the Mineralogical Record

Volume 3/ Number 6
November/ December 1972

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the Mineralogical Record

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feature articles

departments

WULFENITE on mottramite from the 79 mine near Hayden, Arizona. The large crystal measures about 2 cm on its longest edge. The specimen is in the collection of Wayne R. Thomson. Oil painting by Wendell E. Wilson.

Editorial

SNOBBISH, TOO TECHNICAL AND PARTIAL?

We are, as most of our readers understand, struggling to gain acceptance of the *MR* by a large enough number of mineral enthusiasts to assure its financial stability. Since this happy state has not yet been realized we feel that we can be forgiven for taking editorial space (occasionally) to explain why we feel the *Record* deserves the support of a larger segment of mineral hobbyists. A recent letter to me enumerated three areas of discontent over the magazine's content, and the writer stated that he was speaking for "a number of mineral collectors" in his part of the country. The complaints are —

1. The magazine exudes an air of snobbishness, it is dominated by an "in" group, and thus has alienated many subscribers.
2. Certain "too technical" articles are out of place in the *Record* and would be better placed in other journals.
3. A few mineral shows are overpublicized in columns, others are neglected.

The fact that any *group* of collectors feels that these problems exist and that they diminish the appeal of the *MR* for them is a matter of great concern to me as it indicates that we are failing to communicate our basic tenets as we should. Therefore I would like to answer these points in the hope that I can successfully defend what we have done and are doing.

The first criticism is particularly disturbing. The primary objective of the *MR* has been (and still is) to bring together the people who enjoy reading about minerals, to produce an atmosphere of intimacy, especially between the physically isolated collector and the formerly academically isolated professional. All readers are invited to participate. This they may do in a number of ways, including submitting letters for publication, notes for inclusion in columns, news notes, questions for which we try to supply answers and, of course, articles.

It is true that references to specific collectors often appear in the columns. This is mainly because these collectors are active within the hobby, but also because they enjoy the practice. It was thought that such familiarity would destroy the imaginary barriers that have kept apart people operating on various levels of activity as minerals collectors. This is not, I maintain, snobbishness, just as it is not snobishness when America's newspapers carry so many references to President Nixon. We are simply reporting on the people who are participating, and anyone may break into this category. If you want to submit written material, all we ask is that your letters, notes, questions, articles, etc. be accurate, moderately well-written and of interest to collectors in general. Since we do not have staff reporters, we must depend on volunteer reporters to relate to us the activities of distant collectors.

Do you want to make a contribution? Do you want to feel involved? Do you want to see your name in print? If the answer is yes then all you have to do is act, and this is possible BECAUSE of the *Record's* policies, not IN SPITE OF THEM.

As for the "in" group, I suppose I must confess — yes, the magazine is dominated by an "in" group. Our "in" group is composed of talented, energetic, dedicated people who work hard and devote much time to help make it possible for me to produce the *Mineralogical Record.* I utilize my "in" group over and over again and they are more than deserving of any mention they may get (most often there is none) on the pages of the *Record.* We have no paid staff working contentedly in obscurity.

So I plead "not guilty" to the charge of snobbishness.

The second criticism has been voiced before and it serves to amplify the truism "you can't please everyone." We are trying to hold the middle ground between the rockhound magazines and the technical journals. This is a lot of ground to hold. I feel readers would quickly become bored if there was nothing more challenging than a series of articles on the minerals of various mines. We are making an attempt to educate, stimulate and elevate the level of understanding of mineralogy of most collector-readers. The articles cited as too technical are not really very technical. All readers who aspire to learn the rudiments of mineralogy can also reasonably expect to advance their knowledge sufficiently to be able to understand every article in the magazine. Most of these "technical" articles have received wide acclaim. Certainly any collector having some curiosity about the chemistry of minerals would find the recent electron microprobe article, for example, both decipherable and informative. Ideally, we are offering articles that will stimulate a desire to learn more, and we are also offering the articles out of which will come the additional learning.

Allowing that some collectors will not feel the challenge to read the more difficult articles, there is still more meat left on the bones of each issue than you are apt to find in all the other mineral hobby journals in the U.S. put together.

The last criticism is as illfounded as the first two. The *MR* is a mineral magazine. With this orientation it is to be expected that the better mineral shows will be given wide exposure and little, if any, attention will be given to shows that emphasize lapidary almost to the exclusion of mineralogy. The mineral shows most prominently referenced in this magazine have earned the exposure. The sponsors of these shows purposely emphasized minerals over lapidary. The reputations of these shows are therefore well-deserved. There are perhaps only four or five really outstanding mineral shows each year. Even with this small number I cannot attend them all. I write a column (What's New in Minerals?) based necessarily on what I personally witness, but it is also extended by reports from correspondents thus providing better coverage. The opportunity for readers to supply reports about other shows is certainly very much there; if any reader feels that his favorite mineral show has been overlooked, he may write something for consideration of publication.

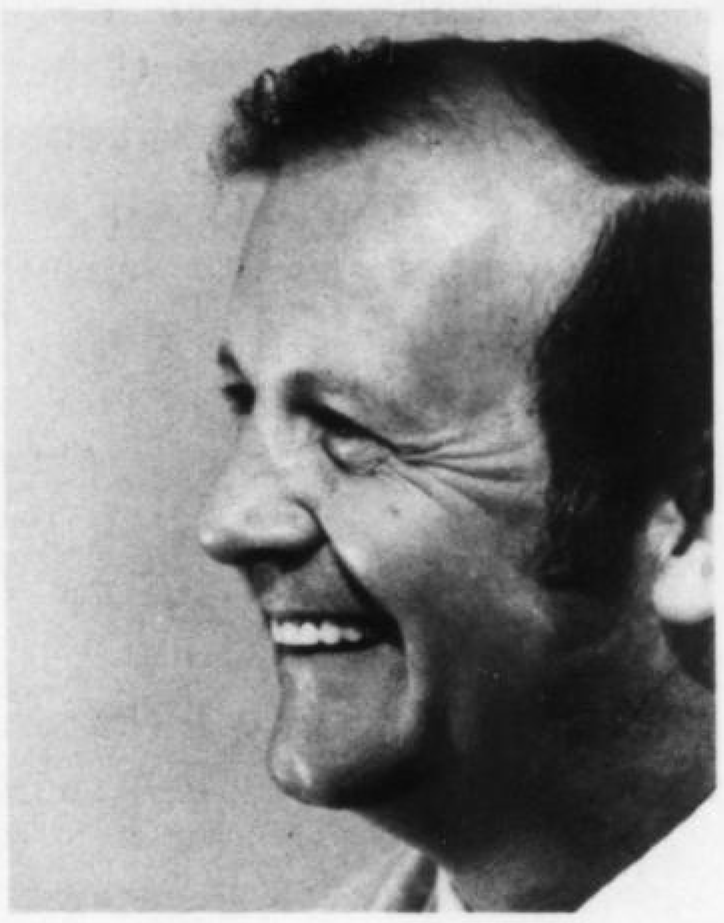
In closing I would like to make two points which speak to all three complaints. The first is that we have received far more manuscripts of the "technical" rather than the popular variety. The second is we have *rejected* more articles written by professional mineralogists than by amateur collectors.

Readers who feel much the same as the gentleman who wrote the letter prompting this editorial may forget that our circulation is composed of a large number of people looking for challenging reading. We wish to serve all of the wide spectrum of readers disenfranchised by the other mineral journals.

John S. White, Jr.

The Museum Record

by Paul E. Desautels



Recently I had occasion to pick up a copy of the magazine *Natural History* (one of the benefits of membership in the American Museum of Natural History, New York). I was looking for an article on jade by Herbert P. Whitlock. Museum buffs can tell it was an old issue (October, 1940) because Mr. Whitlock has been gone many years. By accident, I discovered that in the same issue there is an article by D. R. Barton about Dr. Whitlock himself. Admittedly, the article is a eulogy of Mr. Whitlock, so that everything he thought and did is mentioned as if it were not only right but a model for all to follow. I find myself in vigorous agreement with many of the pronouncements. Others I find of doubtful validity. Whatever the reaction, some interesting points are offered.

"... a curator is by definition a caretaker, and hence a stay-at-home." and "The Museum needs both run-arounds and stay-at-homes to fulfill its multifarious responsibilities. Most department heads are of an intergrade species dividing their time between collecting and taking care of what they collect. But if we are to accept Roy Chapman Andrews as a paragon of explorers — and I think we should — then certainly Herbert Percy Whitlock, sage of minerals and gems, is our model curator."

Leaving aside the merits — or otherwise — of Mr. Whitlock, I think the author has unwittingly put his finger on at least one of the ingredients that go into making a great museum. I agree that a "museum needs both run-arounds and stay-at-homes" and several other types as well if it is to care properly for its traditional activities. Unfortunately, many museums are too poor, too small or too limited in their objectives to have room for a diverse staff. The tendency is to hire a curator who will be all things for all people at a low salary. Then when he fails in one aspect or another of the curatorial load placed on him, he is blamed rather than those who expected too much. It is very difficult to reconcile a stay-at-home, care-for-the-collection type inside the same frail human body and brain with a run-around, get-out-in-the-field, give-speeches, raise-money type. Sometimes, when the museum is large and fat enough to allow diversity, internal politicking, budget manipulation, administrative policy, bureaucratic inertia and other similar ailments may establish a climate which tends to stifle it. Promotion policies, burgeoning research programs, purchase and exchange restrictions, the publish or perish syndrome, balancing-out of pay levels, uneven distribution of supply monies, overstandardization of procedures tending toward uniformity in every action, etc., can all militate against blessed diversity.

As I look back over the "Hall-of-Fame" of mineral curators it is not surprising to see that there were hardly two alike in their educational backgrounds, work experience and approach to their jobs as curators. Herbert Whitlock and Samuel Gordon — two of the best — had no PhD. Charles Palache and Frederick Pough both were PhDs. On the whole among all major curators of all time I would guess the PhDs win hands down. Personalities among the group, on the other hand, were and are as variable as is possible to imagine. From the autocratic egotist to the self-effacing public servant, each has operated the best way he knew how under his own set of circumstances. The only common denominator I can find in the entire pack is an all-consuming love affair with mineral specimens and a desire to assemble and maintain them in a collection. As we look at the results of their labors and listen to the tales about them it is fascinating to see how each one has played his curatorial role toward the same goal with his different talents in a different environment.

If high diversity is a fact of life among curators then perhaps, in appointing new ones, less attention should be paid to the usual standard qualification criteria and much more paid to the real common denominator. To hire a potentially great museum curator hire someone who has demonstrated a love for mineral specimens and the accumulation thereof.

To be sure that I am not misunderstood I must point out that I say *less attention* should be paid to other qualification criteria. Paying *no attention* is courting disaster. A modern model curator must have a technical background, a penchant for public and professional communication through publication or lectures and a considerable knowledge of his subject matter. After all, Mr. Whitlock did have a degree as a civil engineer, he did publish extensively, he knew his way around in the mineralogy of his time and was even elected a member of the American Academy of Sciences. In addition he fortunately was personable and communicative to the point of successfully encouraging Dr. Kunz and Mr. J. P. Morgan and others in their benefactions to the collection. This alone was sufficient to preserve his memory among fellow curators.

continued on page 275

HANSEN MINERALS

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NEW LISTINGS — M—6:

In lieu of quarterly lists we are planning full page specimen listings in future issues of the Mineralogical Record. Please contact us for specific requirements in minerals, reference material or cut gemstones. Please include a check with your order and postage consideration. Any specimen may be returned for cash or credit if you are not satisfied. Refer to list M-6. See us at the following 1973 shows: Tucson; Cincinnati (Midwest Fed.), Oklahoma City (Rocky Mtn. Fed.). Hansen's Minerals, Inc. Dr. Gary R. and Maurine Hansen. Ph. (314) 432-2882. (Showroom: 149 N. Meramec, Clayton, Missouri). Shop ph. (314) 726-2236. Mon.-Fri. 9:00-5:00, Sat. 9:00-2:00.

happy new year!

We would like to wish a very Happy New Year to our many customers and we look forward to serving you in 1973 with continued selections of fine minerals. We hope to see many of you at the TUCSON SHOW, February 9-11, 1973. We will be offering many new specimens from my recent European trip and new material from the St. Joseph Lead District.

Yours sincerely,

Gary R Hansen

Gary R. Hansen

GREEN APOPHYLLITE, Poona India. Beautiful old specimens of a deep green color. Very attractive and clean. TN size, **$10.00 - $30.00.** Miniatures, **$15.00 - $25.00.** Several large choice cabinet to museum specimens will be offered exclusively at the Tucson show.

STIBNITE, Bejutz, Romania. On my European trip I purchased a fine collection of Stibnite from a new mine near Felsobanya. Clean, bright miniatures at **$25.00 - $60.00.** Small cabinet specimens at **$45.00 - $100.00.** Approximately 15 selected choice specimens from 2 x 2 to 3 x 4 in. at **$75. - $300.00.** (The crystals on these specimens are much larger and more isolated than the usual Romanian material.)

A very clean selection of **CALCITE, QUARTZ** specimens associated with minerals such as Wolframite, Chalcopyrite, Sphalerite, etc. from Cavnic, Felsobanya and Herja, Romania and Trepca, Yugoslavia. Miniature to small cabinet specimens at **$15. - $60.00.**

Yedlin on Micromounting

In asking for a list of the minerals occurring at the Ecton copper mine, Montgomery County, Pennsylvania, you have opened a Pandora's box. From what I have heard, there are several as yet unidentified, perhaps not even described. In the minerals listed below, "Gordon" refers to The Mineralogy of Pennsylvania, *1922, by Samuel Gordon; "Montgomery" refers to* The Mineralogy of Pennsylvania — 1922-1965, *1969, by Arthur Montgomery, and "Rose" refers to* Atlas of Pennsylvania's Mineral Resources — Part 3, Metal Mines and Occurrences in Pennsylvania, *1970, by Arthur Rose.*

We read and hear reports, news items and broadcasts, and almost always accept them for what they purport to be, reasonably true and accurate. And then we are confronted with something with which we are completely familiar, and so distorted are the alleged facts, that we wonder if anything promulgated by the purveyors of public information is at all true. In the last couple of years we were subjected to at least two such. Since they have a mineralogical bearing we thought you'd be interested.

Item 1: A few winters ago, during the construction of a large building, a thaw and sudden freeze necessitated safety measures on recently paved, and now icy areas. To the building materials supplier we went for some quantity of rock salt. "We no longer carry rock salt," was the vendor's advice. "We have a new product for the same purpose, a great improvement over the old stuff. Works faster and better. Costs a few cents more per pound, but it's worth it. A new material. Called HALITE"!!!

Item 2: As recently as the Detroit show this past October, a radio advertiser beleagured all who would listen with a paean for a household cleansing powder which "hasn't scratched yet!" For years the manufacturer of this product operated the Ruggles quarry, at Grafton, New Hampshire, to the delight of mineral collectors everywhere, who garnered the residuals, especially the radioactive ones. The sales pundit, reading material formulated at some big-name ad agency, expounded as follows: "Doesn't ever scratch glass or porcelain. There's no harsh quartz in it at all. It is made from a new product researched and developed by the manufacturer. It is a new thing, called FELDSPAR ..."

We thought you'd like to know.

Getting to our request for information about the minerals of the Ecton mine in the July-August (Vol. III, No. 4) issue of the *Mineralogical Record* we've received a number of replies, and we thank all of you who responded. Davis M. Lapham, Chief Mineralogist of the Pennsylvania Geological Survey, Harrisburg, 17120, actually did our homework for us. We pass it on to you verbatim, dated October 20, 1972.

Anglesite (Gordon), ankerite (Gordon; needs verification), arsenopyrite (Gordon), azurite (Gordon), barite (Gordon), bornite (Gordon), brochantite (Montgomery), cerussite (Gordon), chalcopyrite (Gordon), chalcocite (Gordon), chrysocolla (Gordon), covellite (Gordon), copper (Gordon), cuprite (Gordon), devilline (Montgomery), dolomite (Gordon), fluorite (Gordon), galena-argentiferous (Gordon), hematite (Gordon), hydrozincite (Gordon), langite (reported; questionable), limonite (Gordon), linarite (Montgomery), malachite (Gordon), marcasite (Gordon), Millerite (?) (Gordon), pyrite (Gordon), pyromorphite (Gordon), pseudomalachite (Gordon; needs verification), quartz and chalcedony (Gordon), smithsonite (Rose), sphalerite (Gordon), sulfur (Rose), susannite (Montgomery), wulfenite (Gordon).

The Ecton mine was operated as a lead and copper mine but also contained some zinc. Lead was discovered in 1808 and probably mined in 1809 but most mining was in the middle 1800's.

Another missive, this time from Peter Bridge, 248 Rutland Avenue, Carlisle, Western Australia, includes some interesting notes.

"With reference to your comment in the Mineralogical Record *Vol. 3, No. 1, page 37, collinsite. I received my copy of the issue last week* (letter is dated April 7, 1972) *and read about collinsite. I'm interested in this mineral because my specialty is phosphates* (welcome aboard, Peter. So many are fascinated by this series in mineral collecting). *The next day I was measuring x-ray diffraction patterns of material I collected from a variscite locality a fortnight before and a cavity with clear white crystals looked interesting. They were collinsite. I haven't had time to check optical data yet so that this is a preliminary note, personal information only. X-ray diffraction is identical. I'll let you know.*

On Fleischer's book I am sorting the entries on data processing cards under the element; it should be a useful list. Most previous ones have been rather limited in extent, I think."

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MINERALOGY AND PARAGENESIS OF THE 79 MINE LEAD-ZINC-COPPER DEPOSIT

by Stanley B. Keith **2748 E. 9th Street, Tucson, Arizona 85716**

Of Arizona's many lead-zinc-copper mines, the 79 mine has in recent years captured the attention of many mineral collectors. Aurichalcite, wulfenite, mimetite, chrysocolla, hemimorphite, rosasite and smithsonite, in particular, have distinguished the 79 mine as one of Arizona's premier mineral localities.

Location

The 79 mine is situated in the western portion of the Banner Mining district in the southwest corner of Gila County, Arizona (T. 4 S., R. 15 E.). A good map of the area is the 7.5 minute (topographic) Hayden quadrangle (1962) by the U. S. Geological Survey. Hayden (pop. 2500) is the nearest town, with its large smelter and tailings pond serving as conspciuous landmarks. A graded road, periodically damaged by flashfloods, extends northeast to the 79 mine from the highway, about two and one-half miles northwest of Hayden. Passenger cars have been known to make the trek but a suitable off-road vehicle is strongly recommended.

The mine is situated up on the northwest-trending Dripping Springs Mountains. A panoramic view of Hayden, and the Gila and San Pedro River Valleys, can be seen from the mine. Tornado Peak, elev. 4,483 feet, about two miles southeast of the mine, is the most prominent peak. The area is in a youthful state of erosion. Landforms are rugged and exposures of bedrock excellent.

History and Workings

Kiersch (1951) offers a concise historical resume to 1951:

1879 Deposit located by Mike and Pat O'Brien.
1919 Property leased by Continental Commission Co.
1920 Ore was packed on burros to the railway at Hayden Junction. Road to the mine completed in October. Owing to decline in price of lead, operations were suspended in December.
1921 Property purchased for Continental Commission Co., capitalized at $1,000,000.
1922 Production from November, 1919 to May, 1922 was 3,000 tons of ore averaging 24 per cent lead, 1.75 per cent copper, 4 ounces of silver, and 80 cents in gold per ton. Property purchased by Seventy-Nine Mining Co. in May, and production continued at rate of about 50 tons per day.
1923 Property reconveyed to Continental Commission Company after litigation.
1926 Property sold at public auction to satisfy a judgment of $16,000.
1928 Mine reopened by Seventy-Nine Lead-Copper Co. after remaining idle for about six years. More than 2,300 tons of oxidized lead ore shipped to smelter at Douglas. The property ranked fifth as producer of lead in Arizona in 1928.
1929 Production was nearly 15,000 tons of oxidized lead ore containing about 22 per cent lead, 1 per cent copper, 5 ounces of silver, and 0.05 ounce of gold per ton; property became the largest producer of lead in Arizona in 1929 and ranked thirteenth as a producer of silver. Inclined shaft was deepened to 450 feet.
1930 Mine worked only during first half of year, producing 5,400 tons of lead-silver ore and 1,700 tons of copper ore to rank second as a producer of lead in Arizona in 1930.
1936 Nearly 9,000 tons of oxidized lead ore produced. Construction started on a concentrator of 60 tons daily capacity.
1937 Concentrator treated 10,483 tons of zinc-lead ore, and 3,435 tons of lead ore were shipped.
1938 Owing to decline in metal prices, mine and mill were closed in January.
1940 Shattuck-Denn Mining Corporation reopened the mine, initiated extensive exploration on the 5th and 6th levels, and later opened up a 7th level.
1949 Operations suspended.
1950 Property acquired by Callahan Zinc-Lead Company, Inc.
1950-51 Some production by lessee.

Since 1951 the mine has been irregularly operated by several owners and leasees, among them the Callaghan Mining Corporation of New York, Dan King of La Habra, California, and Norman Grissom of Hayden, Arizona. In 1967 Mr. Grissom left the property. Subsequently, the mine enjoyed a brief, but spectacular and notorious, collecting history up to August, 1971. Eventually Inspiration Consolidated Copper Co. of Inspiration, Arizona obtained mining rights to the 79 mine from Dan King. In the fall of 1969 Inspiration conducted what was apparently a rather extensive program exploring for ore at depth by means of diamond drilling. Owing to vandalism and the high risk of injury to collectors Inspiration sealed off the underground workings during August, 1971. Whether the mine will be reopened and returned to production is unknown although this author suspects the chances for its return are good.

In addition to surface workings the mine is developed to seven levels (see cross-section). Over 10,000 feet of tunnels and open stopes, much of which are now caved or backfilled, have been driven. The cross-section (figure 2) outlines the workings. A one-and-one-half compartment -55° inclined shaft presently connects all levels except the 1st, 2nd, 7th and a portion of the 4th, which are reached through winzes or manways. The 5th and 6th levels are the most extensive workings. The 1st, 2nd, 3rd, and 4th levels were developed at vertical intervals of thirty to fifty feet. Vertical intervals between the 4th, 5th, 6th, and 7th levels are 100 feet.

Geological Synopsis

The deposit is situated in or near a rhyolite dike which was intruded in early Tertiary time into Pennsylvanian shales and limestones of the lower Naco formation resting unconformably on Mississippian Escabrosa limestone. The rhyolite intrusions produced considerable contact metamorphic effects in the adjacent sediments, principally garnitized skarns.

At the 79 mine the mineralization may be plausibly interpreted as a lower temperature hydrothermal phase of the rhyolitic melt. Mineralizers closely followed along dike contacts and east-west fractures and faults depositing base metal sulfides in favorable horizons of the adjacent sediments and in brecciated portions of the rhyolite dikes. Deformational textures of lead-zinc ore in polished section suggest continuous shearing and brecciation during mineralization.

Several post-mineral structures transect the mineral deposit. One of these post-mineral structures, the Main fault, which strikes about N40W and dips 60° northeast, directly affected the orebodies at the 79 mine by displacing them about 500 feet down on the east. The fault appears to have "axed" the orebodies before they had completely oxidized, as the orebodies in the upthrown block are much more thoroughly oxidized than those in the lower block.

At the time the Main fault was formed a series of conjugate normal faults of much smaller displacement were also created. These sympathetic small faults, which I shall call the 79 breccia system, roughly parallel the Main fault striking north-south to N25W and dipped 65°to 85°southwest. It was these structures that were to have a decisive effect in localizing the secondary mineral assemblage that has granted the 79 mine lasting fame.

The 79 Deposit

The 79 deposit is a mesothermal lead-zinc replacement deposit. Hot aqueous solutions primarily rich in lead and zinc with accessory copper migrated upwards along preexisting fractures and other channel ways. These solutions reacted with and replaced favorable enclosing rocks under moderate temperatures (200°to 300°C) and pressures (one to ten atm) at moderate depths. As can be seen in the cross section (figure 1), replacement was of two types: bedded and vein replacement. Bedded replacement in the host limestone and shale was molecule for molecule. Replacement in a host rhyolite dike, called the North dike, was restricted to deposition of sulfides as veinlets along antecedant fractures and extensive silicate alteration of the rhyolite. Throughout the mine area one's attention is drawn to large red outcrops of silica breccia closely associated with the mineralization. The limestones were subjected to hydrothermal jasperization. These cherty bodies were then brecciated during sulfide mineralization and infilled by a later generation of primary quartz.

Like most southwestern deposits, oxidation at the 79 mine is fairly deep, being nearly complete above the 5th level and practically absent below the 6th level about 400 feet below the ground surface. A supergene enriched zone, which will be discussed later, developed near the North dike and was exposed by 6th level crosscuts. In the oxidized zone solution channels along the brecciated zones in the limestone are numerous and it is along these that migrating supergene solutions deposited a spectacular array of oxidized secondary minerals. Where open space was available well-crystallized examples of the hypogene sequence are found — particularly in crosscuts through the North dike on the 6th level.

The bedded ore deposits developed by the upper workings have been mostly mined out. However, secondary minerals occurring in the Main fault and 79 breccias were apparently unprofitable to mine. It is these occurrences that have repeatedly received attention by the collectors' hammers and chisels where they are exposed by workings in the oxidized zone.

Mineralogy

The mineralogical fame of the 79 mine rests with its secondary minerals. Of these, aurichalcite is perhaps the most noteworthy, providing the largest and most perfectly crystallized examples in the United States, and rivaling those of Mapimi, Durango, Mexico for the most outstanding North American occurrence. The mine furnished excellent specimens of rosasite although not quite of the caliber of those from Mapimi. Crystallized examples of smithsonite are of surprisingly high quality; of special interest are lustrous apple-green mammillary specimens from the 4th level. Many forms of hemimorphite abound in the upper levels — especially a mammillary form that bears an astonishing resemblance to some of the smithsonite from Kelly, New Mexico. 79 wulfenite is often distinguished by the brilliant orange, often perfectly clear crystals. These are often liberally sprinkled on equally brilliant orange mammillary crusts of mimetite. In addition to its celebrities, the deposit furnished excellent examples of descloizite, chrysocolla, tenorite, and malachite supplemented by well-crystallized pyrite, galena, and sphalerite. There are also excellent representatives of hydrated sulfates, notably chalcanthite, melanterite and halotrichite, derived from post-mine oxidation of primary sulfides. Two notable occurrences of secondary minerals exposed on opposite ends of the 4th level will be referred to repeatedly, and, henceforth shall be called the "aurichalcite area" and "wul-

TABLE I THE MINERALS OF THE 79 MINE LEAD–ZINC–COPPER DEPOSIT

Native Elements

*su	Sulfur
*	Copper

Sulfides

py	Pyrite
gn	Galena
sl	Sphalerite
cp	Chalcopyrite
*cv	Covellite
*cc	Chalcocite
?	Argentite
	Molybdenite

Sulfosalts

td	Tetrahedrite

Oxides

*tr	Tenorite
*gt	Goethite
*hm	Hematite
*	Lepidocrocite
*hd	Hollandite
*	Manganite
*	Pyrolusite
*mu	Murdochite
*pt	Plattnerite
*	Hetaerolite
?	Cuprite

Carbonates

*ce	Cerussite
*mc	Malachite
*smt	Smithsonite
*au	Aurichalcite
*rs	Rosasite
*cal	Calcite
*	Siderite
*az	Azurite
?*	Hydrozincite
	Dolomite

Sulfates

*hl	Halotrichite
*mr	Melanterite
*ch	Chalcanthite
*an	Anglesite
*ja	Jarosite
	Pisanite
*pj	Plumojarosite
*br	Brochantite
*	Gypsum
?	Linarite

Phosphates, Vanadates Arsenates, Molybdates

*wn	Wulfenite
*mm	Mimetite
*dc	Descloizite
*mt	Mottramite
*	Olivenite
*	Clinoclase
?*	Scorodite
?*	Austinite
*ph	Pyromorphite
*vd	Vanadinite

Silicates

qz	Quartz	
	Montmorillonite	
?	Sauconite	
	Kaolinite	
?	Illite	
*he	Hemimorphite	
*cy	Chrysocolla	
	Andradite	Ca-Mg Silicates in skarn
	Diopside	
	Tremolite	
	Epidote	
	Vesuvianite	
	Willemite	
?	Dioptase	

Additional Minerals in Crosscutting Dike Rocks

Pyroxenes
Biotite
Magnetite
Apatite
Sphene
Orthoclase
Plagioclase
Hornblende

fenite area" respectively. A third occurrence of secondary minerals in the stope system above the 470 haulage also will receive considerable attention.

Table I is a complete list of the minerals found to date. Those marked with an asterisk (*) are supergene; those marked with a question mark (?) are of doubtful identity. Abbreviations are included for all those minerals which are referred to on the cross section. The list is arranged chemically with members in each anion group listed in their approximate order of abundance.

Some 67 minerals from the mine and adjacent skarn and dike areas have been identified with relative certainty. The identity of eight others is considered probable or uncertain. Except where noted, identification has been restricted to visual techniques with the aid of various microscopes. Undoubtedly, careful scrutiny will yield others. A description of some of the more noteworthy minerals follows.

SULFIDES

The sulfides, in general, are confined to the lower levels. Extensive leaching by downward percolating groundwater enriched in H^+ has resulted in post-mine oxidation of much of the hypogene sulfides above the water table, especially pyrite. Sulfides intermingle with oxidized materials on the 5th level and become predominant on the 6th level. Occasional sulfide relicts found on the upper levels contain galena or pyrite. No sphalerite was found in any of the unoxidized remnants while at depth it makes up almost 35% of the ore. Covellite and chalcocite have locally enriched the primary sulfides near the North dike where it intersects the 6th and 7th levels.

Galena PbS

Galena was economically the most important hypogene ore mineral. Generally encountered in the massive state, galena is also found as individual cubes or cube groups, especially in the vicinity of number 30 and 31 stopes in the

North dike on the 6th level. Galena is also present but less plentiful on the 7th level. In the oxide zone galena occurs as scattered remnants. Minute crystals of smithsonite encrust much of the crystallized galena on the 6th level where active oxidation has rendered most specimens very crumbly and, consequently, hard to preserve.

Sphalerite ZnS

Equal in abundance to galena, sphalerite occurs not only as massive material but as well-developed tetrahedrons often with curved faces to 3/4ths of an inch. Complex crystals also show dodecahedral modifications. Sphalerite is more prevalent on the 7th level which suggests an increase in zinc with depth.

Chalcocite Cu_2S
Covellite CuS

Chalcocite occurs microscopically as small blebs within sphalerite fractures or as small supergene veinlets scattered throughout oxidizing hypogene sulfides. Covellite is similarly encountered as small feathery laths lining cleavages and fracture openings in galena and sphalerite.

Pyrite FeS_2

Pyrite is the most common sulfide of the hypogene assemblage. It is scarce or absent on all levels above the 5th. On the 5th level pyrite begins to show more abundantly in the tunnel facings. Some pyrite may contain interstitial chalcopyrite as evidenced by blue hairs and "rams horn" forms of chalcanthite, the hydrated copper sulfate, — and more rarely pisanite, the hydrated copper iron sulfate, — rooted in a matrix of pyrite. On the 6th level pyrite is widespread and abundant where a massive siliceous pyrite ore body about 100 feet thick, cut off on the west by the Main fault, extends to the east some 300 feet. Some of this material is found as pale brass-yellow cubes and cube groups. One specimen displaying a fine large highly-modified one inch pyrite crystal, was taken from this area. Forms: {210}, {001}, {112}.

In the vicinity of number 30 and 31 stopes on the 6th level, attractive, pale brass-yellow cubes, striated on {001}, occur associated with galena, sphalerite and quartz. On the 7th level simple cubes up to 3/4 of an inch are found in a clay matrix. Sulfates growing from tunnel facings betray most pyrite areas in the mine. Tarnish may usually be removed from these crystals by immersion in a dilute solution of hydrochloric acid.

Chalcopyrite $CuFeS_2$

Chalcopyrite is a minor mineral in the sulfide zone. In the number 31 stope area chalcopyrite occurs rarely as crystals to 1/2 inch coated by smithsonite. The author collected a group with an excellent 1/2 inch chalcopyrite disphenoid {112} coated by smithsonite and quartz standing on pyrite and quartz in altered rhyolite. Chalcopyrite also occurs as small blebs occupying cleavage planes within galena and sphalerite. Microscopic examination of polished sections revealed small interstitial chalcopyrite blebs in almost every sample of sphalerite. This occurrence is remarkably persistent and suggests solid solution of chalcopyrite in sphalerite.

Molybdenite MoS_2

Although not found in the vein deposits, molybdenite has been noted coating veinlets in the North dike along with pyrite and chalcopyrite (Richard Thomssen, personal communication).

SULFOSALTS

Tetrahedrite $(Cu,Fe)_{12}Sb_4S_{13}$

Tetrahedrite has not been positively identified by the author although Richard Bideaux has identified material from the dump as tetrahedrite by X-ray techniques (personal communication).

OXIDES

Hematite and goethite comprise by far the great bulk of the oxides which are prolific in the upper levels. Manganese oxides are common in post-mineral brecciated zones suggesting that this cation was not indigenous. Hetaerolite, murdochite, and plattnerite occur very sparingly on other secondary minerals that line solution channels in brecciated limestones.

Iron Oxides (Limonite)

Goethite, lepidocrocite, and other iron oxides comprise an ochre yellow mixture familiarly known as "limonite" which represents a final oxidation product of primary minerals. Most of the limonite is present as a variety known as "fluffy" limonite*. Interestingly enough, the occurrence of fluffy limonite is generally restricted to the oxidized portions of bedded replacement orebodies and does not occur extensively in secondary deposits along the main fault or brecciated zones. The fluffy nature of the limonite results from an excess of available carbonate or bicarbonate to react with ferric sulfate derived principally from the oxidation of pyrite. The occurrence of fluffy limonite is "exotic" and not indigenous. This phenomenon implies the presence of enough pyrite to produce the requisite amount of free acid to completely leach and export iron oxides from original primary sulfide sites during oxidation. Only occasionally is limonite found pseudomorphous after pyrite.

Hematite Fe_2O_3

Hematite occurs as earthy red material mainly restricted to the oxidized portions of bedded replacement ore bodies. Specular hematite is occasionally found as a matrix in some of the fault breccias and lends a distinctive reddish color to many of the silica breccia outcrops throughout the mine area.

Mn Oxides — Wad

Wad, a mixture of hollandite, manganite, pyrolusite, and other manganese oxides, is found in many of the fault zones and solution channels intimately associated with iron and copper oxides. One commonly finds sooty black

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*Note: "Fluffly" limonite is described by Roland Blanchard in *Interpretation of Leached Outcrops,* Nevada Bureau of Mines, Bull. 66, 1968.

irregular reniform, globular, and botryoidal masses carpeting solution cavities throughout the oxide zone. Wad often forms alternating bands with goethite indicating contemporaneous deposition. Pyrolusite is present as numerous dendritic forms coating fractures in near-surface limestones.

Goethite $HFeO_2$

Goethite is present throughout the oxide zone as stains on limestone and other gangue minerals. Small (to one inch in length) stalactitic forms are suspended from the roofs and walls of solutions cavities in the 79 breccia system of the upper levels.

Tenorite (Melaconite) CuO

Tenorite appears to occur throughout the oxide zone intimately associated with chrysocolla and malachite as black dull to shiny veinlets and coatings. Much of the material identified as tenorite may be an amorphous gel composed of copper silicates and manganese oxides known as melaconite. Spectrographic tests on dull black oxide indicated the presence of manganese. In several cases where shiny jet-black material was analyzed only the presence of copper could be established indicating the probable presence of tenorite. But since most of the material is an indefinite mixture, the term "melaconite" shall be used throughout the rest of this report.

A fault in the 79 breccia, including abundant chrysocolla, melaconite and malachite, intersects drifts on the 4th and 470 levels. Many specimens from this breccia consistently reveal a central core of melaconite surrounded successively by malachite and occasionally aurichalcite. This layer is then enclosed by chrysocolla which in turn has malachite balls and cerussite scattered upon its bubbly blue surface.

Murdochite $PbCu_6O_8$

Plattnerite PbO_2

Murdochite occurs at the 79 mine as small shiny black crystals (to 0.1 mm) of cubic habit intimately associated with shiny black needles of plattnerite (to 1.5 mm) sprinkled on aurichalcite needles and rosasite. This pair is encountered only rarely in the aurichalcite area. When they are found, plattnerite is by far the more plentiful mineral, by a ratio of about 25 to 1.

Hetaerolite $ZnMnO_4$

This uncommon mineral was found in the stope system extending above the 470 level as massive submetallic black shining encrustations on hemimorphite. Only one example was collected by the author and will be confirmed by X-ray techniques. Spectrographic techniques have confirmed the presence of zinc.

CARBONATES

Carbonates are common throughout the deposit but are most abundant on the upper levels precipitating on a matrix made up of "limonite", goethite, hematite, and manganese oxides. The most outstanding occurrence of carbonates is in a fault of the 79 breccia system intersecting a 4th level drift (the aurichalcite area). Aurichalcite, rosasite, cerussite, smithsonite, malachite, and calcite form seemingly endless splendant combinations with hemimorphite, wulfenite, mimetite, goethite, chrysocolla, descloizite, murdochite, tenorite, and plattnerite. Carbonates predominate in other faults of the 79 breccia and in the oxidized bedded replacements but are conspicuously absent in or near the Main fault.

Cerussite $PbCO_3$

The most abundant supergene mineral, cerussite, once constituted rich ore throughout the supergene zone as numerous ore pillars in the open stopes of the upper levels testify. Cerussite, which is a stable phase of galena alteration, comprised rich oxidized ore that was mined from the Discovery orebody which cropped out at the surface. A large orebody east of the Main fault between the 5th and 6th levels (see cross section), which is now caved and inaccessible, was also largely constituted of cerussite. Within these orebodies cerussite occurs chiefly as earthy-white or yellow grains (sand carbonate) and less commonly as colorless to translucent yellow crystal groups. Some of these groups are of surprising clarity and moderate size (to 3/4 inch in length.) V-shaped and sixling twins are common (figure 5). Crystal locations are noted on the maps. The "jackstraw" variety is found occasionally encrusting manganese stained fractures in limestones adjacent to faults of the 79 breccia system. Cerussite is sparse in the aurichalcite area as delicate elongate white needles balanced on aurichalcite tufts. In the stope system above the 470 haulage sixling twins and other crystal forms (to 1/2 inch in length) rest with malachite on bubbly blue translucent chrysocolla; forms: {001}, {010}, {020}, {021}, {110}.

Malachite $Cu_2(OH)_2(CO_3)$

This green secondary copper carbonate is scattered throughout the supergene zone, being principally limited to the stope area above the 470 level. Here malachite is associated with chrysocolla and melaconite as green veinlets and small balls (to a diameter of 1/4 inch) standing on chrysocolla. Some of the larger clusters reveal the distinct radiating habit of malachite in cross section. Malachite also occurs on the 4th level in veinlets alternating with melaconite and chrysocolla. From the aurichalcite area malachite forms alternating bands with rosasite that together make up individual balls resting on hemimorphite.

Smithsonite $ZnCO_3$

Smithsonite is present in the oxidized zone as crystals and botryoidal masses lining solution cavities in faults of the 79 breccia system. The most outstanding occurrence is in the aurichalcite area on the 4th level. Here attractive smithsonite exhibits crude to sharp, green to white crystals attaining lengths of up to 1/4 inch. Specimens are often enhanced when white smithsonite is contrasted with a brownish-black matrix of wad. Beautiful subadamantine mammillary and botryoidal masses ranging in color from apple-green to robin's-egg blue are also found here (figure 6). Growing on smithsonite in this area are hemimorphite, wulfenite, rosasite, aurichalcite, and "butterfly twinned" calcite. Smithsonite is common in the vicinity of numbers thirty and thirty-one raises, 6th level, where microscopic crystals (to 1 mm) encrust hypogene sulfides and quartz. On the 3rd level small, sharp, cream-colored crystals form beneath a hemimorphite overcoating. Scalenohedrons and rhombohedrons are common forms.

Aurichalcite $(Zn,Cu)_5(OH)_6(CO_3)_2$

The 79 mine is famous for its beautiful, delicate, acicular sprays and elongated lath-like crystals of aurichalcite from the aurichalcite area. Here aurichalcite is present in fine clusters and rosettes ranging in color from a pale sky-blue to a deep lustrous sea-blue-green in some of the better examples. Aurichalcite sprays commonly grow on hemimorphite, smithsonite, and wulfenite. Cerussite, calcite, and, rarely, plattnerite and murdochite are sprinkled on the aurichalcite tufts. Aurichalcite formed contemporaneously with rosasite with which it is commonly associated. Feathery sprays from the 4th level attain lengths of 3/4 inch — exceptional for aurichalcite. Other specimens feature radiant clusters and acicular rosettes of aurichalcite, often with balls of rosasite at their center, perched on micro-stalactites of goethite along with attractive sprays of small colorless hemimorphite laths. Under magnification such specimens resemble miniature forests. Certainly this small solution zone has produced America's best aurichalcite and quite possibly the world's.

Aurichalcite is sparingly present in other parts of the mine but nowhere does it rival the notable occurrence on the 4th level. Aurichalcite is encountered in the stopes above the 470 haulage. Attractive tufts are associated with hemimorphite and chrysocolla along cavities exposed by the 470 haulage.

Rosasite $(Cu,Zn)_2(OH)_2(CO_3)$

One of the later minerals to form, rosasite is cheifly restricted to a noteworthy occurrence in the aurichalcite area where it is present as deep blue-green velvety mats or warty crusts encrusting manganese oxides and smithsonite. Some of these mats may cover a few square inches and are associated with aurichalcite, smithsonite, wulfenite, calcite, malachite, and mimetite. At least in one instance malachite composes outer rings of balls and crusts which apparently grade from a rosasite rich core. This relationship could possibly demonstrate a structural or chemical affinity between the two compounds. Rosasite occurs on the 3rd level as light blue globules seemingly dripping from goethite stalactites associated with hemimorphite and smithsonite. Rosasite is also present in the stope system above the 470 haulage.

Calcite $CaCO_3$

Calcite is common but not prevalent at the 79 mine. Otherwise noted in only one spot on the 2nd level, calcite is most abundant on the 4th level in the aurichalcite area where it occurs crystallized in the "butterfly twin" habit on descloizite, smithsonite and rosasite. Also seen are small (1/8 inch across), frosty-white plates with well developed basal pinacoids perched on aurichalcite sprays.

SULFATES

Two groups of sulfates occur at the 79 mine: post- and pre-mine sulfates. Bitter tasting halotrichite, melanterite, pisanite, and chalcanthite make up the first group which was formed exlusively by post-mine oxidation processes. The occurrence of such sulfates is limited to oxidizing portions of sulfides that are intersected by tunnel cuts on the lower levels where the normal processes of supergene enrichment are effectively pre-empted by sulfatization.

The second group is comprised of the minerals brochantite, anglesite, jarosite, plumbojarosite and linarite. This assemblage formed as a direct result of pre-mine oxidation of sulfide minerals. The proof lies in associations of the sulfates as concentric rings or coatings directly on hypogene sulfides from the lower levels.

Anglesite $PbSO_4$

Anglesite occurs as a vitreous gray alteration product of galena. The mineral is found replacing galena throughout the 6th level. Where replacement is not complete, anglesite forms dark gray concentric rings around a central core of galena. Though only a few specimens were collected, the author does not doubt that anglesite is widespread wherever galena occurs. However, the author is somewhat sceptical of Kiersch's assertion (1947) that anglesite is widespread throughout the entire oxide zone. Cerussite seems to be the predominant stable phase of galena alteration in the 79 mine's supergene zone. Where relict galena occurs the sulfate can be found oxidizing to the carbonate.

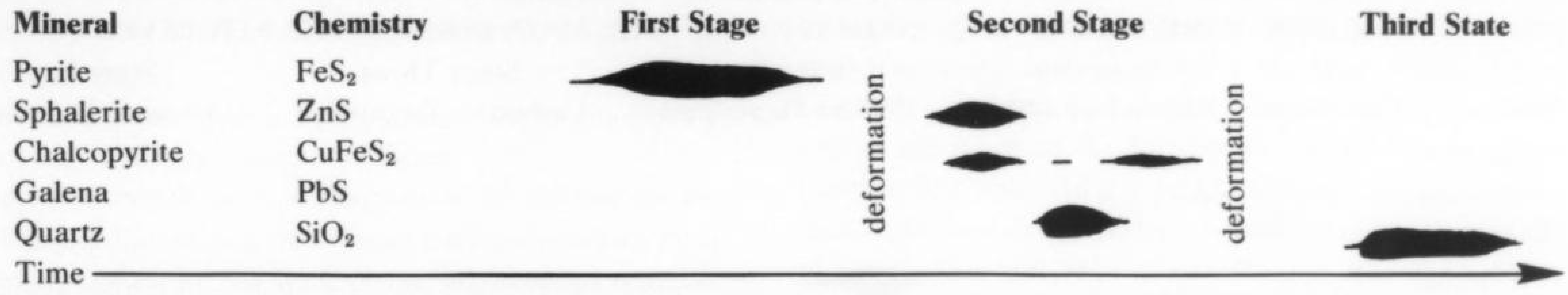
Halotrichite $(Mg,Fe)Al_2(SO_4)_4 \bullet 22H_2O$

This bitter tasting white mineral is the most common hydrated sulfate at the 79 mine. Long arching whiskers of halotrichite, often attaining lengths of 12 inches, grow out of tunnel facings and walls, twisting in all directions. "Ram's horn" forms are common (figure 8). The mineral becomes prevalent in the 5th level transition zone and in the 6th level workings wherever pyrite is present. Copious amounts of the powdery sulfate are currently growing in the area of the massive pyrite ore body where growth rates may be as high as 3 inches per year. In April, 1969, a growth of 1 to 3 inches was noted in an area that had been stripped in May, 1968. On the 7th level the mineral is profuse, falling from the walls to form a continuous mat that crunches underfoot on the tunnel floor. An interesting occurrence of halotrichite stalactites was noted suspended from timbers in a crosscut on the 6th level. Halotrichite is relatively stable in the warm humid air of deeper mine workings but it rapidly dehydrates and crumbles to a white powder upon exposure to dryer surface air making preservation difficult. Plastic spray helps considerably — especially if it is applied to the mineral while it is still in the mine.

Chalcanthite $CuSO_4 \bullet 5H_2O$

Occurring less frequently than halotrichite, chalcanthite (blue vitriol) is nevertheless fairly common where hypogene pyrite appears along tunnel walls on the 5th and 6th levels, although some chalcanthite occurs just below the 3rd level

Table II Hypogene Paragenesis



on the walls of the manway to the 4th level. Attractive specimens of this secondary mineral are found throughout workings of the 5th level and in one area of the 6th level. Distinguished by its deep blue color, chalcanthite occurs in the same manner as halotrichite. Chalcanthite whiskers obtain lengths of 2 inches and occasionally combine to form fine "ram's horns". Often seeming to grade into halotrichite, chalcanthite reflects copper-rich areas in zones of pyrite.

Melanterite $FeSO_4 \bullet 7H_2O$
Pisanite $(Fe,Cu)SO_4 \bullet 7H_2O$

Scarcer than chalcanthite or halotrichite, melanterite occurs sparingly as white encrustations and efflorescences on mine workings on the 5th and 6th levels. On the floor of the 5th level white melanterite blankets, when turned over, reveal short acicular prismatic hairs. On the 6th level the mineral is found altering from pyrite as spotty massive linings on tunnel facings.

An intermediate member in the melanterite series, pisanite occurs sparingly, noted only in an area of active sulfate deposition in a 6th level crosscut. Similar in occurrence to melanterite, pisanite differs by its sky-blue color.

Brochantite $Cu_4(SO_4)_2(OH)_6$

Brochantite is found intimately associated with oxidizing sulfides — especially in the area of numbers 30 and 31 stopes, 6th level. Green mats on sulfides yielded the characteristic diffraction pattern of brochantite.

Jarosite $KFe_3(SO_4)_2(OH)_6$
Plumbojarosite $PbFe_6(SO_4)_4(OH)_{12}$

An ocherous brown massive earthy material, probably jarosite and/or plumbojarosite has been collected from surface and near surface workings. Spectrographic tests confirmed the presence of lead.

PHOSPHATES, ARSENATES, VANADATES AND MOLYBDATES

The occurrence of these anion groups is limited, in general, to a rather notable location along the Main fault and an occurrence on the 6th level. Lesser amounts of the groups are also found scattered throughout the workings where they intersect brecciated limestones. Excellent representatives of descloizite, mottramite, vanadinite, and mimetite intermingle and line cavities in clay and silicified breccia near the Main fault on the 4th level. Descloizite, mimetite and pyromorphite are sparingly present in similar environments of the 79 breccia system while wulfenite is more plentiful. The abundance of the groups in and near the Main fault indicates that the structure was the principle link between the oxidizing orebodies and exotic ions brought in from the outside. On the 6th level, olivenite, clinoclase, and possibly scorodite and austinite occur with other secondary minerals on oxidizing sulfides in a brecciated zone of the North dike.

Pyromorphite $Pb_5(PO_4)_3Cl$
Mimetite $Pb_5(AsO_4)_3Cl$

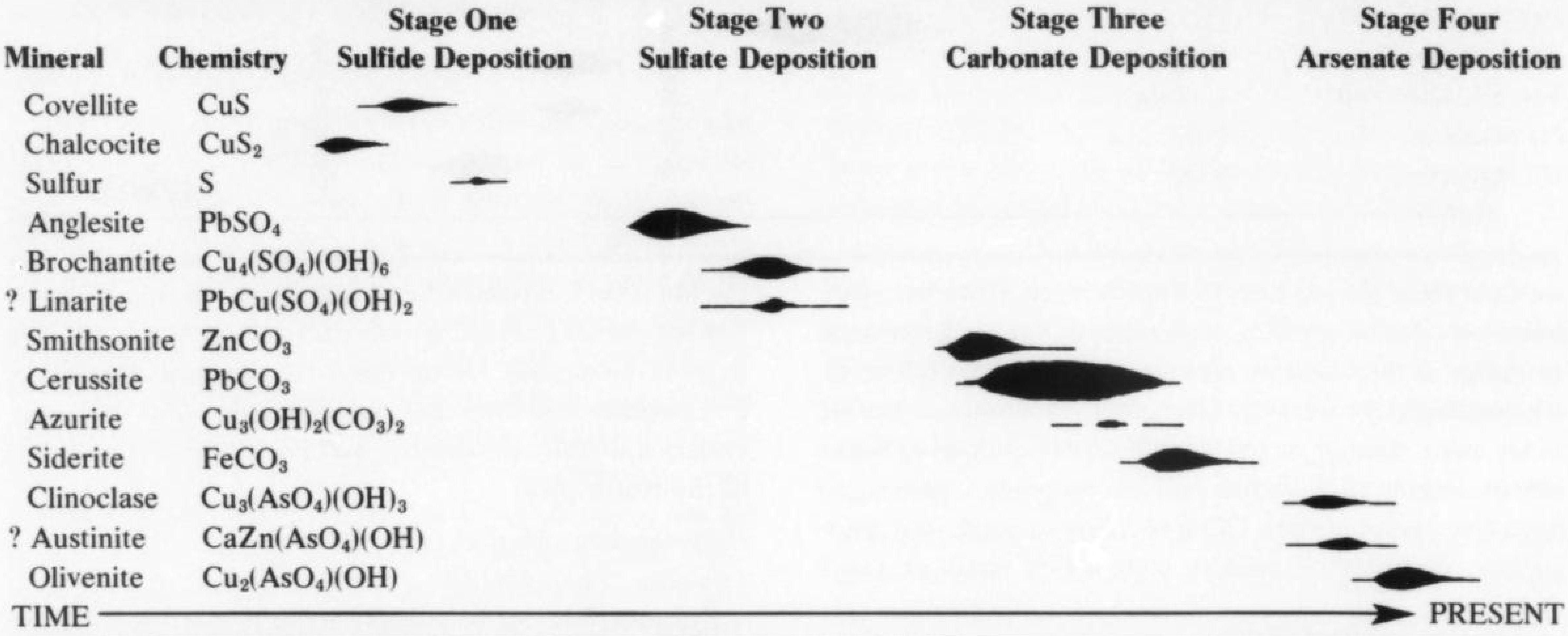
Pyromorphite occurs sparsely at the 79 mine as attractive clear yellow needles scattered on a matrix of chrysocolla from the stopes above the 470 level. These crystals exhibit the well-developed pyramidal forms {0111}, {2021} and {4041} as well as the prism {1011} and basal pinacoid {0001}.

Although the 79 deposit has yielded an unusual amount of well-crystallized species, some of the finest material is not crystallized, such as the brilliant orange, globular, almost translucent mimetite from the Main fault at its intersection with the 4th level. Here numerous pockets containing the bright yellow to orange-yellow mineral occur in the hanging wall of the Main fault. Fine, globular, translucent orange reniform masses, often stalactic, line cavities and tension openings in crumbly montmorillonite clay of the Main fault zone. The arsenate occurs with wulfenite and descloizite. The author has collected a fine cabinet specimen completely covered by brilliant mimetite boasting stalactitic forms, one as large as a thumb. The appearance of such specimens is enhanced by thick, clear, orange wulfenite blades, many 1/2 inch on edge, liberally sprinkled over mimetite. Drusy descloizite often caps some of the stalactitic forms. This occurrence of mimetite establishes the locality as a notable American mimetite occurrence. Very small (to 1/16 inch) canary yellow mimetite appears as individual crystals and clusters coating wad, hemimorphite and wulfenite in the aurichalcite area of the 4th level. Powdery yellow mimetite is found on wulfenite in a silicified brecciated zone intersected in a 2nd level crosscut. The occurrence of mimetite as well as that of wulfenite seems to be restricted to brecciated post-sulfide channel ways.

Descloizite $(Zn,Cu)Pb(VO_4)(OH)$
Mottramite $(Cu,Zn)Pb(VO_4)(OH)$

Both zinc- and copper-rich end members of this isomorphous series are represented. The black mottramite is best developed on the 4th level as crystalline druses encrusting wulfenite and mimetite and lining cavities within breccia of the Main fault zone. Small (to 0.25 mm), brown-

TABLE III
SUPERGENE ENRICHMENT AND OXIDATION IN THE MAIN DIKE ON THE 6TH LEVEL Q



Mineral	Chemistry
Covellite	CuS
Chalcocite	CuS_2
Sulfur	S
Anglesite	$PbSO_4$
Brochantite	$Cu_4(SO_4)(OH)_6$
? Linarite	$PbCu(SO_4)(OH)_2$
Smithsonite	$ZnCO_3$
Cerussite	$PbCO_3$
Azurite	$Cu_3(OH)_2(CO_3)_2$
Siderite	$FeCO_3$
Clinoclase	$Cu_3(AsO_4)(OH)_3$
? Austinite	$CaZn(AsO_4)(OH)$
Olivenite	$Cu_2(AsO_4)(OH)$

ish-green, wedge-shaped crystals of descloizite rest on hemimorphite in the aurichalcite area. Descloizite crystals to 1/4 inch encrust wulfenite and line cavities in the wulfenite area.

Wulfenite $PbMoO_4$

Wulfenite is principally restricted to occurrences in faults of the 79 breccia system and the Main fault. By far the majority of wulfenite collected at the 79 mine comes from a notable occurrence near the Main fault on the 4th level (the wulfenite area). Here the first order tetragonal pyramid is well developed. Very occasionally, the pyramidal form is developed to the exclusion of the basal pinacoid in specimens mounted on a crumbly descloizite-mimetite-montmorillonite matrix. Many examples from this area exhibit striations on {013}. Of moderate size (to 1-1/4 inch on an edge) "79 wulfenite" is characterized by its clarity; many crystals are completely free of internal flaws (figure 4). The more typical flat vicinal crystals occur also throughout the wulfenite area in lenses and seams. Frequently encrusted by mimetite and descloizite, unflawed wulfenite may rest upon a matrix of hemimorphite, chrysocolla, and montmorillonite.

In surface workings the mineral is found as thin yellow blades standing on quartz. Small bright red pyramids and other forms occur with hemimorphite on the 1st level. On the 2nd level wulfenite is encountered in faults of the 79 breccia as thin clear yellow-orange plates to 3/8 inch often encrusted with mimetite, on chrysocolla or mimetite. In addition to the wulfenite area on the 4th level, thin yellow transparent blades with hemimorphite line tension gashes in montmorillonite gangue material near the Main fault. Small translucent red plates with first and second order pyramid forms ({101} and {112}) are sprinkled on smithsonite and clear yellow blades with hemimorphite are often overgrown by aurichalcite in the aurichalcite area. The stope system above the 470 haulage furnishes small (to 1/8 inch) orange opaque tabular wulfenites scattered on vitreous blue chrysocolla crusts. The 470 level itself yields wulfenite as small (to 1/8 inch) deep red orange translucent tabloids with well developed prism forms. Wulfenite was observed on the 5th level in the Main fault as yellow blades on hemimorphite and crystals lining fractures between silicified limestone fragments. On this level wulfenite occurs as scattered crystals with cerussite on goethite. No wulfenite was encountered below the 5th level.

Olivenite $Cu_2(AsO_4)(OH)$

Olivenite and possibly several other arsenate compounds, occur in a small sublevel about 25 feet up in the number 31 raise on the 6th level. The mineral was identified by X-ray diffraction. Olivenite occurs as small olive green crystal clusters on quartz, brochantite, an unnamed mineral, smithsonite, anglesite and siderite. Spectrographic tests on other materials from this locality indicate the possible occurrence of austinite, the calcium zinc arsenate, and scorodite, the iron arsenate.

SILICATES

Like many of the other anion groups, base metal silicate representatives, with the exception of chrysocolla, are confined to the faults of the 79 breccia and Main fault. Chrysocolla and hemimorphite constitute the bulk of secondary silicates formed by the reaction of silica-enriched solutions with resident cations. Willemite was not noted. The development of the secondary silicate mineralogy is most apparent in the 79 breccia system and somewhat less so in the Main fault.

Quartz SiO_2

Quartz is ubiquitous at the 79 mine. Of primary origin, quartz is encountered as attractive long slender six-sided prisms with pyramidal terminations lining fractures throughout the entire deposit. Cryptocrystalline quartz occupies many microscopic fractures in fractured hypogene sulfides as outlined by microscopic study of polished section. The minerals resistance to chemical attack apparently has rendered quartz immune to supergene processes and consequently has remained *in situ* often providing a boxwork skeleton upon which secondary minerals are deposited.

Clay Minerals:

Montmorillonite hydrous magnesium aluminum silicate
Kaolinite hydrous aluminum silicate
Sauconite anhydrous zinc magnesium aluminum silicate

Montmorillonite and, to a lesser extent, kaolinite most probably constitute the bulk of the argillaceous material so prolific in shear and fault zones throughout the 79 deposit. Sauconite, the rare zinc member of the montmorillonite group, may be present near chrysocolla and hemimorphite in the stope system above the 470 level. Spectrographic analysis confirmed the presence of zinc. Polished and gouged clay surfaces exhibit spectacular vertical slickenslides at the intersection of the Main fault with the 4th level in the vicinity of the wulfenite-mimetite area. On the 6th level silicate alteration in the form of clay minerals of the North dike is evident. The original feldspars have been "argillized" to montmorillonite or kaolinite.

Chrysocolla $Cu_2H_2Si_2O_5(OH)_4$

Chrysocolla is the most abundant oxidized copper mineral. It occurs as a massive vitreous blue material which ranges to opaque chalky material. Chrysocolla resembles montmorillonite in mode and occurrence but is distinguishable by its blue color. Chrysocolla is sporadically present throughout the supergene zone, being noted on the top 5 levels. A rich chrysocolla-malachite-melaconite zone extends from the 4th level to the 470 level. Much of this material has been sought after as lapidary material. In the stopes immediately above the 470 haulage, abundant chrysocolla presents several varieties: a translucent blue crust surrounding melaconite cores and often covered with small tabular orange wulfenite crystals or light green malachite balls and more rarely pyromorphite; an opaque, light blue material coating hemimorphite, rosasite and malachite, and as curious acicular hairs lining cavities enclosed by massive chrysocolla. It is possible that these hairs are pseudomorphs after malachite. Chrysocolla has been reported as pseudomorphs after hemimorphite and smithsonite (Richard Bideaux, personal communication). Occasionally, chrysocolla and melaconite line fractures above and below oxidized bedded replacements in the upper levels.

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

Many types of hemimorphite, some well crystallized, establish the deposit as one of the bettèr American occurrences. Although not of the spectacular dimension of the material from Mapimi, Durango, Mexico, typical colorless, thin tabular lath and blade-shaped (parallel to {010}) individuals range to 1/2 inch in length by 1/4 inch in width from the stope system directly above the 470 haulage. Here attractive radiating sprays and crystal groups are found lining numerous cavities and vugs associated with chrysocolla and hetaerolite in brecciated limestone. The zinc silicate is quantitatively the most abundant mineral in this area. Cross sections often reveal the radiating habit of hemimorphite. On the 470 level attractive spindly balls of hemimorphite stand in bold contrast to drusy hemimorphite lining cavities. Also, a sky-blue variety forms undulating carpets lining inter-connecting cavities near one of the raises to the 470 stopes. On the 4th level, attractive, but small (to 1/4 inch) radiating sprays, rosettes and single crystals appear on smithsonite and support tufts of aurichalcite and balls of rosasite and malachite. Many of the crystals are remarkably clear and exhibit well developed striations on {010} . Where a third level intersects a fault of the 79 breccia system white globules and encrustations are found. In addition to the globular encrustation, fine gray-blue mammillary hemimorphite bears an amazing resemblance to some of the smithsonite from the Kelly mine in New Mexico. Lustrous blue hemimorphite covers smithsonite and goethite in small solution caverns. Similar but not as eye-appealing forms of hemimorphite have developed in solution cavities of the 79 breccia faults that intersect 2nd level workings and the surface in the open pit.

Hemimorphite is surprisingly abundant in faults that crisscross the oxide zone. Even though hemimorphite at the 79 often resembles smithsonite in habit and color, it is readily distinguishable from the latter by its chemical inertness to hydrochloric acid.

Andradite $Ca_3Fe_2(SiO_4)_3$

Andradite appears to be the predominant representative of a contact metamorphic mineralogy that includes lesser amounts of tremolite, diopside and epidote associated with intrusive bodies in contact with limestone throughout the deposit. Andradite is most conspicuous in the surface skarns that occur throughout the mine area. Kiersch (1947) reports an area of garnetized limestone exposed by a 6th level drift.

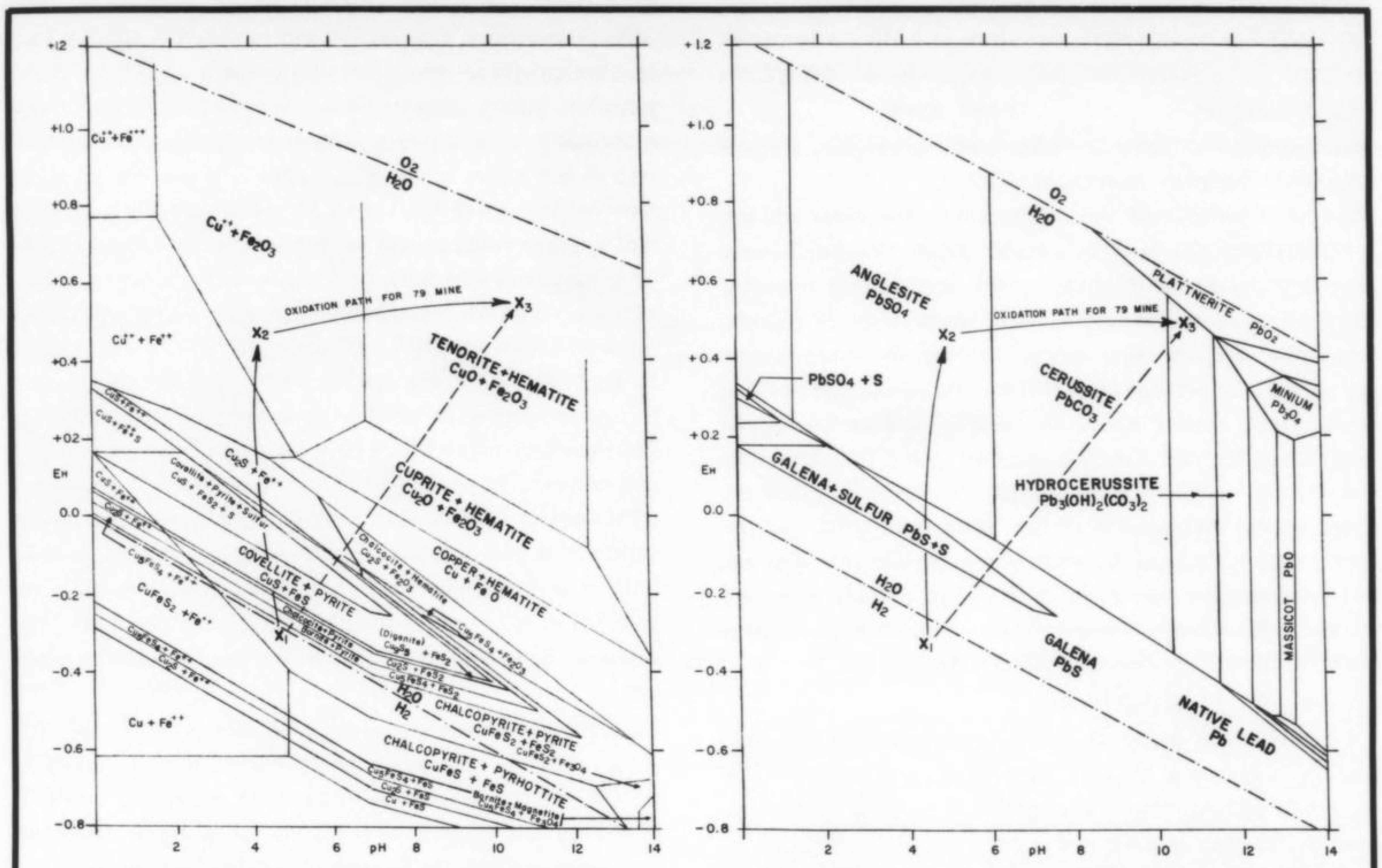
Chemistry of the 79 Deposit

Study of the 79 ores demonstrated that primary mineralizers in the 79 area carried mainly zinc and lead in approximate equal amounts, an accessory amount of copper, and trace silver, antimony and gold. The widespread occurrence of galena and sphalerite with lesser amounts of chalcopyrite supports this conclusion. Tetrahedrite has been reported but could not be identified in any of eight polished sections made of the hypogene assemblage.

Hypogene Paragenesis — Sulfide Deposition

Shortly after the intrusion of early Tertiary rhyolite and latite, metaliferous hydrothermal solutions — probably a lower temperature phase of the recently solidified rhyolite melt — moved into the country rock depositing base metal sulfides. Eight polished sections were prepared to establish the hypogene (primary sulfide) paragenesis (sequence of mineralization) of this phase. The results are summarized in Table II.

It is interesting to note the impressive number of secondary minerals developed from a comparatively simple primary mineralogy. Pyrite formed first, closely followed by



The system Cu-Fe-S-O-H (in part) at 25° C and 1 atmosphere total pressure. Total dissolved sulfur = 10^{-1}m. Adapted from Garrels and Christ (1965).

Stability relations among lead compounds in water at 25° C and 1 atmosphere total pressure. Total dissolved sulfur species = 10^{-15}; total dissolved carbonate species = 10^{-1}. Adapted from Garrels & Christ (1965).

Fig. 1. **Eh-pH diagrams depicting the oxidation trend at the 79 Mine, Arizona.**

deformation. Base metals were deposited in the shattered pyrite, sphalerite and chalcopyrite forming an exsolution pair. Galena followed shortly forming cusps and embayments in the sphalerite. Additional chalcopyrite followed, replacing galena and sphalerite, oftentimes along galena-sphalerite contacts. Finally, after another period of brecciation, late stage quartz penetrated the fractured sulfides.

The deformational characters of galena and sphalerite upon applied stress exhibit interesting patterns. Galena deforms plastically (figure 7) while sphalerite has a brittle deformational behavior. This explains the apparent inability of quartz to readily penetrate galena while numerous quartz veinlets occupy cleavage reentrants in sphalerite.

The paragenetic staging within the hydrothermal phase reflects continued cooling with time. Pyrite possibly crystallized at higher hydrothermal ranges (400° to 600° C). Galena and sphalerite did not crystallize until cooler temperature (200°to 400°C). Late stage quartz did not crystallize until temperatures dropped as low as 150° C. Following deposition of the sulfides the area was not exposed to pre-mine oxidation processes until uplift during Miocene time brought the deposit into contact with meteoric water and air.

PRE–MINE OXIDATION

Supergene Enrichment and Oxidation

As the water table eventually dropped, the sulfide minerals were exposed to oxidation by air and ground water processes. This process, known as supergene enrichment, allows concentration of certain metals above their primary values by downward circulating groundwaters which leach mineralized rocks. A good description of this process can be found in Bateman (1950, p. 274).

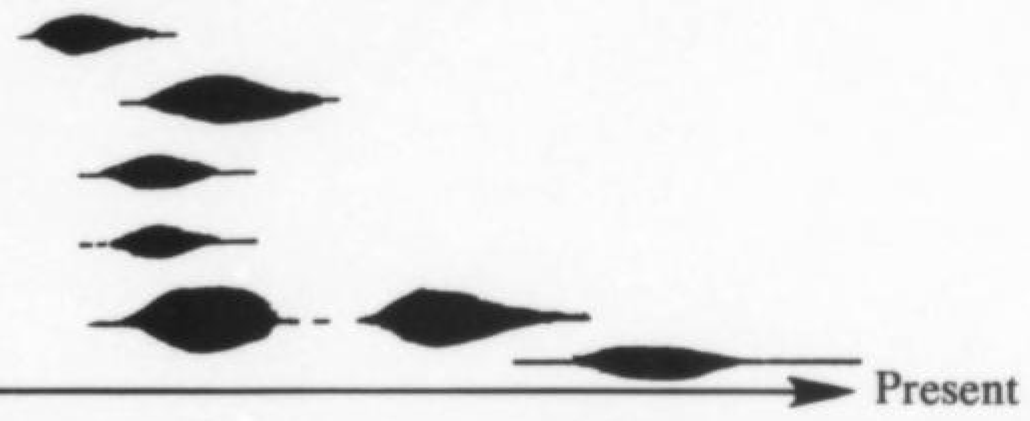
At the 79 mine the supergene enriched zone is restricted to a portion of the vein deposits in the North dike near the water table. Here a relatively neutral host rhyolite allowed a fairly high concentration of H^+ ions (i.e., a low "pH") and thereby permitted the stability of species like covellite, chalcocite and native sulfur. Oxidation processes such as these allowed the partitioning of several distinct oxidation zones each with their own attendant mineral assemblages (figure 2). With the aid of polished sections and hand specimens the paragenesis of supergene enrichment of the 79 deposit was worked out and is compiled in Table III.

Table III summarizes three distinct phases of supergene enrichment and oxidation. One or all phases may be observed on the same specimen, but the pattern is always consistent: a central sulfide core surrounded successively by a sulfate band and then a carbonate band. This is most dramatic in the case of galena where a central core of galena is enclosed by concentric rings of anglesite and cerussite respectively.

It is of interest to speculate on some of the chemical controls operating during oxidation. Figure 1 shows two

TABLE IV
OXIDATION OF RESIDUAL IONS

Mineral	Chemistry
Hematite	Fe_2O_3
Goethite	$HFeO_2$
Plumbojarosite	$PbFe_6(SO_4)_4(OH)_{12}$
Jarosite	$KFe_3(SO_4)_2(OH)_6$
Cerussite	$PbCO_3$
Wulfenite	$PbMoO_4$



Eh-pH diagrams. A description of the meaning and use of Eh and pH is given by Krumbein and Sloss (1963).

In terms of figure 1 it may be assumed that the oxidizing orebodies at the 79 mine were in an aqueous medium. Oxidation will start in a relatively high reducing environment of the sulfide field and move towards species which are more stable in the presence of water and air, i.e., an oxidized environment.

"Paths" have been superimposed upon the Eh-pH diagrams in figure 1 which hypothesize a trend of oxidation at the 79 deposit that progresses from a sulfide (x_1) through supergene sulfides, sulfates (x_2), and finally carbonates and oxides (x_3)*. The supergene paragenesis outline in Table III generally agrees with this path. Two alternative paths shown by the dashed lines has been drawn for comparison. The main difference between the two paths is the presence of some buffer to maintain the pH necessary to allow oxidation along the first path. This could be accomplished by excess sulfuric acid derived from oxidizing pyrite reacting with incoming carbonate-charged meteoric waters to form a buffer at or near the contact of the oxidizing orebody with the wall rock. In a limestone environment the decomposition of calcium carbonate will buffer the solutions at a pH of 8.4 so a pronounced rise of pH across the mineral bands $PbS : PbSO_4 : PbCO_3$, etc., will exist.

Aside from the paragenetic agreements three facts support the choice of this first path as opposed to the path indicated by the dashed line. First, if the deposit oxidized along the alternative path, one would predict the occurrence of appreciable amounts of cuprite and copper. In point of fact, none was found. Second, if the deposit oxidized along the proposed path one would expect sulfate-charged ground waters circulating within the oxidizing orebody. This prediction is confirmed indirectly by the presence of abundant hydrated sulfates growing from tunnel walls where they cross areas of disintegrating sulfides. This is not to say that pre-mine oxidation paralleled post-mine oxidation. It only indicates that sulfate-charged waters probably existed for a short time during oxidation. Third, for the proposed path to occur there must be enough pyrite to generate the free acid required to maintain the buffer. Inspection of the 79 assemblage confirms the presence of more than the minimal amount of pyrite required.

Given that the 79 ore did oxidize along this path, pyrite sooner or later decomposed. Once this happened, the buffer broke down and carbonate-charged ground water quickly neutralized the oxidizing ore at a relatively constant Eh to move from the sulfate field to the carbonate field. This is confirmed by the observation of carbonate rings surrounding sulfate rings.

Final Oxidation

As the sulfides continued to oxidize the sulfur radical was continually depleted and replaced by more stable oxidized species. Now in an environment of strong neutralizing power, iron precipitated as fluffy limonite or remained as indigenous limonite, oftentimes in a quartz skeleton which had resisted supergene processes. Zinc and copper were effectively put into solution as soluble zinc and copper sulfates, which were removed from the now largely oxidized sulfides. The occasional occurrence of melaconite and chrysocolla lining fractures above and below the oxidized bedded replacement orebodies contrasts the mobility of zinc, copper and lead. The more readily soluble copper migrated a short distance while lead remained *in situ* in the form of cerussite. Consequently, examination of the orebodies where they oxidized in place revealed a relatively simple paragenesis (Table IV).

It is then in the fracture and breccia zones where introduced and resident ions intermingled to produce the complex and varied secondary suite so sought after by collectors. In Table V the paragenesis is worked out for each of the two principle solution channelways: the wulfenite area in the Main fault and intersection of the 79 breccia system with the 3rd, 4th and 470 levels.

By inspection of Table V, one can see that the two parageneses are similar except that the mineralogy in the Main fault lacked the carbonate and late oxide phases. The silicate, molybdate and arsenate parageneses are similar and appear to have been introduced at similar times. Sec-

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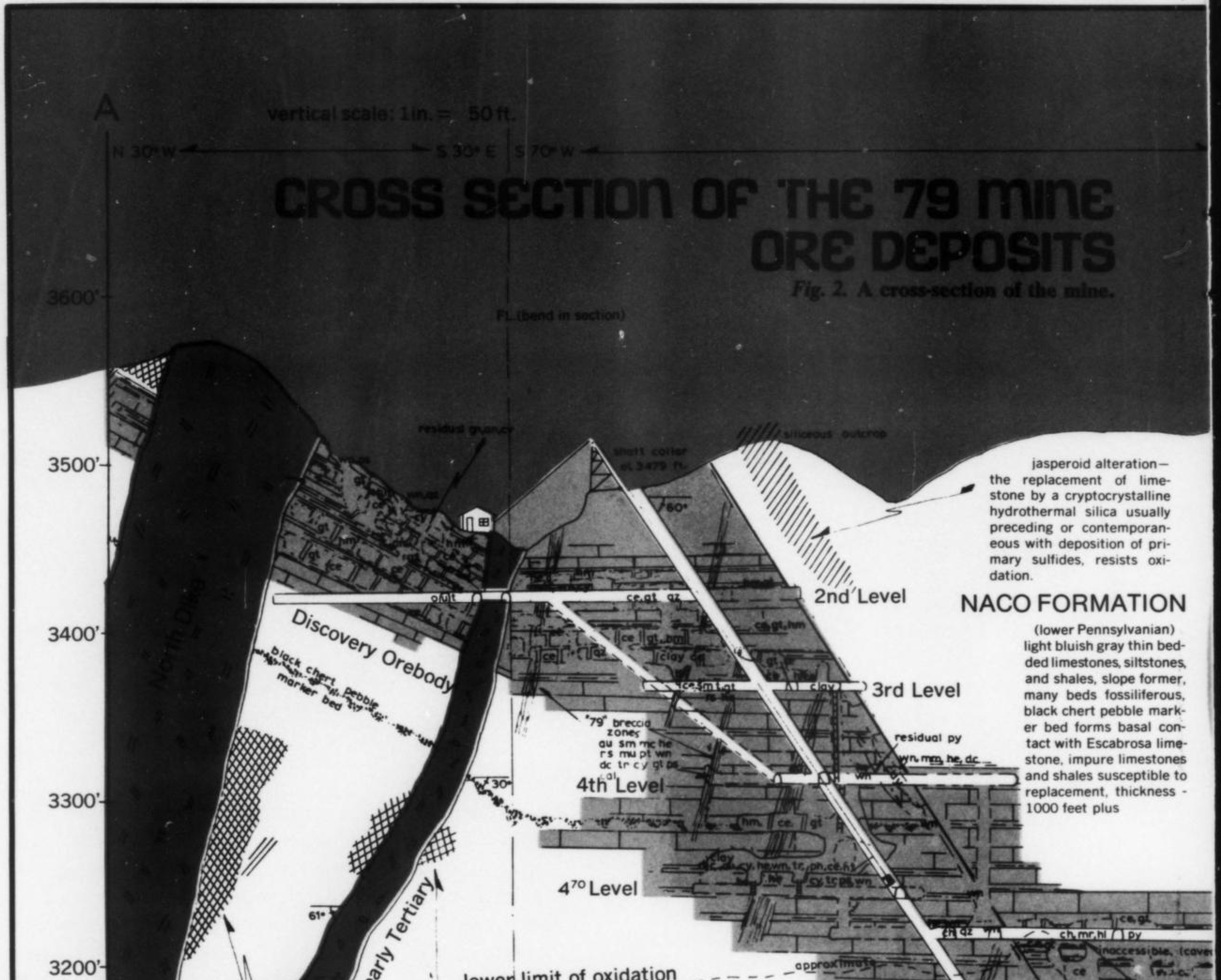
*Note: Eh-pH diagrams are often used to describe oxidation processes. It should be kept in mind that their use is quite problematic since many other parameters affect stability fields (percolation rates, gangue material, relative concentration, etc.). Nevertheless, Eh-pH diagrams serve quite well as 1st order explanatory tools and fit at least qualitatively into discussions of oxidation.



CROSS SECTION OF THE '79 MINE ORE DEPOSITS

Fig. 2. A cross-section of the mine.

jasperoid alteration—the replacement of limestone by a cryptocrystalline hydrothermal silica usually preceding or contemporaneous with deposition of primary sulfides, resists oxidation.

NACO FORMATION

(lower Pennsylvanian)
light bluish gray thin bedded limestones, siltstones, and shales, slope former, many beds fossiliferous, black chert pebble marker bed forms basal contact with Escabrosa limestone, impure limestones and shales susceptible to replacement, thickness - 1000 feet plus

contact metamorphism—local alteration of enclosing rock by ascending intrusives; grossular garnet, epidote tremolite, and other moderate to high temperature minerals comprise what is often called skarn

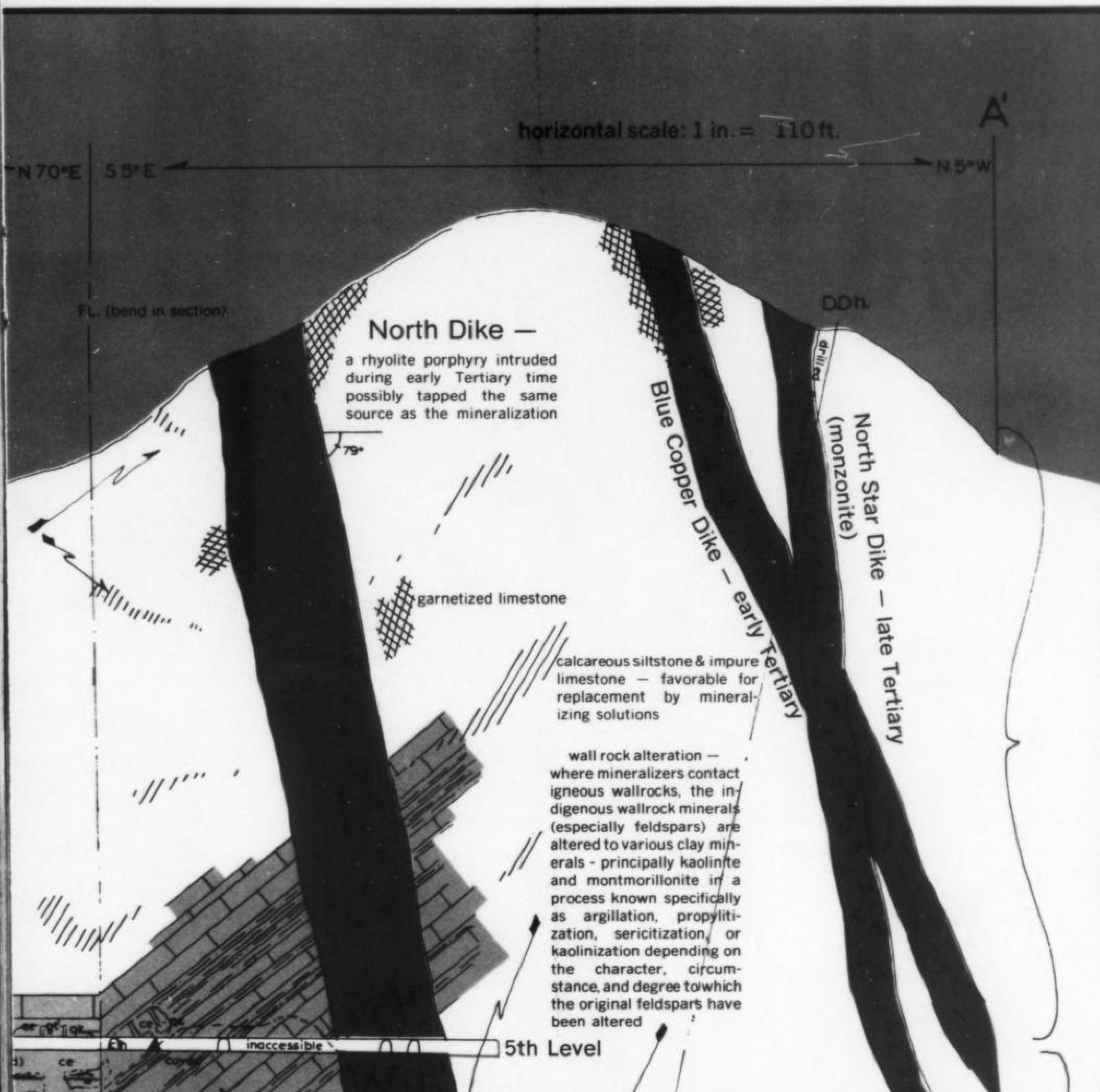
ESCABROSA LIMESTONE

(lower Mississippian)
light gray to dark blue limestone, forms prominent massive cliffs, abundant corals, pinksih brown slope forming upper member, white marker bed one third up from base of formation, less commonly mineralized than Martin limestone or Naco formation, thickness-475 feet

oxidation generally absent below this line — oxygen and downward percolating surface waters are no longer free to circulate

MARTIN LIMESTONE

(upper Devonian)
thin bedded yellow to dark gray slightly magnesian limestone, forms slopes, fossiliferous red siliceous shale member near lower Escabrosa contact, dolomitic lower member often replaced, thickness-360 feet



North Dike — a rhyolite porphyry intruded during early Tertiary time possibly tapped the same source as the mineralization

calcareous siltstone & impure limestone — favorable for replacement by mineralizing solutions

wall rock alteration — where mineralizers contact igneous wallrocks, the indigenous wallrock minerals (especially feldspars) are altered to various clay minerals - principally kaolinite and montmorillonite in a process known specifically as argillation, propylitization, sericitization, or kaolinization depending on the character, circumstance, and degree to which the original feldspars have been altered

sulfatization — a process common in dry climates, occurs when waters enriched in iron and copper sulfates come into contact with dry air inducing evaporation, supersaturation, and subsequent crystallization of various hydrous copper and iron sulfates as efflorescenses encrustations, and stalactites

on old mine workings possible down dropped portion of Discovery Orebody (stratigraphic reconstruction)

GOSSAN

This moderately heavy accumulation of limonitic material, derived principally from the complete oxidation in place of sulfides below, locally extends down several feet from the surface. Gossan may contain casts and boxworks of original sulfides.

OXIDE ZONE

Except as scattered residual sulfides, (galena and pyrite) and resistant quartz, the primary minerals have disappeared. Characteristically, galena and pyrite tended to oxidize in place while the more readily soluble zinc and copper oxidation products migrated. Vagrant arsenic, molybdenum, manganese, and phospherous ions, presumably carried by circulating ground waters, combined with indigenous ions forming an impressive secondary mineral suite.

TRANSITION ZONE

Found here are mixed primary sulfides and minerals of the oxide zone. Oxidation varies laterally & vertically and flow rates, porosity and permiability, Eh and pH, etc.

SUPERGENE ENRICHMENT

During this first stage of oxidation pyrite in the presence of air and water is oxidized to ferric sulfate and sulfuric acid which in turn are the chief reagents in the oxidation of primary sphalerite, chalcopyrite, and galena to supergene chalcocite, covellite, and anglesite.

HYPOGENE ZONE

Here primary sulfides are free generally of supergene processes. Careful study of hypogene minerals and textures can therefore yield knowledge of the composition and environment of deposition of the original hydrothermal fluid.

Fig. 3. **The 79 mine area as seen from the East. Note cement plug in main shaft in lower left center.**

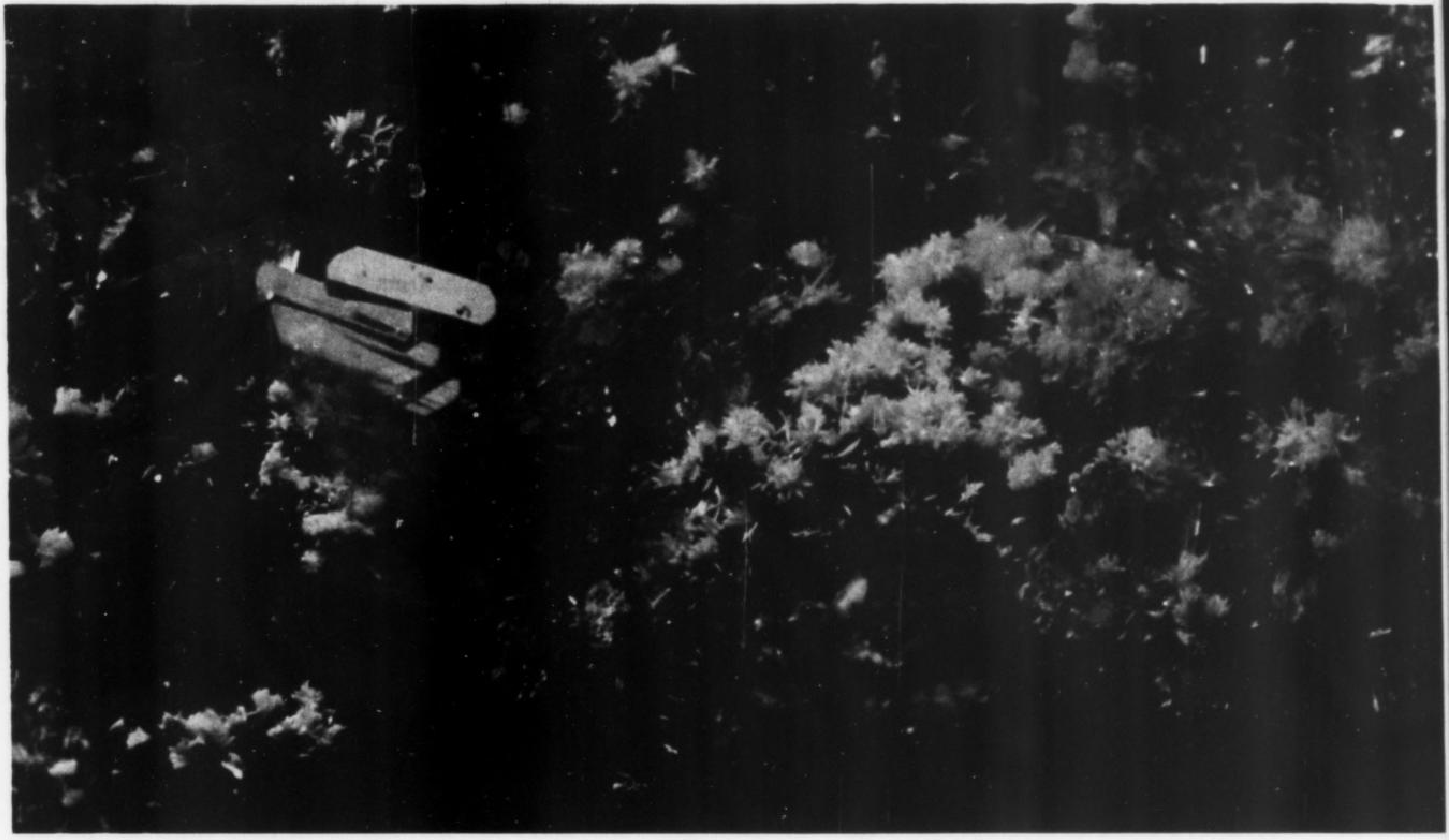


Fig. 4. **Wulfenite, mimetite, rosasite and hemimorphite on wad. Wulfenite crystal is 3/16 inch across. From the collection of S. B. Keith. Photo by the author.**

Fig. 5. **Twinned cerussite from the 5th level. Crystal is 3/8 inch tall. From the collection of Thomas Trebisky. Photo by the author.**

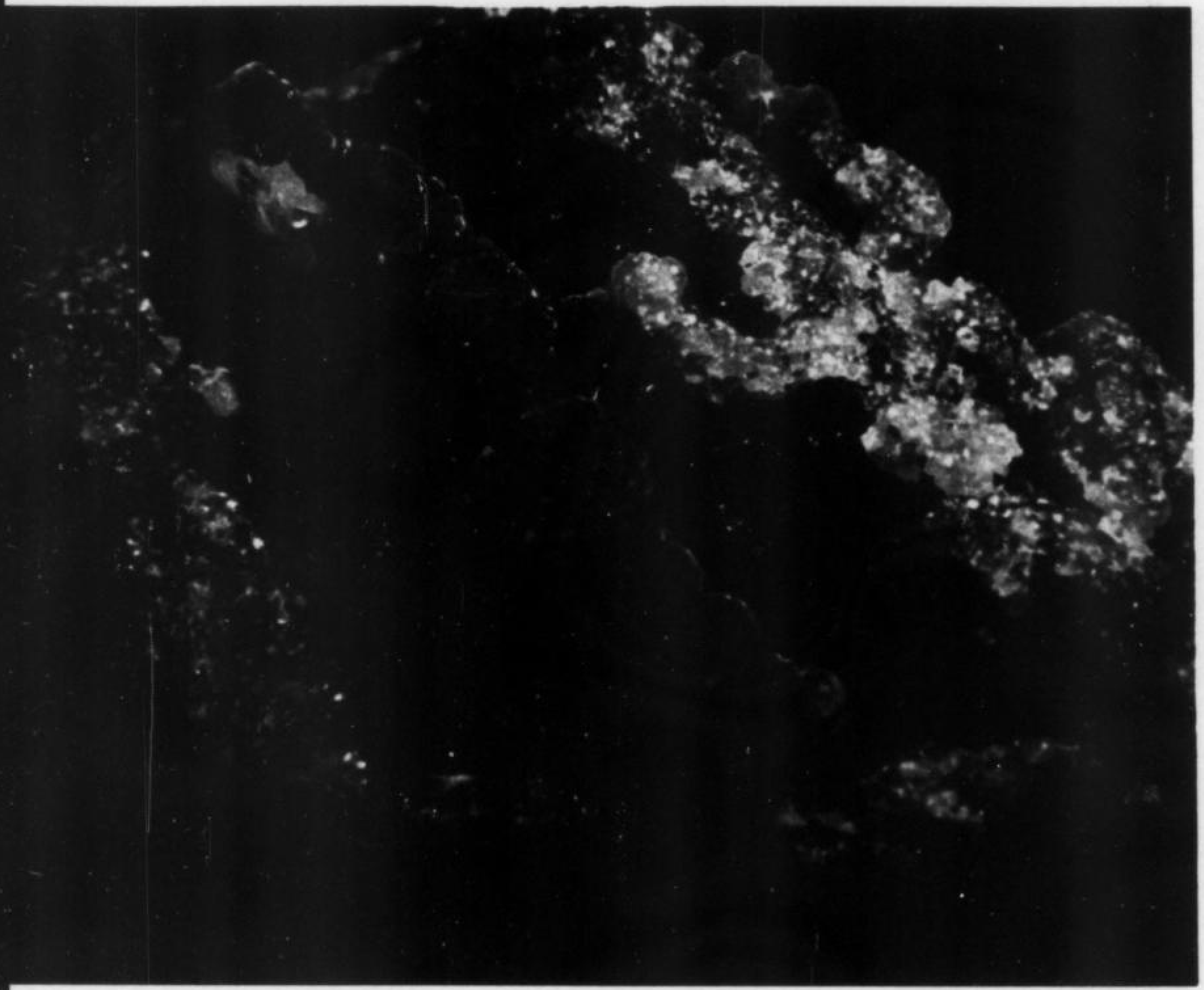


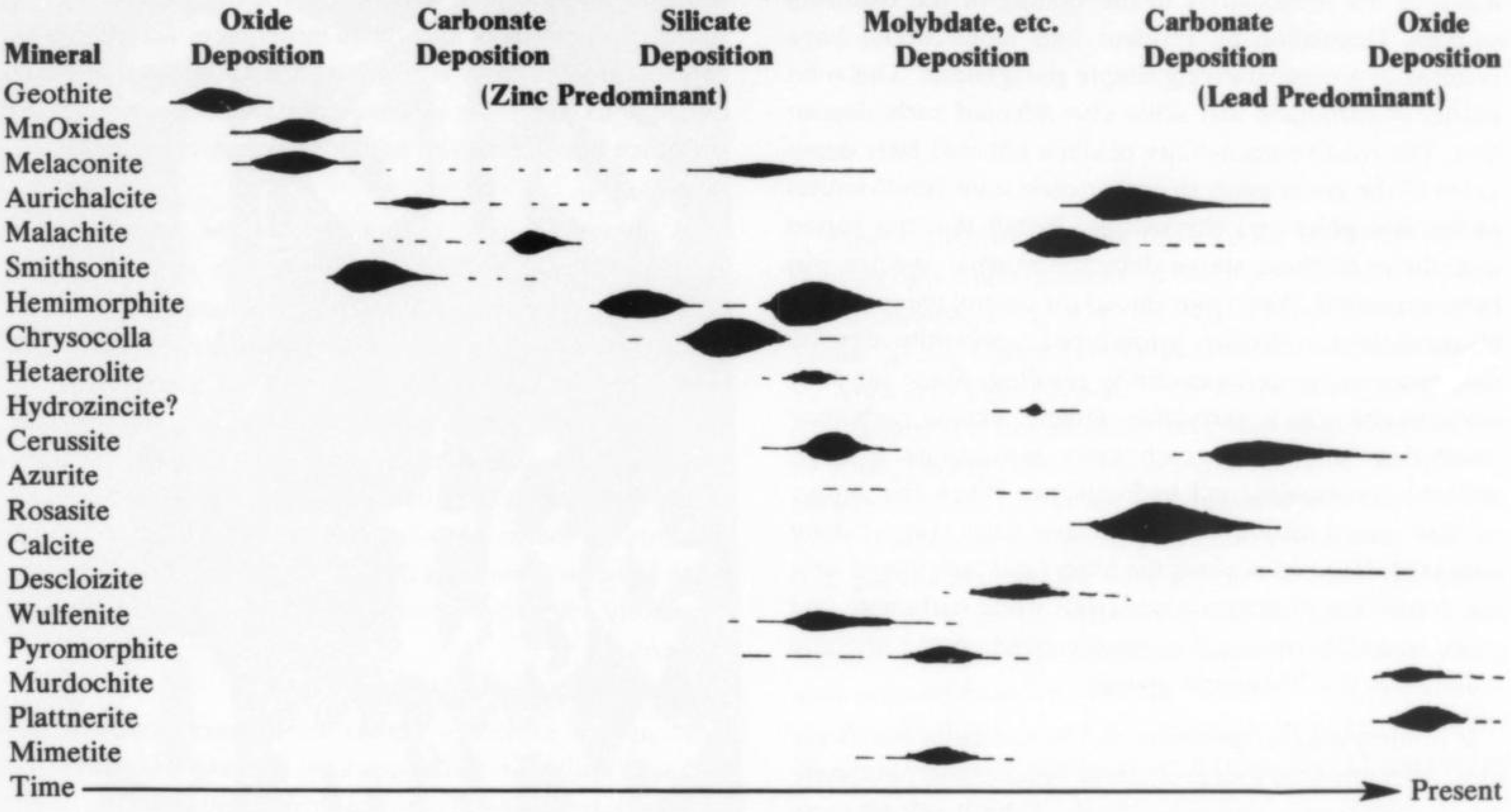
Fig. 6. Smithsonite from the 4th level. From the collection of S. B. Keith. Photo by J. Jacobson.

Fig. 7. Deformational characteristics of galena. Note triangular cleavage pits. Photomicrograph by the author. 80X.

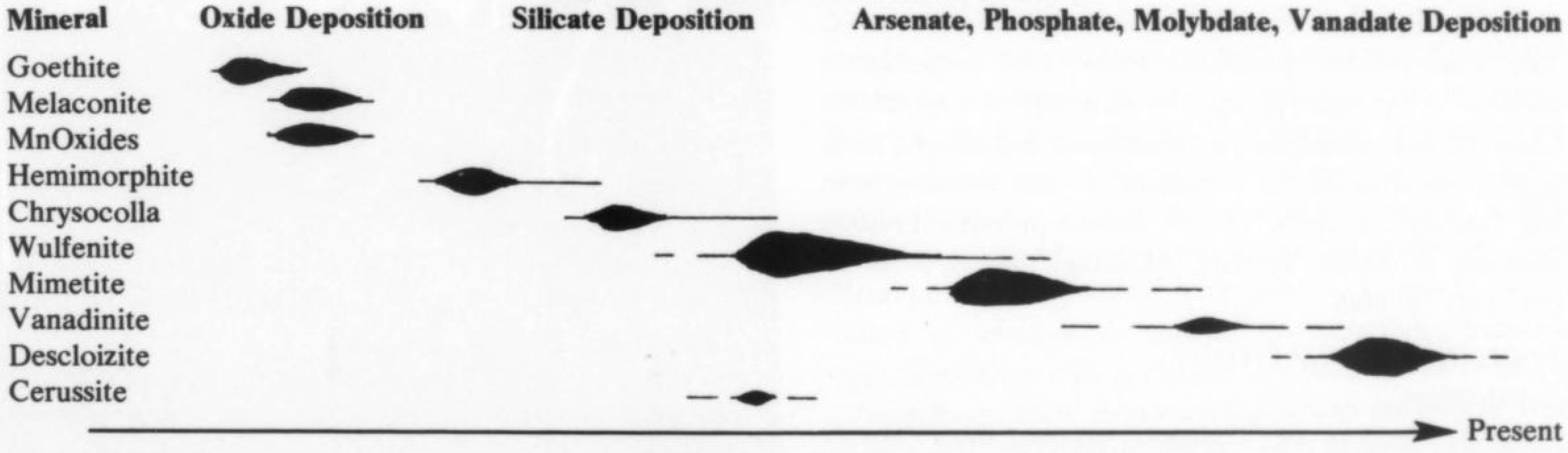
Fig. 8. Halotrichite, 6th level. Specimen is two inches across. From the collection of S. B. Keith. Photo by the author.

TABLE V OXIDATION OF TRANSPORTED IONS

Paragenesis in the 79 Breccia System (3rd, 4th and 470 Levels)



Paragenesis in the Main Fault (4th Level)



ondary mineral paragenesis in other fault zones is surprisingly consistent with those that are summarized in Table V.

That deposition occurred in an aqueous medium is indicated by the compositional fact that the majority of secondary species present have essential water or hydroxyl incorporated in their structures. The existence of stalactitic depositional textures — particularly in geothite and mimetite — also confirms the presence of an aqueous depositional medium. Deposition occurred after the last movements along the faults since the crystals are free standing and there is no evidence of fractured or rehealed crystals. Since crystal growth was not interrupted by physical deformation and depositional periods persisted over relatively long time intervals, many species are well developed in size and of high quality.

The presence of permeable channel ways and available ions in solution resulted in the lengthy paragenesis presented. Undoubtably, the paragenesis reflects to a greater or lesser extent the solubilities of the primary sulfides. The easily soluble zinc cation, not unexpectedly, was the first to leave and the first to be deposited in the post-sulfide solution channels primarily as hemimorphite and smithsonite. Copper was incorporated as zinc became impoverished resulting in chrysocolla, aurichalcite, rosasite, malachite and murdochite. The relatively insoluble lead arrived later and is indicated by intermediate wulfenite and late stage cerussite, pyromorphite and murdochite.

A similar characterization may be given of the anion groups. Excluding oxygen, carbonate and silicate were materially the most predominant anion, followed by the molybdate, arsenate, phosphate, and vanadate anion groups respectively. Carbonate and silicate deposition was well advanced before the appearance of the molybdate ion formed wulfenite. Hence, distance traveled as well as primary solubilities were important factors governing the appearance of the various anions. Presumably, the molybdate, arsenate, phosphate and vanadate ions issued from a source not immediately in the vicinity of the oxidizing sulfides. Deposition by resident ions alone would have resulted in a comparatively simple paragenesis. The solubilities of carbonate and silica also affected early deposition. The relative insolubility of silica effected later deposition of the anion upon an earlier carbonate (smithsonite) as hemimorphite and chrysocolla. Recall that the cation availability in these stages determined what species was to be deposited. When introduced (or exotic) anion assemblages arrived, wulfenite, pyromorphite, mimetite, descloizite, mottramite, and vanadinite resulted. Since the host environment was a carbonate gangue, excess carbonate resulted in the later stage carbonates, aurichalcite, rosasite, malachite, cerussite, and hydrozincite. When the supply of base metal cation was exhausted final stage calcite appeared. Deposition along the Main fault terminated with the deposition of arsenate materials while carbonate and oxide material continued to be deposited on the arsenate minerals in the 79 breccia system.

It is interesting to speculate on the source of the exotic ions. An immediate source of the molybdate and phosphate ions is the disseminated molybdenite of the North dike and accessory apatite of numerous nearby dikes. The source of the vanadate and arsenate cations is a little more subtle. The dikes contain significant amounts of magnetite, a member of the spinel group. The structure of a spinel can brian diabase; vanadium, molybdenum, and arsenic from nearby ore deposits; or vanadium in trace amounts from the Tertiary volcanics. The 79 deposit probably finished oxidizing in middle Tertiary (Miocene) time to await its discovery by man.

POST-MINE OXIDATION

Sulfatization

Development of the 79 deposit exposed the relatively unstable sulfides to new forms of oxidation. The abundant hydrated sulfates on the lower levels were formed by a post-mine process known as sulfatization. A process common in dry climates where underground workings penetrate primary sulfides, sulfatization happens when downward percolating meteoric and acidic groundwaters alter the sulfides (principally pyrite) in the presence of air, i.e., above the water table. The waters subsequently become enriched with iron and copper ions. When these relatively saturated solutions encounter dry air in mine workings they contain a variety of cations. Vanadiferous spinels are known and it is possible that vanadium substituted for iron to a limited extent. Arsenic may have been present as trace amounts in the original ore even though arsenopyrite has not yet been reported. More remote sources for the exotic ions may have been vanadium in the magnetite of Precam- rapidly evaporate to become supersaturated. This causes the waters to "drop their load" resulting in the crystallization of various hydrated copper and iron sulfates as encrustations, efflorescences, and even stalactitic forms on timbers and tunnel walls. The occurrence of such sulfates is limited to portions of sulfide concentrations that are intersected by tunnel cuts on the lower levels where the normal processes of supergene enrichment are effectively preempted by those of sulfatization. Sulfatization is analogous to processes of cave formation except that sulfides are being dissolved and not calcium carbonate.

Conclusion

A unique geologic setting allowed the complex interactions between wall rock, sulfides, air and water that eventually gave rise to the variable mineralogy at the 79 mine. Like many other mines the bulk of the oxidized zone at the 79 mine is of little interest to the collector, comprising a relatively simple mineralogy of which only cerussite may alert the collectors' eye. It is clearly within the fault zones that the right circumstances produced the mineral assemblage that confers fame to the deposit. It is through such fortunate accidents that collectors have benefited and hopefully will continue to benefit from a most fascinating mineralogy.

ACKNOWLEDGEMENTS

The author expresses thanks to Richard Bideaux and John S. White, Jr. and especially Richard Thomssen for critically reviewing the manuscript. Appreciation is extended to Thomas Trebisky and Thomas Mitchell for x-ray diffraction work, and Jim Jacobson for photographic help. I also thank my wife, Susan, for her editing and typing of the various drafts.

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Note added in proof: Recent investigations of new polished sections cut of sulfides from a raise in the 31 stope have established the presence of two new minerals for the 79 mine — tennantite and bornite. Tennantite is late in the hypogene paragenesis replacing galena and veining late stage chalcopyrite. The presence of tennantite locates an immediate source of arsenic for the olivenite, and more remotely for the arsenates up in the oxidation zone. Bornite is present as small supergene veinlets replacing chalcopyrite. Bornite is replaced by chalcocite as would be expected in the path on the Eh-pH diagram.

Folio: the 79 mine

by Wendell E. Wilson

Most collectors consider the 79 mine to be one of the eight or ten finest sources of wulfenite in Arizona and the Southwest, along with the Red Cloud, Rowley, Old Yuma, Glove, Hilltop, Defiance, Bennet, and Mammoth-St. Anthony (Tiger) mines. Truly magnificent specimens of a variety of other minerals have also been found at the 79 mine. Perhaps due to the relative rarity of fine pieces, eastern collectors are often unacquainted with the locality. But collectors in the West, particularly wulfenite specialists, are familiar indeed with specimens from this mine. Offered here, as the *Mineralogical Record's* first color feature, is a portrait collection devoted to some rarely seen mineral beauties from the 79 mine.

A trained eye can usually recognize specimens from the 79 mine; wulfenite, for instance, is frequently characterized by a unique red spot in the center of the yellow crystal plates (see cover painting). Aurichalcite ranges in color from a delicate sky-blue like that of the familiar Mexican specimens, to the deepest, richest blue-green found anywhere in the world. These aurichalcite crusts are sometimes so thick and firm that they support themselves entirely without matrix. More often the aurichalcite is found as sprays on manganese oxides or hemimorphite. Yellow or green crusts of smithsonite similar to specimens from Laurium, Greece, occur here too, occasionally embellished by aurichalcite sprays. An amazingly beautiful specimen of this type is pictured on page 174 of Hurlbut's *Minerals and Man.* Hemimorphite crusts ranging in habit from colorless crystal druses and balls to Kelly smithsonite look-alikes are yet another distinctive feature of this locality. These and other minerals (see Keith, this issue) in good crystallizations are not common on the mineral market.

The appeal of 79 mine specimens probably accounts in part for their failure to spread across the country and the world. Most people simply do not want to part with their specimens at any price (the author included), and when the original collectors themselves feel this way, commercial distribution is, of course, impossible. The recent (physical!) closing of the mine can only increase the scarcity of specimens. Collectors today should stay away from the 79 mine or risk being arrested and heavily fined.

The most intensely collected areas in the mine have been on the third and fourth levels and workings in between, pictured in figure 1. This small area is the origin of nearly all of the high-quality specimens that have made this mine one of Arizona's classic localities.

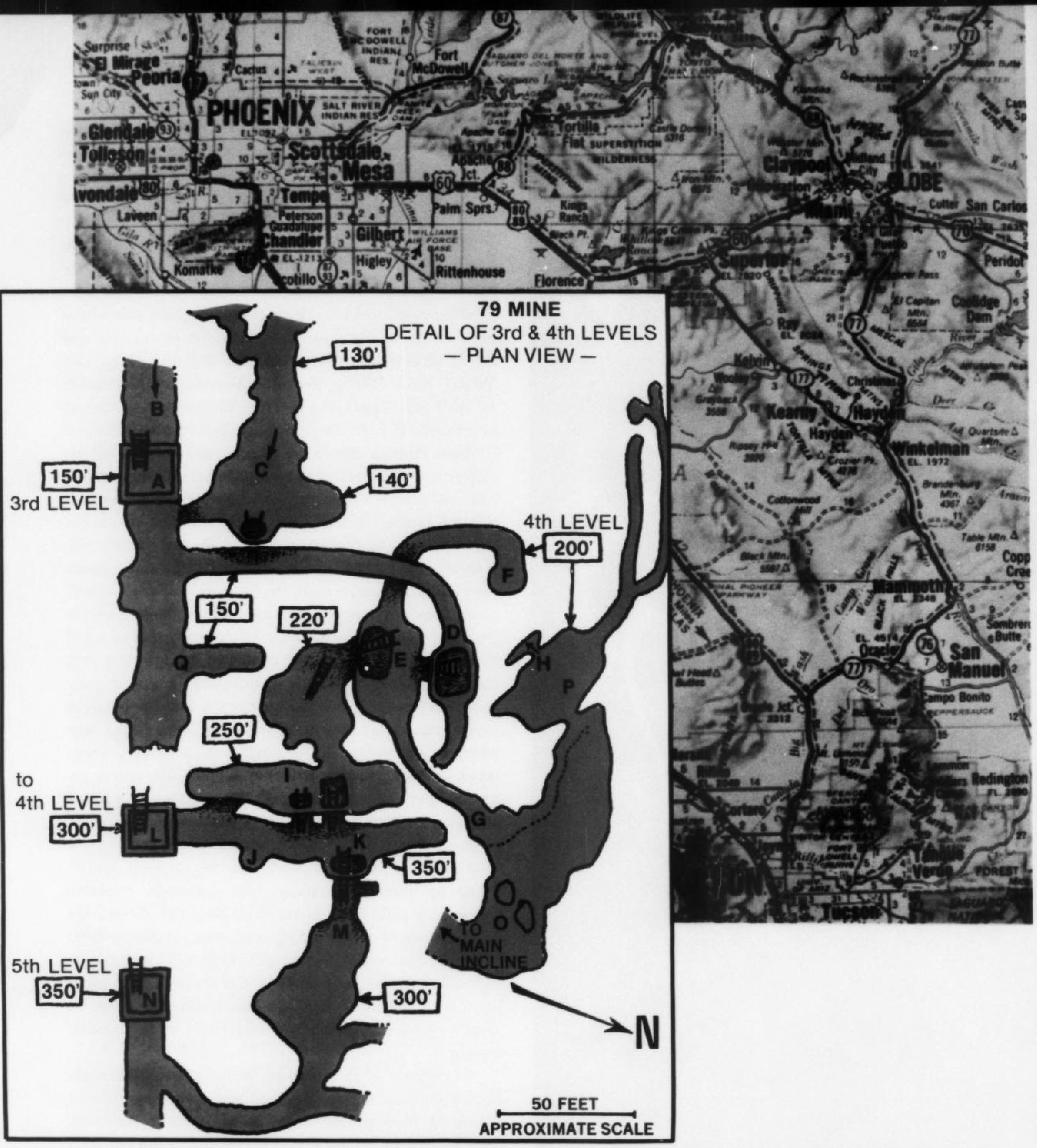


Fig. 1. **A detailed plan view of the third and fourth levels, and workings in between, plus a map covering much of Arizona's best collecting country. Within the boundaries of this area can be found such classic localities as the Apache, Ray, Old Yuma, Magma and Tiger mines, as well as the 79 mine, which is indicated near Hayden.**

Entry in the past has been accomplished by two routes: the main incline (A, L, and N are where the incline intersects various levels), and the lower entrance which leads to B and C. Both entrances are now sealed. Position G, near the entrance to the wulfenite stope, is the most dangerous because of rotted timbers and imminent cave-ins. Chrysocolla is abundant at I and J, rosasite has been found near E and F, and cerussite near C and Q. Other locations are referred to in following figures. Of course many more minerals than those mentioned are found at each of the localities; only the best species for collecting are noted. The foot readings are distance below the surface and can be measured in the mine by counting ladder rungs while descending the main incline.

In a few years it is hoped that arrangements can be made to reopen the mine to collectors. The complexity of the workings is evident; collectors should find the detailed directions given here, and in the companion article by Keith, invaluable.

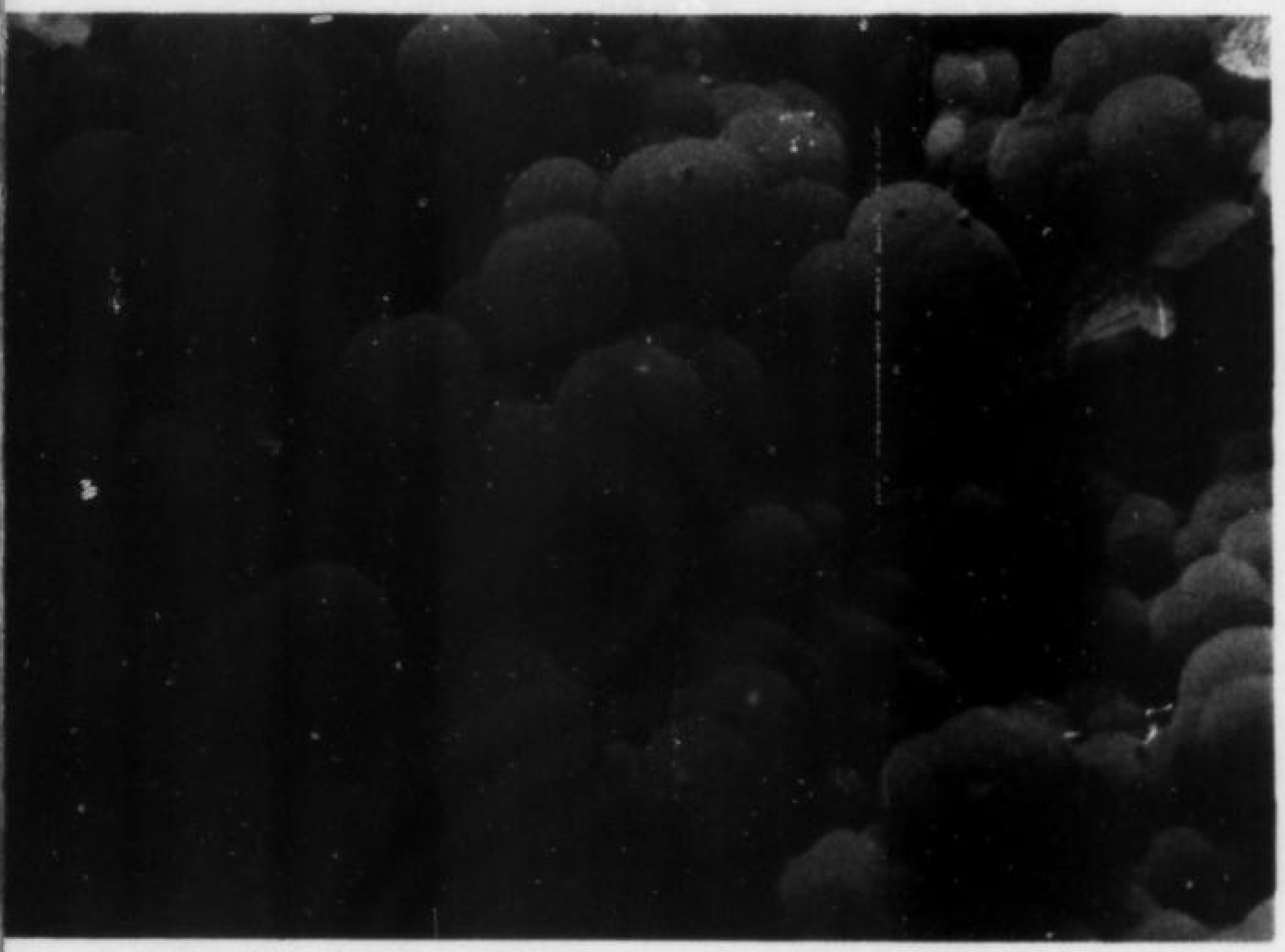


Fig. 2. Mimetite, 4th level. Large balls are 3 mm. From the collection of Stanley B. Keith. Photo by S. B. Keith.

Fig. 3. Wulfenite on mottramite, location H. The crystal measures about 2 x 1 cm, and shows a tiny red center spot. From the Brooks Davis collection, now owned by the Smithsonian Institution. (photo by the author)

Fig. 4. Wulfenite on chrysocolla with mimetite from the 4th level. Crystal is 5 mm on an edge. Collected, owned and photographed by Stanley B. Keith.

Fig. 5. Richly-colored aurichalcite from the aurichalcite room, location F. The specimen is about 7-1/2 cm. tall (and can be seen in the lower left corner of the flat in fig. 7). From the collection of the author. (photo by the author)

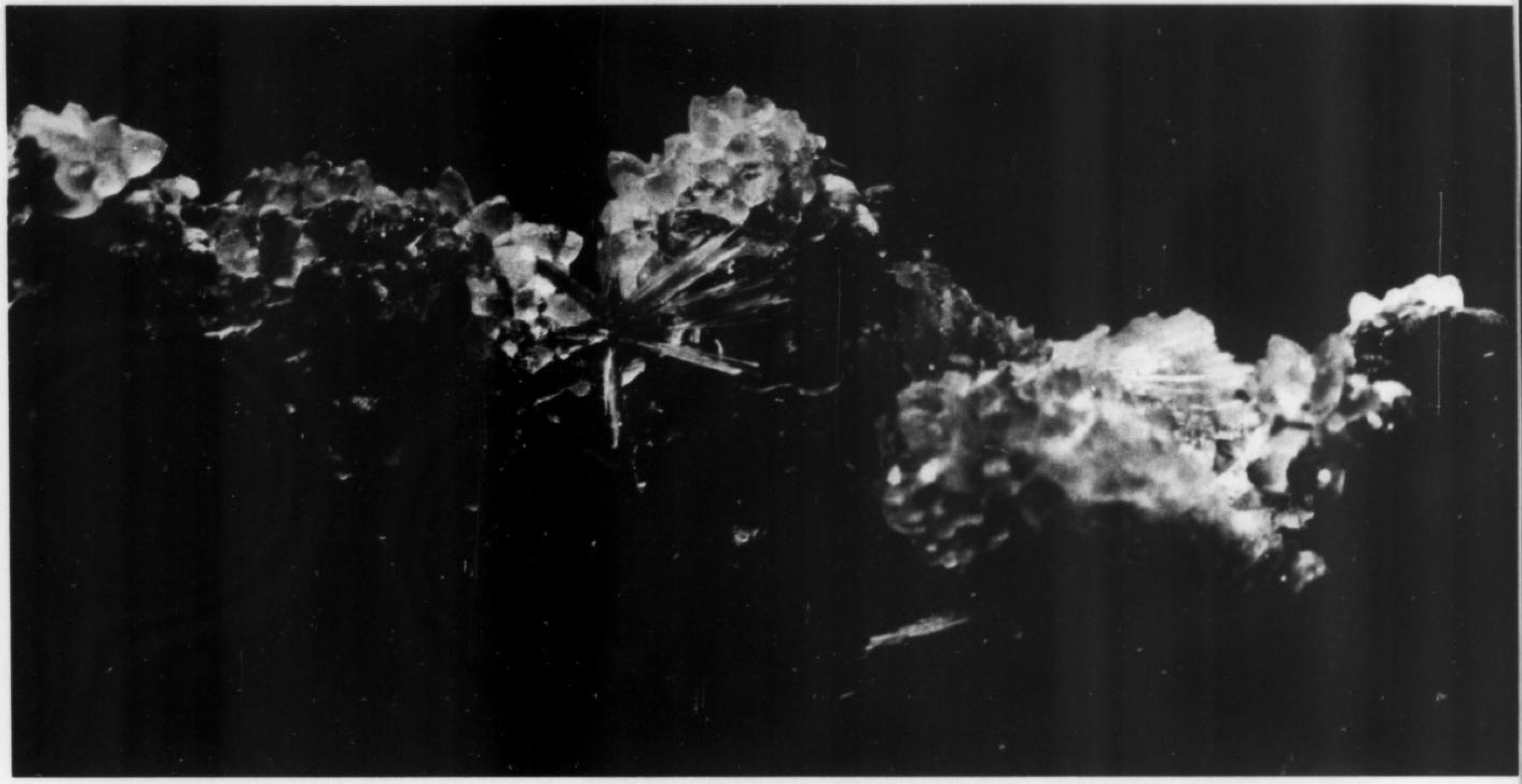


Fig. 6. Smithsonite and aurichalcite from location F. The smithsonite "crystal" near the center measures about 2 mm and is actually a group of sub-parallel crystals as shown in fig. 11. Smithsonian Institution specimen. (photo by the author)

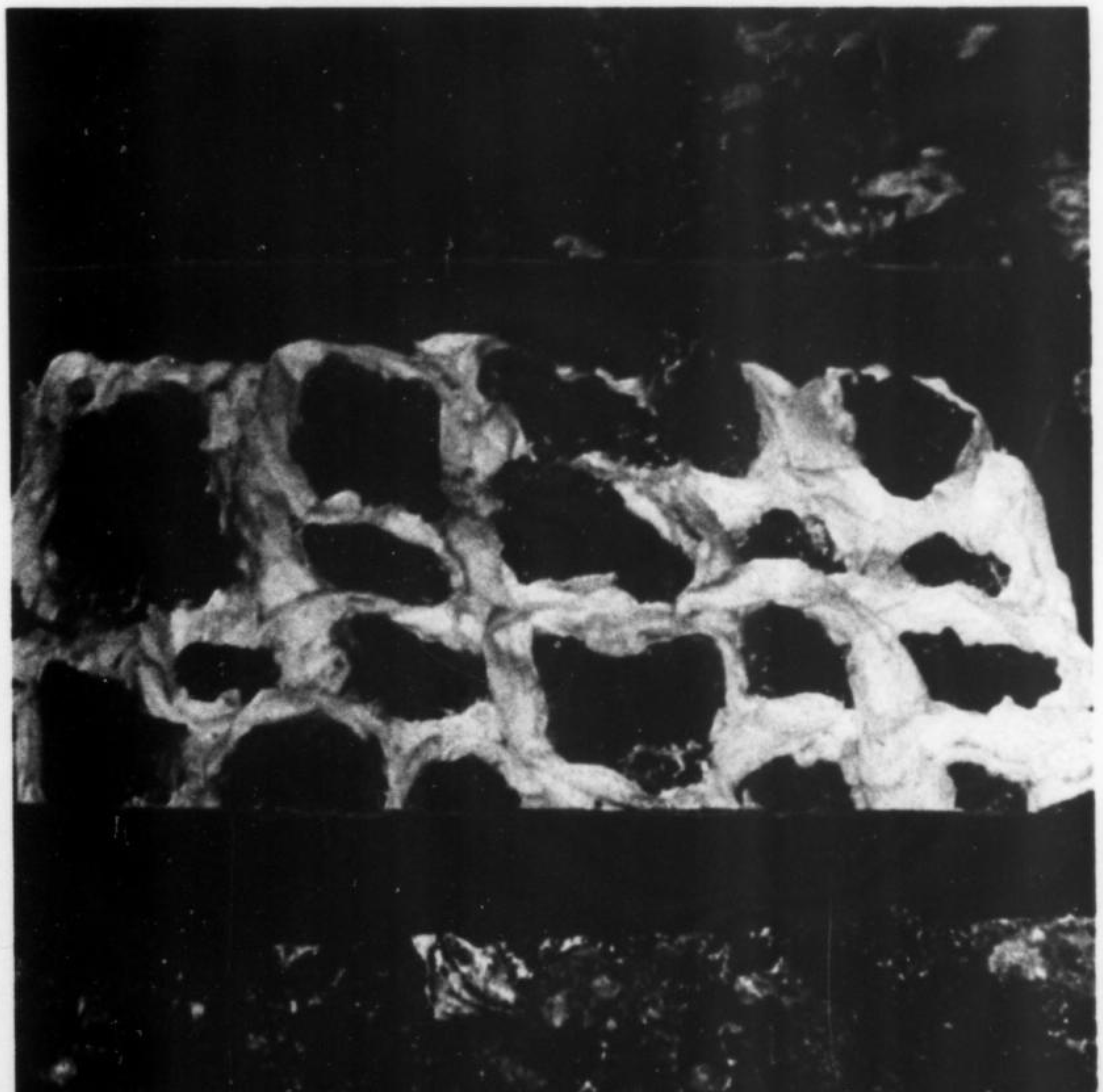


Fig. 7. A flat of aurichalcite shortly after it was removed by the author from the ceiling of the aurichalcite room, designated as location F in fig. 1. This room has yielded the best aurichalcite ever found in the United States. (photo by the author)

Fig. 8. Hemimorphite resembling Kelly mine smithsonite, location K. The specimen, from the collection of Reo Pickens, is about 6-1/2 cm tall. Another fine specimen of this mineral from the 79 mine is pictured on page 31 of *Arizona Highways* magazine, May, 1972. (photo by Reo N. Pickens Jr.)

Fig. 9. Chrysocolla pseudomorphs, probably after smithsonite, from location I. The field of view is about 8 x 12 mm. Collection of Reo Pickens. (photo by Reo N. Pickens Jr.)

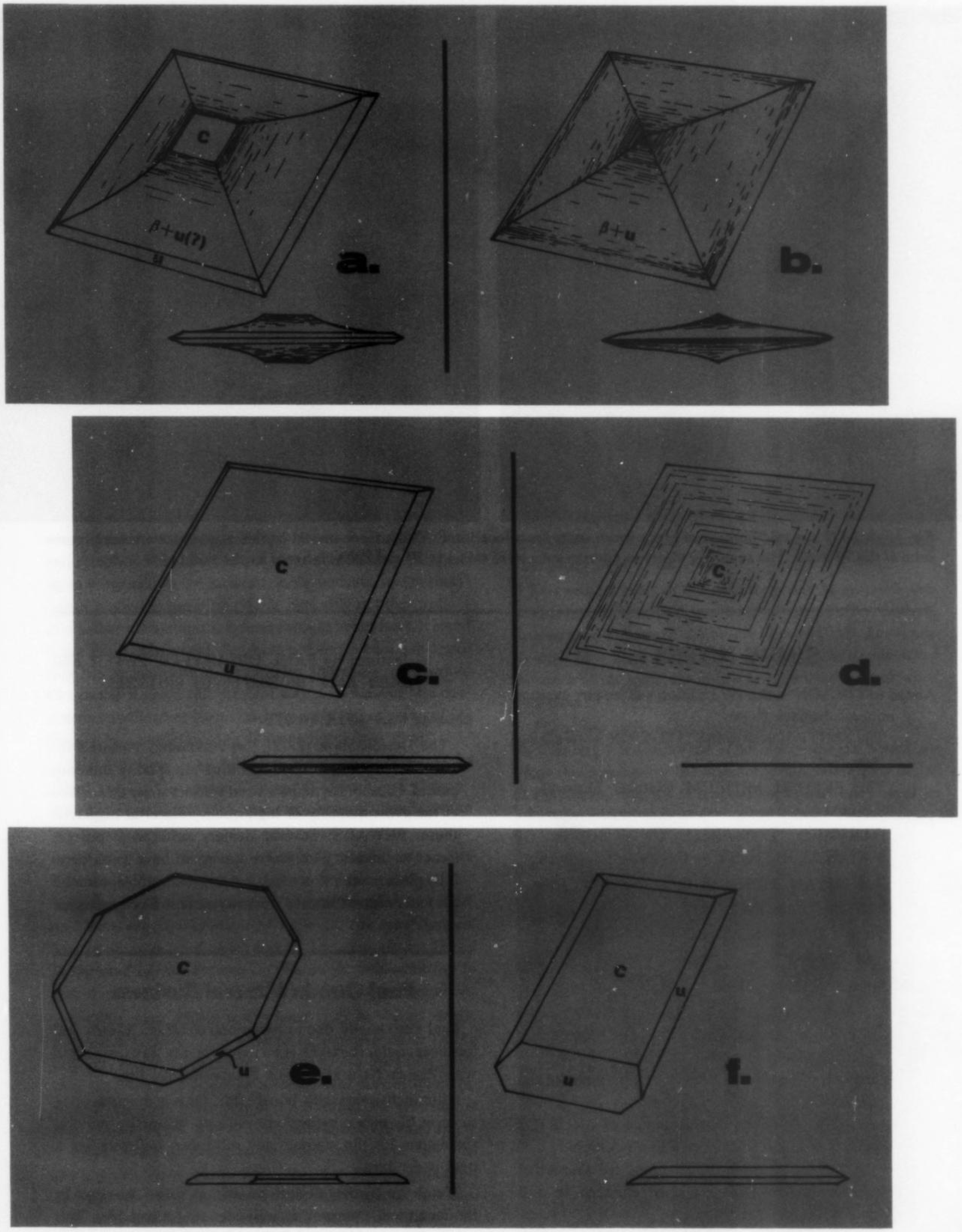


Fig. 10. **Common wulfenite crystal forms at the 79 mine. Crystals similar to (a) most often bear the red center spot. Habits (b) and (c) are sometimes paper thin. Colors range from palest yellow to red-orange.**

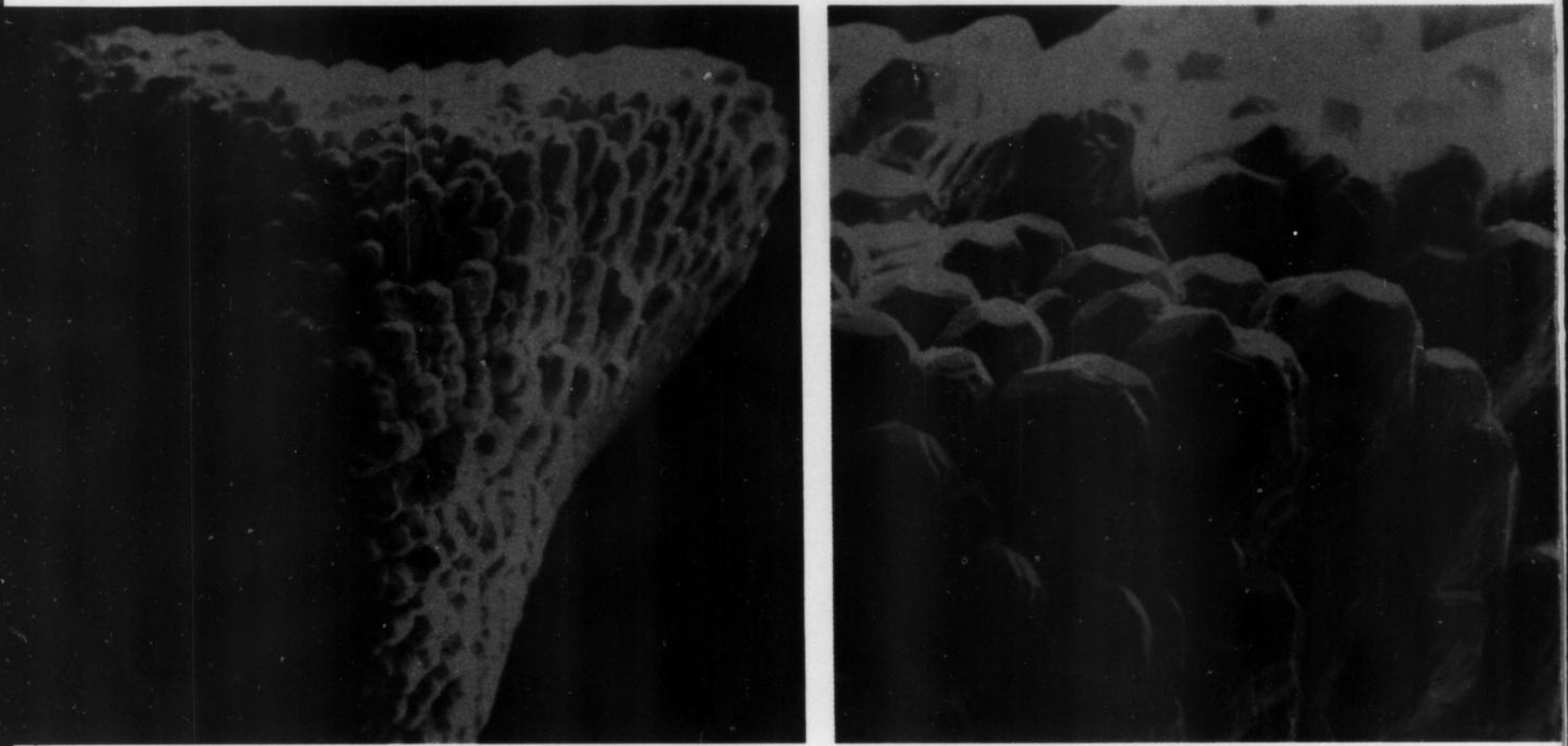


Fig. 11. **A 1-1/2 mm micromount of green smithsonite from location F. These three-armed crystal aggregates are fairly common at the 79 mine. The scanning electron micrographs were taken at 50 and 200X. (photos by the author)**

SHOW NOTES ...

Ahead to TUCSON — the 1973 edition will feature exciting mineral displays from:

The SMITHSONIAN INSTITUTION — Washington, D. C.

The BRITISH MUSEUM (Natural History) — London

HARVARD UNIVERSITY'S MUSEUM OF NATURAL HISTORY — Cambridge

AMERICAN MUSEUM OF NATURAL HISTORY — New York City

The LOS ANGELES COUNTY MUSEUM — Los Angeles

Additional features include:

- competition for the awards sponsored by the Friends of Mineralogy for the best junior and adult educational exhibit
- many fine private displays in competition for the *Ed McDole Trophy*
- competition for the best specimen of AZURITE and/or MALACHITE; open to all comers
- the *Bob Roots Memorial Trophy,* for thumbnail specimens only and limited to children 16 and under
- displays from the collections of well-known collectors from all over the country
- lectures by PAUL DESAUTELS, PETER EMBREY AND DR. CLIFFORD FRONDEL

Looking back at DETROIT —

The Detroit Show (1972), just concluded, featured the most outstanding accumulation of top quality minerals east of Tucson. Participants and visitors were astonished at the great quantity of high quality material displayed there. BEWARE! Several dealers suffered important losses to thieves. The thefts appear to have been carefully planned and executed, not the work of cleptomaniacs and random "lifters." Security cannot be overemphasized.

Paul Otto in Mineral Business

Paul Otto would like to announce to all his friends and business contacts that he is no longer in any way connected with Ward's Natural Science Establishment, Inc.

After eight years with Ward's, Mr. Otto is now planning to form his own company specializing in quality mineral specimens for the average and advanced collector on a mail order basis.

Watch for further notices on this as plans develop. In the meantime everyone is welcome to contact Mr. Otto at his home address of 222 Oakwood Rd., Rochester, New York, 14616.

What's New in Minerals?

by John S. White Jr.

MELANTERITE

Causing consternation at a recent show was some new material from Ducktown, Tennessee — melanterite in groups of large (at least one inch on an edge), transparent, green-blue, pseudo-octahedral crystals. The specimens are very attractive and would make superb display pieces for a mineral cabinet except for two problems, and I don't know which is the more serious. Problem 1 is that the crystals are unstable and will lose water, becoming white and crumbly. Problem 2 is that this material may not qualify as a mineral in the strictest sense because its "natural" origin is open to question. While probably not the product of a deliberate synthesis, it surely would never have formed if the mine didn't exist. So there are those who will argue that this melanterite is a synthetic and those who would like to see it given full mineral status. Whatever the consensus, it will never be an entirely satisfactory mineral for the display cabinet as long as its pedigree is in doubt.

The following note from the geology department of Cities Service Company, Copperhill Operations, Copperhill, Tennessee provides some interesting details about the occurrence:

... I have seen the place where the crystals were found. It is in an old underground drift in Boyd mine that is no longer in use. The bottom of the drift is covered with mud, and there are several pools of water on the mud bottom. The pools have no visible outlets. The crystals are found in the mud on the bottoms of the pools, and adhering to pieces of rusted steel pipe that are found in the pools.

On the mud, above water level, can be found drusy, botryoidal coatings of a mineral of a similar color to the crystals. These occur on the surface of the mud and probably capillary action played an important part in their formation. In some cases, the drusy coatings are growing on top of the crystals. The coatings are about 1/2 inch thick.

There is no question in my mind about the fact that the crystals grew where they are now found. However, because they are found in a man made tunnel, perhaps they technically are still considered artificial.

In addition to the above described locality, there are other places in the Boyd mine where what appears to be melanterite can be found. This is in the form of drusy, botryoidal coatings and clumps, and soft, porous stalactites. However, one small stalactite, 1 or 2 inches long, was hard, solid, and clear, and terminated at the bottom with a flat surface which may be a crystal or cleavage face. This stalactite may be a single crystal.

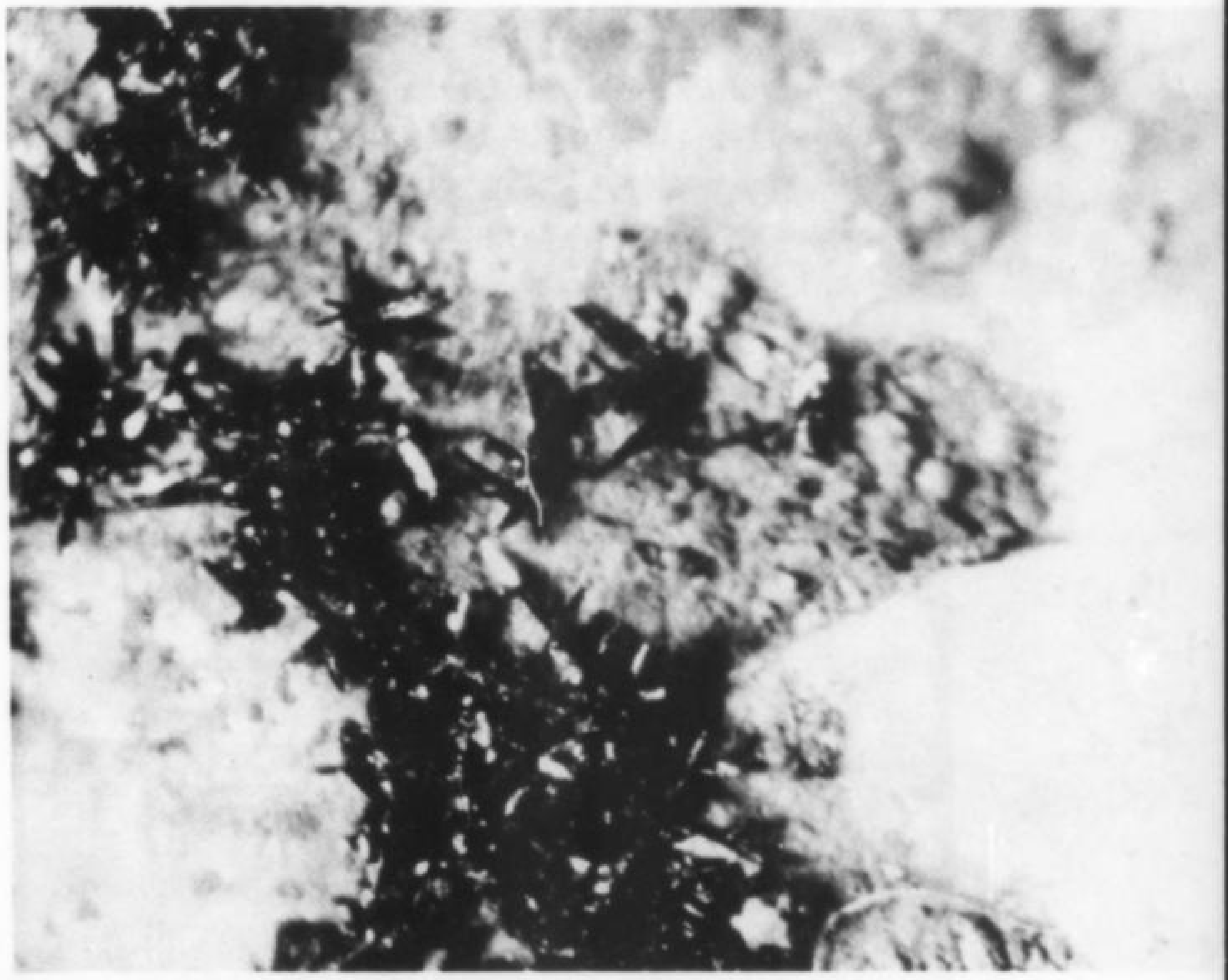
The water level in the pools has risen since they were first observed in July (1972), and the crystals I saw last week (October, 1972) have their edges severely rounded, in contrast to the ones found earlier. All the larger crystals and many of the smaller ones have been removed from the pool, so if the water rises much more, the remaining ones may completely dissolve. In that case there will be no more crystals until the next dry spell (next summer?).

HAÜYNE

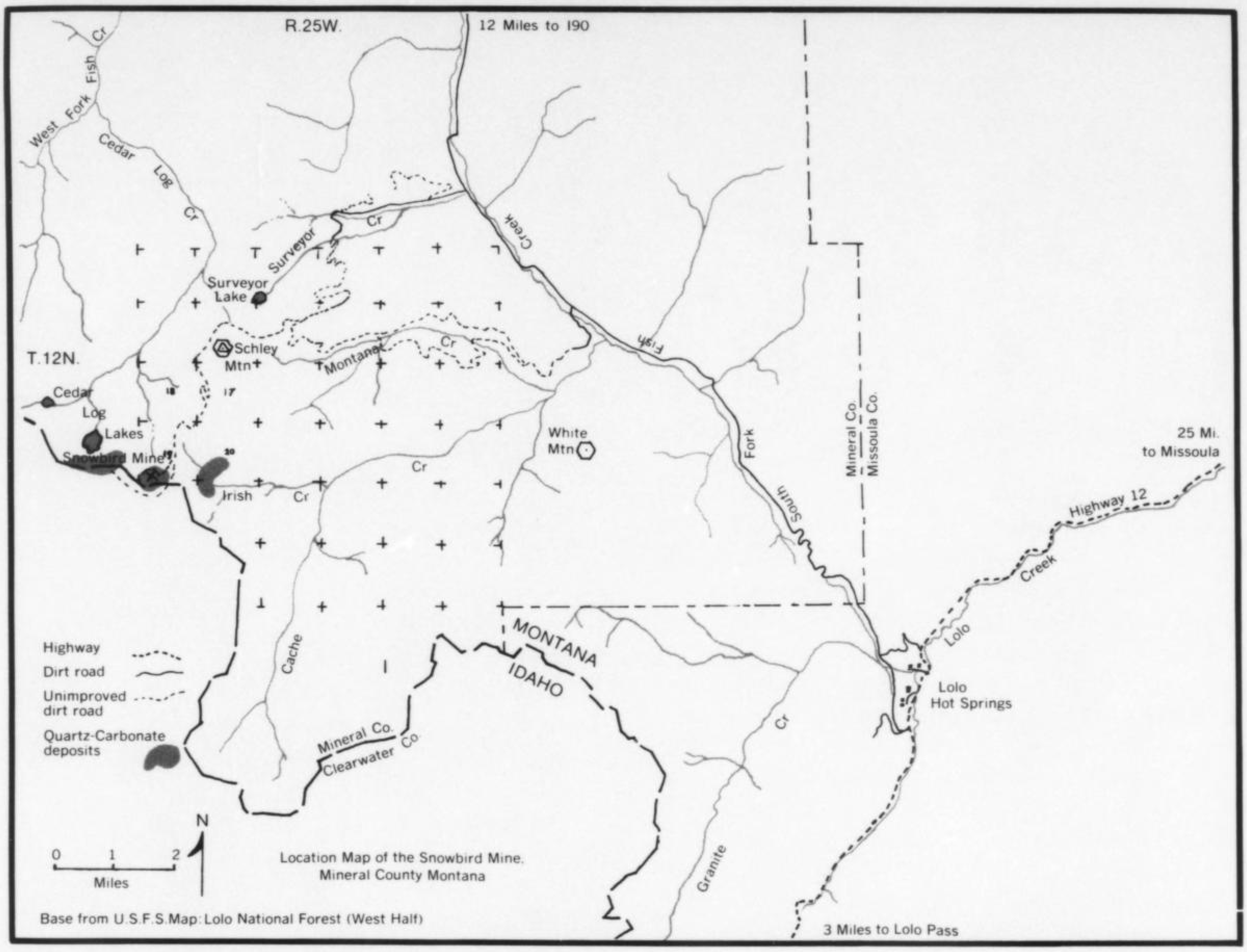
The following appeared in the column "Geotopics" by David E. Jensen, a regular feature in *Ward's Bulletin,* Published by Ward's Natural Science Establishment, Rochester, New York.

This rare member of the sodalite group of minerals was discovered on the 2700-foot level of the St. Joe Minerals Corporation's Edward Mine at Edwards, St. Lawrence County, New York in 1969. It was later found at two other locations in the mine but only a few hundred pounds were collected.

There are only a few localities in the world where Haüyne has been reported. The feldspathoids, which include the members of the sodalite group, commonly occur in the unsaturated alkali igneous rocks that are poorer in



Plattnerite Diamond Mine, Nevada. ***Photo by A. J. Regis.***



Location Map of the Snowbird Mine, Mineral County Montana

Base from U.S.F.S. Map: Lolo National Forest (West Half)

*silica than granitic and other types which contain feldspars. Haüyne has been found in extrusive igneous rocks, phonolites and related rock types. Until recently it was believed that it occurred only in igneous rocks. The Edwards occurrence in a dolomitic marble proves that there are exceptions and that Haüyne does occur (though rarely) in metamorphic rocks. Mineral collectors who have acquired Edwards Mine Haüyne call it "lapis lazuli" (lazurite). This is not surprising since the bright blue color and presence of pyrite in the Edwards material are also characterisitc of lapis from many world localities. Lazurite is considered by some mineralogists to be a sulfide-bearing Haüyne. Lessing and Grout (*Am. Min.*, Vol. 56, 1096, 1971) studied the Edwards occurrence and identified the blue mineral as Haüyne. They also noted that its presence in marble substantiated previous reports of a minimum metamorphic temperature of 500° in the Edwards area.*

Ward's has acquired a small lot of Edwards Haüyne. This bright blue mineral is associated with pyrite, diopside, carbonate, etc.

PARISITE (Still Again!!)

The following from Mr. Lanny Ream ...

Since writing to the Record *about the Snowbird parisite deposit I have read the other letters about it which contain incorrect information, and I have discovered that I made an error in my report also.*

The deposit was known as the Snowbird when owned by the F & S Mining Company of Butte, Montana. The claims were relocated and renamed the Snowshoe in 1967 by some individuals from Utah.

Enclosed is a sketch map showing the location of the mine and the Mineral County-Missoula County boundary. There are three similar deposits in this area, see the map. Parisite occurs at the Snowbird and Cedar Log Lake deposits. As far as I can determine there is no deposit in Missoula County. The Idaho-Montana border is within a couple hundred yards of the deposit.

I visited the Snowbird twice in the last three months. In August I talked with the owners for some time and collected until a severe thunderstorm chased us out. The owners have closed the mine to collectors and rockhounds because of the vandalism and the nuisance. I might add to this a statement to the fact that there is little to collect unless more mining is done to expose new material.

Reconnaissance work by Mike Metz (The geology of the Snowbird deposit, Mineral County, Montana: unpublished M.S. Thesis, Washington State University, 1971) indicates *that there are numerous deposits of a similar quartz-carbonate composition along the area of the eastern margin of the Idaho batholith. The deposits intrude the Wallace formation of the Precambrian belt supergroup. Metz has determined that the probable genesis of the Snowbird deposit is a complex history of intrusion, collapse, and two-stage mineralization by hydrothermal fluids originating in the Idaho batholith.*

The Snowbird contains the following minerals in collectable size and amounts (although they do not all form good crystals) listed in order of decreasing abundance: quartz, calcite, fluorite, ankerite, parisite, pyrite and gersdorffite. The following minerals occur as small crystals or grains in other minerals: magnetite, xenotime, fluocerite, millerite, and rutile. The gersdorffite forms crystals upto 10 cm (or more!) in diameter. The large ones are rounded and irregular, but the smaller, below 2-3 cm, are well-formed crystals. Their morphology is similar to that of pyrite, cubic and pyritohedrons(?) with pits, striations, and triangular markings on the faces. I have been able to collect some crystals up to 2 cm in diameter. The larger ones I have seen are weathered and altered, mostly destroyed, or only the cavity left in the calcite. One area of the deposit may yield some good crystals if mining is done there.

One other reference for additional information is: Sahinen, V. M., Fluorspar deposits in Montana, Montana Bur. of Mines and Geology Bull. *28, 11-14, 1962.*

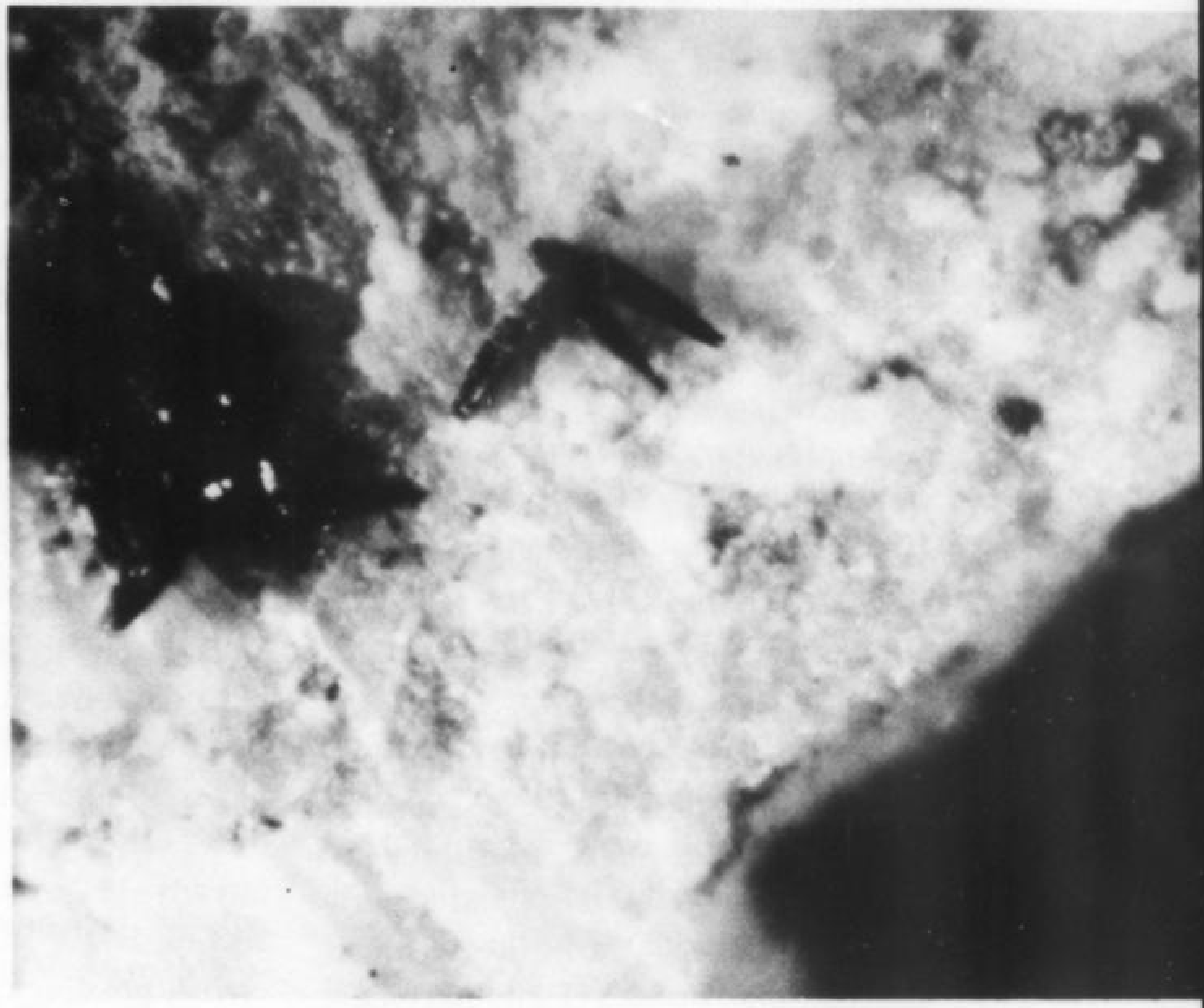
PYROMORPHITE

The following from D. W. Richerson and A. J. Regis ...

The Cottonwood district in the Wasatch Mountains east of Salt Lake City, Utah is highly mineralized and old mine dumps and prospect pits are numerous. The Cardiff mine lies in this district at an elevation of 8750 feet. Its dumps have yielded azurite, malachite, pyrite, quartz and cerussite. Prospect pits in quartz veins on the slopes to the west of the Cardiff mine have yielded interesting pyromorphite crystals.

The pyromorphite crystals are generally very small, rarely exceeding two or three mm in length. They vary in color from apple green to emerald green, some having a thin overgrowth of a grey-white color. The crystals are prismatic, the most common habit being rounded or barrel-shaped, tapering slightly towards a termination which is often slightly skeletal. Other habits vary from well-formed hexagonal prisms with pinacoids to thin needlelike crystals with the prisms tapering almost to a point.

The mineral was identified by x-ray diffraction powder methods.



Plattnerite Diamond Mine, Nevada. ***Photo by A. J. Regis.***

PLATTNERITE

The following also from D. W. Richerson and A. J. Regis ...

Plattnerite has recently been discovered by Mr. Forrest Cureton II and his sons (of Stockton, California) in the main adit of the Diamond mine, about five miles southeast of Eureka, Nevada. The plattnerite was found approximately 3200 feet into the adit on the walls of one of the older lead stopes associated primarily with quartz and limonite.

The mineral occurs as black, elongated crystals approximately one to two mm long thickly clustered in narrow veins. The typical habit of the crystals is a tetragonal prism tapering gradually to a point (see photos, by A. J. Regis).

Identification is by x-ray diffraction powder methods.

Museum Record, continued from page 244

Among other things, Whitlock said "I believe that a modern well equipped museum ranks among the greatest influences for culture, enlightenment and spiritual uplift in any community; because here, as with great music, writing and painting, men of vision may pass on their vision to their fellow men and posterity." The fact that he was not a great research mineralogist or a great educator is irrelevant. He was certainly not an intellectual lightweight and he did have a vision about minerals that he wanted to pass on to others. That's what curating is all about.

The Record Bookshelf

***Color Treasury of Crystals*, by Carlo Bevilacqua and Vincenzo De Michele, Crescent Books, Division of Crown Publishers Inc., 419 Park Avenue, New York, N. Y. 10016 ($1.98)**

This attractive 1972 English version of the 1967 Italian original might better be entitled *Minerals of Europe;* of the 125 color plates, four-fifths are of European minerals, and nearly half are Italian. Carlo Bevilacqua's photography is technically polished, and only the quality of some specimens used is subject to criticism. Considering that all specimens pictured are from the Natural History Museum of Milan, it is understandable that the best specimens by far are of Italian origin. It probably would have been a good idea to devote the entire volume to Italian minerals, or to photograph specimens at more than one institution, but this may not have been practical.

The principal virtue of this edition is the fine color photos of specimens rarely seen in the United States. No black and white photos are used at all, and the quality of reproduction is excellent. Each photo is accompanied by all pertinent information including the SCALE, an important feature ignored in the other well-known volumes of color mineral photography. High points include three exquisite Sardinian phosgenites, fine Italian amethyst, ruby-red heulandite and pink octahedral fluorite, an impressive single crystal of Tasmanian crocoite, and a fine Almaden cinnabar, to mention only a few. Every photo collection has its share of losers and this volume is no exception. The Panasqueira wolframite, for instance, is horrible, and the Mindouli dioptase was a poor choice, especially for inclusion on the cover. The great majority of plates, however, are interesting or very beautiful or both.

Eleven of the eighty pages are devoted to a text on introductory crystallography by Vincenzo De Michele. This section seems out of place; I for one would rather have seen a few more pages of color photos, since there are many other treatments of this subject already in print. Unfortunately this section is also hindered by technical errors, possibly introduced in the process of translation or through over-simplification. For instance De Michele states that two parallel crystal faces always constitute a pinacoid, and that every crystal has a number of two-fold or greater axes plus mirror planes and a center of symmetry. Terms such as *triad* (three-fold axis), *driad* (two-fold axis), and *hexakisoctahedron* (hexoctahedron) are used which apparently are translational errors because the use of these terms in America, at least, would meet with some raised eyebrows. Despite these objections the text is clear and admirably concise.

Color Treasury of Crystals is a handsome addition to any library, and I recommend it highly on the basis of the photos. Book stores offer this 9 x 12 x 3/8 inch, hard-cover volume at an unbelievable $1.98, or about 1 1/2 cents per color plate! At this price absolutely no one should pass it up.

Wendell E. Wilson

***Der Micromounter*, by Alex Kipfer, Publisher Ott, Thun, Switzerland and Munich, Germany, 1972, 212 pp., 14 color plates, 48 black & white photographs, 33.80 Swiss Franks, 29.80 German Marks, about $9.50 U. S. (in GERMAN).**

This book was written, as the title implies, primarily for the micromounter, but it is more than that. It is so comprehensive in its concept that all collectors of crystallized mineral specimens can profit from it. Kipfer explains the concept of micromounts (specimens that require magnification) and thumbnails. A history of the tradition of micromounting follows. A guide for developing a collection is given together with the advantages, space requirements, trading, and the inherent beauty of such a collection. Guidelines for the purchase of minerals are outlined. Faked or manufactured specimens are explained and the author warns to avoid such pieces.

The places to look for minerals and fieldwork in general are thoroughly discussed. Many valuable hints are presented, such as systematic searching and the wise selection of the specimens that were collected. Ethical behaviour in the field is treated through the use of examples. The chapters on trading and shipping of specimens through the mail are especially interesting and have been more that just superficially treated. A description follows of the tools used in the field and the cleaning of minerals. Dry cleaning, wet cleaning, the use of chemicals, solubility of various minerals, and many useful methods are discussed and tabulated.

Selecting the best specimens to mount, the mounting itself, and the storing of the mounts fills the next chapters. Of special interest to all readers will be the sections on maintenance, labeling, indexing and systematic arrangement. The final chapter covers the various optical instruments available for field and home use, as well as their care.

The black and white photographs give the reader a comprehensive overall view of all the aspects of micromounting. The color plates show examples of the beauty of such mounts. The bibliography covers mostly books and periodicals available in the German language.

In reviewing this book I was particularly impressed with the thoroughness with which each chapter was covered. It is, in my opinion, the most comprehensive book on micromounting ever written. This book is extremely readable (for those who can read German). Redundant phrases are no hindrance in reading, but emphasize the importance of certain aspects of the hobby. *Der Micromounter* should find a place on the bookshelf of every micromounter, or any mineral collector, who has a fair understanding of German. It is a valuable addition to the literature and warrants translation.

Paul Seel

***Cleaning and Preserving Minerals* by Richard M. Pearl. Maxwell Publishing Co., Box 1815, Colorado Springs, Colorado, 1971, 80 pp. ($2.75).**

Now here's a book no collector should be without. Dr. Pearl covers an amazingly wide scope of techniques for cleaning and preserving minerals, and appears to have every minute reference ever published at his command, making this truly the *definitive work*. Chapters are included on the removal (or prevention) of dust, dirt, smoke, soot, rust, clay, silica, tarnish, oxidation, deliquescence and efflorescence, as well as advice concerning the effect of heat, cold, light, and plain water on specimens. Preservative coating and imbedding techniques along with a few notes on display methods are included and meticulously referenced.

The chemical information is detailed and invaluable. If a collector or museum were to assemble a mineral preparation lab on the basis of this book (not a bad idea) he would find himself buying such chemicals as sodium gluconate, potassium cyanide, and ethylenediamine tetraacetic acid as well as the more familiar chemicals. Many of the techniques listed were previously almost unknown to collectors in general, and were ferreted out of obscure literature by Dr. Pearl.

It would have been convenient for users of the book if Dr. Pearl had included a list of reagents at the beginning; however, the only serious criticism is the lack of an index of any kind. The most useful would be a mineral species list accompanied by page numbers of references to individual species. Most users will approach the book with a particular problem mineral in hand, and then have to thumb through many pages in frustration looking for advice on the cleaning and preservation of that mineral. Another suggestion might be to include information on the removal of calcite from chemically delicate minerals. But don't hold your breath for another edition; the first edition came out as part of *The Mineral Collector's Handbook* in 1947, and the second only now. So acquire a copy soon, and then send in your personal cleaning techniques to Dr. Pearl for inclusion in the 1996 edition.

Wendell E. Wilson

***Geode Country* by Stephen R. Sinotte, The Geodes Company, Portage, Michigan, 1972, 61 pp. ($2.95)**

More is known about Keokuk geodes than any other variety and Stephen Sinotte may know more about Keokuk geodes than anyone. He owns and operates a "geode mine" in Missouri, sells geodes, and related objects such as slides and posters, and has written three books about the Keokuk geodes.

Geode Country is essentially a condensed, less expensive version of *The Fabulous Keokuk Geodes, Vol. I* (reviewed in the *Mineralogical Record,* Vol. 2, no. 1). The idea behind *Geode Country* — to provide an authoritative, reasonably priced pamphlet on geodes — is good, and such a book should be very popular. Unfortunately, the numerous errors contained in this booklet sharply limit its value.

Mr. Sinotte is obviously familiar with his subject matter but his presentation is at times hampered by his misuse of technical terminology. For instance, instead of the commonly used term "outcrop", he uses the obsolete term "basset" which is unfamiliar even to many professional field geologists. Although the booklet is advertised as nontechnical, the terms calcilutite and biocalcarenite are used to the exclusion of their more widely known counterparts, fine-grained limestone and fossiliferous limestone. And on page 57 he refers to chalcedony forming "a true euhedra of blue quartzoid crystals each no larger that a grain of sugar."

Although most errors are relatively trivial, there are a number of more

serious errors and omissions. For example, in discussing the origin of Keokuk geodes, the author states that "numerous theories have been advanced, ranging from the preposterous idea that geodes formed from gas bubbles in molten rock ..." (p. 13). Although this theory may not be applicable to the Keokuk geodes, it is certainly not preposterous. It is unfortunate that the author's choice of words implies that the theory is incompatible with the formation of geodes in general. Indeed many scientists believe that the gas bubble theory adequately accounts for the origin of many geodes and concretions including the very common geodes from Chihuahua, Mexico and the thunder-eggs from Oregon. Mr. Sinotte does present a good summary of the more widely accepted theory on the origin of the Keokuk geodes.

The bibliography could have been of more value. The four citations made are all but inaccessible to most readers. Two theses, one dated 1912, are cited but published articles based on them are not. The other references are a 1908 article, and a 1895 book. This is unfortunate as more recent articles and books are more readily available.

Although a good description of the field occurrences of the Keokuk geodes is presented, it is surprising that no concise definition of the term geode is offered. This is particularly unfortunate since Mr. Sinotte's conception of a geode differs somewhat from the conventional usage.

I was also disappointed in the illustrations; reproduction on poor quality paper has done an injustice to the fine photographs of these beautiful Keokuk geodes.

From the point of view of the professional geologist "Geode Country" has its shortcomings, but for the interested amateur it remains the only comprehensive pamphlet on geodes.

Robert B. Finkelman

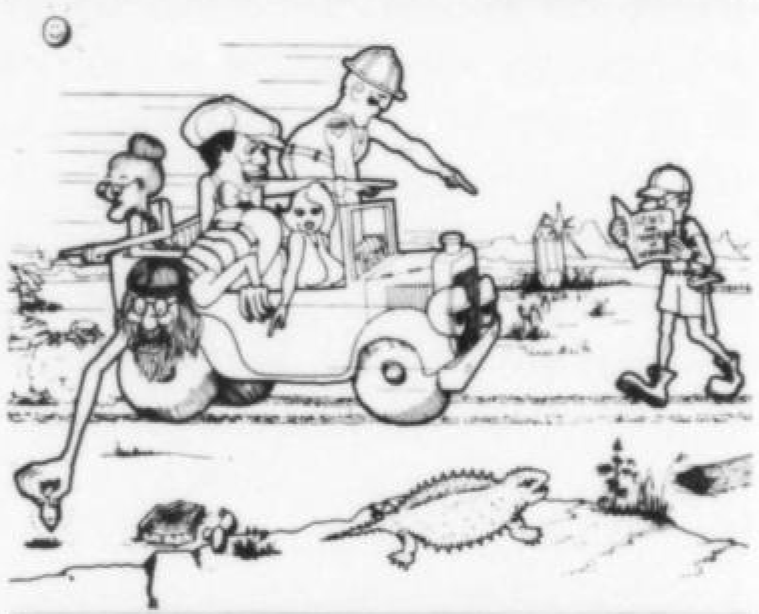
***Minerals and Gemstones of Nebraska,* by Roger K. Pabian, illustrated by Alan R. Cook, University of Nebraska Conservation and Survey Division, Educational Circular Number 2, July, 1971, Lincoln, 49 illustrations, 9 unnumbered cartoons, 4 color plates and frontispiece, 80 pp. ($1.00).**

Described as a handbook for students and collectors of the minerals and gemstones of Nebraska, this modest guide provides basic instructions for collecting in that state. Elementary concepts of geology, mineralogy, and gemology are presented, and an extensive bibliography is included for readers who desire more advanced information.

Mr. Pabian, unfortunately, is not precise in his definitions and descriptions which may result in initial confusion for the novice mineralogist. Because of the paucity of crystallized minerals in Nebraska (though a surprisingly large number of species are reported on), he devotes more attention, both in the text and in the selection of specimens for the color plates, to gemstones and ornamental rocks and minerals.

That which distinguishes this volume from other locality guidebooks are Alan R. Cook's effective illustrations and amusing cartoons, and these features alone merit the book's addition to the mineralogist's library.

R. W. Thomssen



Permission to reproduce this cartoon from Minerals and Gemstones of Nebraska *granted by the Conservation and Survey Division of the University of Nebraska. Drawn by Alan Cook.*

Yedlin on Micromounting, continued from page 246

New tools are always worthwhile. What, to date, of the collinsite? So far, none has been determined in euhedral crystals from British Columbia. The crystals examined turned out to be carbonate apatite, once called quercyite. We'd welcome a find of crystals.

Like all of us who must do dull physical things in order to create mineral collections, Bill Henderson has a thing about preparing plastic boxes for micromounts.

"Faced with the ineffable tedium (he says) *of painting another batch of boxes with flat black paint, I resolved to find an easier method than doing them one at a time. This was done by spray painting in lots of fity or more. I made a shallow box from scrap just large enough to hold fifty bottoms in a five by ten array, the sides just high enough to come flush with the top edges of the boxes. A larger box, of course, would speed the process. I found a spray with very desirable properties: Instant Dry Stencil Ink, from the Reynolds Ink Division, Sprayon Products, Inc., Bedford Heights, Ohio. The ink covers well, gives a flat black finish, and best of all, cuts the plastic of the boxes so that it is impossible to chip off the coating or loosen it with the cementing material.*

A few words of caution: it is best to do the painting outdoors. Hold the spray can quite close to the boxes, and the boxes at about forty-five degrees from the horizontal. Spray lightly several times so as to hit from all sides. Overpainting can soften and warp the plastic: better to let the boxes dry a few minutes and spray again. Using this technique I can do a couple of hundred in twenty minutes."

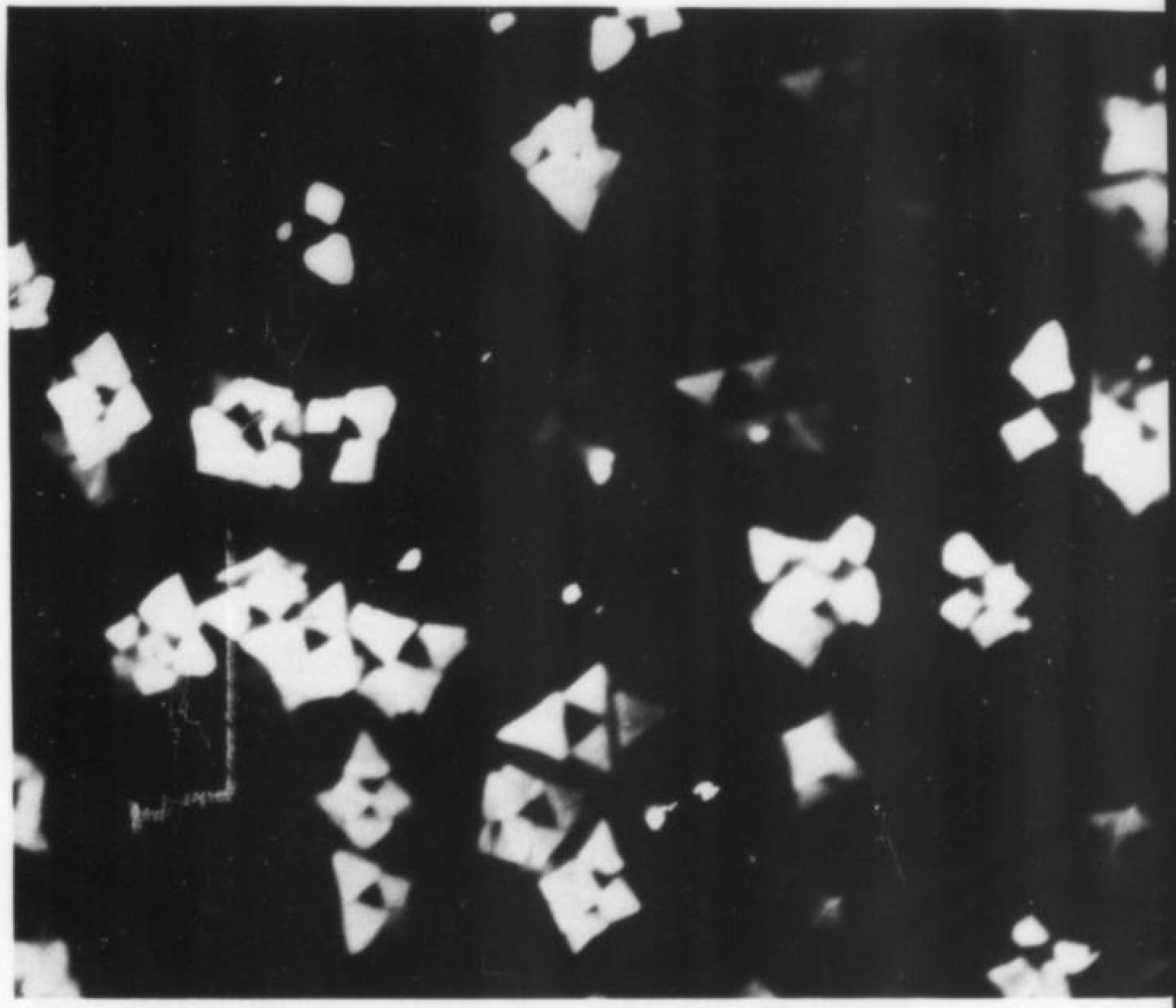
In this age of "publish or perish" in the scientific world, of getting it into print for posterity, there was a discussion concerning techniques and good manners in research and in publishing already recorded data. There was a philosophy that might be summed up tersely as follows:

IA:— If I use as my own, cite and copy from many authors, that's research.
IB:— If I copy from only one, that's plagiarism.
IIA:— If I do it it's research.
IIB:— If you do it it's plagiarism.

We thought this might be a helpful guide to anyone who might take it seriously.

A recent commentator has suggested that at micromount competitions (and it follows, then, as a method for personal collecting) in addition to the pertinent information normally assembled on the box of each specimen there be some marked indication of its ideal magnification for viewing. This, it is suggested, would be a time saver for viewers and especially for judges, who are usually overly pressed for time.

Our own feeling on this is negative. We prefer to determine for ourselves what is best. No micromount should need apologies, directions for viewing, or excuses for being. There is the feeling of limitation in the original suggestion, and it could be assumed that step by step additional directions would be given, not merely as to size, but ultimately as to all else. "Ignore the broken crystals and look only at the remaining ones" might be the next step, and so on to a complete abandonment of present ideals. No, we feel that the specimen should be considered as a whole; that modern microscopes are so easily manipulated that stepping up or down is no longer a delicate or tedious task. With modern optics and "zoom" operation the change in magnifications can be observed throughout. The one viewing the specimen is able to determine for himself the best magnification. Let's hear about this. We may be prejudiced.



Cristobalite in Obsidian, Cerro San Cristobal, Pachuca, Mexico. Neal Yedlin Collection, ***photo by Julius Weber.***

At the Baltimore Symposium, the fifteenth, the subject was mineral identification. Paul E. Desautels, founder of the Baltimore Mineral Society, and the original sponsor of this meeting, opened with the philosophy that the mind acts as a computer, and mentally makes decisions and determinations without awareness, depending upon what has been fed into it in the past by way of experience, association and repetition. Neal Yedlin followed this idea, and suggested that we do not, in making quick visual identification, truly determine minerals — we recognize them. We first note color, even though this is a variable, and this, in conjunction with the locality of the specimen, eliminates hundreds of minerals from consideration. Almost the first question asked by one who is consulted about the identity of a specimen is its source. Franklin, New Jersey, would eliminate all but 200 of the 2000 or so recorded species. Again a mental computer. This added to color, crystal form, cleavage, luster, hardness (scratched by a needle) should be reasonably adequate.

Perloff "came off the ropes" and took over the evening session at the meeting. His photographs of twinning in minerals, coupled with diagrams from Goldschmidt's Atlas der Krystallformen, were outstanding.

Joe Mandarino, of the Royal Ontario Museum, demonstrated crystallographic projections, a difficult concept, but easily understood as he led us along the paths of symmetry.

The work of the participants at the meeting was, as always, excellent. There were new finds — Frank Leans with beautiful cacoxenite, and a plethora of strunzite from Marlton, New Jersey, similar to the Mullica Hill deposit. There was much St. Hilaire material evident; much western (Grandview mine, Arizona; Washington and Oregon zeolites and associates) and many Canadian localities. It was all there, 86 microscopes, about 150 people, and days and nights all to short.

Notes: Micro Mineralogists of the National Capital District. Spring Roundup, May 5 and 6, 1973, at the National 4H Center, 7100 Connecticut Avenue, Washington, D.C. Subject — "A Mineral Smorgasbord" (This does not mean that only Langban, Sweden minerals will be in favor.) Inquire of Mrs. Ruth Cole Wertz, 9707 Sutherland Road, Silver Spring, Maryland 20901.

Palermoite, from North Groton, New Hampshire, in single minute crystals, clear, terminated, striated, prismatic, are available from S. & W. Gems, 54 Tremont Street, Penacook, New Hampshire.

John F. Jedlicka, of the Baltimore Mineral Society, and principal of the Stemmers Run Junior High School was named for the Outstanding Earth Science Teacher Award of the State of Maryland by the National Association of Geology Teachers. This was in recognition of his leadership and organization of geology field trips and his presentation of the earth sciences in the public school systems.

Jack is known by micromounters everywhere for his outstanding work in organization and production of the Baltimore Symposia. His enthusiasm and control have made this one of the outstanding mineralogical meetings in America. We all feel that this recognition was due and justified.

After all the discussion of cleaners for native copper our good wife reached into the pantry and handed us a plastic bottle of "Revere Ware Instant Copper Cleaner". This is a liquid, with no ingredients listed on the container, and is available at most hardware stores, a pint for seventy-nine cents. Pleasant odor, harmless to the skin, and it works. Directions — 1. Shake well. 2. Apply to surface with small sponge or cloth. 3. Rinse immediately with sudsy water. 4. Dry off thoroughly. That's it. Works fine. It will not remove gunk and associates, but on the uncoated copper it does its job. For micros we used a small artist's paint brush. So far, a month after use, the specimens are still shining bright.

Too many exhibitors at major shows are being careless in spelling. At the International Gem Show, at the Eastern Federation convention in Washington, and at the Michigan Mineralogical Show in Detroit we saw specimens on exhibit labeled FLOURITE.

Some years ago Philip Cosminsky acquired a walnut sized piece of obsidian from Cerro San Cristobal, Pachuca, Mexico. Just common obsidian, but included in the pale grey mass were white octahedra of cristobalite, arranging themselves into larger octahedra, the latter randomly oriented. We do not know the why or how. We thought we'd report them and print a photograph of our specimen taken by Julie Weber. We believe that only seven micromount collections have specimens of them. The lucky ones are Cosminsky, the Smithsonian, Paul Seel, Lou Perloff, Bill Yost and Neal Yedlin (that's us). There must be more around, somewhere. Visitors have checked the area with negative results. We plead with dealers and collectors who have any obsidian from the locality to examine it carefully. It belongs in collections, not in storage.

Buy and use a good mineral book, affix a permanent label directly to the specimen, keep your microscope clean and in adjustment, and a new one from Lou Perloff, who exhorts, "Keep your cotton picking hands off anyone else's 'scope unless he has given you express permission to use it. And then restore it to status quo, just as you'd found it — clean, light off, identical magnification."

Neal Yedlin
129 Englewood Drive
New Haven, Connecticut 06515

SPECIAL EVENTS FOR TUCSON SHOW

There are three exhibit competitions scheduled for the February 9-11, 1973 version of the Tucson Gem and Mineral Show, in addition to the standard Federation-type competition. The first of these was pioneered by the Tucson people at their 1972 show. It is a ONE—OF—A—KIND competition. Last year the mineral was wulfenite. Each contestant was permitted to enter one wulfenite specimen in any of several different size categories. The next mineral (actually two) is AZURITE—MALACHITE. The specimen entered may be either azurite or malachite or a combination of the pair. A new wrinkle has been added in that categories have also been established for "worked, finished and polished" specimens of azurite and/or malachite. Each exhibitor may display one item each of lapidary, thumbnail, miniature, or cabinet specimen, making a total of four possible entries.

Cash prizes will be offered in the Friends of Mineralogy sponsored Educational Mineral Exhibit Competition. In the Senior Division, 1st place will be worth $50.00 and the runner-up will win $25.00. The Junior (under 18 yrs.) Division winner will win $35.00 and the runner-up $20.00.

Finally to honor the memory of Ed McDole, collector and lover of fine minerals, a group of his friends will present an "Ed McDole Trophy" for the individual display of the finest minerals. Such factors as showmanship, rarity, spelling, etc., will be considered but the emphasis will be placed on the quality of the specimens. This trophy will be awarded every year at the Tucson Show.

3RD ANNUAL SLIDE COMPETITION

Submit your entries NOW for the 3rd Annual Slide (35 mm) competition to be held in conjunction with the Tucson Gem and Mineral Society's 18th Annual Show, February 9 through 11, 1973. The winning slide will earn for its owner a $25 cash prize and the slide will be used as a cover photograph for the *Mineralogical Record* in 1973.

The contest is sponsored by the *Mineralogical Record.* The winning slides for the first two contests appeared on the covers of Volume 2, number 3 and Volume 3, number 5 respectively.

Please mail your entries securely packaged, to Richard A. Bideaux, 1242 West Pelaar, Tucson, Arizona 85705. Each entrant may submit two slides. Please provide name of mineral and locality. No entries will be accepted after February 5.

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the Mineralogical Record

STATEMENT

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Worldwide

Date: Jan. 1, 1973

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To the Editor

Dear Sir:

Just a note on some of the "letters" in the July/August issue. It is letters such as these from the readers that prove that you are getting across to them. They are some of the most stimulating "letters to the editor" that I have ever read anywhere! Keep up the good work!

Jack Clark
Earth Science Curator
Morris Museum of Arts and Sciences
Morristown, New Jersey

PRE–SHOW SELLING

Dear Sir:

The members of the Newark Mineralogical Society, Inc. of Newark, New Jersey have been very appreciative of the quality of material which your magazine espouses, and we all look forward to each issue knowing that it will enhance our knowledge of the hobby for which our club was formed.

Your recent editorial on Pre-Show Selling (Volume III, no. 4) brought to the foreground a subject which has deeply concerned those of us who wish to keep the hobby a joyous one for all, and it seems that in view of your efforts to bring this to everyone's attention, all clubs should make a concerted effort to give you, at the very least, their encouragement and moral support.

At a recent Board of Trustees meeting of the Newark Mineralogical Society, Inc. a motion was made and passed to publicly support your stand on this issue. At our membership meeting of October 1, 1972 the motion was unanimously passed to ban pre-show selling and that violators should not be allowed to return to future editions of any show at which they continue this practice.

If the subject comes up at the Eastern Federation meeting in Washington our delegate has been instructed to voice our disapproval of pre-show selling and we sincerely hope that this practice will be discouraged in the future.

Alton E. Bythewood, M.D.
President
South Orange, New Jersey

Dear Sir:

I agree with your editorial in the July/August issue, and feel that pre-show selling of mineral specimens should not be allowed. Since all dealers want to make money (and who doesn't?), I have a suggestion that they may want to consider. It is, run a mail auction. This would allow dealers to reach a wider clientele. The dealer who goes this route will revolutionize the business.

For those who don't realize the potential, let me merely say that stamp collecting (the world's second most expensive hobby) offers 70% of its dealings by means of mail auctions. If you don't believe this, just get hold of any philatelic magazine.

The mineral dealer would figure out a set of rules for running the auction, suggest an estimated value for the specimen, list it in a magazine, and wait for the bids to roll in. The open market would determine the fair price, and the specimen would be knocked down to the highest bidder at a slight advance above the second highest bid. Everything would be done by mail. Specimens could certainly be described for the listing; just see how they're described in advertisements right now.

Mail auctions would enlarge a dealer's mailing list for offerings, and bring the knowledge that specimens are available to a greater number of people. Everyone would be pleased. I leave it to dealers to accept or reject this idea.

Henry H. Fisher
Columbus, Ohio

While grateful for your support of my editorial, your proposal is, I fear, fraught with potential problems. Mineral specimens, unlike stamps, are absolutely unique and collectors are not likely to offer bids without first examining the specimens. The features that make one specimen appeal to collector A may be completely overlooked by collector B. Nevertheless, there is nothing preventing any dealer from trying out the idea if he cares to. Ed.

Dear Sir:

My comments re your editorial on pre-show selling are made with the annual Tucson Mineral Show in mind and do not include small shows with which I have little or no experience or interest.

What if the dealers do some pre-show selling? The dealers themselves obviously want this or they wouldn't do it. It relieves a lot of the big rush opening day, and gives them a more leisurely way to do business with their customers.

When a collector takes time off from his business or job (possibly with loss of pay), why shouldn't he be rewarded by a better selection than the collector who saunters in Sunday afternoon?

So what if a dealer "takes in more receipts before the show than during the show"? I doubt if this is true in many, if any cases, but even if it were true, so what? In most cases the dealers have had to travel hundreds or a couple thousand miles to get there — shouldn't they be allowed to sell their minerals over whatever period of time they choose?

Some shows schedule school children to visit mineral shows the opening hour opening day. This is noble in theory, but devastating in practice. It is imperative that crystal collectors see the dealer's minerals before the swarm of pointy-fingered locusts.

Any decision regarding pre-show selling should be made only by the participating dealers.

You are creating a stew and I suggest you keep your long hair out of it.

Russell Filer
Yucaipa, California

Like WOW! Ed.

ON MUSEUMS AND COLLECTION PRESERVATION

Dear Sir:

On the subject of museums and the preservation of collections, I have before me a clipping from a past issue of *Natural History* magazine of the American Museum of Natural History, in which Henry Fielding Osborne writes of the opinion of Goncourt on the donation of personally acquired collections to museums. The citation from Goncourt is popularly known as "de Goncourt's will," and is taken from the auction catalogue of his collection, sold in Paris in 1897, the year after his death. The passage may be translated as follows:

"My wish is that my drawings, engravings, trinkets, books - in a word, all my objects of art which have lent happiness to my life, shall not go to the icy tomb of a museum and the stupid glances of indifferent passers-by. I demand that they shall all be scattered under the strokes of the auctioneer's hammer, and that the enjoyment which the acquisition of each article has rendered me be given in turn, for each piece, to an inheritor of my tastes."

Edmond Louis Antoine de Goncourt (1822-1896), French novelist and historian; bequeathed most of his fortune to endow the Academie de Goncourt ... awarding each year the Prix Goncourt of 10,000 francs to the author of an imaginative prose work of high merit, usually a novel (*Webster's Biogr. Dict.*).

After giving this citation, however, Osborne hastens to say "if it were possible for Edmond de Goncourt to come back to life and visit the Morgan Hall of Minerals and Gems and see how these priceless objects of art and of nature are not for a moment hidden in "the icy tomb of a museum" but are radiating their beauty to hundreds of thousands of joyous visitors from every part of the world ..." etc.

I think you should publish "de Goncourt's will" in your Letters to the Editor column so that still another aspect of the controversy regarding museums and their role in society is brought to the attention of readers.

In the final analysis, each prospective donor must weigh all factors for himself before making his decision to donate or not to donate. In my opinion, truly unique items, be they animal, vegetable or mineral, or some product of the hand of man, probably should go to a responsible museum to be preserved and cherished, but the vast quantity of material in these categories is unfortunately far from unique and its donation to a museum may serve little real purpose except perhaps the selfish ones of indirect gain or enhancement of reputation, living or dead. Yet in contrast to this view it may be said that the donation of non-unique items to museums which by charter are allowed to exchange, greatly increases their ability to bargain for and obtain those items which are unique but which must be purchased. The Museum is enabled thereby to discharge its duty to preserve that which should be preserved.

Among items in my own collections of minerals and antiquarian books there are scarcely any that truly qualify as "unique." Many are rare to be sure, but almost every item has at least its peer somewhere and mostly I am inclined now to view Goncourt's ideas of forced dispersement with favor. I think particularly of his statement concerning the pleasure he obtained in the acquisition of his objects, how they thrilled him once he was able to add them to his collections. The same thrill fills me still and one *must be thrilled* to hold before him a mineral specimen with its pedigree of labels and realize that this piece of stony matter passed through many hands and brought joy to many minds before it ultimately arrived here. Goncourt simply expresses the fear that this inheritance of pleasure (and of learning) would abruptly stop if all objects were consigned to museums upon the deaths of their owners.

John Sinkankas
San Diego, California

SPECIES COLLECTORS DEFENDED (AGAIN!)

Dear Sir:

Apropos your editorial Species Collectors (Volume III, no. 1) I feel some defense is called for from those

you stigmatize, and as one of the 'Damned' I wish to make comment.

Whereas I go along with most of what you say, I do not agree with the way you said it. I quote you 'My distaste for species collectors does not extend to ...'. You are riding a tall horse Mr. Editor. Your later attempts at qualifying your arguments tend to nullify much you say previously. Citing the venerable colonel was a real bad one, he was the arch prince of species collectors, some might even think him a squirrel. Thanks to him, we all know how the Smithsonian benefited. Andor von Semsey could be put in a similar category. Thanks to these old time 'squirrels' there are some very fine public collections available for reference today. As you probably know Mr. Editor, there are some truly great private collectors (species type) extent by whom your National Institution — and others — will some day greatly benefit. Furthermore, the perspicacity and astute nature of some of the old time laymen was responsible for the initial recognition and subsequent careful preservation of much highly desirable material.

I confess to strong desires to possess the unusual (without any guilt complex) but, when I have it, I like to be able to look at it, pretty or not. I could not agree more with your views here — for me, 'picro-mineralogy' is OUT — at least from the collecting standpoint.

Now I think the following will amuse you and maybe some of the readers. It is certainly germaine and just goes to show that things aint altered overmuch in 200 years — so Mr. Editor sir, I don't think you stand a chance! Quote by Gustav von Engestrom taken from 'An Essay Towards A System of Mineralogy' by Axel Frederick Cronstedt (1788):

'Though mineralogy has been studied for several ages, yet its progress has been very slow. Some learned men have, indeed, endeavored to bring it into some systematical order; but as the passion for only collecting minerals and fossils has still predominated over that of enquiring into the nature of the subjects themselves, they have for the most part met with but very little success. Those who were mere collectors, being superior in number to the scientific men or true mineralogists, and having more opportunities of getting new specimens, were most of them not so communicative to the latter as they ought to have been. Some of these were wholly taken up in gathering together immense heaps of things, seeming almost resolved to get the whole of nature into their cabinets without having any regard to any true order; while others, proposing to correct this inconvenience would pretend to some interior knowledge, as if this had been a consequence of their collections: and by that, had fallen into still greater extravagance.'

Thus said G. v. E.! Keep up the good work, I enjoy the *Mineralogical Record* — editorials and all.

J. B. Knight
Manchester, England

LAWSON DEFENDED

Dear Sir:

It is unfortunate that Dr. Duncan McConnell felt it was important to write a letter to the editor (Vol. 3, p. 192) expressing the view that it was "incongruous" that I included a picture of Dr. Andrew Lawson in my article "New Minerals from California" (Vol. 2, p. 152) because "a mineralogist he (Lawson) surely was not." I regret too that such a letter was given circulation in the *Record*. But these things have occurred and require a statement of facts pertinent to Dr. McConnell's complaint.

My article made it clear why Dr. Lawson deserved more honors than it was within my power to bestow: "In 1890 a new era began in California mineralogy. In that year Andrew C. Lawson was appointed as professor of geology at the University of California, Berkeley. With George D. Louderback, who was one of his earliest students, he built the department to an outstanding position. Their students and associates included Waldemar T. Schaller, Frederick A. Ransome, Charles Palache, Arthur S. Eakle, William F. Foshag, Adolph Knopf, Esper S. Larsen, Alfred O. Woodford and Adolf Pabst."

So distinguished a group of students would be hard to match. The group includes four of the first nine presidents of the Mineralogical Society of America, plus two presidents in later years, and two presidents of the Geological Society of America. Dr. Lawson's inspiration is well reflected in the memorial to Waldemar T. Schaller (*Amer. Mineral.*, **54**, 638): "At the University of California ... Waldemar T. Schaller's interest in geology was greatly stimulated by Professor Andrew C. Lawson, Head of the Department of Geology."

I will not engage in a game of silly semantics with respect to Dr. McConnell's complaint that Dr. Lawson was not a mineralogist, but I do wonder when the umbilical cord joining mineralogy to the general field of geology was cut.

Dr. McConnell is perhaps to be forgiven somewhat for judging Dr. Lawson's contributions so narrowly because when Dr. McConnell started his professional studies in the early 1930s Dr. Lawson was already in his seventies and his papers reflected his interest in isostasy and other phases of geology quite remote from some of his earlier work.

There is a final matter that should be covered — McConnell's "proof" that Dr. Lawson was not a mineralogist: "In fact, his one effort with respect to description of a new mineral species (iddingsite) went awry because of his inability to distinguish between a single phase and a mixture." Dr. Lawson described iddingsite in 1893. It was nearly 70 years later that x-ray diffraction analyses showed that it was a mixture. Such a sophisticated tool was required to discredit the mineral as a species because, although a mixture, it has homogeneous optical properites. As new and more sophisticated analytical tools have become available many species have been discredited as mixtures or identical to previously described species; and probably many more species will disappear by the same route.

Could I suggest to Dr. McConnell that he develop a greater appreciation, even reverence, for his predecessors who built the fund of knowledge which is the basis of his own professional opportunities and contributions?.

H. Earl Pemberton
Santa Monica, California

Dear Sir:

In Vol. 3, p. 192 there appeared an article by Duncan McConnell with a sour comment on Andrew C. Lawson, describing him as "erstwhile" professor of Geology at the University of California. The article derides the ability of Professor Lawson on some hair-splitting detail in the description of a mineral.

It was not the writer's pleasure to have known Professor Lawson, though the writer did know some of his contemporaries; and in spite of McConnell's comments questioning his ability, Lawson was definitely one of the California "Greats" in geology and mineralogy. Professor Lawson died in 1952.

A short interesting biography of this man, together with about two dozen of his contemporaries, appears in Bulletin 189, known as *Minerals of California, Centennial Volume* (1866-1966) published by the California Division of Mines & Geology.

We do not question McConnell's criticism of some minor detail as lacking, but Professor Lawson's contribution in inspiring others to follow some line of the mineral profession cannot be decried nor diminished by the petulant grousing of, I presume, another worker in the vineyard.

With editorial permission, we list verbatim the article about Professor Lawson:

"As professor of geology at the University of California at Berkeley, appointed in 1892, Andrew Cowper Lawson pioneered geological and mineralogical studies in many parts of the state. He inspired and directed the education of some of the most distinguished professional workers in the geological and mineralogical fields. With George Davis Louderback, he helped build one of the outstanding departments of geology and mineralogy in North America. Lawson's professional life spanned nearly seven decades, during which he described several new California minerals. Lawsonite, a new mineral from the California Coast Ranges, was named in his honor."

I believe his record speaks for itself.

Henry A. Martin
Watsonville, California

INDEX-VOLUME III

WHAT IS A MINERAL WORTH?

According to one widespread concept of pricing, mineral specimen *A* from an old classic locality would be more valuable than specimen *B* from a contemporary source. A mature analysis, however, recognizes that quality is the best yardstick for measuring value. It is often true that a choice example from an ordinary locality is worth much more than an average example from a rare locality. The highest dividends have come to those who emphasized quality in their selections rather than popular choices that fluctuate according to transient trends. Thus, locality or rarity have never been my chief guiding factors in pricing. My pioneer efforts have always been to seek out and pay premium prices for pieces with intrinsic quality. Time has proven that advancing knowledge gradually recognizes this truth.

This is my protection for you. For whether it be a small sample or a great museum specimen, I take great effort to evaluate it in the scale of merit. This expert knowledge is basically what I have to sell.

Price comparison only has meaning when quality is compared to like quality.

* * *

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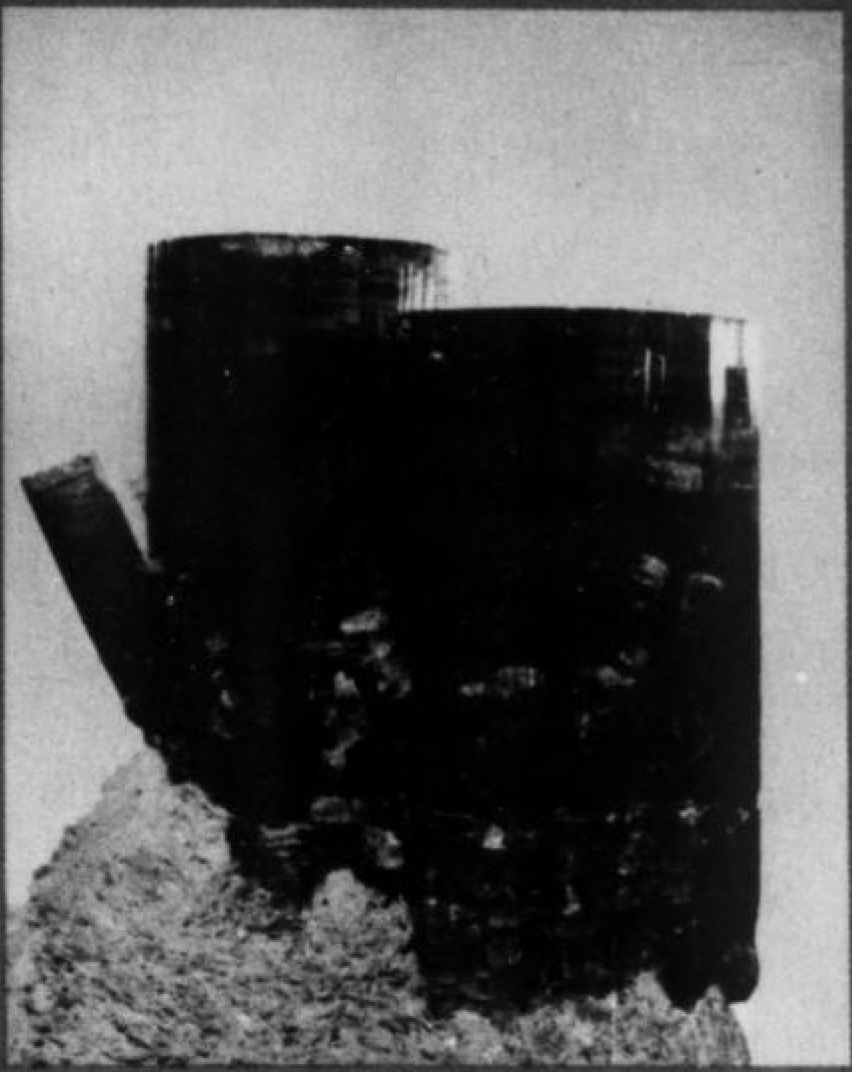

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