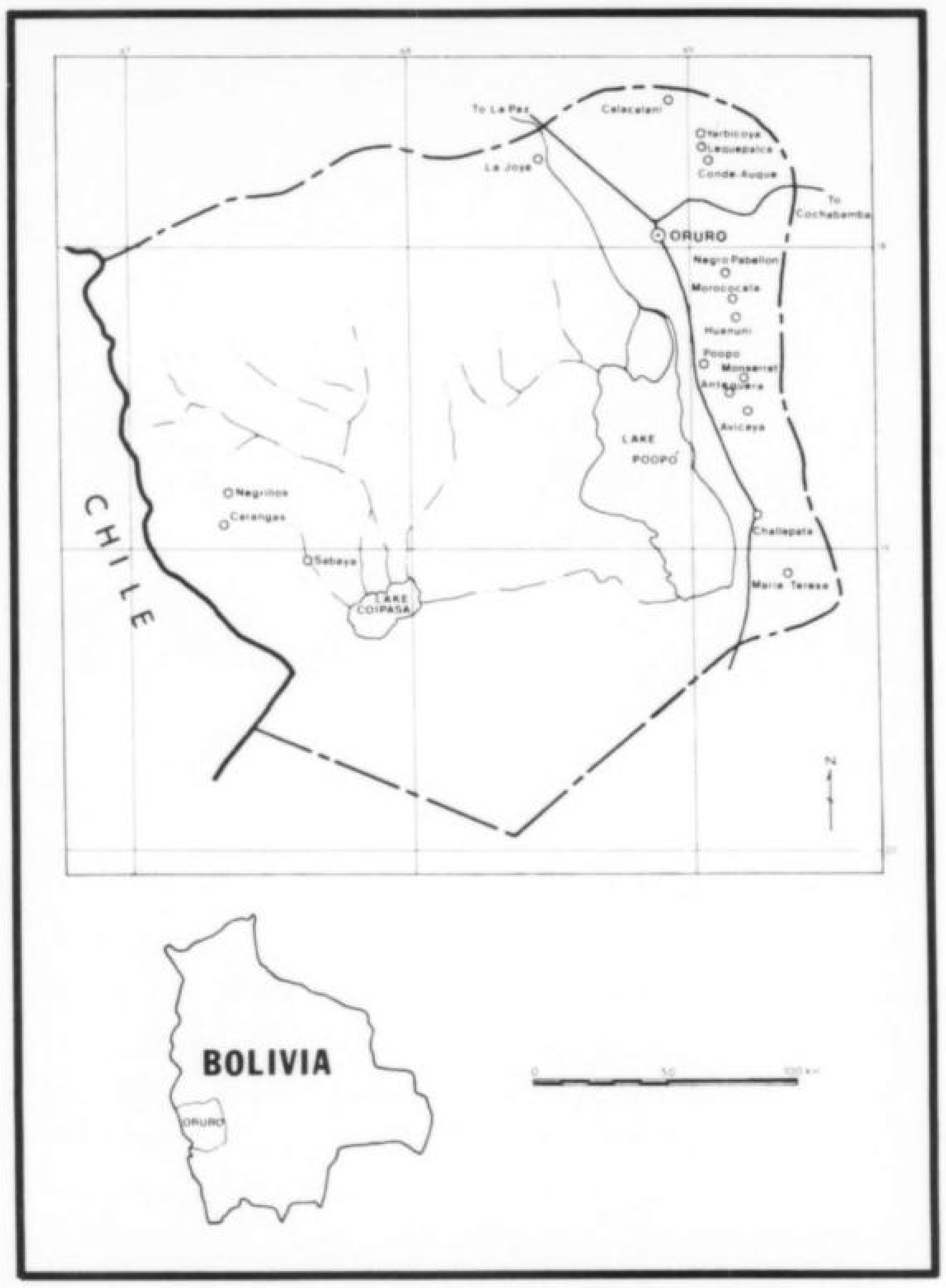

Fig. 2. **Location map, Department of Oruro, Bolivia.**

MINERALOGY

Many of the deposits in the Department of Oruro must be considered unique with respect to mineral species, associations, and paragenesis. Particularly outstanding are the various sulfide, sulfosalt, oxide, tungstate, and phosphate suites. The following descriptive sections deal only with those species which the author considers to occur in either unusual amounts, intriquing forms, or unusual associations. The species are arranged and discussed according to the classical chemical format as presented in *Dana's System of Mineralogy* (Palache, Berman, and Frondel; 1944). The species not discussed but considered of relative importance are presented for completeness in the cumulative tabulation (Table 1).

Elements

Gold - Au - Although gold occurs as an accessory element in many of the tin-silver deposits of the Department of Oruro, it is not known in outstanding specimens or in unusual quantities in more than a few locations. Three such locations mentioned by Ahlfeld (1954) are known to the author. The first of these is the Coriviri mine, approximately 10 km north of the town of Poopó. Here native gold occurs as thin platelets on the cleavage planes of wolframite. In the Chilcani mine, approximately 50 km north-northeast of Oruro, good gold samples have been found within a quartz-stibnite vein. Associated in this vein are stibnite, jamesonite, and chalcostibite. Perhaps the most interesting, currently pro-

text continued on page 132

TABLE I
MINERALOGY DEPT.
ORURO, BOLIVIA

Compilation of significant mineral occurrences within the Department of Oruro with respect to status, district and mine. Species status is designated as follows: rare (r), local (l), common (c), past specimen producer (p), and current specimen producer (n).

		DISTRICT	ANTEQUERA		ARANNUEZ	AVICAYA	CALACALANI	CARACOLLO	CARANGAS	CHALLAPATA	CONDE-AUQUE			HUANUNI
		MINE	El Salvador	Bolivia	Yarvicoya	Avicaya	San Antonio	Tarumita	Carangas	Vicunita	Juliana	Santa Isabelle	La Bomba	Porvenir
SPECIES	SUBDIVISION	FORMULA												
ELEMENTS														
Gold	metal	Au												
Silver	metal	Ag							lp					
Copper	metal	Cu			l									
SULFIDES														
Chalcocite	A_2X	Cu_2S			l									
Bornite	A_3X_2	Cu_5Fe_4												
Galena	AX	PbS	r	r	r	r			c	lp				l
Sphalerite	AX	(Zn,Fe)S	c	c		l			c					l
Chalcopyrite	AX	$CuFeS_2$			l	l		l	l					l
Stannite	AX	Cu_2FeSnS_4	r			l								lp
Wurtzite	AX	(Zn,Fe)S	lp	cn		r				r				l
Pyrrhotite	AX	$Fe_1\ S$				l								l
Covellite	AX	CuS												
Cinnabar	AX	HgS						cp						
Herzenbergite	AX	SnS												
Linnaeite	A_3X_4	$(Co,Ni)_3S_4$												

		DISTRICT	HUANUNI		LA JOYA	LEQUEPALCA	MONSERRAT	MOROCOCALA	NEGRILLOS	NEGRO PABELLON	ORURO			
		MINE	Quimsacoya	Mariá Francisca	San Andrés	Chilicani	Ichucollo	San Luis	Negrillos	Cuyuma	Antofagasta	San José	Itos	Santo Cristo
SPECIES	SUBDIVISION	FORMULA												
ELEMENTS														
Gold	metal	Au				lp					ln			
Silver	metal	Ag							l			r	r	
Copper	metal	Cu												
SULFIDES														
Chalcocite	A_2X	Cu_2S												
Bornite	A_3X_2	Cu_5Fe_4												
Galena	AX	PbS		l	r		lp		c	c		in	l	
Sphalerite	AX	(Zn,Fe)S	r	l		l	l		c	c		l	l	
Chalcopyrite	AX	$CuFeS_2$		r	l		r	r	r			r	l	
Stannite	AX	Cu_2FeSnS_4		l			lp					lp	lp	
Wurtzite	AX	(Zn,Fe)S		l			lp					l	r	
Pyrrhotite	AX	$Fe_1\ S$		l			c					l	l	
Covellite	AX	CuS			l							r	r	
Cinnabar	AX	HgS												
Herzenbergite	AX	SnS												
Linnaeite	A_3X_4	$(Co,Ni)_3S_4$				r								

		DISTRICT	ORURO		POOPÓ					SALINAS DE GARCIA MENDOZA	SEVARUYO	TURCO			
		MINE	Socavon	La Colorada	Coriviri	Trinacria	Candaleria	San Francisco	Santa Cruz	Mariá Luisa	Amistad	Cuprita	Azurita	Margarita	Mariá Teresa
SPECIES	SUBDIVISION	FORMULA													
ELEMENTS															
Gold	metal	Au			r										
Silver	metal	Ag													
Copper	metal	Cu									l	l	l		
SULFIDES															
Chalcocite	A_2X	Cu_2S									l	l	l		
Bornite	A_3X_2	Cu_5Fe_4									l				
Galena	AX	PbS	l	l		l	l		r	c				c	
Sphalerite	AX	(Zn,Fe)S	l	l		c		c	c					c	r
Chalcopyrite	AX	$CuFeS_2$	r	l		r	r		r		l	r	r	l	
Stannite	AX	Cu_2FeSnS_4	l	l		l	l	l	l						l
Wurtzite	AX	(Zn,Fe)S	r	r		lp	cp	l	l						
Pyrrhotite	AX	$Fe_1\ S$	l	l	l										
Covellite	AX	CuS													
Cinnabar	AX	HgS													
Herzenbergite	AX	SnS													lp
Linnaeite	A_3X_4	$(Co,Ni)_3S_4$													

TABLE I
MINERALOGY DEPT. ORURO, BOLIVIA

SPECIES		Stibnite	Kermesite	Pyrite	Marcasite	Arsenopyrite	Stephanite	Pyraragyrite	Proustite	Tetrahedrite	Tennantite	Enargite	Meneghinite	Bournonite	Freieslebenite	Boulangerite	Miargrite
SUBDIVISION		A_2X_3	A_2X_3	AX_2	AX_2	AX_2	$AmBnXp$	A_3BX_3	A_3BX_3	A_3BX_3	A_3BX_3	A_3BX_4	A_3BX_4	A_2BX_3	A_2BX_3	ABX_2	ABX_2
FORMULA		Sb_2S_3	Sb_2S_2O	FeS_2	FeS	$FeAsS$	Ag_5SbS	Ag_3Sb_3	Ag_3Sb_3	$(CuFe)_{12}Sb_4S_{13}$	$(CuFe)_{12}As_4S_{13}$	Cu_3AsS_4	$Pb_{13}CuSb_7S_{24}$	$PbCuSbS_3$	$PbAgSbS_3$	$Pb_5Sb_4S_{11}$	$AgSbS_3$
							SULFOSALTS										
MINE	DISTRICT																
El Salvador	ANTEQUERA			c													
Bolivia				l													
Yarvicoya	ARANNUEZ			c													
Avicaya	AVICAYA			c													
San Antonio	CALACALANI	c		l													
Tarumita	CARACOLLO	cp		l													
Carangas	CARANGAS			c			r	l	l								
Vicunita	CHALLAPATA			c													
Juliana	CONDE-AUQUE			l													
Santa Isabelle				l													
La Bomba				l													
Porvenir	HUANUNI			c		l										l	
Quimsacoya		cp		l													
Mariá Francisca				c		l										l	
San Andrés	LA JOYA			c							l	l					
Chilicani	LEQUEPALCA	c		l													
Ichucollo	MONSERRAT			l	l	lp											
San Luis	MOROCOCALA	c		c													
Negrillos	NEGRILLOS			l			r										
Cuyuma	NEGRO PABELLON			l			l	r	r								
Antofagasta	ORURO	cn		l													
San José		r		cn	c	l	lp	r		cp			rp	lp	rp	cn	rp
Itos		r		cn	c	ln	l	r		cp			rp	r	r	c	r
Santo Cristo		l		l													
Socavon				cp	c	l		r					r	r		l	r
La Colorada				cp	c	l		r					r	r		l	r
Coriviri	POOPÓ			l		l											
Trinacria				c													
Candaleria				c													
San Francisco			rp	c													
Santa Cruz				c													
Mariá Luisa	SALINAS DE GARCIA MENDOZA			l													
Amistad	SEVARUYO			l													
Cuprita	TURCO			l													
Azurita				l													
Margarita				c													
Mariá Teresa				c													

TABLE I
MINERALOGY DEPT. ORURO, BOLIVIA

SPECIES	SUBDIVISION	FORMULA
Chalcostibite	ABX_2	$CuSbS_2$
Montesite	ABX_2	$PbSn_4S_5$
Teallite	ABX_2	$PbSnS_2$
Franckeite	$A_2B_2X_5$	$Pb_5Sn_3Sb_2S_{14}$
Jamesonite	$A_2B_2X_5$	$Pb_4FeSb_6S_{14}$
Andorite	$A_2B_3X_6$	$PbAgSb_3S_6$
Plagionite	$A_2B_3X_6$	$Pb_5Sb_8S_{21}$
Semseyite	$A_2B_3X_6$	$Pb_9Sb_8S_{21}$
Zinkenite	AB_3X_4	$Pb_6Sb_{14}S_{27}$
Cylindrite	AB_3X_4	$Pb_3Sn_4Sb_2S_{14}$
Cuprite	A_2X	Cu_2O
Valentinite	A_2X_3	Sb_2O_3
Cassiterite	AX_2	SnO_2
Cervantite	AX_2	Sb_2O_4
Stibiconite	AX_2	$Sb_3O_6(OH)$
Tungstite	A_mX_n	$WO_3 \cdot H_2O$

MINE	DISTRICT	Chalcostibite	Montesite	Teallite	Franckeite	Jamesonite	Andorite	Plagionite	Semseyite	Zinkenite	Cylindrite	Cuprite	Valentinite	Cassiterite	Cervantite	Stibiconite	Tungstite
												OXIDES					
El Salvador	ANTEQUERA			lp		l								lp			
Bolivia				ln		cn				l				r			
Yarvicoya	ARANNUEZ																
Avicaya	AVICAYA													lp			
San Antonio	CALACALANI														l	r	c
Tarumita	CARACOLLO														l	r	
Carangas	CARANGAS			lp													
Vicunita	CHALLAPATA													lp			
Juliana	CONDE-AUQUE																l
Santa Isabelle																	
La Bomba																	
Porvenir	HUANUNI				lp	l					r		rp	cn	r	r	
Quimsacoya														r	l		
Mariá Francisca					cp	l					r			l			
San Andrés	LA JOYA																
Chilicani	LEQUEPALCA	lp				l									l		
Ichucollo	MONSERRAT			cp	cp									cp			
San Luis	MOROCOCALA													l	r		
Negrillos	NEGRILLOS																
Cuyuma	NEGRO PABELLON																
Antofagasta	ORURO														r		
San José		r		ln	ln	cn	rp	rp	rp	ln	r		rp	lp	r		
Itos		r		r	l	l	rp	rp	rp	ln				lp	r		
Santo Cristo																	
Socavon				l	r	l				l				l			
La Colorada				l	r	l				l				l			
Coriviri	POOPÓ													l			
Trinacria				r	lp	l					cp			r	r		
Candaleria			l	r		r								r			
San Francisco														r			
Santa Cruz				r	l	r								r			
Mariá Luisa	SALINAS DE GARCIA MENDOZA										lp						
Amistad	SEVARUYO											c					
Cuprita	TURCO											c					
Azurita												c					
Margarita																	
Mariá Teresa				l										l			

TABLE I
MINERALOGY DEPT. ORURO, BOLIVIA

SPECIES	SUBDIVISION	FORMULA
Hochschildite	AmXn	$PbSnO_3 \bullet H_2O$(?)
Souxite	AmXn	$SnO_2 \bullet H_2O$
Cerargyrite	AX	AgCl
Fluorite	AX_2	CaF_2
Calcite	$A(XO_3)$	$CaCO_3$
Siderite	$A(XO_3)$	$FeCO_3$
Rhodochrosite	$A(XO_3)$	$MnCO_3$
Smithsonite	$A(XO_3)$	$ZnCO_3$
Cerussite	$A(XO_3)$	$PbCO_3$
Bismutite	$Am(XO_3)pZq$	$Bi_2(CO_3)O_2$
Barite	AXO_4	$BaSO_4$
Celestite	AXO_4	$SrSO_4$
Anglesite	AXO_4	$PbSO_4$
Gypsum	$A(XO_4) \bullet xH_2O$	$CaSO_4 \bullet 2H_2O$

MINE	DISTRICT			HALIDES		CARBONATES						SULFATES			
		Hochschildite	Souxite	Cerargyrite	Fluorite	Calcite	Siderite	Rhodochrosite	Smithsonite	Cerussite	Bismutite	Barite	Celestite	Anglesite	Gypsum
El Salvador	ANTEQUERA														
Bolivia			l												
Yarvicoya	ARANNUEZ														
Avicaya	AVICAYA				l										
San Antonio	CALACALANI						c								
Tarumita	CARACOLLO												lp		
Carangas	CARANGAS			l		c		l							
Vicunita	CHALLAPATA														
Juliana	CONDE-AUQUE					c	c								
Santa Isabelle															
La Bomba					c	c	l					c			
Porvenir	HUANUNI				l		c					l			r
Quimsacoya															
Mariá Francisca															
San Andrés	LA JOYA							l							
Chilicani	LEQUEPALCA						l		l			l			
Ichucollo	MONSERRAT	l				l	l							l	
San Luis	MOROCOCALA														
Negrillos	NEGRILLOS							c							
Cuyuma	NEGRO PABELLON											l			
Antofagasta	ORURO														
San José				rp			l			lp		l		r	r
Itos							l					l		r	r
Santo Cristo															
Socavon							l					l		r	
La Colorada							l					l		r	
Coriviri	POOPÓ										lp				
Trinacria															
Candaleria															
San Francisco															
Santa Cruz															
Mariá Luisa	SALINAS DE GARCIA MENDOZA									l					
Amistad	SEVARUYO														
Cuprita	TURCO														
Azurita															
Margarita										l					
Mariá Teresa															

TABLE I
MINERALOGY DEPT.
ORURO, BOLIVIA

			ANTEQUERA		ARANNUEZ	AVíCAYA	CALACALANI	CARACOLLO	CARANGAS	CHALLAPATA	CONDE-AUQUE			HUANUNI			LA JOYA	LEQUEPALCA	MONSERRAT	MOROCOCALA	NEGRILLOS	NEGRO PABELLON	ORURO						POOPÓ					SALINAS DE GARCIA MENDOZA	SEVARUYO	TURCO			
SPECIES	SUBDIVISION	FORMULA	El Salvador	Bolivia	Yarvicoya	Avicaya	San Antonio	Tarumita	Carangas	Vicunita	Juliana	Santa Isabelle	La Bomba	Porvenir	Quimsacoya	Mariá Francisca	San Andrés	Chilicani	Ichucollo	San Luis	Negrillos	Cuyuma	Antofagasta	San José	Itos	Santo Cristo	Socavon	La Colorada	Coriviri	Trinacria	Candaleria	San Francisco	Santa Cruz	Mariá Luisa	Amistad	Cuprita	Azurita	Margarita	Mariá Teresa
Chalcanthite	$A_2(XO_4)\bullet xH_2O$	$CuSo_4\bullet 5H_2O$			l																																		
Alunite	$A_2(XO_4)Zq$	$KA1_3(SO_4)_2(OH)_6$												l					r			l		l	l														
Jarosite	$A_2(XO_4)Zq$	$KFe_3(SO_4)_2(OH)_6$												l		l	l							l	l		r	r											
PHOSPHATES																																							
Vivianite	$AB_2(XO_4)\bullet xH_2O$	$Fe_3(PO_4)_2\bullet 8H_2O$				lp								ln					lp																				
Variscite	$A(XO_4)\bullet xH_2O$	$AlPO_4\bullet 2H_2O$												r																									
Augelite	$A_2(XO_4)Zq$	$A1_2(PO_4)(OH)_3$																						rp	r														
Apatite	$A_5(XO_4)_3Zq$	$A_5(RO_4)_3$																																					
		$(F,OH,C1)_3$												r										rp	r														
Wavellite	$A_3(XO_4)_2Zq$	$A1_3(PO_4)_2(OH)_3$																																					
	$\bullet xH_2O$	$\bullet 5H_2O$												rn										rp	r														
TUNGSTATES																																							
Huebnerite	$A(XO_4)$	$(Mn,Fe)WO_4$										cp			cp																								
Wolframite	$A(XO_4)$	$(Fe,Mn)WO_4$				r								r	l									r					l										
Ferberite	$A(XO_4)$	$FeWO_4$					lp					cp																											
Scheelite	$A(XO_4)$	$CaWO_4$					l				l		lp																										

ducing gold occurrence is the Antofagasta mine, approximately 15 km southeast of the city of Oruro. Here native gold also occurs in a quartz-stibnite vein. The dump of this mine contains moderate quantities of vein material which upon careful examination yields interesting specimens of stibnite crystals with interstitial quartz and native gold.

Silver - Ag - The Department of Oruro is not noted for large quantities of native silver even though the overall production of this element is very outstanding historically. Native silver and ruby silver are reported by Ahlfeld (1954) from the mines around the now almost-inaccessible camp of Carangas in the western part of the department. Native silver also occurs in the Negrillos area 15 km to the north of Carangas. Few samples from these two districts exist today. However, apparently very large quantities of both native silver and ruby silver as supergene enrichment products were mined by the Spaniards in the 18th and 19th centuries.

Sulfides

Cinnabar - HgS - Unusual examples of cinnabar occur in the Tarumita mine in the district of Caracollo north of the Oruro-Cochabamba railroad. This is the only deposit in Bolivia where cinnabar occurs in a stibnite vein. Unusual examples of cervantite crystals coated with cinnabar are found in the upper portions of the vein.

Stannite - Cu_2FeSnS_4 - Stannite occurs in most of the important tin-silver districts in the Department of Oruro. Reported localities include the mines at Monserrat, María Teresa, Antequera, Poopó, Oruro, and Huanuni. Although the mines in these districts have never produced specimen-grade material equal to that of Llallagua, moderate to excellent specimens have been produced from the mines near the city of Oruro. It is from these mines, and specifically from the upper levels of the Bronce vein, that Spencer (1902) first described the axial ratios for this mineral. Stannite occurs here as 3 mm crystals lining the inside of vugs associated with pyrite, andorite, zinkenite, quartz and excellent needle tin. Chace (1940) describes abundant stannite in the Verde vein of the San José mine, Oruro. Massive stannite with occasional crystal-filled vugs occurs on the extensive dump of the Itos mine near Oruro. Very complex stannite crystals are illustrated from the Porvenir mine at Huanuni by Ahlfeld (1943). Gordon (1924) describes twinned crystals up to 1 cm recovered from the Maria Francisca mine, Huanuni.

Wurtzite - (Zn,Fe)S - Wurtzite has been reported in the literature from at least five different districts in the Department of Oruro. It occurs with needle tin in the Antequera district about 7 km south-southeast of Monserrat. It is relatively abundant in several deposits near the town of Poopó, the most noted of which is the Candelaria mine. Pyramidal crystals up to 1.5 cm long occur in the Porvenir mine of the Huanuni district. In the Ichucollo vein at Monserrat two generations of wurtzite can be recognized (Ahlfeld, 1943). The first generation is typified by very sharp, dark brown pyramidal crystals up to 1.0 cm in diameter. Small transparent crystals intimately associated with teallite crystals occur as a second generation. Minor quantities of wurtzite have been reported from the San José mine at Oruro.

Herzenbergite - SnS - This exceedingly rare and incompletely-described species has been noted only from its type location in the María Teresa mine southeast of the town of Challapata. The mineral occurs in dark gray, metallic masses intimately associated with pyrite, stannite, sphalerite, arsenopyrite and quartz.

Linnaeite - $(Co,Ni)_3S_4$ - This mineral is known from only one location in Bolivia. It occurs in the Lequepalca district to the north of Oruro as compact masses and as small twinned (Spinel Law) crystals associated with smithsonite.

Stibnite - Sb_2S_3 - Stibnite is a rather common accessory mineral throughout the Department of Oruro, occurring in many quartz veins which have been worked periodically for small quantities of high grade ore and, perhaps more interestingly, in veins associated with primary tungsten mineralization. Seven specific mines and districts are referenced in Table 1, three of these being worthy of further elaboration. The Quimsacoya mine in the Huanuni district is noted for large vugs lined with small quartz crystals upon which rest coarse stibnite crystals sprinkled with wolframite crystals. In the San Antonio mine at Calacalani, about 12 km southwest of Colquiri, coarsely crystalline stibnite occurs in vugs with ferberite crystals. Small vugs filled with stibnite exhibiting a brilliant luster and occasional bright blue tarnish occur in a quartz vein with native gold at the Antofagasta mine east of the city of Oruro. Nearer the city of Oruro, coarsely crystalline stibnite occurs in vugs in the Santo Cristo mine. Coarsely crystalline stibnite occurs in vugs associated with cinnabar and cervantite in the Tarumita mine near Caracollo.

Kermesite - Sb_2S_2O - Ahlfeld (1943) reports kermesite from the San Francisco mine at Poopó. It occurs in red radial aggregates coating jamesonite. This is the only reported occurrence of this mineral in Bolivia.

Pyrite - FeS_2 - Pyrite is a very common and ubiquitous mineral in virtually all hydrothermal vein deposits in the Department of Oruro, particularly those of the tin-silver type. Excellent specimens exhibiting both octahedral and pyritohedral forms can be obtained on dumps in the major districts. The dumps of the San José and Itos mines at the town of Oruro yield exceptional specimens exhibiting octahedral habit with crystal faces ranging up to 5 cm on an edge. Excellent specimens of large octahedra modified by the pyritohedra are common in portions of the active mine at Huanuni.

Arsenopyrite - FeAsS - Arsenopyrite is another relatively common sulfide in the deposits near the city of Oruro, Huanuni, and Monserrat. In the upper levels of the San José mine at Oruro cavities containing simple prismatic arsenopyrite crystals up to 1 cm in length are quite common. Cavities containing sharp arsenopyrite crystals and franckeite crystals may be found on portions of the San José dump.

Sulfosalts

Tetrahedrite - $(Cu,Fe)_{12}Sb_4S_{13}$ - Tetrahedrite and andorite are the chief sources of silver in the veins near the city of Oruro. Rather typical specimens exhibiting tetrahedra up to 1 cm across are reported associated with andorite crystals from both the Itos and the San José mines. Dumps of these mines yield moderate quality specimens with careful searching.

Bournonite - $PbCuSbS_3$ - A comparatively uncommon sulfosalt in the Oruro districts, bournonite has been described in detail only from the tin-silver mines near the city of Oruro. Kozlowski and Jaskolski (1932) describe magnificant specimens taken in the late 1800's from the upper levels of the Bronce vein. A picture of such a specimen in the Mark Bandy collection, probably preserved from this find, was recently published in the *Mineralogical Record* (Jones, 1973). Smaller, tabular, untwinned crystals are reported from the Grande vein in the La Colorada mine by Chace (1948).

Boulangerite - $Pb_5Sb_4S_{11}$- Boulangerite occurs in moderate to large amounts in the tin-silver veins near the city of Oruro and in similar veins near the town of Huanuni. Some confusion exists in the literature concerning the relative abundance of boulangerite and zinkenite in the Oruro district. As originally reported by Kozlowski (1932), zinkenite was considered to be the most common lead sulfosalt in the deposits. Later x-ray work by Chace (1948) has shown that much of what was thought to be zinkenite is actually boulangerite. Boulangerite from the San José mine occurs as felted masses of dark gray needles resembling jamesonite. Small cavities completely filled with boulangerite are common in boulders on the dump of this mine. Minor amounts of boulangerite associated with massive pyrargyrite can be found on portions of the Itos dump.

Miargyrite - $AgSbS_2$ - Miargyrite is a rather uncommon mineral in the Department of Oruro. According to Ahlfeld (1943), crystals up to 1 cm long were encountered in the Bronce vein at Oruro and other excellent specimens have been recovered from the Itos mine.

Chalcostibite - $CuSbS_2$ - Spencer and Prior (1907) describe small crystals from the mines near Oruro occurring in cavities with andorite, stannite, quartz, and pyrite. The mineral occurs in vugs in massive tetrahedrite as bright, steel-gray, tabular or blade-shaped crystals rarely exceeding 1 cm in length. Chalcostibite is also reported by Ahlfeld (1943) with stibnite, jamesonite, quartz, siderite and barite near the Chilcani mine about 50 km north-northeast of Oruro.

Montesite - $PbSn_4S_5$(?) - The inactive Candelaria mine, adjacent to the Trinacria mine in the southern-most part of the Poopo district, is the type locality for this incompletely described species. Montesite occurs in the deeper portions of the vein as steel-gray metallic aggregates resembling teallite.

Teallite - $PbSnS_2$ - Teallite was originally described from specimens obtained in the Ichucollo mine, Monserrat. Outstanding specimens were produced consisting of sharp teallite, wurtzite, and acicular cassiterite crystals on crystalline pyrite. The Vicuñita prospect, several kilometers southeast of Challapata, once contained outstanding drusy aggregates of teallite partially replaced by galena and covered with brilliant large crystals of needle tin.

Good teallite specimens are also reported from the Candelaria mine, Poopó; the El Salvador mine, Antequera; the Porvenir mine, Huanuni; and the San José mine, Oruro.

Franckeite - $Pb_5Sn_3Sb_2S_{14}$ - Franckeite occurs in relative abundance in four districts. Perhaps the finest specimens were found years ago in the Ichucollo mine, Monserrat. Sharp crystals up to 1 cm in length occurred on wurtzite associated with needle tin. A few kilometers to the west of Monserrat, argentiferous franckeite occurs in the veins at Poopó. Outstanding specimens occur in the Trinacria mine where franckeite aggregates form the matrix for cylindrite.

Two mines near Huanuni, the Porvenir and Maria Francisca, once produced great quantities of argentiferous franckeite ore. Unfortunately vugs were not common, although specimens containing franckeite crystals to 3 mm with dolomite and pyrite are reported (Ahlfeld, 1943).

Franckeite-bearing tin-silver ore has been continuously produced from the various mines near the city of Oruro since their discovery in 1595. Notable are the Santo Cristo, Socavon, La Colorado, and San José mines. Interesting specimens of franckeite on stannite and zinkenite crystals occurred in the Santo Cristo mine. Chace (1948) describes abundant franckeite in the Grande vein and points out the typical association of franckeite, plagionite, and galena. Coarse-grained aggregates of franckeite exhibiting individual grains to 2 cm in a matrix of fine-grained teallite are still produced from the San José mine. The dump of this mine contains boulders cut by narrow veins of massive franckeite. Crystal-lined pockets may be occasionally encountered in these boulders with uncommon amounts of work.

Jamesonite - $Pb_4FeSb_6S_{14}$ - Jamesonite, displaying an identical habit to the more familiar Mexican material, is quite common in almost all of the major tin-silver districts of Oruro. Intriguing jamesonite in complex crystal aggregates, with individuals reaching 6 cm in length, occurs with wurtzite crystals in the active Bolivia mine approximately 5 km east of Poopó. Matts of jamesonite with associated boulangerite, zinkenite, and arsenopyrite occur in vuggy dump material at the San José and Itos mines, Oruro.

Andorite - $PbAgSb_3S_6$ - The Itos and San José mines at Oruro have probably produced the finest andorite specimens known. Vugs containing highly complex crystals up to 3 cm long are described from the upper levels of the Purisima and Bronce veins by Prior and Spencer (1897), whose illustrations have been perpetuated in Volume I of *Dana's System of Mineralogy* (Palache, Berman, and Frondel; 1944). The dumps of the Itos mine occasionally yield small andorite crystals in quartz crystal-lined vugs.

Plagionite - $Pb_5Sb_8S_{17}$ - Plagionite, occurring as coarse tabular crystals on meneghinite, was originally described by Zambonini (1916) from the Purisima vein, Oruro. Sharp crystals up to 1 cm in diameter occur in small vugs in the same vein associated with needle tin and galena. Chace (1948) reports tabular crystals up to 5 mm intimately associated with rounded clusters of franckeite on a U. S. National Museum of Natural History specimen (C4926) from the Socavon portion of the Purisima vein.

Semseyite - $Pb_9Sb_8S_{21}$ - Spencer (1907) described an argentiferous variety of semseyite from the mines near the city of Oruro that he had obtained from the Foote Mineral Company in Philadelphia. The mineral occurred as iron-black crystals with a bright metallic luster grouped in rosette-like aggregates associated with "plumosite." This mineral must be considered rare within the Department of Oruro.

Zinkenite - $Pb_6Sb_{14}S_{27}$ - Zinkenite is common in almost all of the tin-silver veins near the city of Oruro, occurring as masses, columnar to radial-fibrous aggregates, and in felted masses of tiny acicular crystals coating vugs, particularly in pyrite. As noted previously there is some confusion as to the actual distinction between zinkenite, jamesonite and boulangerite among individual specimens. In recent years outstanding examples of zinkenite have been produced from the San José mine. Here the mineral occurs as discrete crystals up to 5 cm long in loose aggregates or individually upon pyrite associated with andorite.

Cylindrite - $Pb_3Sn_4Sb_2S_{14}$ - This is undoubtedly the most unusual of the sulfosalts and is perhaps unique in the mineral kingdom, occurring in what apparently should be crystals but instead, as the name implies, in cylinders "terminated" by hemispheres. Along with franckeite and teallite, cylindrite completes a triad of minerals that are relatively important and abundant in Bolivia and yet are almost unknown elsewhere.

The premier occurrence of cylindrite is the Poopó district. Frenzel (1893) first described the mineral from ore of the Santa Cruz mine. Here cylindrite occurs in abundance in "tubes" up to 3 cm long in a pyrite-sphalerite vein. The most noted location is the Trinacria mine in the extreme southern portion of the district. Large amounts of cylindrite-rich ore were mined here years ago. The mineral occurs in a matrix of franckeite, sphalerite, and pyrite as unoriented aggregates of cylinders reaching 1 cm in diameter and 5 cm in length. Excellent though somewhat weathered specimens can still be found on the dump with luck.

Ahlfeld (1943) reports cylindrite associated with jamesonite, boulangerite, and franckeite in the María Francisca mine, Huanuni district. Cylindrite has also been reported as included in franckeite of the Grande vein, Oruro.

Oxides

Valentinite - Sb_2O_3 - Ahlfeld (1943) describes excellent valentinite occurring on the 110-meter level of the Porvenir mine, Huanuni. The mineral occurs as radial groups of crystals with individuals ranging up to 5 mm in length within vugs in boulangerite and associated cervantite. Several excellent specimens of valentinite as individual crystals reaching 2 cm in length on matrix were observed in the town of Oruro. The origin of these crystals is not positively known but are probably from the upper levels of the San José mine.

Cassiterite - SnO_2 - Cassiterite is the mineral for which Bolivia is most well known. It has been estimated that cassiterite has been produced in economic quantities from no less than 17 districts and approximately 600 individual mines. Ahlfeld (1943) has divided macrocrystalline cassiterite into four major categories based upon dominant crystallographic forms. The first category is that in which cassiterite occurs exhibiting only pyramidal faces. This type of occurrence is most typical of pegmatitic deposits and is quite uncommon within the Department of Oruro. The second category is that in which a wide variety of crystallographic forms are displayed in conjunction with very complex twinning (ex. Araca). The third category reflects dominant development of the prism with termination by the simple pyramid only. The fourth characteristic occurrence is that of "needle tin" in which the prismatic faces are highly exaggerated.

Specimen-grade material equal to that of the famous occurrence at Araca (Department of LaPaz) is virtually unknown in the districts of Oruro; however, lesser though still exceptional specimens occur in a number of the mines. Brilliant lustrous crystals of the type-two occurrence are known from the mines at Huanuni and Avicaya. Here crystals are typically a dark mahogany brown, are less than 1 cm in diameter, and are twinned on (101). Excellent specimens of this type material are occasionally produced from the operating mine at Huanuni in vugs in massive cassiterite. The vugs are typically less than 6 cm in diameter.

Specimens of type-three cassiterite in which the prism faces are dominant occur in the Huanuni, Poopó, and

Fig. 6

Fig. 3

Fig. 4

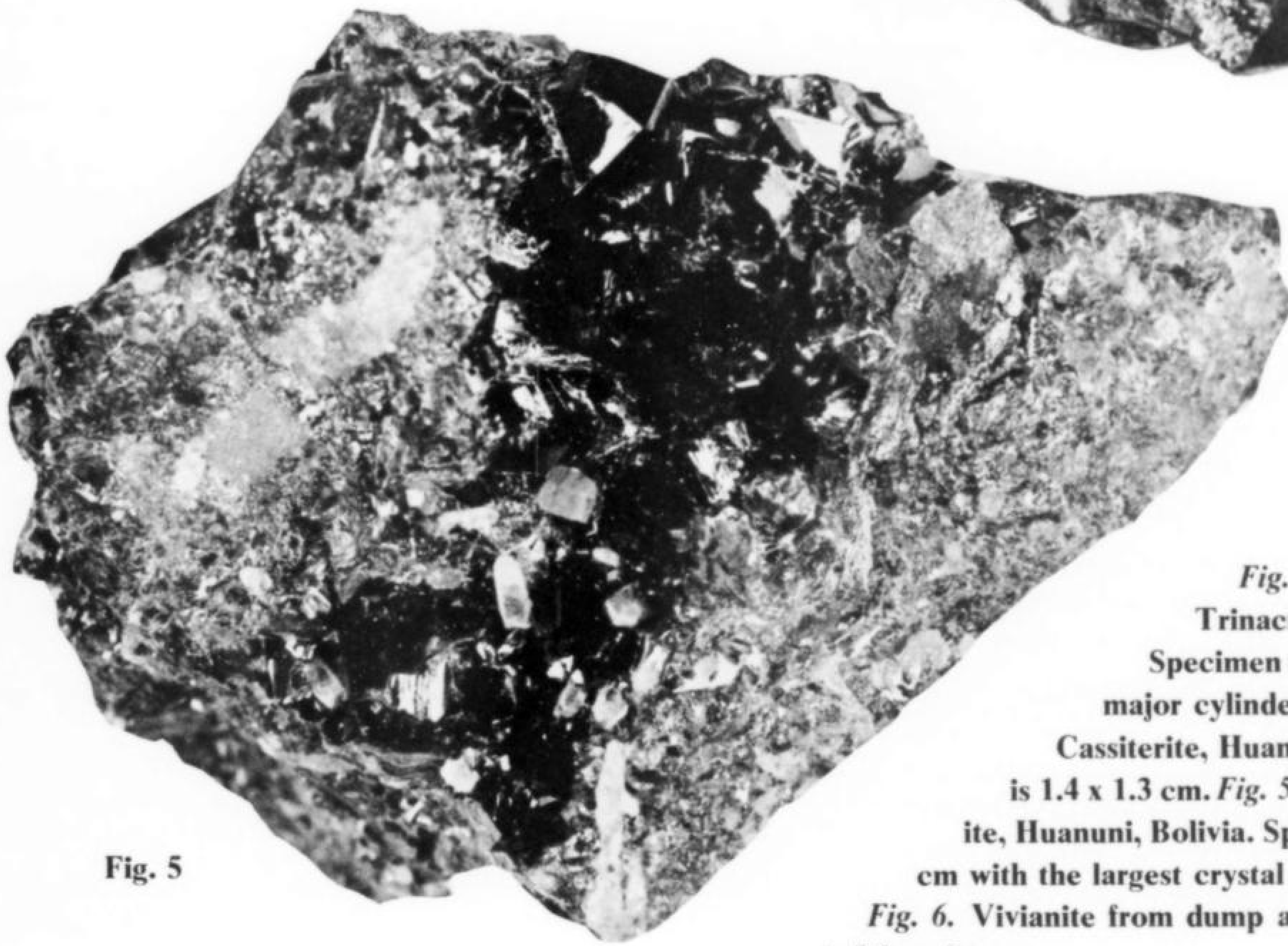

Fig. 5

Fig. 3. Cylindrite in sphalerite, Trinacria mine, Poopó, Bolivia. Specimen measures 2.5 x 2.0 cm with major cylinder 1.1 cm in length. *Fig. 4.* Cassiterite, Huanuni, Bolivia. Major crystal is 1.4 x 1.3 cm. *Fig. 5.* A rather typical cassiterite, Huanuni, Bolivia. Specimen measures 8.0 x 5.0 cm with the largest crystal being 0.9 cm in diameter. *Fig. 6.* Vivianite from dump at Avicaya. Central crystal is 5.0 cm long.

Avicaya districts. Brilliant black crystals up to 2 cm in length occur either singly or with crystalline quartz at the mine in Huanuni. Excellent miniature and thumbnail specimens are occasionally produced. It has been shown in thin section that these apparently simple prismatic crystals are really twins consisting of four interpenetrating prismatic crystals producing a single pseudoprismatic crystal.

Outstanding examples of type-four cassiterite, needle tin, occur within the Department of Oruro. The Ichucollo mine at Monserrat has produced far more needle tin and far better specimens than any other mine in Bolivia. Excellent aggregates of needle tin occur within vugs in wurtzite intimately associated with crystalline teallite, franckeite, pyrite, galena and quartz. Individual crystals range up to 5 mm in length, are yellow, and exhibit a brilliant luster. Samples are also known from the Porvenir mine at Huanuni, the El Salvador mine, and Antequera. Crystals of needle tin up to 2 mm in length occur as aggregates in vugs in pyrite from the upper levels of the Itos and San José mines near the city of Oruro.

Stibiconite - $Sb_3O_6(OH)$ - Stibiconite is a rather common mineral in the antimony veins of the department, however, specimen-grade material is not particularly abundant. Mediocre specimens have been obtained from the Tarumita mine in the Caracollo district. Interesting specimens were produced from the Porvenir mine, Huanuni, where stibiconite occurred as small, yellow acicular crystals arranged in radial aggregates on Boulangerite.

Tungstite - $WO_3 \cdot H_2O$ - Rather typical examples of tungstite and associated hydrotungstite occur as alteration products after ferberite and scheelite at the Calacalani mine near Colquiri and at the Juliana mine in the Conde-Auqui district.

Hochschildite - $PbSnO_3 \cdot H_2O$(?) - This exceedingly rare mineral (?), described by Herzenberg (1942), is reported only from the Monserrat area. Hochschildite occurs in yellow masses in the upper portion of the mine, apparently originating from the oxidation of teallite.

Souxite - $SnO_2 \cdot H_2O$ - This unique material, described by Herzenberg in 1949, occurs as a secondary product after stannite in the Antequera district. The mineral is relatively common here, occurring in rather porous, yellowish-brown masses and is of interest only to the species collector.

Halides

The halides are not particularly well-represented in the ore deposits of the department. Cerargyrite has been reported from the Carangas mines and the San José mine near Oruro. Minor quantities of fluorite are reported from the La Bomba mine and the district of Huanuni.

Carbonates

Calcite and siderite are rather common constituents of the primary gangue of many of the hydrothermal ore deposits. Rhodochrosite is particularly common in the Negrillos, La Joya and San Andres deposits. Cerussite has been reported from the upper levels of many deposits, occurring as an oxidation product of galena and various lead sulfosalts. Good to excellent specimen-grade material occurs in the upper portions of the San Jose mine. Sharp aggregates of transparent crystals reaching 4 cm in length occur here exhibiting a bladed, simply-twinned habit.

Phosphates

While the spectacular phosphates of the Llallagua district to the east of the Department of Oruro are well known among collectors for their unique species and unrivaled quality, several districts within the department have produced similar phosphates species, in some instances approaching in quality those of Llallagua.

Vivianite - $Fe_3(PO_4)_2 \cdot 8H_2O$ - With regard to beauty and perfection, perhaps vivianite is the finest phosphate species known in the Bolivian tin-silver deposits. The three most outstanding occurrences in the department are in the districts of Avicaya, Huanuni, and Monserrat. The most spectacular single find was in the Ichucollo mine, Monserrat, in 1947. In this discovery a large cavity was uncovered which contained very sharp transparent vivianite crystals up to 20 cm in length. Generally abundant in this mine were small specimens containing vivianite crystals up to 1 cm in length covering crystalline quartz and wurtzite. Occasionally, radial groups of acicular crystals are found coating wurtzite. Ahlfeld (1943) describes vivianite crystals from Huanuni equaling those from the famous Siglo XX mine, Llallagua. The dumps in the Avicaya district occasionally yield specimens of vivianite in crystals up to 6 cm long coating iron stained, vuggy quartz.

Apatite - $A_5(RO_4)_3(F,OH,Cl)_3$ - This species is not particularly common in the tin-silver vein deposits of the department. However, interesting samples are occasionally produced from the mines of Huanuni and Oruro. Kozlowski and Jaskolski (1932) describe apatite in the San José mine, Oruro, as 1 mm long prismatic crystals coating barite, marcasite and kaolin.

Wavellite - $Al_3(PO_4)_2(OH)_3 \cdot 5H_2O$ - Very fine wavellite specimens have been produced in the past from the Purisima, Bonce, and San Luis veins at Oruro. Kozlowski and Jaskolski (1932) describe individual colorless crystals up to 5 mm across forming aggregates and groups occasionally coating stannite crystals. Wavellite is quite late in the paragenetic sequence for these deposits, is later than alunite and kaolin, and apparently contemporaneous with marcasite.

Augelite - $Al_2(PO_4)(OH)_3$ - This mineral is known in excellent specimens from the Socavon mine near the city of Oruro. It occurs here in colorless tabular crystals up to 5 mm in length and is occasionally associated with alunite.

Tungstates

Huebnerite - $(Mn,Fe)WO_4$ - Good to excellent huebnerite specimens occur in two districts in the Department of Oruro. The first occurrence is the Quimsacoya mine in the Dalence province. Excellent huebnerite crystals occur here in radial aggregates in vugs and fissures in white quartz. Huebnerite in this mine accompanies, but is later than, stibnite. Radial aggregates of huebnerite exhibiting a rich reddish-brown color occur in the veins of the Santa Isabelle mine in the District of Conde-Auqui.

Ferberite - $FeWO_4$ - Very fine ferberite specimens occur at Calacalani, approximately 12 km southwest of Colquiri. Ferberite occurs here in rather coarse crystals with crystalline quartz and siderite, occasionally replacing earlier scheelite. The crystals are quite interesting in that they present a pseudocubic habit due to the presence of three dominant pinacoids. Tabular ferberite crystals occur in the Santa Isabelle mine in the district of Conde-Auqui. The vein is commonly quite vuggy, containing late ferberite crystals coating crystalline quartz and siderite within its interior portions. Excellent tabular crystals of ferberite, occasionally covered by radial sprays of stibnite, occur in the San Miquel mine near Lequepalca, approximately 40 km northeast of Oruro.

Scheelite - $CaWO_4$ - Although scheelite occurs in many of the tungsten veins in the department, mediocre to good specimens are known from very few deposits. The La Bomba mine in the Conde-Auqui district occasionally produced scheelite in aggregates of crystals up to 1 cm in diameter. These crystals are quite sharp and are typically associated with gangue fluorite, barite, calcite and aragonite.

Silicates

Although a wide variety of silicates occur within the Department of Oruro, they are predominantly the typical rock-formers and ore-related and gangue minerals. Outstanding or unusual occurrences warranting inclusion in this paper are unknown.

CONCLUSION

So here you have it, a review of what must be acknowledged as one of the most mineralogically intriguing regions. As can be seen by the material presented and the references cited, a fair amount of original mineralogical research has already been conducted on various deposits in the Department of Oruro, however, an enormous amount of data remains to be collected. It is with this thought in mind that I extend the challenge to fellow mineralogists to continue the fine tradition of Bolivian mineralogy.

ACKNOWLEDGEMENTS

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REFERENCES

ALFELD, F., 1954, *Los yacimientos minerales de Bolivia*: Bilbao, Imprenta Industrial, S. A., 227 p.

——————, and MUÑOZ REYES, J., 1943, *Los minerales de Bolivia*: Direccion General de Minas y Petroleo, La Paz, 276 p.

CHACE, F. M., 1948, Tin-silver of Oruro, Bolivia: *Econ. Geol.*, **43**, 333-383, 435-470.

FRENZEL A., 1903, Ueber den Kylindrit: *Neues Jhbr. Min., 1893*, 125-128.

HERZENBERG, R., 1942, Hochschildita, un nuevo mineral de estaño, decubierto en Bolivia: Univ. de Oruro.

JONES, R. W., 1973, The Mark Chance Bandy mineral collection: *Mineralogical Record*, **4**, 280.

KOZLOWSKI, R. and JASKOLSKI, ST., 1932, Les gesementes argento-stanniferes d' Oruro en Bolivia: *Arch. Min. Soc. Sci. Varsovia*, **8**, 121 p.

LJUNGGREN, P., 1962, Bolivian tin mineralization and orogenic evolution: *Econ. Geol.*, **57**, 978-981.

MONTGOMERY, A., 1974, An American mineralogist, part V.: *Mineralogical Record*, **5**, 160-166.

PALACHE, C., BERMAN, H., FRONDEL, C., 1944, *Dana's System of Mineralogy*, Vol. 1: John Wiley and Sons, Inc., 834 p.

PRIOR, G. T., and SPENCER, L. J., 1897, The identity of andorite, sundtite, and webnerite: *Min. Mag.*, **11**, 286-301.

SPENCER, L. J., and PRIOR, G. T., 1907, Notes on some Bolivian minerals: *Min. Mag.*, **14**, 308-344.

TURNEAURE, F. S., 1971, The Bolivian tin-silver province: *Econ. Geol.*, **66**, 215-225.

——————, and WELDER, K. K., 1947, The ore deposits of the Eastern Andes of Bolivia. The Cordillera Real: *Econ. Geol.*, **42**, 595-625.

ZAMBONINI, F., 1916, Contributi allo studio dei solfosali naturali: gruppo plagionite: *Zeits. Krist.*, **55**, 380-386.

ERRATA — An American Mineralogist, Part IX.

(1) Author's name, Arthur Montgomery, was omitted from p. 57.

(2) On page 60, in the first paragraph under heading AN AMERICAN MINERALOGIST, the second sentence should read "There is, first, the need to do justice to his contributions to mineralogy, scientific and amateur-oriented both - for he accomplished much, in different ways, in these two fields."

Yedlin on Micromounting

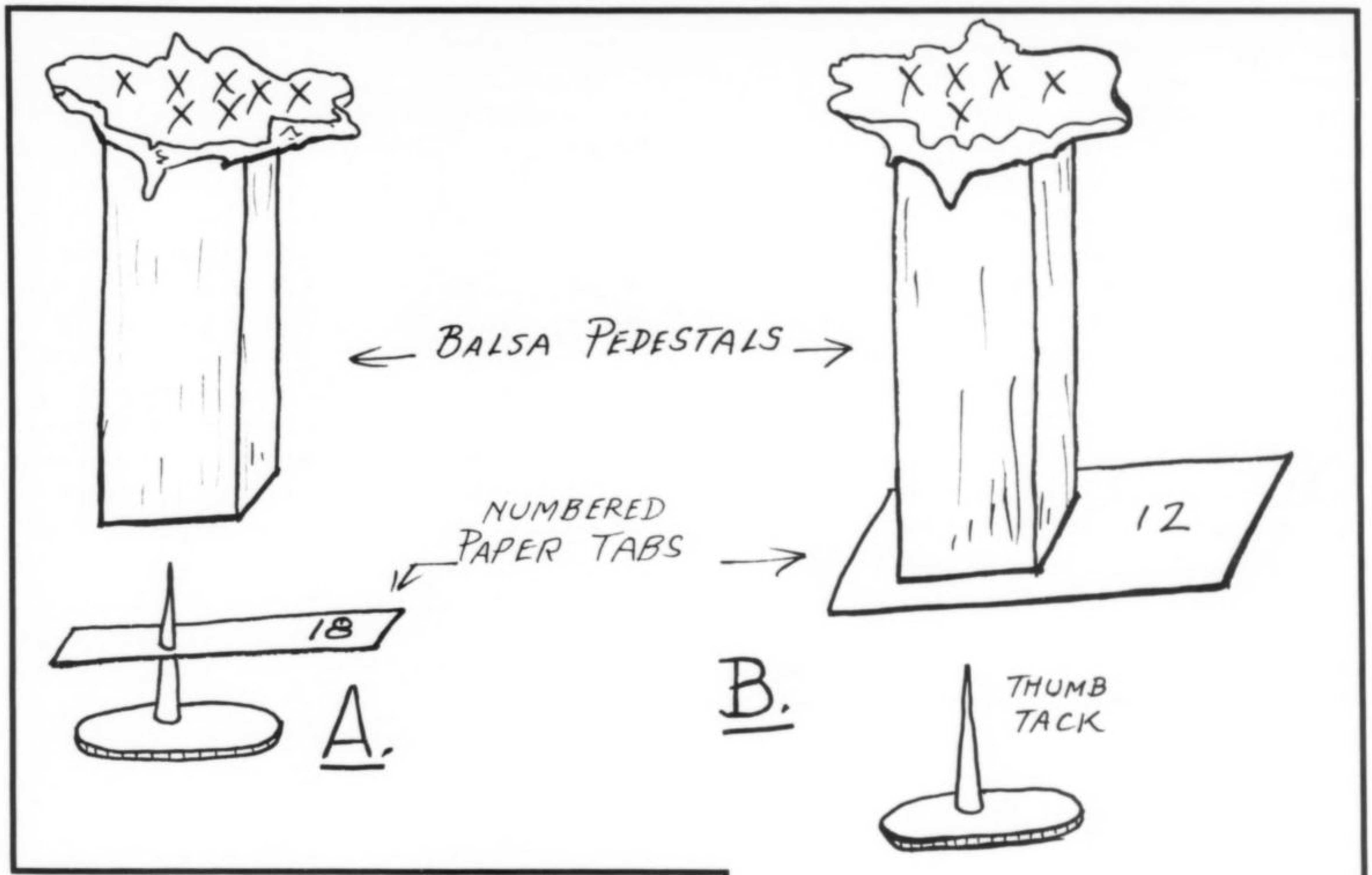
There was an unusual response to the article anent mineral localities in St. Lawrence County, New York, (*Mineralogical Record*, Volume 5, Number 5, 1974) and active interest was indicated. The included map of the area, the original of which was redone at the editorial department, contained no fewer than 13 errors, from the misspelling of talc and uraninite to that of Rossie, and the omission of item 3 from the sketch. However, a letter from George Robinson, 387 Division Street, Kingston, Ontario K7K 4A6, with an enclosed copy of a descriptive publication, done by him and Schuyler Alverson in 1971, updates the data and can be used as a field guide for anyone who wants to do serious collecting in the area. The publication, a 42 page booklet, is entitled *Minerals of the St. Lawrence Valley*. It describes and maps the major collecting areas of the region, and includes photographs of many specimens. The price is $2.50, and is something you should have, whether you plan to visit and collect, or have specimens that originated in this part of New York in your collection. A bibliography is included and the 1971 status of 14 noted localities is discussed as to present collecting. Interestingly the authors include, in the notes at the end of a locality description, the tools needed properly to collect thereat. This is a good manual.

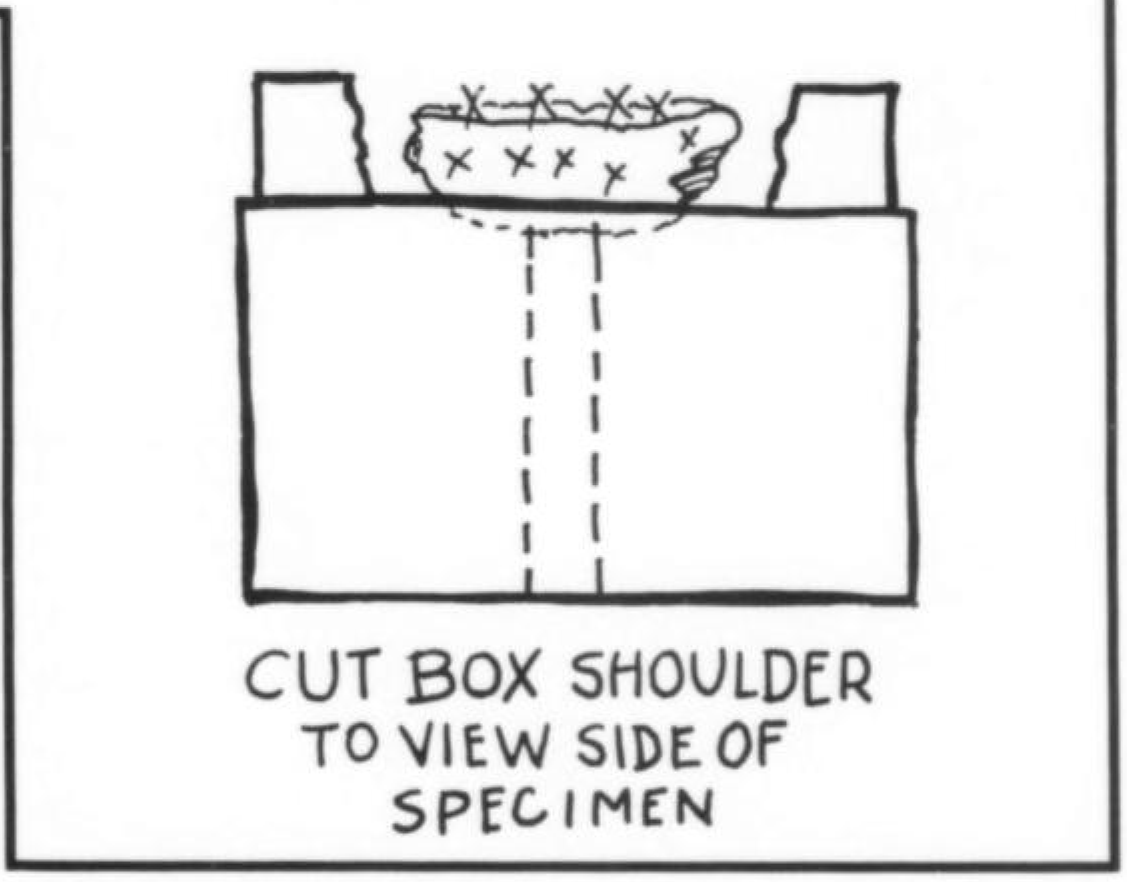
Marty Plotkin, 117 Clover Drive, Massapequa Park, New York 11762, an old-time collector who learned his early mineralogy under the aegis of Jack Boyle at the Childrens' Museum in Brooklyn, suggests: "If you have a mount which has something interesting on the side as well as the top - another vug, different crystal faces and more - notch one or more top edges of the box until the cut hits the shoulder. This permits visibility to the sides of the specimen, but still seals the box, maintaining a reasonably dust-free medium when the cover is on. Any utility knife will do the job, or cutting pliers, file - whatever is available". We've sketched his box. Works well. Another method of setting up visual availability is to cement the specimen to the box cover as a base, using the clear container as a cover. When the clear box is removed the specimen can be viewed from any angle and from all sides except the bottom. The chief objection to this method is the possibility of damaging the specimen if the box inadvertently makes contact with the specimen when being removed or replaced. Marty is a species collector, has an extensive cabinet, including specimens of all sizes.

Some collectors ship specimens individually labelled and some include a number in each wrapping, the numbers corresponding to an included list. In recent weeks we've received a couple of the latter. Now our usual mounting procedure is to do a dozen or so at a clip, setting them up on balsa pedestals after cleaning and shaping. We stick a thumbtack onto the bottom of the wood, and set the item on a sheet magnet for drying. This is great where you take the specimen apart and have a quantity to mount. It speeds up the "carpentry", a necessary part of micro-mounting. Question:- How to maintain accuracy of name and locality during this process? Where we have jahnsite, or some other from more than one locality, it is essential that the finished product be accurate. This is what we do. We cut small bits of paper, about 1/2 by 1 inch, place numbers on each to correspond to the specimen being worked on, and spear this tab with a thumbtack prior to affixing the pedestal to the tack. Looks like the sketch herein. To do a one handed job touch the balsa bottom to the tongue and moisten it. Touch the paper tab with the balsa and it will adhere. Press the whole on the tack. Presto, you've got it made! (See sketch "B".)

We attended the Nassau Mineral and Gem Society's show at Freeport, New York, in November last. It was a good session, with much to see. Among the exhibits were a couple of cases that we consider the most important in the show. These illustrated mineral identification through visual characteristics, with actual specimens, and showed color, streak, hardness, cleavage, lustre, fracture, taste, tenacity, density, crystal systems and crystal habits. These cases should be preserved *en toto*, to circulate throughout schools and colleges.

There was, too, a micromount exhibit at the show; not merely a competitive set-up, but a live demonstration. Irving Horowitz conceived the affair, and using large cardboard boxes, 2 x 2 inch lumber as pedestals, and hand sized specimens, created what he titled "Anatomy of a Micromount". Two borrowed Olympus stereo-binocular 'scopes were in use constantly, and many collectors saw for the first time the magnificent beauty that minerals can attain. Jules Bernhardt supplied color prints of micros from his own collection, done by him with contrived equipment, originally photographed on kodachrome through his microscope. Fine exhibits were the rule, and some outstanding specimens were to be seen.





Notes:

Pharmacolite was distributed at the Baltimore Symposium last September in one of the "give-away" boxes. Turns out to be gypsum, isostructural with pharmacolite. Shows that the X-ray is not the final word in mineral determination, and is but one of the important tools in pinning down an identification.

The South African Micromount Society has just come into being. Volume 1., Number 1. of its *Views and News*, issued in October, 1974, and written by Horst Windisch, 30 van Wouw Street, Groenloof, Pretoria, 0001, South Africa, tells of the aims of the organization and details of membership, contains a book review, a handy hint for collectors (simple height gauge), an article on the "Mineralogy of the Platinum Group Elements" by Andre de Ruyter, and, believe it or not, an offer to swap by Arthur Smith, 7118 Concho, Houston, Texas 77036. Welcome aboard!

E. Russ De Roo, 141 Willard Avenue, Totowa, New Jersey 07512, is in the process of organizing another such group, "The Micro Minerals Study Group", in New Jersey. He writes: "I have great hopes about the group. I hope that we will be able to make connections with someone who can give us some help, both with organizational details, and with identifications, or with knowledge beyond that which we have, so that we may up-grade our abilities. We plan a major meeting devoted to the minerals of Fort Lee, New Jersey; these came out about ten or twelve years ago when they were blasting through the basalt to tie new roads in to the new lower level of the George Washington bridge across the Hudson River. Zeolites, titanite, needle apatite, amphiboles, magnetite, epidote and allanite were some of the fine micros to appear. We'd like to do a definitive work on the locality and record it in the literature. Right now we meet at members' homes, have no officers, and do not want to become involved in administration."

Alright, you New Jersey micromounters, lend a hand here. The 1974 directory of such collectors lists some fifty of you.

A new price list by Hatfield Goudey, 1145 West 31 Avenue, San Mateo, California 94403. Some real goodies, and if you want to do your own mounting the prices are good. One of Hat's old lists, dated 1954, had a 3 page summary entitled "Micromounts, Why and How". His present catalog updates that summary, and you may have it for a couple of dime postage stamps, the cost of sending it through the mails.

And Lt. Col. Quint Wight takes us to task for using "Scotch tape" to hold data on leather bound books. "The leather", he says, "especially if the book is an old one, comes off with the tape, leaving an ugly scar. I called the Library of Congress restoration department, and the recommendation was to use toluene. It should be worked under the tape with a soft brush. The leather darkens at first, but soon the tape lifts off, and the toluene dries, leaving no mark. This works with tape on paper, too, as does acetone but, if the paper is colored, check to see if there is a color change." Quint is a Canadian, presently stationed in Washington, and we've amended his letter by elimination of "colour" and substituting "color".

Recently we were handed a sheet of native copper from Santa Rita, New Mexico, about 4 by 6 inches in size, partially crystallized, with acicular cuprite (chalcotrichite) coating the hollows and irregularities in the metal. An included note asked the best way to cut up the copper for boxed specimens. Well, we wouldn't. The specimen is too fine as a cabinet piece, and we've never advocated destroying such to make micros. In fact it's been our tenet to preserve good specimens. Boxes are more easily come by than minerals. Were we so disposed we could bend an outstanding (literally, not esthetically) piece of the copper until the metal fatigue severed it from the main, and thus have our cake and eat it too. Were we determined to break it down to many pieces we could have used a pair of tin snips, bolt cutters or even a thin carborundum saw blade. But why? In this case the cuprite is not so rare that another could not be obtained. We cannot, therefore, make an all encompassing judgment about such matter; so much depends on the immediate. Meanwhile, the specimen goes on to our library shelves.

Bad news. Union College, Schenectady, New York, was invaded by thieves over a weekend in early December. Elmer Rowley, curator of the collection, advises that some rare and superb specimens were burglarized. At this writing inventory was being taken, but immediately evident were all of the crocoites, stibnites, fluorites, cerussites, mimetites, vanadinites, Siberian alexandrite crystals in matrix, bournonite, cylindrite and others. Many of the specimens were from the Otto Pfordte collection, acquired about 1910, and the Charles M. Wheatley collection, *circa* 1862. Wheatley was the owner and operator of the lead mines at Phoenixville, Pennsylvania, who willed his assemblage to the college. The Phoenixville specimens were the best to be had, and his general collection was one of the finest. Wheatley's labels were plain ones, with the letters "C. M. W." on the lower left. Pfordte's labels bore the legend "Mineral Collection of Otto Pfordte, Rutherford, N.J." at the top. Please watch for old-time fine minerals being offered for sale by unknown sellers.

Overhaul your collecting equipment, especially your breakers and saws, lay in a good supply of labels (and boxes if you can get them), shop around for Duco cement (It varies in price from 39 to 49 cents, but watch out for quantities; some tubes hold but 3/4 ounce instead of 1-3/4), clean and adjust your 'scope, and buy and use a good mineral book.

Neal Yedlin
129 Englewood Drive
New Haven, Connecticut 06515

What's New in Minerals?

THE ZURICH MINERALBOURSE

The following report is by John Marshall, of Millis, Massachusetts. It first appeared in the Bulletin of the Boston Mineral Club, 22 January 1975:

The Zurich Mineralbourse was held in early November 1974. It is the "Tucson" of Europe and by far the largest mineral show in the continent, over 200 dealers in an area larger than a football field, all covered and well lighted. Those dealers setting up early could actually drive cars or trucks to their tables and unload. During the two day show, an estimated 25,000 people attended.

There were very few new minerals. Some nice Spanish fluorite, similar to Rosiclare but lavender rather than the deep purple of Illinois fluorites. Some had associated galena and prices were about the same as we are used to for Illinois specimens. Also two nice golden barites from Sardinia, new to me. Excellent pyromorphites from Les Farges, but light grass-green solid crystalline masses without matrix, rather than the olive-green crystals on barite that we usually see. Also a large number of Nepal tourmalines, many with nice crystal forms and terminations, but generally very light pink or bi-colored pink and white, generally cloudy with no gemmy material.

An interesting observation was the almost total lack of any classic European specimens. The only things close were the recently collected hematite roses and Swiss quartz crystals galore. Some of the roses were up to 2" and then priced from $200-400. I was astounded to find no Chessy azurites or French prehnites or axinites. Also only two rather poor pink fluorites from the Swiss Alps.

The material that was on hand was interesting, and often in tremendous quantity, such as Mibladen vanadinites by the thousands. Specimens I would price at $6-7 was being sold for $1-1.50. Exceptional pieces showing large crystals up to the size of a dime on a 3x3" specimen were $60-75. A few days later, in Geneva, at a downtown mineral boutique and also at the airport store, I saw all kind of minerals for sale, particularly the Mibladen vanadinites. Even here, prices were less than at the stateside shows. The quality was notable, with most specimens free of any damage.

Roumanian stibnites were so common I tired of seeing them. Quality was fantastic, better than anything in the US, even at Tucson. Specimens up to 10x10" with matrix, without matrix, nice sprays of crystals scattered on matrix, and some crystals in groups with needles up to 4 or 5" long. The larger specimens (6x6" range) were selling from $200-400, but smaller fist-sized specimens were "a-dime-a-dozen" and not selling because they were dwarfed by the larger pieces.

Panasquiera material was abundant, especially large wolframites; many damaged, and often priced high, I thought. The mind-blower of the show was the crocoite, with at least two dozen specimens as good as anything in the Harvard cabinets. Some priced up to $5000, but a really handsome piece (museum quality to me) could be bought for $400. From what I gathered, the material came out of Tasmania two years ago and almost all ended up in Europe. Vera Cruz amethysts were also common, with large 6x6" and 4x4" pieces showing crystals on matrix. These were reasonable at $100-150. I could not find out if they were old stock, or recently produced. Lots of fine Spanish dolomites, at high prices, some 1" crystals selling as high as $50-75. Spanish aragonites were also common and golf-ball-sized single crystals were 75¢ to $1. Tons of Elba pyrite, not very attractive, and not selling at all.

Most dealers were Swiss and German, with a few each from Italy, France, England, Scandinavia and Spain. The only US dealers were Pala Properties and Plumbago Mining.

THE TUCSON SHOW - 1975

The following report of the Twenty-first Annual Tucson Gem and Mineral Show is by William Moller, of Long Beach, California. It first appeared in The Bulletin of the Mineralogical Society of Southern California, March, 1975:

Tucson! The very name is vibrant with expectation of fun, fellowship and the acquisition of new minerals to those pilgrims who yearly brave the miles to attend the show of the Tucson Gem and Mineral Society. Evidence that their expectations are amply rewarded can be found in the increasing numbers of MSSC members who regularly make the long trek; this year their count stood almost at eighty!

Even more eloquent testimony to the excellence of the exhibition can be discovered in the show attendance: an estimated 20,000 paid admissions! Add to that the several thousand school children who were bussed to the display plus the hundreds of participants who were admitted without charge, and some appreciation of the outstanding quality of this magnificent presentation can be attained.

Vast numbers of spectators for the first time came face to face with crystals. A dawning appreciation of the difference between a rock and a mineral began to develop as participants were treated to such outstanding displays as that offered by the American Museum of Natural History with its remarkably fine case which included a superb proustite crystal group from Chanarcillo, Chile, an astonishing scorodite specimen from Zacatecas, Mexico, and an incredible chrysoberyl originating in Minas Gerais, Brazil.

The Royal Ontario Museum offered an intriguing display of serandite and its various associations as found at Mont St. Hilaire, Quebec, Canada. Superb tourmaline specimens were shown by the Harvard Mineralogical Museum, while the Smithsonian Institution exhibited a case of astonishing zeolites and associated species. Among the latter were apophyllites of gigantic size on prehnite from Patterson, N.J. and enormous natrolite crystals from the famed Bound Brook location of the "Garden State."

Marching shoulder to shoulder with the institutional exhibits was the offering of member Keith Proctor, whose excellent display featured a mimetite of unbelievable excellence from Tsumeb, South West Africa, scorodite as found at the Noche Buena mine, Concepcion del Oro, Mexico, and fluorite on quartz of Gőschener Alp, Switzerland.

An unusual display was prepared by Roger Titeux whose case was highlighted by "Reproductions of Original Drawings and Mathematical Research of Professor Hauy, who discovered the mathematical laws governing the symmetry of crystals." The exhibit included the type crystals upon which Abbe Hauy made his measurements!

Dr. R. V. Gaines provided an impressive presentation of minerals containing beryllium with forty nine of the known fifty-two species on display, while J. Gordon McGinley captured the attention of viewers who favor bright colors with an unusually large and excellent crocoite crystal group from Dundas, Tasmania, plus extraordinary rhodochrosite euhedrons originating in Alma, Colorado.

Best of Species award for cabinet size specimens went to Larry Smith with his high quality barite crystal cluster on calcite from Otero Co., La Junta, Colorado. In the miniature class Les Presmyk took top honors with an excellent barite crystal group from the Magma Mine, Superior, Arizona, while Janet Smith won first position for her thumbnail specimen of the heavy spar.

The Ed McDole Trophy for the case of finest minerals presented by an individual was accorded to F. John Barlow. This latter presentation was highlighted by specimens of wolframite of superb quality from Chicote Grande, Inquisivi, Bolivia, and an acanthite of comparable excellence from Freiberg, Germany.

Fascinating talks by knowledgeable speakers punctuated the three-day program. These included remarks on mineral collecting in Baja California by member Josephine Scripps, and presentation of "The United States Crown Jewels" by Paul Desautels, who also holds membership in this Society. Of particular interest to mineral collectors were comments by Richard Hauck, who spoke on the "Minerals of Franklin Furnace, New Jersey." Mr. Hauck's efforts were supplemented by an excellent display in the exhibit area; this presentation included an unusually fine willemite from the famous Eastern locality.

"Minerals of the Nepheline Syenite Complex, Mont St. Hilaire, Quebec" was the title of a talk by Robert I. Gait, who supplemented his remarks with some excellent slides. Paul B. Moore of the University of Chicago drew a good crowd Saturday evening when he spoke on, "A Mineralogist Looks at His Profession." (To be published in the *Mineralogical Record*. Ed.) He particularly emphasized the frivolity of the importance placed upon determining new mineral species and lamented the lack of knowledge concerning the parameters under which certain mineral phases develop.

Prominent again this year were numbers of foreign buyers who apparently can purchase fine specimens in this country and re-sell them at a profit on the Continent. This is somewhat paradoxical in light of the astronomical prices charged for creditable specimens in the United

States. Already unreasonably high, the cost of good minerals has been made worse by rampaging inflation.

This season, as in nearly every previous one, a certain species of mineral was in vogue. Lazulite from Yukon Territory, Canada, was the "in" mineral this year. Exquisite indigo-blue crystals on mica schist drew the attention and admiration of viewers (see photo in Pala Properties ad. *Min. Rec.* **6**, p. 4, 1975). Rivaling the phosphates for appreciation were superb clusters of green apophyllite crystals from the Poona region of India. Unique pyrite euhedrons twinned repeatedly on (001) from the Amax Mine, Boss, Missouri were worthy of note too.

"Motel room hopping" provided additional opportunity to view and to acquire further fine material. Numerous rooms of two nearby hostelries were occupied by dealers who displayed their wares from atop bed spread and dresser surfaces.

If the Tucson group were to be faulted at all, it might be to observe they were able to entice too many people to their show—what an enviable criticism! It could be mentioned, too, the food serving facilities leave much opportunity for improvement.

This Society extends its congratulations to our sister group, the Tucson Gem and Mineral Society, for another superb exhibition. Particularly deserving of credit are the several people who spearheaded this annual effort. It is with justification the Arizona show is known as the Finest Gem and Mineral Show in the World. It is without peer. MSSC members are urged to plan now to attend the 1976 presentation.

QUIPS

24 CARAT CALCITE

From *Rocks and Minerals*, September 1974...

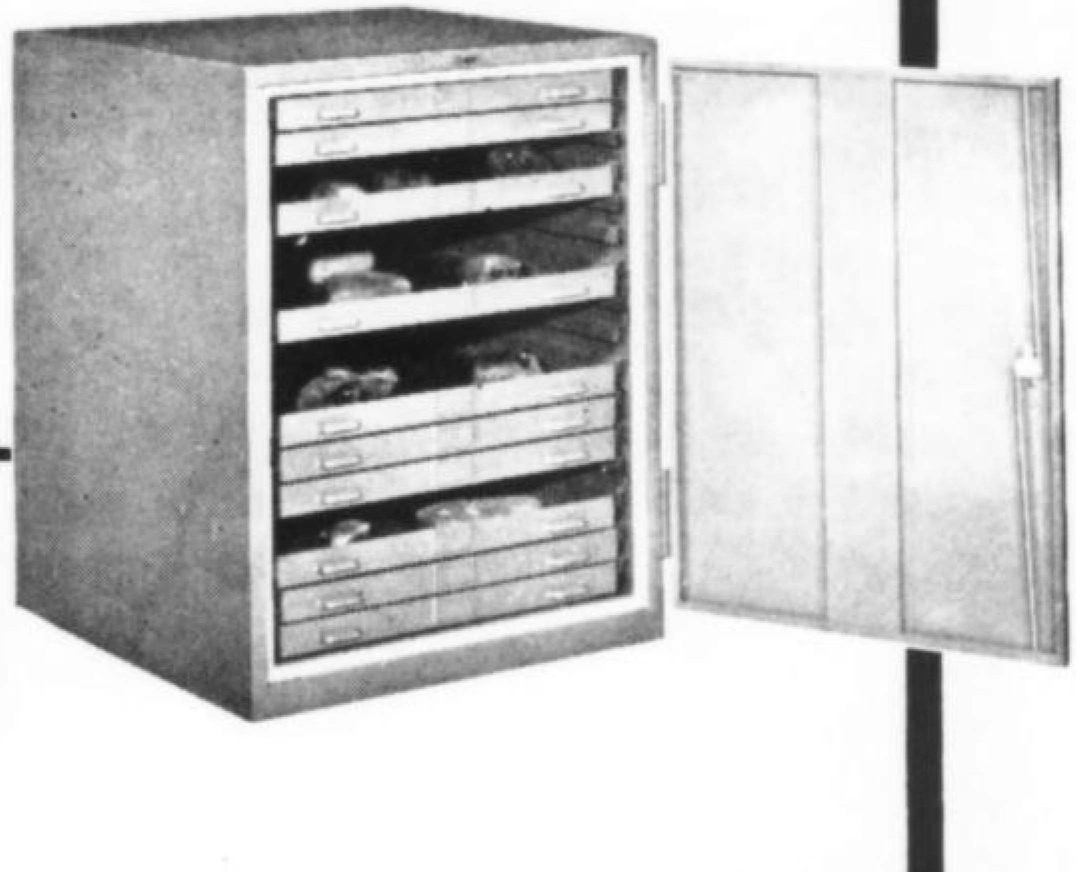
"Among the precious minerals that have been discovered and are mined in Siberia, there is one that occupies a special place. It is iceland spar, which is much more expensive than gold."

A GLOWING RECEPTION

From *Rocks and Minerals*, Nov. 1974...

"At the recent ALL-FLUORESCENT MINERAL SHOW in San Gabriel, California, the fluorescent Mineral Society honored Thomas Warren"

*Do you suppose the Society is **effervescent** too?*



WHAT'S IN A NAME: STARKEYITE vs. LEONHARDITE

by K. G. Snetsinger
Space Science Division
Ames Research Center
National Aeronautics and Space Administration
Moffett Field, California 94035

In previous what's-in-a-name articles, Mason (1971) and Fleischer (1972) have both noted that difficulties arise when two different names are available for the same mineral. I recently had personal contact with such a case, and although the mineral is rare and not likely to be encountered by professional or amateur mineralogists, I think the problems of nomenclature encountered are of enough interest to make the incident worth telling about. My involvement in this situation came about as follows.

In the summer of 1969, I was in northern California sampling chromite localities. The Alta troilite mine (now-defunct) in southern Del Norte County yielded, as well as chromite, some small troilite boulders dusted with a yellowish efflorescence. Qualitative laboratory tests showed the dust had iron, magnesium and sulfur present in major amounts, the iron being ferrous. Ten milligrams of the efflorescence (obtained by brushing the dust off the troilite, followed by hand-picking of impurities) were analyzed quantitatively, giving MgO 17.5, FeO 4.5, SO_3 41.0 and H_2O 36.0 weight percent, summation 99.0. This calculated out to the formula $Mg_{0.86}Fe_{0.12}(SO_4)_{1.02}(H_2O)_4$, and the mineral was therefore $MgSO_4 \cdot 4H_2O$ with some iron substituting for magnesium. X-ray study confirmed this, giving a pattern similar to synthetic magnesium sulfate tetrahydrate. Chemistry of the mineral was thus simple but a look at the literature showed that picking a name for it was not so easy. Two names, starkeyite and leonhardtite, were available, as a result of the events below.

Grawe (1945), in a long treatise on the pyrite deposits of Missouri, noted finding a dull, white, powdery efflorescence on an altered mixture of pyrite and marcasite at the Starkey mine in Madison County. He assumed the dust was iron sulfate tetrahydrate, based on its association with iron sulfides, positive qualitative reaction for iron, and agreement of the x-ray pattern with that of $FeSO_4 \cdot 4H_2O$. As this phase had not previously been found in nature, Grawe decided he had a new mineral and named it starkeyite. The data were somewhat circumstantial for definition of a new mineral; lack of quantitative chemical results is particularly apparent. Upon reading Grawe's paper, W. T. Schaller reported to M. Fleischer that the refractive index given for starkeyite by Grawe was too low for $FeSO_4 \cdot 4H_2O$. Subsequent check of the composition at the U. S. Geological Survey showed minor FeO but abundant MgO, suggesting starkeyite was a magnesium rather than an iron sulfate. Subsequently—unfortunately many years after the erroneous description—Grawe (1956) transferred the name starkeyite to the magnesium sulfate. In the time between the initial publication and the revision of the starkeyite data, however, Berdesinski (1952) had an opportunity to find his own occurrence of $MgSO_4 \cdot 4H_2O$. Apparently characterizing the mineral by x-ray data alone, he called it leonhardtite (after Prof. J. Leonhardt, who had done research on analogous compounds). Berdesinski's description of leonhardtite was not very full, but he did correctly diagnose the chemistry of the mineral. He was apparently unaware of Grawe's (1945) work, and Grawe (1956) seems not to have seen Berdesinski's (1952) paper. Choice of the name leonhardtite for $MgSO_4 \cdot 4H_2O$ was unfortunate because—as noted by Fleischer (1952; 1957)—leonhardite (after Karl C. von Leonhard, German mineralogist) had long been used for a zeolite variety: dehydrated laumontite. Availability of two names for one mineral creates confusion; the problem is not alleviated if one of the two names is nearly identical to that of an entirely different mineral. Berdesinski knew of the leonhardite-leonhardtite interference but dismissed it by saying that leonhardite "...ist vor einiger Zeit gestrichen worden" (had been rejected some time ago). This opinion of Berdesinski is incorrect; leonhardite definitely remains in use today for the zeolite. (Incidentally Fleischer and Berdesinski in their discussions actually happen to spell the zeolite name with two "t's", but it is my distinct impression that zeolite workers more often spell it "leonhardite.")

In 1957 Fleischer suggested that in order to avoid confusion with the zeolite leonhardite, starkeyite be used instead of leonhardtite for $MgSO_4 \cdot 4H_2O$. Strunz (1966) and Hey (1962), however, continued to use leonhardtite (for the sulfate) and leonhardite (for the zeolite). Such was the state of nomenclatural affairs when I found the further example of $MgSO_4 \cdot 4H_2O$. Having characterized the mineral, and wishing to publish the data on it, I felt it was my responsibility to decide what to call it.

In weighing starkeyite *vs.* leonhardtite it had to be realized that leonhardtite definitely has precedence over starkeyite for the sulfate composition. In essential agreement with Fleischer's 1957 discussion, however, I felt that sufficient confusion existed between leonhardite and leonhardtite as to justify rejection of the latter. I did take into account that in a scientific context there would be no confusion between the name leonhardite occurring in a zeolite paper and leonhardtite in a report on sulfates. Further, most workers dealing with sulfates have in their research reports tended to use leonhardtite rather than starkeyite. Nevertheless I felt—and still strongly feel—that leonhardite and leonhardtite are similar enough to be considered identical, and the duplication should be eliminated by rejecting leonhardtite. I drafted a proposal in favor of starkeyite, and submitted it to the I.M.A. Commission. In what was apparently a rare note of unanimity within the Commission, starkeyite was approved by a vote of 17-2, with one abstention (Fleischer, personal communication). I eventually published the starkeyite data with the approved nomenclature (Snetsinger, 1973), and that would seem to have put an end to the problem.

The I.M.A. Commission, however, obviously does not (cannot) enforce its rulings, and subsequent workers may in publication ignore I.M.A. rulings if they feel they have a good case for doing so. In this connection I have received communications from two professional mineralogists saying they regret the I.M.A. vote on starkeyite because they feel leonhardtite has precedence. I would therefore not be surprised to see a future sulfate paper repudiating starkeyite and insisting upon leonhardtite. At this point one may repeat the question "What's in a name?"; but as Mason (1971) points out, the problem is not trivial or mere hair-splitting.

I believe there are two very obvious lessons to be learned from the starkeyite *vs.* leonhardtite problem—but not so obvious that repeating them would be out of order: (1) minerals should not be named without first obtaining full chemical data, and (2) a name should not be given if it is so similar to an earlier one that confusion would result.

REFERENCES

BERDESINSKI, W. (1952) Sanderit, Leonhardtit, Allenit und Hexahedrit, neue Mineralien der Marinen Kalisalzlagerstatten. *Neues Jahrb. Mineral., Monatsh.* No. 1, 28-29.

FLEISCHER, M. (1952) New mineral names: sanderite, leonhardtite. *Am. Mineral.* **37**, 817.

__________(1957) New data: starkeyite. *Am. Mineral.* **42**, 433.

__________(1972) What's in a name; Mac *vs.* Mc in mineral names. *Mineralog. Record* **3**, 235-236.

GRAWE, O. R. (1945) Pyrite deposits of Missouri. *Missouri Geol. Surv. and Water Resources* **30**, 1-482.

__________(1956) Starkeyite, a correction. *Am. Mineral.* **41**, 662.

HEY, M. H. (1962) An Index of Mineral Species and Varieties, Arranged Chemically. British Museum of Natural History. Second Edition.

MASON, B. (1971) Merrillite and whitlockite or what's in a name? *Mineralog. Record* **2**, 277-279.

SNETSINGER, K. G. (1973) Ferroan starkeyite from Del Norte County, California, *Can. Min.* **12**, 229.

STRUNZ, H. (1966) Mineralogische Tabellen. Akademische Verlagsgesellschaft, Leipzig. Fourth Edition.

The Museum Record

by Paul E. Desautels

During the winter season I usually review my travel plans for the coming year. As I do, invariably some intense thinking takes place about where sufficient travel money can be acquired for a return visit to London during the next year. On a cold winter's evening it is pleasant to think of seeing Peter Embrey, John Fuller, Eva Fejer, Max Hey, Clive Bishop and the others in London at the British Museum. Peter will once again lead me to his favorite gourmet restaurants and will be the perfect host, always permitting me a large block of time to myself for wandering in a daze through the great mineral exhibit gallery. Other than at the Smithsonian collection the British Museum collection is my favorite place to browse among mineral specimens.

The British Museum (Natural History) moved its collections into the museum as we now know it in South Kensington in 1880. Long before that time all the British Museum collections had been housed together in the intolerably crowded and cluttered quarters of the Montagu House in Bloomsbury where they had originally been brought together in 1753 when the British Museum was founded by act of Parliament. Later, outgrowing these quarters, the collections were housed in new buildings built at the same site in Bloomsbury during the 1820's. In another 50 years even this expansion into new buildings was to prove inadequate, prompting the splitting off of natural history collections to South Kensington. As might have been predicted, these particular collections have never stopped growing. Pressures from the growth have since led to construction, adjacent to the original South Kensington building, of a new library, space for recent mammal collections, a building for administration, photography, computing and other central services and, finally, a large building, now nearing completion, for paleontology collections. In spite of the relief of this additional space, it has proved necessary to move the Bird Section and the Oceanographic Section to a site in the country far from the parent building. Rather wisely, it seems to me, the question at the British Museum (Natural History) has never been, to my knowledge, one of halting expansion of collections and services but of searching continuously for new housing to care for normal increases in collections and collection oriented activities.

By 1837, while still in the old Bloomsbury quarters, a separate Geology Department had come into being. In 1857 the present Mineral Department was split off from it with Professor Story-Maskelyne receiving the first appointment as Keeper of Mineralogy. A succession of dedicated Keepers and their assistants has continued to nurture, curate and love the collection. Even to the casual and mildly knowledgeable visitor this is obvious from looking at its present contents and their condition. Dr. Claude Guillemin, in his book mentioned before in this column, speaks of the British Museum collection as "sans doute la plus importante du monde". Personally, I wouldn't want to exchange collections with Peter Embrey but must admit that I could be quite content curating either one.

There is a saying among curators that all the great institutional mineral collections in the world are built on private collections. This is true but the statement gives a false impression that these collections were all donated. Some were but, as the record shows, it is likely that just as many were purchased by the museums in question as were given. There are now 180,000 mineral specimens in the British Museum collection. Getting to that point took 222 years, lots of money, lots of good luck and lots of hard work. Much of the story of its early growth can be found in a publication *History of the First Hundred Years of the Mineral Collection in the British Museum*, written by W. Campbell Smith and published in 1969 by the Museum.

It all began with the establishment of the Museum in 1753. Parliament saw fit at this time of founding to acquire the natural history collection of Sir Hans Sloane who was Queen Anne's personal physician. Among the tens of thousands of objects it contained were approximately 10,000 specimens of a mineralogical sort. Although these mineral objects were of little importance by modern specimen standards they at least established the precedent for having a mineral collection in the new-born museum. Subsequently, almost 50 years later, in 1799, Hatchett's mineral collection of about 7,000 specimens was purchased and the Rev. Cracherode bequeathed over 800 fine British specimens. The collection was now obviously on its way to its present magnificence. Organized cataloging was begun and the records show that such notables as the Count de Bournon (for whom bournonite is named) worked on the cataloging in 1803. In 1810 a committee of scientists, consisting of Babington (babingtonite), Chenevix (chenevixite), Davy (?), de Bournon (bournonite), Wollaston (wollastonite) and others convinced Parliament that it should buy the great Greville collection of almost 15,000 specimens. By this single act the B. M. collection became the greatest in the world, not to be challenged for 150 years.

The record also shows that every major collection acquired for the remainder of that century was purchased. These purchases included the collection of Baron von Moll (1815), Baron von Beroldingen (1815), Dr. Montcelli (1823), Lady Aylesford (1834), Dr. A. Krantz (1859), T. Allen - R. H. Greg - R. P. Greg (1860), and General N. I. Koksharov (1865).

Just as the 19th century was one of collection purchases the 20th seems so far to be one of donation. Collections including those of Pennant given by Lord Denbigh (1913), F. N. Ashcroft (1914 to 1938), Rev. J. M. Gordon (1922), Dr. Trechmann (1926), Prof. A. Liversidge (1927) and the magnificent 14,000 specimen collection of Sir Arthur Russell (1964) have been given. The Ashcroft collection, kept separately in special storage, must certainly have the best catalog of any collection ever assembled. For each specimen the exact locality is given with marked photographs and maps as well as descriptions of associated minerals, date of collection, dealer's name, price and any other pertinent information that could be accumulated.

Much of the Museum's collection is now housed in the enormous mineral exhibit gallery that runs almost the full length and width of the second floor to the right of the main foyer entrance to the building. This makes an impressive sweep of exhibit cases of at least 250 feet down the gallery. The large upright glass cases against the walls and the ranks of glass-top cases arrayed across the vast floor present about 8000 specimens to public view. In the dust-free cabinet drawers beneath the floor cases can be found the bulk of the rest of the collection. Except for some of the British minerals, some of the more recent acquisitions and certain small special exhibits, the arrangements are all systematic in a familiar order from native elements, through sulfides and on down through the various chemical groupings of increasing complexity.

Several times at intervals of a year or more I have looked at every specimen and have made notations in my little book of those specimens which seem most remarkable to me. The list is a long one, so long that it is difficult to remember and keep track of all the individual pieces. As one might expect, and as it should be, the British minerals are incredibly good, being far better than any such suite in any other museum. The English barites, calcites and fluorites in size, color, habit, beauty and locality representation are almost too much to believe.

Dr. Claude Guillemin lists 38 specimens in the gallery as being "echantillons exceptionnels" and 35 as "echantillons excellents". "Exceptionnels" in his classification means that they are the best in the world of their kind. "Excellents" means that they are not just very good specimens but are superb. My own count at the moment is 38 "Exceptionelles" and 101 "Excellents". It is rather significant, I think, that he and I have lists with more than 80% overlap in our choices. For my tastes, however, the Cornwall bournonites are the finest specimens in the collection. There are three matrix groups of crystals, any one of which would be far better than the rest of the bournonites in the museums of the world. In my memory they get better all the time. Imagine, if you will, great shining silvery metal cogwheels measuring 3 to 3-1/2 inches in diameter and 3/4 inches thick stacked in attractive and undamaged groups on matrix. Peter Embrey tells me that the wood parts of the case where they are housed are beginning to rot from my drooling so much over them. But after paying my respects to the bournonites I always hurry along because I don't dare miss another look at the beautiful and enormous euclase crystal from Tanzania; the superb and

BRITISH MUSEUM (NATURAL HISTORY), LONDON, S.W. 7. Length of front 675 feet. Height of Towers 192 feet. Opened to the public 18th April, 1881.

largest known sperrylite crystal from South Africa, the Hunan cinnabar, the incredibly large and well-formed pyrosmalite from Sweden, the large siderite cubic box formed as a cast after fluorite and containing small white quartz crystals, the whole suite of English barites in every size, color and habit, the anapaite from Anapa which is the best specimen for the species I have ever seen anywhere, a truly superb axinite from Bourg D'Oisan, France, the group of extraordinarily large atacamite crystals from Australia, the fine acanthites (after argentite) from Saxony, Swiss hematites as good or better than any to be seen elsewhere, the English chalcocites, cuprites, linarites, leadhillites, matlockites and others of their kind are an endless source of pleasure to the specimen connoisseur.

Although in good part less spectacular, one group of specimens — the real backbone of the collection — must be mentioned. These are the hundreds of type minerals and described specimens worked on by several generations of mineralogists and references to which are well peppered through the literature of mineralogy. An irreplaceable group, it is one of the greatest resources of our science. Fortunately, they are well curated and well documented.

Although the emphasis in this column has been on the collections themselves, in other aspects the mineralogical stance of the British Museum is just as significant. Its research programs which had their meager beginnings in 1860 have expanded so that a staff of over 30 people is involved. There is now a steady flow of work from its x-ray diffraction, wet chemistry, x-ray fluorescence, electron microprobe, emission spectroscopy, optical and other laboratories supporting studies in mineralogy, petrology, meteoritics and oceanography. There is continuing descriptive study of mineral species supported also by a superb library. In short, the British Museum (Natural History) has been a long time leader in those activities among mineral sciences which nurture and support any kind of interest in specimen mineralogy.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THE U.S.

The Record Bookshelf

A Guide to Mineral Collecting at Franklin and Sterling Hill, New Jersey, **by Ervan F. Kushner. Ervan F. Kushner, Books, 5 Colt Street, Paterson, New Jersey 07505. 1974, 91 pages, 65 photographs, 3 maps (one a fold-out), ($4.50)**

This book was written by an enthusiastic and dedicated amateur "...for the hobbyist", and as such will be a useful book for many, though it is not without error. It is different in purpose and design from *The Minerals of Franklin and Sterling Hill—A Check List* by Professor Frondel (*Mineralogical Record* **4**, 44, 1973). The chapter headings (here paraphrased and abbreviated) give the scope of the work: History of Mining at Franklin and Sterling Hill; The Rock Formations; Theories Related to the Origin of the Orebodies; List of Minerals; Fluoresence (by mineral and by color); Crystal Forms; Chemical Elements and Symbols; Glossary; Bibliography; Index.

The book is enlivened with 15 photographs of people and of scenes of the area in the old days—an outstanding feature of the book—and fifty black and white mineral photographs. The history chapter details the involved story of mining at Franklin: the shipment of several tons of "red ore" to England by Lord Stirling about 1774; the anguish caused by trying to smelt franklinite thinking it was an ordinary iron oxide; the many legal ownership battles brought about, in part, because of the complexity of the ore; and other troubles and triumphs. The chapter on rock formations is adequate, although sometimes older rather than current names are used. The orebody theory chapter discusses in a highly simplified way many of the numerous theories seeking to explain Franklin's unique mineral deposit.

The chapter on minerals in the Franklin area lists over 250 minerals in the Dana [and not alphabetical] order, giving the derivation of the name, chemical composition, crystal system, color, hardness, specific gravity, fluorescence, and occasionally other properties. Regretfully, some of the crystal system information is wrong; over 10% are assigned to the wrong system.

For the reader's information, these are listed below under the correct crystal system; the minerals are in the same order as in the book. *Isometric*: sphalerite; *Tetragonal*: bornite, woodruffite, pyrolusite; *Hexagonal:* arsenic, birnessite; *Orthorhombic*: rammelsbergite, berthierite; *Monoclinic*: arsenopyrite, todorokite, tenorite, manganite, rosasite, celsian, barkevikite, esperite, uranophane, alleghanyite, roeblingite, bannisterite, bementite, halloysite, montmorillonite, nontronite, brochantite, and serpierite. *Triclinic*: chalcophanite, pectolite, wollastonite, kaolinite, and symplesite.

The Author includes several species that are no longer recognized, sometimes indicating that the species is doubtful, sometimes not (manganbrucite, manganhedenbergite, roepperite, ferroschallerite, fuchsite, and baumite).

Mr. Kushner—along with many others—dislikes to see old mineral names, long used, give way to others. "To the confusion of the hobbyist, the experts continue, in the interest of scientific progress, to alter the nomenclature of the minerals. However, to many collectors, both serious and casual, there appears to be no substantial reason why this should occur." Again, "These continued controversies over nomenclature, 'Jeffersonite' is another example, are part of the delicious minutia which only serve to confuse the week-end Franklin mineral collector." Regrettable though the discrediting of a mineral named for President Jefferson may be, it is important—as new minerals continue to be reported at a suprising rate—to weed out duplicate names, whether for reasons of priority or better chemical analysis.

There are other errors, some of which should be pointed out lest the unwary reader be misled. Apophyllite and prehnite are assigned to the zeolite group (with which they are often associated). In the glossary, several definitions should be taken with a grain of salt: calcsilicate bodies; divalent (also the example belies the definition); primary mineral; secondary mineral; and skarn. In the crystal form chapter, several minerals are again assigned the wrong system: isometric - calcite; orthorhombic - alleghanyite, arsenopyrite and bementite; and monoclinic - wollastonite. The most painful error is the definition "Isometric. 'Equal Measure'. Every like direction measures the same. All faces are squares and equal in size, all angles right angles." A glance at *most* pyrite crystals would give one second thoughts about that statement!

In spite of some shortcomings, this book brings together in one place and in usable form a vast amount of information about the Franklin area and its minerals.

Arthur Roe

***Ein neues Hobby: Kleinmineralien*, by Alex Kipfer, Franckh Verlag, W. Keller & Co., 7000 Stuttgart I, Postfach 640, W. Germany, (about $2.00 U.S.) (in German)**

The author is Alex Kipfer, Zurich, Switzerland, who recently published a larger work *Der Micromounter*.

The present booklet contains 64 pages with 39 color photos, eight black and white photos and five diagrams. The author discusses the advantages of collecting small specimens, particularly for beginners. He explains what to collect and how, and discusses the building of special collections. Optical aids, like hand lenses and simple microscopes are discussed. Tools, trimmers and the various ways of preservation and storage are shown. Reference is frequently made to the author's previous book.

This booklet is a valuable guide for beginners as well as anyone interested in mineral collecting. Even the more advanced collectors will appreciate being re-exposed to some forgotten facts.

Paul Seel

TITLE ONLY

***The Geology of Continental Margins*, edited by C. Burk and C. Drake, Springer-Verlag New York Inc., 175 Fifth Avenue, New York, NY 10010 10010 ($34.50).**

***Crystalline basement of the Antarctic Platform*, by M. G. Ravich and E. N. Kamenev, Halsted Press, A Division of John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10016 (1975), 582 pages, ($68.00).**

***Sediments and Sedimentary Rocks 1*, by Hans Füchtbauer, Halsted Press, A Division of John Wiley & Sons, Inc., 605 Third Avenue, New York, NY 10016 (1975), 464 pages, ($49.50).**

To the Editor

CYCLONE TRACY

Dear Sir:

Enclosed please find my subscription for 1975 and forgive me being late with same. We have been visited by Cyclone Tracy, our Christmas present on 24 December, and are slightly discommoded as a result.

An earlier cyclone, Selma, on the 4th December did not come as predicted and as it was 37 years since our last one, we did not take too much notice of Tracy and made less preparation for her and she did come with a vengence. It was a night of total horror and the last night of all for many—49 officially dead and 58 missing, although I can see no way in the world that the total was not higher as whole suburbs were razed one after another and there was nowhere for anyone to flee for protection during the nightmare hours. Nine thousand homes totally destroyed out of 12,000 and less than 2,000 of the remaining repairable.

In a remarkable and heroic manner officials managed to evacuate 30,000 people in a week from the ruined city (46,000)—and the evacuees suffered the most gruelling conditions while being evacuated as we are only 12 degrees below the Equator and quite tropical. It was necessary to gather people up in buses in large groups, overcrowded, with crying children, take them to the aerodrome and leave them sitting exhausted and overcome with heat and nervous prostration in the sun as the waiting rooms were already crowded with evacuees waiting for their plane. Planes took off every half hour, 750 people the first day and stepped up to 6000 per day. Ten thousand fled by road. Our nearest city is 2,000 miles away so they all had a frightful time getting away.

For the 10,000 who remained (and they implored us to go because of lack of amenities) we found no water, sewers, power, electricity, radio, etc. We were indeed cut off and alone, but as the days went by the radio came on again and we learned a little of what had happened to us. Later again water was restored—what a blessing when we could use the sewer again; in the meantime we had been catching water from drain pipes, rain, anywhere, rationing it carefully, and then the water carts came around and we all rushed out with our containers to get the precious commodity. Have you ever been without a bath in 90(+) degrees heat?

H.M.A.S. Melbourne arrived bringing several hundred stalwart Navy boys who have been helping to restore order out of chaos, 300 policemen

added their weight, food arrived and they set up depots in the Darwin High School, and then ICE. Precious ice. While my husband spent ten days mending the roof with scrounged iron—there was plenty of that lying around. I did the daily queuing. Twelve miles my round to get mail, ice, meat, groceries, etc., when these things became available, and after re-roofing as best he could (we being one of the lucky ones whose house mainly stood) he turned his hand to glazing 28 windows but could not match the glass, ours being an old house for Darwin, 34 years old. Where he could not glaze, he patched with board or masonite, put in louvres from downstairs (which all blew in).

Personal losses were hundreds of precious wildflower books obtained from all over the world during 28 years which got wet when the large hotel illuminated sign smashed through the two solid walls of fibro asbestos, and downstairs four six foot cabinets of minerals. Broken glass, minerals, labels, mounts in wildest confusion and inches deep in muddy water. Cleaning up the glass alone I obtained ten cut fingers (but I'd already had my tetanus and typhoid shots). The cyclone even pulled the pins out which held the labels on the styrofoam mounts!

Outside in my garden there was a terrible wilderness of fallen trees, 40 of them and 13 palms, every one down in an inextricable mess and all threaded through with dozens of sheets of galvanized iron from each of our neighbors as the cyclone changed direction. The garage wall had fallen in on the three cars and damaged them, but two are usable, and the roof joined the garden twisted around trunks of trees and threaded through anything it could entwine. It was impossible for me to get down to see my treasured collection of tropical potplants, more than 400 of them.

Cleaning up inside the house alone has taken up all my non-queuing time so that I have not had time to more than glance at the minerals which are lying in a heap where my husband threw them in from the garden as he found them lying near the shattered cabinets.

Banks only open from 10 to 12 noon so I was not able to join the queue there until essential foodstuffs had been acquired, so that is the reason for the delay in sending my subscription. I had only just received a year's subscription from you and thank goodness, it was safely away in a drawer and undamaged. Could not find out for some time as it was impossible to open drawers and close doors as they were so swollen with water.

Now the gallant Navy are pulling out for a well-earned rest and several hundred Army men are coming in to relieve them. It is now the 24th day and we are hoping desperately for electric light and power soon. Things have moved fast but time hangs heavily in our misery, but all this will pass. Good wishes to you, Mr. Editor, I can hardly wait for my *Mineralogical Record* to come but know it will be a long time yet as mails are weeks behind.

Nancy G. Eddy
Darwin, Australia

ON CLOSED MINES

Dear Sir,

As a professional mining man I was tempted to write some time ago when Richard Bideaux wrote his article on collecting underground. That letter would have been a scorcher. Now I have just read your guest editorial on "Where Have All The Quarries Gone" by Marie Hurizing. Due to Mr. Bideaux's article I must assume a future issue will contain an editorial on "Where Have All The Mines Gone".

Perhaps we in the mining industry should allow the collectors into the pits, quarries, and underground operations, and let them do their thing. Then in another future issue we will read "Where Have All The Collectors Gone", which in turn will be followed by an extra thick issue dedicated in fond memory of____________.

The mining industry in Canada is dedicated to the continuance of safety at all times for those people who are involved in mining. All mining companies accept the moral and legal responsibility for those who for any reason are on the premises of an operating mine. This also applies to trespassers even after the mine has ceased operations.

Now we come to the collector. It has been my experience over the years that for each responsible collector there are a hundred irresponsible clods that ignore safety regulations, abuse privileges bestowed on them, destroy equipment, and in general convey to the mining industry that they are of no value to the industry and, in fact, are a total unnecessary evil. Thus the

doors are closed, nailed, barred and concreted to the collecting fraternity.

It is most unfortunate that many fine minerals will no longer be available to those of us who appreciate them. The collector created the situation, and the doors will continue to close as long as one irresponsible clod remains to destroy the good relationship that is necessary between the collector and the mining industry.

Now Marie Hurizing would like to know what can be done to reopen all these doors. May I suggest that an excellent start in this direction would be to insure the continuance of collecting privileges at the few mines that still have an open door policy. Perhaps the proof that collectors can be very responsible people with these mines and quarries, will eventually cause other operators to reconsider their position in this regard. You cannot expect improvement overnight. The mining industry is composed of a hard nosed people who are not easily hurt, but when they are, they take the necessary steps to ensure it will never happen again. Only through an excellent collector-mining industry relationship can changes be made, and then, only because one mine operator will convey to other mine operators his pleasure with the relationship developed with the collectors at his mine.

As a dedicated mining man with the responsibility of continuing a family mining tradition that dates back before the turn of the century, and a dedicated mineral collector, I am most concerned with the problems on both sides. I would be most interested in hearing more on this subject, as well as offering advice to other interested individuals.

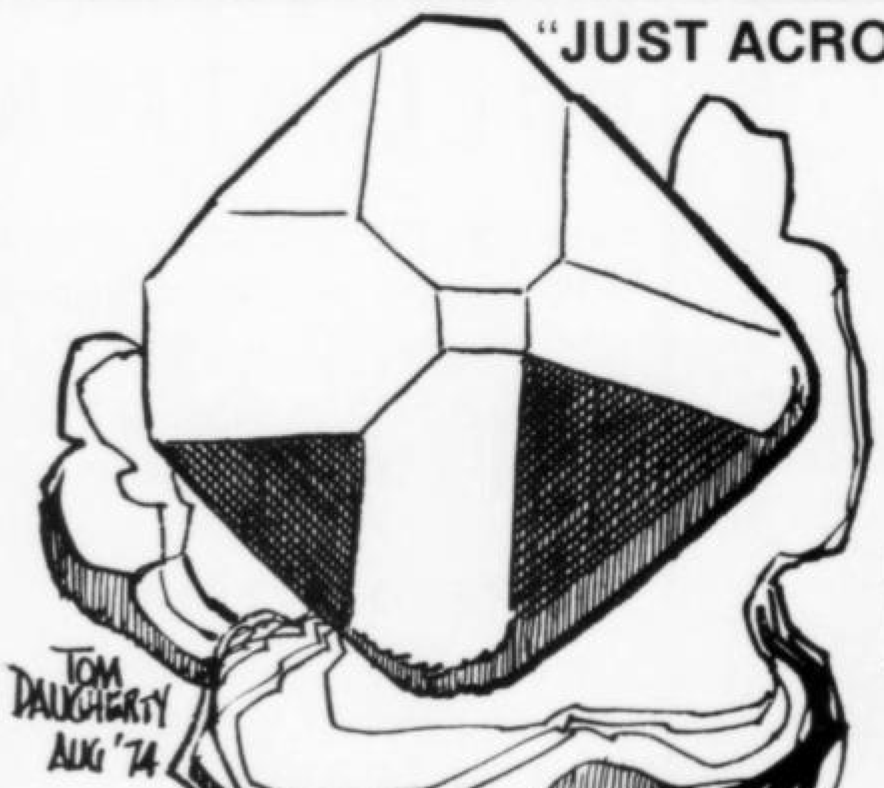
William J. Fink
President
Economic Mineral
Investigations LTD.
Porcupine, Ontario
Canada

The "Bideaux" article alluded to is probably the Wilson article, Vol. 5, p. 128. Ed.

Dear Sir,

How timely was your guest editorial titled "Where Have All the Quarries Gone?"! Recently, myself and another mineral collector visited a large traprock quarry in central Connecticut where we were informed that the quarry (and many others in the area, also owned by the same company) was closed to collectors due to the death of another collector, who collected there alone, without permission, on a day when the quarry was closed. While the story was not verifiable, certainly potential experiences such as this lead to the reluctance of many quarry operators to allow collectors onto their properties.

In regard to this, in the article "Gem Tourmalines-Rediscovered at Newry" we find "Arrived back at the site about dawn. Frank was already working inside the hole". Is this the type of collecting safety *MR* approves or that would endear collectors to quarry operators? If such unsafe practices are followed on one's own property, surely it is not too farfetched to imag-



ine even more unsafe ones on property that does not belong to you.

May I suggest as a first step in showing quarry operators our emphasis on responsible collecting, some type of registration system, perhaps by a well respected group such as FM, whereby those not registered not be allowed into quarries under any circumstances. Such a system may well *require* of collectors some type of instruction on safe collecting practices, perhaps by major mineral clubs, schools and colleges, etc. After such a system comes into play, perhaps then we may exert influence upon those quarry operators with closed quarries to open them up for collecting, even if only on a limited basis.

Perhaps such a plan is too bureaucratic and beyond the means of the collecting community, but for the sake of having something to collect, for opening up the classic sites, and most importantly, for preventing injuries and death, such an undertaking ought to be considered.

Terry Stransky
Hauppauge, NY

Dear sir,

Virtually any active collector must agree with Marie Huizing's guest editorial, "Where Have All the Quarries Gone?", in Vol. 6, No. 1., The bottom line is the important question: "What can we do NOW to reverse this unhappy trend?" I have a suggestion. In my experience the main obstacle to collecting, especially on abandoned or dormant properties, is the LAW which makes property owners liable for injuries incurred by sanctioned visitors as well as outright trespassers. Some owners have visitors sign a "release" before entering the property, but I'm told it is legally worthless and they are still open to suit. I feel collectors should be responsible for their own safety, especially (but not only) when collecting without permission. The only solution I can think of is to submit a bill to the U.S. and/or state legislatures to change the law. Mine owners would then be infinitely less paranoid about collectors, and less determined to keep us out. This bill would probably be most effectively written and organized by lawyer-collectors with the backing of the Friends of Mineralogy. Any comments or volunteers?

Wendell Wilson
Minneapolis, MN

EXCHANGES

Dear Sir:

Have you an exchange column for minerals? I have lots of extra material to trade, like chabazite crystals from Paterson and Franklin fluorescent material.

Kenneth J. Walling
91 Magnolia Avenue
Westbury, New York 11590

Not yet. We are hoping to develop an exchange section, meanwhile this entry in our letters column may help get things started for you. Ed.

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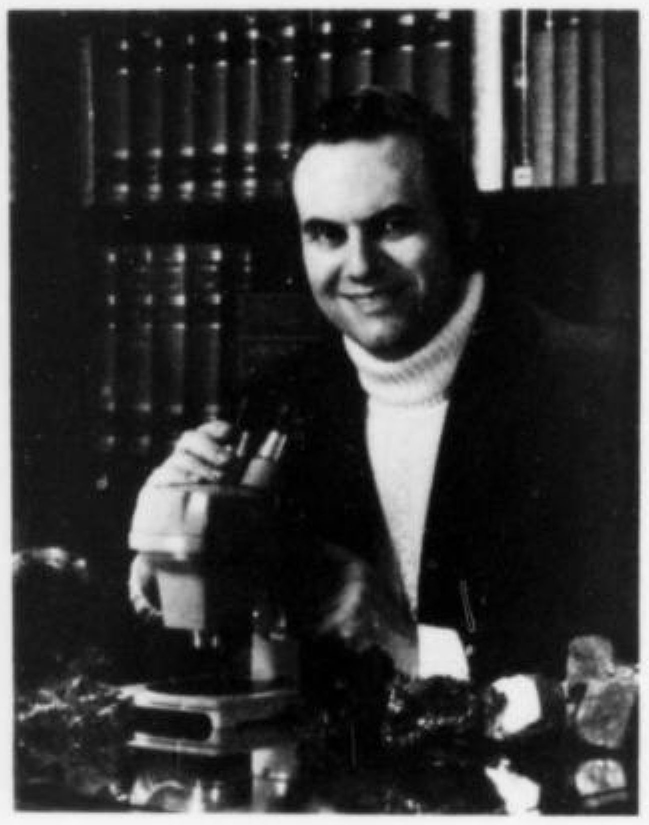

SECOND HAND MINERALS

I have a particular love of specimens which I once owned.

If you have any of these items, please consider this - aside from the normal increases over the years, I find that I will pay much more for one of my "old friends" than I will pay for the same piece on the open market.

I'm not sure exactly why, but it may have something to do with the fact that, like almost everyone in this field, I started out as a collector, and this somehow satisfies my collector instincts as I do not have a "private" collection.

As far as values are concerned, I recall a certain Azurite-Malachite stalactite slice (actually, the one pictured in the Kunz book). Well, I would gladly pay the owner ten timeswhat he paid me, if he would only sell it.

Another piece that comes to mind is a jewel-like Azurite crystal on pale green Smithsonite from Tsumeb that my uncle originally bought from Martin Ehrmann in 1938 for $5.00. If I recall correctly, I sold it around 1963 for $200.00. I would pay a thousand for it now. If the owner is reading this, it's a firm offer.

I could go on with many examples. One problem is that I've forgotten who bought what, so please surprise me with an offering and I'll surprise you with the price.

* * *

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