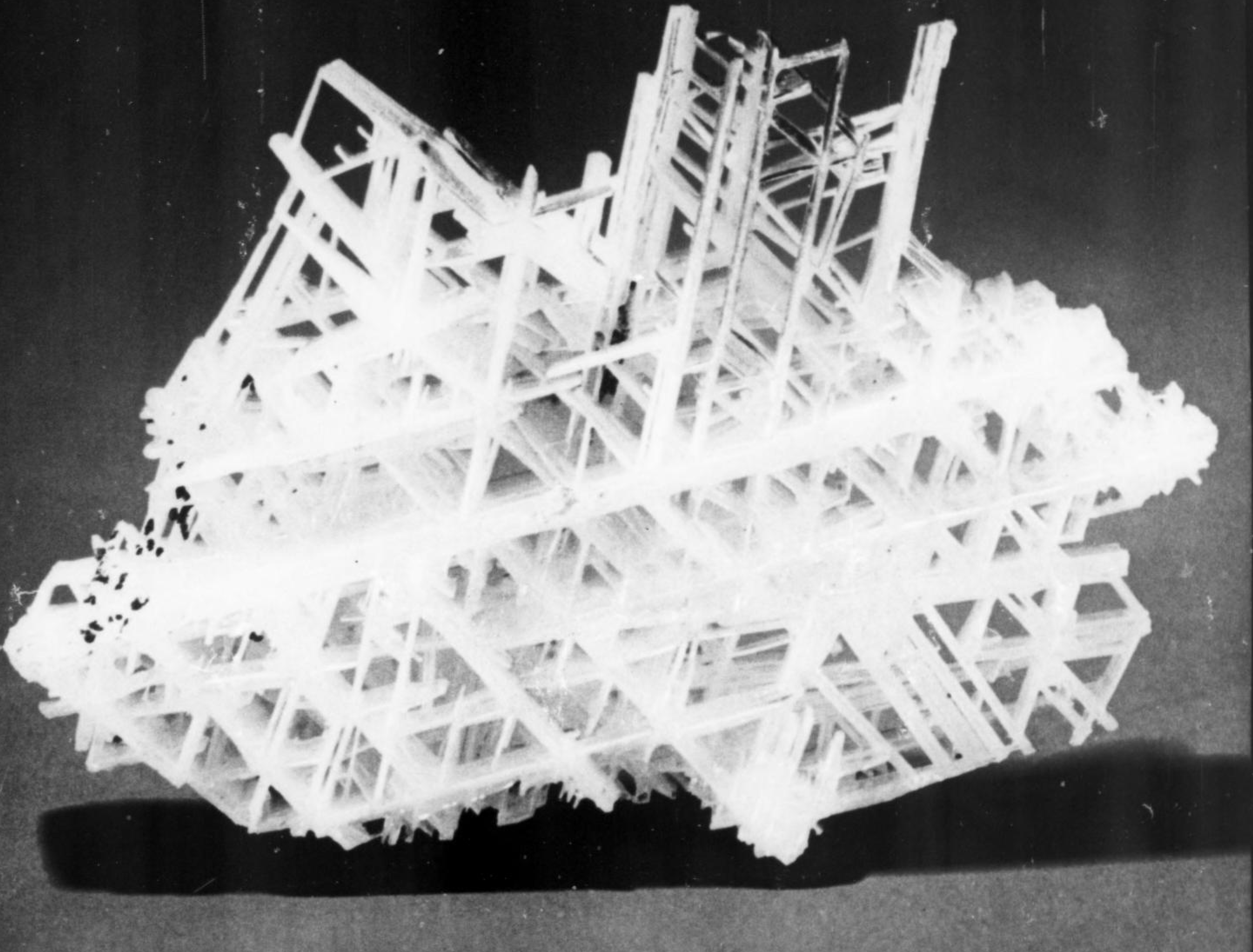
the Mineralogical Record

Volume Five/Number One



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January—February, 1974

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feature articles

departments

CERUSSITE. Tintic district, Utah. A textbook example of a reticulated aggregate of crystals resulting from twinning. *Smithsonian specimen from the Washington A. Roebling collection. Photo by Lee Boltin.*

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Editorial

COMMERCIAL GEM AND MINERAL MALL SHOWS — A NEW FACT OF LIFE

Marie Huizing, Cincinnati, Ohio

They started appearing about two years ago, just a sprinkling along the east and west coasts. Rapidly they worked their way inland until now it is a rare city that has not had one, or will not have one in the near future. These are the shopping mall gem and mineral shows, mass produced by individuals strictly for personal gain. For the month of October, 1973, twenty such shows were listed in one of the hobby publications.

These commercial shows consist of dealers and whatever demonstrations and exhibits the sponsor can arrange, often through area clubs. Most clubs refuse to participate and, as a result, the show consists only of a handful of dealers; really a "minimum" show. The sponsor takes this same basic show on a cross-country tour.

Communities without organized clubs and areas with clubs that do not sponsor shows are said to be enthusiastic supporters of these mall shows. However, reaction from many show sponsoring clubs has ranged from surprise to a frustrated, "Hey, they can't do that!", based on well-founded objections. In some cases mall shows are scheduled just prior to or, worse yet, at the same time as the club show, with the mall show capitalizing on club-generated publicity. Saturation of the mineral show market is another real concern. Just how many mineral shows can a given city support in any one year? The California and Midwest Federations dislike the image set forth by these shows and they fear that participating clubs could lose their non-profit tax exempt status. They have, therefore, adopted resolutions not to support or participate in any commercially sponsored shows.

There are also clubs that object to commercial shows because they fear the competition. Someone else is offering the same thing they are. The clubs that are worried are the ones putting on "skeleton" shows similar to the commercial show, because they lack either the desire, imagination, or leadership to put on a broader show. Their main goal seems to be to trim costs in order to enhance the prospect of making a larger profit, in which case their shows and the commercial shows are the same in concept and execution and are indeed competitors. Both view shows as strictly moneymaking ventures.

This is in contrast to the clubs that sponsor shows for the purpose of educating the public and enabling their members to grow in the hobby. Making a profit to them is simply a matter of good management. Any surplus income from dealers and admissions is plowed back into more and better educational features at future shows. The two philosophies result in two different types of shows.

Therefore, if a club honestly feels threatened by the competition of a commercial show, this could very well be regarded as critical commentary on what their show is offering to the public. Club shows have mineral dealers but they could include much more: interesting speaker and movie program, demonstrations, competitive and non-competitive displays, special exhibits from individuals and museums, hobby literature, free specimens for children, mineral identification booth, panel discussions, swapping, and more, all artistically wrapped together with careful attention to detail. Perhaps the best things to come from the commercial show will be introspection and upgrading of club shows.

There is nothing illegal about commercially sponsored shows, although the ethics of their timing and frequency can be questioned. These shows are probably here to stay and club shows must learn to co-exist with them. How this affects individual shows boils down to survival of the fittest. The good in-depth educational club show will survive because it is a better product; the inferior club show, and perhaps the commercial mall show, will be left by the wayside.

STEARNS J. BRYANT

Stearns J. Bryant, 55, of East Winthrop, Maine, died Tuesday, November 20, 1973. Mr. Bryant was born and raised in Oxford County, Maine, the site of the two famous tourmaline discoveries, Mt. Mica and Newry. Mr. Bryant moved to East Winthrop in 1955, and became a charter member of the Kennebec Rock and Mineral Club. In 1958 he built and began to operate, with his wife Priscilla, the Winthrop Mineral Shop at their home on Case Road, moving in 1968 to the location on Route 202. His outdoor tumbler built of airplane tires, rotating and revolving on a circular track is a landmark for residents and visitors alike. Mr. Bryant participated in the tourmaline find at Plumbago Mountain in 1972, and was a distributor for the Plumbago Mining Corporation.

Mrs. Priscilla Bryant will continue to operate the Winthrop Mineral Shop.

Stearns Bryant will be sadly missed by his many good friends throughout the country.

CONTRIBUTION FROM THE MINERALOGICAL CLUB OF GREATER HARTFORD

At its December 12, 1973, meeting the Mineralogical Club of Greater Hartford (Connecticut) unanimously approved a motion to make an unrestricted contribution of $25.00 to the *Mineralogical Record*. "The amount of the enclosed check is limited only by our small treasury and hardly reflects our appreciation for the high quality of your publication and the valuable information it provides so many of its readers. Our club wants to support your fine efforts to the best of its ability. At the same time we would like to challenge all other mineral clubs, lapidary clubs, micromounters' groups, etc., from all over the world, if need be, to join us in the financial support of the *Mineralogical Record* to insure continued publication of the finest magazine of its kind."

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QA column

Q. **Recently a specimen was purchased from a commercial source, without a locality label. Hopefully, through your Q/A column an answer will be forthcoming.**

The specimen, about 2" x 2", contains nearly colorless crystals of mica, presumably muscovite, but possibly phlogopite, on a pegmatite-like matrix of feldspar, possibly with small flecks of biotite. The unusual character of the mica is that the crystal books are sharply pointed, usually in a six pointed star (hexagonal network) arrangement. Interpenetration crystals are not uncommon. After inquiry, the dealer supplied the retailer with the locality "Minas Gerais". If you have seen this material, can you be more specific?

Davis M. Lapham
Chief Mineralogist
Bureau of Topographic and
Geologic Survey
Harrisburg, Pennsylvania

A. The material described above first hit the U.S. market more than a year ago. Many of the collectors are quite understandably calling it "star mica". The specific mine is not known by any of our associates but the locality is *near* Taquaral in Minas Gerais. It is not, however, from the rose quartz-eosphorite-roscherite-wardite locality Lavra da Ilha, which is also near Taquaral. Many of the groups are quite striking but nearly every one has been carelessly mined so that the tips of the points are usually smashed. At least several thousand of these specimens have been mined recently.

Q. **I recently obtained a mineral specimen labeled argentopyrite. According to *Dana's System of Mineralogy*, by Palache, Berman, and Frondel, 7th ed., p. 248, argentopyrite, argyropyrite, and "silberkies" may all be related minerals dimorphous with sternbergite. It seems that work done on these minerals dates from the latter part of the 19th century. Is there any new data supporting argentopyrite as a species sparate from sternbergite? The crystals I have are distinctly elongated hexagonal prisms with a bronze color. The specimen is from Schneeberg, Saxony.**

William M. Duarte
Fremont, California

A. Indeed there is new data! An article by G. K. Czamanske and R. R. Larson, "The chemical identity and formula of argentopyrite and sternbergite", appeared in Volume 54 (pp. 1198-1201) of *The American Mineralogist*, 1969. The following data were presented:

		a	*b*	*c*	*Z*
argentopyrite-orthorhombic,	Pmmn	6.64	11.47	6.45	4
sternbergite-orthorhombic,	Cmma	6.63	11.60	12.68	8

Both have the identical formula, $AgFe_2S_3$

Although argentopyrite and sternbergite have become fully legitimized as species, argyropyrite and silberkies are now out of favor. Silberkies is a very old name and appears to have been used as a synonym for argentopyrite, sternbergite and even argyopyrite. The name has no utility and should be forgotten. Argyropyrite is probably either argentopyrite or sternbergite. Unfortunately, the original description was not thorough enough to permit assigning it to one or the other, or establishing it as a distinct species. This name, too, should be forgotten.

Q. **On a small specimen with feldspar, rubellite and a crystal of rhodizite from Ambatofotsikely, Madagascar, I have noticed minute grains of a yellow brown transparent mineral embedded in rubellite which I am unable to identify. The total amount is probably less than one mg. but I hope that I won't have to sacrifice this for x-raying if someone could give me an idea of what it is.**

Roy Kristiansen
Fredrikstad, Norway

A. Our best guess is something in the microlite — pyrochlore family. We have seen this association before from pegmatites in Brazil and elswhere. Perhaps some of our readers can come to the rescue.

Q. **German pyromorphite specimens appear on the market and in museums with a dazzling array of place names, for example: Ems, Bad Ems, Nassau, Braubach, etc. Is there any hope of making some sense of these confusing locality designations?**

John Marshall
East Wollap, Vermont

A. The following note was graciously provided by Dr. Werner Lieber, of Heidelberg, Germany.

I believe that it is difficult to obtain proper locality designations because many of the labels with the specimens are either incomplete or wrong. However, in the case of German pyromorphites I can help easily. Today, the part of Germany around Bad Ems belongs to the state Nordrhein-Westphalia. In former times (before 1914) it belonged to the district of Nassau. There is still a village called Nassau, after which the old state of Nassau was named. Bad Ems is a well-known historic town and was, in earlier times, the center of a mining district. Smelters have also been there.

This is the reason why some labels say Bad Ems for minerals that were found near this town. Braubach and Ober-Lahnstein are villages along the Rhine River, about 10-14 km southwest of Bad Ems. The old Friedrichssegen mine (closed since 1880) is halfway between Bad Ems and Braubach. The old Rosenberg mine (closed since 1963) is near Braubach. At the present time the correct labeling for these mines would be:

1. Friedrichssegen mine, near Bad Ems, Rheinland-Pfalz (or Rhinelands) (formerly Nassau), W-Germany
2. Rosenberg mine at Braubach, near Bad Ems, Rheinland-Pfalz, W-Germany

The Rosenberg mine produced mostly brown, light brown, and rarely white or green pyromorphite crystals. The green crystals sometimes show barrel shapes, but not very curved. The Friedrichssegen mine produced mostly green and also brown pyromorphites, and the barrel shape is very pronounced.

All other names for localities, such as Nassau, Ems, Braubach, are not complete. However, labels with the locality "Nassau" must be old, and the specimens should be from Friedrichssegen. Very close to Bad Ems have been other mines for lead but they did not produce pyromorphite. Hofsgrund, Baden, and Schauinsland, Baden, are the same. Hofsgrund is a village along the foot of the Schauinsland mountain. The mine is within the very mountain of Schauinsland.

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Pennsylvania Mineral Collecting Symposium

by Martin L. Anné, Region 3 Coordinator

At our Region 3 general meeting, held during May, 1973, at Pennsylvania State University, ways and means were discussed to get new activities moving in our area. Other FM Regions are facing the same problem. Dr. Raymond Grant (Lafayette College) suggested a symposium on Pennsylvania minerals and mineral collecting, open to all interested. At our later executive committee meeting the idea was formally approved, and planning began. Dr. Grant arranged for the two-to-three day meeting to be held in the Lafayette Geology Department, Van Wickle Hall. Don Schmerling, Region 3 Newsletter editor, printed up the program. Notices and invitations were sent out to FM members and all mineral clubs and interested institutions in Pennsylvania. A number of professionals and amateurs were invited to give talks. The symposium was planned for the week-end of Nov. 2, 3 and 4, 1973.

On Friday and Saturday, Nov. 2 and 3, one hundred and fifteen persons registered in attendance, far more than anyone expected. The three-day meeting started Friday evening with a talk by Dr. Grant summarizing Pennsylvania geology as a means to better understanding of mineral occurrences in the state. He pointed out the various geologically-distinct regions and described the minerals found in each. Those present from western Pennsylvania were put on their mettle to make new finds and turn up additional species in their relatively poorly-mineralized section. His talk was followed by several hours of socializing and good fellowship centering in the room set aside for workshop activities, where already specimens were piling up intended for later study, identification and exchange. The workshop area become the focal point for the rest of the symposium. Many persons brought minerals to share with others their microscopic study, to have identified by x-ray and other advanced techniques, or to make possible their exchange. A lot of first-class duplicate material was there simply to be given away.

On Saturday the talks began. They were divided into three main sessions, with the first devoted to notable collections of Pennsylvania minerals. Dr. Arthur Montgomery (Lafayette College), who has been acting as honorary curator of minerals at the Philadelphia Academy of Natural Sciences, described the Academy collection of Pennsylvania minerals, making clear the contributions of Samuel G. Gordon, former long-time Academy curator, toward making that collection the finest of its kind in the state. Delbert Oswald, mineral curator at the Carnegie Museum in Pittsburgh, described and showed slides of the Jefferis collection, one of the greatest and most historic Pennsylvania collections. Third speaker was Donald Hoff, earth-science curator at the William Penn State Museum in Harrisburg, whose illustrated talk covered the rapid growth of this new major collection so rich in state minerals and outlined plans for its enlargement and future use in public and mineralogical education.

After a mid-morning coffee break the second session, on regional occurrences of minerals in Pennsylvania, began. Dr. Robert Smith of the State Geological Survey was the first speaker. His talk was on the lead-zinc mineral occurrences in the state he recently investigated. It covered a lot of regional geology and geochemistry, was enlivened by amusing anecdotes about old and new mining localities, and was illustrated by slides. Milton Leet, mining geologist with Bethlehem Steel Company, next gave an illustrated talk on the interesting minerals associated with the Cornwall-type of iron-ore deposits in Pennsylvania. The final speaker in this session, Dr. Alice Weeks, Geology Department chairman at Temple University, discussed the various types of uranium-mineral occurrences in Pennsylvania, explained each one in relation to its geological environment, and

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compared and contrasted them with similar deposits she has studied in the western United States.

The third session started after lunch and dealt with case histories of specific minerals in their Pennsylvania occurrences. Dr. Deane Smith (Pennsylvania State University) talked about the procedures and problems involved in the scientific determination and description of a new species, using for a specific example a new copper mineral from Cedar Hill quarry, in Lancaster County, on which he and co-workers and now completing the research. This aroused much interest because of the lack of knowledge on this subject among mineral amateurs generally. Delbert Oswald of the Carnegie Museum then treated the descriptive mineralogy of wurtzite in Pennsylvania, concentrating on the several rare polytypes first described from western Pennsylvania by Seaman and Hamilton and which he has extensively collected and studied in a wide area around Pittsburgh. John Way of the State Geological Survey presented the final talk, a paper prepared for the symposium by Dr. Davis Lapham, chief mineralogist of the Survey, who unfortunately could not be present because of illness. This was on various approaches to the definition of a mineral, using for provocation the example of the recently discovered sublimates found as freshly-formed encrustations deposited from vapors associated with several Pennsylvania burning-coal mines. A lively discussion followed on the pros and cons of whether these crystallized sub-

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After a mid-afternoon coffee break, an open forum was held in the lecture hall to allow representatives of different Pennsylvania Mineral Clubs to be heard on such matters as relations with Friends of Mineralogy, conservation of state mineral localities, and collecting and other activities carried on in their local areas. One of the topics discussed was the role of FM as a possible unifying agent to encourage closer cooperation among state mineral clubs in the causes of mineral conservation and education.

On Sunday two field trips were scheduled and quite a few collectors took part. In the morning time was spent in the Williams quarry just north of Easton. This locality is famous for the many rare uranium-thorium minerals once found there, and a Geiger counter was used by the group to locate occurrences of some of these. In the afternoon one of the old waste dumps at the Friedensville zinc mines south of Bethlehem was visited and good specimens of hemimorphite and greenockite, among other minerals, were collected.

During the symposium, micromount study, specimen

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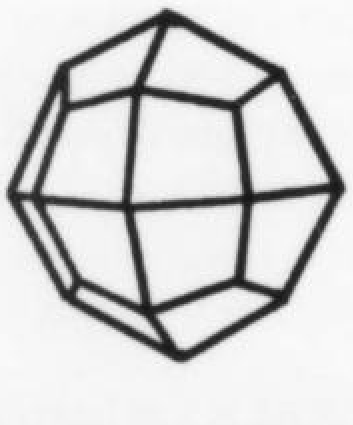

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swapping, and a great deal of mineral talk went on until late at night. Students of the Lafayette College Geology Club participated in the program in various ways, such as providing a service in rapid x-ray identification of mineral unknowns and furnishing refreshments at appropriate times, and they helped to make the whole program a success. There were a number of special exhibits developed for the meeting and on view in the Geological Museum of Van Wickle Hall. Several of the mineral displays were put on by individual collectors, while others had been developed by the Lafayette geology staff. One display of major interest showed a number of unique items for scientific value from the Pennsylvania collection of the Philadelphia Academy of Natural Sciences. This was owed to the courtesy and efforts of the Academy, its geology department chairman Earl Shapiro, and mineralogical assistant Julia Snyder. At the registration desk, at all times, there were on view, and available for purchase, hard-cover copies of Samuel Gordon's *Mineralogy of Pennsylvania*. The reprinting, financing and distribution of this volume, otherwise unavailable to collectors, was carried through entirely on the initiative of our Region 3 group as an educational project and service to all interested in Pennsylvania minerals.

Sincere thanks go to the organizations and institutions involved, especially Lafayette College, the speakers, exhibitors, and many persons participating and responsible for making this symposium such a fine success.

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

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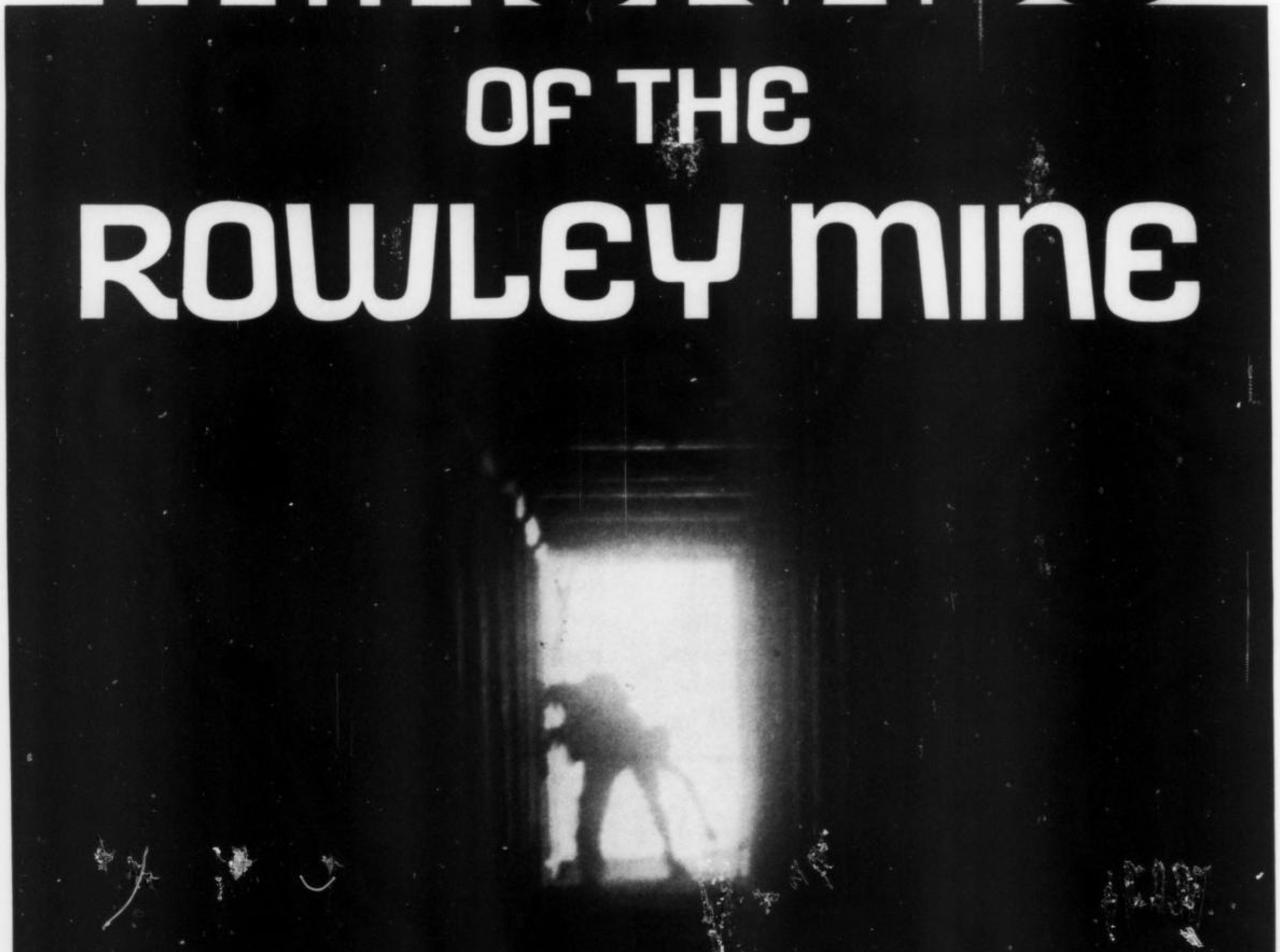

by Wendell E. Wilson
Dept. of Geology & Geophysics, University of Minnesota, Minneapolis, Minnesota 55455
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(Photographs by Wendell E. Wilson)

Fig. 1. Ascending the timbered (No. 1) incline requires caution; the ladder ends about 15 feet from the surface.

INTRODUCTION

The Rowley mine is another of Arizona's famous wulfenite localities. Although the deposit was first located around the turn of the century, it miraculously escaped the notice of collectors until around 1945. Mr. Charles A. Rowley of Los Angeles, California, the owner since 1927, graciously allowed collectors free access to the mine for many years. In 1968 a fire occurred in the mine causing serious caving, and collectors later tore down large volumes of rock from the ceiling and walls in their search for more wulfenite. Mr. Rowley finally closed the mine to collectors (see *Brewery Gulch Gazette*, Bisbee, Arizona, Sept. 24, 1970), and posted a security guard. At this writing the mine is still off-limits to collectors. We have attempted without success to contact Mr. Rowley.

The Rowley mine is located about 60 miles southwest of Phoenix, Arizona, on the west slope of the Painted Rock Mountains, overlooking the Gila River Valley. Access is via the Painted Rock Road which branches off U. S. Highway 80, 4 miles west of Theba, and continues northward about 12.6 miles to the mine road (Fig. 3). The precise location is the eastern 1/2 of section 25, R8W, T4S. Confusion persists regarding the name of the mine. It was originally named the Reliance mine, is misspelled "Rawley" on the quadrangle map, and has also been known as the Theba mine and the Rainbow mine in the 1958 edition of *Minerals of Arizona* by Galbraith and Brennan. Some people still believe the Rainbow or Theba mines are distinct from the Rowley mine, or even from each other, and are "lost" in the hills somewhere. There is no proof of this; all four names probably refer to the same property.

HISTORY

The original owners were as colorful and rugged as the country in which they sought their fortune. An adventurer, Marshall Bond, described them in his personal diary:

> *November 20, 1913. Met Mr. H. Rowley at the station ... a wizened, lean man. Rowley has a constant flow of profanity and good humor.*
>
> *November 21, 1913. Mrs. Rowley ... proved to be a tall, strong woman with a straight forward manner. She has prospected and followed mining for some years with a grim determination to conquer poverty.*
>
> *November 22, 1913. Mrs. Rowley and I left town at 11:15 A.M. in a wagon drawn by two male Indian ponies. We had an interesting conversation on the way out.*
>
> *For years she has camped and driven about these deserts, often alone and with a Winchester rifle on the seat of her wagon.*

The mining properties, consisting of seven claims totaling 144 acres, were first purchased by the Rowley Copper Mines Company around 1909 when the company was incorporated. The Rowley Company was succeeded by the Reliance Company in 1922. The Rowley Company confidently speculated on the richness of its properties in an early stock prospectus:

> *With the ore bodies practically in sight and greater ones virtually certain to be opened up in the near future, it is reasonable to expect that stockholders will, by the close of 1913, begin to get large returns upon their investment and that those who come in early enough will receive more in annual dividends than the whole of their original outlay. The Company is developing the property as rapidly as possible to insure speedy and large returns for all who become stockholders. It invites to become stockholders, such persons as would like to place some money where all evidence indicates it will bring them sure and large returns ... The Rowley will probably become one of the great copper mines of the world.*

But the mine was never to be what the owners hoped, for all the ore shipped from the Rowley mine brought only $10,000.00.

The mine was exploited intermittently from 1909 to 1923. By 1917 wulfenite had been found and a 75-ton concentrator was built to treat it. It had been hoped that the mine would be rich in copper, but only one small car of ore averaging 15% copper was recovered.

While reading through the literature of mining in various districts one is constantly horrified by the large tonnages of wulfenite, vanadinite, azurite, malachite, dioptase — a whole plethora of well-crystallized minerals — that went straight to the crusher without ever meeting the eyes of a collector. It seems unfortunate that the economics of mining so often make this more profitable or more convenient than selling at least a small part of the output for specimens. The painful case in point: over 30 TONS of wulfenite *concentrate* from the Rowley mine was shipped to a buyer in California.

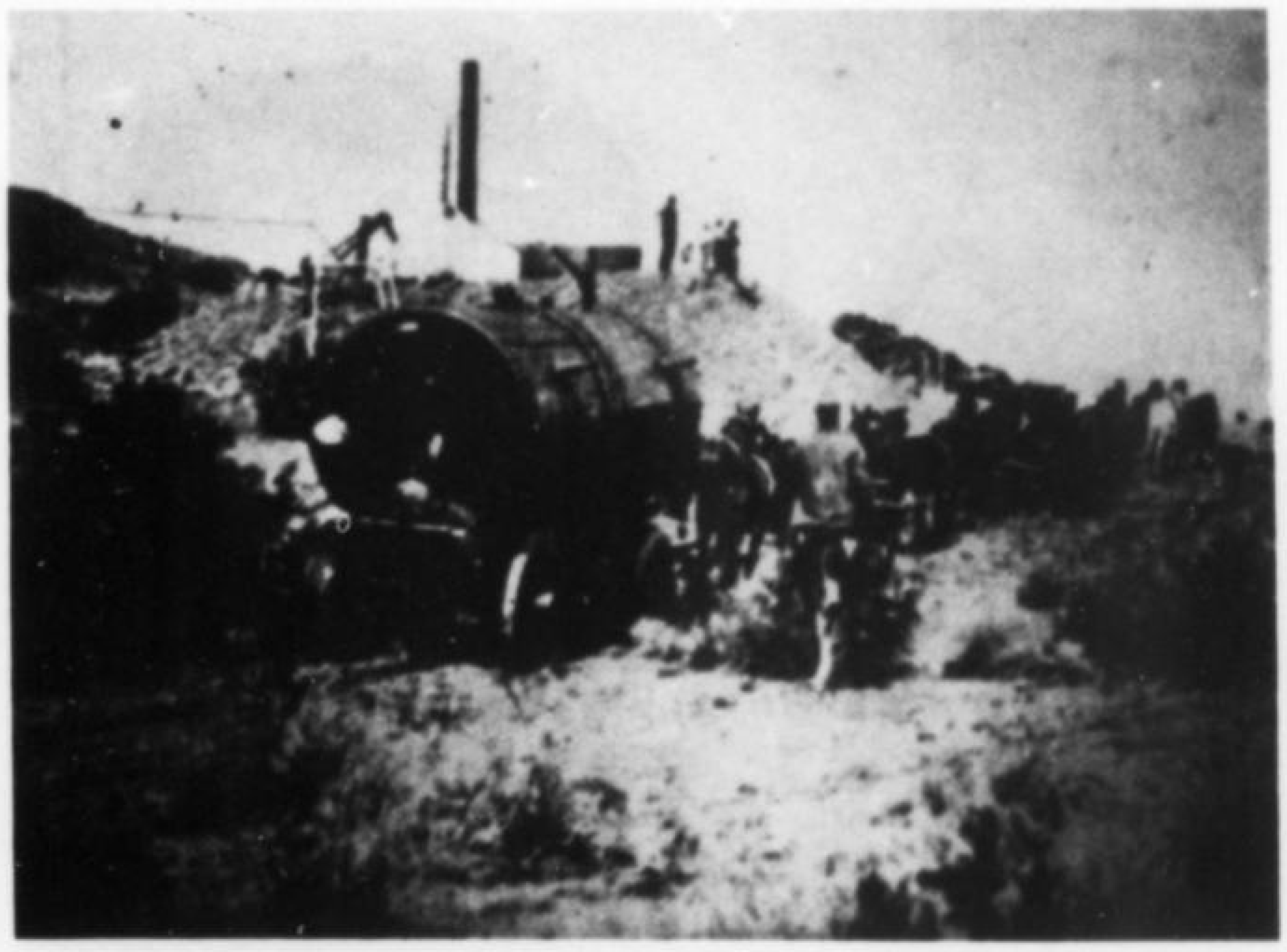

Fig. 2.* Arrival of a heavy boiler at the mine in April, 1912. *Photograph from a 1912 Rowley Copper Co. prospectus.

THE ROWLEY MINE LOCATION

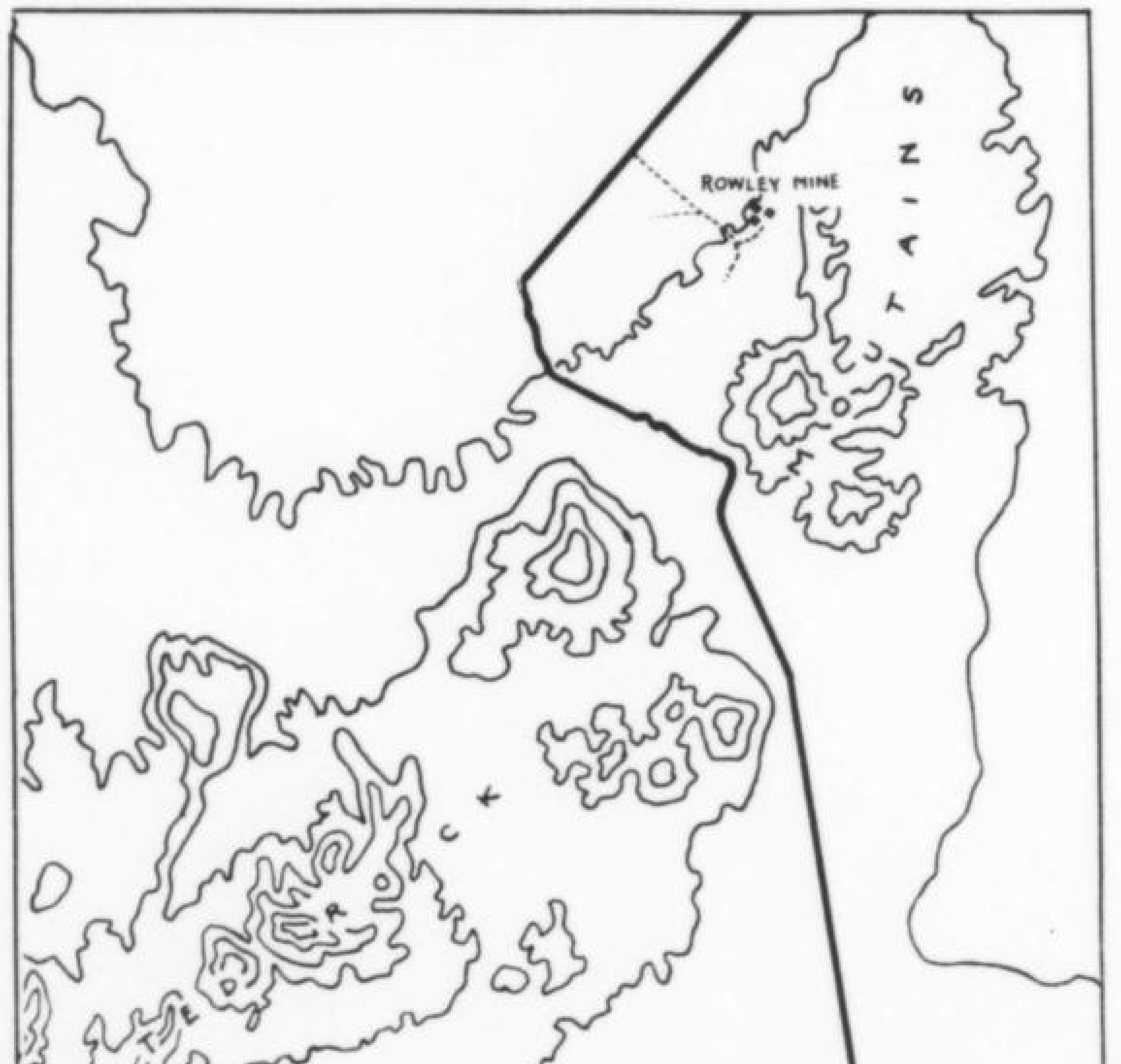

Fig. 3. **Location of the Rowley mine (Maricopa Co., Arizona).**

GEOLOGY

The geology of the Rowley mine area has been outlined by Stewart and Pfister (1960) and by Kirkemo, et al., (1965). Flat-lying Tertiary andesite and rhyolite flows underlie the Rowley claims and the adjoining San Carlos claims. These are overlain by basalt flows. The andesite and rhyolite flows partly cover a domed area over a biotite granite intrusion. All of these units were cut by an andesite porphyry dike apparently related to the source of the mineralization.

A fault zone, striking N 30°-37°W and dipping 37°-50° east, cuts the andesite flows and extends about 4000 feet across the claims. Mineralized segments of this fault comprise the Rowley vein. The vein actually consists of two distinct veins within the same fault structure: a quartz vein on the foot wall and a barite vein on the hanging wall. For 75 feet down the inclined No. 1 shaft the barite is against the foot wall as well as the hanging wall. Below this point the quartz vein wedges in against the foot wall.

The quartz vein has a fairly uniform width of about 5 feet, and contains no fault gouge or breccia. A few widely spaced tight fractures cut the vein and extend a few feet into the andesite.

The barite vein ranges from 15 to 30 feet in thickness, and appears brecciated and deformed in places. Its contact with the quartz vein is sharp and regular whereas the hanging wall boundary is quite irregular. The barite and a 3 to 4 foot zone of fractured and slightly brecciated andesite in the hanging wall are separated by about 4 inches of gouge. Massive sulfides and some of their alteration products form part of the barite vein, but there is no gossan zone in or near the vein and no evidence of a zone of supergene enrichment at depth.

THE MINE

The actual workings (Fig. 4) include a main inclined shaft (No. 1), originally extending to the 160-foot level (but now back-filled to the 100-foot level), and another inclined shaft (the Jobes Shaft) located about 100 feet north of the No. 1 shaft. The Jobes shaft originally extended to the 100-foot level but caving and collecting activity along the shaft have buried the connection with the 100-foot level. A vertical shaft located about 225 feet northeast of the No. 1 shaft extended down 280 feet and afforded access to extensive workings on the (now inaccessible) 160-foot level. The total amount of drifting is unknown but is thought to be in excess of 1800 feet. Water and back-filling now fills the mine to within 15 feet of the 100-foot level.

The No. 1 shaft (Fig. 5) is well-timbered, with two hoisting and two manway compartments, one of which still contains a useable ladder. The Jobes shaft (Fig. 6) was sunk vertically for about 30 feet beyond which it is inclined along the foot wall of the vein in the same manner as the No. 1 shaft. The stopes adjacent to the Jobes shaft above the 100-foot level were mined for wulfenite and are the

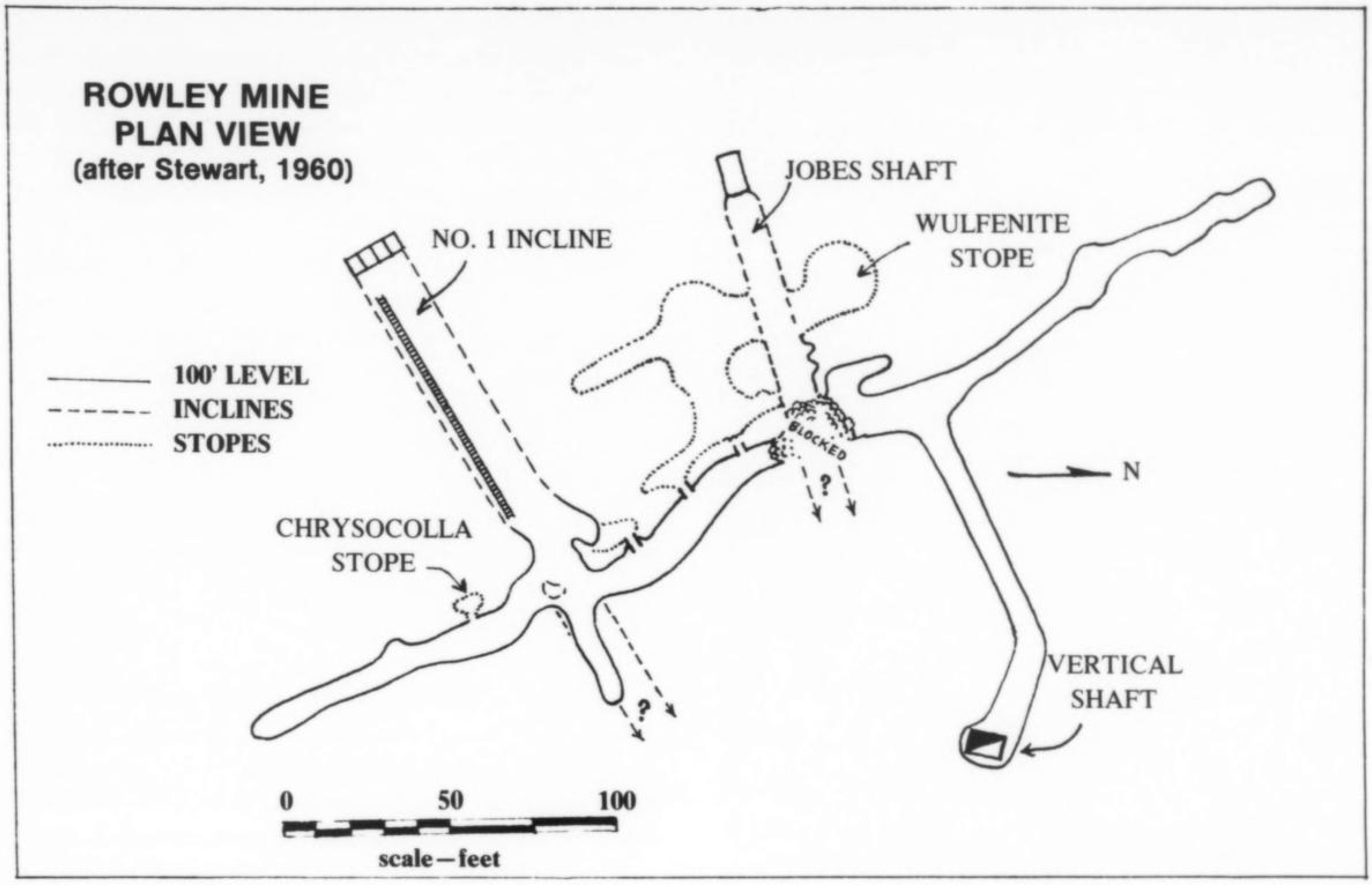

Fig. 4. **Rowley mine, plan view (Stewart, 1960).**

Fig. 5. **The entrance to the Rowley mine: the No. 1 incline.**

Fig. 6. **The vertical portion of the Jobes shaft.**

principal collecting area today. Access is most easily gained by descending the No. 1 shaft to the 100-foot level, then moving north and climbing up the second ore chute (Fig. 7) into the stope which connects with the Jobes shaft.

MINERALOGY

Suites

The primary mineral suite apparently consisted of barite, quartz, fluorite, galena, pyrite, and possibly chalcopyrite, and sphalerite. Nearly all galena deposits also contain sphalerite as a primary mineral. Zinc is usually mobile under supergene conditions whereas lead remains *in situ* during alteration. Hence sphalerite was probably originally present but has been removed by intense weathering. The upper levels of the 79 mine, Gila Co., Arizona, (Kiersch, 1949, and Keith, 1972) are a parallel example. Similarly chalcopyrite was probably present in small to moderate amounts, and has been altered to a variety of secondary copper minerals.

There are at least four secondary mineral suites in and near the ore body. Segregation into specific areas, possibly as a result of Eh-pH differences during formation, has left little, if any, overlap of species between the suites.

suite 1: The cerussite-anglesite suite consists of cerussite and anglesite with minor galena, chrysocolla, and very minor wulfenite.

suite 2: The wulfenite suite consists of abundant wulfenite and mimetite, usually on a matrix of barite. A single specimen in the Smithsonian collection was found to have descloizite substituted for mimetite; the wulfenite displayed a rare crystal form {3.4.75} . Another single specimen in the Smithsonian collection had white acicular willemite in place of mimetite.

suite 3: The caledonite suite consists of caledonite, linarite, leadhillite, atacamite, cerussite, anglesite, diaboleite, and boleite. This suite is restricted to small veins near the ceiling of the Jobes shaft. Where leadhillite is present, linarite and cerussite are usually absent.

suite 4: The vanadinite suite consists of vanadinite and descloizite on barite.

In general the mineralogy is reminiscent of the more famous deposit at Tiger, Arizona, although Tiger has produced a somewhat wider variety of rare secondary minerals.

Primary Minerals

BARITE — BaSO[1] — Barite comprises the bulk of the Rowley vein; the layers appear to have formed or crystallized roughly parallel to the fault faces but are bent, broken and swirled into twisted patterns in many places (Figs. 9, 10). This may be the result of movement along the fault during crystallization. A moderate amount of brecciation suggests that there was also slight fault movement after barite deposition. Cavities often are lined by colorless barite crystals up to 2 cm on an edge and 2 to 4 mm in thickness (Fig. 17). Other cavities are only defined by broken surfaces of barite. Either type is likely to also contain the fine wulfenite crystals for which the deposit is famous. The barite appears pink because of its intimate association with powdery hematite. The hematite apparently fills cracks and grain boundaries on a very small scale.

A second generation of barite occurs in very small amounts as microscopic (0.01 - 1.5 mm) crystals on coarsely crystalline barite, wulfenite and mimetite. The crystals taper to a sharp point and have a diamond-shaped cross-section at the base. They usually are water-clear with an adamantine luster when free-standing, but also sometimes partially coat wulfenite plates like frost on a window.

QUARTZ — SiO_2 — The quartz vein is composed primarily of massive quartz and a minor amount of the jasper variety, with small amounts of hematite and sparse grains of pyrite in some places. Quartz also formed as microcrystals in cavities in the barite.

FLUORITE — CaF_2 — Fluorite occurs in very minor amounts as colorless to violet masses associated with the quartz and malachite veins, and as colorless microcrystals of a second generation formed on wulfenite and mimetite (Fig. 11). Cube and dodecahedron forms are common on

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[1] All mineral formulas after Fleischer (1971), except boleite (Rouse, 1973).

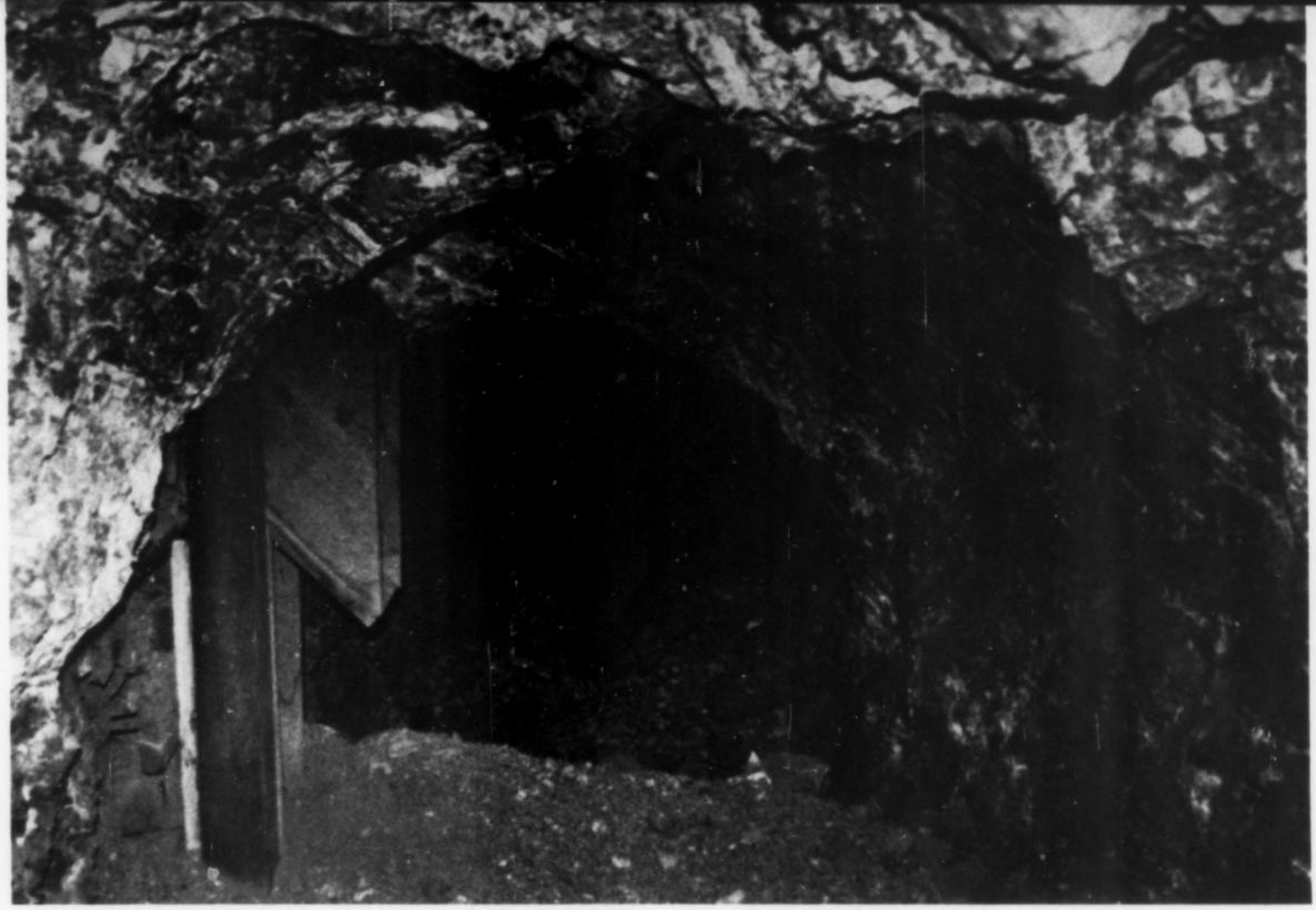


Fig. 7. **The second and third ore chutes on the 100-foot level. The second chute (foreground) leads to the wulfenite stopes and the Jobes shaft.**

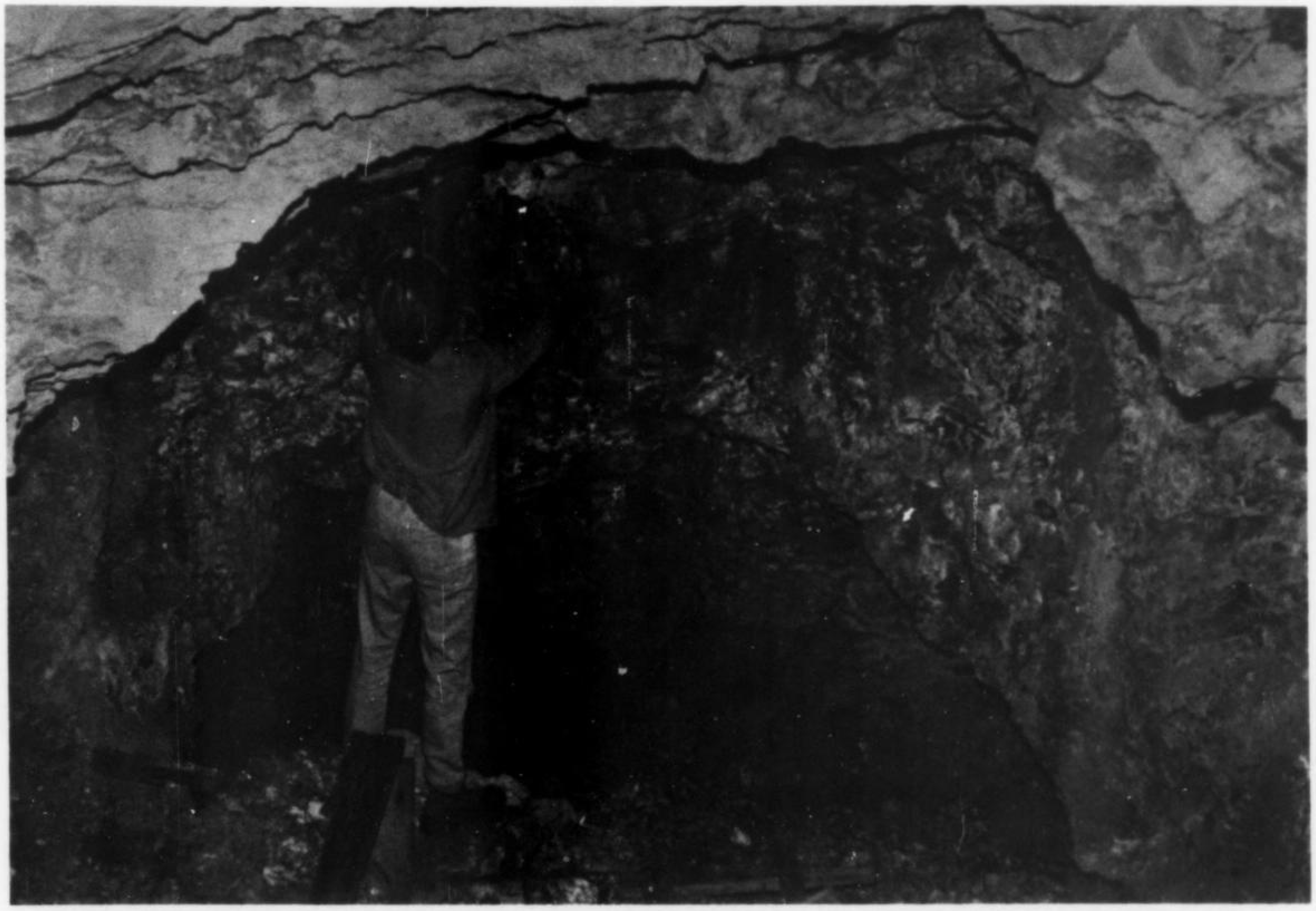


Fig. 8. **A view looking down the Jobes shaft in the section which is inclined at about 30°. The ceiling has been raised nearly two meters by collectors, and the resulting debris now blocks the intersection with the 100 — level crosscut.**

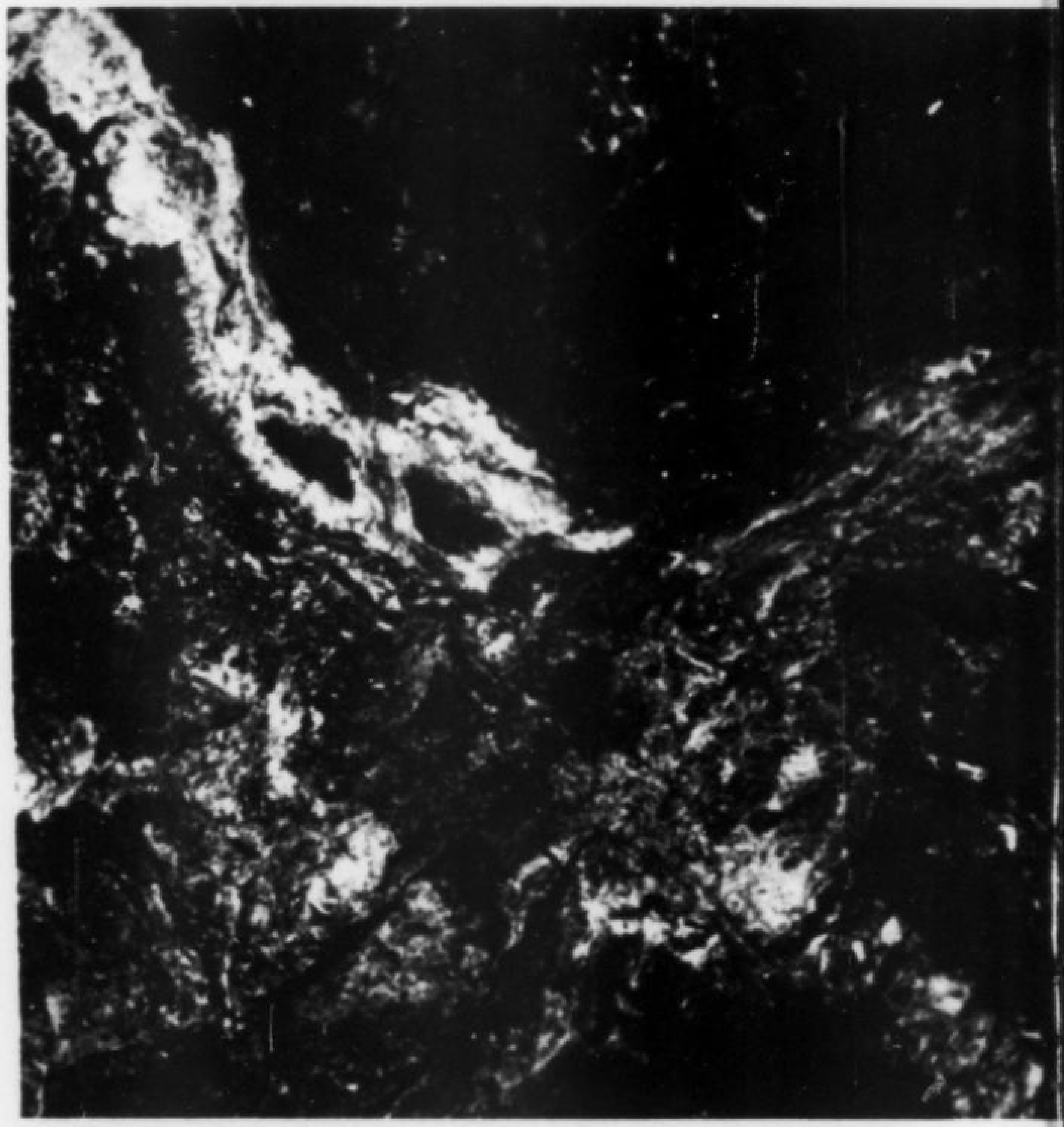


Fig. 9. **Disrupted barite layers in the main vein. A 20-cm slab of barite crystals broke loose from the vein wall during crystallization and was then covered on all sides by more barite. Exposures of this type indicate at least minor movement along the fault during mineralization.** ***Fig. 10.*** **Thick layers of barite crystals in the main vein, cut by a vein containing anglesite and cerussite (bottom center). The field of view is about 1.5 meters square.** ***Fig. 11.*** **Colorless fluorite cubes (0.2 mm) on a wulfenite crystal (1 cm).** ***Smithsonian Institution Specimen. Fig. 12.*** **"Eyes" of galena** ***in situ*** **near the upper end of the Jobes shaft. The two "eyes" (about 3 cm each) are surrounded by anglesite and cerussite as a vein in hematite-stained barite.**

Fig. 13. **Caledonite (2 mm).** ***Smithsonian Institution Specimen.***

the microcrystals; the cubes often occur as crystal aggregates elongated or repeated along the [111] axis.

GALENA — PbS — Relatively little galena remains unaltered, but pieces showing the characteristic "eye" structure (Fig. 12) (rounded lumps of unaltered galena surrounded by concentric layers of anglesite and cerussite) can still be collected in the Jobes shaft.

Secondary Minerals

HEMATITE — Fe_2O_3 — The ubiquitous iron-red color at the Rowley mine is due to powdery hematite. Whether this material is primary or represents altered pyrite is not known. Much of the hematite may be the result of the weathering of iron minerals in the surrounding andesite.

CHALCOCITE — Cu_2S — Chalcocite is present as small blebs and stringers in the quartz vein, and may represent an intermediate step in the alteration of (hypothetical) chalcopyrite ($CuFeS_2$) to malachite and chrysocolla.

COVELLITE — CuS — X-ray analysis revealed that covellite occurs intimately mixed with the chalcocite on a microscopic scale.

ANGLESITE — $PbSO_4$ — Greasy-lustered massive anglesite as well as rare aggregations of late-stage, sandy-textured crystals can be found in the Jobes shaft. Intimate mixture with cerussite usually makes exact identification difficult. The anglesite and cerussite are sometimes colored gray as a result of microscopic inclusions of unaltered galena. Crystals only occur in the caledonite suite.

CERUSSITE — $PbCO_3$ — Massive cerussite is relatively abundant. Small crystals not exceeding a few millimeters are common in the caledonite suite. These crystals are clear and sharp with many modifications. Cerussite in the caledonite suite appears to have been leached away in places where leadhillite is present.

CHRYSOCOLLA — $Cu_2H_2Si_2O_5(OH)_4$ — Stringers and small masses of chrysocolla, and sometimes MALACHITE — $Cu_2(CO_3)(OH)_2$ — occur sparingly throughout the deposit. One area (see Fig. 4) has yielded "quartz-rich" chrysocolla of gem grade, but most is friable to powdery or finely fibrous. These minerals also occur for distances of as much as 3 feet along isolated fractures cutting the vein and extending into the andesite. Small pockets of secondary copper ore have been mined.

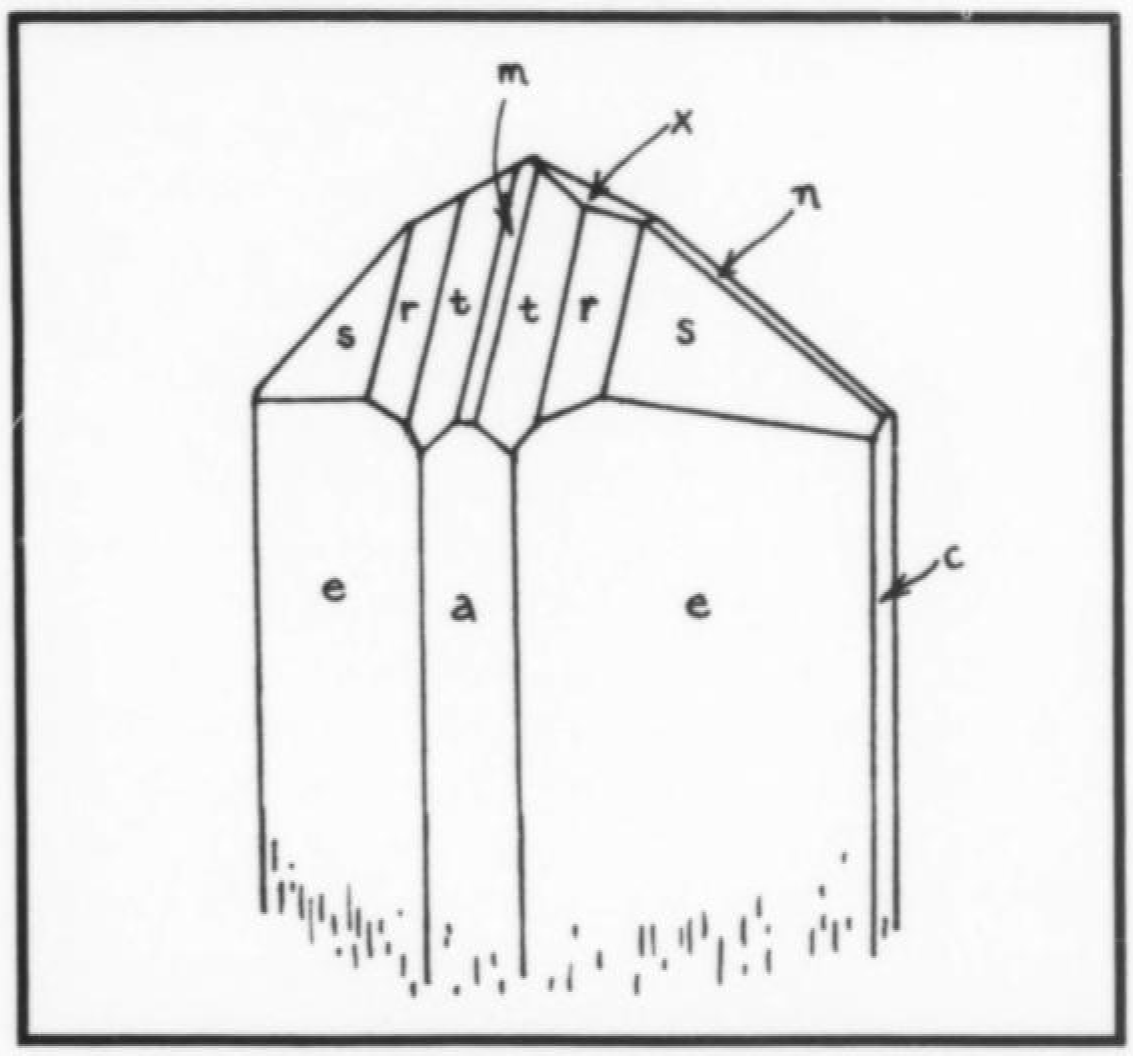


Fig. 14. **Crystal forms found on caledonite at the Rowley mine. s = {223}, r = {111}, t = {221}, m = {110}, x = {201}, n = {203}, e = {011}, a = {010}, c = {001}.**

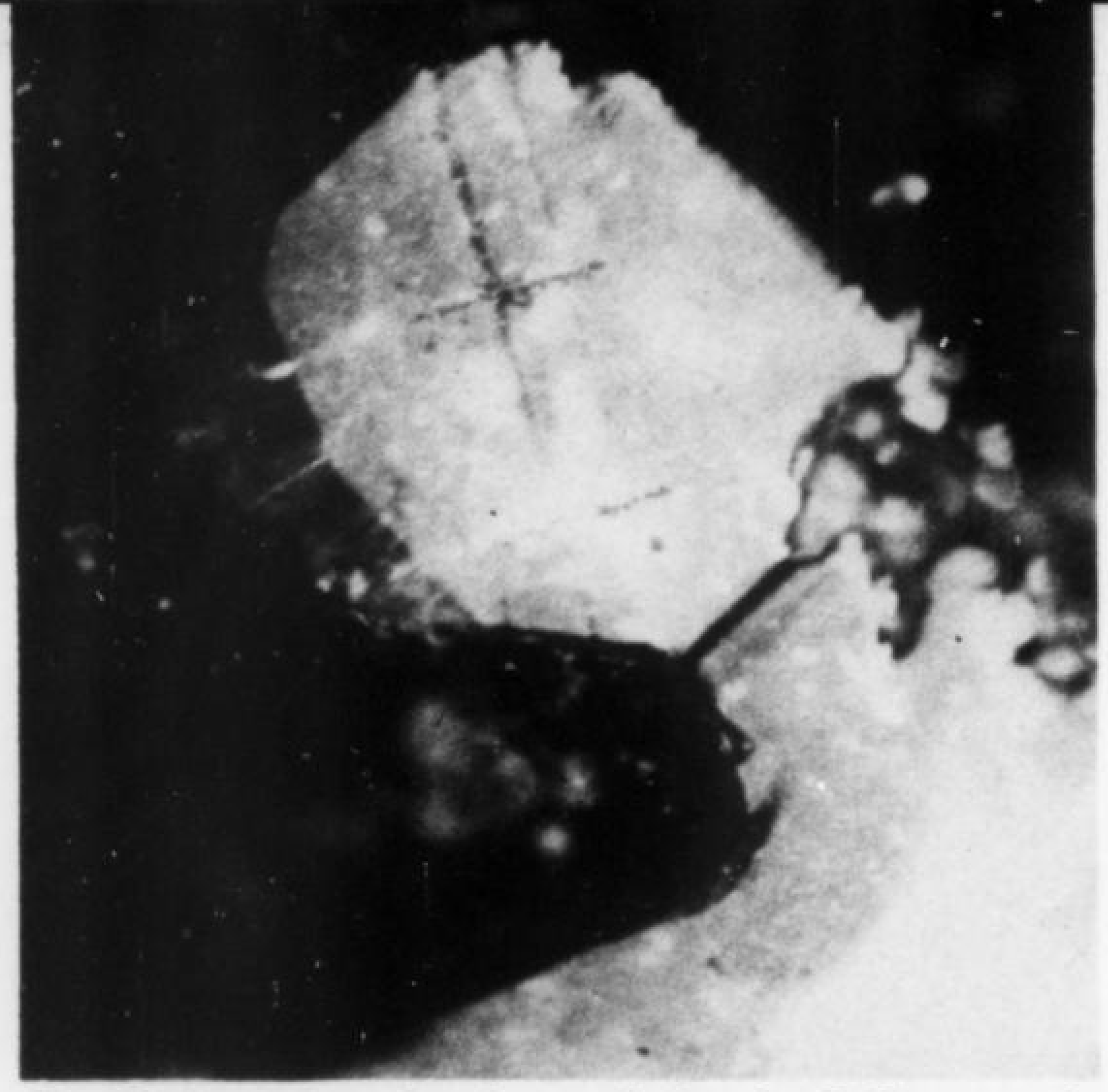


Fig. 15. **A portion of a clear, colorless leadhillite crystal (2 mm) which has grown around a caledonite crystal (lower left).** ***Smithsonian Institution specimen.***

CALEDONITE — $Pb_5Cu_2(CO_3)(SO_4)_3(OH)_6$ — Fine blue-green crystals up to several millimeters in size (Fig. occur in small veins near the ceiling of the Jobes shaft. The crystals are clear and sharp, and make excellent micromounts, especially when accompanied by cerussite and blue linarite or leadhilite.

LINARITE — $PbCu(SO_4)(OH)_2$ — small masses of crystalline linarite, often containing smaller imbedded masses of atacamite and diaboleite, occur in the caledonite suite. Sharp, unetched crystals are seen only rarely. It appears possible from textural relationships that linarite was in the process of altering to caledonite or dissolving completely.

ATACAMITE — $Cu_2Cl(OH)_3$ — Small areas not larger than 4 or 5 mm of powdery green atacamite occur associated with the caledonite suite, and may be remnants of an alteration to diaboleite or linarite.

DIABOLEITE — $Pb_2CuCl_2(OH)_4$ — Diaboleite occurs very sparingly associated with linarite and anglesite, as imbedded masses and sandy aggregates. It can be distinguished by its subtle color which is slightly lighter and greener than linarite but bluer than caledonite. Distinct well-formed crystals have not been observed.

BOLEITE — $Pb_{26}Cu_{24}Ag_9Cl_{62}(OH)_{48}$ — Boleite and percylite ($PbCuCl_2(OH)_2$) are apparently indistinguishable on the basis of their x-ray powder data, but it is likely that percylite is not a valid species (Winchell, 1963). Mary Mrose (USGS), Roland Rouse (Smithsonian Institution) and others are currently trying to clarify relationships in this general group of minerals. The occurrence at the Rowley mine is here tentatively assigned to boleite. The mineral forms tiny (0.01-0.03 mm) spheres on cerussite, and is associated with the caledonite suite. Because of the very minute amount of material available no chemical tests have been attempted.

LEADHILLITE — $Pb_4(SO_4)(CO_3)_2(OH)_2$ — Fine, water-clear plates of leadhillite with many modifications (Fig. 15) occur sparingly in the caledonite suite. The crystals measure up to 6 mm and display typically excellent cleavage. The cleavage faces are smooth and brilliant with a pearly luster. Where leadhillite occurs in the caledonite vein it is associated only with caledonite and anglesite.

WULFENITE — $PbMoO_4$ — Exceedingly choice crystals of yellow to orange wulfenite can be found in moderate abundance at the Rowley mine, although they are difficult to collect undamaged. The crystals are always quite clear, sharp and lustrous, with crystal forms as illustrated in Fig. 16. Crystals range in size up to nearly 2 cm, but crystals 1/2 to 1 cm are more common. Associations are limited to mimetite and barite in most cases, but have rarely included cerussite, descloizite and willemite.

MIMETITE — $Pb_5(AsO_4)_3Cl$ — Mimetite occurs at the Rowley mine in a stimulating variety of micro-forms. A continuous sequence of crystal forms has been observed, from minute, perfect hexagonal prisms less than 1 mm in size (Fig. 22) to nearly perfect spheres up to 4 or 5 mm (Fig. 26). The development of the spheres from the prisms is

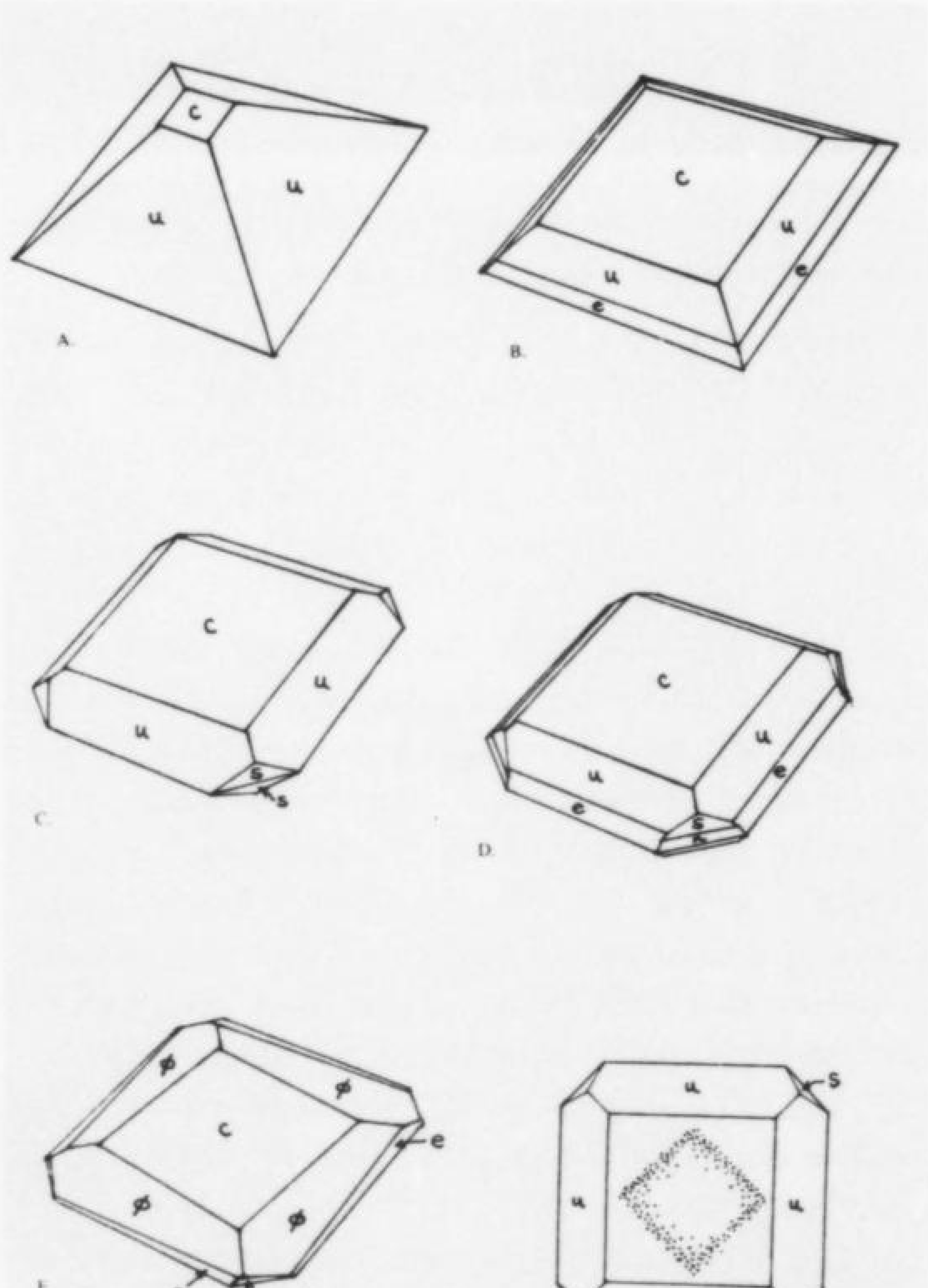


Fig. 16. **Crystal forms found on wulfenite at the Rowley mine.** ***c*** **={001},** ***u*** **={114},** ***e*** **={112},** ***s*** **={103},** ***n*** **={101},** **ϕ ={3.4.75}. F. inclusions of vanadinite (?) in wulfenite.**

Fig. 17. White barite crystals with wulfenite (4 mm). Wilson collection.

Fig. 18

Fig. 18. **Wulfenite crystal (5 mm) displaying {3.4.75} faces, on descloizite and barite.** ***Smithsonian Institution Specimen.***

Fig. 19. **Wulfenite with tiny mimetite crystals on barite. The two wulfenite crystals measure about 9 x 15 mm each.** ***Miller collection.***

Fig. 19

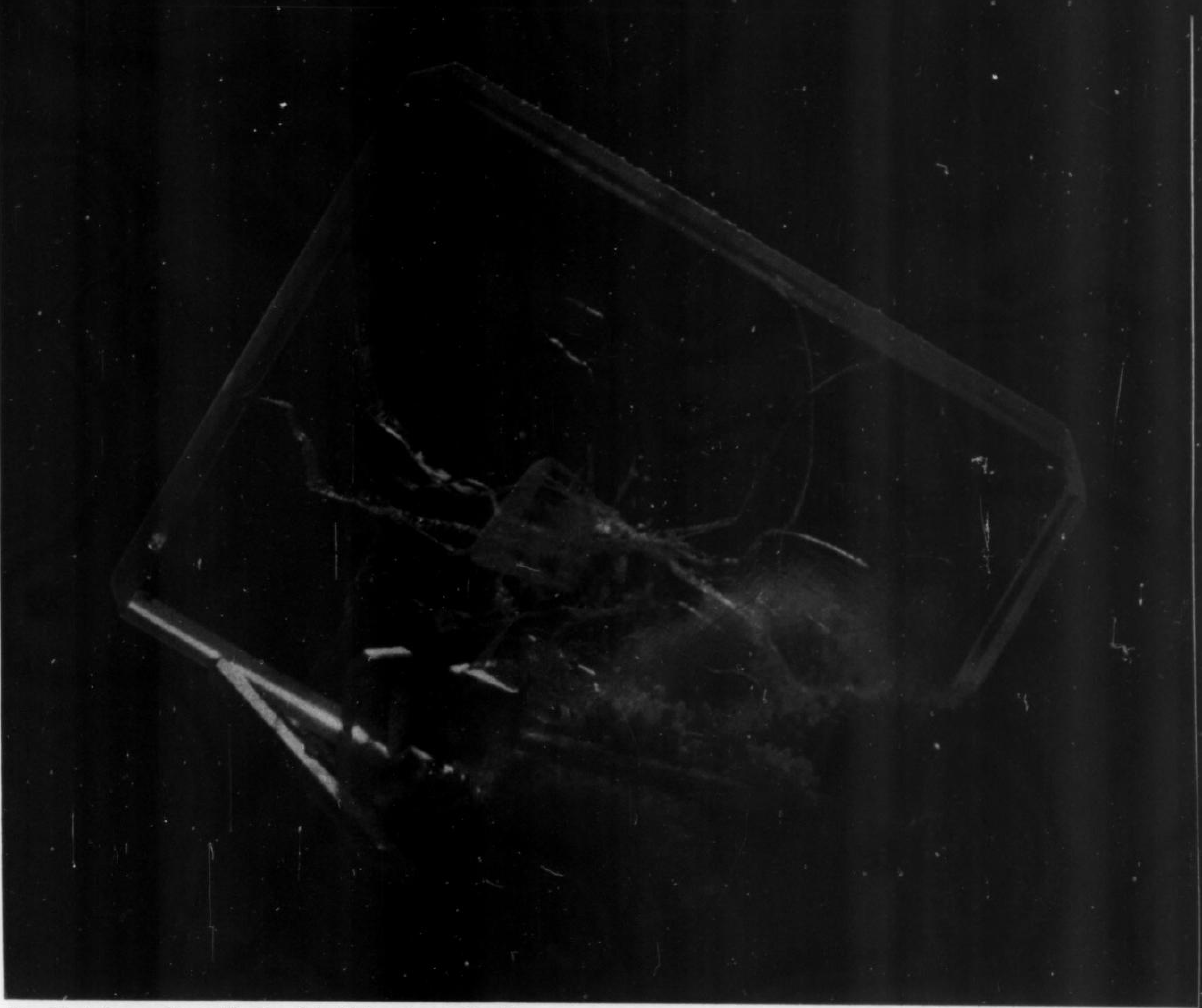


Fig. 20. **A large, thin wulfenite plate (1.5 cm) on mimetite.**

Fig. 21. **Nearly complete pyramidal development of a small wulfenite crystal (1.5 mm).** ***Smithsonian Institution specimen.***

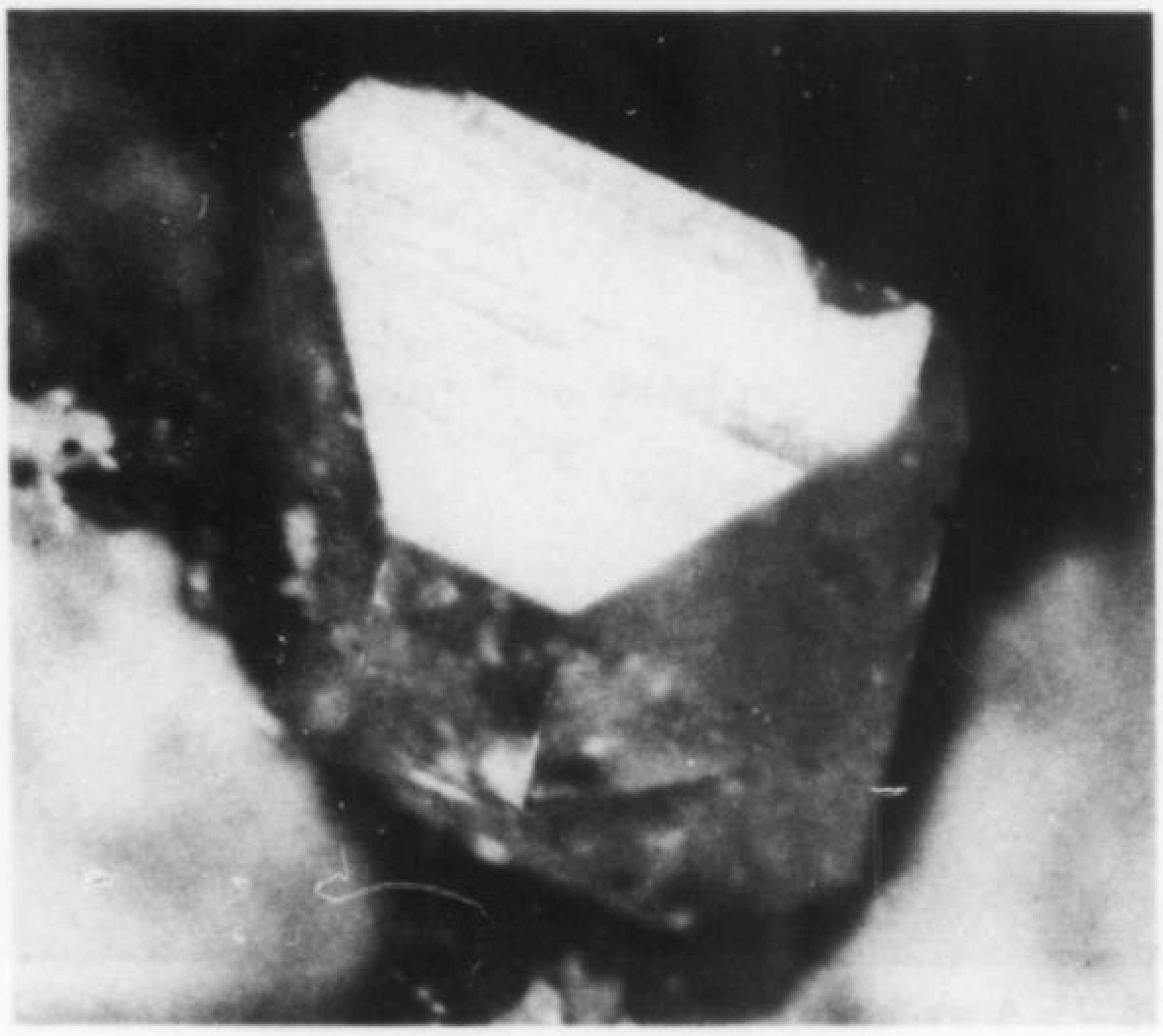


Fig. 22. **Mimetite prism (2 mm) with slightly flared ends.** ***Smithsonian Institution specimen.***

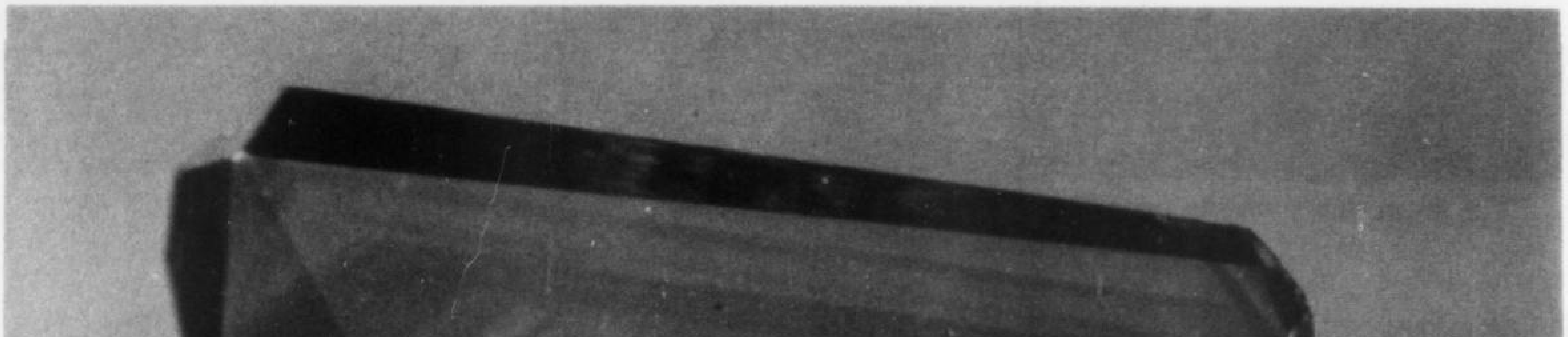


Fig. 23. **A wulfenite crystal (5.5 mm) showing growth zoning.** ***Smithsonian Institution specimen.***

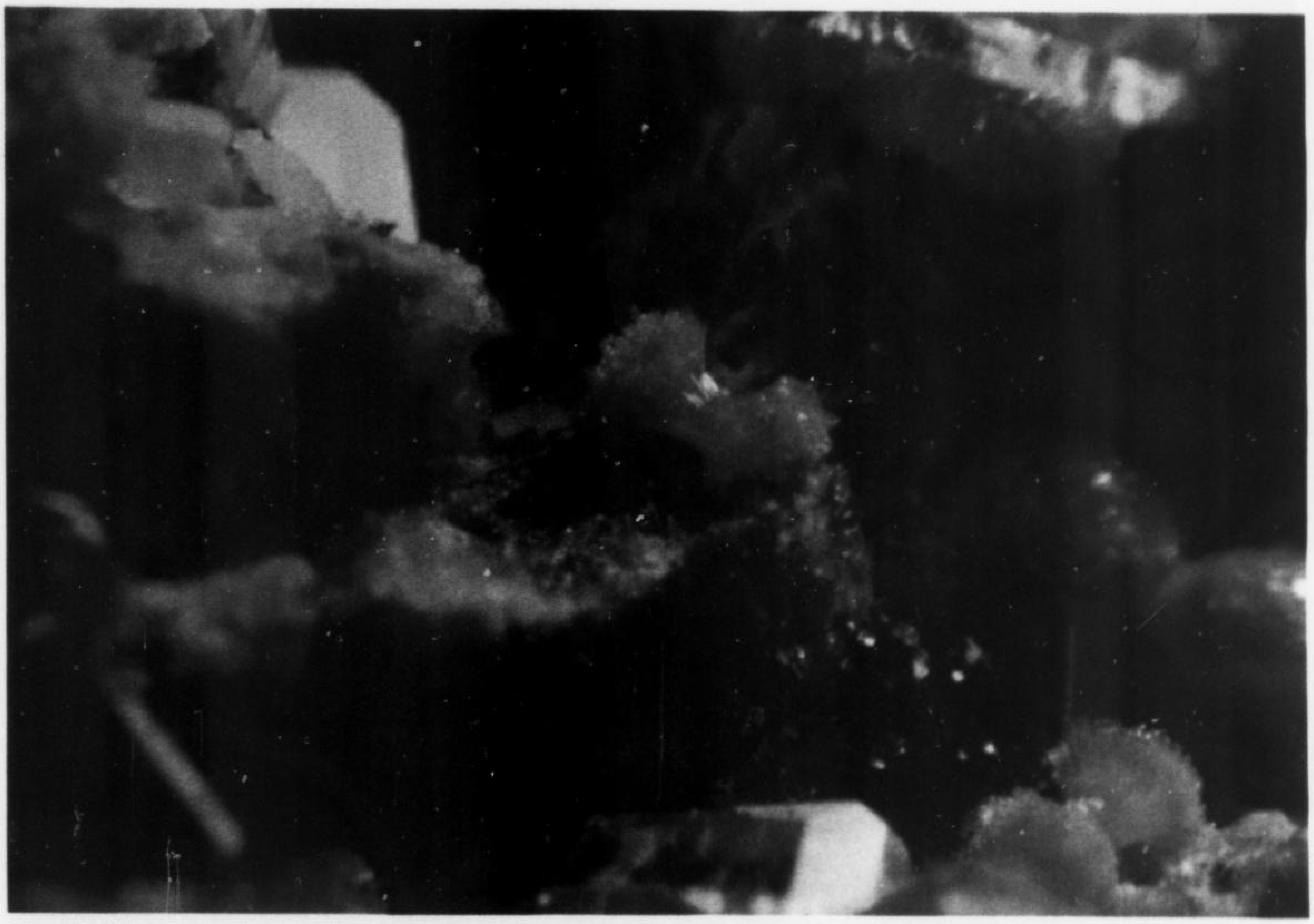


Fig. 24. **"Wheat-sheaf" growth of mimetite (0.7 mm).** ***Smithsonian Institution specimen.***

Fig. 25. **Extreme wheat-sheaf development of mimetite (1 mm) approaching formation of a sphere in the lower aggregate.** ***Smithsonian Institution specimen.***

seen to be the result of a process whereby the ends of the prisms grow faster than the centers, becoming expanded, divergent forms resembling the familiar "wheatsheaf" growth of stilbite. The ends of the sheaves continue to grow and diverge until the opposite ends join all the way around and eventually become a sphere. The spheres then are multiple crystals with the c-axes always perpendicular to any point on the surface of the sphere. (This contrasts interestingly with "campylite" crystals, from Cornwall, which are "barrelled" instead of flared.) Mimetite also forms as submicroscopic crystals in dull mats coating barite, or as acicular tufts (Fig. 28). Color ranges from yellow to red, but deep red is quite rare. Individual crystals may be zoned, with the center of the crystals orange and ends yellow. The most prized specimens are those with good wulfenite and large, red mimetite balls.

VANADINITE — $Pb_5(VO_4)_3Cl$ — Minor amounts of vanadinite occur as crystals up to 3 or 4 mm in size (Fig. 27) but usually smaller. The forms include the hexagonal prism, dipyramid and basal pinacoid. Color ranges from bright red to brown to pale yellow. Some orange crystals have yellowish-white caps on both ends. The caps and centers were separated under the microscope and x-rayed; no difference in x-ray pattern was observed. The color difference is probably due to a minor chemical difference reflecting a slight change in the nature of the depositing solution. A similar zoning in mimetite may indicate that they both formed at about the same time and were both influenced by a minor but widespread change in the depositing solutions. Vanadinite coating wulfenite, as inclusions in wulfenite, and even replacing wulfenite has been observed, but usually the two minerals are not found together.

DESCLOIZITE — $PbZn(VO_4)(OH)$ — Black coatings of minute needles of descloizite occur associated with vanadinite and very rarely with wulfenite. The rarity of this mineral and other zinc minerals suggests an extreme depletion of zinc.

WILLEMITE — Zn_2SiO_4 — One specimen in the Smithsonian collection, from an unspecified location within the mine, contained typical wulfenite with abundant white willemite in small acicular crystals and tufts resembling artinite, and also in powdery masses of intimately mixed willemite and fluorite.

MINIUM — Pb_3O_4 — Rare nodules and disseminations of minium have been observed in the wulfenite suite.

OTHER MINERALS — Other species have been reported in publications and personal communications to the authors, but were not observed in this study. These include pyrite, wolframite, pyromorphite, ferrimolybdite, and ecdemite. ECDEMITE — $Pb_6As_2O_7Cl_4$ — bears a close physical and chemical relationship to mimetite. In an effort to verify the presence of ecdemite at the Rowley mine, 10 samples representing every variety of yellow and orange minerals resembling ecdemite were x-rayed. All proved to be mimetite. A sample labeled ecdemite in the Smithsonian collection (from Tiger, Arizona) was x-rayed for comparison but also proved to be mimetite. Only the Smithsonian specimens from Sweden proved to be genuine ecdemite, but no similar pattern was found in any Rowley mine material x-rayed. This of course does not rule out the possibility of ecdemite at the Rowley mine, but, even though rumors of its existence there have persisted for many years, the authors are still unaware of any actual proof.

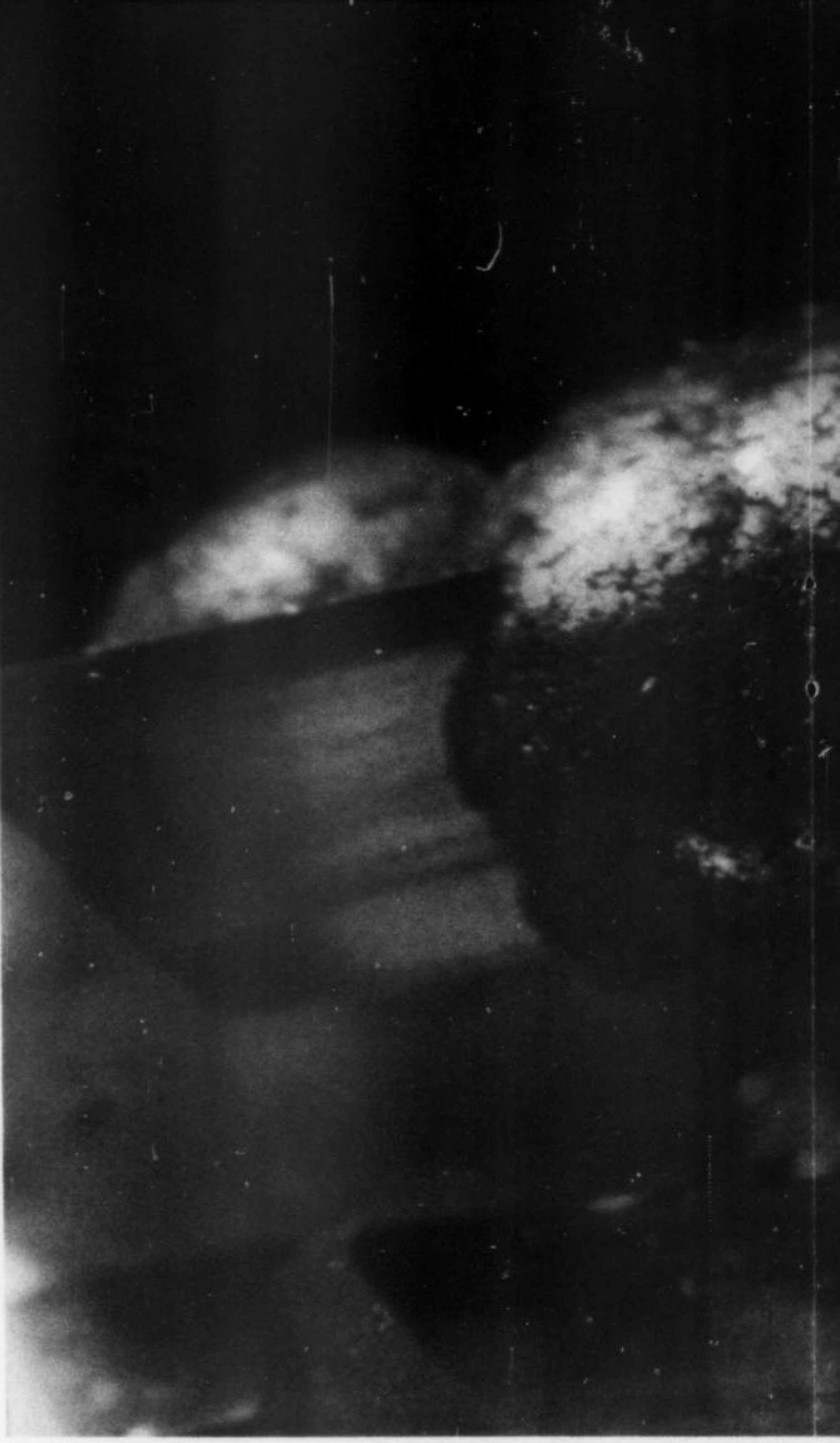
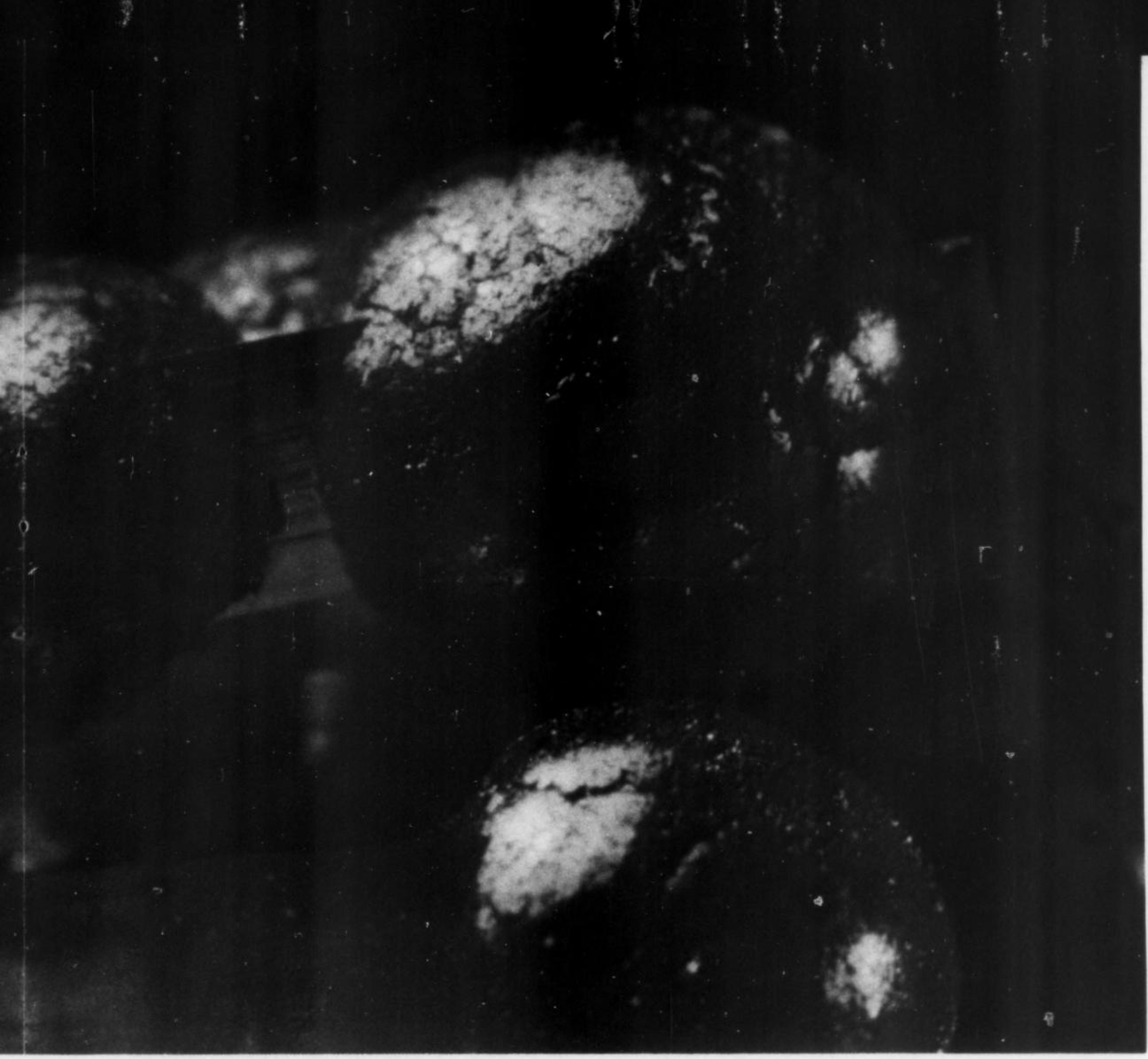


Fig. 26. **The end product of wheat-sheaf development: spherical crys**

PARAGENESIS

Eh and pH are measures of two crucial aspects of water in geological environments. Actually they are measures of the degree to which the water can supply electrons (oxidation-reduction potential) and protons (acidity) for chemical reactions involving the minerals and ions in the system. A high Eh corresponds to an oxidizing environment, low Eh to a reducing environment, high pH to a basic environment, and low pH to an acidic environment. Garrels (1954, 1960), Garrels and Christ (1965) and others have developed a theoretical method for paragenetic analysis based on Eh-pH changes. The stability fields of



l crystal aggregates, (3 mm). ***Smithsonian Institution specimen.***

minerals and ions are plotted relative to Eh-pH, and zones of mutual stability as well as possible alteration sequences are visible at a glance. Calculating the stability zones can be difficult, but once done they are applicable to any situation where the concentrations of all components are as specified in the calculations. A great deal is still unknown regarding the alteration chemistry and paragenesis of lead deposits, but a few general interpretations can be made.

Fig. 29 shows the probable course of Eh-pH change for the Rowley vein, from primary deposition to surface alteration. In physical terms alone it seems obvious that the barite and quartz veins, in their present segregated, side-by-side form, could not have crystallized simultaneously. Such a case would yield a barite-quartz mixture. It also seems improbable that a 30-foot-wide fault zone could be held wide-open at depth, containing only a hydrothermal solution quietly precipitating minerals. It is more likely that the fault was forced open inches at a time while minerals precipitated. The jumbled barite layers shown in Fig. 9 suggest that the fault was active during barite deposition. Tiny quartz crystals in barite breccia cavities suggest that the quartz vein was the second to form: no corresponding barite crystals in vugs in the quartz vein were found. The structurally weak barite-wall rock contact would be a logical place for the quartz vein to form.

Formation of massive anglesite and cerussite from galena was the first major change after primary deposition. Titley and Anthony (1961) define limits of stability of the molybdate ion (MoO_4^{2-}) in solution, which are probably close to the stability limit for wulfenite ($PbMoO_4$). Williams (1966) studied the relation between approximate Eh-pH during formation and the dominant crystal form and associations for wulfenite in general. The crystal forms of Rowley wulfenite place it in the lower Eh and lower to higher pH range. The forms {111} and {113} characteristic of high Eh and pH were not observed on Rowley wulfenite. Mimetite is by far the commonest association, which again indicates, according to Williams (1966), mildly acid waters and fairly low Eh. One specimen was found which contained wulfenite and acicular willemite, an association

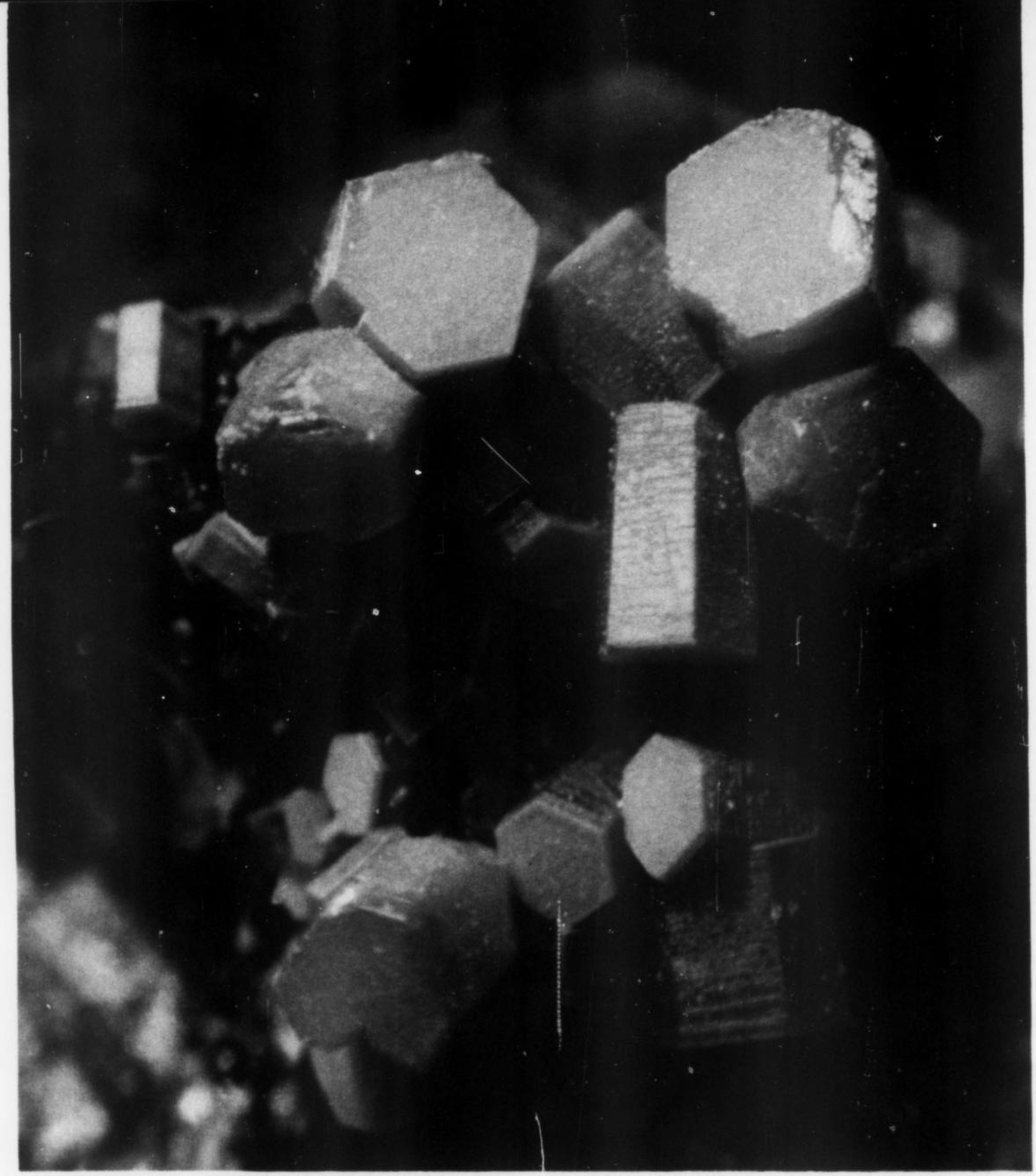


Fig. 27. **Vanadinite crystals (2 mm).** ***Bud Standley collection.***

indicative of high Eh and pH corresponding to near-surface conditions of oxidation. However the crystal forms match equally well with the low Eh forms. The willemite may have formed long after the wulfenite, wulfenite may have been influenced by parameters other than Eh-pH, or perhaps wulfenite actually did form under a great range of Eh-pH at the Rowley mine. Uncertainties of this type make Williams' work difficult to apply because he also had no independent verification of Eh-pH conditions while wulfenite of a particular habit was growing.

Takahashi (1960) has noted the general tendency for wulfenite to form a short distance away from the cerussite and galena bodies rather than in direct contact with them. This tendency is observable at the Rowley mine but the cause is not clear. Possible causes are a rate difference in the crystallization of cerussite and wulfenite, or an incompatability of chemical potential of lead between galena, cerussite and wulfenite. Or perhaps cerussite is not stable in Mo-containing solutions, under certain circumstances, and has been altered completely to wulfenite in some areas by late-stage Mo-surges. A much better theoretical and experimental foundation will be required for a solution to this problem.

The origin of the molybdenum is indeed a problem. Titley and Anthony suggest that in cases where there is no evidence for primary molybdenite the molybdenum

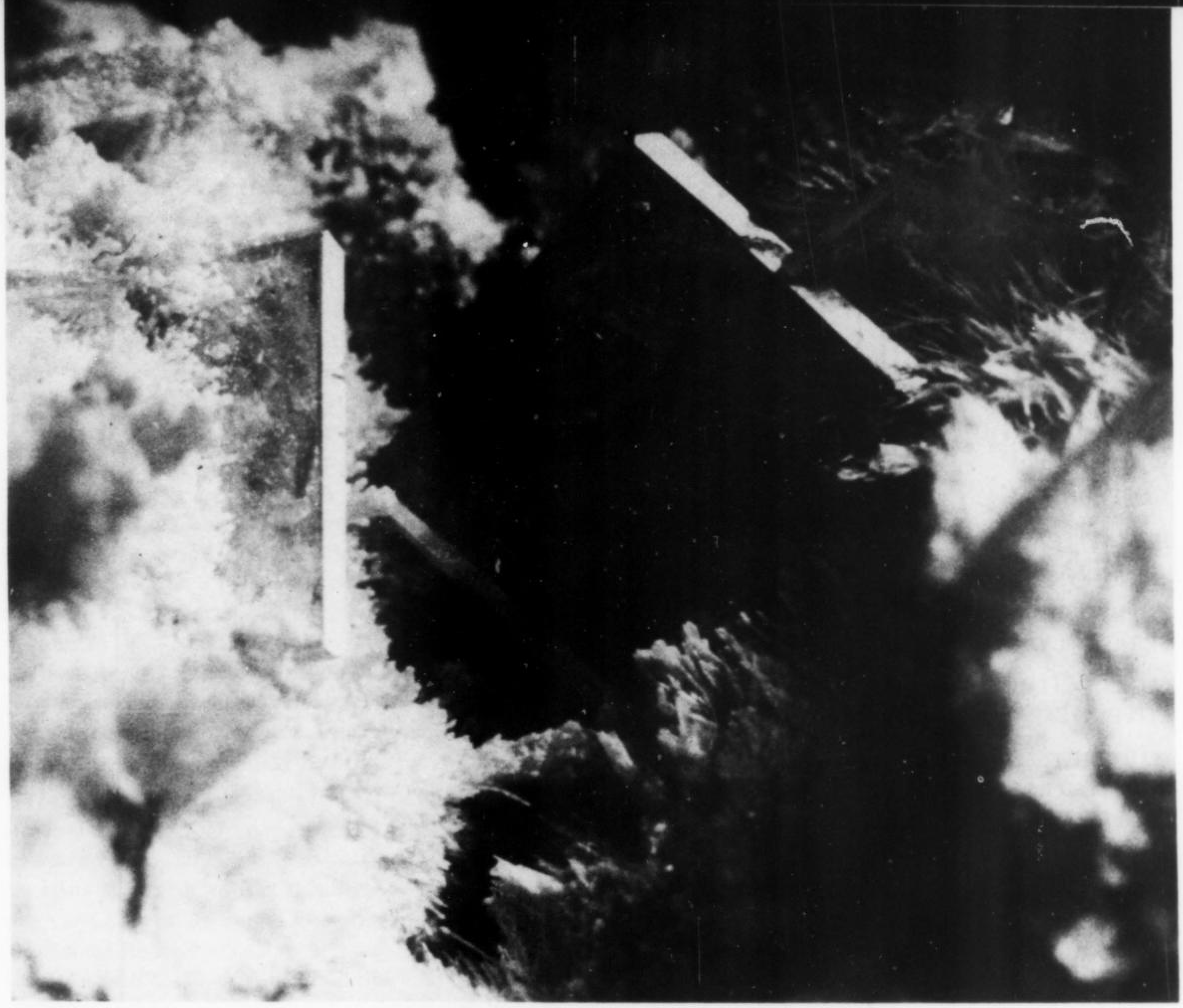


Fig. 28. **Wulfenite plates (6 mm) in acicular yellow and orange mimetite.** ***Wilson collection.***

could have been transported to the site from elsewhere as the soluble molybdate ion, and need not be indigenous to the deposit. A hydrothermal source was apparently first proposed by Dittler (1914), and later Peterson (1938) and Creasey (1950), agreed, at least regarding wulfenite formation at the Mammoth mine near Tiger, Arizona. Considering the mystery surrounding the origin of hydrothermal waters, it is possible that these two theories are not as incompatible as they might first appear. Again, more hard data is needed to resolve this problem.

Eventually the Rowley deposit became situated above the water table, and alteration took a somewhat different course (Fig. 29). The trend during near-surface alteration was probably one of decreasing pH (increasing acidity) and increasing Eh. This may be because freely circulating ground waters were no longer able to assist in the neutralization of acids formed during sulfide decomposition, thus allowing the pH to decrease. Sato (1960) showed, among other things, that a decrease in pH near the surface must be accompanied by a rise in Eh. This apparently took place in small veins near the hanging wall of the Jobes shaft resulting in the formation of the caledonite suite. The sequence of formation was atacamite, linarite-diaboleite, more cerussite, and caledonite, with progressively increasing acidity. The anglesite field of stability was then reentered and a small amount of sandy, second-generation anglesite was formed. Any wulfenite in this area then became unstable and was taken back into solution. This return to the anglesite field is substantiated by the presence of leadhillite as the last mineral to form in the caledonite suite. Leadhillite is not stable in the cerussite zone[2] , and cerussite has been leached away on leadhillite specimens. Certain areas in the wulfenite zone apparently experienced a rise in Eh and pH as evidenced by the appearance of minium.

Sometime after the wulfenite formation a second gen-

---

[2] One of us (WW) studied 63 leadhillite specimens in the Smithsonian collection (mostly from Leadhills, Scotland; Granby, Missouri; and Tiger and Bisbee, Arizona) and found only one specimen on which leadhillite was in contact with cerussite (metastably?). The preferred association was anglesite and often caledonite and linarite, indicating that the zone of mutual stability of leadhillite and cerussite is extremely small if it exists at all. In one case leadhillite appeared to be altering topotaxially to cerussite.

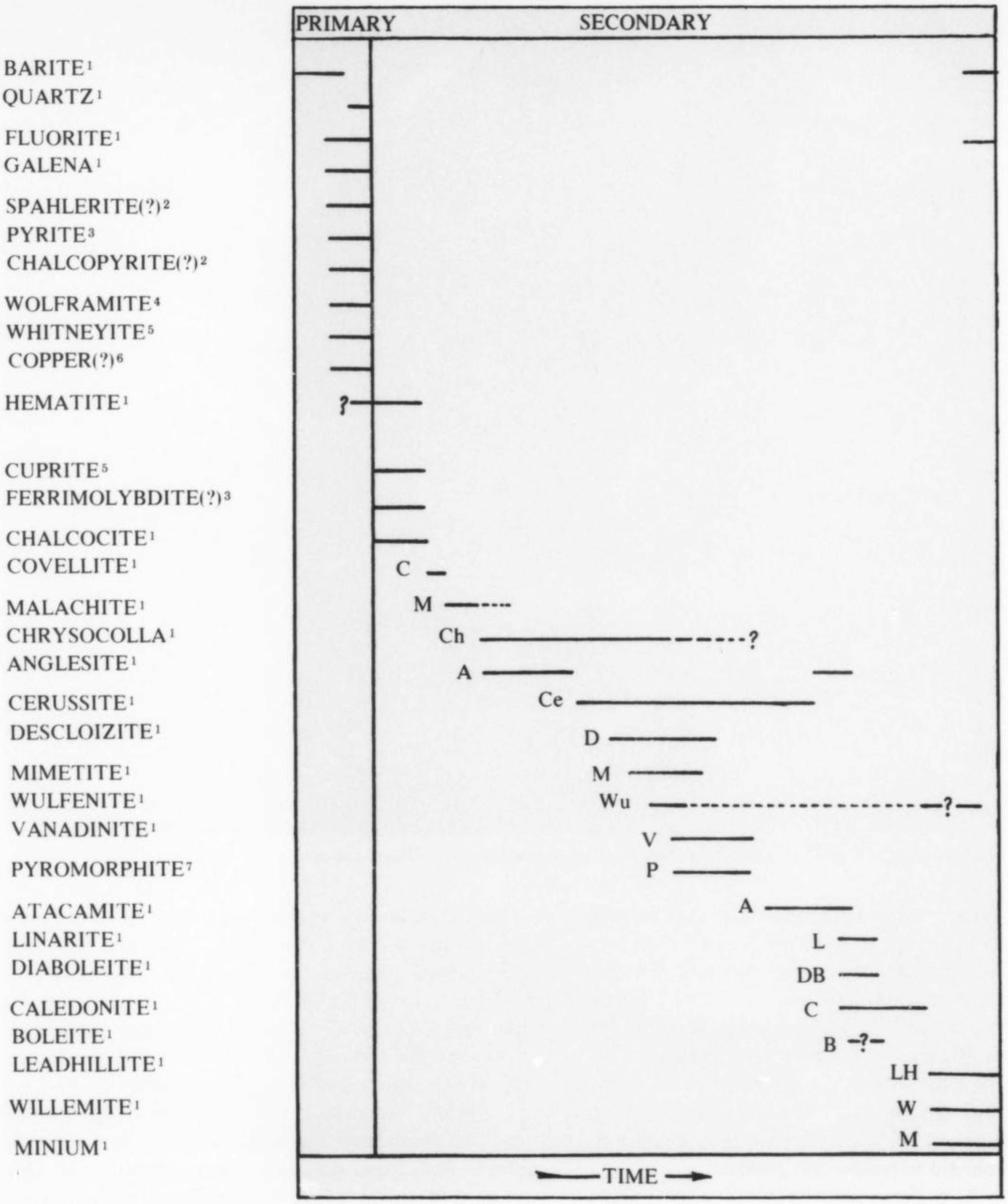


Table 1. Minerals at the Rowley mine, and their paragenetic sequence.

Time scale is relative only. Due to the present scarcity of primary minerals their paragenesis cannot be determined in detail.

1 — Identity confirmed by x-ray diffraction.

2 — Inferred as having once been present.

3 — Unobserved in this study but reported by Kirkemo, et. al, (1960).

4 — Unobserved in this study but reported by Galbraith and Brennan (1970).

5 — Unobserved in this study but an early mine prospectus quotes a report by a geologist, Edwin Walters, dated February 14, 1912, which notes the presence of whitneyite and cuprite.

6 — Unobserved in this study but Stewart and Pfister (1960) quote a report dated November, 1933, by Walter X. Osborn, former manager of the Rowley Co., which notes the presence of "galena and copper". It is possible that Osborn was speaking loosely and did not mean *native* copper but rather *copper-containing* ore.

7 — Unobserved in this study but reported by Eugene Colvin (personal communication).

eration of barite and fluorite formed in very minor amounts. Whether this is related to Eh-pH changes is not clear, but these late minerals were not deposited in the caledonite zone, and were not accompanied by any etching of wulfenite, hence they probably formed under moderate Eh and high pH.

Table 1 shows the paragenetic sequence for minerals at the Rowley mine as determined by microscopic inspection of grain contacts and overlapping relationships, and by very general Eh-pH considerations where possible. Sources for the various stability boundaries are indicated by the circled numbers on the lines (Fig. 29).

Eh-pH diagrams are regrettably inflexible relative to real conditions and must be interpreted with care. Assumptions about the nature of the solution can be wrong, and in the real situation a fluctuation of ionic concentrations is possible and even probable. For instance higher $\Sigma\ SO_4^=$ and lower $\Sigma\ CO_3^=$ could drastically shift the anglesite-cerussite boundary. The alteration trends on the fixed-concentration Eh-pH diagram (Fig. 29) might conceivably reflect changing concentrations as well as real Eh-pH changes.

ACKNOWLEDGMENTS

The authors are indebted to Mr. John S. White, Jr., and Mr. Bud Standley for making many specimens available for study. Dr. Arthur Roe helped with the task of x-raying the many specimens used in this study. We also wish to thank the Mineral Resources Department of Arizona and Dr. Roland Rouse for locating and making available certain references to us. Mr. Richard A. Bideaux, Dr. John W. Anthony, and Mr. Walter Dibble critically reviewed the manuscript and provided helpful suggestions.

REFERENCES

Bond, M. (1913), personal diary, courtesy of Arizona Department of Mineral Resources, Phoenix.

Creasey, S. C., (1950), Geology of the St. Anthony-Mammoth area, Pinal Co., Arizona, *Arizona Bur. of Mines Bull.* **156,** 63.

Dittler, E., (1914), Weitere versuche zur synthetischen darstellung des wulfenites, *Zeit. für Krist.* **54,** 332-342.

Fleischer, M., (1971), *Glossary of Mineral Species 1971.* Mineralogical Record, Inc., Bowie, Md., 121 pp.

Galbraith, R. W., and D. J. Brennan, (1970), *Minerals of Arizona. Ariz. Bur. of Mines Bull.* **181,** 116 pp.

Garrels, R. M., (1954), Mineral species as functions of pH and oxidation-reduction potentials with special reference to the zone of oxidation and secondary enrichment of sulfide ore deposits. *Geochim. et Cosmochim. Acta,* **5,** 153-168.

————(1960), *Mineral Equilibria.* New York, Harper Bros.

Garrels, R. M., and C. L. Christ, (1965), *Solutions, Minerals, and Equilibria.* Harper and Rowe, New York.

Hoffman, V. J., (1967), Mineralogy of the Mapimi mining district, Durango, Mexico. Unpublished Ph.D. thesis, Univ. of Ariz., Tucson.

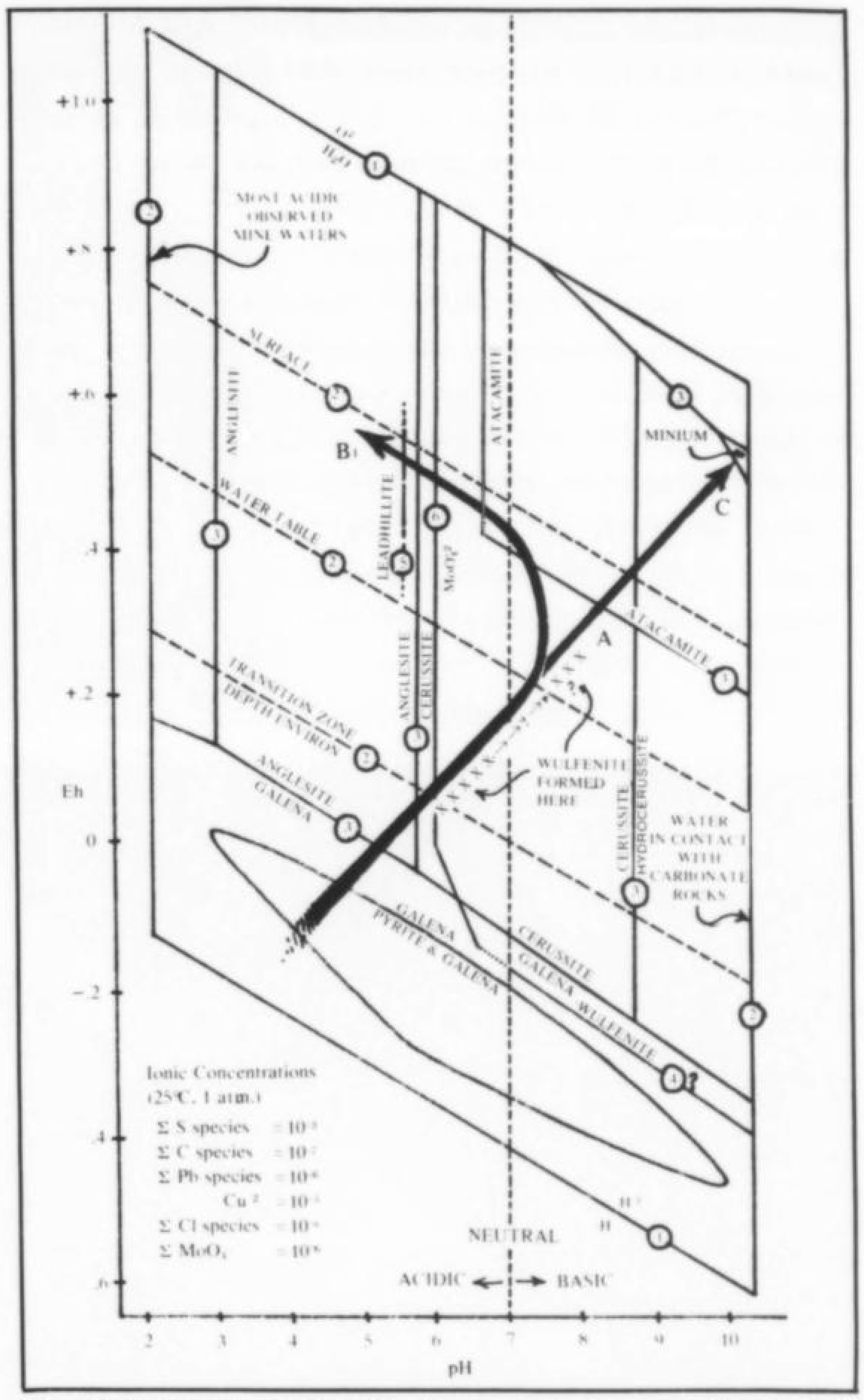


Fig. 29. **Trend of Eh-pH changes during weathering of the Rowley vein. As erosion brought the deposit closer to the surface, changes followed the large arrows. Changes for the bulk of the deposit culminated at A; the conditions in a few small veins (the caledonite suite) continued to B.**

The trend for other small areas continued to the minium zone (C). The best available references for stability boundaries are given below: calculations were *not* made considering all components simultaneously. Possible interactions resulting from overlaying of the various diagrams are assumed to be insignificant.

1 — Garrels and Christ (1965).
2 — Sato (1960).
3 — Hoffman (1967).
4 — Takahashi (1960). Judging from the galena boundary on the published diagram of Takahashi, it appears that the sign of the Eh has been reversed. The wulfenite boundary used here has been reversed back to the probably correct position. It is also possible that Takahashi's solubility product value for wulfenite is in error, altering the stability boundary somewhat.
5 — Estimated here (see footnote #1).
6 — Titley and Anthony (1961). Based on free energy data which are "probably in need of revision" (Anthony, Personal communication).

Kiersch, G. A., (1949), Structural control and mineralization at the Seventy-nine mine, Gila County, Arizona. *Econ. Geol.*, **44,** 24-39.

Keith, S. B., (1972), Minerals of the 79 mine. *Mineralogical Record*, **3,** 247.

Kirkemo, H., C. A. Anderson, and S. C. Creasey, (1965), Investigations of molybdenum deposits in the conterminous United States, *U. S. Geological Survey Bull.* **1182-E,** E6-E10.

Peterson, N. (1938), Geology and ore deposits of the Mammoth mining camp area, Pinal Co., Arizona, *Ariz. Bur. Mines Bull.* **144,** 43.

Rouse, R. C., (1973), The crystal structure of boleite – a mineral containing silver atom clusters, *J. Solid State Chem.*, **6,** 86-92.

Sato, M., (1960), Geochemical environments in terms of Eh and pH. *Econ. Geol.*, **55,** 928-961.

Stewart, L. A., and A. J. Pfister, (1960), Barite deposits of Arizona. *U. S. Bur. of Mines Report of Investigations* **5651,** 41-44.

Takahashi, T., (1960), Supergene alteration of zinc and lead deposits in limestone. *Econ. Geol.*, **55,** 1083-1115.

Titley, S. R., and J. W. Anthony, (1961), Some preliminary observations on the theoretical geochemistry of molybdenum under supergene conditions. *Arizona Geol. Soc. Digest*, **4,** 103-116.

Williams, S. A., (1966), The significance of habit and morphology in wulfenite. *Amer. Miner.*, **51,** 1212-1217.

Winchell, R. E., (1963), X-ray study and synthesis of some Cu-Pb oxychlorides, Unpublished Ph.D. thesis, Ohio State Univ., 173-184.

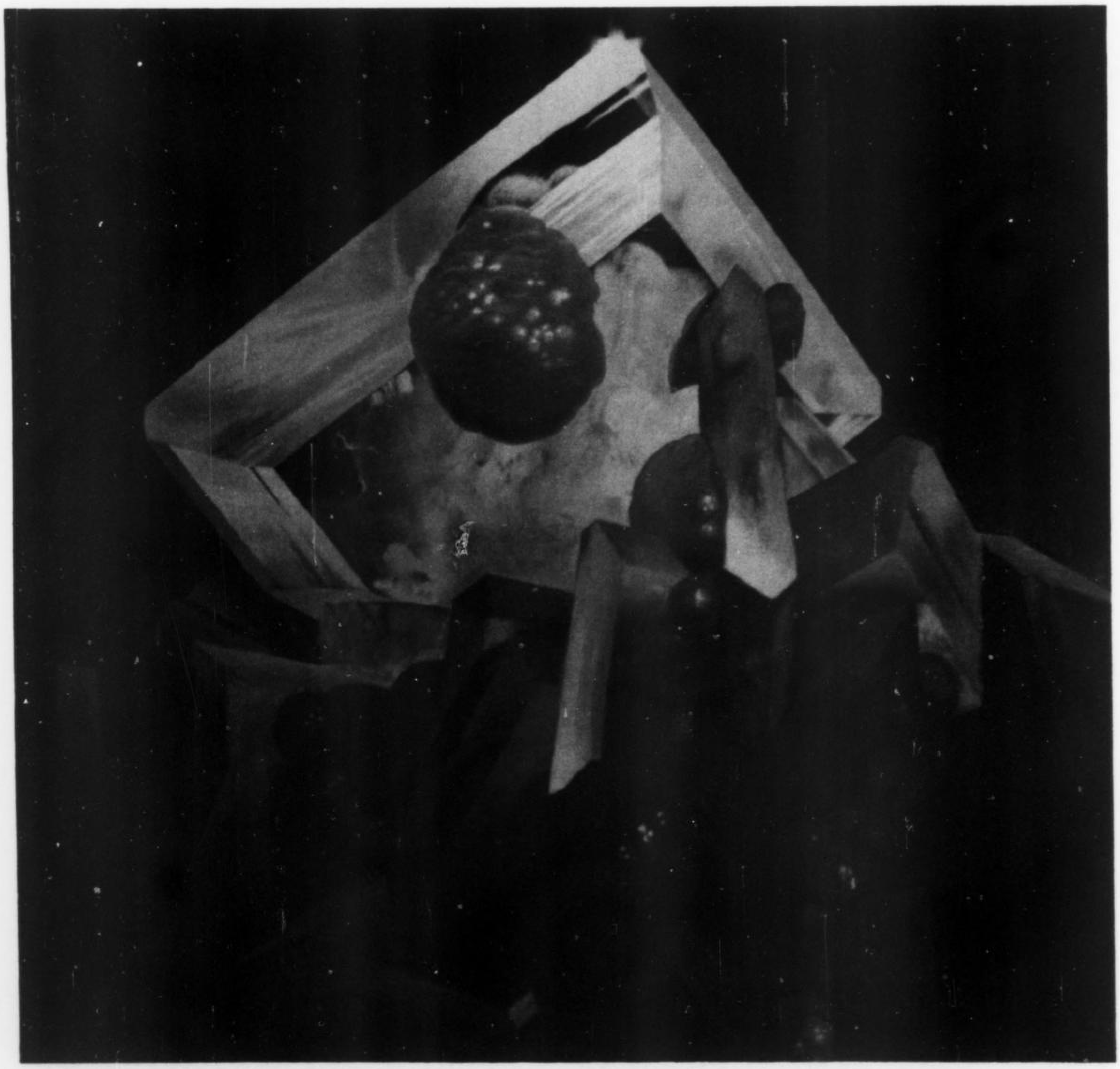
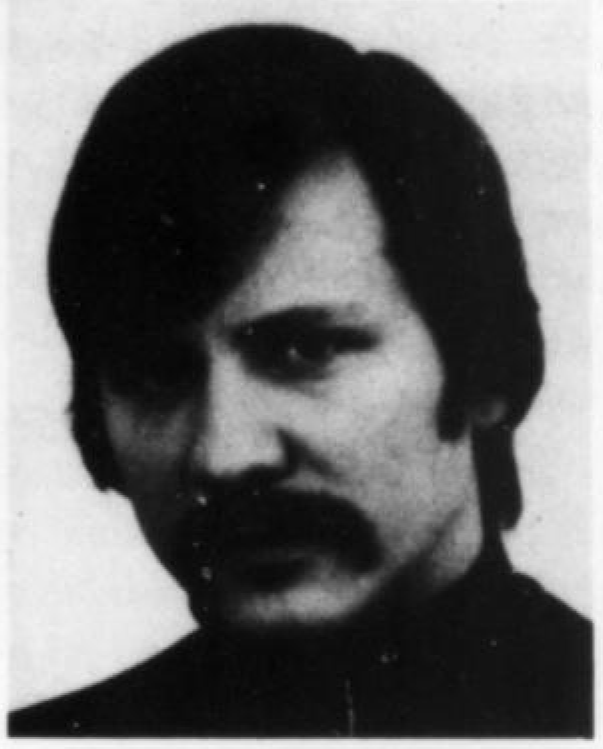


Fig. 30. **Oil painting by Wendell E. Wilson of mimetite on wulfenite from the Rowley mine. The specimen from which the painting was made is a miniature in the Smithsonian's collection.**

The Photographic Record

by Wendell E. Wilson



Close-up photography is probably the most popular range because so many people collect miniatures and thumbnails. The large studio lights used for photographing cabinet specimens can be dispensed with in favor of small high-intensity desk lamps (12V) or microscope lamps. Neither is there a need for yards of background cloth and large, sturdy stages. On the other extreme is the wide range of expensive microscope equipment, also unnecessary for close-up work.

A few pertinent definitions might be helpful here:

Magnification: image height (on film) divided by actual object height.

Close-up photography: photography at magnifications up to about 3x (arbitrary cut-off).

Photomacrography: photography at magnifications from 1X to 50X.

Macrophotography: the making of giant-sized prints or negatives.

Photomicrography: photography through a microscope.

Microphotography: the making of very small photographs, e.g. microfilm.

There exists a confusing jumble of equipmentand combinations of equipment that can be used for photomacrography. I will attempt in this installment to briefly describe and sort out this jumble, and make a judgment as to the best choices. The following pieces of equipment can all be used for photomacrography.

Extension tubes: hollow metal cylinders that attach between lens and camera body to increase magnification. They come in sets of three, but two sets can be used together for greater magnification. Homemade tubes can be several feet long. Extention tubes can be used with any lens or lens combination.

Bellows: cloth accordian-like apparatus which attaches between lens and camera body. Bellows can be lengthened or shortened within certain ranges to produce desired magnifications exactly. The longest bellows made for 35mm photography extends to 600mm but most are considerably shorter. They can be used in conjunction with any of the other pieces of equipment described here.

Accessory lenses, also called close-up attachment lenses: extra lenses which screw onto the main lens like filters to increase magnification. They usually come in sets of three and can be used separately or in combination for middle-range magnification.

Telephoto lens: a lens of long focal length, usually over 80 mm. The long focal length yields a longer working distance (lens-to-subject) for a given magnification but requires longer bellows to achieve the same magnification as lenses of shorter focal length. Distortions such as "barrelling" common to wider angle lenses are eliminated. Some telephoto lenses stop down to f/32, but the general tendency of telephoto lenses to be inferior in optical quality to other lenses usually results in inferior resolution.

Normal lens: a lens whose focal length is near the diagonal dimension of the film, usually around 50mm. These lenses are the most commonly used lenses for ordinary photography because they are versatile and the perspective obtained is very similar to that seen with the human eye.

Wide-angle lens: a lens of short focal length, usually 35mm or less. The lens-to-subject distance is relatively short but magnification increases more rapidly as bellows length is increased, compared to lenses of longer focal length. Reversing the lens tends to improve optics for close-up work and it also increases magnification somewhat.

Tele-extender, also called a teleconverter: a lens attachment which increases the effective focal length of any lens. They are commonly available in powers of 2X and 3X, although they can be grouped for even larger changes, for example a 2X and a 3X tele-extender used together acts as a 6X tele-extender. A 2X tele-extender converts a 50mm lens to a 100mm lens. Tele-extenders, in effect, double or triple magnification but do *not* increase the minimum focusing distance.

Macro lens: a lens designed specifically for photomacrography. The optical corrections are more accurate for close-up work than are those of other lenses, and most macro lenses stop down to f/32 for maximum depth of field. Macro lenses come in a variety of focal lengths and magnification capabilities. They can be used with all other accessory equipment but should not be reversed. See the Winter 1974 issue of *35-mm Photography* for an article by Norman Rothschild on the use of long-focal-length macro lenses.

In choosing a system the important considerations are resolution and depth of field. Magnification is another important factor for some people. Resolution (for definition see *MR,* **3**, no. 4, pg. 152) can be maximized simply by choosing a high quality lens and adding as few pieces of extra glass to the system as possible. Each glass surface causes a little "flare" which has the effect of decreasing contrast and resolution. So if given the choice of using accessory lenses or bellows to achieve a desired magnification, the bellows are best. Macro lenses, being designed specifically for close-up work are optically superior to normal, wide-angle, or telephoto lenses. But if you don't own or can't afford a macro lens you can simulate one by reversing (turning end for end) your own lens and attaching it backwards to your camera bellows or tubes with the proper ring adapter. Resolution is best when the lens focus is set at infinity.

It has been said that depth of field is greater for lenses of short focal length. This may be true, but the effect is insignificant; the overall trend is simply a decrease in relative depth of field with increasing magnification, regardless of focal length. The rule, more accurately stated, is that depth of field is proportional to the lens-to-subject distance and inversely proportional to the diameter of the *aperture* (hole which admits light to film when shutter opens). Since working distance is proportional to focal length we can express the depth of field as a "stop number" which is a function of the focal length and aperture diameter (in mm).

$$\frac{\text{Focal length (f)}}{\text{aperture diameter}} = \text{"stop number"}$$

This equation is usually rearranged to:

$$\frac{\text{Focal length (f)}}{\text{"stop number"}} = \text{aperture diameter}$$

So if you have a lens whose focal length is 32mm and it is

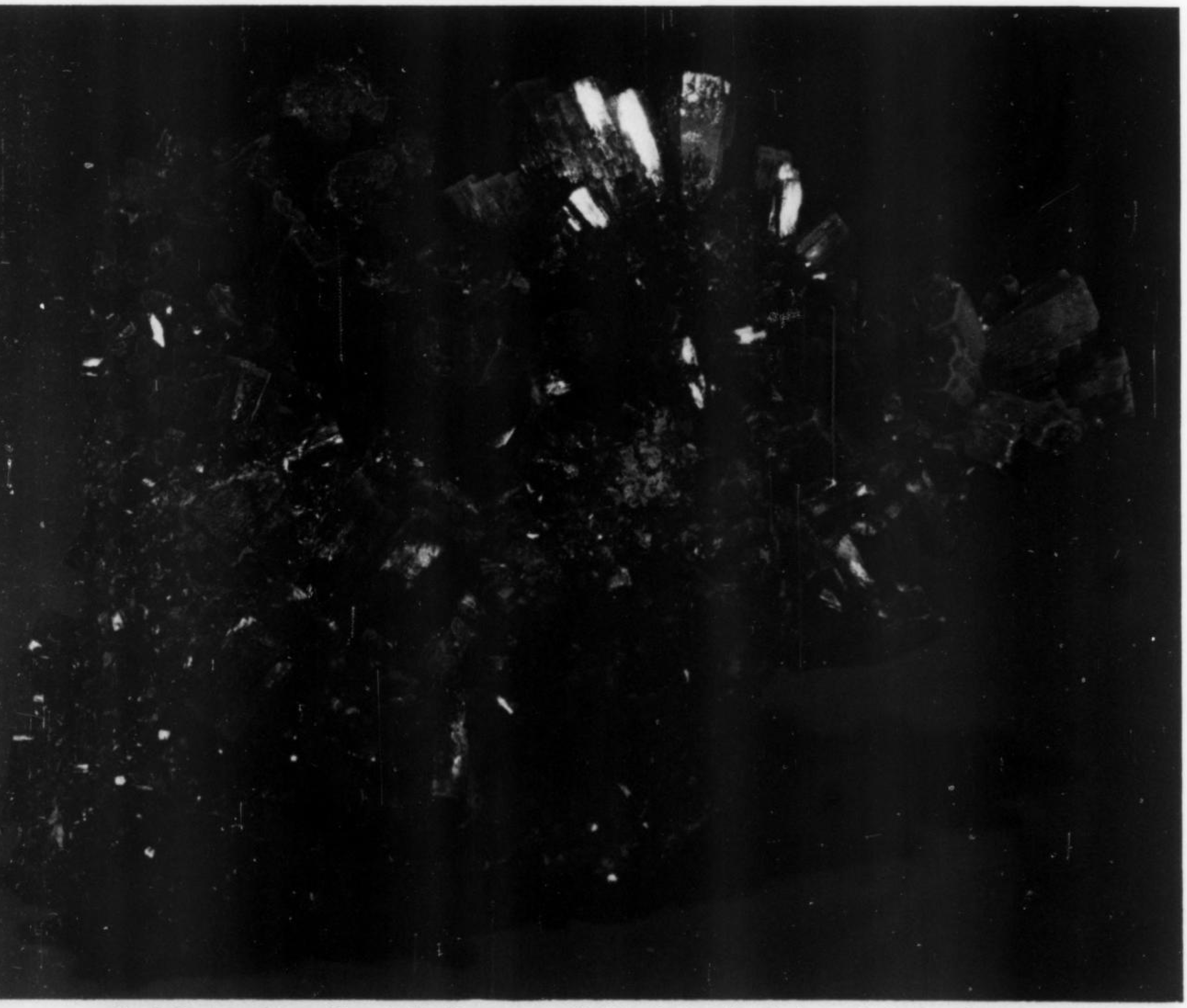


Fig. 1. **Pyromorphite — Phoenixville, Pennsylvania (Smithsonian specimen). A superb close-up photograph of a miniature size specimen. The magnification of the image on the 4x5 inch transparency was 2X. As reproduced on this page the magnification is nearly 4X. The photograph is by Lee Boltin.**

set at f/16, you can quickly ascertain the aperture diameter as 32/16 or 2mm. It follows that f/16 on a lens of *different* focal length will not be the same size hole. For a 64mm lens it would be 64/16 = 4mm. Many macro lenses and some telephoto lenses stop down to f/32 for better depth of field than lenses which only stop down to f/16 or f/22. I don't plan to go into too many formulas in this column, but if you are curious to see concepts of depth of field, focal length, resolution, etc. in numbers, I recommend *Introduction to Photographic Principles* by Lewis Larmore.

For a long time I brooded over the apparently impossible task of getting smaller apertures than f/32 for even better depth of field. I was told that no manufacturer makes lenses with smaller apertures, and that even if they did the diffraction effect around such a small hole would be objectionable. Then I read an article by Jerry Lesser (*Peterson's Photographic Magazine*, Oct. 1973, p. 54) which demonstrated the use of a tele-extender for increasing depth of field. Lesser used a 28mm wide-angle lens in the reverse position, a set of extension tubes, and a 3X tele-extender connected to the camera body (in that order of assembly) and obtained depth of field at f/16 which is 50% greater than the depth of field obtained by the best macro lens at f/16 and identical magnification!

Tele-extenders were designed for telephoto applications but they have the effect of multiplying the *stop number* as well as the focal length. It is obvious from the above equation for stop number that if the focal length is multiplied by 3 and the aperture diameter is not changed the stop number must also be multiplied by 3. Hence f/16 with a 3X tele-extender becomes f/48. Use the same tele-extender with a macro lens at f/32 and you obtain a fantastic f/96! By grouping tele-extenders together one could obtain virtually any f/stop; the concept is limited by the point at which the cumulative flare added by all those extra pieces of glass becomes too objectionable. Increasing the stop number also cuts down drastically on the light reaching film and viewfinder, so it becomes increasingly difficult to see the specimen or obtain a proper exposure in a reasonable period of time. Lesser recommends using an electronic flash situated only a few inches from the specimen. As a final note on this technique, It is more convenient to use the tele-extender with a lens of short focal length so that the required bellows are as short as possible for any particular magnification.

Magnification is not really a problem because you can simply increase the bellows or tube length to gain higher magnification.

In a future column I will discuss methods of obtaining high magnifications (15 - 20X) without any microscope equipment. Julius Weber, incidentally, has promised us a column or two on his sophisticated photomicrography techniques. It should be very enlightening.

Wendell Wilson
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Fig. 1. **Collecting at the Parker Shaft, Franklin, 1924. Gordon (center), M. Biernbaum (Baldwin), left, Frankenfield (right).**

An American Mineralogist Part II

by Arthur Montgomery
Lafayette College, Easton, Pennsylvania 18042

FIRST COLLECTING EXPEDITION

In 1921 Gordon went to the Andes of South America, visiting Ecuador, Bolivia, Chile and Peru, on the first of a long-continuing series of one-man collecting expeditions to foreign countries. So began a new phase of interest, travel and associated mineral research which lasted for twenty years. During that time, he dug out of the earth and extracted from mine openings a marvelous wealth of rare and superbly-crystallized minerals. There ensued from his pen a stream of highest-quality scientific papers and expedition stories of absorbing human interest.

A man stood behind these expeditions, who encouraged and helped finance them. This was George Vaux, Jr., a well-to-do Quaker and nephew of the Academy patron, William S. Vaux. His uncle had started him off to be a mineral collector while still a boy, and he was in the process of assembling in his Bryn Mawr home every bit as outstanding a private collection (later given to Bryn Mawr College) as the older man had willed to the Academy. For years Gordon had dreamed of going off to far-distant places in search of beautiful and rare minerals — that was what inspired his expeditions. But it's doubtful whether he ever could have managed those ambitions and lengthy journeys without the private backing of George Vaux. The Academy had no funds available for such purposes, except for about five hundred dollars provided annually from the William Vaux endowment. That was all there was, outside of Gordon's own curatorial salary, to underwrite the general expenses of the mineral department.

Some may have supposed that the "Vaux-Academy" (or, as later termed, "Academy-Vaux") mineral collecting expeditions were chiefly financed by George Vaux. This is far from the truth. Records on costs of the first Andes expedition of 1921 show that the funds used to pay total expenses of about $1650 came percentage-wise from the following sources: George Vaux, a fourth; W. S. Vaux fund, a fourth; S. G. Gordon, more than a third; later sales of duplicate minerals collected on the expedition, the remainder. What stands out is Gordon's contribution — substantially more than any other. Even more remarkable is that the six hundred dollars he contributed toward the six-months-long expedition made up half his annual salary at the Academy. It is unlikely that the extent of the young curator's personal sacrifice, to make possible this and later Academy-Vaux expeditions, has been revealed before. A further irony, in the light of Gordon's financial sacrifice, was the gain to the Academy from every such expedition of hundreds of superb minerals. But Gordon gladly did it, through loyalty to his institution and for the sake of going to far places in search of the minerals he loved.

The arrangement with George Vaux with regard to distribution of the minerals secured on the Academy-Vaux expeditions was one where the financing interests involved, George Vaux, W. S. Vaux fund (Academy) and S. G. Gordon (Academy), shared equally in a three-part alternating selection of best specimens. A coin was tossed to see who would choose first, whether George Vaux for his own collection or Gordon for the Academy. In contributing toward this first expedition, as later toward the others, Mr. Vaux took a chance that the proceeds in fine minerals might be poor. But the risk was slight, considering Gordon's well-known collecting abilities. For his investment of several hundred dollars, the private backer received a large number of magnificent specimens which would have cost him many times as much if purchased from mineral dealers of that period. He also had the pleasure of sharing in a great adventure.

One can hardly imagine the excitement felt by this twenty-four year old collector on his first full-scale mineral expedition. His popular account of the trip, illustrated by photographs, appeared in the 1922 issue of the Academy *Annual Report* (p. 3-12) under the title, "Mineral Collecting in the Andes". He did no more in it than describe his travels, saving the mineral-collecting experiences and scientific results of the trip for other publications, such as the Academy *Proceedings*. The ten-page account is written in an engaging style, describes the sea voyage as well as the travels through the high Andes to reach little-known mining districts, and constantly reflects the author's delight in making such a journey to new lands and among strange peoples.

The first indication of important mineralogical discoveries made on the Andean expedition was Gordon's brief note in *Science* (July, 1922, p. 50), where his finding, study and analysis of two Bolivian minerals new to science were summarized. These two closely related mineral species he described and named *vauxite* and *paravauxite* in honor of George Vaux, Jr.

A third Bolivian mineral believed to be new by Gordon, a sulfosalt, was collected on the same expedition and named *keeleyite*. Mr. Keeley must have been highly pleased to be so honored by his assistant curator. Unfortunately, some years later keeleyite was found by x-ray study to be identical with an earlier-described species, zinckenite, thus had to be discarded as a new mineral name.

Gordon now seemed to be nearing the end of that phase of his interest and work primarily devoted to description and interpretation of field occurrences of minerals. A final article of this type came out in *The American Mineralogist* (**7**, 1922, p. 189-190) on a classic locality, Corundum Hill in North Carolina. After that, and following the publication of his volume on *The Mineralogy of Pennsylvania*, he turned to a different kind of scientific mineralogy. For the next twenty years nearly all of his research efforts and published papers were to be concentrated upon morphological study of mineral crystals, their description, measurement, drawing and identification. What inspired the change, surely, must have been the abundance of beautifully crystallized, rare and new species brought back from the Andes; that, plus an irresistible desire to study, measure under the microscope, and portray accurately and artistically upon paper their fascinating geometric crystal shapes.

FIRST CRYSTALLOGRAPHIC PAPERS

Gordon's first published crystallographic papers were not on the newly-acquired South American minerals, but on certain of those from the zinc deposits of Franklin, New Jersey. These Franklin minerals, which he had been collecting for some years during short trips to that famous locality, offered a special incentive to crystallographic study because of their tendency to form clean-cut microcrystals in small cavities of the ore-bearing rock. His description of "keeleyite" appeared in the Academy *Proceedings* of 1922 (**74**, p. 101-103). His paper, "Crystallographic notes on glaucochroite, willemite, celestite, and calcite" followed in the same issue (p. 105-112). Some excerpts from the latter publication, including the crystal drawings, are reprinted here because of their interest as early examples of his crystallographic studies. First, however, a correction should be noted with respect to Gordon's misidentification of the rare species, glaucochroite. He thought he had found it in unusually well-formed crystals, but it turned out to be the structurally-related, far commoner silicate, tephroite. The misidentification was pointed out in a letter to Gordon from the noted mineralogist, W. T. Schaller, on the basis of determination of the optical properties. Gordon's error was due to too much dependence on crystallographic measurements alone. He was becoming adept at rapid measurement of interfacial angles on tiny crystals, followed by calculation of axial ratios, to yield a short-cut means of mineral identification. Additional data, such as accurate determination of the optical properties, especially the refractive indices, were also needed for pinning down a rare non-opaque species with certainty. It should be remembered that techniques for rapid identification of minerals by x-ray diffraction had not yet been developed. Gordon took the mistake too much to heart, perhaps because he had sent reprints of his paper to a number of mineralogists in addition to Dr. Schaller. He proceeded to correct his error on glaucochroite in a note published in the February 1923 issue of *The American Mineralogist*.

Crystallographic Notes on Glaucochroite, Willemite, Celestite, and Calcite from Franklin, New Jersey

On a recent trip to the famous zinc mines at Franklin, N. J. the writer secured a series of specimens for the Vaux Collections which included the following minerals: calcite, celestite, galena, glaucochroite, hardystonite, wille-

mite, and zincite. Crystallographic measurements of the glaucochroite, willemite and calcite showed the presence of new forms; while the celestite represents a new occurrence of this mineral.

GLAUCOCHROITE

Glaucochroite was described by Penfield and Warren (Am. J. Sci. 8, 343-346, 1899) in 1899. The original specimens consisted of small prismatic crystals in nasonite. As no terminal planes were found, the twin-plane (011) was used in calculating the axial ratios. Subsequently Palache (Am. J. Sci. 29, 181-182, 1910) described briefly the results of measurements on two terminated crystals.

The specimens which formed the basis of the present study are far superior to those which have been heretofore found. Several large masses of franklinite-willemite ore contain fractures lined with small glaucochroite crystals associated with greenish-white crystals of willemite. The glaucochroite is readily identified by the remarkable fact that the mineral is bluish-green by daylight, but pink by artificial light. The largest crystals measure 2 mm. in length. Four crystals were measured the results being given in Table I. Six forms are new: r (130), z (270), d (101), k (011), l (131), and y (122). The relative development of the faces and their position are shown in figures 1 to 4.

WILLEMITE

One of the specimens obtained consisted essentially of franklinite and willemite on which was a cavity containing a number of brilliant, greenish, transparent, highly modified crystals of willemite associated with glaucochroite. A single crystal, 1/2 x 1 mm. was measured. The general habit of the crystals is indicated in figure 5. Several of the forms are new: $v\ (4\bar{2}\bar{2}3)$, $K\ (31\bar{4}2)$; $(9.1.\overline{10}.0)$, *and* $(10.\bar{1}.\bar{9}.0)$; *v and K were present as prominent faces, although v occurred but once on the crystal measured; the other two forms were represented by line faces in the prism zone.*

CELESTITE

While appreciating the greatness of Franklin, N. J., as a mineral locality, and the extreme variety of minerals that have been discovered there, it was still with considerable surprise to the writer that the material described here proved to be celestite, $SrSO_4$.

The specimen consists of part of a vein of pink rhodochrosite on a mass of calcite through which is disseminated much franklinite. The rhodochrosite, which is quite crystalline, is filled with solution cavities which are coated with druses of brilliant colorless crystals, rarely over 1 mm. in size. The mineral was found to be biaxial, positive; $\alpha = 1.621$, $\beta = 1.625$, $\gamma = 1.631$; *all* $\pm .003$. *A single crystal was measured with the results given in Table III. The habit of the crystal measured is shown in fig. 6; other crystals were tabular parallel to c (001).*

CALCITE

The calcite occurs as a cavity lining on a calcite-zincite mixture which forms laminations in an ore consisting of franklinite and reddish serpentine. The crystals are rarely

***Fig. 2.* Collectors (about 1925) including Frankenfield (left), Knabe (third), Gordon (fourth), Wherry (fifth), Baldwin (sixth).**

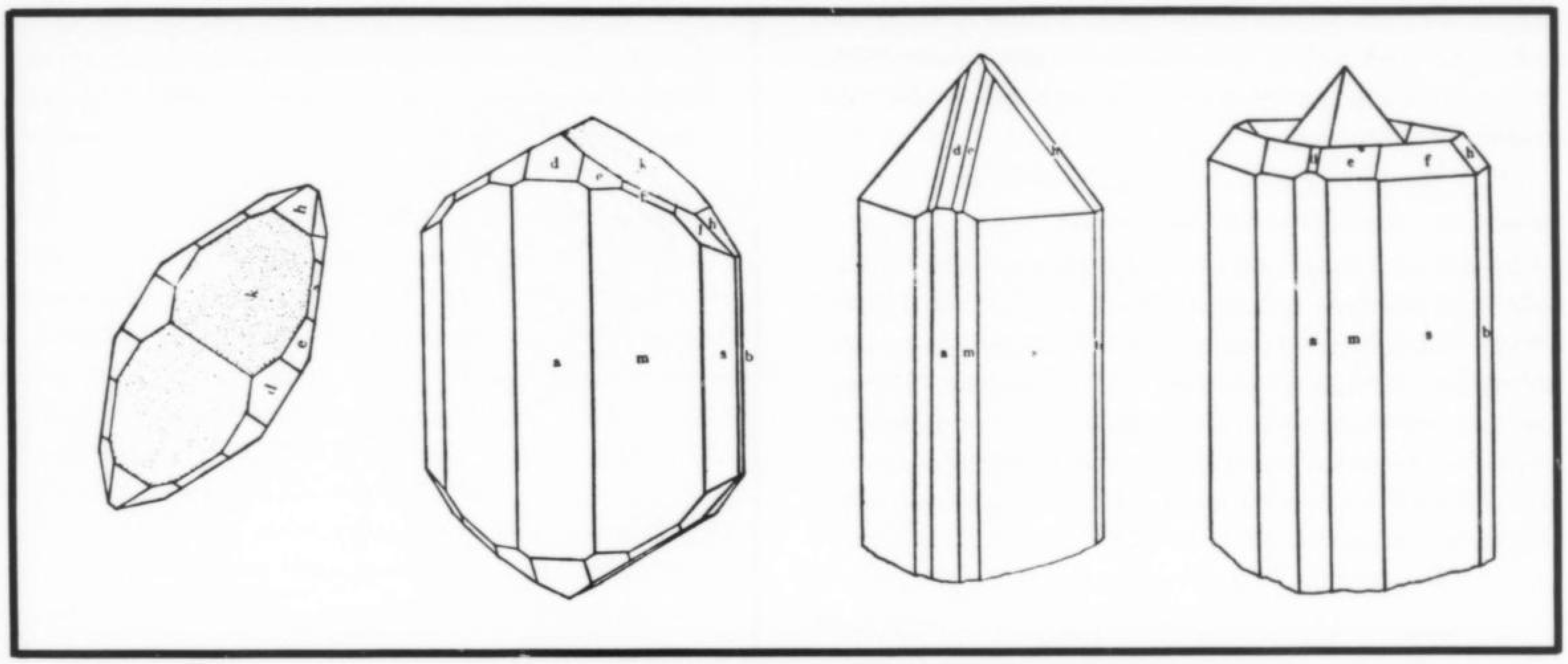

Fig. 3. **Tephroite, Franklin, N. J. (originally incorrectly labelled *glaucochroite*) (Gordon's Figs. 1-3).**

over 1 x 3 mm. in size; but are colorless and give good reflections. The habit of the crystals is indicated in figure 7. Two forms are new: (3.0.$\bar{3}$.16) and ($\bar{3}$.0.3.16).

Another crystallographic paper on Franklin minerals, "Crystallographic notes on hodgkinsonite, datolite, and calciothomsonite, from Franklin, New Jersey," came out in the Academy *Proceedings* of 1923 (**75,** p. 271-274). In the same issue there is the first complete description (p. 261-270) of the two new phosphates, vauxite and paravauxite, which he collected at the tin mines of Llallagua, Bolivia. Included in the paper are Gordon's crystallographic data on the two species, replete with angle tables and drawings, also his data on physical, optical and chemical properties. The chemical analyses were made by J. E. Whitfield, chemist for the Philadelphia assayers, Booth, Garrett and Blair. Whitfield's two analyses proved to be insufficiently accurate and chemically incomplete, thus had to be determined again later with greater precision by three analysts: E. V. Shannon, mineral chemist and curator at the U. S. National Museum; H. J. Hallowell; and Gordon himself. The later analyses, together with the other descriptive data on vauxite and paravauxite, were included in Gordon's lengthy eighty-page report on "The mineralogy of the tin mines of Cerro de Llallagua, Bolivia," published in the Academy *Proceedings* of 1944 (**96,** p. 279-359).

Although Gordon at times relied too little on the determination of optical properties of minerals in their identification, he had become expert at this advanced mineralogical technique. His competency is illustrated in a paper, "Optical notes on thomsonite," printed in *The American Mineralogist* (**8,** 1923, p. 125-127). This useful paper clarified the optical data and determinative optical procedures pertaining to identification of the four similar-appearing, fibrous zeolites, natrolite, thomsonite, mesolite and scolecite. It was based on his own optical study of these minerals in specimens from a number of localities, and probably stemmed from his crystallographic investigation of thomsonite from Franklin. The data in this paper proved helpful in cases where these fibrous zeolites are confused with one another and have been insufficiently verified.

In the 1924 issue of the Academy *Proceedings* (**76,** p. 335-338) there was another crystallographic paper, "Crystallo-

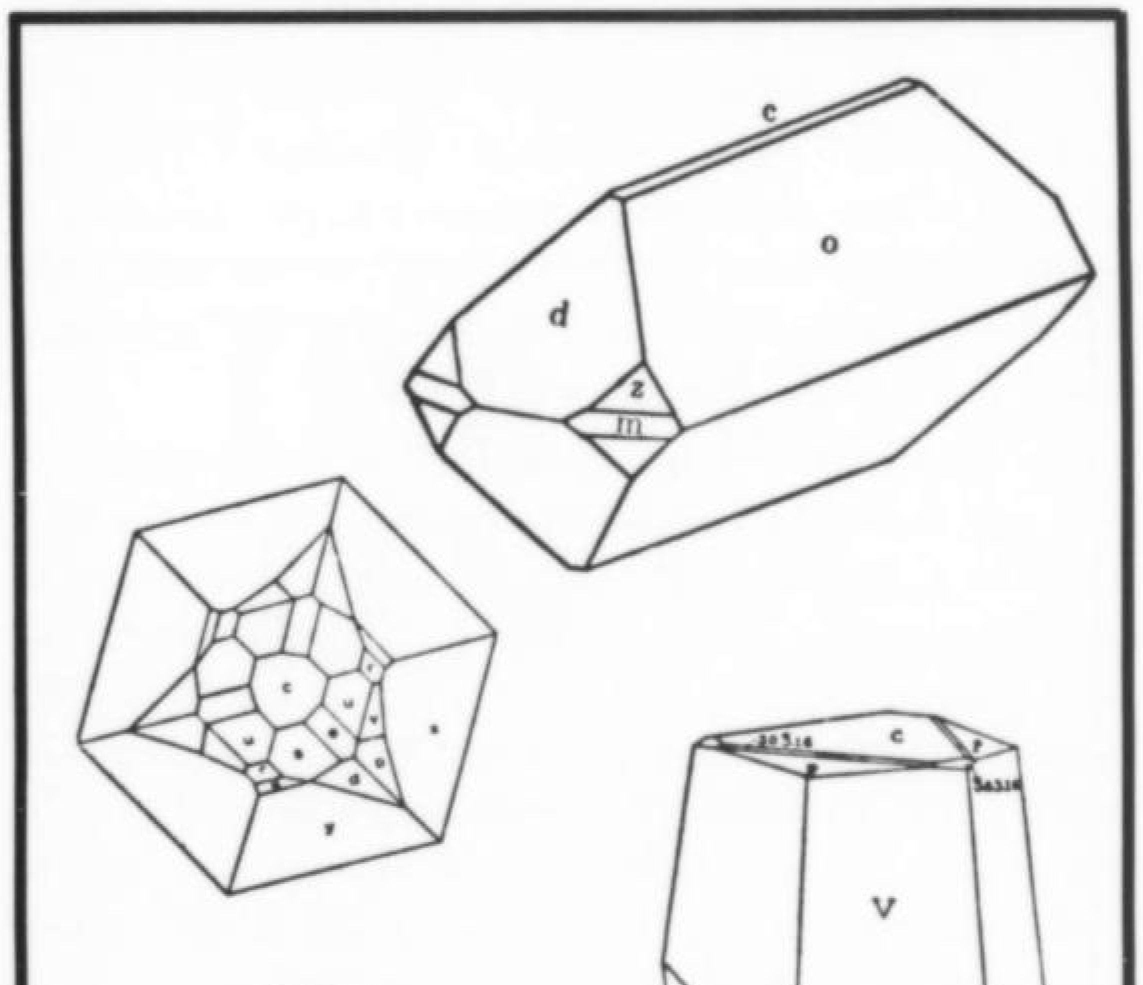

Fig. 4. **Willemite, celestite, calcite, Franklin, N. J. (Gordon's Fig. 5-7).**

graphic notes on six minerals from Peru and Bolivia," on several minerals collected during the Andean expedition. Parts of this are reprinted for their crystallographic and locality interest.

Crystallographic Notes on Six Minerals from Peru and Bolivia

On the Academy-Vaux Andean Expedition of 1921, striking crystallized specimens were obtained of the following minerals; tetrahedrite and bournonite, Peru; and valentinite, cassiterite, vivianite, and wolframite, Bolivia. Crystallographic descriptions of these are given below. A new form was found on vivianite from Llallagua, and two new forms on wolframite from Tasna; the latter as well, showed an unusual habit.

TETRAHEDRITE, MOROCOCHA, PERU

The mines of Morococha are situated in the Department of Junin, on a spur of the Central Railway of Peru, at an altitude of 14,800 feet, about 170 km. from Lima. The ore veins consist largely of quartz, pyrite, tetrahedrite, and enargite, and cut a porphyry near its contact with a series of Mesozoic limestones and quartzites.

Tetrahedrite crystals are of common occurrence in vugs of the massive mineral. The writer, on his visit in 1921, was fortunate enough to open up a vug filled with crystals of extraordinary splendor.

The vug was pipelike in form, and about two feet in length. Lining it were iron-black, splendent crystals up to 2 cm. across, associated with some enargite and chalcopyrite. Those placed on exhibition in the museum soon lost their brilliant luster, and became dull and tarnished. Specimens kept in a drawer fared better.

The crystals have a specific gravity of 4.64 (weighed in benzol), and are perhaps intermediate in composition between tetrahedrite and tennantite. Measurement on the goniometer showed them to be a combination of the following forms: o (111), ó (1$\bar{1}\bar{1}$), d (110), and n (211). The faces of all were smooth and brilliant, excepting o (111), which showed the growth figures indicated in Figure 1. There was a marked tendency to a tabular grouping of crystals parallel to o (111), parallel to which the crystals were frequently flattened.

BOURNONITE, CASAPALCA, PERU

Bournonite has been found at a number of localities in Peru, but has seldom been described from any of them. Particularly attractive specimens occur at the silver mines of Casapalca, on the Central Railroad of Peru, about 140 kilometers from Lima. The ore veins occur in andesite, and consist principally of quartz, pyrite, sphalerite, and some calcite and siderite.

The bournonite occurs in vugs as lustrous, steel-gray, crystals up to a centimeter long, associated with twinned dodecahedra and octahedra of sphalerite (up to 4 cm. in diameter), on both of which are many radial aggregates of small quartz crystals. The crystals of bournonite are usually simple, although some twins were noted. The following forms were identified by measurement: a (100), b (010), c (001), m (110), o (101), n (011), and u (112). Figure 2 shows the common habit. The smaller crystals on the sphalerite of one of the specimens simulated an isometric or tetragonal crystal, as shown in Figure 3.

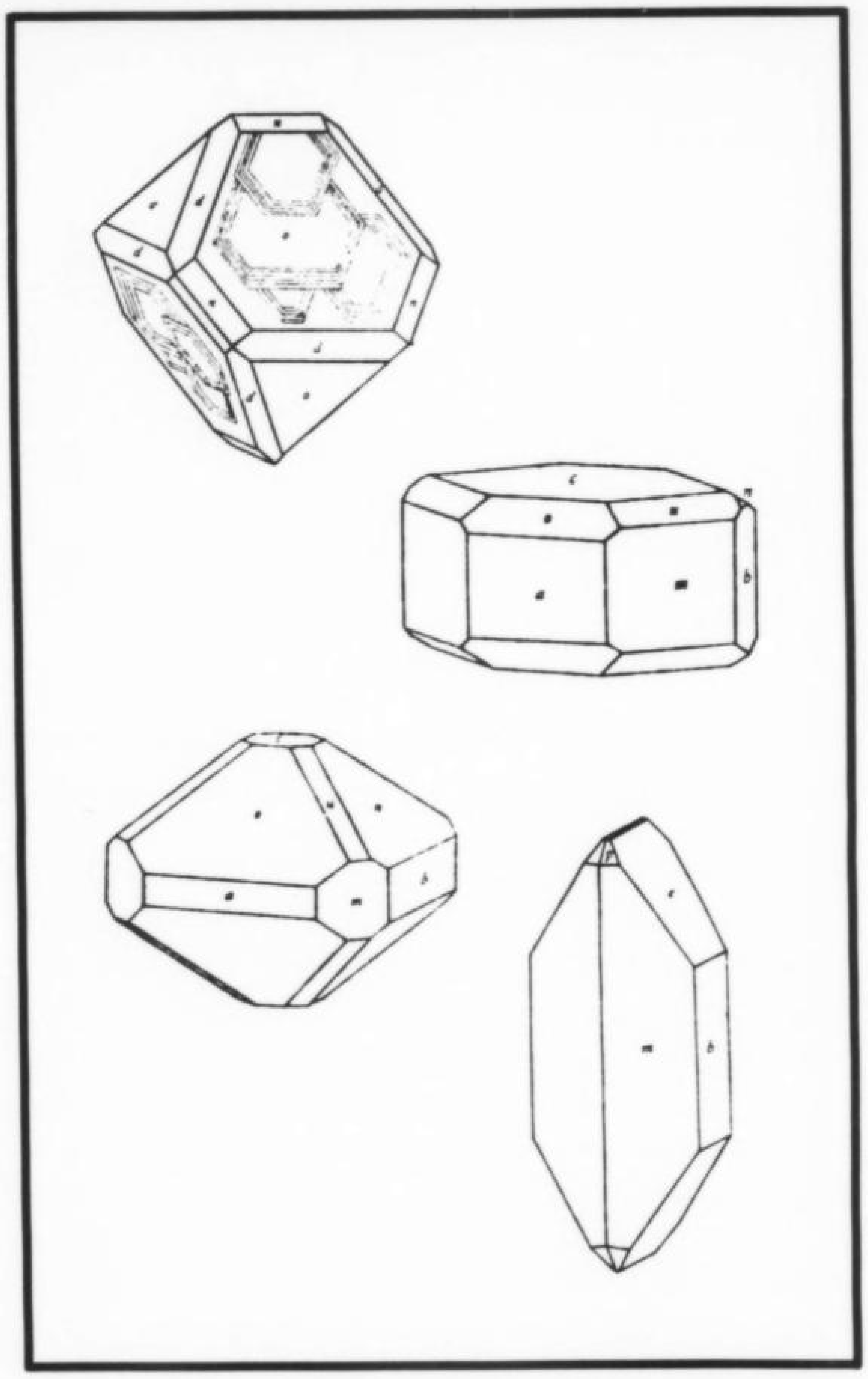

Fig. 5. **Tetrahedrite, Morococha, Peru (Gordon's Fig. 1); bournonite, Casapalca, Peru (Gordon's Figs. 2-3); valentinite, Huanuni, Bolivia (Gordon's Fig. 4).**

VALENTINITE, HUANUNI, BOLIVIA

Valentinite from Tatasi, Bolivia, was described by Spencer (Min. Mag. 14, 328, 1907). It occurs also at the Porvenir mine, Huanuni, as veinlets in a mixture of fibrous jamesonite and granular sphalerite.

Form	*Faces measured*	*Measured*		*Calculated*	
		φ	ρ	φ	ρ
m (110)	*3*	*68 29*	*90 00*	*68 31*	*90 00*
p (111)	*3*	*68 32*	*49 49*	*68 31*	*49 45*
e (072)	*2*	*00 00*	*57 18*	*00 00*	*56 38*

The valentinite forms druses of crystals, not infrequently in radiating aggregates, with individuals measuring up to 2 x 1 x 1 mm. A single crystal was attached by the matrix to a bit of wax, and measured on the goniometer. The following forms were observed: a (100) line face; b (010), *c (001), narrow, m (110), p (111), and e (072), (Fig. 4). All gave good signals, although those of e were multiple. The results of the measurements are given above, and indicate the essential correctness of the axial ratios determined by Spencer, and Ungemach (Bull. Soc. franc. Min. 35, 539, 1912). Following Goldschmidt (Atlas der Krystallformen) the ratios of Ungemach were adopted for the calculation of the angles. The ore vein consists essentially of jamesonite, franckeite, and sphalerite, with some cylindrite, galena, pyrite, stannite, and siderite. It cuts through slates, is about 1 meter wide, and strikes approximately N. 20° E. A similar vein occurs at the Maria Francisca mine, nearby. The jamesonite is typically fibrous; for about a decimeter from the wall of the vein, the fibers are parallel to the wall. The franckeite is in small radiating plates. The sphalerite is usually massive, filling the interstices between fibers of jamesonite, and radiations of franckeite, but druses of small brilliant crystals, resembling Fig. 2 of Dana (System, 1892) are not uncommon. Twinned crystals of stannite, 1 cm. in size, rarely occur in a fibrous lead sulfantimonate, probably zinckenite.*

By 1923, at the age of twenty-six, Gordon had made himself, largely through self-learning, into a talented descriptive mineralogist. He had more than a dozen scientific papers published to his credit. He had collected, established for mineralogical identity, and fully described in the literature three new species. His crystallographic studies, only recently begun, were proving to be first-class examples of the art. But collecting in far places was still most of all in his blood, and he had been getting ready for the most exciting and rewarding expedition of any he was ever to undertake.

CALIFORNIA FEDERATION CELEBRATES THIRTY-FIFTH ANNIVERSARY

In 1974, the California Federation of Mineralogical Societies will celebrate its Thirty-fifty Anniversary. They will join with the host society, the Gem and Mineral Society of San Mateo County, California celebrating its Twenty-fifth (Silver) Anniversary as a double anniversary theme for the annual Convention and Show.

The double anniversary will be held at the spacious San Mateo County Fair and Exposition Center, San Mateo, California on June 28, 29, 30 1974. A "prestige show" featuring internationally known speakers, lecturers and craftsmen will complete a well planned program for the three day event.

Over two hundred competitive exhibits are expected, competing under the American Federation of Mineralogical Societies Uniform Rules and/or the California Federation of Mineralogical Societies Supplementary Rules.

Special Exhibits will feature some of the finest mineral collections in the world encompassing private collections of Norman Dawson, Charles Hansen, David Wilber, Pala Properties, Lidstroms, Stewarts and others. Collections from Smithsonian and other museums will be presented in special showcases situated in the grand concourse of the main show building. Some two-hundred other special exhibits in the fields of Faceting, Carving, Jewelry, Fossils, and Lapidary will also be featured. Special exhibits from foreign countries will be highlighted by a large collection of SUI SEKI stones from Japan, the private collection of Mr. Hideichi Esaki, President, Nagoya Geological Research Society, Nagoya Japan.

The annual awards banquet will be held at the beautiful new Royal Coach Hotel, near the fairgrounds, on Saturday night June 29th.

Camping facilities for over six-hundred camper or trailer vehicles are available within the fairgrounds.

Information packets are available by writing: Mr. Carl O Gustafson, Director of Public Relations, 3941 Pacific Blvd. San Mateo, CA 94403. These packets include general information and numerous brochures on places to go and see while attending the "FIESTA OF GEMS AND MINERALS".

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MINERAL NOTES

NEW MINERALS

ZAPATALITE

Zapatalite, a new mineral from Sonora, Mexico

Sidney A. Williams

Min. Mag., **38**, 541-544, 1972

Zapatalite, $Cu_3Al_4(PO_4)_3(OH)_9.4H_2O$, occurs as poorly crystalline massive material in a silicified limestone near Cerro Morita, Sonora, Mexico. It appears to have replaced both libethenite and pseudomalachite and is an uncommon mineral at the locality. It is associated with libethenite, chenevixite, beaverite, alunite and pseudomalachite. Also associated with zapatalite but less abundant are silver, cornwallite, jarosite, hematite, goethite, malachite, and chrysocolla.

The mineral has a pale blue color and a paler blue streak. The hardness is about 1½ and the mineral is gummy and sectile when scratched. There is one good basal cleavage. Zapatalite resembles chrysocolla, chalcoalumite and chalcophyllite. Zapatalite may alter to chrysocolla. The name is for Emiliano Zapata, a popular hero of the Mexican Revolution.

Tetragonal

		strongest X-ray lines
a = 15.22 Å	ϵ = 1.635	11.60 (10)
c = 11.52 Å	ω = 1.646	7.62 (10)
	uniaxial (-)	
Z = 6		5.75 (7)
	sometimes biaxial (-)	
G (calc.) = 3.017		6.82 (7)
G (meas.) = 3.016		3.04 (5)

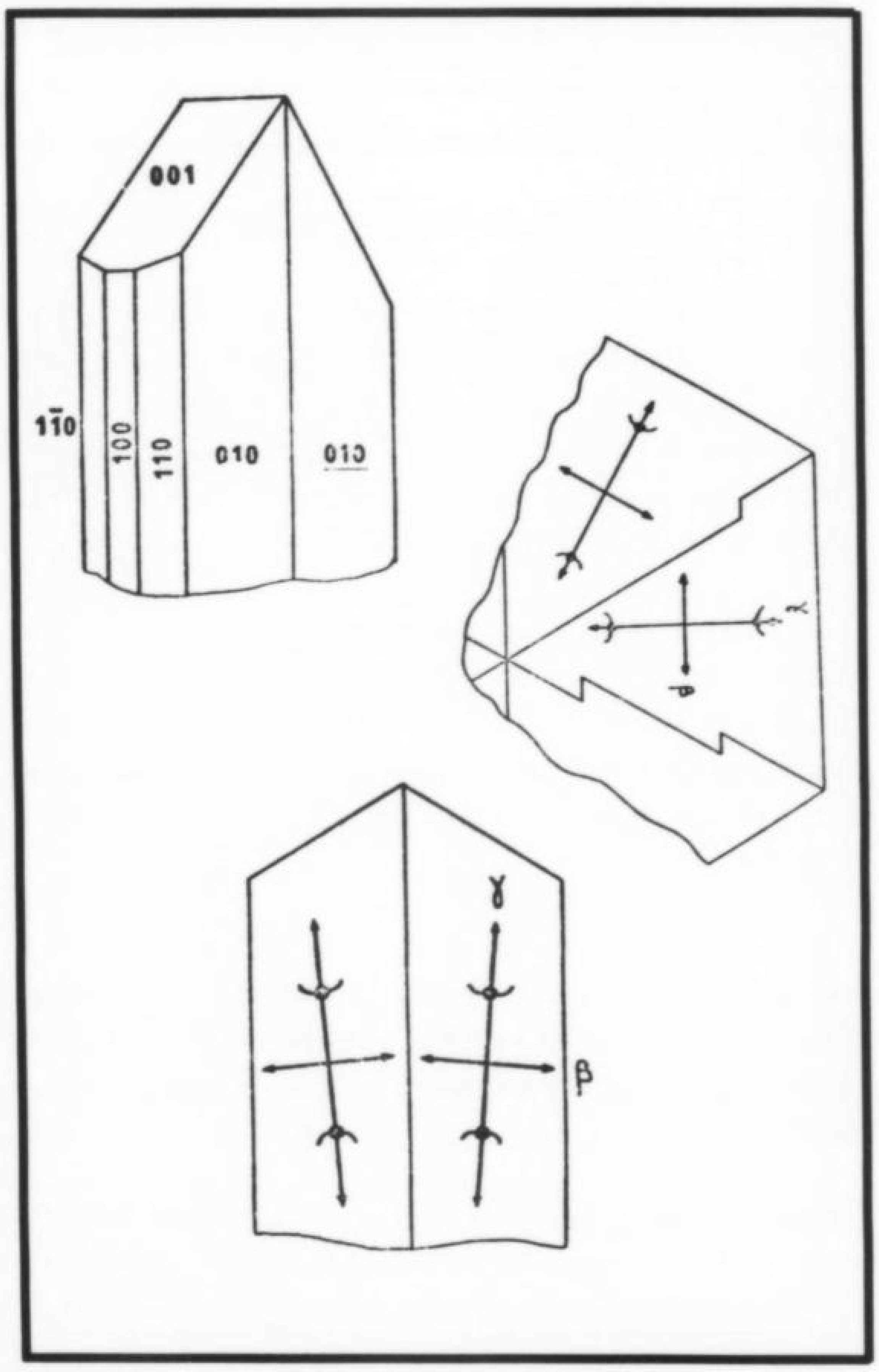
RAMEAUITE

Rameauite and agrinerite, two new hydrated complex uranyl oxides from Margnac, France

F. Cesbron, W. L. Brown, and P. Bariand

Min. Mag., **38**, 781-789, 1972

Rameauite, $K_2O.CaO.6UO_3.9H_2O$, occurs as minute (less than 1 mm) monoclinic crystalls twinned on {100}, and flattened on {010}. The crystals are usually elongated parallel to {001} and sometimes are pseudo-hexagonal. The observed forms are the pinacoids {100}, {010}, and {001}, and the prism {110}.



Figs. 1 to 3: Fig. 1 (left). **Twinned crystal of rameauite.** *Fig. 2 (bottom).* **Optical orientation of reameauite, in projection on (010).** *Fig. 3 (right).* **Twinned crystal of agrinierite, in projection on (001), showing the optical orientation.**

The color is orange and the cleavage parallel to {010} is good. Rameauite is found associated with calcite and α-uranophane on pitchblende (Uraninite) from Margnac, France. The name is for Jacques Rameau, prospector for the Commissariat à l'Energie Atomique.

Monoclinic, *C 2/c*	strongest X-ray lines	
a = 13.97 Å	7.12	vvs
b = 14.26 Å	3.495	vvs
c = 14.22 Å	3.139	vvs
β = 121°1′	3.124	vvs
Z = 4		
G (calc.) = 5.55		
G (meas.) = 5.60		

AGRINERITE

Rameauite and agrinerite, two new hydrated complex uranyl oxides from Margnac, France

F. Cesbron, W. L. Brown, and P. Bariand

Min. Mag., **38** 781-789, 1972

Agrinerite, 2 $(K_2O,CaO,SrO) \cdot 6UO_3 \cdot 8H_2O$, occurs as minute orthorhombic crystals with a pseudo-hexagonal section and they are tabular on {001}. The color is orange and the cleavage parallel to {001} is good. Agrinerite is found associated with uranophane in small cavities in "gummite" from Margnac, France. Other minerals found with agrinerite are becquerelite, billietite, schoepite, compreignacite, and rameauite which is the most abundant of these. The name is for Henri Agriner, engineer in the mineralogical laboratory of the Commissariat à l'Energie Atomique.

Orthorhombic,	*Cmmm*	strongest X-ray lines	
a = 14.04 Å		7.08	vvs
b = 24.07 Å		3.128	vvs
c = 14.13 Å		3.485	vs
Z = 8		3.153	vs
G (calc.) = 5.62			
G (meas.) = 5.7			

EMBREYITE

Embreyite, a new mineral from Berezov, Siberia

Sidney A. Williams

Min. Mag., **38**, 790-793, 1972

Embreyite, $Pb_5(CrO_4)_2(PO_4)_2 \cdot H_2O$, occurs as drusy crystalline crusts. The crusts are comprised of microscopic tabular crystals and the luster of the crystals may be dull to sparkling or resinous. The color is dull orange and the streak yellow. The hardness is 4 and there is no cleavage. The mineral does not dissolve in cold reagents but in dilute HNO_3 or $HC1$ becomes coated with $PbNO_3$ or $PbC1_2$.

Embreyite is found at Berezov, Siberia, although it should be noted that all the known specimens of embreyite were museum specimens of the other chromates with which embreyite is associated. These associated minerals are crocoite, vauquelinite, and phoenicochroite. Embreyite is later in the deposition sequence than crocoite and phoenicochroite and may replace crocoite. Cerussite and vauquelinite may replace embreyite. The name is for Peter Embrey, mineralogist of the British Museum (Natural History).

Monoclinic *P*2$_1$/*m* (probable)			
		3.167	(100)
a = 9.755 Å		2.818	(60)
b = 5.636 Å	α = 2.20	4.751	(60)
c = 7.135 Å	$\beta = \gamma$ = 2.36	1.917	(45)
β = 103°5′			
Z = 1			
G (calc.) = 6.41			
G (meas.) = 6.45			

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The Museum Record

by Paul E. Desautels

Periodically we will hear that some museum somewhere has hired a new curator to take care of the mineral collection. The hiring has usually been done quietly, seldom with advance notice that a position has even been open, seldom with available information about the conditions or salaries or duties involved in the appointment. This state of affairs probably exists as a result of several causes. Having seen it happen often enough I've come to the conclusion that the primary cause is museum poverty. Since most museums with mineral collections can't afford the luxury of a professional curator they must settle for the best they can get for the money available. This usually means a part time college professor or high school science teacher or a financially hard-pressed geology graduate student or an available part-time housewife or an active member of the local mineral society on his nights off or a retired banker who always wanted to work in a museum. Sometimes these arrangements function beautifully. Usually, the museum gets only what it pays for unless it is lucky enough to find one of the many souls who loves minerals and is willing to dedicate time to them even to the point of sacrificing his own welfare. Such people really do exist and fortunate is the collection that has one of them.

Let's suppose a museum does have the funds to hire a professional full time curator and starts looking for one. Where are these people to be found and how do you know one when you see one? If you have even been involved in such a search, and know that you may never get such a choice again once it's made, the experience has probably been traumatic. Part of the problem is that museum directors generally don't know what they want a mineral curator to do nor what minerals are all about anyway. This is to be expected because museum directors rarely are physical scientists, but are usually trained administrators, educators or biologists of one sort or another. They shouldn't be expected to understand or have a feeling for the special essence of mineralogy which is, after all, a physical science. Then too, the directorate usually has mixed emotions about whether it should hire a scientist, an educator and public relations curator, or a collection builder. Hopefully all three will come in one package but, if they don't, which is to take precedence? Three of the larger museums in the United States are trying to resolve this problem for themselves at the moment in three different ways. I have a feeling that, ultimately, what a museum does with its mineral collection depends on who is hired to do the work. The rest of the problem is finding a qualified curator of any kind.

Recently it has been my pleasure to be serving on a committee for a large museum. The committee has been charged to outline a reasonable program in mineralogy, draw up a list of necessary basic laboratory equipment, suggest a staffing plan, and supply names of candidates for hiring purposes. In the process, the committee members have dredged up every name of curatorial caliber they could recall in the country and overseas. There are drawbacks to this system. In the first place, the committee members do not know personally all the eminently qualified people that must exist. Nor could they possibly know who is available or interested. Nor could they really know all the qualifications of someone who might not have had the opportunity to display them in a working curatorship. Nor could they know which currently employed curators are looking for something better. We have been surprised how relatively few names we have had to work with.

What we need is some sort of employment referral bureau for mineral collectors. At the risk of arousing all sorts of criticisms and problems and pressures, I would like to make a proposal. I would like to volunteer to maintain a dossier, at the Smithsonian, for every person who is interested in such employment both here and abroad. We are frequently asked for suggestions of names for mineral curators of every type from advanced scientific research on down to the lowest levels of museum support staff. Such a dossier would be kept in absolute confidence. If a museum asks for names for some position they would not be given directly but the candidates would be notified to make the contact. I think such a system could work well and I'll begin by asking anyone interested to send in a statement of interest, qualifications, etc., so that I can tell whether you are the one who is a natural for some opening. Even if you are not interested you can tell your local museum director that he can write or call me if he needs help in his search.

Speaking of museum employment, I am happy to announce that Daniel Appleman has been hired by the National Museum of Natural History to fill the vacancy left by the recent departure of Joel Arem. Dr. Appleman comes to us from the U.S. Geological Survey by way of a sabbatical leave at Princeton University where he has been teaching mineralogy for a semester. Obviously, since Dr. Appleman has already created such a fine record and reputation for himself in x-ray crystallography, his duties and pursuits in our Division of Mineralogy will be much the same as at the Geological Survey. We are delighted, of course, to be looking forward to his experience and skill in his field, much of which we hope will rub off on the rest of us. Also, those of us who know Dan look forward to having a very personable and stimulating new colleague to add to our "one big family".

Although Dan started his academic preparation in Santa Monica, California, his PhD was completed at Johns Hopkins University in Baltimore in 1956. He is a Fellow of the Mineralogical Society of America and has been Associate Editor of *The American Mineralogist* for a time. Dan is a member of the Mineralogical Society of Great Britain, Geological Society of America, American Crystallographic Association, American Association for the Advancement of Science, Mineralogical Association of Canada, Sigma Xi, American Geophysical Union, and the Geological Society of Washington. He is a member of the Mineralogy Committee of the Joint Committee on Powder Difraction Standards. Also, he serves on the Committee on Automatic Data Processing of the International Mineralogical Association Commission on Abstracts. Currently, he is holding posts as Councillor of the Mineralogical Society of America and Chairman of the Society's Committee on Management. A current listing of his professional output includes 52 titles to his credit, several in cooperation with some of the best known names in professional mineralogy today. To top it all off, Dan has a deep appreciation for mineral specimens and collections.

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To the Editor

ON DEFINING MINERALS

Dear Sir:

I am not sure if Mr. Wendell Wilson's letter in your last issue is serious or not. If not, I congratulate him on his sense of humour. However, I suspect that his comments are serious so I would like to say a few things about his proposals.

First, let me point out a serious flaw in Mr. Wilson's preamble to his definitions. I get the impression that he believes that mineralogy started with the publication of Dana's *System of Mineralogy* "... 136 years..." ago. Such a provincial attitude excludes a lot of important work done prior to that publication date.

In his definition of a mineral, Mr. Wilson does not include any reference to the words "natural" or "Nature". Exclusion of a natural origin would automatically raise most of the chemicals in a chemical catalogue to the status of minerals. This is not the only flaw in the definition.

Mr. Wilson's expansion of the definition of mineraloid raises many interesting points. If a mineraloid is to be "any substance of interest to mineralogists, for whatever reason, but which fails to meet one or more of the criteria for a *mineral*..." then a number of hitherto unknown mineraloids emerge. By Mr. Wilson's definition, my wife is a mineraloid! I a mineralogist, am interested in her and she does not meet the requirements of a mineral. (When I called my wife mineraloid after reading Mr. Wilson's definitions, I received a rather strange look). Other substances which qualify for mineraloid status, to mention just a few, are alcohol, tobacco, food, and money.

Yes, I am being facetious and that is just the point. Mineralogists know what minerals are without having a definition. At the IGC-IMA Congress in Montreal in 1972, a panel discussion was held on just this subject — What is a mineral? The panel consisted of some of the world's top mineralogists — Dr. Fleischer (USA), Dr. Hey (UK), Prof. Dr. Strunz (Germany) Prof. Permingeat (France), Dr. Frondel (USA), Prof. Gottardi (Italy) and Prof. Chukov (USSR). After an hour and a half, it was quite clear that a rigid definition was not forthcoming. The closest they came to an acceptable definition was Dr. Frondel's statement that "A mineral is a thing".

Finally, I would suggest that Mr. Wilson lean back, have a glass of his favorite mineraloid, and relax.

J. A. Mandarino,
Curator of Mineralogy,
Royal Ontario Museum.

Dear Sir:

I have only two comments on Dr. Mandarino's letter (above):

(1)"inorganically produced" is a better term than "naturally occurring" because it excludes all organic help in mineral formation (and humans are organisms).

(2) does Dr. Mandarino's wife know that she was not intentionally man-made?

Wendell Wilson
Bloomington, Minnesota

Dear Sir:

I was taken somewhat by surprise on reading Mr. Wilson's letter ("Minerals and Mineraloids," 4:5, p. 243). I suppose my surprise is due in part to the relative isolation of some of us who

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are academic mineralogists from the world of collectors, museum curators, and the mineral industry. At any rate I had never considered the point that we might be "developing a science based on PRETTINESS," although I suspect that the visual attractiveness of minerals had a great deal to do with the early development of the study of minerals and that mineral collecting as a hobby (not science) is to some extent based on prettiness.

Over a period of years that I have been teaching college level mineralogy I have used four different books as the required text. Each of these has a slightly different definition of a mineral. Each year during the first class meeting of my course I give the students a definition of a mineral which I have developed over the years to my own satisfaction but which is not precisely the textbook definition. The definition I give is: a mineral – a naturally occurring, inorganically formed, chemical element or compound, usually with long-range internal order, whose chemical composition may vary within fixed limits.

This corresponds to some extent with Mr. Wilson's proposed definition. One major difference concerns the crystalline aspect of a mineral. Although most minerals have long-range order (diffract x-rays), I see no reason to exclude opal, for example. There is nothing different about the formation or occurrence of opal to distinguish it from other minerals – only the fact that it does not diffract x-rays. Thus I favor the "usually with long-range order" clause.

I am still bothered however, even in my own definition, with the "inorganically formed" modifier. First, because we sometimes may not know the exact process by which a mineral was formed and, second, because I see no reason to exclude from the realm of minerals say, pyrite occurring in black shales which was formed through the action of sulfide-fixing bacteria. So, I continue to give my students the above definition with a few disclaimers thrown in.

The jist of what I am getting to of course, is that often even in the sciences a rigid definition is sometimes not desirable or possible. I would thus have to reject the tenor of rigidity and precision voiced by Mr. Wilson. I would also have to reject his definition (although it is very similar to mine) simply because his definition allows synthetics (flame-fused ruby

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for example) to be called minerals since he does not include the "naturally occurring" criterion.

Furthermore, I would also take issue with his statement that, "the practice of giving various substances mineral status on an individual, arbitrary basis, without applying rigid rules is unacceptably imprecise and unscientific." Surely Mr. Wilson is not referring to the practices of the Commission on New Minerals and Mineral Names of the I.M.A.

Mr. Wilson's great concern for precision and rigidity in our science requires, in my opinion, tempering with an appreciation of geologic time, human history, and man's effect on the natural environment. Can one forsee the day perhaps when those rusty cars *are* goethite and not "mineraloid goethite"? Or, should we perhaps say that minerals formed prior to the emergence of man are truly minerals but those formed since that time are not? How far has man's influence on natural processes extended? It seems to me that man has become a significant factor in the geochemical cycle, concentrating some elements here and dispersing other elements there,... and that this period in the earth's history will reflect that fact for a very long time.

C. Alan Berkebile
Associate Professor of Geology
Southampton College
Long Island University
Southampton, New York

Dear Sir:

I would like to comment on Wendell Wilson's letter concerning the definition of the noun *mineral*. This problem has been of concern to many eminent mineralogists; it has defied exact solution because a rather small number of naturally occurring substances accepted as minerals simply do not have all the properties which characterize the vast majority of minerals. Mike Fleischer, who understands this problem perhaps better than anyone else, has stated that for any characteristic one can put into such a definition, he can name a commonly accepted mineral which does not fit.

There are some legitimate reasons for doubt or complaint about a few substances which have been accepted as minerals, although the Committee on New Minerals and New Mineral Names of the International Mineralogical Association has gone a long way toward eliminating abuses in recently described species. Formost among my own personal doubts concerns the matter of giving mineral names to substances, the derivation of which have been helped by the hand of man. Probably in this matter, no precise line can be drawn, and one can only hope that common sense will prevail as each case is judged.

It is unfortunate that Wilson puts so much emphasis on "prettiness". In the great majority of current new mineral descriptions, the question of prettiness never entered the author's head, mainly because most new minerals are either anhedral, nondescript, or microscopic. It is questionable whether prettiness has ever been a factor. *Asphalt* is not considered a

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mineral not because it lacks beauty, but because it has a highly variable composition and is amorphous. It might better be characterized as a rock, much like obsidian. Sulphur is a mineral for many obvious reasons; the fact that some deposits of it are biogenic should not mitigate against it any more than against biogenic deposits of marine limestone (i.e. calcite) or iron deposits (i.e. hematite) derived from biogenically deposited iron hydroxides and silicates.

Most minerals are solid, monophase, crystalline, inorganically derived, and have compositions which vary within narrow limits. As long as we use the term "most", we are on safe ground. Substances which do not fit one of these five criteria should be judged with more than normal care, but not necessarily excluded. It would be a gross mistake to exclude substances like water (our most abundant mineral) mercury, allophane, chrysocolla, whewellite, or samarskite.

A substance which is never found except under recent biologic conditions should be excluded from the list of minerals, but I can see no harm in referring to calcium carbonate in an oyster shell as calcite, or iron hydroxide derived from the weathering of steel objects as goethite. These terms have a more specific meaning than "calcium carbonate" (which could be goethite, akaganeite, or lepidocrocite). Some might prefer terms like α, β or γ calcium carbonate, but the average person would have to look up these terms to identify which refers to which structural type, and reference books on mineral names are more easily found than those containing such purely chemical terms.

I find the idea of lumping everything that does not correspond to the common definition into the category of "mineraloid" unnecessary, confusing, and trivial. Why, in the first place is it necessary to have a rigid definition of "mineral"? Minerals are substances which are accepted as such by general agreement, and we all know pretty well what they are. The exceptions to the normal definition are so few that they need not concern the majority of us; current definitions are adequate, as long as the terms "most" or "some" are used.

To insist on a rigid definition can only create problems. It is a well known axiom that every rule must have an exception, and mineralogy is no exception to this philosophy.

Richard V. Gaines
Pottstown, Pennsylvania

Dear Sir:

Mr. Wendell Wilson is quite correct in stating that "The lack of an accepted definition of *mineral* is an embarassment to us all." I have long been in agreement with the proposal to exclude liquids and substances without three dimensional, regular, atomic arrangements from the category of minerals. Wilson's proposed definition is not, however, entirely consistent internally as I understand the meanings

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of two of the words used. His proposed definition includes the phrase "compound whose composition varies only within narrow limits." Unless I am mistaken, the word compound to most chemists means a substance of fixed composition (see for example, Linus Pauling, *General Chemistry*, second edition, p. 77, W. H. Freeman and Company, San Francisco, 1953). Substances with three-dimensional, regular, atomic arrangements, the compositions of which vary between limits are, I believe, usually considered solid solutions. Moreover, in the cases of gold, electrum, and silver, which surely belong in the category of true minerals, the variation of composition is between wide limits, all the way from pure gold to pure silver. The subsequent question how far the so-called inorganic rule should be extended is one that I would find difficult to answer. It should really be something for the Commission on New Minerals and Mineral Names of the International Mineralogical Association to consider thoroughly.

George Tunell
Professor Emeritus
Recalled To Active Duty
Past President of the Mineralogical Society of America
Past President of the Geochemical Society
Univeristy of California — Santa Barbara, California

ON EDUCATIONAL EXHIBITS

Dear Sir:

I have one question about the article in Vol. 4, number 5, on FM Educational Mineral Exhibit Competition. When in 1972 did the American Federation of Mineralogical Societies accept Bob Jones' Rules and Guidelines on Educational Exhibits? I attended most of the Uniform Rules Meeting in Anaheim in 1972, but did absent myself occasionally to wash my hands. While I understood Bob Jones had requested time on the floor to present his proposal, he did not appear while I was in the meeting. I checked with others who did not recall his appearance or that the AFMS had adopted his proposal *in toto*. Bob is very articulate and forceful in his talks and writings which are excellent.

David E. Jensen
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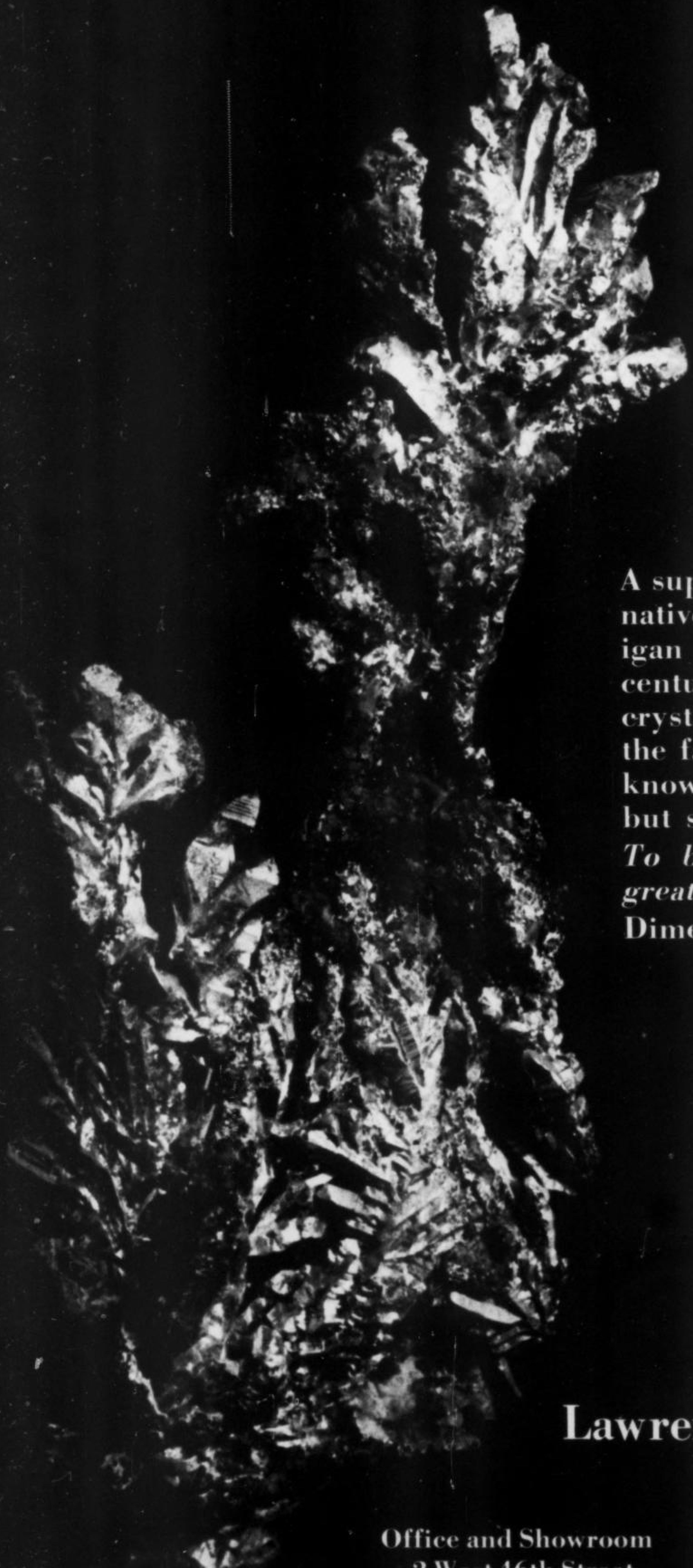

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