# ARIZONA-II


the Mineralogical Record

Volume Eleven, Number Four
July–August 1980 $3


WULFENITE — RED CLOUD MINE (ED OVER SPECIMEN)

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# the Mineralogical Record

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Volume Eleven, Number Four
July–August 1980

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## Articles



## Departments




COVER: AURICHALCITE, hollow hemispheres on hemimorphite from the 79 mine, Gila County, Arizona. The largest hemisphere is about 1.5 cm. Tom Gressman specimen; Wendell Wilson photo.



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# notes from the EDITOR

## SMITHSONIAN LABELS

Some readers may have noticed the labels (added for scale) in Figures 1 and 2 of the article on toxic minerals (*Record,* **11**, 6–7). Well, the world should be told that the Smithsonian does not use hand-written labels . . . all of their labels are neatly typed. The labels pictured are quickly prepared duplicates which had been sent out with the specimens for photography, without knowing they would actually appear in the photo. I, being in a hurry, did not think to request better versions at the time the photos were taken.

## THE TEN-YEAR INDEX

Yes, it's still planned. But not in the lavish detail in which it was originally conceived. Subsequent studies showed that the total cost for a comprehensive 100-page index would approach $20,000. We felt that most readers would rather see that money spent in some other way, presuming it could be raised in the first place. For example, $20,000 would pay for approximately 40 pages carrying 50 color photographs. The ten-year index, as it is currently being compiled, will be at approximately the same level of detail as that of the annual indexes.

## SOMETHING FOR (almost) NOTHING

Peter Bancroft recently returned from a trip to St. John's Island in the Red Sea, the famous ancient locality for peridot (forsterite) crystals. (See the article on this locality in vol. 7, no. 6, p. 310–314.) The trip was part of his research for the forthcoming book on famous localities to be published by the *Record.* Dr. Bancroft personally collected about 20 small peridot crystals, ¼ inch or less in size but well terminated. These he is offering to anyone, on a first-come basis, for $1 each to cover postage and packaging. Address your letters as follows:

Dr. Peter Bancroft — PERIDOT
3538 Oak Cliff Drive
Fallbrook, CA 92028

Letters so addressed will be returned unopened after the last crystal has been given out.

## ERROR

The following note was received at the last minute from Jan Solgard, Hønefoss, Norway.

In the January-February 1980 issue, Bob Sullivan says in his column that the Norwegian Amateur Geologist Association (NAGS) is going to have their 1980 mineral show in Kongsberg. Actually it was their 1979 show which was in Kongsberg . . . the 1980 show will be held August 9 and 10 in Barkåker (near Tønsberg).

# the *Defiance* mine
## and vicinity, cochise county, arizona

by
**J. Robert Thompson**
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Glendale Community College
6000 West Olive Avenue
Glendale, Arizona 85301

***The Defiance mine ranks as one of Arizona's famous wulfenite localities, having yielded wulfenite-lined cavities as large as 14 meters in length. The Defiance and neighboring mines still continue to produce fine specimens of wulfenite and other minerals.***


*Figure 1.* **Looking north toward Gleeson Ridge. The Defiance mine location is shown by the arrow. Photo by the author.**

**LOCATION**

The Courtland-Gleeson mining district, sometimes known as the Turquoise district, is located in southwestern Arizona, about 20 miles north of Bisbee and 15 miles east of Tombstone, along a dirt road connecting Tombstone and Elfrida. It may be found on the Outlaw Mountain, Arizona, quadrangle with most of the other Gleeson mines, situated in Sec 32, T19S, R25E. The principal feature of relief is Gleeson Ridge, a northwest-southeast trending hill about 1½ miles long, and ½ mile wide, which rises about 200 m above the adjacent plain. A profusion of old mines exists in the area, and only a few have been thoroughly explored by collectors. Except during one short period, exploration and collecting efforts have been hampered by unhappy mine owners, dangerous mine conditions, and an incredible population of wasps. The one mine which has attained moderate acclaim by collectors is the Defiance, situated high on the northwest end of Gleeson Ridge (Fig. 1). The Defiance mine has produced large quantities of rather distinctive wulfenite.

**GEOLOGY**

The workings of the Defiance mine appear to be entirely within the Pennsylvania-age Naco limestone, mostly along a major fault which also may be observed in the Tom Scott and Silver Bill mines. Very irregular, scattered bunches of ore are found along this fault zone and following watercourses or solution cavities which tend to parallel the beds of limestone. These beds vary from 30 to 120 cm in thickness, strike northwest and generally dip northeast from 40-50 degrees. The fault is easily visible in the ceiling of the main haulageway, often marked by gouge slickensides or expanding into red-brown to black breccia. The dip of the fault varies considerably within short distances, and solution cavities are commonly quite irregular. The limestone is in contact with quartz monzonite about 200 m south of the shaft opening, and is cut perpendicularly to the bedding by a dike of quartz monzonite-porphry immediately north of the shaft.

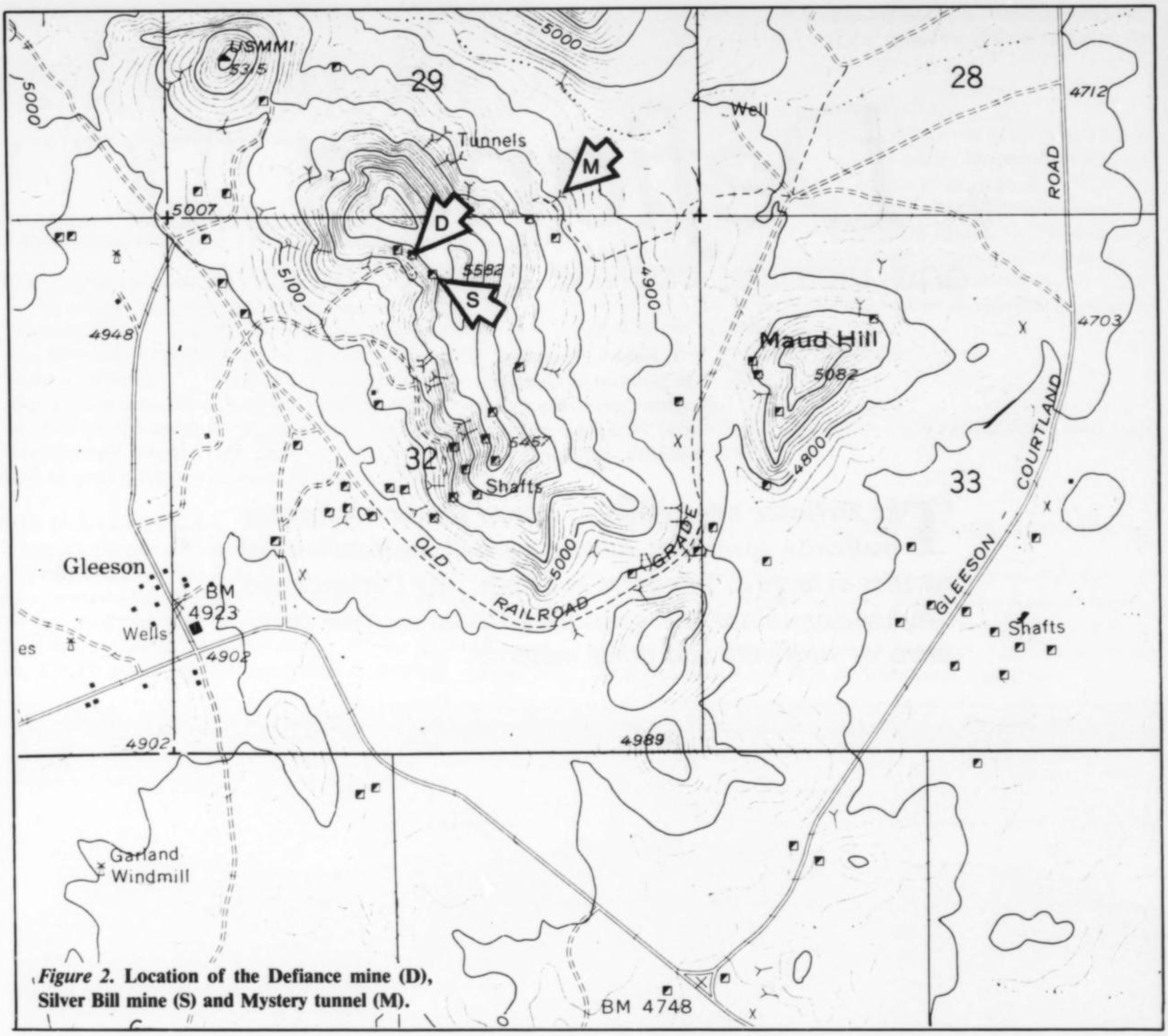


*Figure 2.* **Location of the Defiance mine (D), Silver Bill mine (S) and Mystery tunnel (M).**

**ORE DEPOSITS**

The principle ore deposits found along Gleeson Ridge and in the Defiance mine are lead, silver and zinc replacements in fissures, faults, and bedding slips occuring in the Naco limestone. The ore bodies occur as irregular replacements associated with the main fault zone and are probably related to transverse northeast fissures. Solution caverns and watercourses are locally numerous, and some of them contain accumulations of oxidized ore. The ore bodies, composed almost entirely of oxidized minerals, were generally largest and thickest where two or more mineralized fractures intersect, or where a single one turns or flattens. Total production for the area exceeds 2,000,000 pounds of lead, mostly from cerussite and anglesite.

Near the base of the southwest end of Gleeson Ridge some important copper deposits were located in the Abrigo limestone. Over 45,000,000 pounds of copper were produced from these oxidized copper deposits. Fine crystallized specimens of azurite, malachite, and cuprite were found during early operations. Many sources believe that very likely many specimens marked from Bisbee are from these Gleeson deposits.

**MINERALOGY**

Listed below are the ore and gangue species that occur in the Courtland-Gleeson mining district. The metallic minerals are grouped according to their principal metal, and listed as nearly as possible in the order of their local economic importance. The gangue minerals, or minerals of no economic importance, occur associated with the ores.

**Copper Minerals**

| | |
|---|---|
| Chalcopyrite | Tenorite |
| Chalcocite | Chrysocolla |
| Bornite | Native copper |
| Malachite | Turquoise |
| Azurite | |

**Lead Minerals**

| | |
|---|---|
| Cerussite | Galena |
| Anglesite | Plattnerite |
| Wulfenite | Plumbojarosite |

**Silver Minerals**

| | |
|---|---|
| Cerargyrite | Native silver |

**Gold Minerals**

Native gold

**Zinc Minerals**

| | |
|---|---|
| Smithsonite | Aurichalcite |
| Sphalerite | |

**Iron Minerals**

| | |
|---|---|
| Pyrite | Magnetite |
| Goethite | Xanthosiderite |
| Hematite | |

**Manganese Minerals**

Pyrolusite

**Gangue Minerals**

| | |
|---|---|
| Quartz | Kaolinite |
| Sericite | Garnet |
| Calcite | Chlorite |
| Epidote | Aragonite |

The following list indicates association and peculiarities of occurrence in the Defiance mine:

**Cerussite** ($PbCO_3$)

Cerussite occurs associated with varying amounts of anglesite and iron and manganese oxides, and is usually in granular form. It was the principle lead ore of the Defiance mine and the district.

**Anglesite** ($PbSO_4$)

Anglesite, generally surrounded by cerussite, occurs associated with iron and manganese oxides. Good crystals were found in the Silver Bill mine.

**Wulfenite** ($PbMoO_4$)

Wulfenite occurs in the Defiance, Mystery, Tom Scott and Silver Bill mines as crystals scattered through the ore and lining cavities. In the Defiance mine small to large solution cavities were sometimes completely coated with wulfenite ranging from paper thin to 3 mm thick and varying in size from 2 mm to 7 cm. Much of the material was associated with thin, platy calcite and soft manganese oxides. The largest wulfenite pocket in the Defiance mine measured over 1.5 m high, 6 m wide and 40 m long.

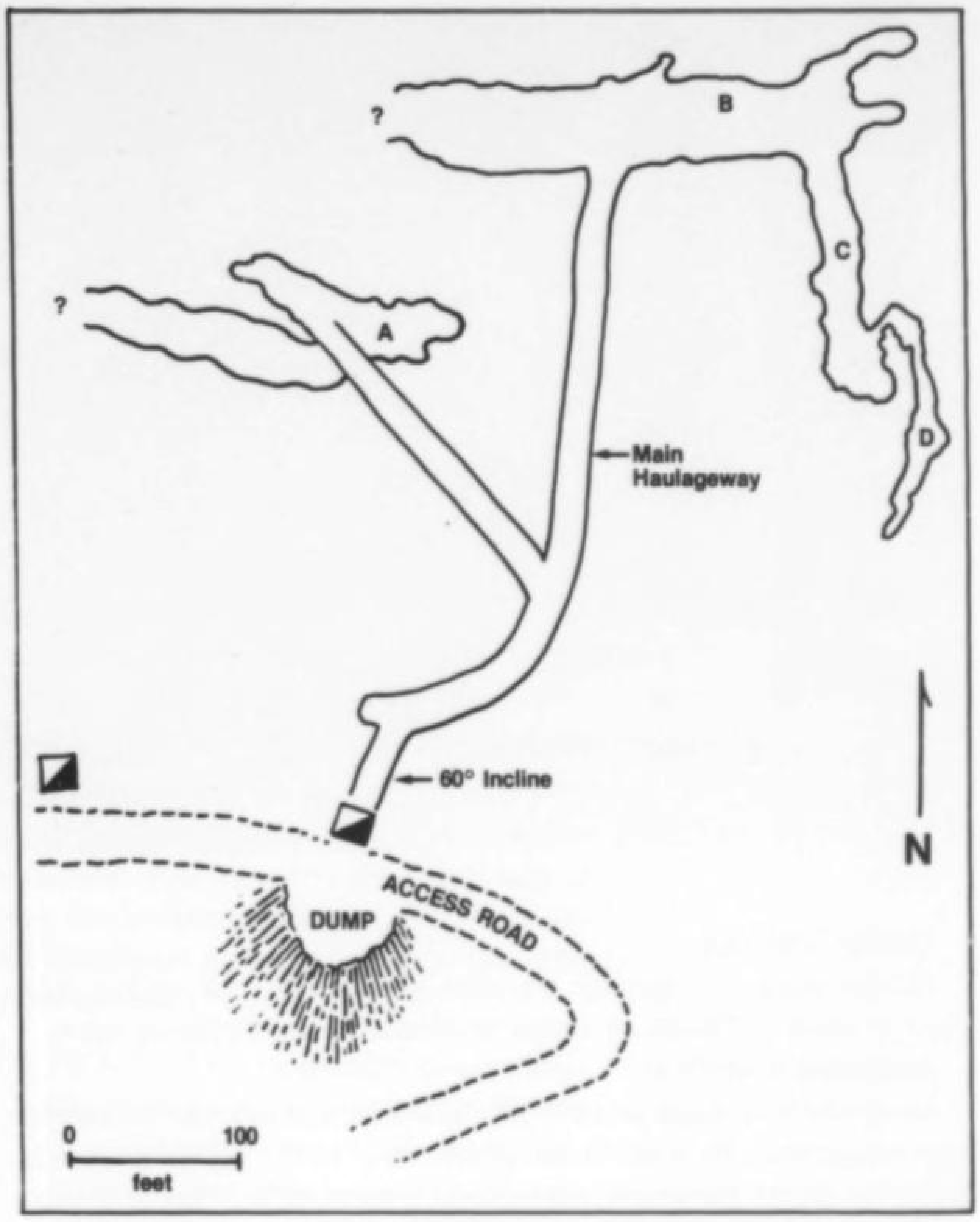


*Figure 3.* **Mine plan of the specimen-producing area of the Defiance mine. The stopes are all inclined at 45° to 60°, following the ore veins.**

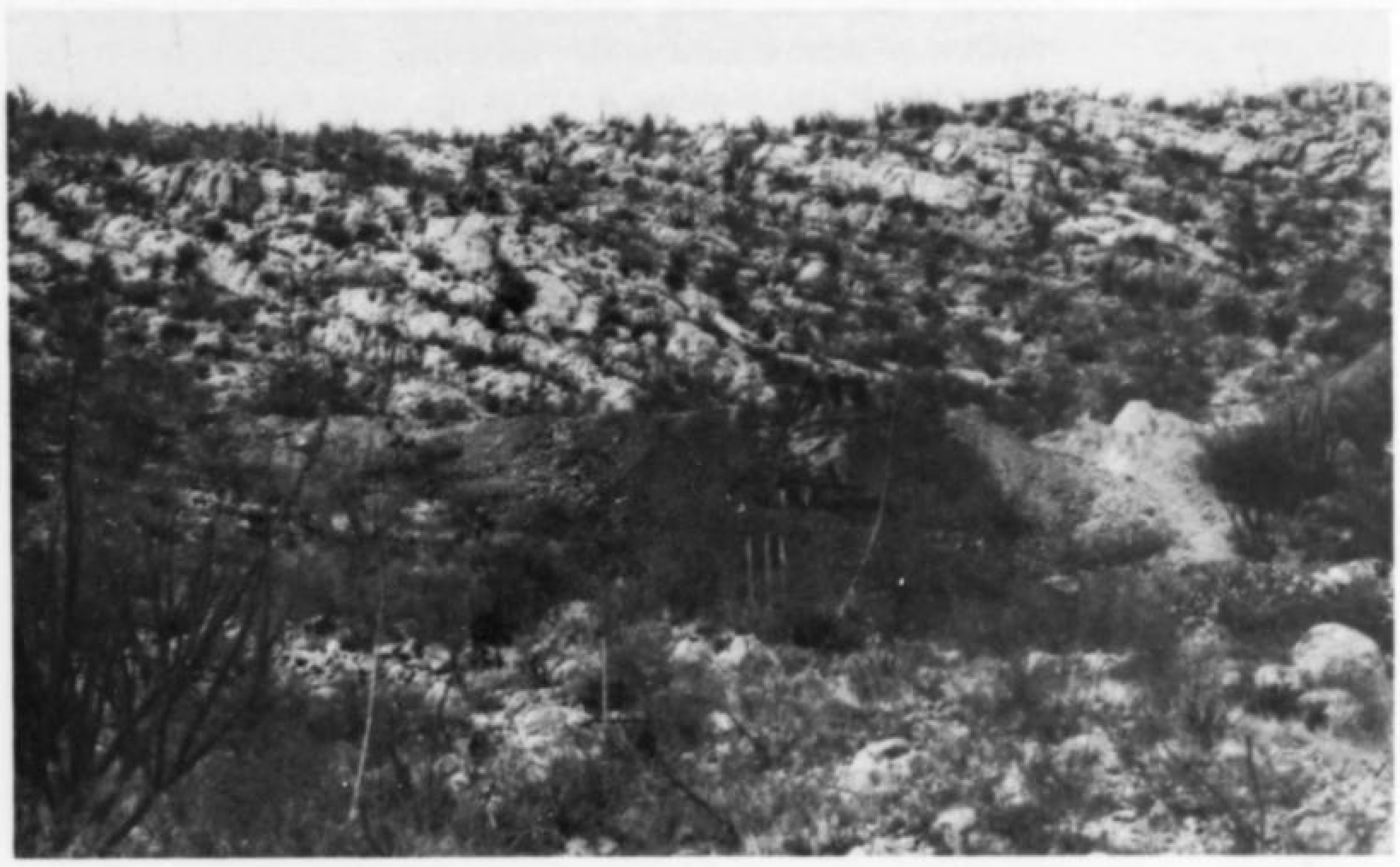

*Figure 4.* **A view of the Defiance mine looking up Gleeson Ridge. Note the dipping beds of the Naco formation. Photo by the author.**

**Cerargyrite** (AgCl)

Small pockets of this mineral were found in the ore deposits of the Defiance, Silver Bill, and Mystery mines; some crystals were mined. One pocket of cerargyrite ore in the Defiance was reported to contain 3000 ounces of silver per ton.

**Gold** (Au)

Most of the ores from the district carry a small amount of gold that is too finely scattered to be visible, even with the aid of a microscope.

**Goethite** ($HFeO_2$)

Goethite occurs as a particularly abundant constituent, of the ore bodies of all of the lead-silver mines along Gleeson Ridge, along with hematite and manganese oxides.

**Hematite** ($Fe_2O_3$)

Hematite occurs mixed with goethite and manganese oxides throughout the ore body as earthy masses.

**Jarosite** ($KFe_3(SO_4)_2(OH)_6$)

Jarosite occurs as small flakes associated with goethite in the ore deposits.

**Pyrolusite** ($MnO_2$)

Pyrolusite occurs as dusty, earthy masses mixed with iron oxides in the ore bodies of all of the lead-silver mines along Gleeson Ridge. This combination of minerals is responsible for the reddish-brown to black coating which strongly attaches itself to all who enter and work in the Defiance mine.

**Quartz** ($SiO_2$)

Quartz is present as a secondary constituent in all of the mineralized limestones of Gleeson Ridge.

*Figure 5.* **Entrance to the Defiance mine, a steep 60° incline topped by a concrete cap and small headframe. Photo by the author.**

**Calcite** ($CaCO_3$)

Calcite occurs in varying amounts in the wall rock and as thin platy crystals either on or under wulfenite in the Defiance mine.

**Aragonite** ($CaCO_3$)

Aragonite is present in many of the solution cavities as stalactites and stalagmites. In some areas, particularly in the Mystery tunnel, aragonite occurs as white, arborescent masses of bubbles and needle sprays which commonly fluoresce yellow-green under short-wave ultraviolet light.

## HISTORY

**1887**—John Collins, who made the first exploration and digging, filed the first claim on Gleeson Ridge.

**1878**—Joshia Bryant filed five claims, including the Tom Scott. Other locations were probably made at about the same time, but hostile Indians and the remoteness of this wilderness area allowed little work to be done until 1883.

**1883**—The Silver Bill, Tom Scott, and Gleeson mines produced high grade silver, lead, and copper ore from near surface oxide deposits. The Tom Scott workings reported a profit of $50,000 for the year.

**1887**—Kit Charleston located the Tejon and Charleston claims. An unfortunately bitter misunderstanding and litigation arose in the district in the early days, and continued, with great ultimate loss to all (except the lawyers), through most of the prosperous years.

**1890**—The Silver Bill shaft was sunk, increasing production of high grade ore.

**1896**—John Gleeson discovered the Copper Belle deposit on the Charleston claim. This deposit produced over $280,000 worth of copper ore from 1896–1900.

**1900**—The town of Turquoise was moved to the southeast and became known as Gleeson.

**1907**—Phelps Dodge, Calumet and Arizona, and Great Western began prospecting locally, thus beginning a "boom time" for the area.

**1909**—The Arizona Eastern and the El Paso and Southwestern railroads raced each other in the construction of rail lines to Courtland and Gleeson.

**1912**—Maximum copper production for the district was reached.

**1920**—Most of the major mines had reduced production or were idle, but leases on small mines were still producing.

**1923**—Due to the work of lessees and small operations, maximum lead production of the district was attained.

A dump sorting operation at the Silver Bill dump produced 150 to 900 tons of ore per month averaging 10 ounces of silver, $1.50 in gold, 10% lead, and 3% manganese per ton. The original ore must have been very high grade indeed.

The Shannon Copper Company, which had purchased the Copper Belle mine for $100,000, attempted a Rube-Goldberg method of roasting and leaching ore in place. This plan entailed, first, setting fire to the mine workings, in the belief that the sulfide ore bodies, once they were kindled, would burn in the persistent fashion of other known sulfide mine fires; next, after the fire had burned itself out, flooding the workings with water to dissolve the copper sulfates; and, finally, pumping out the water and passing it over iron scrap to precipitate the copper from solution. Accordingly, the timbering of the mine was ignited, quantities of fuel-oil, firewood, and old railroad ties were dumped down the shaft, and the fire burned satisfactorily for a few months; but, unfortunately, after about a year it gradually died down without accomplishing its purpose. For a time, the water was allowed to rise in the workings; but in May, 1926, it was being pumped out, and partial retimbering was in progress (Wilson, 1927).

Many of the mines along Gleeson Ridge were worked intermittently during the 1930's—little data is available concerning this period.

During World War II, the Giacoma brothers worked the Defiance mine, shipping over 2,000 tons of high grade lead ore.

**1952**—Mine expansion and production was revived in the Defiance by Jim and Tony Giacoma. Four workers were producing 75 to 100 tons of ore per month averaging 20% lead, 10–15% zinc, 5–6 ounces of silver and $1.50 in gold per ton. Over 75 feet of incline and 500 feet of drifting were dug.

**1953**—Stoping took place above the main drift in the Defiance.

**1957**—A winze was sunk in the Defiance mine extending to the lower portions of the mine. Almost 130 m of drifting were done on the lower level. At this time the "big find" of wulfenite was discovered and removed. The mine ceased production in late December 1957.

**1964**—Exploration work started in the Defiance in February by Conley and Kennedy. Drilling continued intermittently during the year and was discontinued in November.

I have not been able to verify any bona fide mining activity at the Defiance since 1964. Mining since that time has apparently been strictly for mineral specimens.

In 1970, an article by Winters appeared in the *Mining Record*, entitled "High graders hit Defiance mine," which indicated great displeasure of the owners and lessees with people who had been

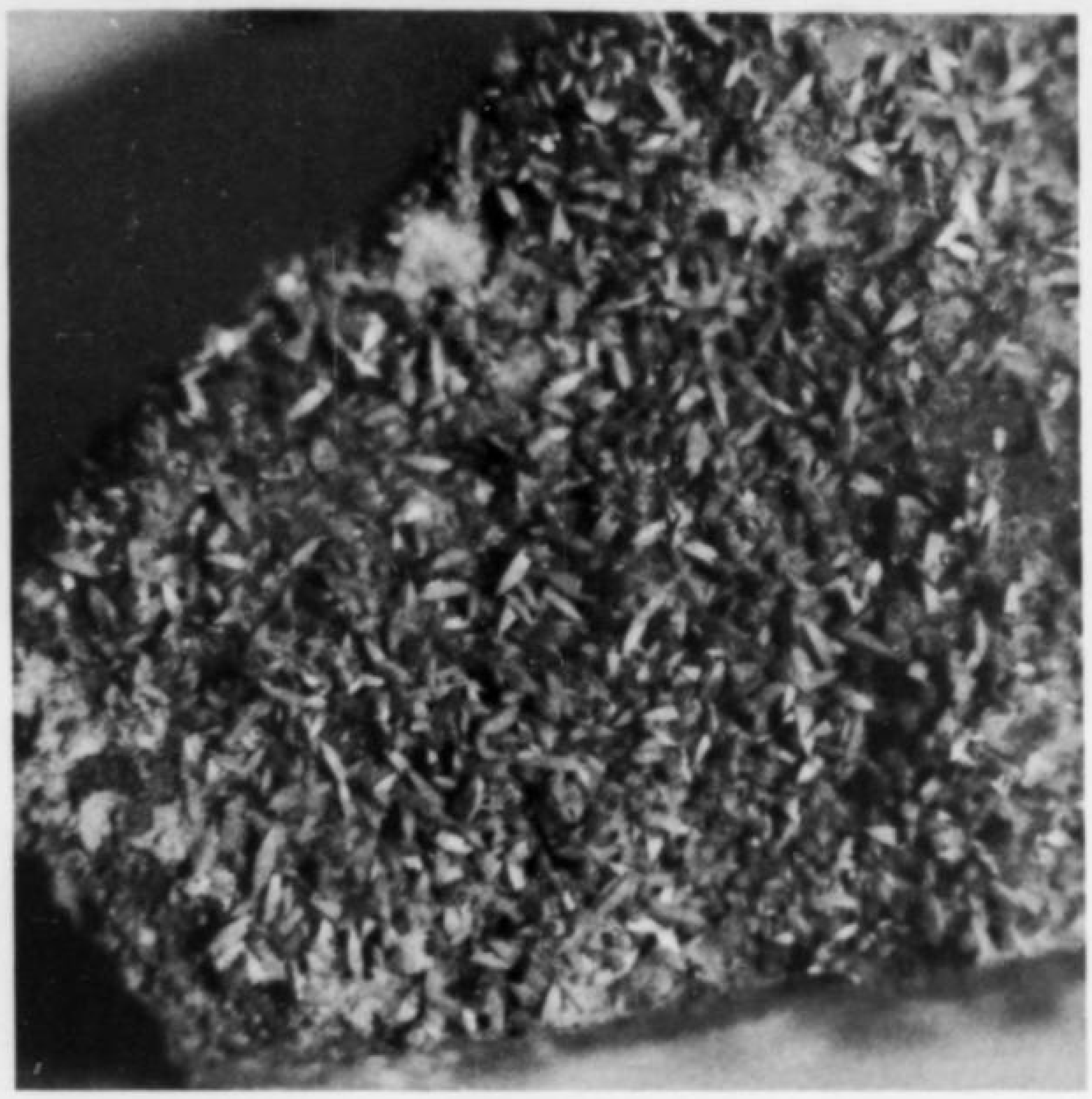

*Figure 7.* **Blocky yellow-brown wulfenite crystals to 4 mm from the Defiance mine. Photo by the author.**

*Figure 6.* **Doubly terminated, yellow-brown, bipyramidal wulfenite crystals a few mm in size from the Defiance mine. Photo by the author. (All specimens pictured are from the collection of the author.)**

digging in the Defiance for mineral specimens. Prosecution of the "thieves and fences" was threatened. I have not been able to find evidence of prosecutions, and a recent visit to the Defiance showed it to be open with no posted signs, and showed recent collecting activity. The most recent information on ownership showed the owner to be the Costello estate, and the lessee as Jack Conley of Tombstone.

## MINE WORKINGS

The Defiance is a relatively small mine, with only about 300 m of drifts running from levels as deep as 70 m. Most of the ladders have been ripped out, and access down the 60° inclined shaft is facilitated by holding on to a pipe and crawling down about 25 m to the main haulage level. The main haulage level runs about 150 m north-northeast and branches off at about 60 m, this branch running northwest about 50 m. At the end of the left drift (A) (see Fig. 3) is a stope which contains small 2 mm to 12 mm, doubly terminated, bipyramidal wulfenite (Fig. 6). The main haulage crosscut intersects a large stope and winze (B) worked mostly during 1953–57. This stope extends up about 55 m and connects down to the lower levels. The stope (B) dips east about 30°. Large quantities of exceedingly thin, fragile wulfenite (Fig. 8) have been recovered from this stope-winze. The lower level consists of a crudely mined irregular watercourse (C) leading to the south about 40 m. In this area the thicker, more desirable wulfenite (Fig. 9) has been recovered. A recent visit to the Defiance provided evidence that recent collecting has extended to a new and smaller watercourse (D) adding about 20 m of crude drifting to the lower level.

## COLLECTING

During the summer of 1956, Wallace Platt, while engaged in surveying the underground workings of the Defiance mine, collected several specimens of wulfenite. These specimens, calcite with several 1.5-cm opaque, brown, tabular wulfenite crystals, were later shown to Richard Bideaux.

On January 29th, 1957, Wallace Platt, Richard Jones and Richard Bideaux visited the mine. They were surprised to find a large solution cavity exposed in the working face. This cavity was in

*Figure 8.* **Thin, platy, pale yellowish wulfenite crystals from the Defiance mine, the largest measuring about 1 cm. Photo by the author.**

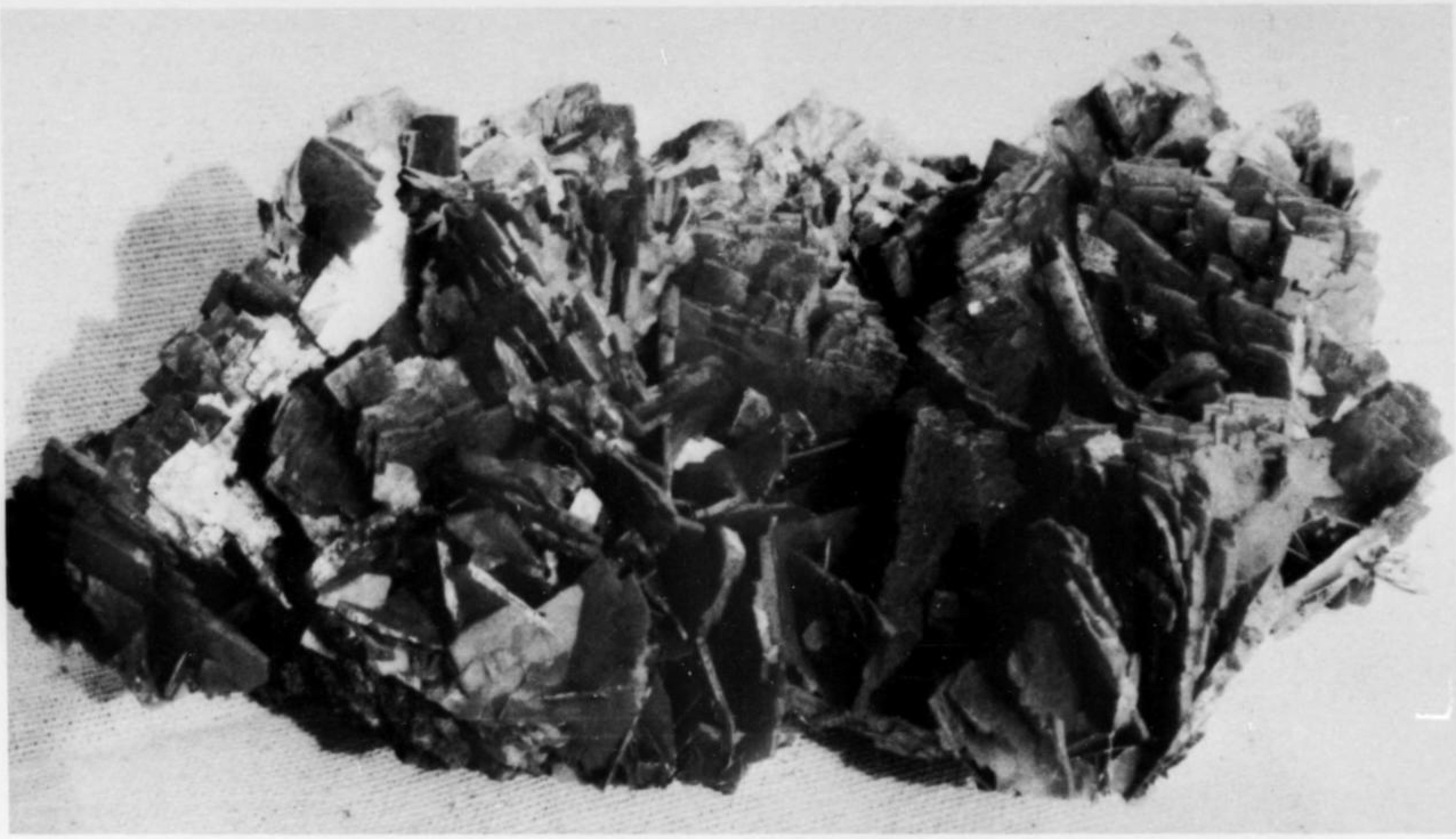

***Figure 9.*** **Yellowish brown crystals of thick platy wulfenite to 5 cm. The group is 18 cm across. This habit was characteristic of the "big find" of 1957. Photo by the author.**

the bedded limestone, and had a flattened, horizontal aspect. Some of it had been removed during mining, but the portion left was about 11 m (35 feet) long, 4 m (12 feet) wide, and from 60 to 120 cm high. The surprising thing was that the walls, floor and ceiling were encrusted with wulfenite and calcite crystals. The wulfenite crystals were similar to those Wally had collected previously, but some were almost 2.5 cm (1 inch) along an edge.

They were unprepared for the quantity of material exposed, so they confined their collecting that day to a smaller pocket beneath the large one. This smaller pocket produced a number of transparent, thin, tabular wulfenite crystals of a beautiful yellow color. Many of the crystals were 2.5 cm wide. Although the specimens are fragile, they are superb examples of wulfenite. The matrix is limonite.

They returned the following weekend, in the company of Ben Drew and Tom Tucker, to find that about three-fourths of the large pocket had been destroyed by mining operations. However, another remarkable cavity had been penetrated adjacent to the first one, and this new pocket was entirely unblemished. Like the first, it was a solution cavity in the limestone even more heavily encrusted with wulfenite and calcite crystals. This one was roughly circular in cross-section, and about 14 m (45 feet) of its length was accessible.

Said Richard Bideaux, "It was an unforgettable experience to crawl into this pocket and be completely surrounded by millions of glittering crystals. Many hundreds of pounds of wulfenite were in sight, so easy to collect that specimens could be pried from the walls without even using tools in many cases. These specimens were so easily collected that less than one percent of all the crystals we handled were broken on our return to Tucson" (Bideaux, 1957).

The best wulfenite in this pocket occurred as thick crusts either on the limestone walls or on a layer of mixed iron and manganese oxides. Both calcite on wulfenite and wulfenite on calcite were obtained. All wulfenite crystals in the pocket were the same brown tabular habit as the previous crystals. The largest crystal recovered was 70 mm (2¾ inches) on an edge (Bideaux, 1957).

Drifting continued along this series of fissures for 40 m before the last traces of wulfenite were passed. Several other good-sized solution cavities were encountered during this time, also lined with wulfenite, but the contents of these were shipped with the ore.

According to the late George Bideaux the majority of this wulfenite was marketed on the west coast.

After the "big find" of 1956–57 the Defiance mine was well established with mineral collectors as a good source of wulfenite. Mining operations hampered any collecting for the next few years, but with closure in 1959 the crystal diggers began to descend on the mine. Large quantities of wulfenite, mostly fragile, thin blades on a very crumbly manganese and iron oxide matrix were removed.

The mine owners became quite upset and put a concrete cap on the Defiance with a steel door held down with a gigantic chain. The chain lasted a few weeks and once again the crystal diggers were back (Winters, 1970). I personally visited the mine in 1971 and spent some time looking over the area and talking with a few local residents of Gleeson. No evidence was found, either by conversation or posted signs, which indicated any prohibition to enter the property. Hence, I and others dug in the Defiance on several occasions, producing a moderate amount of wulfenite.

Upon crawling out of the mine, everyone appears in the same condition: exceedingly dirty (coated with iron and manganese oxide dust). Anyone, after visiting this mine, could present a formidable challenge to detergent company advertising. Clothes end up permanently stained and skin surfaces require repeated scrubbings before resuming a natural color.

In 1971, after a day in the Defiance mine, a friend and I were stopped by the Border Patrol while driving along the highway because the officer thought we were illegal aliens from Mexico. A quick wipe of the brow with a wet towel satisfied the patrolman that our skin coloration was, indeed, due to the conditions in the Defiance mine and not to our ancestry.

A recent visit to the Defiance proved the mine to be still open, still very dirty, and recently worked for wulfenite, including work with a Cobra drill. During the period of 1970–76 one of the water-course stringers was lengthened over 18 m (60 feet) by collectors. To my knowledge very little wulfenite of the quality of the 1957 find has been recovered since that time. However, impressive quantities of the thin 6 to 18 mm variety are still recoverable. Thus, for those willing to crawl into a dirty hole, the Defiance mine can still be considered a producing locality.

**ACKNOWLEDGMENTS**

The author wishes to thank the fine people at the Arizona Department of Mineral Resources in Phoenix for their valuable help in doing research for this study, and special thanks to Wendell Wilson for his help in providing information.

Several portions of Richard Bideaux's article on the "big wulfenite find of 1957" were adapted with minor changes as a bit of literature reclamation. The article appeared originally in the *Mineral Explorer,* a local publication which never had a circulation of more than about 60. Extant copies are understandably rare.

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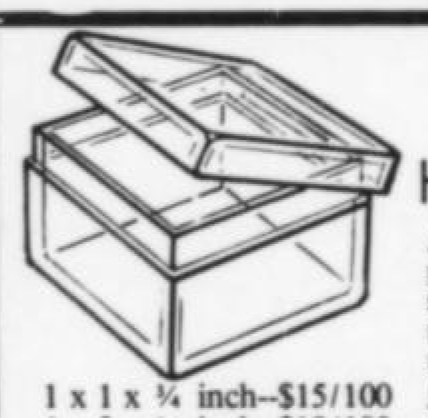




# *Slide Competition Winners*

**SLIDE COMPETITION WINNERS**

Shown on the opposite page are all six of the winners in the annual *Mineralogical Record* slide competition, held at the Tucson Show.

*Upper left.* Wulfenite, from San Pedro Corralitos, Chihuahua, Mexico (Smithsonian specimen). Eric Offermann photo (First Place, professional category).

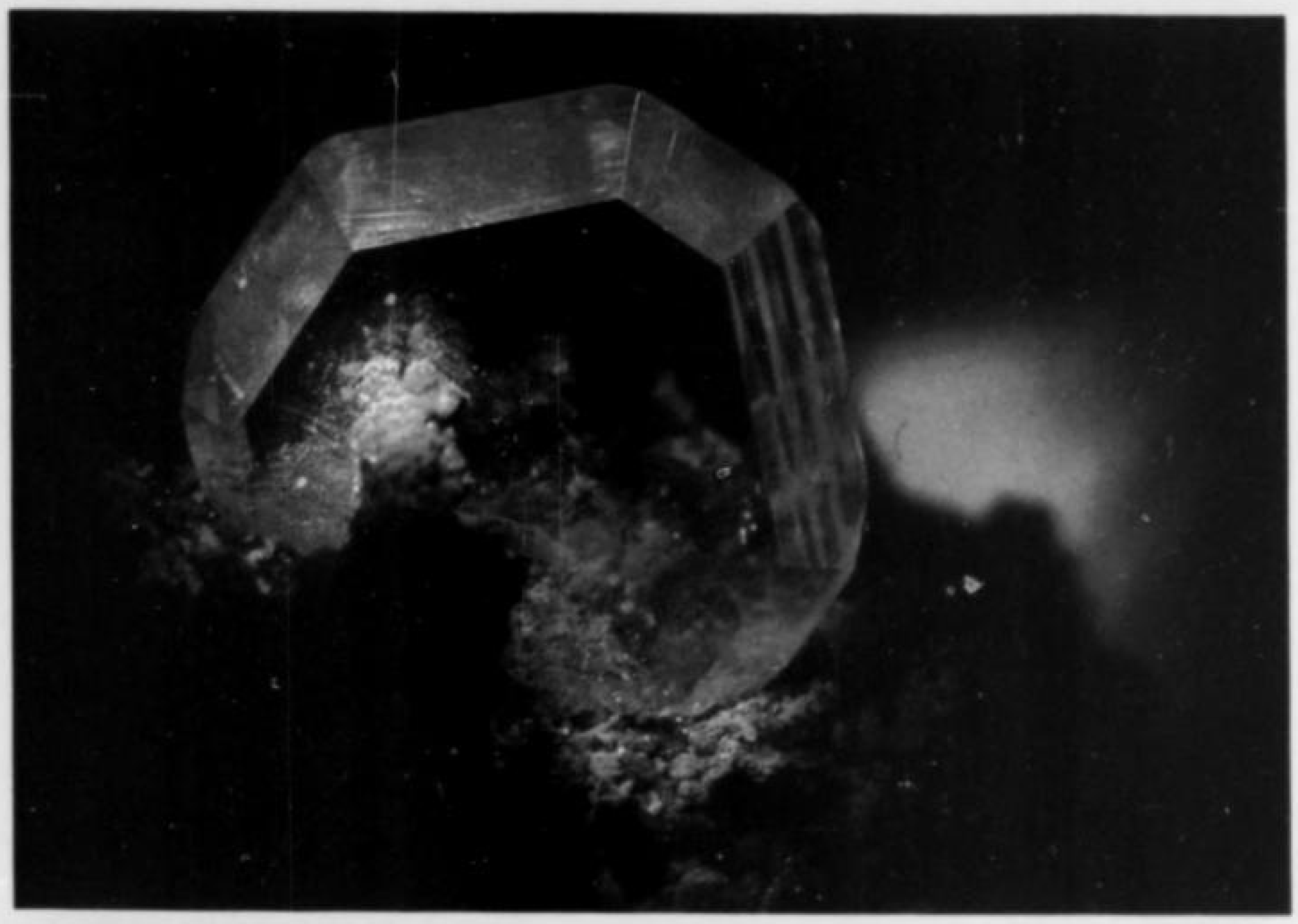
*Upper right.* Calcite and aragonite from the Monte Cristo mine, Rush, Arkansas. Donald Heins photo (First Place, amateur category).

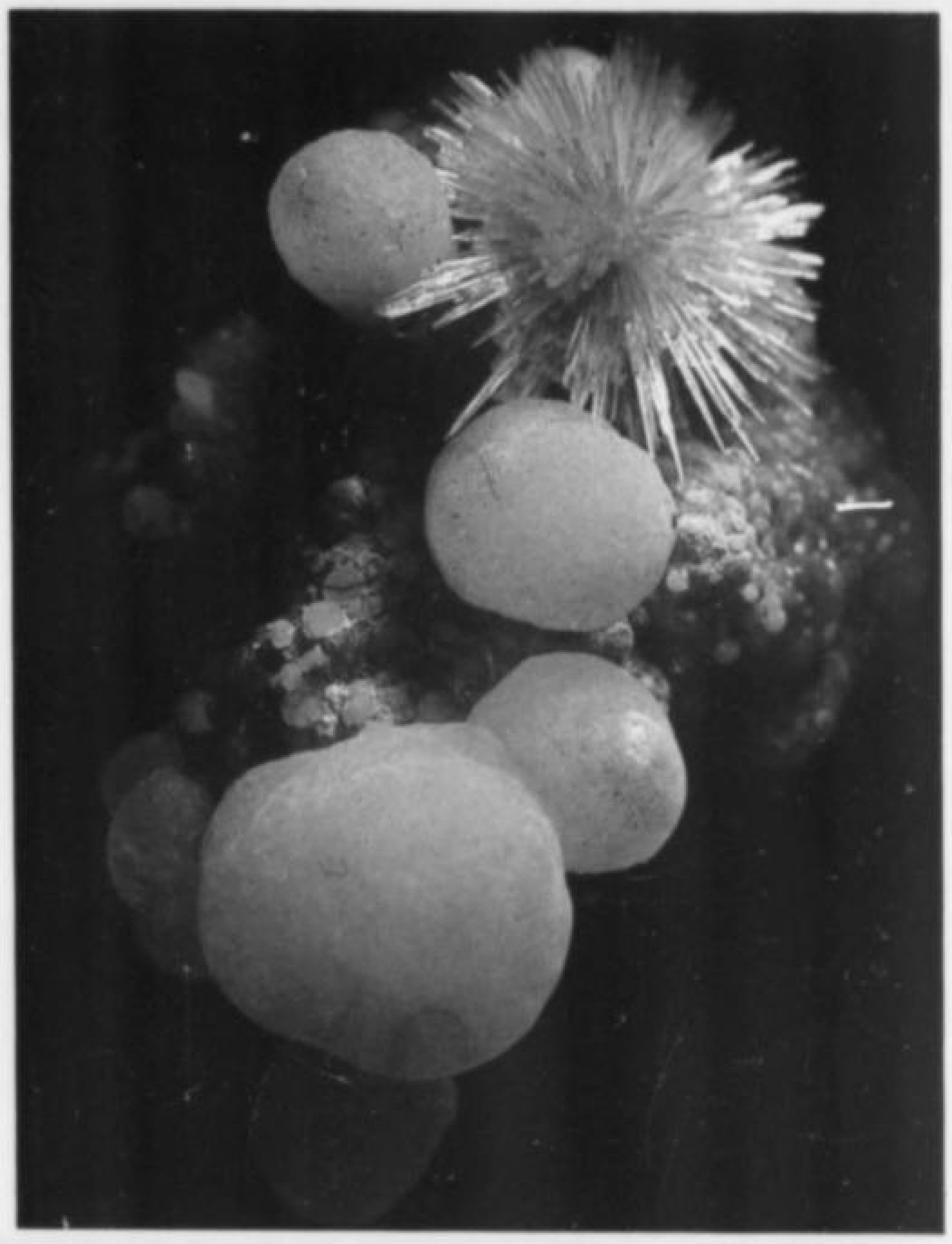
*Middle left.* Cyanotrichite from the Grandview mine, Grand Canyon, Arizona. Clint Lincoln photo (Second Place, amateur category).

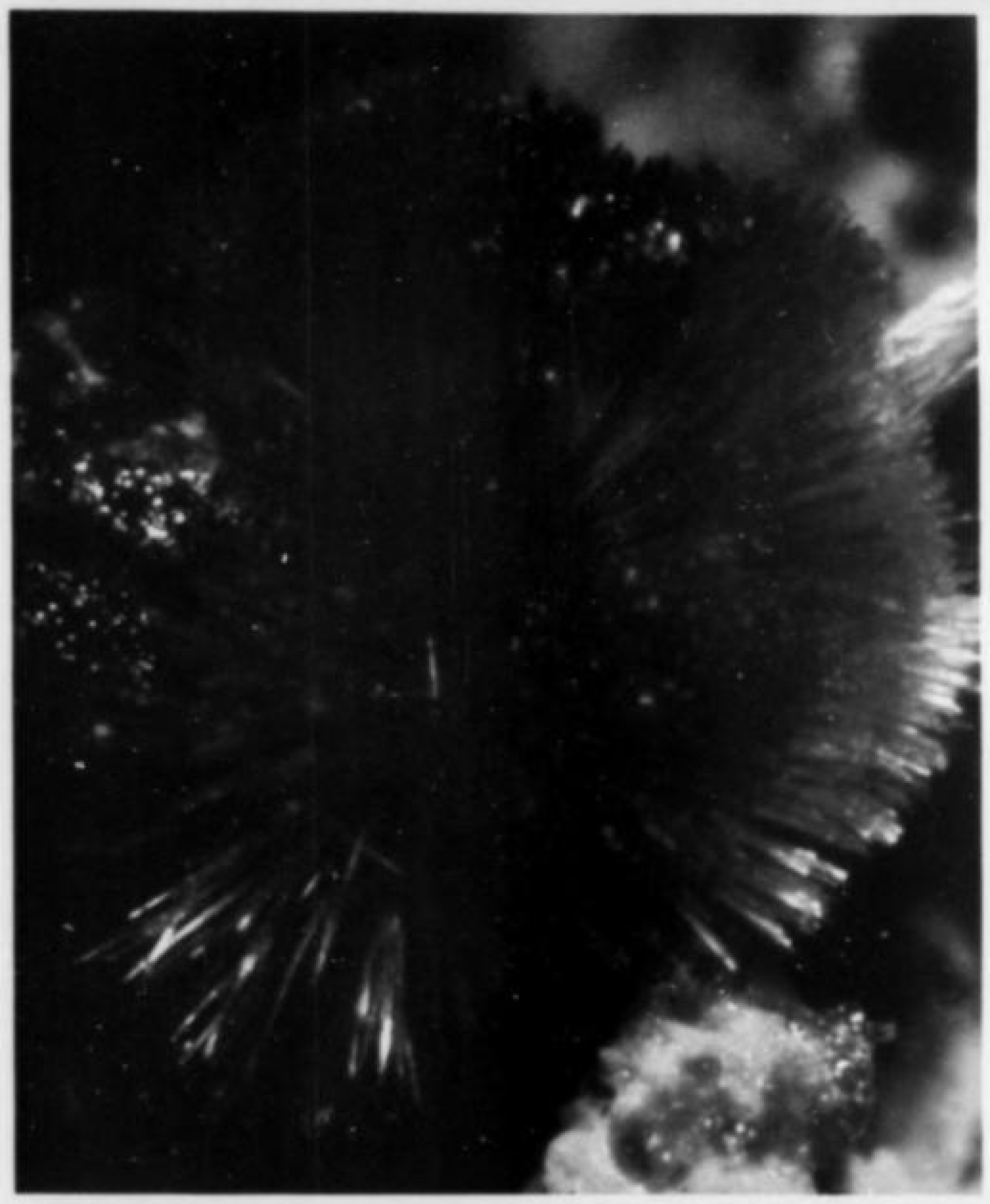
*Middle right.* Wulfenite on dioptase from Tsumeb, Southwest Africa. Michael and Karen Pabst photo (Third Place, amateur category).

*Lower left.* Proustite from Schneeberg, Saxony (Herb Obodda specimen). Breck P. Kent photo (Third Place, professional category).

*Lower right.* Natrolite from Maricopa County, Arizona. Eric Offermann photo (Second Place, professional category).

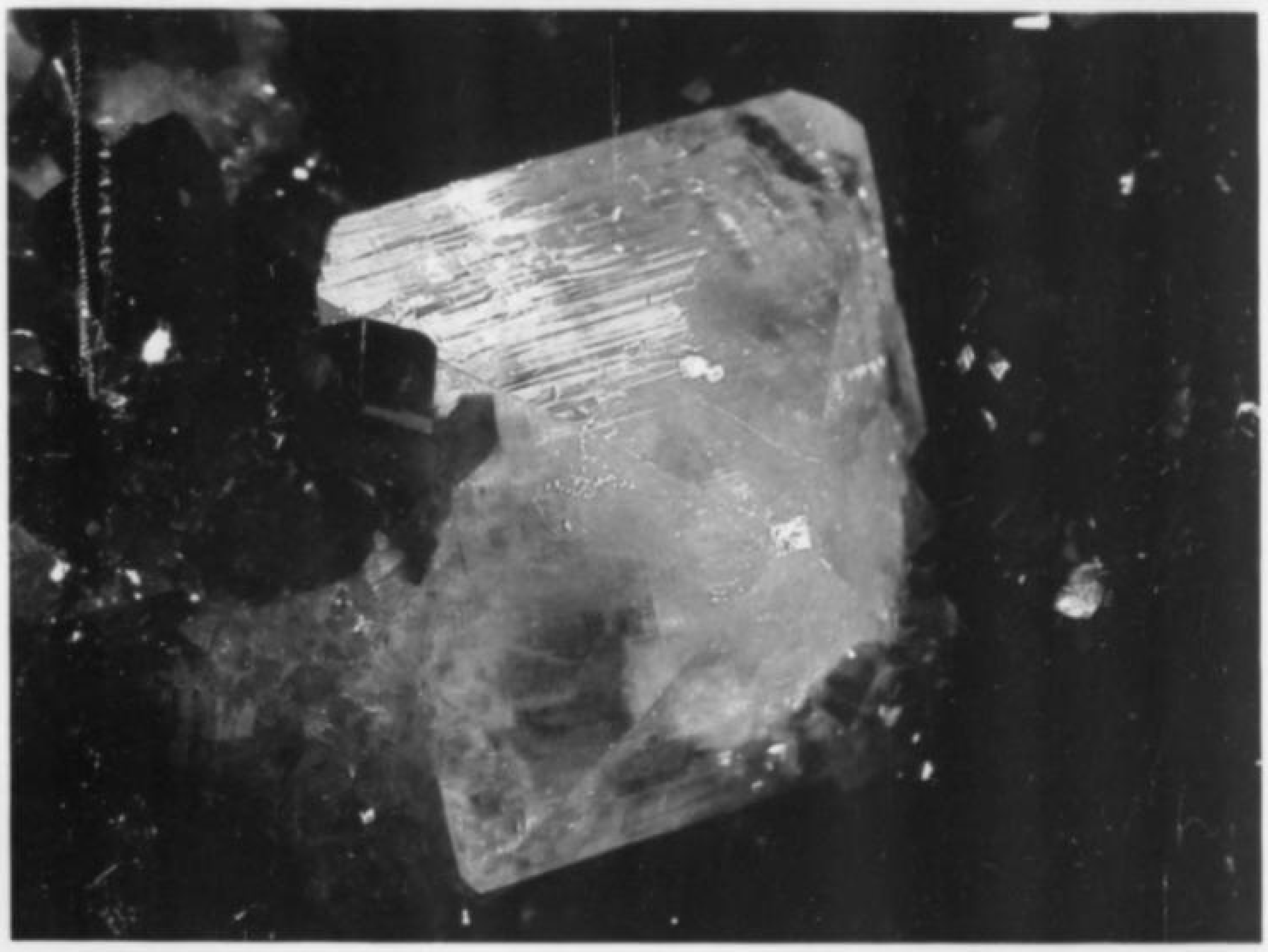


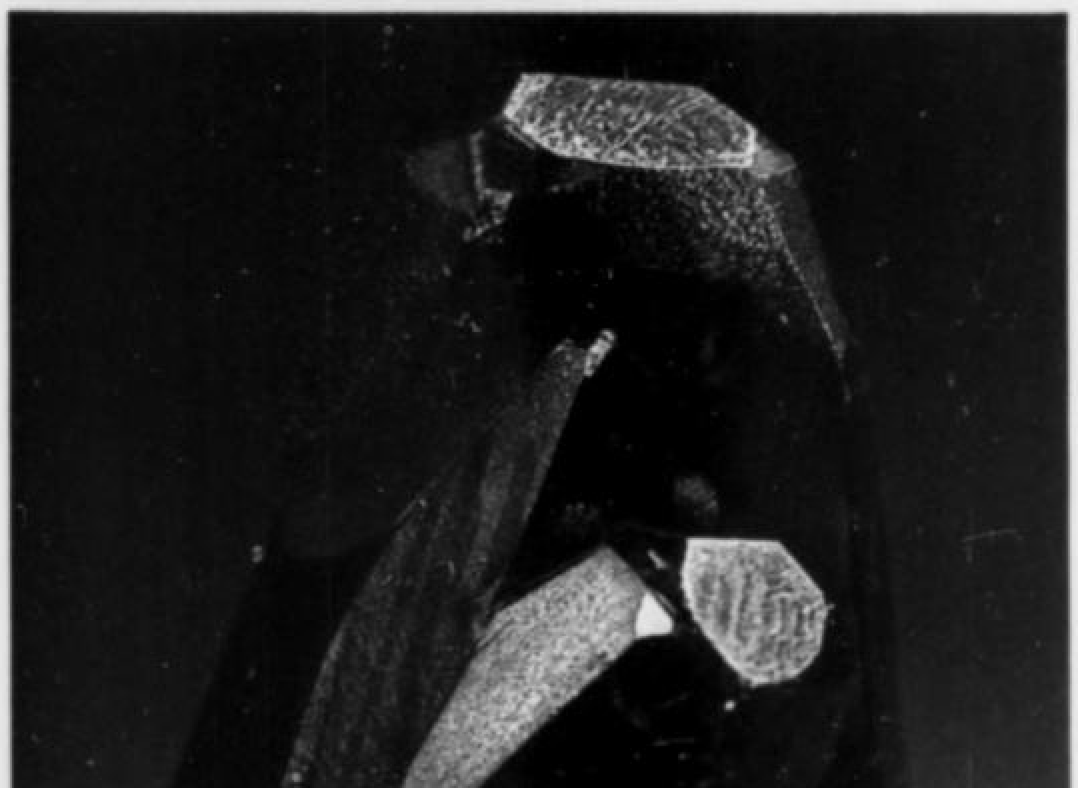


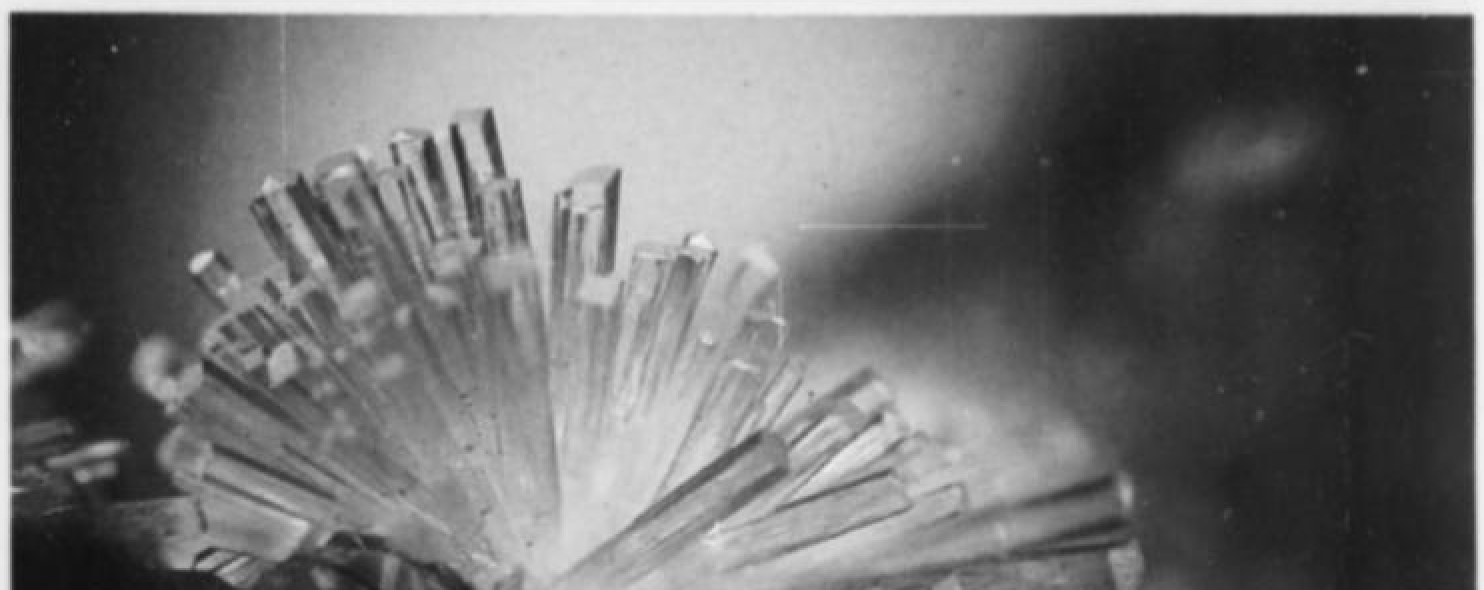


# SLIDE COMPETITION WINNERS

(see opposite page for photo data)







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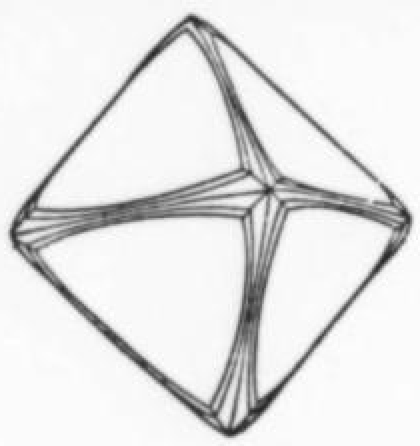

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# the C. & B. mine
## gila county, arizona

by
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Newark, California 94560

***The C. & B. mine, though little known among collectors, is an interesting locality for a variety of minerals including cerussite, descloizite, vanadinite and lanarkite.***

### INTRODUCTION

The C. & B. mine is located on the north side of the Dripping Springs Mountains, about 10 miles northwest of Christmas, Gila County, Arizona. The locality was described by Trebisky and Keith (1975), Ross (1925), and Allen and Butler (1921). It is in the NE¼, Sec. 32, T3S, R15E, on the El Capitan 7½-minute U.S.G.S. topographic sheet, shown as the "Vanadium Mine."

The main workings are located on the south side of a small, dry ravine. These workings consist of two interconnected stopes accessible by short adits. This paper is the result of several periodic examinations from 1970–1977.

### GEOLOGY

The C. & B. mine is located in a faulted contact zone between a medium grained, dark greenish diabase intrusion and a limestone. The contact zone trends approximately north-south, and dips steeply to the east.

In several places along the contact, the limestone and diabase are brecciated, and the breccia fragments are coated with various secondary minerals. Silicification has occurred, and one area located along the northwest wall of the stope in the middle workings is composed of an interlocking mass of small broken quartz crystals with abundant pyrite crystal molds. The rock in this silicified area is heavily oxidized, and descloizite in bladed microcrystals is scattered throughout. Faulting and fracturing have occurred, both parallel and normal to the contact between the diabase and the limestone. Most of these faults and fractures now contain varying degrees of mineralization.

### HISTORY

The C. & B. mine was discovered during the early 1920's. According to Ross (1925) the original owners were a Mr. Cutler and Mr. Bywater. The first letter of each last name was used to generate the mine name.

Early development consisted of two adits on the south side of the ravine, and a shaft on the north side of the ravine (Ross, 1925). Since that time considerably more work has been done, according to Trebisky and Keith (1975), "probably during World War II." The mine now consists of an upper adit and stopes that connect with the middle workings by four winzes. The middle workings are a series of interconnected stopes and drifts. A vertical winze is set in the floor of the largest stope and connects this stope with a short haulage adit. This same stope is open to the surface on the south side of the ravine. A near-vertical winze is located in a drift a few hundred feet inward from the open stope. The extent of the workings from this nearly vertical incline is unknown. Several other winzes are also located in the middle workings.

The C. & B. mine, as of 1977 was not visibly posted, and appeared to be open to collecting. The access road to the mine crosses private ranch land, and permission to trespass must be obtained from the owners.

The mine is dangerous for collecting, both due to the faulted and brecciated condition of the rock, and the abundance of vertical to near-vertical drop offs and winzes.

### MINERALS

The only primary mineral found was galena, occurring as relict kernals surrounded by massive to crystalline lanarkite and cerussite. Pyrite is absent, but empty, well preserved, cubic, striated pyrite molds are abundant in some areas. The presence of secondary copper and zinc minerals indicates that other sulfides were present and have been oxidized. The following secondary (oxide zone) minerals have been identified by X-ray diffraction and optical methods: calcite, cerussite, chrysocolla, descloizite, lanarkite, mimetite, pyromorphite, vanadinite and wulfenite. Secondary quartz occurs on some specimens of cerussite as a coating of minute, drusy crystals.

#### Calcite

Calcite occurs as small white crystals and as rounded, poorly formed blobs associated with vanadinite and descloizite.

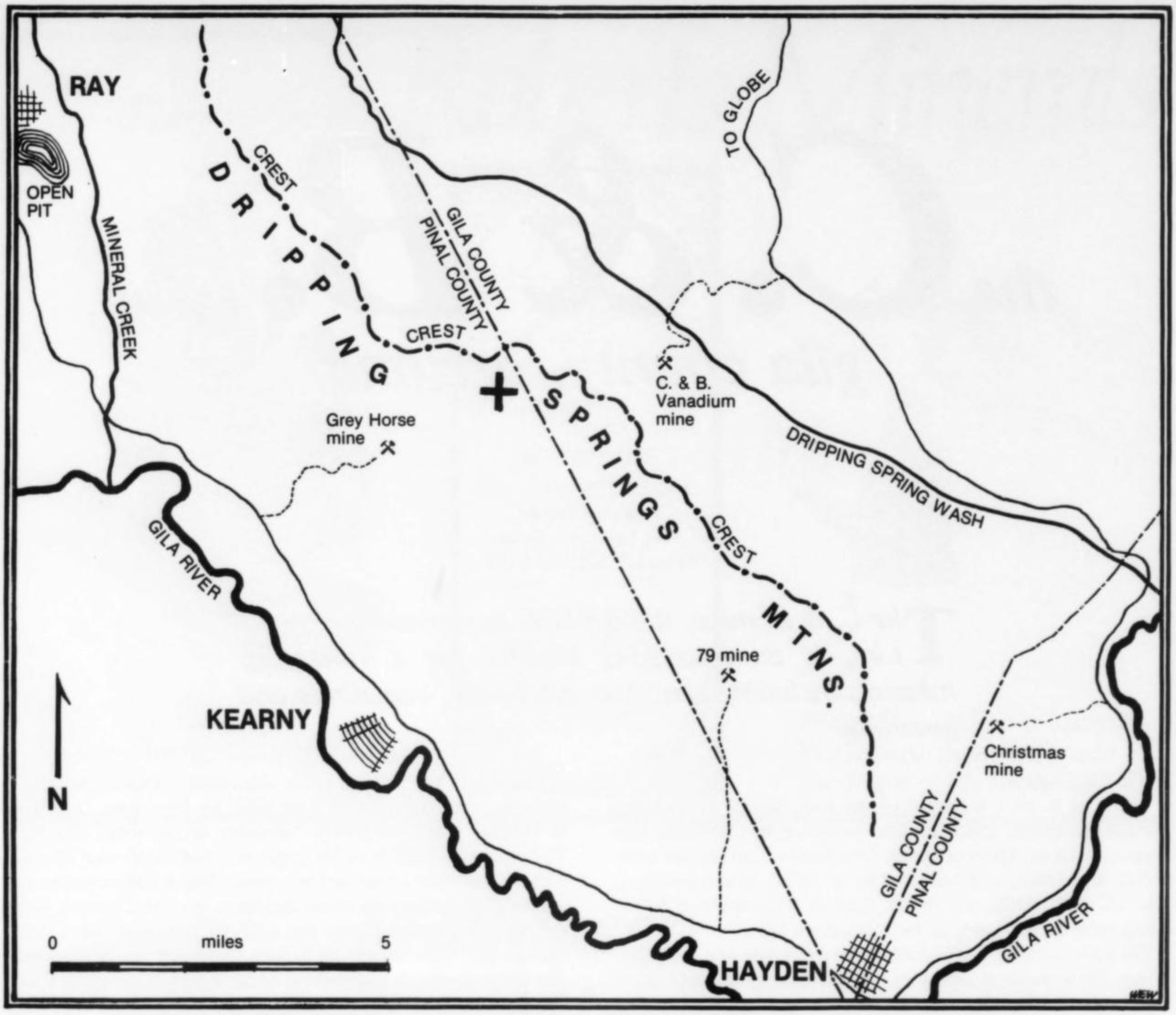



*Figure 1.* **Mineral localities in the Dripping Springs Mountains include the Ray mines, Grey Horse mine (see p. 231), 79 mine, Christmas mine and C. & B. mine. The cross near the center of the map is the meeting point of the four 7½-minute quadrangles which cover most of the mountains. These are the *El Capitan Mountain* (northeast), *Hayden* (southeast), *Kearny* (southwest) and *Sonora* (northwest) quadrangles. The Christmas mine is in the Christmas quadrangle.**

**Cerussite**

Cerussite occurs in several places in the upper adit stopes. The crystals range from micro-size to about 2.5 cm in an acicular habit. Crystal specimens are very delicate and quite difficult to remove undamaged from the walls of the mine. The cerussite has a large variety of shapes and forms. Various styles of "V" twins are very common. Butterfly twins and various types of reticulated and stellate twins on *m*{110} are nearly as common.

Cerussite occurs as flesh-pink, gray, white, yellow, pale lime-green and colorless crystals. The color seems to correlate with the crystal habit to some extent. Generally the colored crystals are short and more intricately twinned. The clear to colorless crystals tend to form acicular, untwinned crystals as well as twinned crystals. The least common form is the equant pseudo-hexagonal twin habit.

The yellow and lime-green crystals may owe their coloring to microscopic inclusions of mimetite, considering that it is present in the matrix on some of the specimens. Alternatively, the cerussite may be tinted by a trace of chromium as is Tasmanian chromian cerussite, which is also highly twinned. The source for the chromium might be the adjacent diabase.

**Chrysocolla**

Chrysocolla is present as a powdery, blue material associated with, and occasionally included within, cerussite creating bright blue cerussite crystals. The material did not yield a good X-ray pattern.

**Descloizite**

The occurrence of descloizite was described by Trebisky and Keith (1975). The mineral occurs in greenish-brown, brown, orange, and blackish-brown drusy coatings and as partial coatings of individual crystals with a flattened, blade-shaped habit. The crystals are small, rarely reaching 4 mm in size. Associated species include vanadinite and calcite. In some cases vanadinite rests on descloizite in rather attractive groupins of flower-like composites as much as 7 mm in diameter, with small descloizite crystals also scattered on the vanadinite. In most instances the two minerals show contemporaneous crystallization.

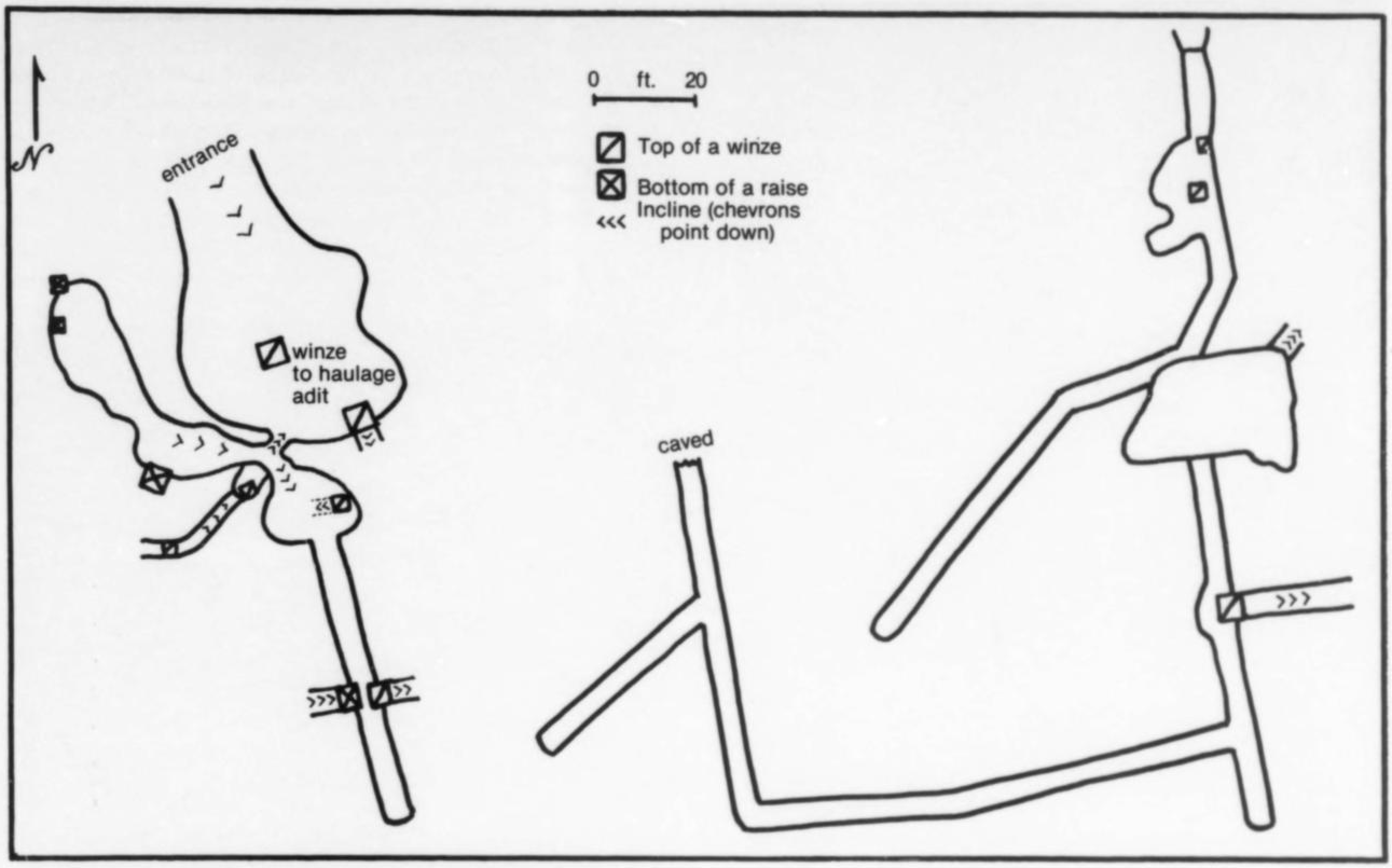



*Figure 2.* **Mine plans for the middle-level workings (left) and the upper workings (right) of the C. & B. mine.**

*Figure 3.* **A view looking south toward the C. & B. mine dump, showing the open stope just behind the dump. The entrance to the upper workings is just to the right of the dump, and a short caved adit is farther to the right.**

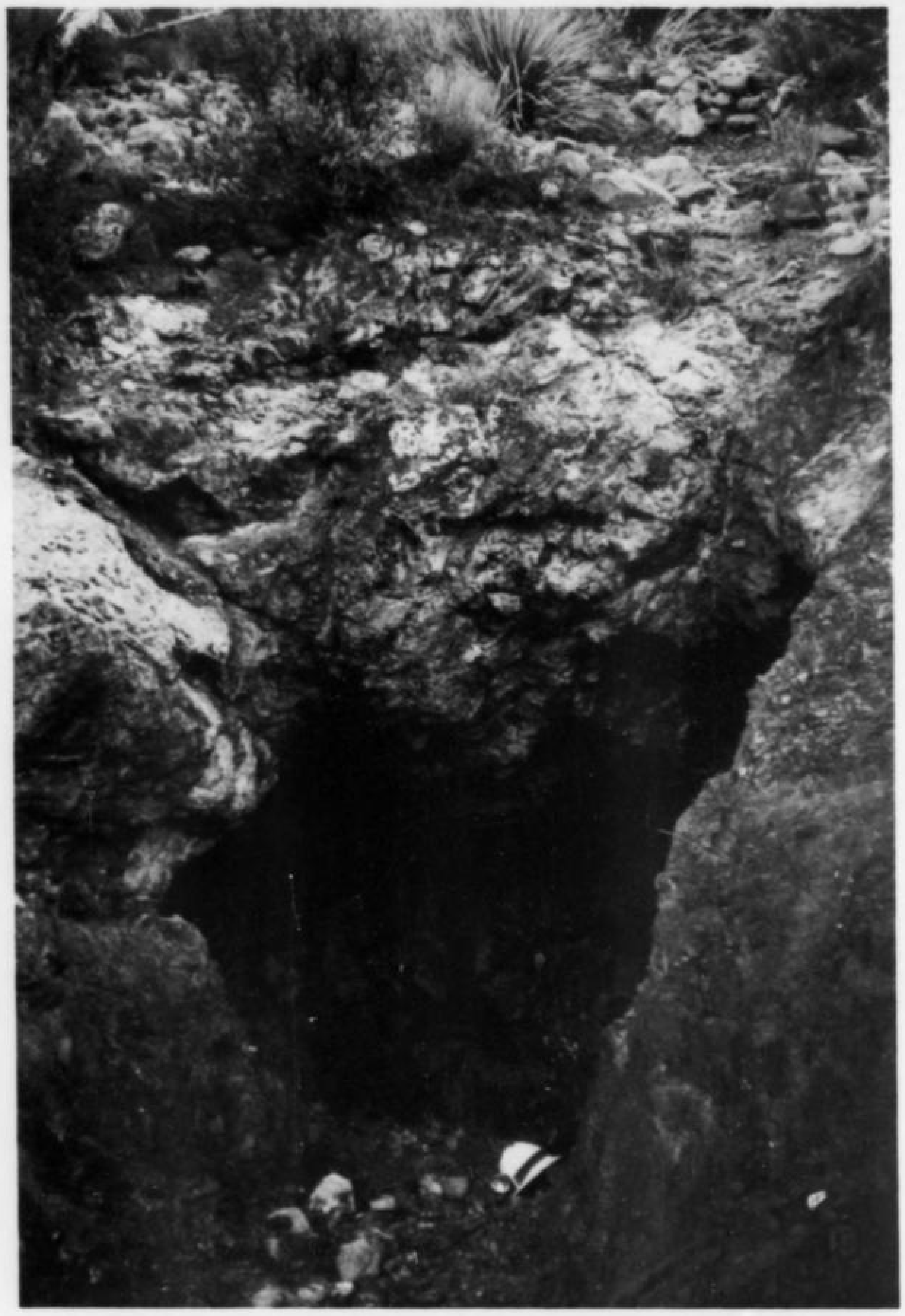


*Figure 4.* **The entrance to the upper adit, showing diabase (right) in contact with brecciated limestone (center).**

**Lanarkite** $Pb_2(SO_4)O$

The discovery of lanarkite at the C. & B. mine apparently marks the first documented occurrence of this mineral in the United States. All of the lanarkite seen at the mine has been partially to completely replaced by cerussite, and is also usually coated by crystalline cerussite. Lanarkite specimens are rare, and are found in a restricted area of the roof in the upper adit, where it opens into the stope. Fewer than a dozen specimens containing lanarkite have been found out of several hundred cerussite specimens examined. Completely replaced pseudomorphs are present, but their poor preservation in the mine makes positive identification as cerussite pseudomorphs after lanarkite most difficult.

Lanarkite has a distinctive cleavage (Richard and Wolfe, 1938), different from cerussite. This feature led to the initial recognition of the mineral as something other than cerussite. Its color varies from pearly white to very pale, slightly greenish yellow. It is not fluorescent as described in Palache and others (1951). The X-ray data match quite well with that of lanarkite from the type locality in Scotland (Heddle, 1901 and Binnie, 1951).

**Mimetite**

Mimetite occurs as microcrystals associated with wulfenite and vanadinite and less frequently with cerussite. An interesting occurrence of mimetite is on the hanging wall of the upper stope. Here it occurs as the middle member of a complete series ending with bright red vanadinite grading into orange vanadinite, then orange-yellow to yellow mimetite and then into bright lime-green pyromorphite.

Identification of the mimetite, vanadinite and pyromorphite was made on the basis of the comparisons between their X-ray patterns and the A.S.T.M. standards. The three minerals occur in patches and clots of microcrystals, on massive to crystalline cerussite and highly altered diabase in the contact zone between the diabase and the limestone. The crystallization sequence for the three minerals is pyromorphite-mimetite-vanadinite. Vanadinite is the most common of the three minerals, and formed last, resting on and replacing mimetite. The restricted occurrence of pyromorphite and mimetite in scattered patches in close proximity to the diabase suggests that the phosphate necessary for the two minerals came from

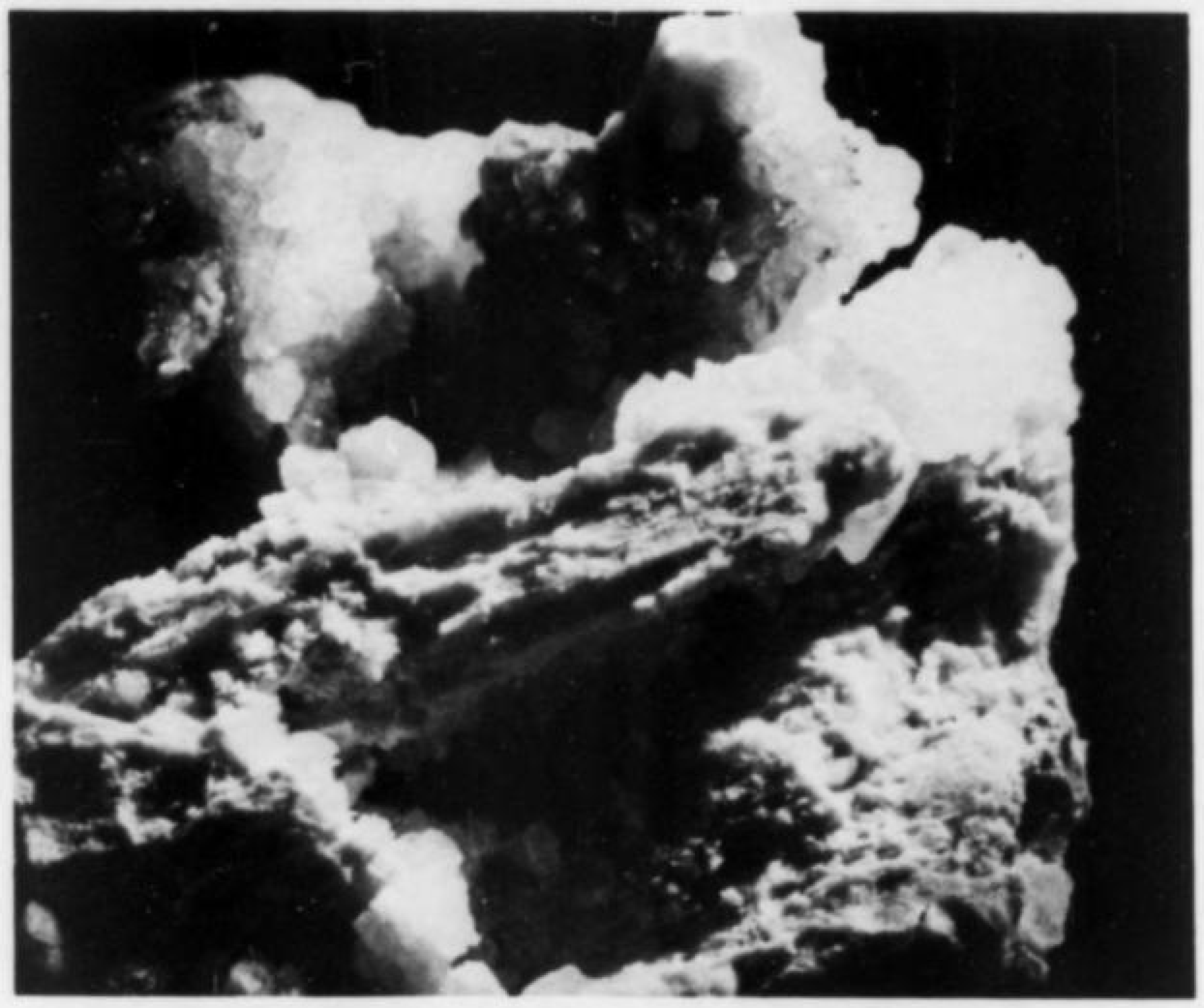
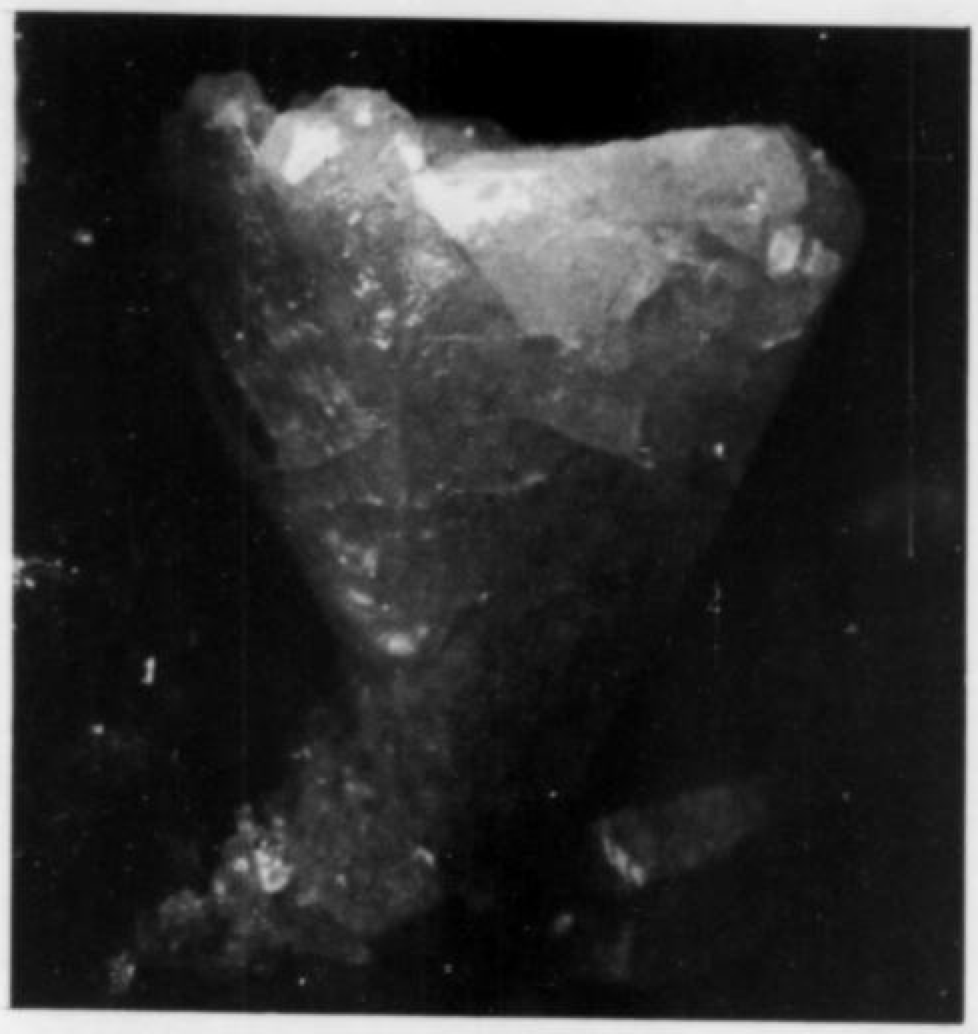
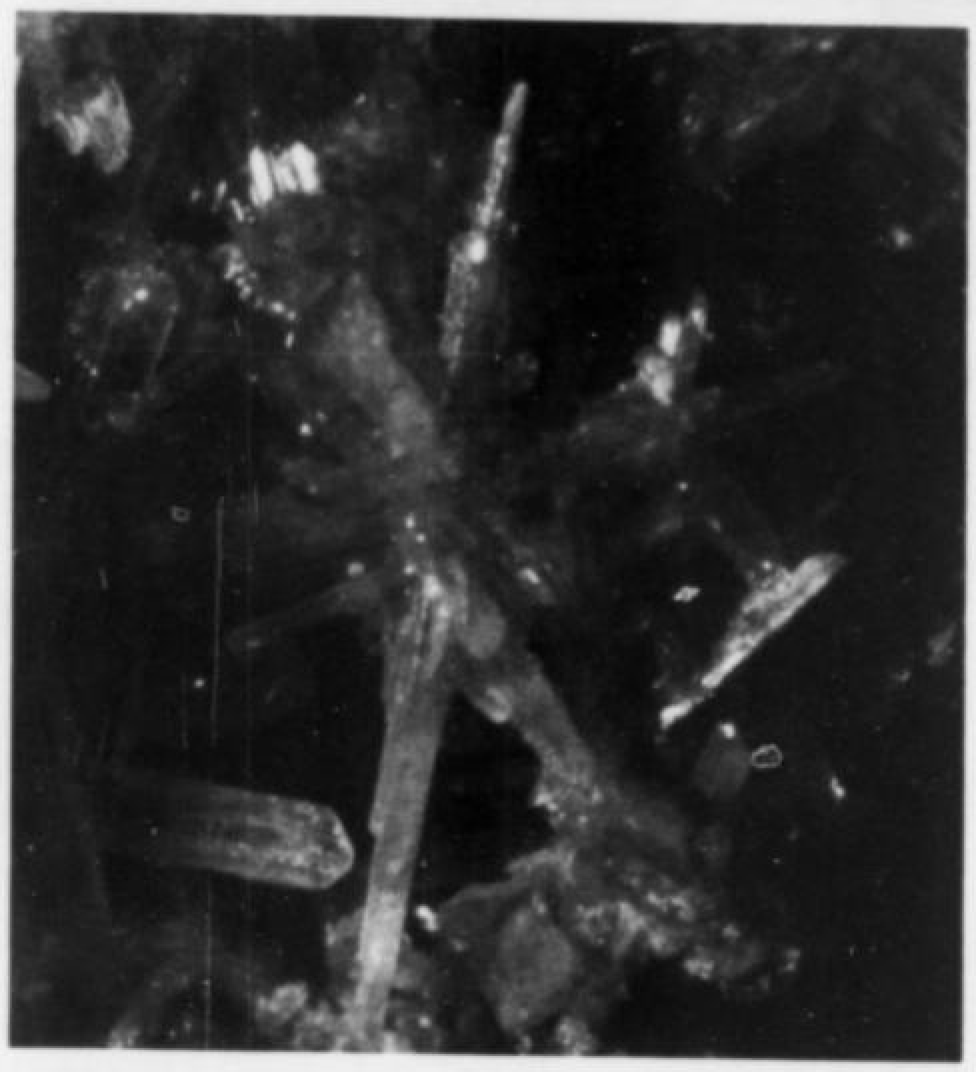


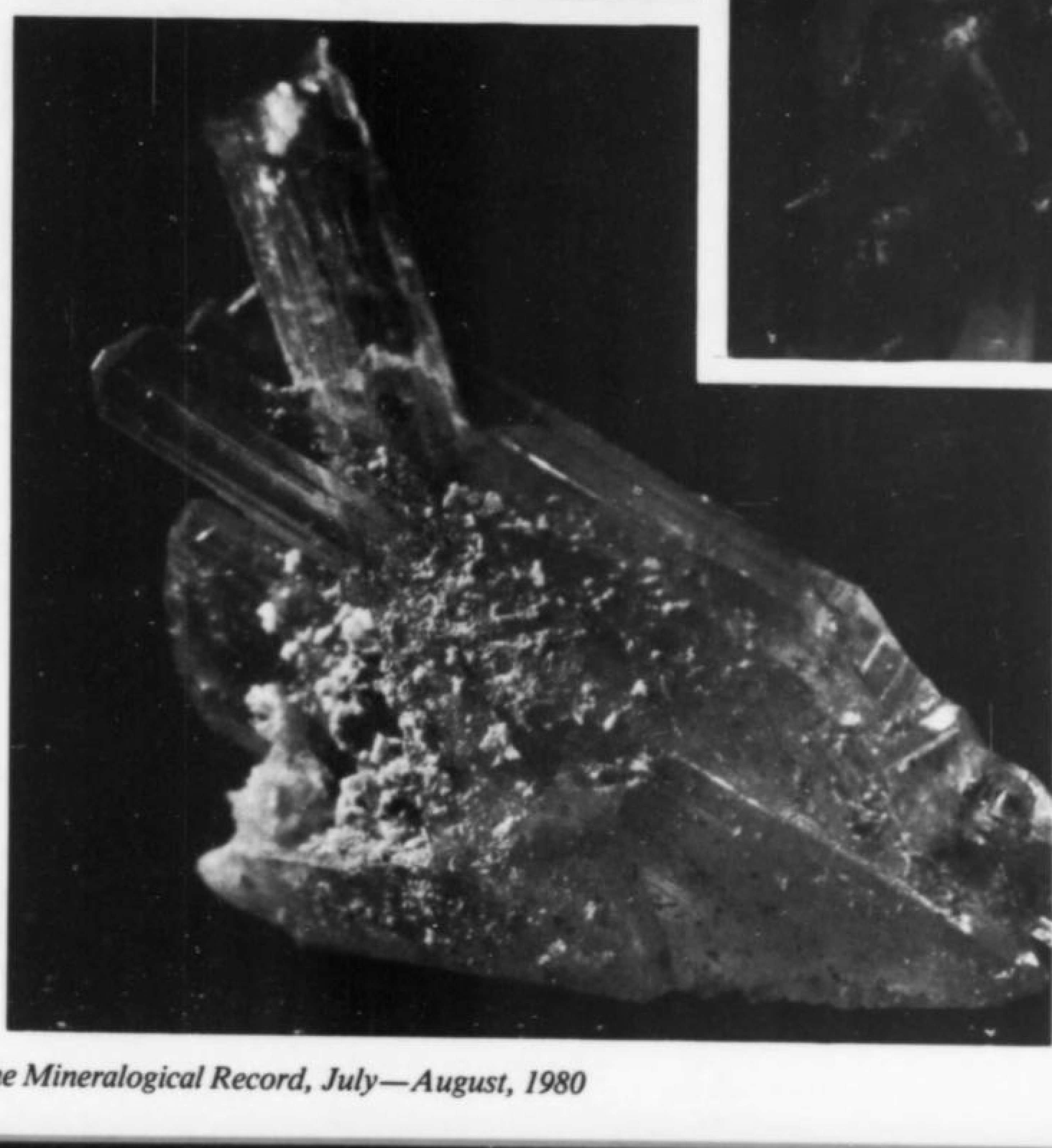
*Figure 5.* **An almost totally replaced lanarkite prism, showing an additional coating of cerussite (specimen width is 2 cm).**

*Figure 6.* **A lanarkite prism partially altered to cerussite, still showing well-developed lanarkite cleavage. The crystal is about 1 cm in length.**

*Figure 7 (opposite page).* **Several habits of cerussite twins from the C. & B. mine.**







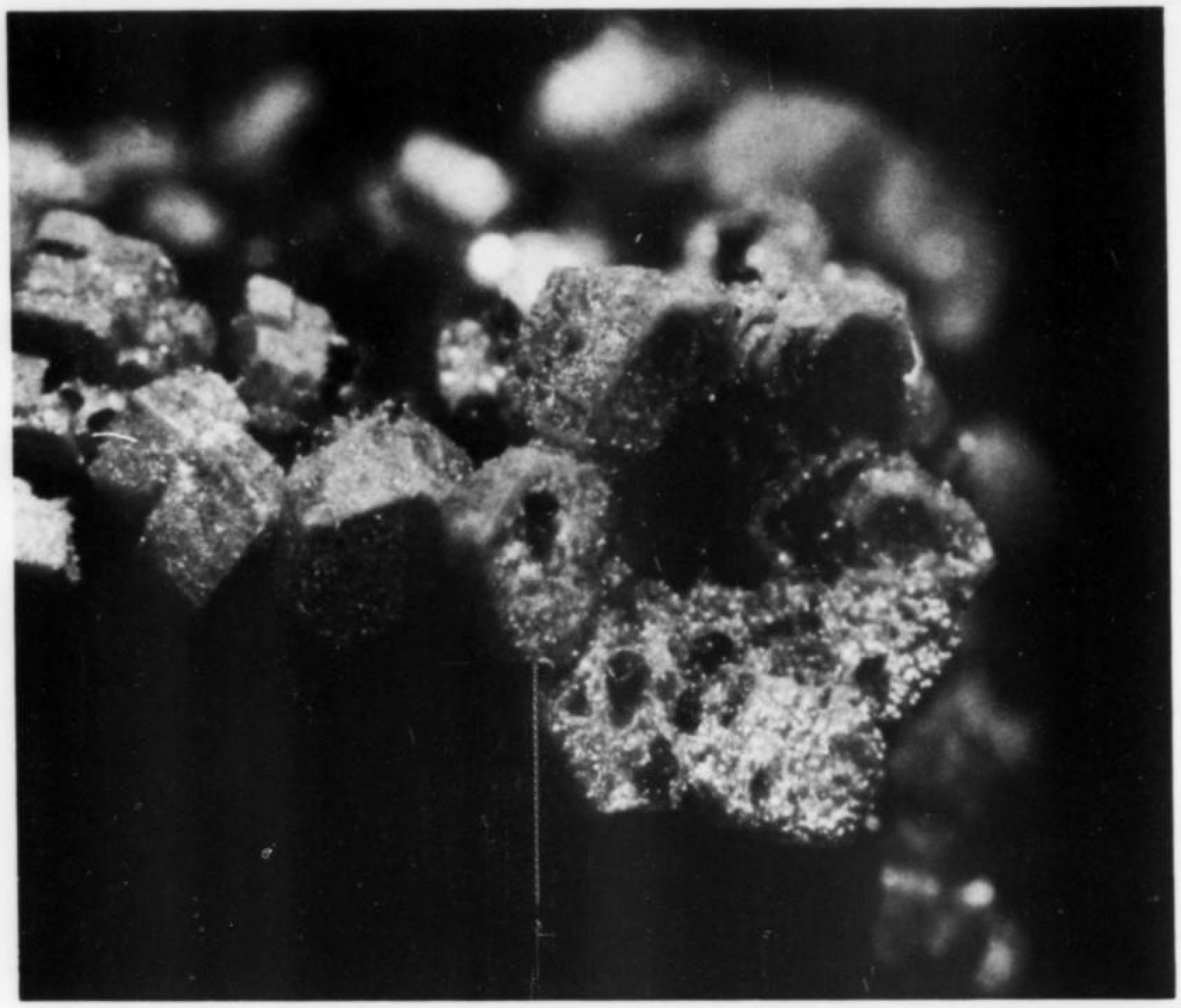



*Figure 8.* **A 5 mm flower-like composite crystal of red vanadinite with dark descloizite crystals on the surface.**

weathering of apatite in the diabase. Mimetite is present on both sides of the contact, but is much more abundant on the limestone side of the contact, while vanadinite is more abundant on the diabase side of the contact.

**Vanadinite**

Vanadinite is common in the stopes as bright red-orange, orange, and tan crystals. A slightly different occurrence from the usual habit is found adjacent to the southernmost winze in the middle workings where the vanadinite occurs in flat hexagonal crystals that occur as flower-like composites.

**Wulfenite**

Wulfenite is fairly common in the upper adit and stope, but is rare in well crystallized specimens. It forms thin seams, powdery coatings of microcrystals, and masses with open interstices. It is found in the same areas as the cerussite and commonly occurs as a crystalline layer between the cerussite core and the country rock wall. Wulfenite sometimes occurs on crystallized cerussite. Crystals are generally small, usually in the 3 to 5 mm range. They are bright orange, translucent to transparent, and resemble the wulfenite from the Rowley mine, near Theba, Arizona. Mimetite, in tuft-like crystal aggregates, is usually associated.

**Anglesite**

No anglesite, either massive or crystalline, has been identified from the mine during this investigation. Trebisky and Keith (1975) cite anglesite as being present with cerussite, but do not mention how it was identified.

## PARAGENESIS

During the initial stages of oxidation lanarkite was the species derived from galena, rather than the usual sulfate, anglesite. Later changes in the environment, including introduction of carbonate ion with an increasing pH, caused cerussite to be the stable phase forming from galena, with cerussite also replacing much of the pre-existing lanarkite. Wulfenite began crystallizing after cerussite, forming on the edges of the cerussite veins and, in places, at the expense of cerussite. It also crystallized in vugs in massive cerussite. The descloizite-vanadinite assemblage forms an independent alteration series (Trebisky and Keith, 1975).

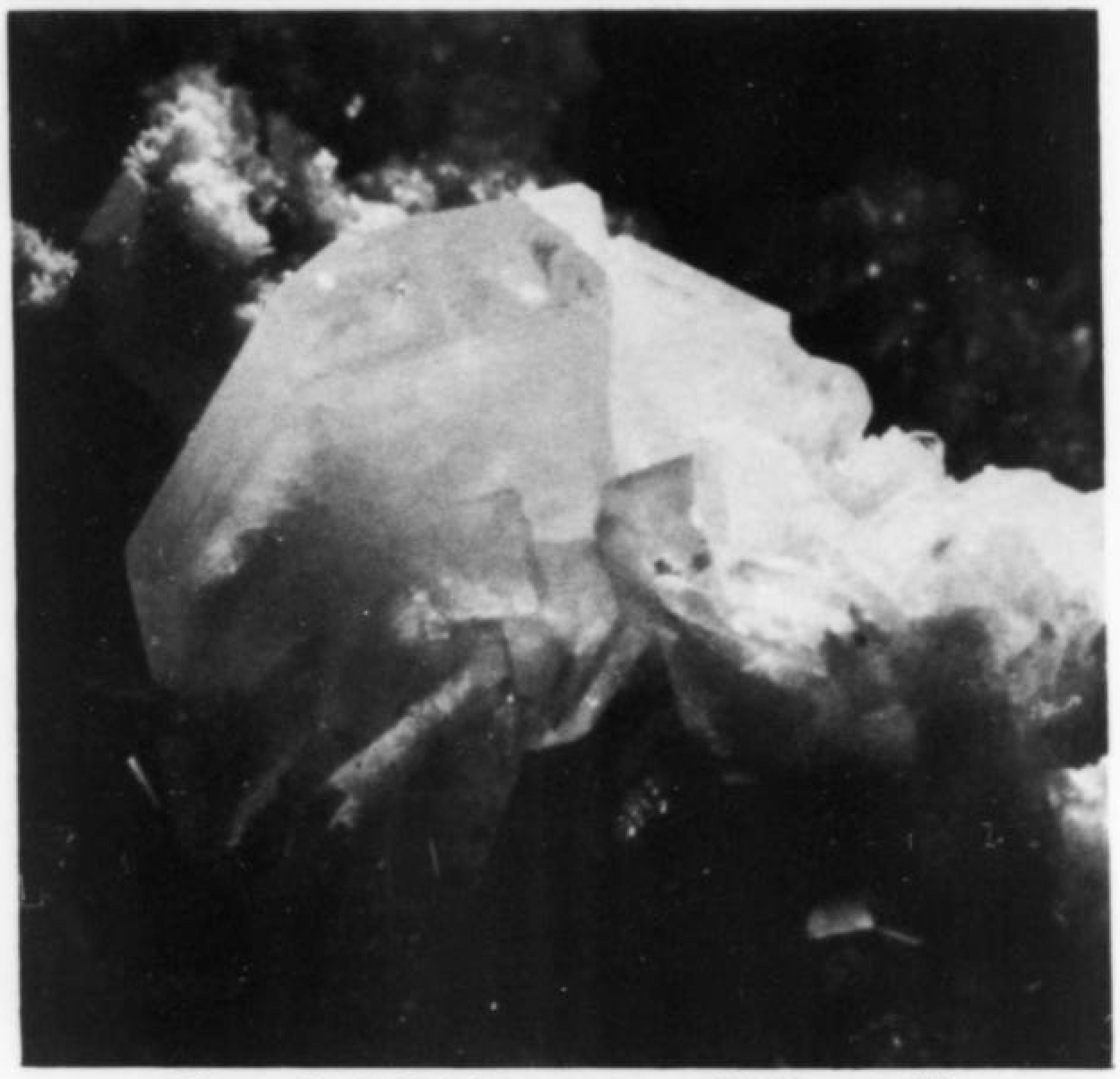


*Figure 9.* **A bright orange wulfenite crystal about 4 mm with mimetite on cerussite.**

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# the Grand Reef mine
## graham county, arizona

by
**Robert W. Jones**
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***Known as a specimen locality only since the 1960's, the Grand Reef mine has since become one of Arizona's new localities of significance. The mine is most famous for superb linarite crystals to more than 1 inch, as singles and groups, but has also produced fine leadhillite, cuprite, and other species.***

**LOCATION**

The Grand Reef mine is located in the Santa Teresa Mountains, Graham County, approximately 60 miles northeast of Tucson, Arizona. Specifically, the mine is in the Aravaipa mining district, Laurel Canyon, 4 miles northeast of Klondyke. Nearby mines include the Dog Water (a source of small yellow wulfenite crystals), Silver Cable, Aravaipa, Arizona, Black Hole, Iron Cap, Head Center, and others. All, including the Grand Reef mine, are referred to in the literature as a series of small lead-zinc deposits also containing some silver, copper and gold.

**MINE WORKINGS**

The mine contains some 4000 feet of underground workings which are partially accessible through a single half-buried adit at the base of the large dike-like structure (called the "reef") which is a dominant topographical feature of the area. Collectors have found a surface exposure near the "glory hole" opening to be considerably more productive of specimens than the underground workings. That fact, plus a colony of bats in residence (hanging from the ceiling) in the entrance adit, results in few collectors venturing underground. In a state where most productive localities are secreted away below the surface, it is a pleasure to be able to collect in the sunshine at the Grand Reef mine. This pleasure is somewhat blunted (as are chisels and other tools) by the incredible hardness and resistance to fracturing which the reef rock presents. The rock is a silicified breccia, the two components apparently forming a composite material which, like fiberglass, retains the strongest physical properties of both components. Collectors generally restrict themselves to splitting small rubble blocks, rather than working the rock face, unless they have brought a Cobra drill and dynamite.

**HISTORY**

The Grand Reef deposit was discovered in the 1890's by J. W. Mackay, who worked it to a depth of 300 feet. Some time between 1915 and 1919 a small mill was built to handle concentrates and during the mid-1920's a flotation mill for the ore was built in Aravaipa. From 1929 to 1930 the oxidized lead ore mined at the Grand Reef made it the second largest producer in the state at that time. In 1939 the Grand Reef Mining Corporation installed a 100-ton-per-day mill. During 1941 the Calistoga Mining and Development Company worked the tailings. No further work on the property has been reported since then. American Zinc, Lead and Smelting Company has been the reported owner since 1959. However, other sources indicate that the current owner is a Mr. Reibold of Safford, Arizona (from whom permission to collect should be obtained). I am unaware of the connection, if any, between Mr. Reibold and A.Z.L.&S. Company.

Collectors, including the famous Ed McDole, visited the property from time to time but with little success until 1969, when exploratory drilling at the surface exposed a vuggy zone containing crystallized minerals. Probably the first significant collecting effort was mounted by Dick Jones of Casa Grande, Arizona, on August 2, 1969. Dick's son Roy found the first linarite crystal in the creek bed and they traced it up to the outcrop. During the following months, Jones and his party recovered hundreds of choice display specimens, especially of linarite, which were sold to prominent collectors and museums. Collectors since that time have made regular visits, scouring the dump and extracting a fine selection of micromount, thumbnail and miniature-size specimens. Cabinet-size specimens have always been rare, as the pocket size tends to be under about 3 inches.

In order to take pictures and review the collecting possibilities, I visited the locality in June, 1978, with Dan Davis (then Acting Director of the Arizona-Sonora Desert Museum), William Panczner (Earth Science Director of same), and well-known micromounter Arthur Roe. Due to the June heat, a lack of time, and no formal permission, we did no collecting, but we found the visit interesting, and the ruggedly beautiful terrain of the Santa Teresas satisfying. This is no place for small children though, as the steep dumps and open glory hole can be dangerous. Flash floods have been known to bury cars in the wash near Klondyke.

## GEOLOGY

The Grand Reef mine is located along a massive dike which trends 12° west of north and dips 70° west. The dike is over 100 feet wide and 200 feet high and, according to Wilson (1950), this dike is of silicified breccia enclosed in a rhyolite porphyry. Simons (1963) describes the dikes of the region as a swarm 1 mile wide and 4 miles long whose composition ranges from rhyolite to andesite. From his studies it should be noted that the chemical composition of the rhyolite is similar to the alkali granite pluton identified 1 mile east of the dike swarm. This granite pluton makes up the bulk of the Santa Teresa Mountains. Diabase formations have also been noted

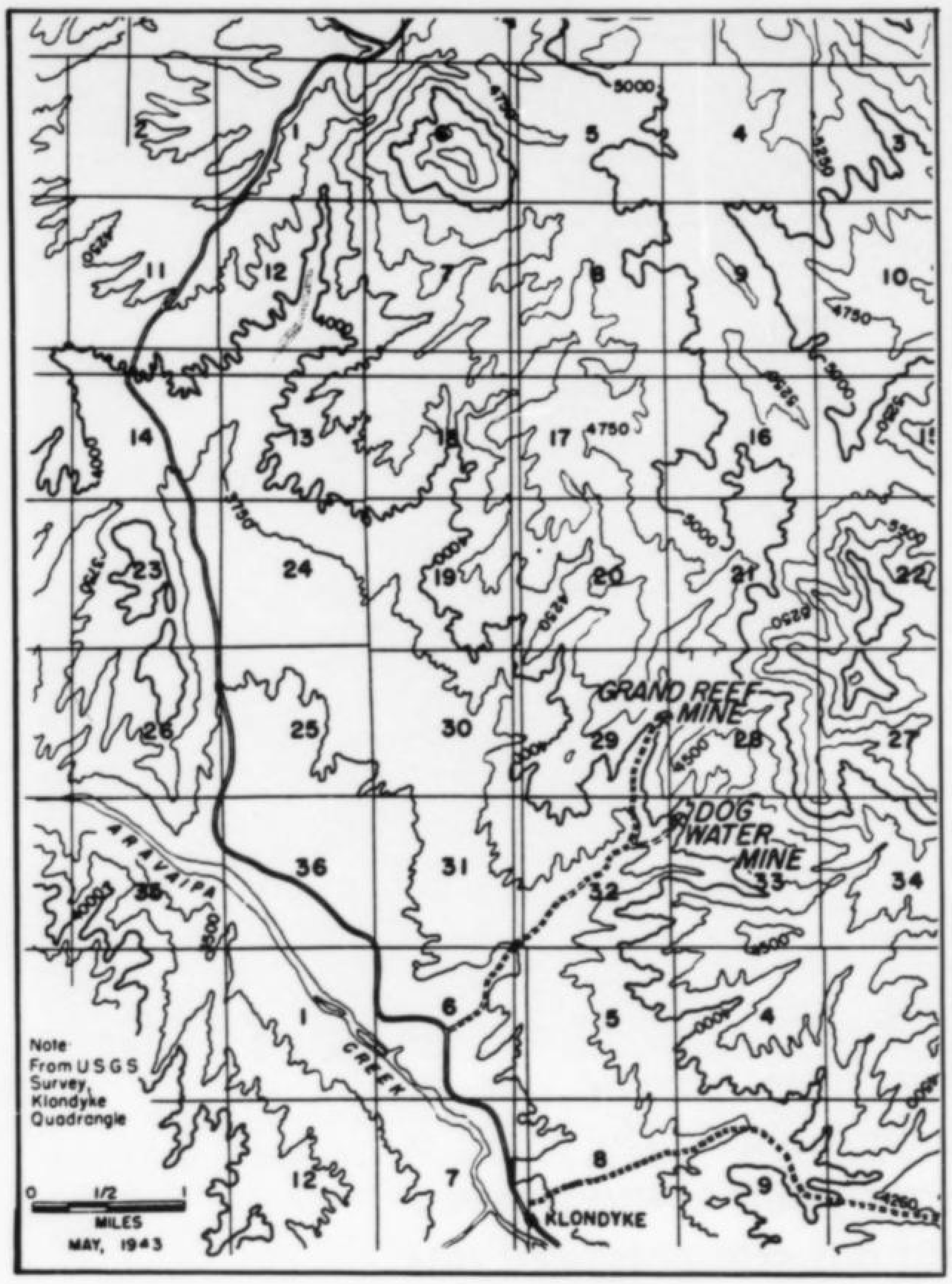


*Figure 1.* **Location of the Grand Reef mine, in the Santa Teresa Mountains north of Klondyke (Denton, 1947).**

*Figure 2.* **The Grand Reef mine as viewed from the approach in Laurel Canyon. A low dike stands out from the face of the main structure; at its right (arrow) is the main collecting area, and near its center (just left of arrow) is the glory hole opening. The tunnel entrance is at the extreme lower right of the large dike (not visible here).**

*Figure 3.* **Fine crystals of linarite to ¼ inch. Richard Bideaux specimen.**

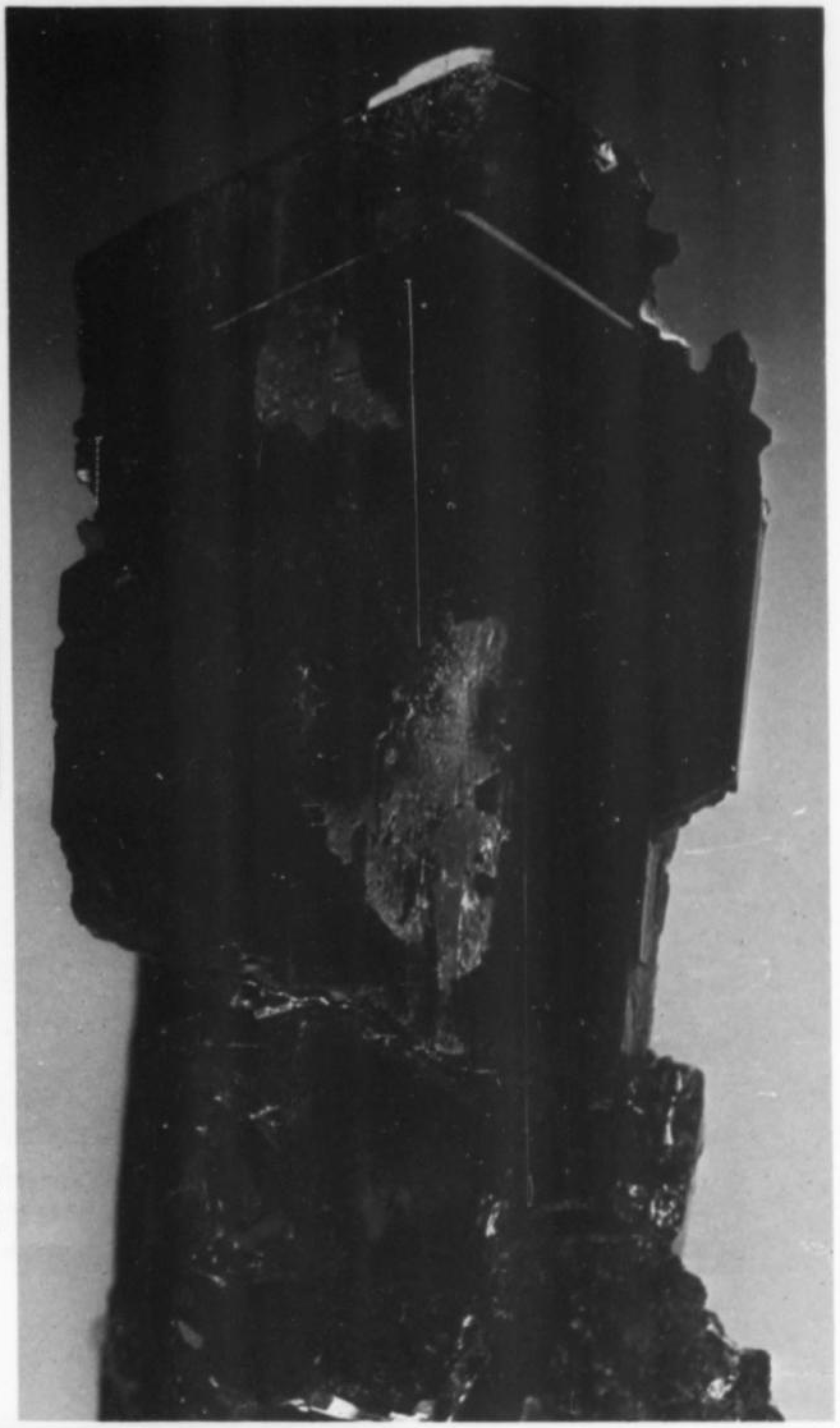

*Figure 4.* **An extremely large crystal (repaired), recovered recently. The crystal is ⅝ inch across and 1⅜ inches tall. Arizona-Sonora Desert Museum specimen.**

*Figure 5.* **Leadhillite crystals with blue centers. The large crystal is about ¼ inch across. Richard Bideaux specimen.**

*Figure 6.* **The main collecting area is a small pit in the face of the main dike, occupied, in this photo, by William Panczner (arrow).**

in the area. Ross (1925) identified a number of formations in the region including Gila conglomerate of Tertiary age, Cretaceous age conglomerates, sandstones and shales, Miocene age rhyolite, the Tornado and Martin limestones of Carboniferous and Devonian age respectively, and Precambrian Pinal schist.

The ores of the Grand Reef have largely followed steep dipping faults, the rhyolite prophyry being most favorable to the deposition of minerals (Wilson, 1950). Dick Jones reports tracing a fault from 8 feet west of the intruded breccia which follows a curving path through the site of the most fruitful collecting area. Rubble piled high by collectors has since obscured this feature, except where the fault meets the dike at the southern end of the collecting area.

Later secondary mineralization, which resulted in the minerals most sought now by collectors, occurred along the fault system, the minerals being deposited in quartz-lined pockets rarely exceeding 2 or 3 inches, and along the face of tight seams in the rock.

**MINERALS**

The minerals of the deposit include a number of popular collector species, some of them quite rare and fine. The small pockets have tended to restrict crystal size somewhat, but few collectors complain about electric-blue blades of linarite to an inch or so. The rare larger pockets to 4 inches have been found containing linarite crystals exceeding 2 inches in length. Dick Jones reports finding one star-shaped pocket which yielded three 8 x 10-inch cabinet pieces. The other species seldom reach an inch in size. Among the rubble blocks a bonanza of micro-size caledonite, linarite, leadhillite, brochantite, aurichalcite, and even silver may be found.

**Linarite**

This is the most sought-after and most easily identifiable of the species occurring at the Grand Reef mine. It occurs as single blades and groups of blades in quartz-lined cavities. The individual crystals range from a few mm to an inch or so in length, about half that in width, and very thin. Rare crystals to 2 inches have been seen. A brilliant luster and vibrant, transparent blue color make these particularly showy. The crystals are very brittle, a fact not helpful to their safe removal. Linarite also occurs as blue coatings and smears along seams in rock; the coatings occasionally show crystal faces parallel to the rock surface up to an inch in length. Linarite is ubiquitous in the surface zone and is therefore associated with most of the other species there.

**Leadhillite**

Grand Reef mine leadhillite occurs as single gray to pale blue crystals rarely exceeding ¼ inch and usually smaller. Pseudohexagonal crystals similar in appearance to aragonite twins have been observed. Some individual crystals show a color variation, becoming darker blue toward the core. Tabular crystals have also been found, showing the typical bright pearly luster and perfect cleavage. Leadhillite is most commonly associated with linarite; David Shannon reports collecting a single crystal of leadhillite impaled on a single blade of linarite (now in the David Richerson collection).

**Cerussite**

Cerussite was a major ore mineral of the mine along with anglesite. The best specimens have been collected underground. Collectors recently found fine 1-inch sixlings without matrix.

*Figure 7.* **A ¾-inch crystal of colorless anglesite on quartz surrounded by galena. Evan Jones collection; photo by the author.**

Wendell Wilson reports pulling back a large slab from the wall underground, at the base of the glory hole, and finding both sides of the fissure coated with ¼ to ½-inch gemmy, equant cerussite crystals and up to 1-inch azurite crystals on matrix lined with chrysocolla. Most of the large azurite crystals spanned the fissure and so were broken when the fissure was opened, but several boxes of fine cerussite were collected. In the iron-stained vugs near the surface, fine, lustrous, gemmy crystals to ¼ inch have also been found, including ¼-inch sixlings on matrix, and small "V" twins to 1 inch.

**Anglesite**

Anglesite is more common than cerussite in the surface exposure of the vein. Years ago I found a 2-inch pocket lined all around with bright, gemmy anglesite crystals to ¼ inch. Along one end of the pocket lay a single euhedral blade nearly 1 inch in length. The quartz-lined pocket showed no other minerals but was encircled by a halo of galena. Other collectors have found similar specimens. The fluorescence of cerussite (yellow-cream in longwave ultraviolet light) as opposed to the non-fluorescence of anglesite from this locality renders identification simple.

**Gearksutite**

This uncommon clay-like mineral, a calcium-aluminum-hydroxide-fluoride-hydrate, was first found as waxy, white pocket fillings by Dick Jones and sent to the Smithsonian for identification. It occurs as seam and pocket fillings and linings, sometimes with a slightly greenish tint. No recognizable crystals have ever been observed. A few minerals, including chalcotrichite, have been found on the white clay which coats some quartz-lined pockets.

**Caledonite**

Bright blue-green prisms in radiating sprays, groups and as singles to 1/8 inch have been found at the Grand Reef. Though uncommon, it may be found protruding from white gearksutite or in association with leadhillite or linarite, or by itself.

**Olivenite**

One specimen (Fig. 10) showing acicular, green tufts of olivenite crystals to ⅛ inch on azurite was found recently (Arizona-Sonora Desert Museum specimen).

**Silver**

Wires and sheets of silver up to ½ inch have been reported in pockets (Dick Jones), and a single fine wire of micro size has been reported by Arthur Roe.

**Galena**

No crystals have been reported for this ore mineral at the Grand Reef, but it is common as gray halos around cerussite and anglesite, and as irregular veins and masses in the breccia.

**Brochantite**

Dick Jones reports finding "brochantite in small but very brilliant needle-like crystals acting as the background for linarite and leadhillite."

**Quartz**

Ubiquitous as a cementing agent in the breccia, and as drusy linings of cavities and seams, quartz is usually clear and colorless but may be stained yellow, red or black by various inclusions.

**Cuprite**, variety Chalcotrichite

I have observed two occurrences of fine chalcotrichite at the Grand Reef mine, both as mats of brilliant, lustrous red filiform crystals on gearksutite in small pockets. These occurrences each yielded several specimens. The first was found by Dick Jones and is now in the collection of Tom McKee. It consists of 1 x 1½-inch mass of fiery red hairs of superb delicacy, on matrix. The second is a pocket found by David Shannon, the largest piece being about 1 inch across and an equally fiery red.

**Hematite**

Hematite has been found largely as earthy fillings and coatings throughout the deposit, but has also been reported as lustrous specular flakes.

**Fluorite**

Fluorite has been found as partially developed crystals with octahedral faces in cavities with gearksutite. It occurs as crystalline masses at the surface near the current diggings (Dick Jones, personal communication).

**Creedite**

Dick Jones reports finding two specimens, one of them now in the University of Arizona collection. The crystals are pale violet in color and up to ¼ inch long.

**Aurichalcite** (?)

David Shannon reports finding pale blue tufts of what appear to be aurichalcite at the surface.

*Figure 8.* **Colorless natrolite crystal ⅓ inch tall on linarite. Arizona-Sonora Desert Museum specimen. Photo by the author.**

**Chrysocolla**

Chrysocolla has been found as coatings and smears but more interestingly as pseudomorphs after cerussite and anglesite, microscopic in size. Dick Jones reports finding a chrysocolla-caledonite pseudomorph after a dipyramidal cerussite sixling ½ inch across.

**Halotrichite** (?)

A white, fibrous efflorescence occurs on some of the damp mine walls underground. None was collected for this report, but it is suspected to be halotrichite.

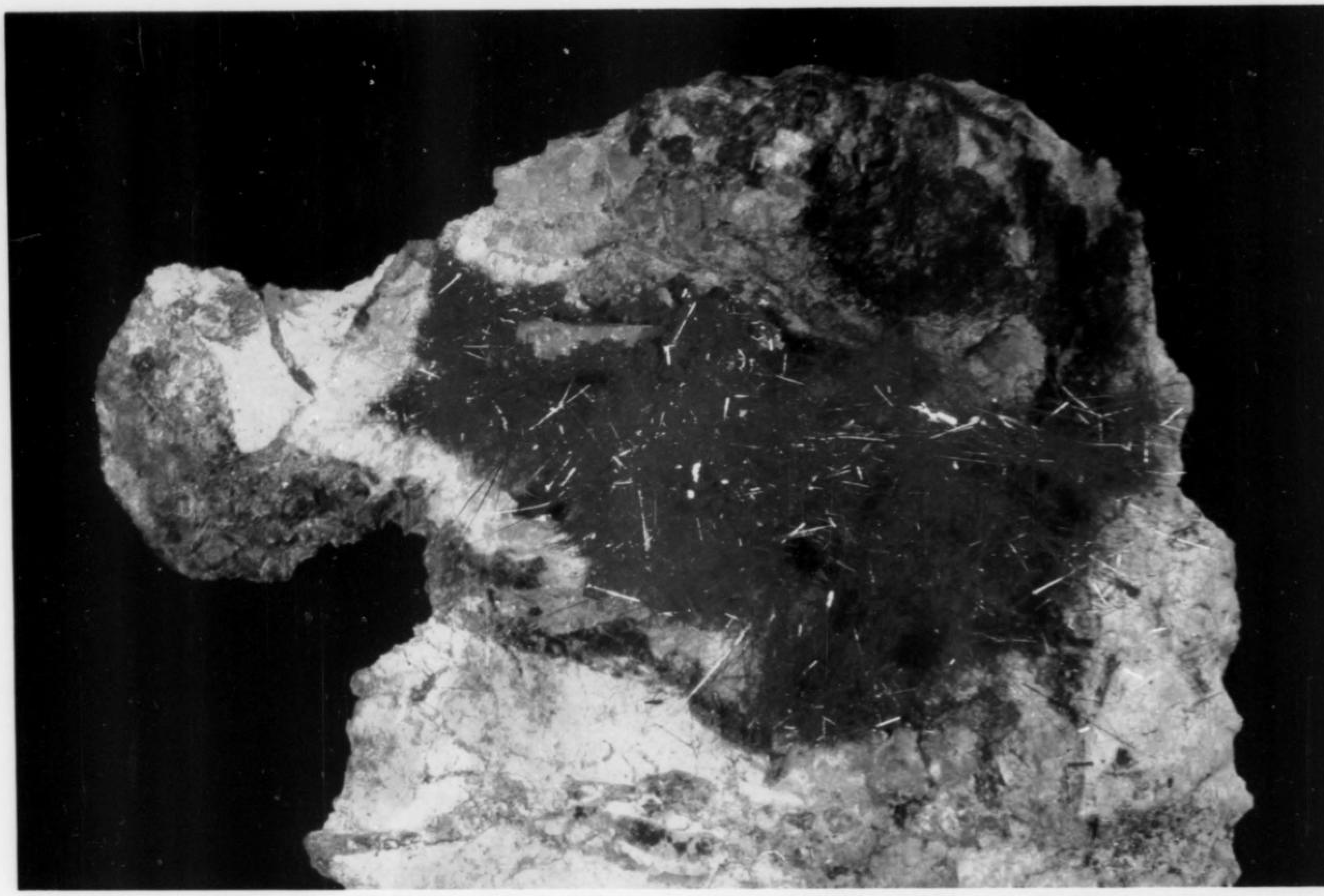

*Figure 9. (above)* **Cuprite, variety chalcotrichite, filling a pocket in breccia 1½ inches across. Tom McKee specimen. Photo by RWJ.**

*Figure 10. (below)* **Needles of olivenite surrounding a ¼-inch azurite crystal. Arizona-Sonora Desert Museum specimen.**

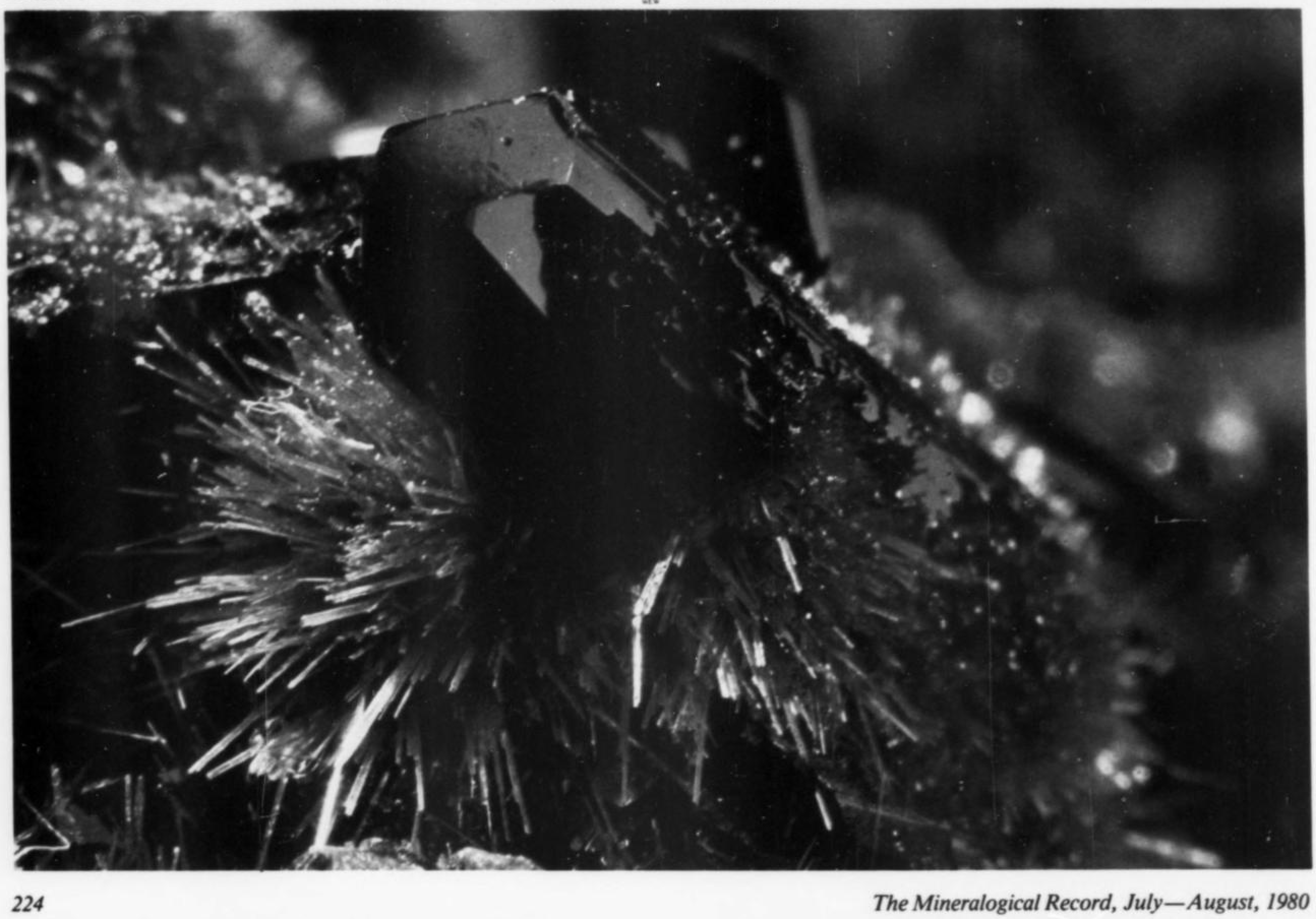

*Figure 11.* **Collecting underground, at the base of the glory hole. The wall here was covered by chrysocolla, cerussite and azurite.**

**Boothite** (?)

A considerable amount of bright blue, relatively firm and stable copper sulfate exists in places underground. This material was originally thought to be chalcanthite, but its stability suggests that it may be boothite (Charles Lewis, personal communication).

**Azurite**

Dull blue blades of azurite have been collected at the surface, as sharp, slightly etched, intergrown groups of crystals to 1 inch across. The crystals found underground by Wendell Wilson are sharp and lustrous, also reaching 1 inch.

**Natrolite**

The Arizona-Sonora Desert Museum collection contains a 1 x 2-inch specimen of intergrown linarite crystals upon which is perched a clear natrolite crystal 3/8 inch long.

**Other species** reported but not described

Manganese oxides, tenorite, chalcocite, barite, chalcopyrite, acanthite, tetrahedrite and malachite have all been reported by other collectors.

## DISCUSSION

From observations at the surface and collecting experience it seems clear that the controlling factors in the formation of the fine crystallized minerals are the dike and associated faults. No specimens have been reported from outside of the faulted area on the south face of the dike. Linarite has not been found underground, but azurite occurs in both areas.

Quartz lines openings and appears to have been the first pocket mineral to form. Most of the other species occur intergrown on one specimen or another and appear to have formed simultaneously, except for gearksutite which formed late.

## ACKNOWLEDGMENTS

I wish to thank Dick Jones, whose correspondence provided much insight into the mineralogy of the deposit and its collecting history; David Shannon who made specimens and information available; Tom McKee and Dick Bideaux who provided several fine specimens for study and photography; William Panczner who served as chauffeur, raconteur, and resource person on our recent visit to the mine and who made museum specimens available for study; and Arthur Roe and Dan Davis who accompanied us on that trip and told great stories about micromounts and bears.

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# Hematite

## *from the Dome Rock Mountains near Quartzsite, Arizona*

by
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***Prospects in the Dome Rock Mountains have yielded some of the finest specimens of hematite in the world. Large, lustrous hexagonal plates of hematite associated with quartz and pyrophyllite are typical of major finds made in 1978, 1974 and earlier.***

**LOCATION AND HISTORY**

The hematite area is located in the Dome Rock Mountains about 6 miles west-southwest of Quartzsite, Yuma County, Arizona. The Crystal Caverns claim, as it was first called, was worked sporadically by claimants Helwig and Hubbard as far back as 1949. There is no record of production, but a few old specimens apparently found in the 50's and 60's exist in various collections.

A discovery there by us in 1974 and by Dick Jones in 1978 yielded a number of excellent specimens, demonstrating that this area still holds potential as a specimen producer. Jones now has three claims spanning the area, the main producer being the Veta Grande claim, which overlaps the old Crystal Caverns claim. Permission to collect there may be obtained from Dick Jones (117 W. 10th St., Casa Grande, AZ 85222); be sure to write for permission in advance. Dick will not permit the use of power equipment or explosives unless he is on the site.

**MINERALS**

Hematite crystals from the Dome Rock Mountains are characteristically simple tabular in habit, with large, lustrous *c* faces dominant, rimmed by equally brilliant *r* and *a* faces. A common association is quartz. Many of the quartz crystals from Dick Jones' 1978 pocket are curved. Less common associates include a pale green pyrophyllite in crystals to just a few mm in size, zunyite and anatase, also as micro crystals. The crystals occur in quartz veinlets which cut across aluminous schists and quartzites of Mesozoic age. It is interesting to note that an area south of Quartzsite, having similar geology, also produces hematite crystals, but in the group-habit commonly known as iron roses *(eisenrosen)*.

Cavities in quartz are rare and scarcely exceed 2 or 3 cm across. Most commonly the hematite crystals are frozen in solid quartz and exhibit dull, irregular faces when broken loose.

**1978 POCKET OF DICK JONES**

This pocket, found by Neal Pfaff, is probably the largest ever found, roughly 1½ by ½ by ½ meter. It was found in October and first reported by Wilson (1979). Several hundred specimens with crystals to about 2½ cm appeared before and during the 1978 Pasadena Gem and Mineral Show.

**1974 POCKET**

Our cavity started as a hole no bigger than a match. Since we were using hand tools, our main problem was penetrating a tough thickness of quartzite. Fortunately, a hairline crack ran through the length of the pocket, and we were able to remove the outside wall of the fissure and completely expose the pocket. Inside was a jum-

*Figure 1.* **Our 1974 pocket is shown with most of the specimens except the large ones along the base removed.**

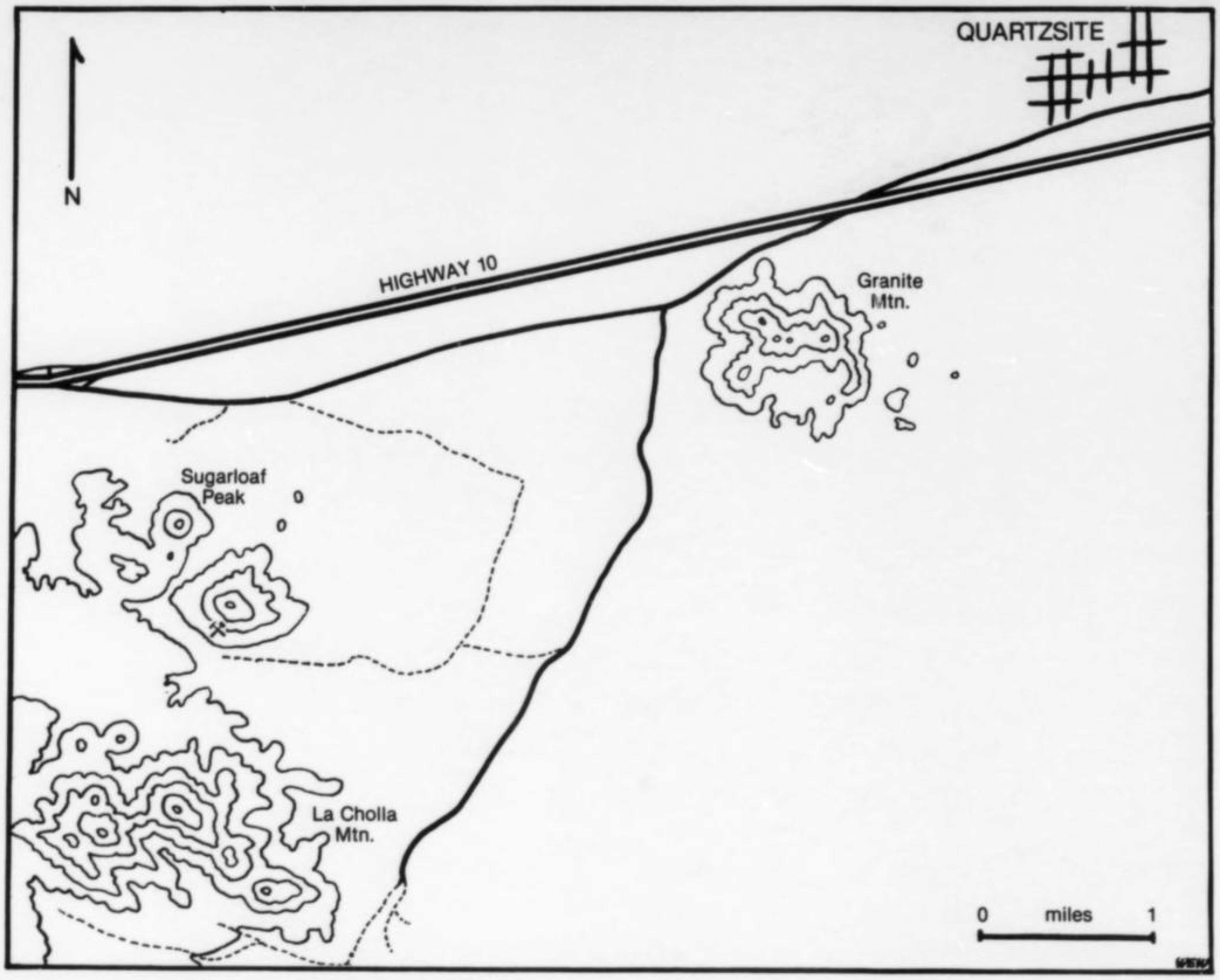


*Figure 2.* **Location map showing the Veta Grande claim.**

*Figure 3.* **Two views of the best hematite group, the largest crystal measuring about 6½ cm across (2½ inches).**

*Figure 4.* **Two specimens from the 1978 pocket. The hematite crystal on the right is about 2 cm across. Miriam and Julius Zweibel specimens.**

*Figure 5.* **The second best specimen from the 1974 pocket. The crystal measures 6½ cm across. Arizona-Sonora Desert Museum specimen.**

ble of fine silt, quartz crystals and hematite crystals. When all of the loose material was removed, the opposite wall and the base of the pocket were still covered by a packed mat of silt. My wife Sandra began washing down the area with a hand-sprayer while I fished around in the pasty mud for more crystals. I watched the base of the pocket as the stream of water slowly exposed a large black face. Like an unveiling, the water gently washed away the silt to reveal an additional side-cavity filled with large hematite crystals. The crystals were all firmly anchored to the floor of the pocket, one behind the other, in a narrow train going back into the quartzite for about 30 cm.

Possibilities for successful removal of the specimens seemed hopeless. A friend who had been watching this operation even suggested prying out what could be salvaged with a screwdriver! Checking closely, however, we found another hairline crack, an extension of the earlier one, continuing across the top of this new cavity as well. After packing the cavity with paper to protect the crystals, a flat chisel was driven along this crack. The outer wall moved slightly and the specimens separated neatly, without damage.

The total pocket was about 1 meter long, 50 cm tall and 10 cm wide. The largest crystal to come out is 7½ cm (about 3 inches) across the *c* face, but is not on matrix. Two crystals, each about 6½ cm across, did come out on matrix. One is still owned by the author (Fig. 2) and the other is in the collection of the Arizona-Sonora Desert Museum (Fig. 5).

Futher work on the outcrop exposed yet another cavity, about half the size of the previous one, yielding hematite crystals to 4 cm across. Neighboring outcrops failed to produce any hematite.

**REFERENCE**

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# the Grey Horse mine
## pinal county, arizona

by
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and
**Gary Fleck**
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***In 1976 an important new locality for vanadinite was added to the list of Arizona localities: the Grey Horse mine. Crystals to over an inch coating cavities up to 8 inches wide, 2 feet tall and 6 feet deep were found. Crystal-covered slabs from the largest pocket are being reassembled for a display in the Arizona-Sonora Desert Museum.***

**LOCATION**

The Grey Horse mine (relocated in 1976 as the Coral Canyon mine) is situated in the Riverside mining district, in the Dripping Springs Mountains, about halfway between the well known Ray and 79 mines. Specifically, the location is in the south-center of Sec. 3, T4S, R14E, Kearny quadrangle. (See map, p. 214. Ed.)

**HISTORY**

Prospector J. J. Sullivan broke ground for the Grey Horse tunnel in 1912, and by 1919 approximately 1000 feet of tunnels, drifts and crosscuts and 260 feet of shafts, winzes and raises had been driven (Flagg, 1919). The ore consisted exclusively of vanadinite and some descloizite, located for the most part along the Grey

*Figure 1.* **Dumps of the Grey Horse mine are visible on the southwest flank of the Dripping Springs Mountains.**

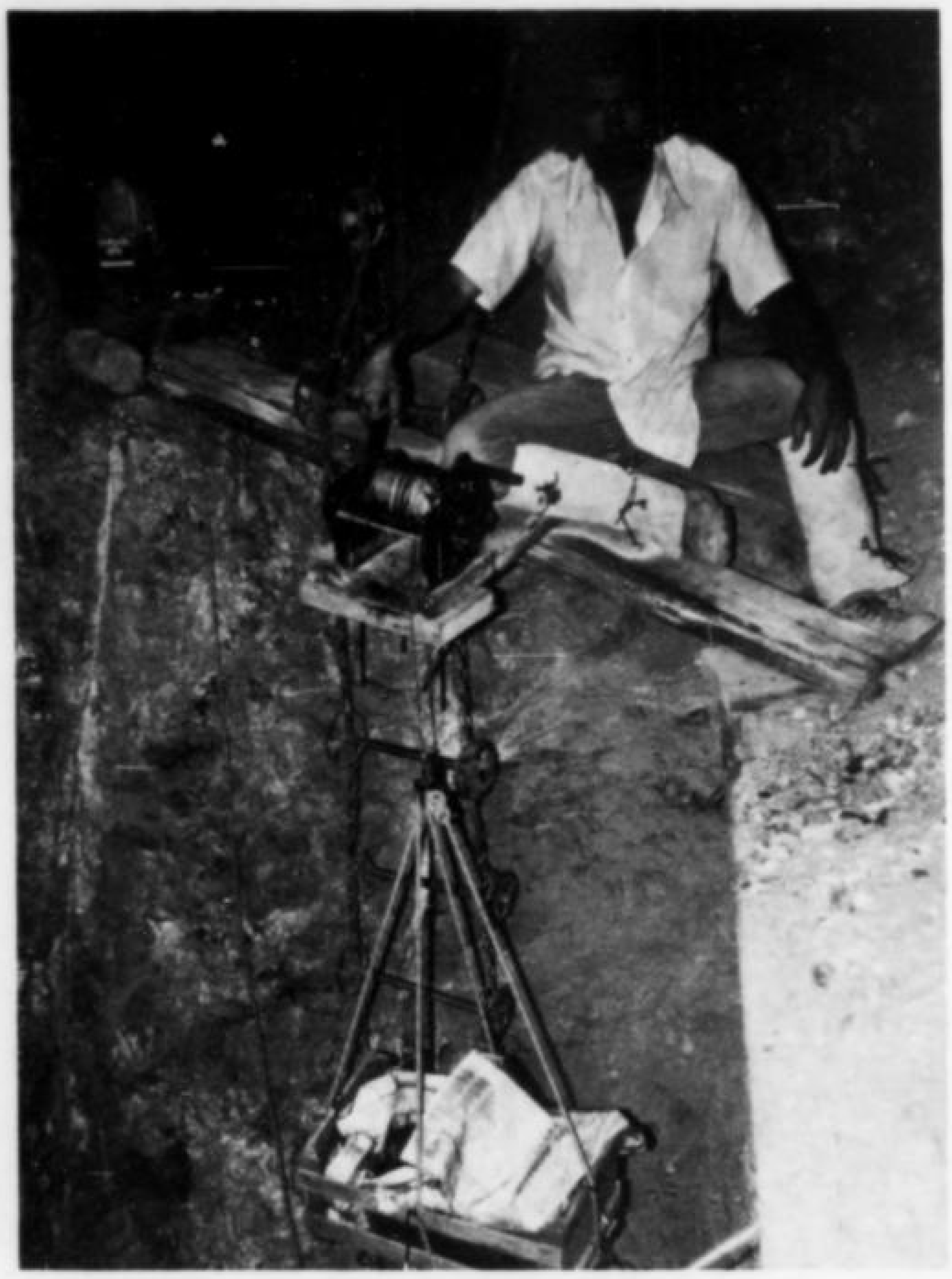

*Figure 2.* **Specimens had to be hand-winched up the untimbered shaft.**

Horse vein. Noted Arizona mineralogist Arthur Flagg prepared a report for the U.S. Vanadium Development Company, owners of the property in 1919, which indicated the property to be of commercial value. Flagg's report, however, stipulated that a suitable method of recovering vanadium from ore containing 1% or less $V_2O_5$ needed to be developed, and he refrained from making an estimate of the tonnage of ore available. As a result, the mine was never worked again, and "high-grade ore" was left in place.

So the situation stood until June of 1976, when we decided to investigate the property for specimen potential. Easy to reach upper portions of the mine showed the footprints of many people, probably curious collectors like ourselves, who had entered, found nothing of interest, and left. To reach the lower sections Gary descended a shaft by rope. Apparently no other collectors had done this; there were no new footprints. Proceeding along the drift in the Grey Horse mine, Gary came to the end and found an open fissure about 2 x 2 feet and 6 feet deep completely lined with large vanadinite crystals on one side . . . the "high-grade ore" just as the miners had left it sometime before 1919!

We placed a new claim on the original (1916) Grey Horse claim (renaming it the Coral Canyon mine for the time), and mined the vein for specimens. Subsequently William Panczner of the Arizona-Sonora Desert Museum decided to acquire for the museum enough crystal-covered slabs to reconstruct a pocket in the new Earth Science Center still under construction. Several hundred other fine specimens have since been removed.

## GEOLOGY

Rocks in the general area of the mine consist primarily of Precambrian sedimentary rocks of the Apache group, including the Mescal limestone and Troy quartzite. These rocks are extensively faulted and intruded by diabase as irregular masses and narrow dikes sometimes enveloping blocks of limestone. The Grey Horse vein consists of a quartz vein filling a fissure striking generally east-west and dipping 70 to 80 degrees toward the south. For most of its exposed length the vein follows the contact between diabase and an enveloped block of limestone, but for a short distance cuts through the limestone block. It is this section, bounded on both faces by limestone, where we have collected vanadinite.

## MINERALS

### Vanadinite

The vanadinite is generally a bright red to orange-red, and has formed crystals to about 1 inch in length. Those we have collected exhibit a curious and distinctive habit which appears to be a combination of cavernous growth and multiple crystals forming composites. These occur growing outward horizontally from one face of near-vertical fissures in the hanging wall. The mineralized fissures vary from tightly closed to 8 inches in width, 2 feet in height and about 6 feet in depth. Fissures occur every few feet, extending as much as 8 feet into the rock of the hanging wall, but relatively few are well-mineralized. The first pocket found in 1976 yielded five major plates, the finest measuring 9 x 15 inches and completely covered on one side with fine red vanadinite. A second pocket removed in 1977 yielded smaller specimens, cabinet size to thumbnails, including a few exceptionally well crystallized museum-quality pieces, and a specimen which won the best-of-species (cabinet size) vanadinite competition at the 1978 Tucson Show.

Flagg (1919) reported finding characteristic "smooth-faced vanadinite" unlike what we found, but also described "curious combinations of partly hollow crystals" more typical of our material.

### Calcite

White rhombohedrons and blades of calcite cover much of the vanadinite in what amounts to a mixed blessing. The calcite protects the fragile vanadinite during drilling, blasting, packing, transfer and trimming, but must then be carefully removed by chemical means (phosphoric acid). Whereas the vanadinite occurs mainly on one face of a fissure, calcite is found coating both sides as a later mineral, and sometimes intergrown with vanadinite in a manner suggesting simultaneous growth. As a result, it is unwise to remove *all* calcite from a specimen.

### Other minerals

Small sixlings of white cerussite to 1/6 inch have been found in pockets lined with drusy quartz. Yellow crystals of wulfenite of ¼ inch and micro-size descloizite crystals also occur. Both are relatively unspectacular; the wulfenite occurs mostly in the main vertical vein where we have not worked, and the descloizite shows a

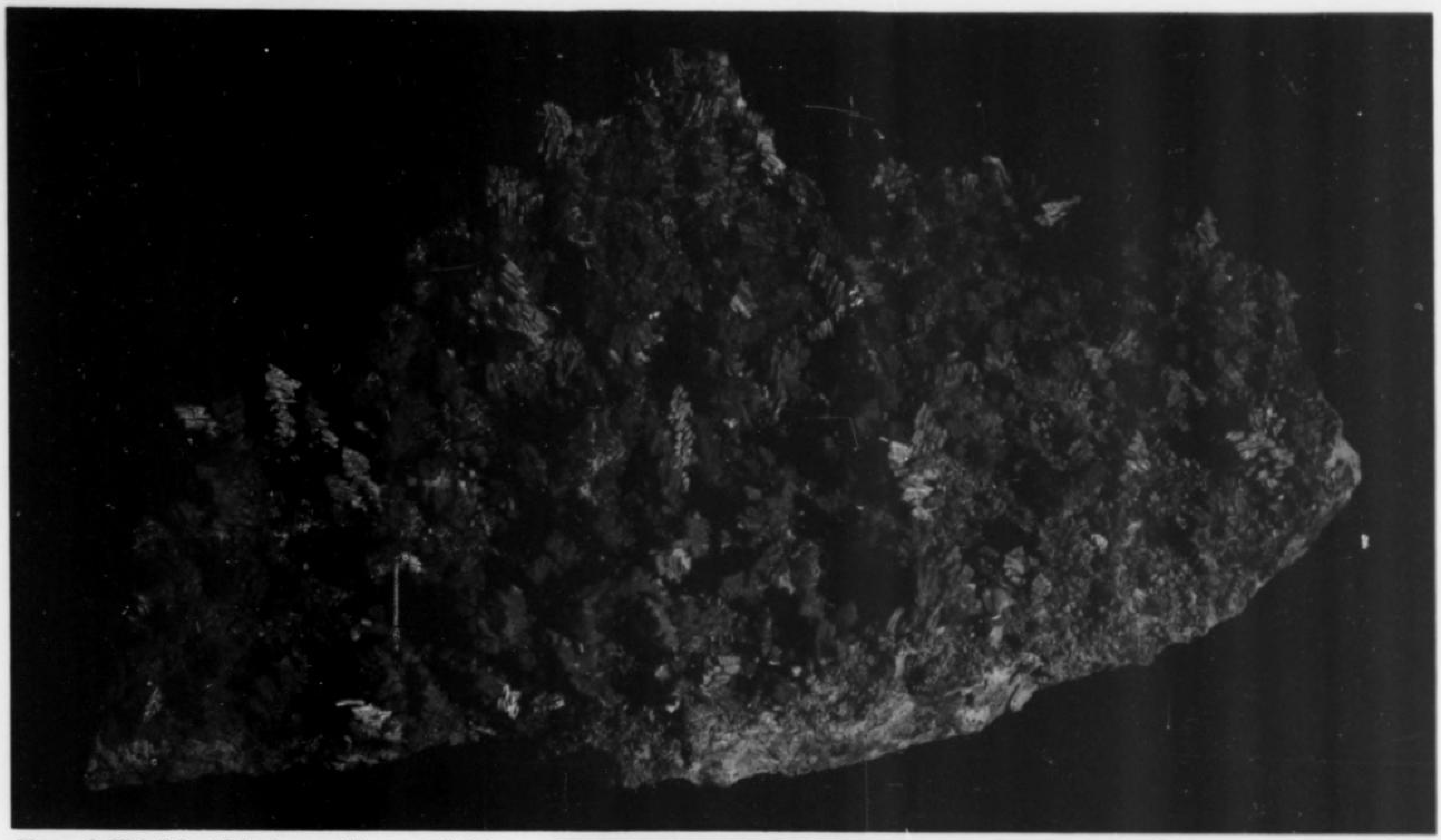

*Figure 3.* **This 9 by 15-inch, crystal-covered slab is the largest of those removed in 1976. Photo by J. Kurtzeman.**

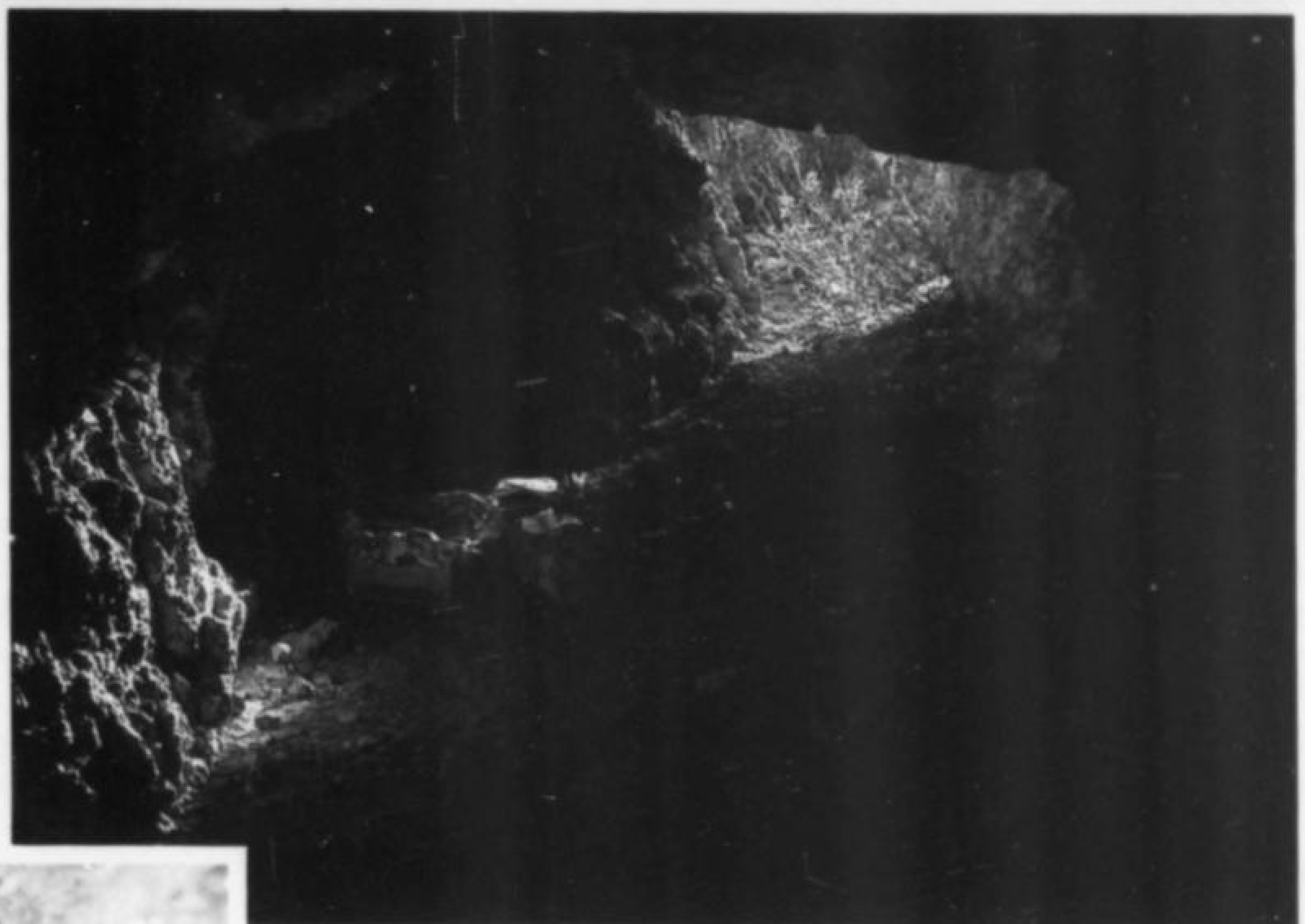

*Figure 4.* **Inside the entrance of the Grey Horse mine.**

*Figure 5.* **The pry-bar stands next to one of the mineralized fissures, one wall of which is completely coated with calcite and large vanadinite crystals.**

preference for the more silicified limestone areas, sometimes forming a thin druse over vanadinite crystals. Remnant fragments of galena have been found in gouge and vein fillings.

## COLLECTING

The mine is still under claim and collectors are not allowed.

## REFERENCE

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# the Congden Earth Sciences Center Arizona-Sonora Desert Museum

by
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Administrator of Mexico Programs
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The summer sun was high as a young red tailed hawk circled overhead. Instinctively it sighted its prey; below on a path walked a curator carrying a box containing fragile Tiger wulfenites. The bird dove with wings spread and talons exposed, landing abruptly on the edge of the box much to the dismay of the startled curator.

Where else could such an event have taken place, but at the Arizona-Sonora Desert Museum? The Arizona-Sonora Desert Museum, located in Tucson Mountain Park, just west of Tucson, Arizona, has long been noted as one of the world's leading zoological and botanical institutions. The Desert Museum has combined the best of all three worlds, the zoos, gardens and museums, into a "living museum" which has been a leader with its innovative approaches for displays. From its initial inception in 1951, plans incorporated the display and interpretation of the rocks, gems and minerals of the Sonoran Desert region. The museum's co-founder and first Director, William H. Carr, while Associate Curator of Education at the American Museum of Natural History, was influenced by his friend and colleague, Herbert P. Whitlock; and as plans unfolded for this new museum, Whitlock's influence became apparent. Because of space limitations and lack of monies needed to properly display our region's minerals, only one small case was ready when the Desert Museum opened on Labor Day, 1952.

Prior to opening, the museum co-founders, Arthur Pack and William H. Carr, contacted several mineral societies within southern Arizona for help in obtaining minerals for the museum. At first, several of the local collectors loaned specimens to the museum. One of these loans was an outstanding suite of minerals from Tiger. Several years later George Griffith replaced his loan with another, the best of what was then the "new" Mexican legrandite. (Both of these were later sold by George, unfortunately not to the Desert Museum.) Names like Dan Caudle, Clayton Gibson, George Bideaux, and George Griffith began to appear on the museum's donor records. Support for the museum's fledgling collection was gathered from local collectors and friends. The museum's collection began around the small but historic collection of Arizona's first territorial Geologist and Dean of the School of Mines, William P. Blake.

A newly elected museum trustee, J. Rukin Jelks, Jr., took great interest in this newly formed and growing collection and, over the next 20 years, added countless thousands of specimens. During the late 50's, 60's and early 70's he obtained three major collections for the museum as well as many outstanding specimens from leading collections of the world. These, with other minerals, were boxed, partially cataloged, and placed in storage for later display.

In 1973, a major event took place at the museum. The two missing ingredients to bring the collection out of storage were obtained: money and display space. The estate of the late Museum Trustee and geologist, Stephen H. Congdon, donated $200,000 to establish an earth sciences center.

The Congdon name is well known within the mining industry, both here in Arizona and in Minnesota. Stephen's grandfather, Chester Congdon, already known in the iron fields of Minnesota, was one of the leading forces in the founding of the Calumet and Arizona Mining Company here in Arizona. Years later this company merged with Phelps Dodge to form the largest mining organization in the state. Stephen, not only a fine geologist but also a collector in his own right, spent many hours on the dumps of the mines around Tucson with his friends, Richard Bideaux and Jonathan Brown (later to become his brother-in-law).

Early in 1974, construction of the Congdon Earth Sciences Center began and a search for a curator was started. Debate soon arose as to the type of person needed for this position. Should the museum hire a traditional type individual, a researcher, an educator or what? The museum administration decided on a geologist with wide experience in minerals, a strong emphasis on education/interpretation, and a desire to work with people. In September, 1974, the Earth Sciences Department was established and for the first time the collection had a permanent home and a keeper. The first several months' curatorial duties were divided between unpacking the collection and working with the Director on planning of the new Congdon Earth Sciences Center under construction. Each day was like Christmas as boxes were opened and their mineral contents unpacked. Late one afternoon, a small box was opened and there beneath the cotton lay a 4.5 inch crystal of malachite pseudomorph after azurite on matrix from Bisbee, Arizona. In the corner of

*Figure 1.* **The entrance to the Congden Earth Sciences Center. All of the rock outcrops are man-made. Photo by C. Allen Morgan.**

another box, wrapped carefully, was a 4 inch by 8 inch plate of 3-inch crystals of chrysocolla pseudomorphs after azurite from Miami, Arizona. These types of surprises continued for almost a year. Slowly the full extent of the collection was revealed. There were areas of strength, such as minerals from the mining camps of Bisbee and Tiger, but there were conversely many areas of weakness, too.

In October, 1974, the museum placed its first exhibit at a mineral show in Bisbee, Arizona. From this point, the museum has exhibited the minerals and interpreted the great mineral heritage from the Sonoran Desert in most of our regional shows and many gem and mineral shows around the United States.

Now the word was out: the Desert Museum did have a collection and the local mineral collectors quickly responded; collections and specimens were now being donated again. A few of the gaps within the collection were being filled.

In May of 1977, the Congdon Earth Sciences Center was dedicated. Because of the large scope of this project, the building was designed and built so that it could be opened in phases. The first phase contained the simulated limestone caves. Due to the cost of this initial stage ($750,000), the museum was forced into a second phase, incorporating the most dynamic and largest single interpretive effort ever undertaken at the Desert Museum. This phase contains three galleries. The first develops the history of the Sonoran Desert region from both the geological and biological standpoint. The second gallery contains the minerals. Here, portions of the collection will be exhibited in the latest display techniques to "show off" the beauty of the Mineral Kingdom, man's relationship to it, and heritage from it. The third gallery will be devoted to mining and minerals. It will contain three mineral vugs reconstructed in a totally natural setting in a mine environment. Imagine for a moment an 80-square-foot pocket of 2-foot selenite crystals, or a 2-foot pocket of brilliant yellow wulfenite with orange mimetite, or a wall coated with ½-inch to 1-inch brilliant red vanadinite crystals. This is what is in store for the visitor to the Congdon Earth Sciences Center when Phase II is completed. As of this writing, the plans are complete and a major fund-raising drive is underway for this dynamic $700,000 project. The planned opening will be in June, 1981, depending on money availability.

Over the past five years the staff of the Earth Sciences Department has grown. From the initial Curator, the department now has two Research Scientists, Drs. Mary Ellen Morbeck and Arthur Roe (now retired as Emeritus and works on a volunteer basis); a Budget and Sales Coordinator, Manny Hecht; an Earth Sciences Supervisor, Anna Pollard; a Mineral Specialist, Adela Rivera; two geological technicians, Jeff Durant and Allen Kelley; and a Consulting Geologist, Peter Kresan. The Department has 20 Research Associates and three Docents who volunteer their specialties when needed.

In 1978, after a major museum reorganization, the Earth Sciences Department combined with the museum's Mexico Unit to form the new Earth Sciences/Mexico Programs Department. With this newly organized department, came Karelia Coronado as Administrative Assistant. It is planned that by year's end a Conservator of the geological collection be added.

Even the museum's administration and Board of Trustees reflect the impact of earth sciences. Our Director, Dan Davis, is an anthropologist-geologist. Dr. Miguel Romero of the Romero Mineral Museum in Tehuacan, Puebla, Mexico, and David Ackerman, Vice President of AMAX, are members of our International Board; Dr.

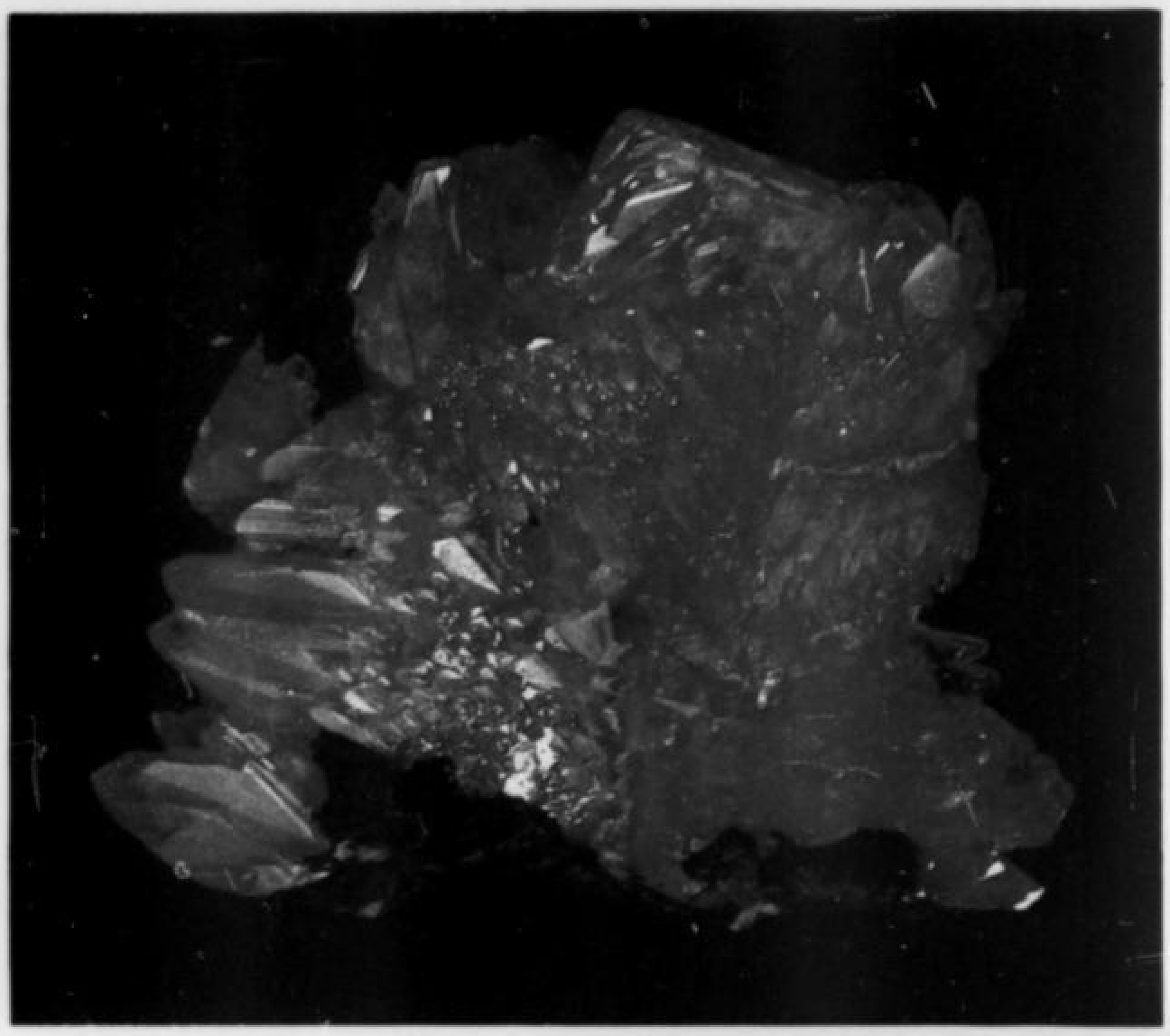


*Figure 2. (above)* **Choice scalenohedrons of rhodochrosite from Santa Eulalia, Mexico. The group is 2½ inches across. Arizona-Sonora Desert Museum specimen. Photo by Bob Jones.**

John Anthony, Mineralogist and Curator at the University of Arizona, is a member of the Advisory Board; Al Snedden, retired Vice President of ASARCO, and J. Rukin Jelks, past President, are members of the Board of Trustees. Mr. C. W. Campbell, General Manager of Western Mining ASARCO, is a member of our Development Committee.

**THE COLLECTION**

As our collection is still growing, it has become necessary from both an accountability and management standpoint to develop a statement as to the purpose and use of the collection.

The collection will interpret the Mineral Kingdom, its diversity, man's relationship to it, and heritage from it. Because of the regional nature of the Desert Museum, the collection should also reflect this aspect (the Sonoran Desert region includes the state of Arizona, the Mexican states of Sonora, Baja California North and South, the Gulf of California, and all the islands contained therein). The collection will contain specimens which illustrate similarities and differences between the minerals of the Sonoran Desert and those of other desert regions of the world.

The collection will be utilized in three basic ways: *INTERPRETATION*—both in display and in educational settings on and

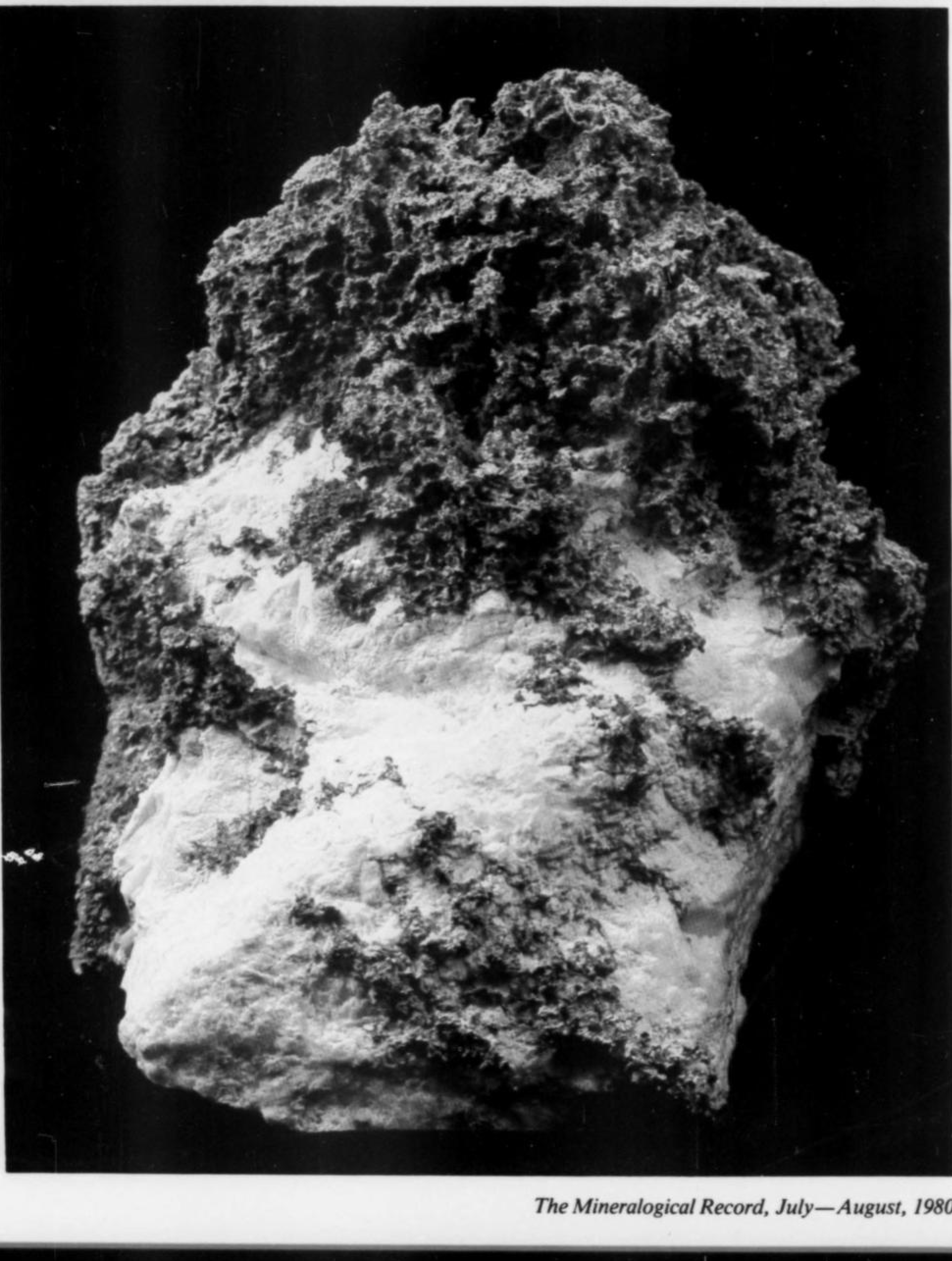


*Figure 3.* **Spongy gold in quartz from the Dos Cabezas Mountains. The specimen is 5½ inches tall. Photo by William Panczner. Arizona-Sonora Desert Museum specimen.**

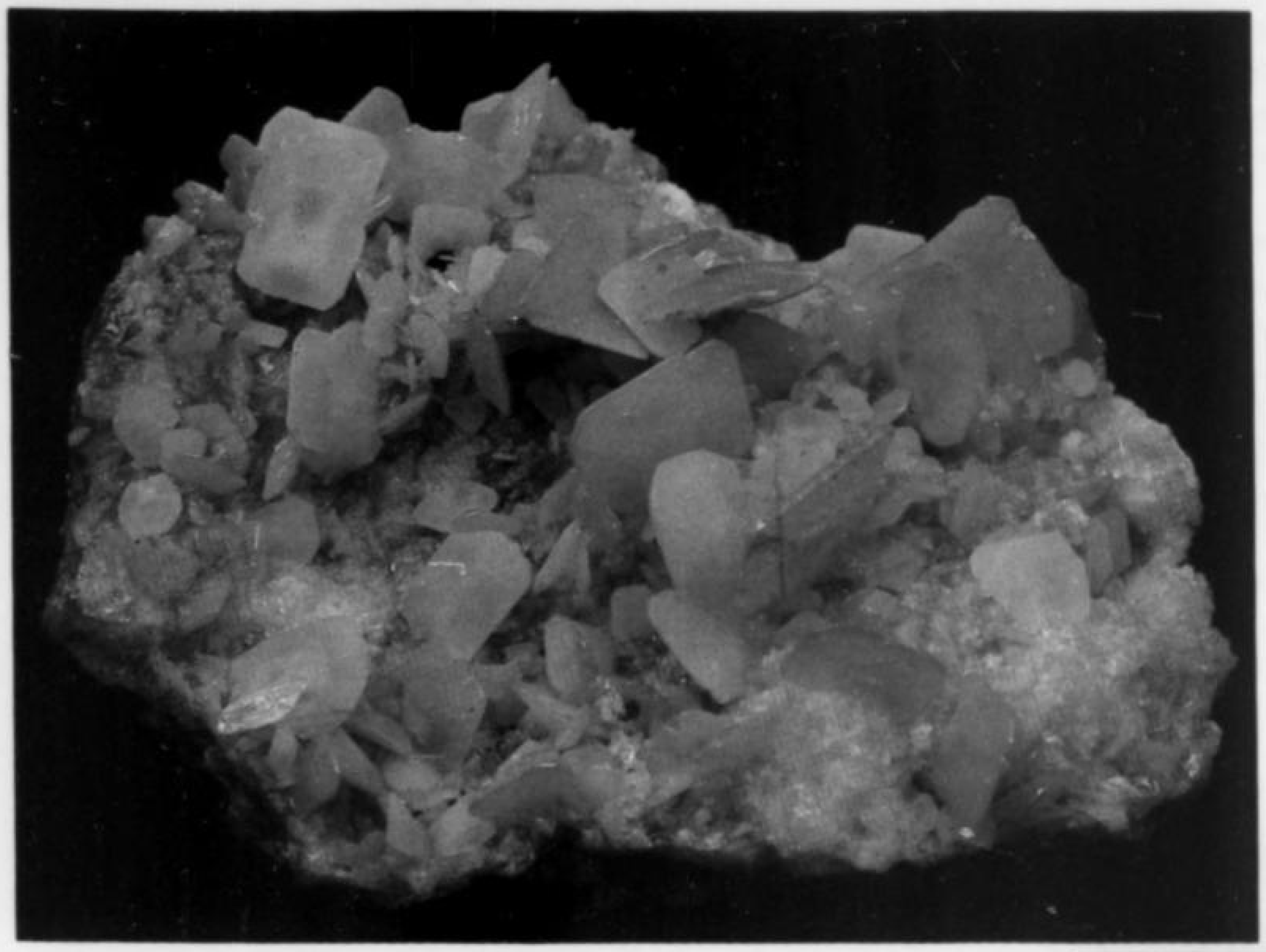
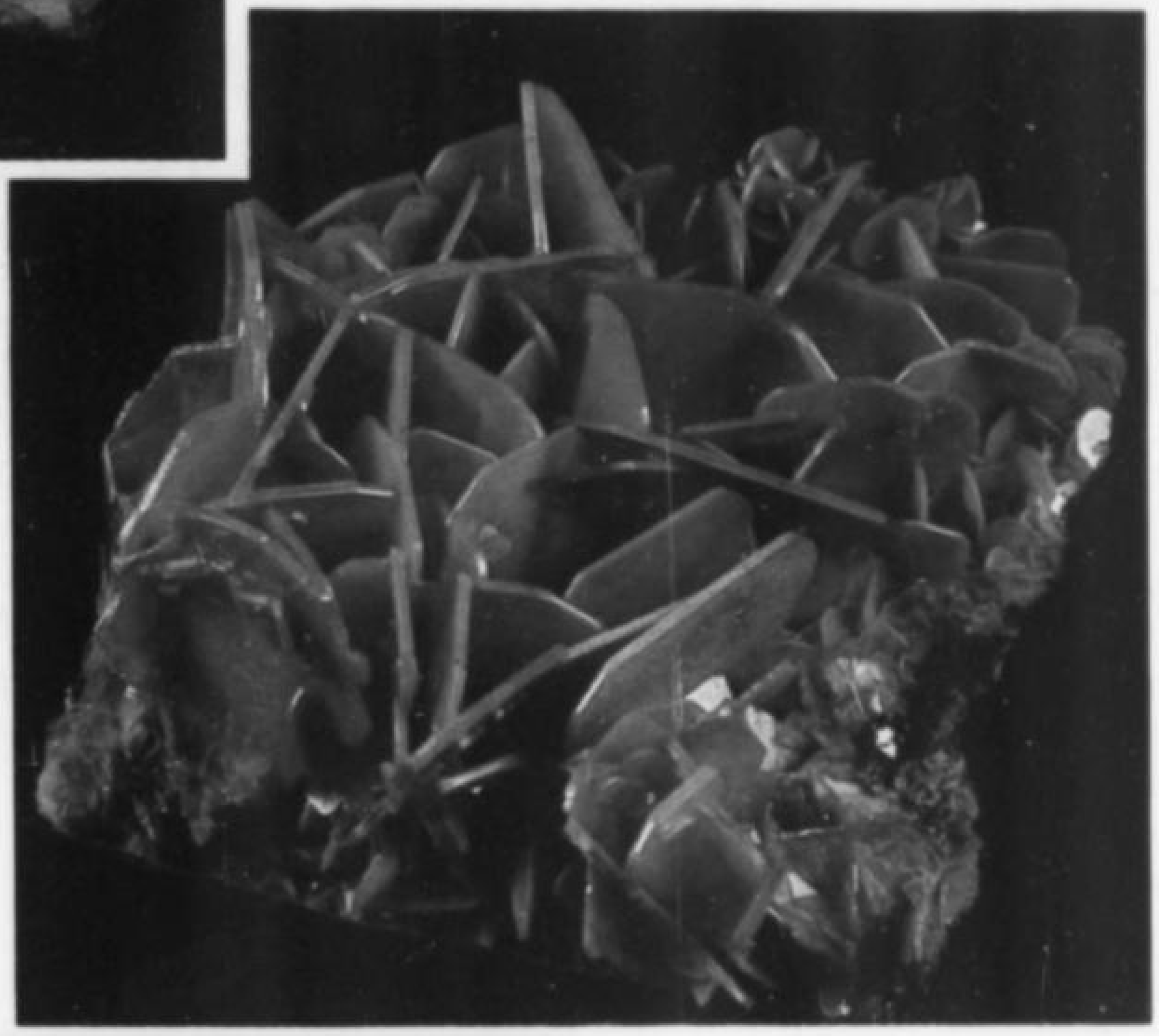


*Figure 4.* **Wulfenite from the Hilltop mine, Cochise County, Arizona. The specimen is 3¼ inches across. Arizona-Sonora Desert Museum specimen. Photo by Robert H. Perrill.**

*Figure 5.* **Large wulfenite crystals from the Glove mine, Santa Cruz County, Arizona. The group is 4½ inches across. Arizona-Sonora Desert Museum specimen. Photo by William Panczner.**



off the museum grounds, *REFERENCE*—locations and species, and *RESEARCH*—new species and locations.

The Desert Museum does have one major policy on the acceptance of specimens of collections. The Museum *does not* accept specimens or collections with restrictions. Specimens and collections will be utilized to their fullest extent for the betterment of the museum, whether it be for display, educational purposes, reference, research or trading or sale to obtain needed items or money for the collection. The museum does not budget money for the addition of new specimens to the collection; all of the new specimens are obtained through the above procedures or donations.

The collection is divided into six major divisions: minerals, micromounts, gems, rocks, ores, and fossils. The mineral portion of the collection is arranged in storage drawers in the following order: Arizona, Bisbee, Tiger, Mexico, and other desert regions. The minerals in each of the above categories are arranged tradi-

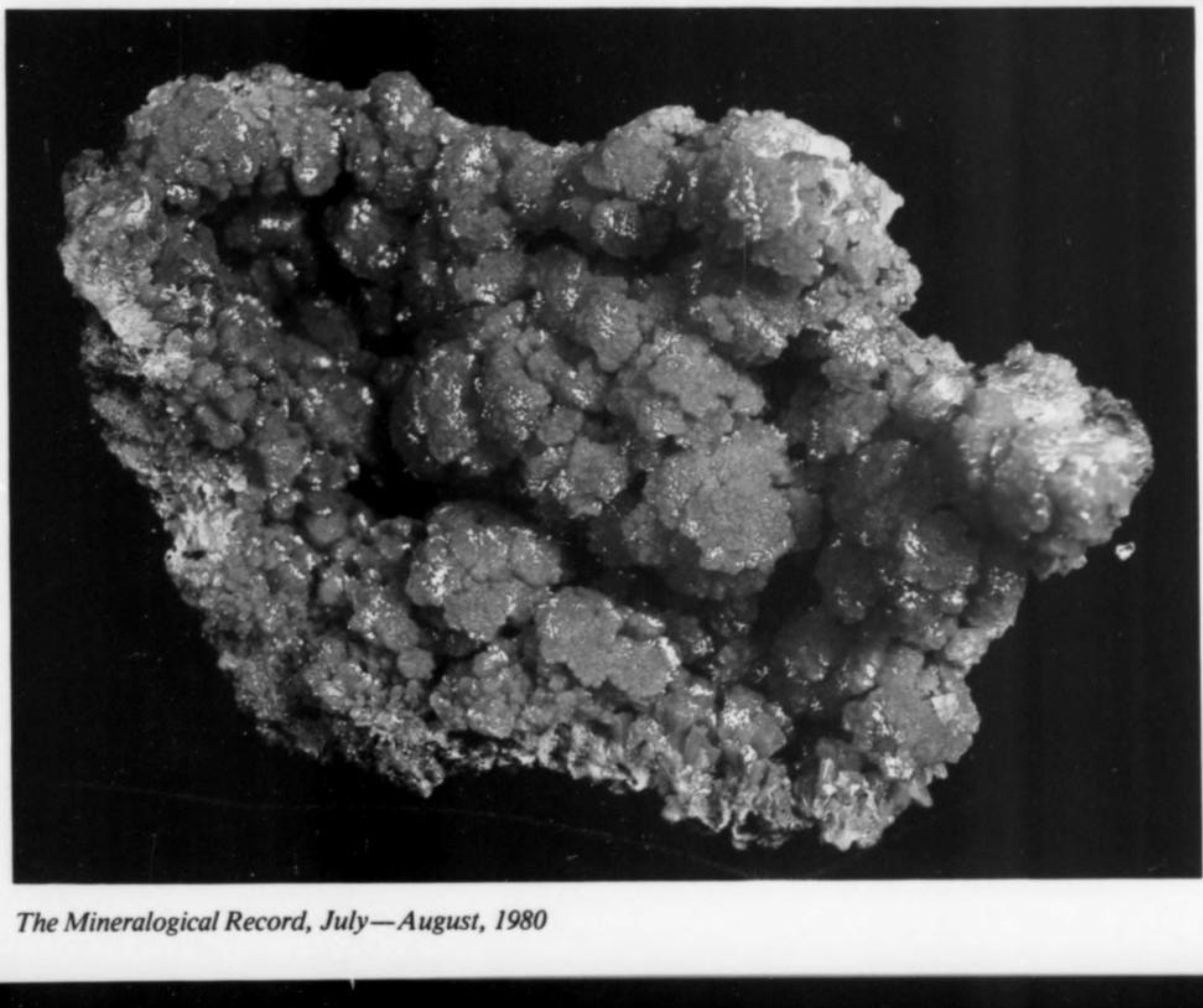


*Figure 6.* **Mimetite from the Santo Domingo mine, Santa Eulalia, Chihuahua, Mexico. The group measures 5 by 7 inches. Arizona-Sonora Desert Museum specimen. Photo by William Panczner.**

tionally according to chemical composition. The micromount mineral collection is arranged in drawer units in alphabetical order, both in species and location. The gems are stored in standard gem boxes in drawers. The rocks, ores, and fossils are presently being unpacked, properly stored, and will be cataloged.

At present, the mineral and micromount mineral portion of the collection is cataloged. The cataloging method utilizes standard entry sheets and also computerization. Two computerized catalogs are maintained: alphabetical and numerical. The museum selected a modified Selgem program for possible interfacing with other institutions both here in the United States and Mexico. Our computer catalog has slightly more than 3,000 specimens in both the mineral and micromounts portions of the collection.

The collection has in the past five years been supported greatly by several of the local mineral and gem societies. The Tucson Gem and Mineral Society donated money for the purchase of several of our mineral drawer storage units and is presently aiding in financial help with computer costs. The Bisbee Gem and Mineral Society, the Mineralogical Society of Arizona, and the Scottsdale Gem and Mineral Society have aided in financial assistance for the acquisition of mineral specimins to the collection. Other organizations have aided in different ways: The Micromount Study group of the Mineralogical Society of Arizona and the Northwest Chapter of The Friends of Mineralogy have helped with our micromount mineral collection. The University of Arizona Department of Geosciences has aided in numerous ways: the use of X-ray equipment for identification, technical expertise, and just good plain moral support.

**Noted collections contained within the main collection**

*The William P. Blake Collection*—This collection of 24 specimens was assembled during the late 1800's and contains mostly ore samples. This was the museum's first collection.

*The Mark C. Bandy Collection*—When the Bandy collection was donated to the Los Angeles County Museum, the Desert Museum received, through the generosity of Mrs. Mark (Jean) Bandy and the cooperation of the L.A. County Museum, the minerals from the Sonoran Desert. This collection contains many remarkable specimens from the famous mines within the region; included in this are several fine wulfenites from the Glove Mine, Arizona, and an excellent dioptase from Tiger, Arizona.

*The Bawden Collection*— This collection of southwestern minerals many fine Tiger and Bisbee specimens. Also received with this collection was the entire stock from Dr. Bawden's retail mineral store. This has been the backbone of the trade and sale stock.

*The Grant Dowell Collection*— Originally part of the famous Dr. James Douglas Collection, came to the museum from a former Trustee, Arthur Hall (retired Vice President of ASARCO). It contains many outstanding "old-time" Bisbee, Arizona, azurite and malachite specimens.

*The Davis Collection*—This is the second collection of mineral dealer, Suzie Davis (the first went to the Smithsonian Institution). This collection contains minerals from Arizona and Mexico obtained during the 1970's. Included in this collection is a remarkable suite of minerals from the San Francisco mine, Sonora, Mexico, a 2-inch anglesite crystal group from the Flux mine, Arizona, a 6-inch crystal cluster of copper coated with malachite from Ray, Arizona, and a 6-inch scheelite crystal from the Cohan mine, Arizona (originally from the Shipley collection).

*The Harry Hill Collection*—This Arizona collection adds greatly to the museum's "old-time" Arizona collections. The museum has only a small portion of this fine collection. Noted specimens are: wulfenite from the Hilltop mine, Arizona, cerussite from Tiger, Arizona, and pyrite from the Yankee Boy mine, Mayer, Arizona.

*The Lemmons Collection*—This old-time Arizona collection was assembled by the mother and father of mineral dealer Suzie Davis in the early 1900's. It contains many old specimens from within the state. One of the most noted specimens is a 4-inch by 6-inch cluster of 1-inch malachite pseudomorphs after azurite from Tiger, Arizona.

*The Ed Mattison Collection*—This is only a partial collection of slightly more than 60 specimens from the famous mines of Tiger, Arizona. It contains many rare and outstanding mineral specimens; included in these are: an incredible bideauxite, a cluster of remarkable 2-inch matlockite crystals, a cluster of 2.5-inch crystals of phosgenite, and a 2-inch linarite crystal.

*The Motel Collection*—This collection of primarily Arizona minerals was assembled by Tucson mineral dealers, Mr. and Mrs. Claude Motel. Included in this fine collection are two large quartz (Japan-law twins) crystal specimens from Arizona (Holland mine), and several wulfenites from the Glove mine, Arizona.

*The Fred Houghton Collection*—This small collection is from the mines of Tiger, Arizona. It was assembled during the 1930,s and early 40's by Mr. Houghton while working as a mining engineer at the mines.

*The John Sinkankas Collection*—This is only the Arizona part of his fine collection. It contains many outstanding specimens including several Bisbee azurites and malachites, plus many fine specimens from Baja California, Mexico.

*The Charles Towle Collection**—This collection of both mineral specimens and choice polished agates was a fine addition to the museum's collection. This collection was a memorial to Charles' wife, Jean, who was a docent at the museum before her death.

*The J. Rukin Jelks, Jr. Collection*—This extensive collection, when completely received by the museum, will add over 2,000 more specimens to our catalog. It contains mostly Arizona and Mexican minerals. Included in this collection are many gold specimens from our region, including a 32-ounce nugget from southern Arizona, an outstanding copper from Ajo, Arizona, and many Bisbee azurites and malachites. The collection is the working backbone of the museum's collection.

Other fine collections that are part of the Desert Musuem's collection include: *the Fred Burr Collection* of Arizona minerals, the *Frances Saunders* micromount collection, the *Dyer collection* of western minerals, the *Van Dyne collection* of southwestern minerals, the *Tom Trebisky collection* of southwestern and Mexican minerals, the *Cesar collection* of Arizona petrified wood, the *Walt Peck collection* of regional gemstones and fluorites, the *Dan Caudle collection* of fluorescent minerals, the *Frank Kleiderer collection* of western minerals, *the Clarence Coil collection* of pegmatite minerals, the *the William Panczner collection* of fossils and fluorescent minerals (father of Curator William Panczner).

Specimens also have come from other famous collections, including Amsbury, Bideaux, Bosch, Dosey, Greame, Miller, Muller, Obler, Presmyk, Roebling, Romero, Schlepp, Schupp, Swaboda, Thompson, Van Scriver, and Wright to name a few.

The collection has had many benefactors but one stands out above the rest. A person who unselfishly saved and protected countless thousands of specimens that otherwise would have been lost to the people of the Sonoran Desert. A special thank you must go to Mr. J. Rukin Jelks, Jr. and to the many others who have made the collection what it is today.

The collection at the Arizona-Sonora Desert Museum, in its 27 years has grown rapidly. Now there is positive direction and as the years pass, the museum's collection will, we hope, become one of the finest of its kind in the world.

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* The Charles Towle collection is a fine example of how the Museum utilizes a gift. The tourmaline portion of the collection was traded with the exception of the regional tourmalines for a remarkable 38 ounce matrix gold specimen from Arizona

# the Mineral Museum of the University of Arizona

by
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***Any who are inclined to equate academic departmental mineral collections with dusty bins in cobwebby basements should be most pleasantly surprised with the Mineral Museum of the Department of Geosciences in the University of Arizona, Tucson.***

Although the University of Arizona mineral collection is a departmental responsibility and as such enjoys limited curatorial resources, it is available to the public throughout the year. The minerals have been assembled over the years primarily for teaching and research purposes, but the display facilities, provided by an administration appreciative of public goodwill, are remarkably good—about 2200 square feet of floor space is devoted to an attractively housed display and to mineral storage, and another 200 to preparation and study.

The museum became a formal entity in 1919 at the instigation of Gurdon Montague Butler, professor of mineralogy and petrology, who clearly made the best of the influence attendant on his position as Dean of the College of Mines and Engineering (Anthony, 1962). Of course, the minerals which constituted the nucleus of the new museum collection had been accumulating during the years following the founding of the university in 1885. Butler's consolidation of the local collections was indeed farsighted since many of our prized large specimens descend from the heydays of some of the famous Arizona mines in the late nineteenth and early twentieth centuries, and these specimens probably would not have survived the doorstop period unscathed were it not for the protection Butler's museum provided.

A few very active faculty members of the (then) Department of Geology were especially involved with the growth and curation of the collection. Among them were William Phipps Blake (Raymond, 1911), Arizona's first (and only) territorial geologist and professor in the university (*blakeite*, Frondel and Pough, 1944); Frank Nelson Guild (Short, 1940; *guildite*, Lausen, 1928); Fredrick Leslie Ransome (*ransomite*, Lausen, 1928); Bert Sylvester Butler; Maxwell Naylor Short (Anthony, 1953; *shortite*, Fahey, 1939); and Frederic W. Galbraith. Carl Lausen himself contributed to the museum and is recalled through *lausenite* (Butler, 1928).

From the early part of this century into the 1950's, the collection was housed (displayed is too kind a word) on the top floor of the old engineering building on the University of Arizona campus. Those who have not experienced the summer heat of the American Southwest may not appreciate the summer temperatures which can be attained in the top floor of an unairconditioned building. Max Short transported his entire collection of polished ore minerals to the basement after discovering that the heat softened the sealing wax mixture in which the specimens were anchored, so that the entire collection had to be re-polished. When I first saw the mineral collection in 1944, the visual impact was less than inspiring. There was, as I recall, one lonely, unshaded, fly-specked, early-vintage, clear-glass light bulb dangling wistfully over some dusty rocky lumps concealed behind dingy glass set in somber oaken cases. But the specimen quality was there, and the move into spacious, well-lit quarters in the newly-completed geology building in 1957, together with the appearance of refurbished cases, made a world of difference. Suddenly there appeared the makings of a very nice mineral display. Largely because of the loving efforts of Fritz Galbraith, Curator and Head of the Department of Geology, the display collection was substantially fleshed out with quite a number of fine pieces, especially from the great Mexican localities.

Increase in size and improvement in quality of the collection over the years has been strongly influenced by the support of the State of Arizona, local mining companies, particularly the Phelps Dodge Corporation, students, alumni (some of whom, because of our traditional strength in the training of economic geologists, work and collect in some geologically exciting and remote areas of the

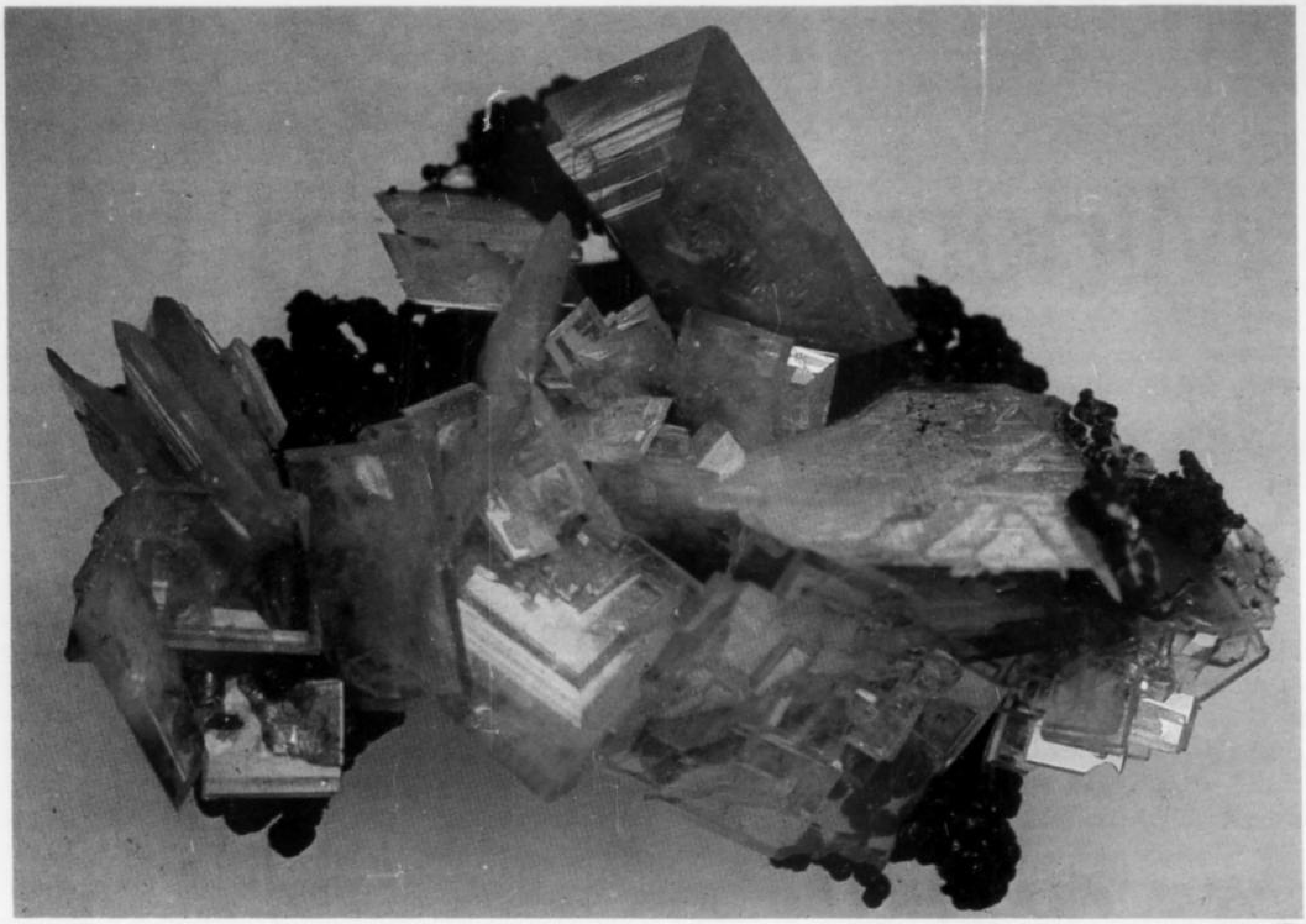

*Figure 1.* **Wulfenite from the 79 mine, Gila County, Arizona. The group is 1¾ inches across. University of Arizona collection.**

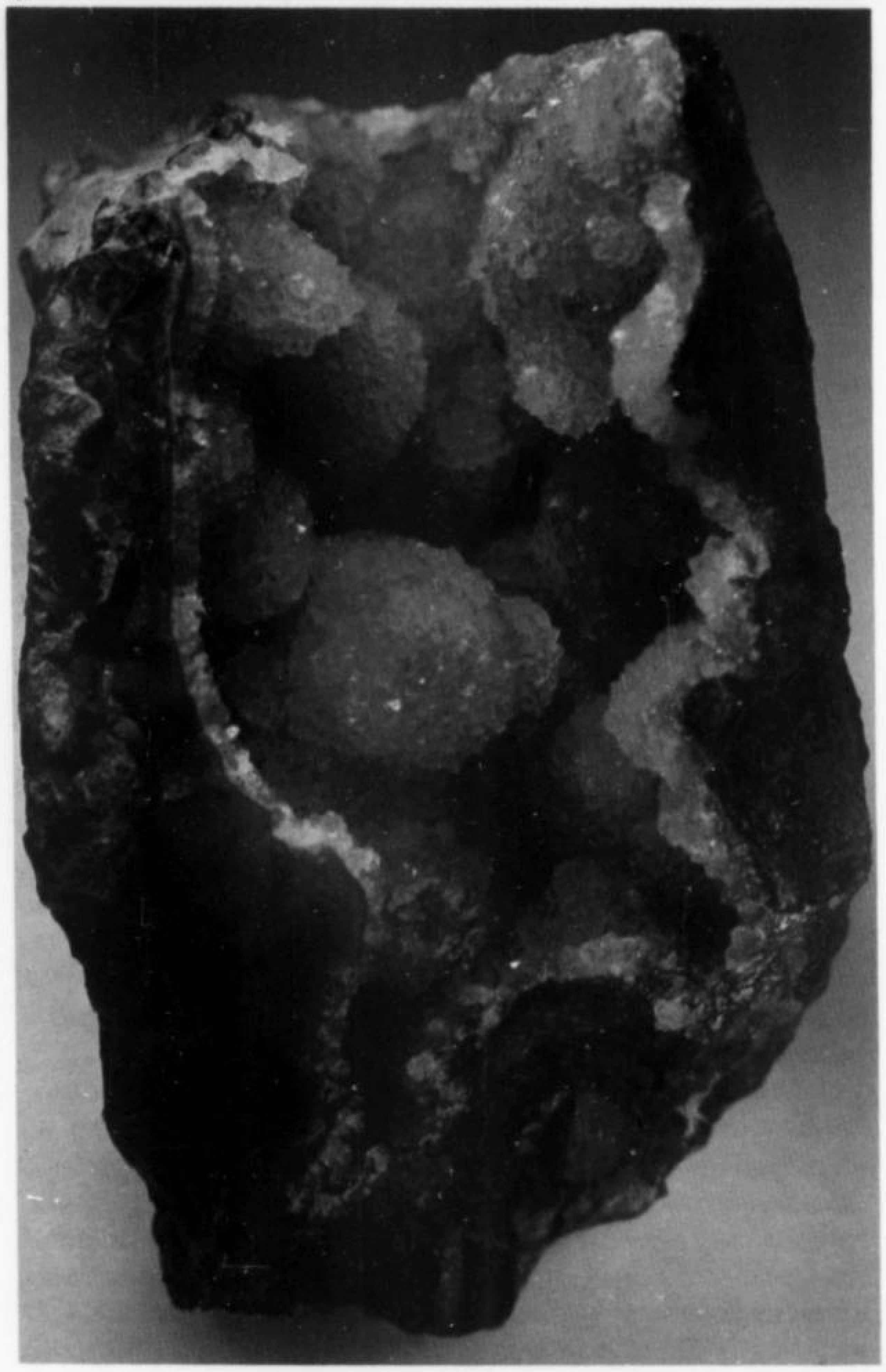

*Figure 2.* **Drusy quartz on chrysocolla from the Inspiration mine, Gila County, Arizona. The specimen is 4¼ inches tall. University of Arizona collection.**

earth), the Tucson Gem and Mineral Society, friends of the collection, and the Internal Revenue Service. A few small collections of moment have found their ways to the museum. Notable among these are many fine gemstones from G. M. Butler, the P. G. Beckett collection in which are some first-rate Bisbee specimens, excellent tri-state minerals from Boodle Lane and Martin Schwerin, and a variety of fine display specimens from J. E. Burton. Among local mineral dealers who have been especially helpful in upgrading the quality of the museum collection are Suzie Davis and the Bideauxs.

Of approximately 10,900 cataloged specimens representing 1200 species, about 1900 are in view. The most extensive display catagory is the so-called Dana collection of 910 specimens representing 325 species. Several smaller display groupings emphasize some of our nicest holdings. We are especially proud of our exciting exhibits of Arizona and Mexican wulfenite. Distinguished wulfenite from the Mammoth-St. Anthony mine at Tiger, the Glove mine south of Tucson in the Santa Rita Mountains, the Defiance mine in the Turquoise mining district of Cochise County, the Rowley mine in the Painted Rock Mountains of Maricopa County, the celebrated Red Cloud mine near the Colorado River in Yuma County, and magnificent crystals from Mapimi in Durango, and from the San Francisco mine in Sonora, Mexico, are all well represented. We are blessed, through the foresight of our curatorial progenitors and the kindness of the Phelps Dodge Corporation through the decades, with an exceptional group of Bisbee malachites and azurites. Other small special exhibits include some attractive, large tri-state fluorite and galena specimens, vivid secondary uranium minerals from the Colorado Plateau (the Monument No. 2 mine *is* in Arizona), a selection of Mammoth-St. Anthony mine minerals, a case of handsome Mexican minerals, a small but excellent collection of meteorites, some very well crystallized borate minerals from

California, a popular booth of fluorescent minerals, and an entertaining replacement of pseudomorphs.

A selection of about 400 cut and rough gems showing the beauty of gemmy varieties of some of the common (and cheaper) minerals occupies a central position near the museum entrance. Some 37 large mineral specimens on low pedestals are set about the room so that they can be touched by children—and adults.

We are increasing the variety and quality of the collection through the efforts of Arthur Roe who is building a collection of micromount specimens. In time, we hope to make this collection available to the interested public by means of an ingenious optical/mechanical apparatus as yet not devised. Continued pressure applied to the curatorial staff of the Mineral Museum by the local micromounter fraternity has finally persuaded the former of the elegance of this mode of mineral collection and preservation. With the generous assistance of Bill Hunt and Marvin and Virginia Deshler of the Phoenix area, and several local micromounters, our collection has grown to an amazing 1000 specimens in only three years.

Although the educational potential of the museum has not been extensively developed because of limitations of time and personnel, we do enjoy the visits of about 5000 school children each year. Informal programs for school children were started in the 1950's by Therese Murchison and the more elaborate presentations developed later by Jan Wilt are administered today by Shirley Wetmore.

A description of this mineral museum would be incomplete without mention of two other excellent special mineral collections of the Department of Geosciences. The better known of these is the comprehensive suite of polished ore minerals assembled by M. N. Short; the other is the extensive collection of minerals and rocks representing a large number of types of ore occurrences from around the world. These suites, of course, are not in public view, but qualified visitors may have access to them. Together with the bulk of the iceberg which comprises the 90 percent of the Mineral Museum *not* on display, they are a worthy mirror reflecting Arizona's great mineral wealth.

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# some unusual secondary minerals from
# the Mineral Park Mine
## mohave county, arizona

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The Mineral Park mine, located approximately 25 km north of Kingman, Mohave County, Arizona, has long been known for its superb turquoise. However, during the past few years several rare or unusual minerals of interest to mineral collectors have been found.

The Mineral Park mine is an operating, open pit, porphyry molybdenum-copper deposit formed by the intrusion of Laramide quartz monzonite prophyry stocks into Precambrian gneiss and schist. Related to, but slightly later than, the molybdenum-copper mineralization is a group of northwest-trending lead-zinc veins (Eidel *et al.,* 1968). The minerals discussed here, hinsdalite, wavellite, wulfenite, and mimetite, resulted from the oxidation of these late veins and the porphyry mineralization. The wulfenite and wavellite represent the first reported occurrences of these minerals at Mineral Park.

**Hinsdalite**—$(Pb,Sr)Al_3(PO_4)(SO_4)(OH)_6$

Hinsdalite was first identified at Mineral Park by Sidney A. Williams (personal communication) and subsequently "lost." About a year ago it was reidentified by X-ray diffraction from samples collected on the 4390W bench. Hinsdalite occurs as pearly white, hexagonal plates and aggregates of plates on a thin coating of chalcocite replacing sphalerite. The hexagonal plates are approximately 0.1 mm in diameter. Coalescing aggregates form an indistinct white crust on sphalerite.

Mineral Park is the only reported locality for hinsdalite in Arizona (Anthony *et al.,* 1977).

**Wavellite**—$Al_3(PO_4)_2(OH)_3 \cdot 5H_2O$

Although not commonly reported, wavellite may be a fairly common mineral in the porphyry copper environment. It is common at Mineral Park in a wide variety of colors, from clear to green and black. The most common habit of wavellite is as spheroidal, crystalline aggregates up to 18 mm in diameter on quartz crystals. It occurs most spectacularly as sprays of individual microcrystals on quartz and on native copper. The best macrospecimens are thumbnails of black spheroidal aggregates on white to clear quartz crystals.

There appears to be a distinct vertical zoning between **turquoise** $[CuAl_6(PO_4)_4(OH)_8 \cdot 5H_2O]$ and wavellite in the pit. The wavellite is in part mixed with turquoise but is most abundant below the turquoise zone. This suggests that the two minerals may be part of a continuous process, with wavellite forming as copper is depleted in the mineralizing solution.

*Figure 1.* **Plates of white hinsdalite on sphalerite from the Mineral Park mine. The crystals are about 0.1 mm in diameter. (A.R. specimen.)**

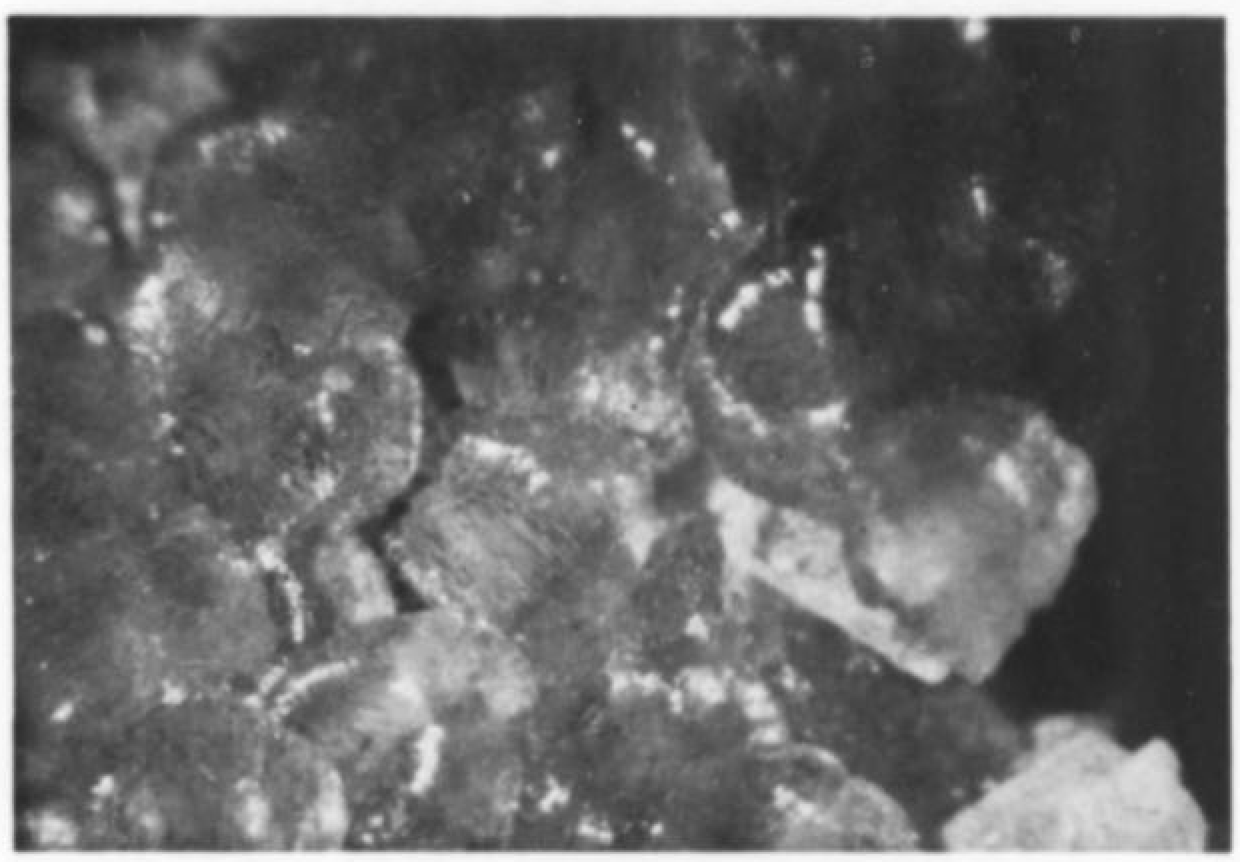

*Figure 2.* **Pale green wavellite in spherical aggregates from the Mineral Park mine. The spheres are each about 1½ mm across. (University of Arizona specimen.)**

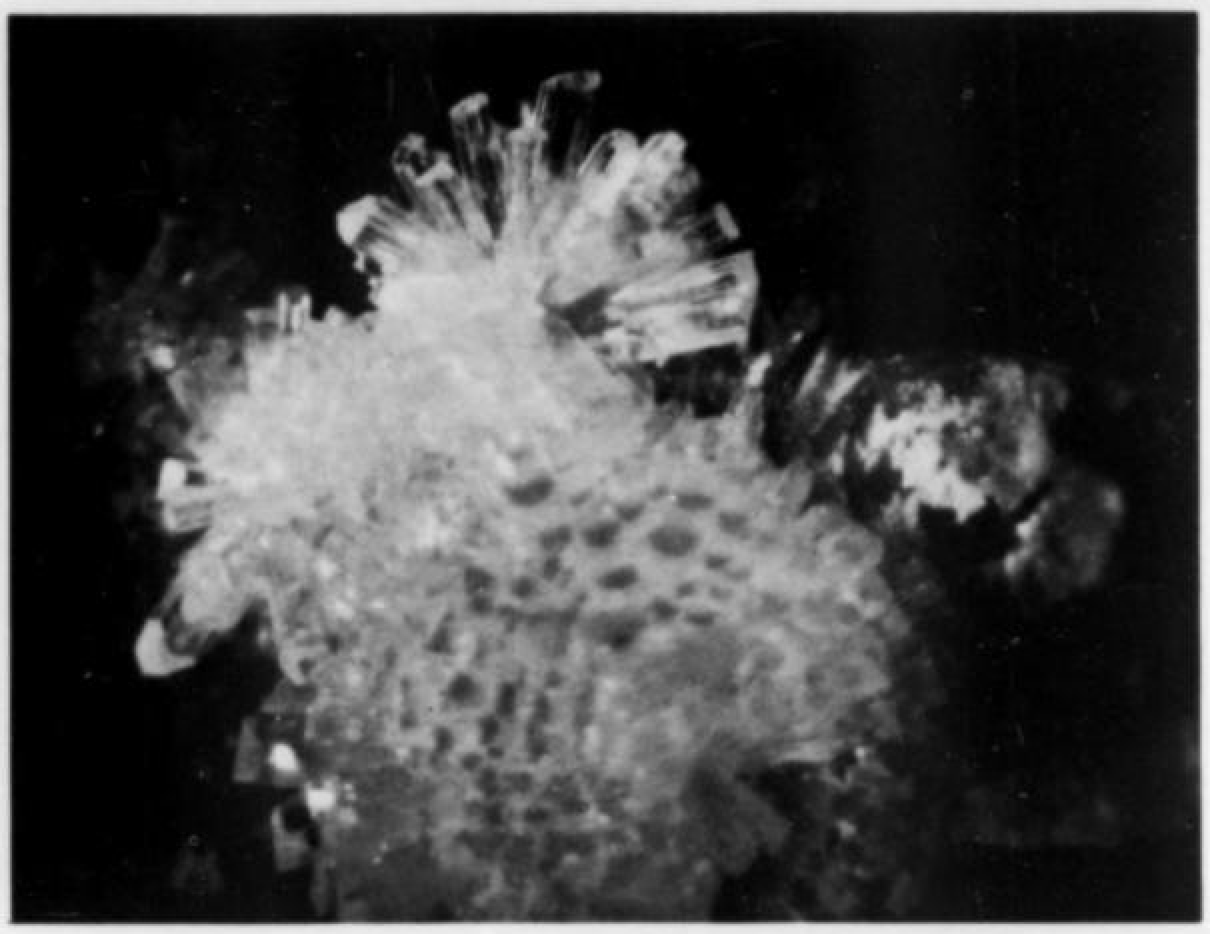

*Figure 3.* **Colorless wavellite crystals 1 mm in size, on quartz, from the Mineral Park mine. (A.R. specimen.)**

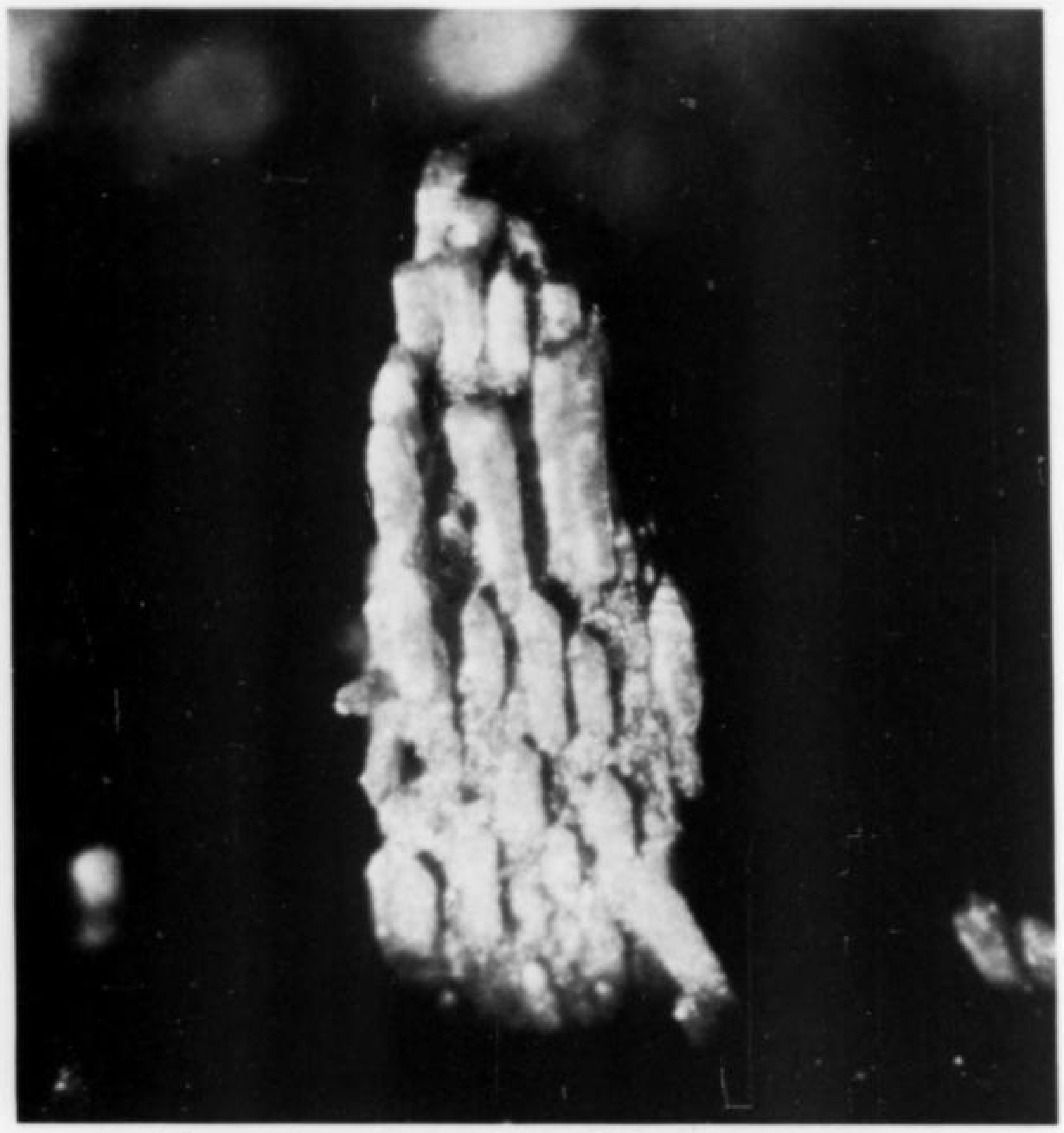

*Figure 4.* **A group of parallel, (second generation?) yellow wulfenite crystals grown upon a single crystal substrate. The group is about 3 mm tall, from the Mineral Park mine. (Carlos Williams specimen.)**

**Wulfenite**—$PbMoO_4$

Wulfenite has not previously been reported in the district, but its presence was not totally unexpected in the oxidized portions of the Mineral Park deposit. Wulfenite is not very abundant and its crystal size is small but the crystal habit makes the wulfenite of interest to mineral collectors.

The wulfenite occurs as light brown to honey-colored dipyramidal crystals up to 5.0 mm maximum size. While many of the crystals are squat dipyramids with virtually no prism development, there are several modifications of interest. In some crystals the prisms are steep and the pyramids elongated, and both of these forms may show cavernous or "hopper" developments. Several generations of wulfenite may be present where early wulfenite is overgrown by smaller, later wulfenite which forms what appears to be oriented growths. Extreme steepening of prisms and elongation of pyramids produce a straw-like habit called "wheat-straw" or acicular wulfenite.

Wulfenite occurs not only in the lead-zinc veins but also in quartz-pyrite veins where the pyrite is being replaced by chalcocite, with wulfenite deposited on the chalcocite. Wulfenite is occasionally associated with small cerussite crystals and in one specimen with hinsdalite; and wulfenite is later than the hinsdalite.

**Mimetite**—$Pb_5(AsO_4)_3Cl$

Mimetite does not occur in the Mineral Park Mine but it is found nearby in the district where it forms an unusual habit. The mimetite locality is approximately 3 km west of the Mineral Park mine in a small prospect on a lead-zinc vein. Mimetite has been previously reported from the Wallapai mining district (Thomas, 1949, and Dings, 1951), but no precise location was given. At the above locality, the mimetite occurs as yellow-orange, very elongated feathery crystals on limonite associated with wulfenite.

*Figure 5.* **Yellow wulfenite crystal group about 8 mm tall from the Mineral Park mine. (Carlos Williams specimen.)**

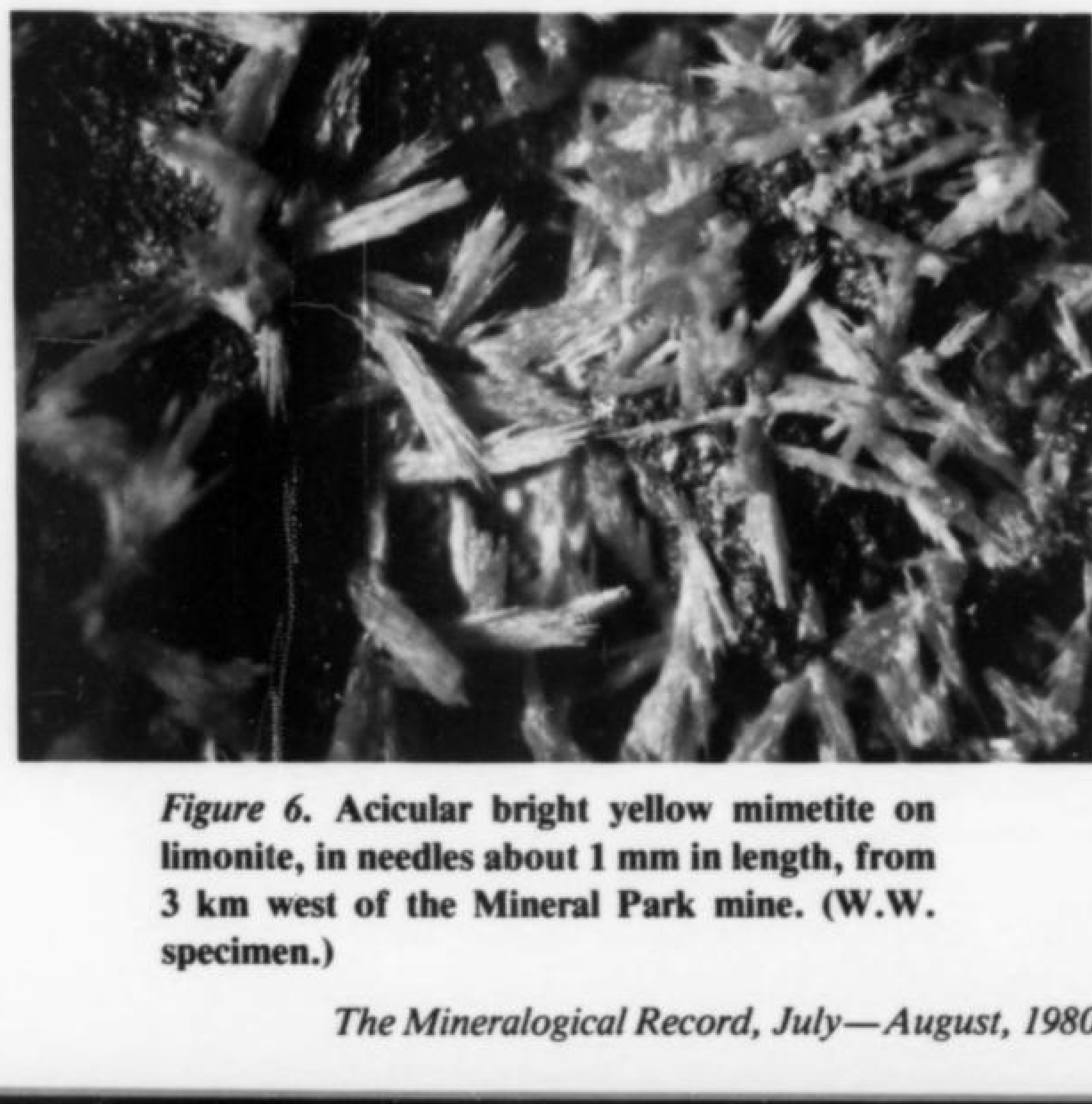

*Figure 6.* **Acicular bright yellow mimetite on limonite, in needles about 1 mm in length, from 3 km west of the Mineral Park mine. (W.W. specimen.)**

## DISCUSSION

Besides being of interest to mineral collectors, the suite of minerals discussed provides some insight into the oxidation history of the Mineral Park deposit. The following five features are of particular importance:

1. Chalcocite, turquoise, and native copper are minerals characteristic of the supergene environment.
2. Hinsdalite is deposited on chalcocite.
3. Wavellite is deposited on native copper.
4. Wavellite is vertically zoned with respect to turquoise.
5. Wulfenite is deposited on both chalcocite and hinsdalite.

These relationships establish the minerals discussed here as part of the late-stage supergene enrichment process and support the following partial paragenetic sequence:

chalcocite → native copper → hinsdalite + wavellite → wulfenite.

## ACKNOWLEDGMENTS

The authors gratefully acknowledge the Duval Corporation for permission to publish this paper and Mr. W. J. Roper, General Manager, and Luis Vega, Geologist, at the Mineral Park mine for permission to visit the property and for geologic discussions. All of the photographs were taken by one of the authors (A.R.).

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# Chrysocolla Pseudomorphs
## *from ray, arizona*

by
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On September 2, 1976, an extraordinary pocket of chrysocolla pseudomorphs was discovered at the Ray mine, Pinal County, in an operating open pit of the Kennecott Minerals Company. These were saved as a result of a pre-existing specimen concession agreement between Kennecott and Southwestern Mineral Associates (S.M.A.), a specimen recovery company.

For years, small and indistinct chrysocolla pseudomorphs (probably after azurite) had been noticed occurring in the silicate ore body of the Ray mine. In the summer of 1976 the Divsion Geologist at Ray, Neil Gambell, showed us a single specimen of sharp, blue pseudomorphous crystals up to 2 inches long; this he had found while mapping on the 2260 level. (Benches in open pit mines are generally labeled by their elevation above sea level, rather than distance below the surface as in underground mines.) A few weeks later, Richard Dalton, Mining General Foreman, mentioned that a high percentage of chrysocolla had some up in drill cores from the same area, at about 2260 feet.

For the next few weeks we watched the zone, patroling it regularly after blasts. Some attractive specimens of drusy quartz on chrysocolla turned up on August 29 and 30. On September 1 a single group of small chrysocolla pseudomorphs to about ½ inch was found . . . a hint of things to come. Andy Clark (of S.M.A.) found the first pseudomorph the following day. Above that on the freshly blasted talus slope he quickly found another, then a small

*Figure 1.* **The zone of pockets which yielded chrysocolla pseudomorphs after azurite at the Ray mine in 1977.**

group, and finally, after moving some rock, the main pocket. The pocket was filled with large pieces of matrix; attached and loose crystals were everywhere, the loose crystals having been popped loose by the shock of the blasts. By late afternoon, hundreds of single crystals and dozens of matrix pieces were packed and checked out at the mine office. What a birthday present (it was the author's birthday)!

Fortunately the breaks were clean and, after a few hundred hours of comparing loose crystals to crystal bases on matrix, many excellent specimens were reassembled. The pocket ended up yielding 10 major pieces and a dozen more very fine specimens, as well as a few hundred 1 x 1-inch single crystals and small groups. The discovery was reported by Wilson (1977) in the *Mineralogical Record.*

The next day the S.M.A. crew split, Gary Fleck and Andy Clark going to the Metcalf mine (also under a specimen recovery contract), and Jack Lowell, Jeff and Brad Archer remaining with me at Ray. We dug for three more days, and opened a second smaller pocket on the 5th. The entire bottom of this pocket came out as a single slab 10 x 12 inches, with about 30 sharp crystals to 3 inches in length on the matrix. Two additional pockets, smaller still, were uncovered late in the afternoon. Then, early on the 6th, mine personnel set off a major blast in the area, and the zone was gone forever.

In April of 1977 we encountered a second zone of pseudomorphs. Andy Clark and Brad Archer removed two more pockets yielding eight major pieces, some of which later became part of the Kennecott Minerals Company collection, the Ed Swoboda collection, and the Arizona-Sonora Desert Museum collection.

***Figure 2.* A huge block of matrix from the 1977 find, covered with chrysocolla pseudomorphs, the largest standing crystal measuring about 3 inches. Kennecott Minerals Company collection. Photo by Jeff Kurtzeman.**

This second zone was on the 2340 level, about 80 feet (two benches) higher in the pit than the first zone, and farther back into the pit wall, because mining had been progressing between the times of the two major discoveries. Nevertheless, the fractures in which the two major pocket zones were discovered were nearly vertical and parallel, perhaps no more than 20 feet separating the planes of the two fractures.

There has been some discussion about the original species after which the chrysocolla formed such fine pseudomorphs. Morphology suggests azurite, but there is additional evidence. Some pseudomorphs have been found with a small malachite core. Three or four benches below the lowest chrysocolla pseudomorph pocket, in the same fracture system, we found malachite pseudomorphs most likely after azurite, having very similar morphology to the chrysocolla pseudomorphs. And finally, one or two benches below that, we found druses of small, unaltered azurite crystals. The entire fracture system is wet, and most likely represents a single geochemical system from an oxidation standpoint. The chrysocolla specimens are probably pseudomorphs of malachite after azurite ... a sort of double pseudomorph.

Our dream, of course, is that in some as-yet unmined section of the fracture system we will find unaltered azurite crystals as large and as fine as the chrysocolla pseudomorphs . . . these would rival azurite from the best localities in the world. One can only hope. The situation is somewhat reminiscent of the discovery of huge stibiconite pseudomorphs after stibnite in Mexico a few years back. Had those crystals been found before being altered, they would have rivaled Japanese stibnite for the title of World's Best. To date, as far as I know, unaltered stibnite crystals of equal quality have not been found at depth in the deposit.

The chrysocolla pseudomorphs, when first removed, were wet and an extremely dark and rich turquoise-blue. Within 6 hours they dried out and turned a somewhat lighter blue. Even subsequent heating to 150–200° for several hours failed to further lighten their color or cause significant cracking. The crystals have an extreme affinity for finger oil, however, and should be handled with clean cloth gloves or tissue paper whenever handling is necessary. Finger oil stains will eventually turn the chrysocolla a more brownish, yellowish shade of blue, as the material is very absorbent.

## OTHER ARIZONA OCCURRENCES

Chrysocolla pseudomorphs have been found at a number of Arizona localities. Sometime around 1960, for example, a pocket of chrysocolla pseudomorphs after azurite was discovered by a miner at the Bagdad open pit copper mine in Mohave County. Few facts about this pocket are available, and few specimens, though remarkably fine ones, were recovered. The best is a large spray of blue pseudomorphed crystals similar in habit to Tsumeb azurite (now in the Harvard collection), and another is in the Arizona-Sonora Desert Museum. Earlier, from the 1930's through the 1950's, fine chrysocolla pseudomorphs after azurite were occasionally found in the Live Oak pit of the Inspiration mine near Miami. These specimens, generally covered by a thin layer of transparent chalcedony, are represented in several local collections. The Arizona-Sonora Desert Museum has a plate approximately 8 x 12 inches with several crystals to 2 inches each, and another fine specimen is in the Les Presmyk collection. Chrysocolla pseudomorphs, probably after smithsonite, are known from the 79 mine in Gila County, and one such specimen is illustrated in color in Wilson (1972). Other occurrences include Morenci (after azurite roses to 1 inch), the Grand Reef mine (after cerussite crystals to 1 inch), and undoubtedly many other lesser occurrences.

## ACKNOWLEDGMENTS

Without the complete cooperation of Kennecott Minerals Company and its personnel, notably Ken Matheson, Ken Vance, Richard Dalton, Stan Johnson, Neil Gambell and John Witner, these specimens would never have been saved from the silicate vats. The science owes much to these people for their enlightened attitude toward conservation.

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# The TOMBSTONE District Cochise County, Arizona

by
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***Mines surrounding the notorious nineteenth century mining camp of Tombstone, Arizona, have yielded many millions of dollars in silver and other metals. Fine specimens of wulfenite, jarosite, cuprite, various halides, and a unique suite of more than 40 tellurium oxysalts, many of which are new to science, have been found there.***

**HISTORY**

The first mineral location in the area was the Bronco claim some 5 miles west of the Tombstone district proper. Located in 1857 it was worked by Frederic Brunckow who was later murdered by one of his employees. In 1887, Ed Schieffelin visited the claim and noted that the veins trended to the northeast. Following these to the east he found what he thought was rich silver ore. He took some samples to his brother Albert and an assayer, Richard Gird, at the McCracken mine in Mohave County, Arizona. Finding that they were indeed rich ore, the Schieffelin brothers and Gird returned to Tombstone as partners, quickly discovering the Lucky Cuss and Toughnut deposits. However, the richest lode, the Grand Central, was located by Oliver Boyer and Henry Williams, prospectors who arrived soon after the Schieffelin party.

Boyer and Williams had agreed to share their claims with Schieffelin and Gird in return for assays of their samples. The former ignored this agreement in staking the Grand Central claim and Gird was incensed. He knocked down the corner monuments, reducing it to half its original size, and relocated the remainder as the Contention claim. Shortly thereafter Boyer killed a man in Tucson,[1] and Gird later recalled that he had been lucky, not knowing Boyer's disposition (Underhill, 1979).

The fame of the camp spread quickly and production peaked at over five million dollars in 1882, declining steadily thereafter. The decrease of the price of silver coupled with formidable pumping problems at the mines worked below the water table was a major factor.

The Tombstone mines were no safer than any other mines of the day; a number of miners, killed underground in various mishaps, are buried in the famous Boothill cemetery. The cemetery is a tourist attraction now, along with several museums and other historic exhibits in Tombstone. The Goodenough mine has been reopened by *The Rocksmiths* for guided tours (collecting allowed, but from the floor areas only).

[1] I was mortified to learn of this *after* oboyerite had been approved, named in his honor.

**PRIMARY ORES**

Ores produced in the district occurred in two types of settings. Much of the ore, and especially rich ore, was produced from faults and fissure veins cutting both sediments and dikes. Frequently these ores were richer in gold than was average for the camp. However, considerable ore was also produced from replacement bodies, especially in the upper Naco limestone and certain beds in the Bisbee group.

For the most part, ore contained galena, sphalerite, and pyrite. In fact, this is typical of many famous silver camps. It takes very little silver, on the order of 0.05% to 0.1%, to make "silver ore" of material containing many times as much lead or zinc. Thus, in silver ore of this type, the silver minerals may be seen but rarely or never in material containing highly visible galena and sphalerite.

All of the mines in the district carried galena and sphalerite (with pyrite) including those in limestones such as the Lucky Cuss, Bunker Hill, and Herschel, and those in shales and siltstones of the Bisbee group rocks such as the Contention and Grand Central.

Chalcopyrite is less commonly seen. Perhaps it was most abundant in quartz veins at the Emerald mine and it was also observed in massive alabandite at the Lucky Cuss. However, it is also usually present as microscopic beads in sphalerite wherever that mineral occurs in the district.

Tetrahedrite occurs sporadically in the district. It was once abundant in the Toughnut mine where specimen ore is reported to have carried 85 ounces of silver per ton (Butler *et al.*, 1938). Tetrahedrite was also common at the Emerald, Oregon, Prompter, and State of Maine mines where it appears to have been the major silver-bearing mineral.

Alabandite was found in considerable amounts in the Lucky Cuss mine and smaller mines nearby. Typically it occurred as nearly pure masses in crystalline limestone with minor amounts of pyrite and base sulfides.

Tombstone is not noted for well crystallized sulfides, and none of them could be said to represent potential specimen material. Possible exceptions might be alabandite and pyrite. Although alabandite

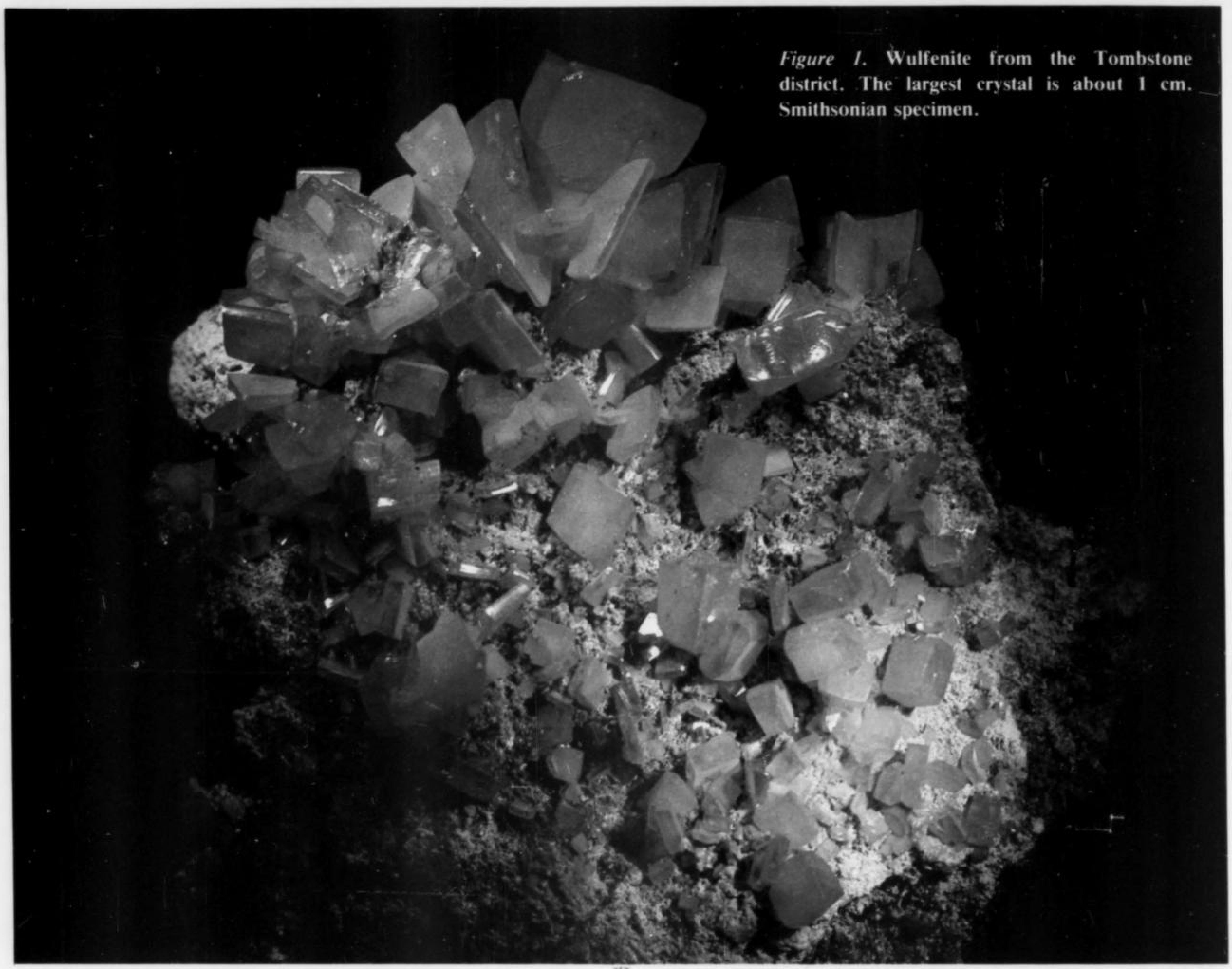

*Figure 1.* Wulfenite from the Tombstone district. The largest crystal is about 1 cm. Smithsonian specimen.

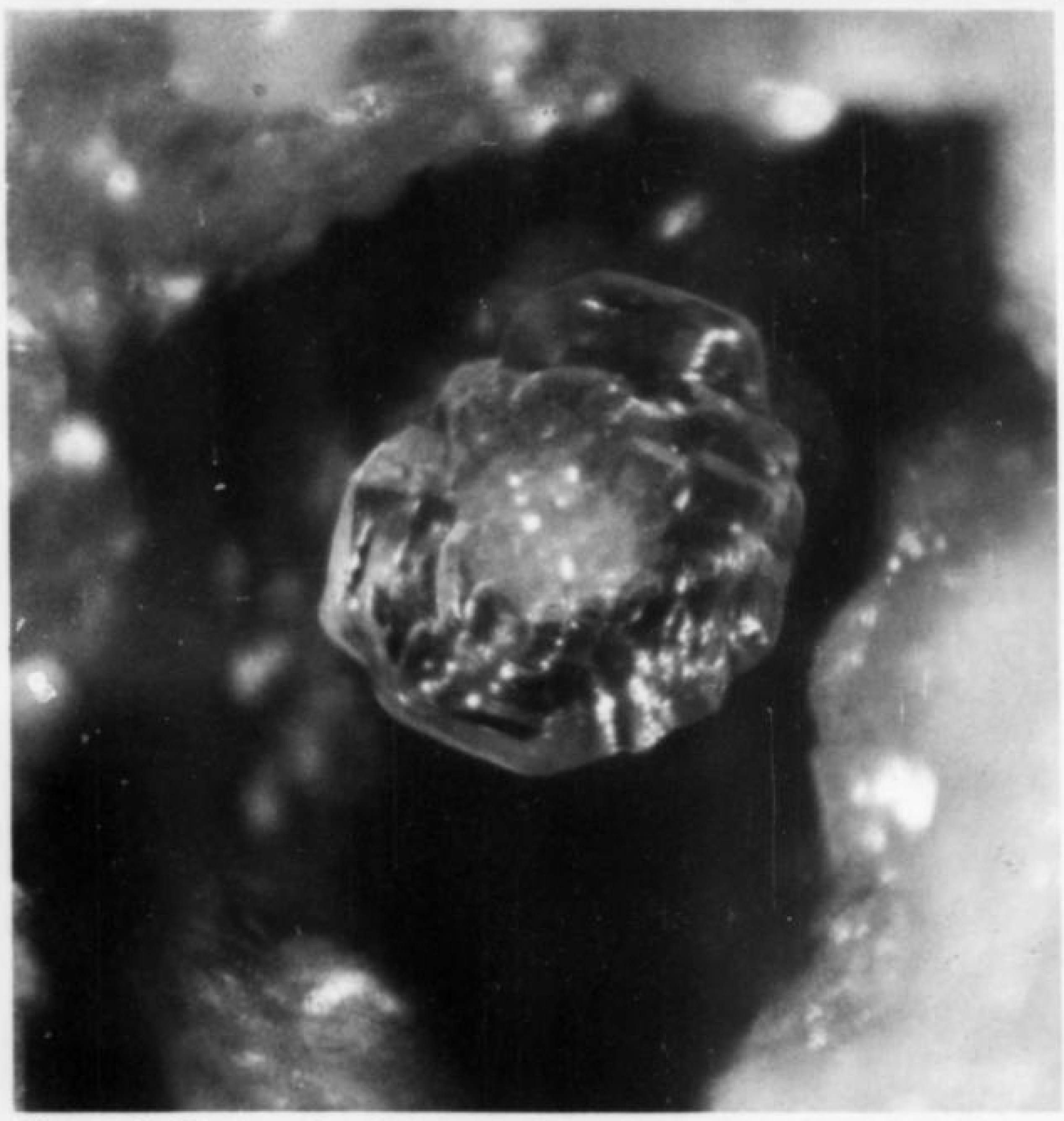

**Figure 2.** **Emmonsite from the Grand Central mine. Photo by Julius Weber.**

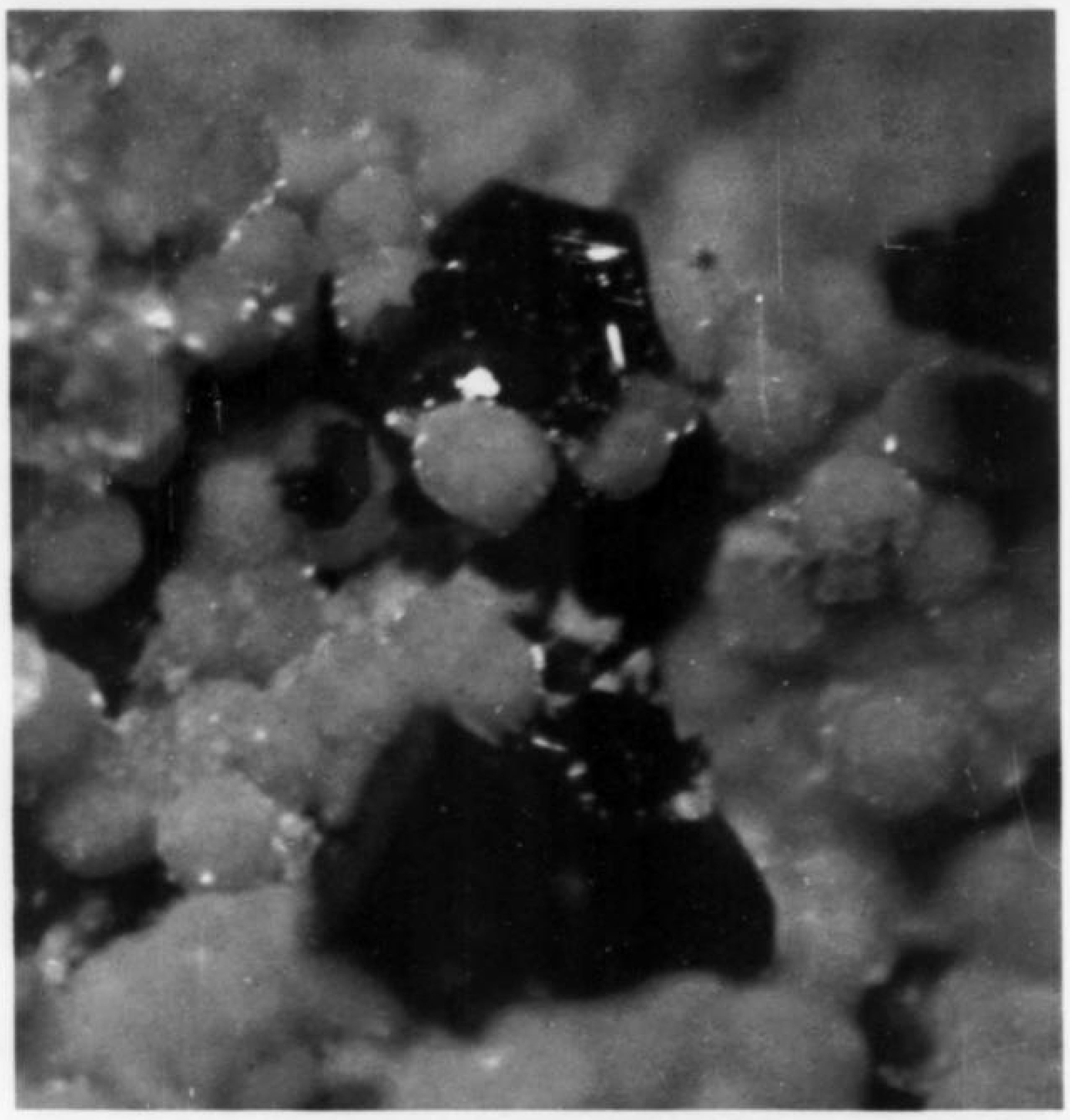

**Figure 3.** **The type specimen of parakhinite (dark green), including an as-yet undescribed new tellurium mineral (bright green), from the Emerald shaft. Photo by Arthur Roe.**

occurs only as massive material, very rich specimens can be found and they are handsome, with pitchy, greenish-black alabandite set in a white calcite matrix.

Very fine pyrite crystals must have come from the district. The massive, buff to tan colored adularia-opal matrix at the Grand Central mine is sometimes sprinkled with perfect 10 to 15 mm pyritohedra. All I have found, however, are jarosite pseudomorphs.

The very rich bonanza ores that were mined were telluride ores quite unlike the base-metal ores. Examples of such ores are very rare in the dumps, not only because of their limited distribution in the mines but because they were undoubtedly mined with considerable diligence.

Hessite has been described from the West Side mine by Genth (1887). It occurred in vein quartz with supergene native silver and unidentified blue to green minerals. Recent examination of dumps, especially those known to be anomalously high in tellurium, has failed to disclose hessite.

Recent collecting along the Contention ore zone has turned up small amounts of other tellurides not previously reported from the district. These generally appear in crushed vein quartz or brecciated shales intensely altered to adularia. Especially noteworthy is empressite, found as fine granular masses of bright tin-white color, some up to an inch in size. The empressite is usually corroded by rickardite and anglesite.

One piece was found with clusters of tiny krennerite crystals set in native tellurium. This piece was unusually pyritic and also contained pockets of well crystallized paratellurite, an uncommon mineral in the district.

In addition to the primary minerals described above, a few others have been noted, usually in microscopic studies of ores. These include stromeyerite, famatinite, and bournonite.

## OXIDE ORES

Native gold, silver and copper have all been reported and all three appear to have been oxidation products. Gold is particularly suspect, occurring in partly or wholly oxidized telluride ores as pinhead-size grains with goethite, lead tellurites and tellurates, and with quetzalcoatlite. Although supergene native silver was uncommon, the silver halides are abundant and have been noted in every mine in the district. There is little doubt they accounted for most of the silver produced.

Both chlorargyrite and bromargyrite are common with all possible variations in between. Butler *et al.* (1938) report an analysis of nearly pure bromargyrite from the Empire mine, and it has been noted all along the Contention zone. Generally this bromine-rich mineral is rich yellow to orange-yellow and is less sensitive to light than chlorine-rich varieties. Chlorargyrite tends to be pale yellow to greenish-yellow, quickly turning to lavender-grey in the light. Although noted at the Comet mine in limestone, bromargyrite also seems most abundant in ores produced from non-carbonate rocks whereas chlorargyrite occurs in any environment. The Cl:Br ratio varies whimsically, even in a single specimen. It is not uncommon to find chlorargyrite in one cavity in a specimen, embolite or bromargyrite in another perhaps an inch away.

These halides are generally well crystallized (usually as octahedra) with brilliant faces. The usual appearance is a perfect octahedron with rounded edges, as if slightly melted. Chlorargyrite also often fills hairline fractures. When rich ores are pried apart, it is common to find waxy skins of chlorargyrite partly torn from the fresh break.

One rich piece recently found in the Contention zone carried bromargyrite octahedra scattered about nuggets of crystalline iodargyrite partly altered to granular miersite. This remarkable piece also contains two new silver iodides, previously known only as man-made compounds.

Of special recent interest at Tombstone is the discovery of numerous new tellurium oxysalts, although tellurites have long been known to occur there. The first mention is by Hillebrand (1885) who described emmonsite "from near Tombstone, Arizona Territory—the exact locality of occurrence being unknown ..."

The analytical results reported by Hillebrand in the original paper and in a later one (Dana and Wells, 1890) are recast in Table 1 by averaging and bringing to 100%.

***Table 1.* "Emmonsite" analysis of Hillebrand (1) compared to calculated analyses.**

| | 1 | 2 | 3 |
|---|---|---|---|
| $Fe_2O_3$ | 20.79% | 23.7% | 18.5% |
| $TeO_2$ | 75.41 | 71.0 | 74.1 |
| $H_2O$ | 3.80 | 5.3 | 3.1 |
| HCl | | | 4.2 |
| | 100.00 | 100.0 | 99.9 |

Columns 2 and 3 in Table 1 are theory for emmonsite and rodalquilarite respectively. Remembering that three of Hillebrand's analyses were based on brownish material, undoubtedly admixed with goethite, the ratio of $Fe_2O_3$:$TeO_2$ should move somewhat closer to that of rodalquilarite. Finally, the optics of emmonsite are described by Cross (in Hillebrand, 1885) and related to planes of cleavage that are characteristic of rodalquilarite, not emmonsite. The type description of emmonsite is therefore surely based upon rodalquilarite!

Recent work has shown that rodalquilarite is common in some ores along the Contention zone. Bright siskin-green cleavage plates up to an inch across occur in opalized shales with anglesite, jarosite, and lesser amounts of botryoidal (never well crystallized) emmonsite. Rodalquilarite is also noteworthy as perfect, sharp microcrystals ($\approx 5$ mm) in vugs with jarosite and winstanleyite.

Because so much pure material was available, a partial study was undertaken to try to resolve the chemical and structural differences reported by Lopez *et al.* (1968) in the original description of rodalquilarite. Analytical results are presented in Table 2.

***Table 2.* Chemical analyses of rodalquilarite.**

| | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| $Fe_2O_3$ | 18.59 | 18.70 | 18.54 | 18.45 |
| $TeO_2$ | 73.36 | 73.82 | 74.10 | 72.85 |
| HCl | 4.09 | 4.12 | 4.23 | 4.94 |
| $H_2O$ | 3.34 | 3.36 | 3.13 | 3.42 |
| | 99.38 | 100.00 | 100.00 | 99.66 |

(1) Average of two closely agreeing analyses on 1.824 and 4.005 mg, Marjorie Duggan, Analyst.
(2) Analysis of Column 1 reset to 100%.
(3) Theory for $H_3Fe_2(TeO_3)_4Cl \cdot \frac{1}{2}H_2O$.
(4) Analysis by Lopez *et al.*, type material.

Tombstone material supports the formula $H_3Fe_2(TeO_3)_4Cl \cdot \frac{1}{2}H_2O$. Crystals were also examined by X-ray, giving $a$ = 9.00Å, $b$ = 5.10, $c$ = 6.64, $\alpha$ = 103°22', $\beta$ = 106°38', $\gamma$ = 78°4', thus for Z = 1 $D_{calc.}$ = 5.08 g/cm³. The measured specific gravity using 7.68 mg (Berman balance) is 4.97.

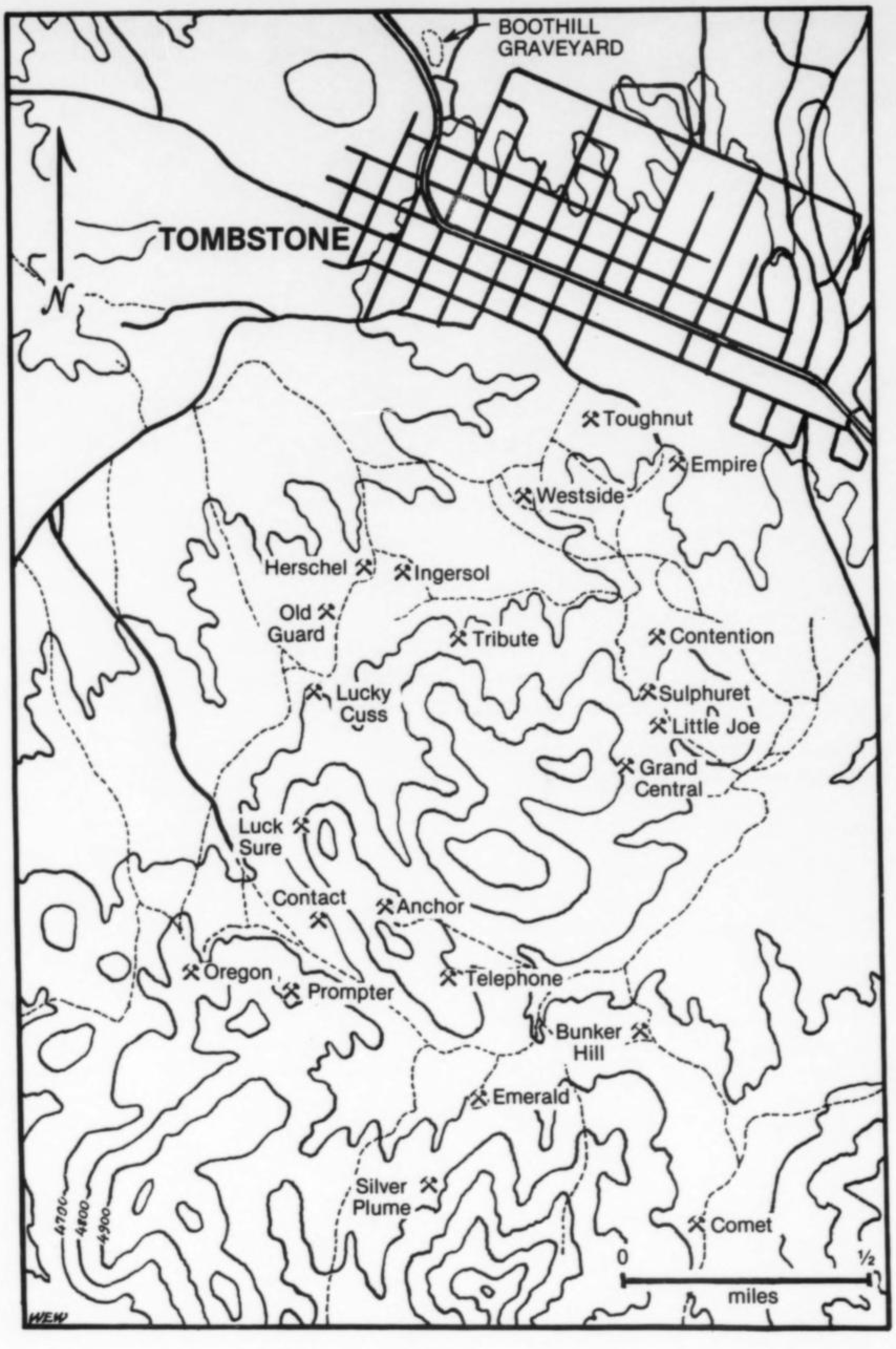


***Figure 4.* Mines in the portion of the Tombstone district nearest the town of Tombstone.**

Although these data support the formula with $\frac{1}{2}H_2O$ they certainly do not prove it, for the formulae with and without the $\frac{1}{2}H_2O$ differ by about 1% which is surely less than the net effect of analytical errors.

Although a rare mineral, dugganite has been found at several mines in the district. The type specimen is unique, with spherules of water-green hexagonal prisms abundant in a sugary, vuggy quartz matrix. This piece was found at the Emerald mine embedded in the face of the dump during the time the dump was being excavated and removed for leaching operation.

A few pieces containing the rare species sonoraite were found on the dump of the (Little) Joe shaft. The mineral occurs as tiny spicular to bladed yellow crystals in heavy goethite-jarosite gossan with emmonsite.

On my second visit to Tombstone, within the first five minutes, the type specimen of khinite was found. The dump of the Old Guard mine had been removed for cyanide leaching and was scraped clean to bedrock with one piece of oxide ore lying on the surface. On this specimen khinite occurs as corroded deep green crystals lying in rings about chlorargyrite and replaced outside the rings by dugganite. This piece also contained the only quetzalcoatlite found at Tombstone. No more khinite has ever been found.

Parakhinite, identical in composition but hexagonal, not orthorhombic, was later found at the Emerald mine with dugganite, xocomecatlite and a host of other tellurium salts. Only two pieces of this species were found.

More recently a number of lead-tellurium salts were found at the Grand Central mine. Not only did these prove to be rare, but they are inconspicuous; all being white or colorless minerals. The species occur in the very richest ores (gold as well as silver) with an abundance of lead. Although fresh altaite has not been found, it seems probable that it was once present.

Tombstone has the usual suite of other oxide minerals common to a desert climate. Very nice wulfenite and mimetite specimens in

*Figure 5.* **Miners single-jacking in a 5-foot thick vein of argentiferous galena on the 500-foot level of one of the Tombstone Consolidated Mines Company's mines in 1904. Photo courtesy of the Arizona Historical Society.**

gossany, leached quartz have been found in the Empire, Emerald, and Grand Central mines. The wulfenite crystals are invariably thin tablets of a lovely orange color.

Butler *et al.* (1938) described a specimen of cuprite from the Toughnut mine that, when broken open, revealed a cuprite-lined vug with connellite needles, brochantite, malachite, and two unknown species.

Perhaps most noteworthy, however, is the rich variety of well crystallized rhombohedral sulfates. Jarosite is abundant and some truly spectacular material has been found. The best pieces are rich in jarosite crystals of deep coffee-brown color; tablets up to 1 cm have been found. Crystals of pseudocubic habit are more rare but are common in the type winstanleyite specimen along with rodalquilarite.

Alunite is also common as sparkling crystalline druses of clear to greenish crystals. Tan natroalunite occurs with emmonsite frequently, and hydronium alunite of greenish color has been noted at the Joe shaft. Other minerals of this group that are relatively plentiful but usually massive include plumbojarosite, argentojarosite, beaverite, hidalgoite, and osarizawaite. Beaverite and osarizawaite seem most common in suites derived from tetrahedrite-rich ores for they often occur with duftite, bindheimite, conichalcite, and olivenite. Suites of these minerals were once especially common at the Emerald, Oregon and Prompter mines.

Manganese oxides are also abundant and varied, particularly in those mines that worked in limestone wallrocks such as the Lucky Cuss. It seems likely that most or all of the manganese has derived from oxidation of alabandite. These species have been discussed by Rasor (1939) who identified hetaerolite and pyrolusite, referring other species to "psilomelane" and "wad." Shortly thereafter cryptomelane was described (Richmond and Fleischer, 1942) from some of the "psilomelane." Recent work has identified manjiroite, manganite, and hydrohetaerolite as well, but more work deserves to be done. These minerals are all black or nearly so, and are most amenable to study by X-ray.

## SILICATES

Only a few occurrences are noteworthy. At the Grand Central mine, where veins cut shales and siltstones, considerable quantities of the rock have been converted to massive adularia. Crystal-lined voids are rare. The adularia appears to represent a transitory stage, for much of the rock is further altered to massive opal. This appears to be the rock called "novaculite" by early workers in the district.

At the Lucky Cuss mine, limestones have undergone severe metamorphism and some contain unusual silicates such as monticellite, hillebrandite, and thaumasite. These are best appreciated in thin section, however.

A list of the non-tellurium species now known to occur at Tombstone is presented in Table 3. Each mineral is followed by either an A (abundant), U (uncommon) or R (rare). The tellurium minerals and their compositions are shown in Table 4.

In addition to the species listed above, another 25 new ones have been found in the district, bringing the total to 157. The most spec-

*Table 3.* **Non-tellurium minerals reported from the Tombstone district. R = rare, U = uncommon, A = abundant.**

| | | | | | |
|---|---|---|---|---|---|
| **Silicates** | Orthoclase (A) | Conichalcite (R) | Beaverite (U) | Bromargyrite (U) | Gypsum (U) |
| Actinolite (R) | Pennine (A) | Connellite (R) | Bindheimite (R) | Chlorargyrite (U) | Halotrichite (R) |
| Allanite (R) | Pigeonite (U) | Copper (R) | Bournonite (R) | Embolite (U) | Hematite (A) |
| Andradite (A) | Plagioclase (A) | Covellite (U) | Cerussite (A) | Iodargyrite (R) | Hetaerolite (R) |
| Biotite (A) | Quartz (A) | Cuprite (R) | Corkite (R) | Miersite (R) | Hydrohetaerolite (R) |
| Clinochlore (A) | Serpentine (A) | Duftite (R) | Descloizite (U) | Silver (R) | Hydronium |
| Clinozoisite (U) | Smectite (U) | Famatinite (R) | Duftite (R) | Stromeyerite (R) | alunite (R) |
| Diopside (A) | Titanite (A) | Linarite (R) | Galena (A) | | Hydrozincite (R) |
| Epidote (A) | Tremolite (A) | Malachite (A) | Hidalgoite (R) | **Others** | Jarosite (A) |
| Fayalite (A) | Vesuvianite (A) | Miersite (R) | Leadhillite (R) | Alabandite (A) | Magnetite (A) |
| Forsterite (U) | Wollastonite (U) | Mixite (R) | Linarite (R) | Alunite (U) | Manganite (U) |
| Grossular (A) | | Mottramite (A) | Mimetite (U) | Apatite (A) | Manjiroite (R) |
| Hemimorphite (U) | **Copper Minerals** | Olivenite (R) | Mottramite (A) | Barite (U) | Natroalunite (R) |
| Hillebrandite (R) | Aurichalcite (U) | Osarizawaite (R) | Osarizawaite (R) | Calcite (A) | Pyrite (A) |
| Hisingerite (A) | Azurite (U) | Rosasite (U) | Plumbojarosite (U) | Cryptomelane (U) | Pyrolusite (A) |
| Hornblende (A) | Beaverite (U) | Stromeyerite (R) | Pyromorphite (R) | Diaspore (U) | Rhodochrosite (R) |
| Kaolinite (U) | Bournonite (R) | Tenorite (U) | Vanadinite (R) | Dolomote (A) | Smithsonite (R) |
| Microcline (A) | Brochantite (R) | Turquoise (R) | Wulfenite (U) | Ettringite (R) | Sphalerite (A) |
| Monticellite (R) | Chalcocite (R) | | | Fluorite (U) | Sulfur (R) |
| Muscovite (R) | Chalcopyrite (R) | **Lead Minerals** | **Silver Minerals** | Goethite (A) | Thaumasite (R) |
| Opal (A) | Chrysocolla (U) | Anglesite (U) | Acanthite (R) | Gold (R) | |

*Table 4.* **Tellurium minerals from the Tombstone district. (All may be considered rare.)**

| | | | |
|---|---|---|---|
| **Dugganite** | $Pb_3Zn_3(TeO_6)_x(AsO_4)_{2-x}(OH)_{6-3x}$ | **Paratellurite** | $TeO_2$ |
| **Dunhamite** | $PbTeO_3$ | **Quetzalcoatlite** | $Zn_8Cu_4(TeO_3)_3(OH)_{18}$ |
| **Emmonsite** | $Fe_2Te_3O_9 \cdot 2H_2O$ | **Rickardite** | $Cu_7Te_5$ |
| **Empressite** | AgTe | **Rodalquilarite** | $H_3Fe_2(TeO_3)_4Cl$ |
| **Fairbankite** | $PbTeO_3$ | **Schieffelinite** | $Pb(Te,S)O_4 \cdot H_2O$ |
| **Frohbergite** | $FeTe_2$ | **Sonoraite** | $FeTeO_3(OH) \cdot H_2O$ |
| **Girdite** | $H_2Pb_3(TeO_3)TeO_6$ | **Spiroffite** | $(Mn,Zn)_2Te_3O_8$ |
| **Hessite** | $Ag_2Te$ | **Tellurium** | Te |
| **Khinite** | $Cu_3PbTeO_4(OH)_6$ | **Tlapallite** | $H_6(Ca,Pb)_2(Cu,Zn)_3(SO_4)(TeO_3)_4TeO_6$ |
| **Krennerite** | $AuTe_2$ | **Winstanleyite** | $TiTe_3O_8$ |
| **Oboyerite** | $H_6Pb_6(TeO_3)_3(TeO_6)_2 \cdot 2H_20$ | **Xocomecatlite** | $Cu_3(TeO_4)(OH)_4$ |
| **Parakhinite** | $Cu_3PbTeO_4(OH)_6$ | | |

tacular effect of mineralogical research on Tombstone has been to increase the number of tellurium oxysalts. Including new but undescribed species as well as older ones, 43 occur at Tombstone of which 20 remain to be described and 9 others have been described with Tombstone as the type locality. (The total list of known Te-oxysalts worldwide numbers about 80.) Further work in the district will doubtlessly find more, and the species list could also probably be increased by study of the manganese oxides.

## ADDITIONAL COMMENTS

Although prospecting activity continues at Tombstone, it seems unlikely that serious underground mining will ever again be undertaken in the main part of the district. Mineral collecting is limited to the surface and is complicated by complex ownership of claims. Little dump material remains to be examined because almost all has been removed and piled on leaching pads, the minerals destroyed by cyanidation.

Deep workings remain flooded throughout the district and the upper levels are generally caved or in dangerous condition. Just recently, for example, a rumble was heard deep in the Sulphuret shaft, followed by a cloud of dust at the surface (Burt Devere, Jr., personal communication, 1980).

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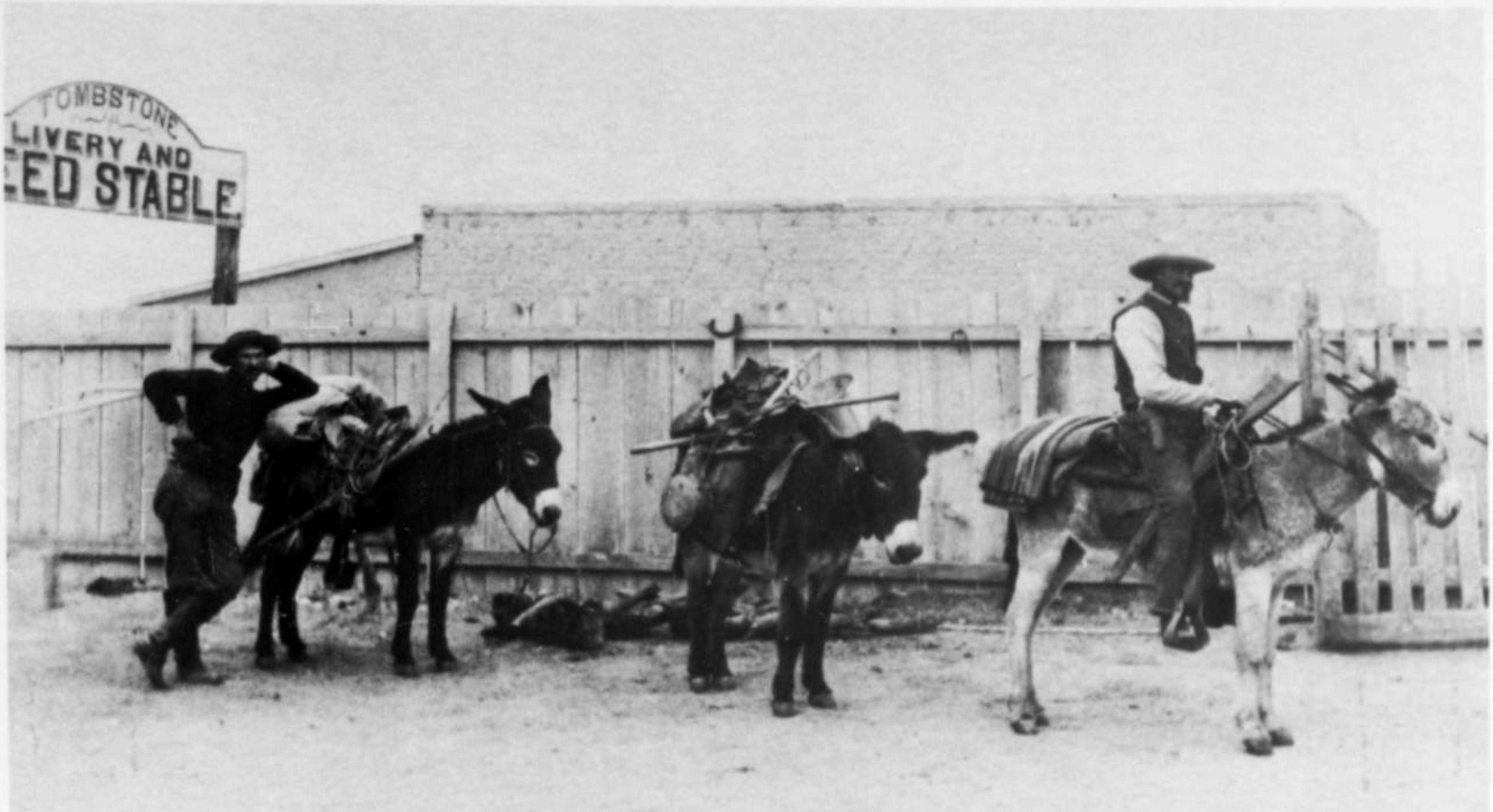



***Figure 6.*** **Prospectors in the 1880's, outfitted and ready to leave Tombstone. Photo courtesy of the Arizona Historical Society.**

# Some Tombstone Epitaphs from Boothill Graveyard*

*The mining camp at Tombstone was notorious for good reason in the 1880's. The various fates of these people buried on Boothill give a glimpse into the life (and death) of those times.*

**VAN HOUTEN, 1879**

He was beaten in the face with a stone until he died. Trouble was over his mining claim which he had not recorded.

**JOHN HICKS, 1879**

He was shot by Jeremiah McCormick, superintendent of the Lucky Cuss mine, in a saloon brawl.

**FREDDIE FUSS, 1882**

A small boy who died from drinking mine water.

**JOHN GIBSON, 1881**

Gibson, driver of an ore wagon, fell from his wagon and suffered a crushed skull when the wheel ran over his head.

**TOM WATERS, 1880**

Likely the T. J. Waters shot over the color of his shirt.

**WILLIAM ALEXANDER, 1880**

An old prospector who was fatally injured when a blast went off prematurely.

**CHARLES HELM, 1882**

Shot by Wm. McCauley in a disagreement over the best way to drive cattle, fast or slow.

**SIMON CONSTANTINE, 1882**

He and Thomas Kearney were blown up in a mine blast.

**JAMES TULLEY, 1881**

Tulley was a miner in the Grand Central mine. He attempted to jump from an out-of-control cage and fell 250 feet to the bottom of the shaft.

**JAMES HICKEY, 1881**

Shot in the left temple by Wm. Clayborne for his over-insistence that they drink together.

**GEORGE WHITCER, 1882**

Killed when a cable broke, hurling his cage to the bottom of the mine shaft.

**MARGARITA, stabbed**

Margarita and Gold Dollar were two dance hall girls who quarreled over a man. Gold Dollar won.

**GEO. JOHNSON, hanged by mistake**

Johnson innocently bought a stolen horse and suffered the consequences.

**UNKNOWN, 1882**

He was found at the bottom of a 60-foot shaft at the Minute mine. He was well-dressed, suggesting he was not a miner, but there was no identification on him.

**KILLEEN, 1880**

Shot by Frank Leslie in a disagreement over Killeen's wife. Leslie married the widow.

**BILLY CLANTON, TOM McLAURY, FRANK McLAURY, 1881**

Killed by Wyatt and Virgil Earp and "Doc" Holliday in the O.K. Corral.

# George A. Bideaux

## 1899–1978

by
**Arthur Roe**
3024 E. 6th Street
Tucson, Arizona 85716

We knew George Bideaux best as a mineral collector, but he was much more: an artist; a newspaper columnist, editor, and owner; an Army veteran wounded in World War I; a devoted husband; and father of two talented children. He was a gentle and generous man who made friends easily and kept them. He died in Tucson on August 15, 1978, of a heart attack several days after successful gall bladder surgery.

George was born in 1899 in northwestern Pennsylvania, of descendants of early French settlers. After high school, he enlisted (underage) in the Army, and was gassed and machine-gunned in the Argonne Forest. After convalescence, he studied architecture at the University of Pennsylvania, art at the Philadelphia Academy of Fine Arts, and journalism at the University of North Carolina at Chapel Hill. He left North Carolina before completing his Master's degree to accept a job with the *Miami Herald*—the beginning of a long and joyful career in journalism. He worked as a reporter for several newspapers, including the *New Orleans Picayune,* and in 1929 was on his way to a job with a newspaper in Sacramento when he got off the train in Tucson—and never got back on! His first home in Tucson was a tent on a homestead near the city.

He continued his newspaper work on various papers in the Tucson area, and in 1934 became editor of the *Southwest Veteran,* a publication of the American Legion. Beginning that year and continuing for 44 years without interruption until his death, he wrote a weekly column—the last one the day before he died—called variously "Down in Cochise County," "Down in Santa Cruz," etc. For about 20 years his column "With Pick and Knapsack" appeared weekly in Bisbee's *Brewery Gulch Gazette.* In addition, he wrote many columns for special purposes, specific occasions, and for special issues of various publications. When he took trips abroad he would write enough columns in advance to last until his return.

His Tucson stay was interrupted in 1943 for several years when he went to Washington, D.C., as Executive Secretary for Senator Ernest McFarland, when McFarland was first elected. His weekly column was kept up during the Washington years.

"Down in Cochise County" was a gentle (usually) and often humorous commentary on current affairs—local, national, and international. The one he wrote in the hospital the day before he died touched on television reruns (George didn't approve); Ambassador Andrew Young (whose most ardent supporter he was not!); a friend's visit to Scotland; the price of gold; the importance of copper mining to Arizona; and the end of Pete Rose's long hitting streak (George was glad Pete didn't beat Joe Dimaggio's record).

The column was usually introduced by a four-liner for which George became justly famous. Examples:

Where myrtle grows
Between the stones
Lies Alexander
"Slow-draw" Jones.

Mary had a little lamb
It followed her around
Until one day she realized
T'was worth too much a pound.

She said you promised
The world we'd roam.
Now we're stuck here
In a mobile home.
Without wheels.

Election over
Strife is gone
The ship of state
Sails on and on.

Hardly a man
Is now alive
Who drives his car
At eighty-five.

And, the last one:

Summer's here
So is the heat.
And TV programs
"Repeat, repeat."

"Down in Cochise County" appeared at various times and under various titles in a number of papers in Arizona, including those in Willcox, Benson, Tombstone, Sierra Vista, Nogales, Green Valley, Kingman, and of course Bisbee's famous *Brewery Gulch Gazette* (which George bought in 1959 with partner Bill Epler).

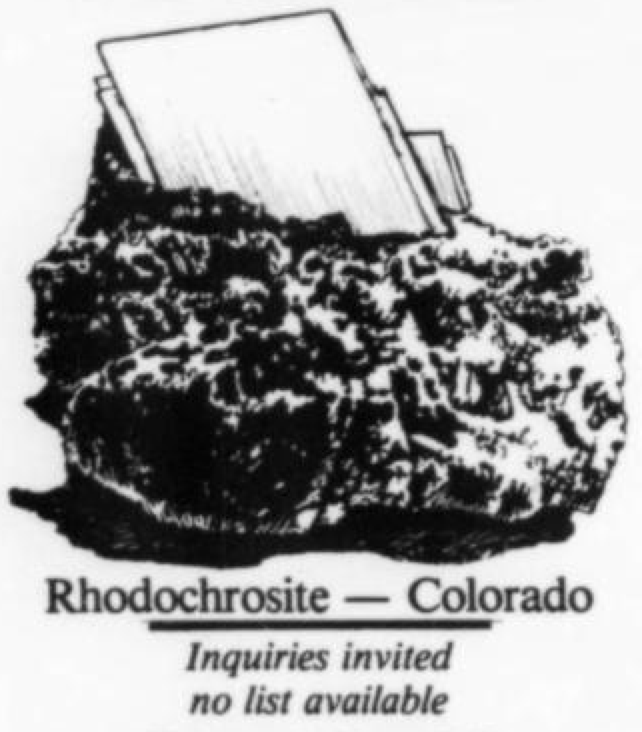
George's mineral column "With Pick and Knapsack" was started about 20 years ago. It contained a potpourri of chitchat about ghost towns, new mineral discoveries, Arizona mineral shows, collecting at various sites, talks with dealers and other visitors, rumors about mineral collections bought and sold, and his trips abroad visiting collectors and dealers. One column in 1973 discussed: mineral collecting in Europe; new minerals from Mexico and Brazil; a visit with Professor Sergio Gallo of Italy who visited George in Tucson; and two out-of-state collectors bemoaning their poor luck collecting at famous Arizona sites (the 79 cemented up; being run off the Glove mine property; Red Cloud and Rowley accessible but the collecting poor; fair luck at the Defiance; nothing at Bisbee; three mediocre boxes from the Apache; and some vanadinite from the Old Yuma).

George's interest in minerals was kindled a bit late in life when his son, Richard, took up the hobby in 1948. George did all he could to further his son's interest. Richard, as a student, won an award at the first Tuscon Gem and Mineral Society Show in 1955. Together, they created one of the finest mineral collections in the Southwest. George's interest in, and knowledge of, minerals led him to establish "Bideaux Minerals" in 1965 at 111 West Washington Street in Tucson. (The business is now flourishing under his son at a new Tucson location.) This well-known mineral shop was a "must" stop for mineral collectors and dealers whenever they visited Tucson, and for many attending the Tucson Show in February. Neal Yedlin always spent half a day there in February going through the collection for micromounts.

In his spare time George did other chores, including two years as Executive Secretary of Civil Defense for Southern Arizona; holding a number of offices in the American Legion State and National Organizations; Public Relations Director for The Arizona Portland Cement Company for 20 years until his death; member of the Merit Council of the Arizona Highway Patrol; member of the Board of Directors of Pima Savings and Loan Association; and Legislative Chairman of the Tucson Chamber of Commerce. His watercolor paintings of Arizona scenes are highly prized by the fortunate few who possess them.

George's contributions to the mineral community are many. His "With Pick and Knapsack" columns in the *Brewery Gulch Gazette* were luminous. He supported and promoted the Tucson Gem and Mineral Show and the newer Bisbee Show. His knowledge of Arizona minerals and who had them (and who wanted more) was encyclopedic. Bideaux Minerals served well collectors and dealers alike by furnishing outstanding mineral specimens. And, certainly not least, he encouraged his son Richard to develop his love and knowledge of minerals. Dick Bideaux is now one of this country's most knowledgeable mineral collectors and dealers—a most worthy son of a remarkable father.





# MICROMOUNTING in arizona

by
**Arthur Roe**
3024 E. 6th Street
Tucson, Arizona 85716

The excellent book *Mineralogy of Arizona* by Anthony, Williams, and Bideaux, published in 1977, lists 605 minerals reported from Arizona. Of these, 48 were first discovered in the state. Since that time, more than 30 minerals new to Arizona have been reported, most of them new to science. (These will be included in a supplement to accompany the second printing of the book, scheduled to appear in 1980.) Many of Arizona's minerals contain copper, and many are a delight to the eye. To the micromounter's immense satisfaction, a goodly number of them can still be found on one or more of the thousands of mine and prospect dumps in the state, and in the mine shafts and adits to which safe access can still be had. Sad to say, many of the more accessible localities have been so thoroughly searched that the yield of micromounts per hour of digging (mm/hd) is distressingly low.

This article will tell of Arizona micromount material which has come to light recently. Many of the specimens discussed have either been found or have come out of hiding within the last three or four years, although most of the localities mentioned have been producing specimens for the better part of a century.

First a word about micromounters in Arizona. The largest and most active group, spearheaded by Bill Hunt, is associated with the Arizona Mineralogical Society in Phoenix. A smaller group is part of the Tucson Gem and Mineral Society. Micromount study collections are now being established at both the University of Arizona (Geosciences Department) and the Arizona-Sonora Desert Museum, with the help of the two groups mentioned above (particularly Hunt, Virginia and Marvin Dashler, Robert Mudra, and myself). The University collection now has about 800 mounts, and the Desert Museum 1300 or so, thanks to the recent gift of the Frances Saunders micromount collection by her son. (Additional donated specimens will be gleefully received by both museums, incidentally!)

One cannot hope, in one short article, to mention every new occurrence or every superb Arizona micromineral, but I'll try to hit some of the highlights. One of the most satisfactory localities, which resumed commercial operations in May, 1979, is the Christmas mine in Gila County. It is famous, of course, for *kinoite* (although Helvetia, in Pima County, is the type locality), recently observed in bow-tie specimens, some half-included in apophyllite. The new mineral *ruizite,* a hydrous calcium manganese silicate, occurs in attractive, radiating, tan needles, some on kinoite, and some included in apophyllite (Fig. 1). Christmas mine dioptase is well-known; of late some delightful arborescent sprays of very small needles have been noted; some are included in calcite. *Cuprite* is far from common here, but very small octahedral crystals impaled on dioptase make attractive mounts. Some of these octahedra, less than 0.1 mm on a side, appear to have the measles—even smaller octahedra (?) growing all over the surface. Another new mineral, *whelanite,* occurs in powder-blue needles and thin plates. *Stringhamite* (a hydrous copper calcium silicate), another of the rarish new Christmas mine minerals, forms cornflower-blue intergrown plates on stringy wollastonite. *Junitoite* (a calcium zinc silicate), another rare one from this locality, occurs in white (or rarely purple) platy crystals half a centimeter long. *Xonotlite* is not usually a micromounter's delight, but the Christmas mine has recently produced attractive mounts of creamy white acicular crystals, together with microcrystalline blobs (sorry, but that's what they look like) included in apophyllite, with kinoite adding a bit of color. Some mountable *scawtite* has recently appeared from the Christmas mine, along with some curious *chrysocolla* pseudomorphs.

The Old Yuma mine, in Pima county a few miles northwest of Tucson, still produces elegant micromounts. Within the last two years George Godas brought out some deep orange *vanadinite* and *wulfenite* crystals (Fig. 2), the latter with phantoms of deeper orange; *mimetite* surrounds the crystals. Chris Panczner has supplied some interesting prismatic vanadinite on *palygorskite.*

The Silver Hill mine, in Pima County northwest of Tucson, continues to yield micros of interest from the dumps; *rosasite* balls impaled on quartz; a *cerussite* sixling atop a cluster of encrusted *quartz; libethenite; azurite*—light blue and silky; and *smithsonite* in clear rhombs, conchoidal masses, and milky white, bullet-shaped prisms. One word of caution about Silver Hill rosasite; the University of Arizona collection has some specimens from that locality labeled rosasite. Several of them were X-rayed and, to our astonishment, about a third of them were malachite, although no visible difference among them was noted.

The nearby Silver Bell open pit copper mine, still a vigorous producing property, has given up some delightful *torbernite*—brilliant green plates that slowly turn opaque as they alter to metatorbernite (Fig. 3). Ken Bladh, who found some of the better ones, has kept them in their pristine condition in a vial with moistened cotton. Some interesting acicular groups of *libethenite* (Fig. 4) have recently come out of this mine, as have acceptable mounts of *jarosite, alunite, pseudomalachite,* and *brochantite.* Bladh also found some crystals of a green mineral whose X-ray pattern closely resembles but is not quite identical with turquoise (Lynch Station, Virginia, look out!), and identified a specimen of *leucosphenite* from this locality.

The Silver Bill mine, near Gleeson in Cochise County, has been worked recently by Pete Knudson, Tom Hughes, and others, yielding a rich assortment of *wulfenite* (Fig. 5), *rosasite, smithsonite, aurichalcite, hemimorphite, cerussite,* and other assorted goodies. The aurichalcite is out of this world; one small specimen of it impales small green balls of rosasite. The wulfenite forms clear yellow plates, often having rounded corners. Smithsonite often appears as milk-white, silky, bullet-shaped prisms reminiscent of those found at Silver Hill, and at other times as opaque, slightly curved rhombs. Some small *plattnerite* crystals also appeared one day. About two years ago George Godas found *coronadite* in long thin needles impaling quartz, some completely covered with very small, doubly terminated quartz crystals and others included in larger quartz crystals. Some Silver Bill *hemimorphite* is also spectacular: sugared with quartz; impaling rosasite; etched; and in one case forming a cast of a long-since miss-

*Figure 1.* **Blue kinoite with apophyllite and yellow ruizite from the Christmas mine. Gene Wright specimen, Arthur Roe photo. (45x)**

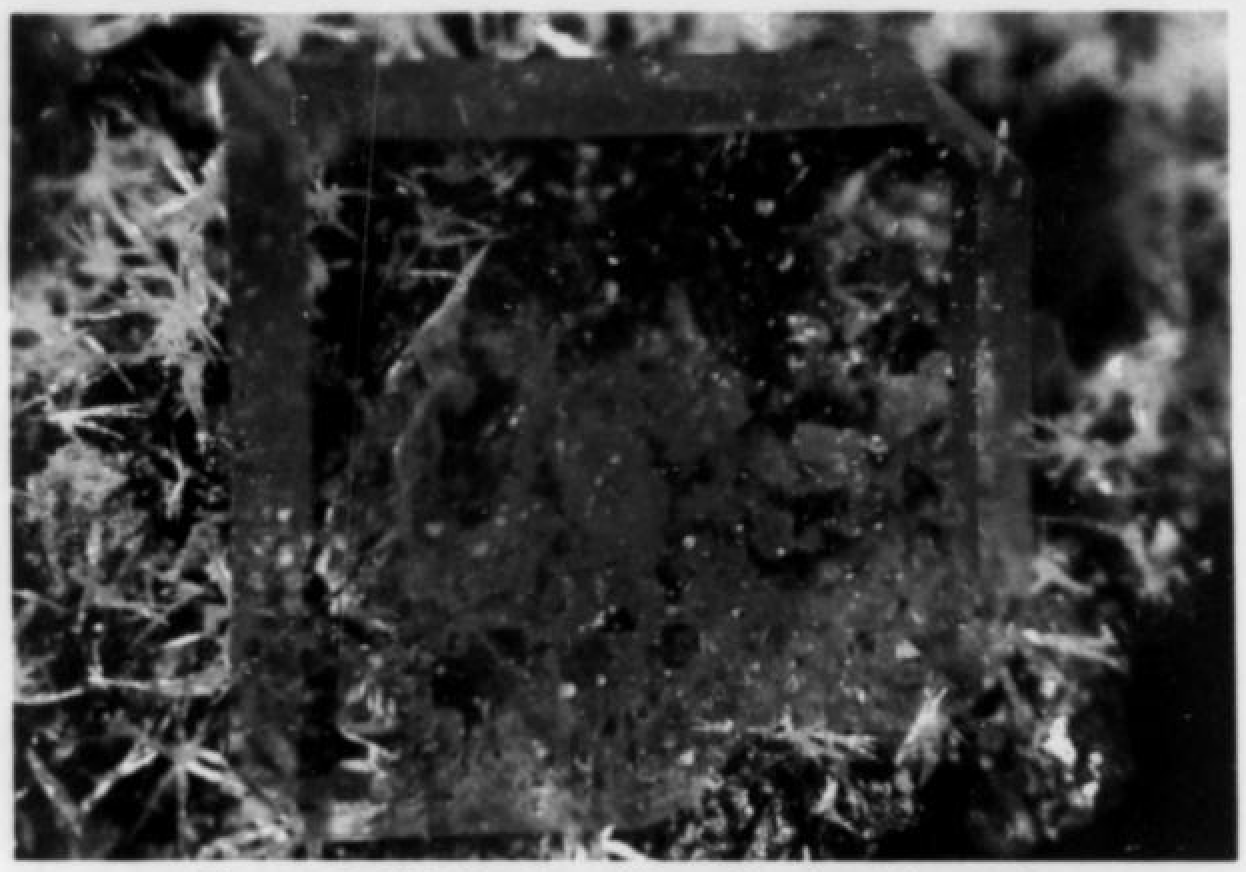


*Figure 2.* **Wulfenite with red mimetite center from the Old Yuma mine, near Tucson. Specimen and photo: Arthur Roe. (35x)**

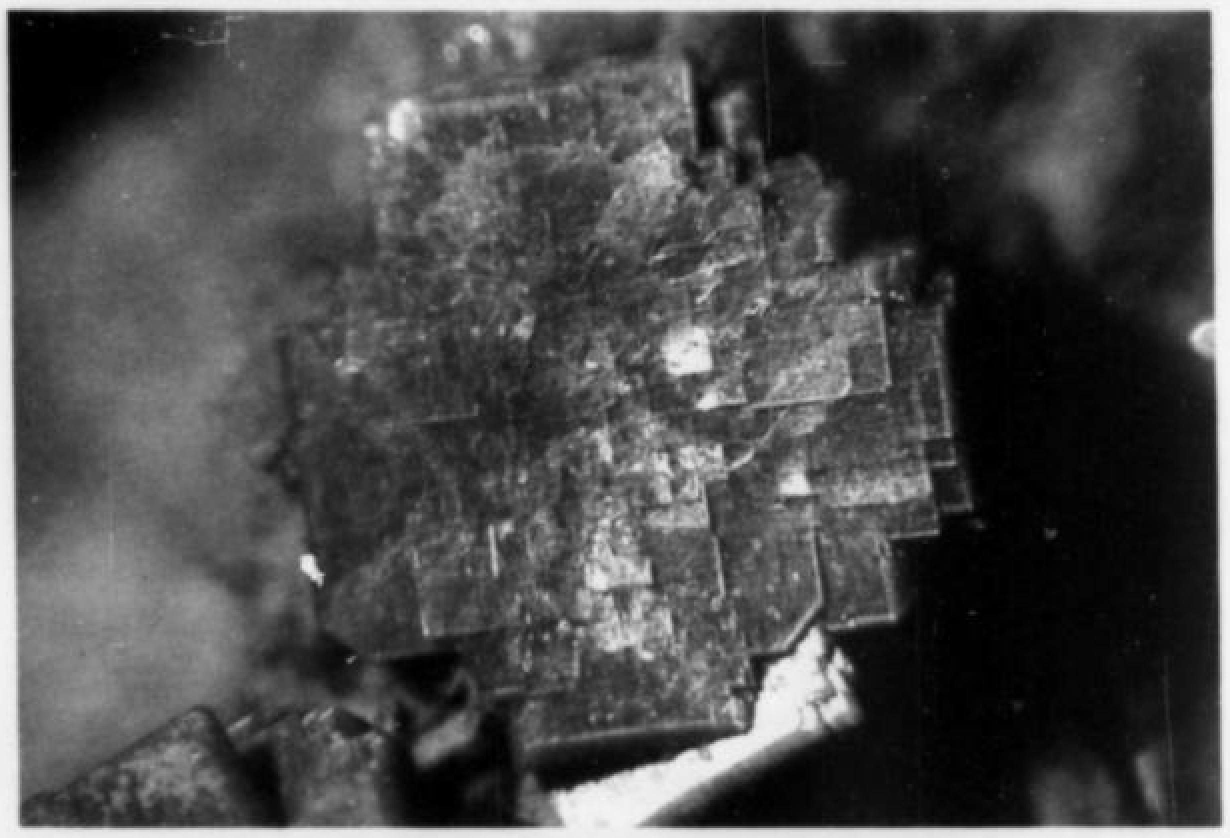


*Figure 3. (center left)* **Torbernite from the Silver Bell mine. Kenneth Bladh specimen, Arthur Roe photo. (19x)**

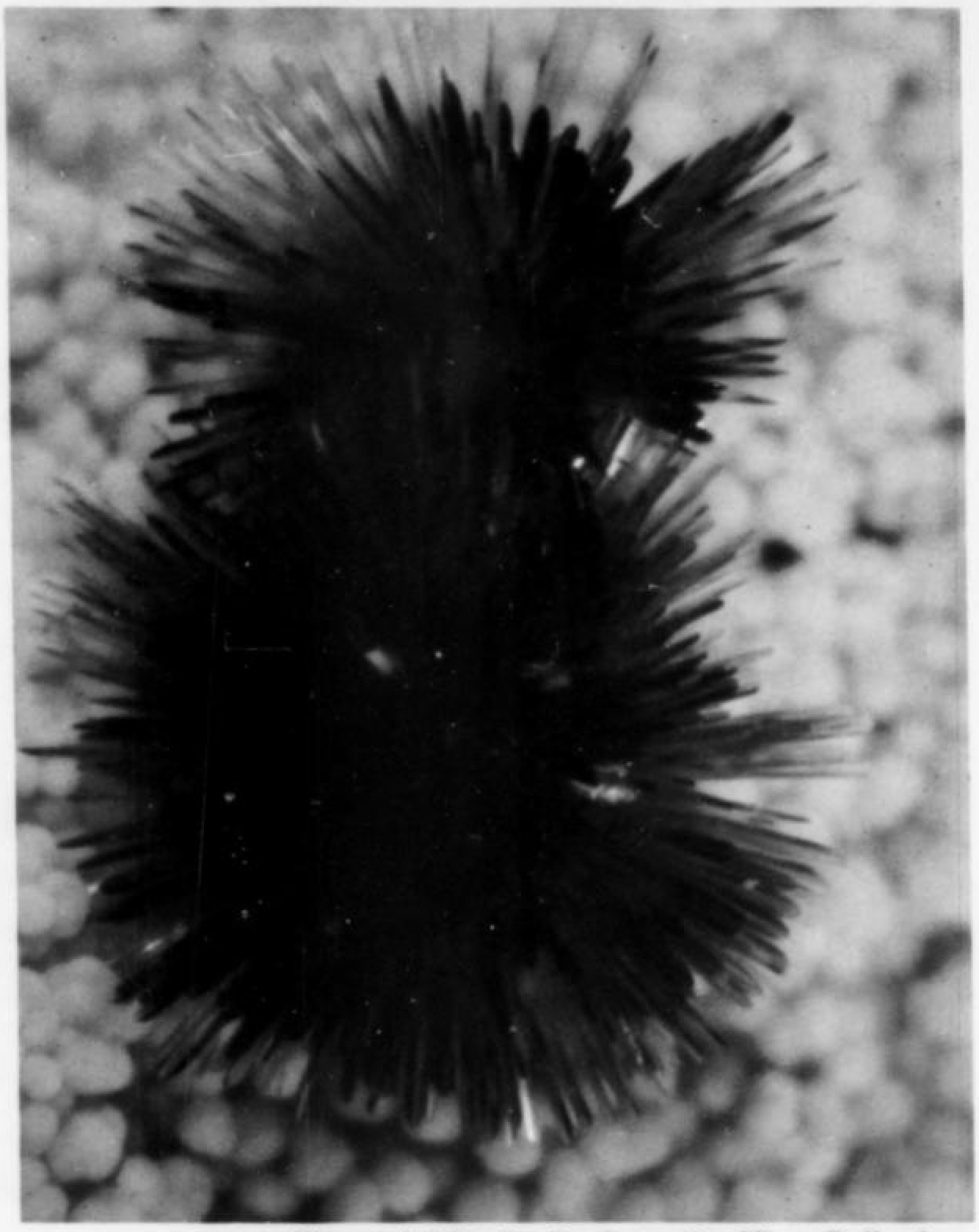


*Figure 4.* **Libethenite from the Silver Bell mine. Specimen and photo: Bill Hunt. (16x)**

*Figure 5.* **Wulfenite from the Silver Bill mine near Gleeson. Specimen and photo: Arthur Roe. (8x)**

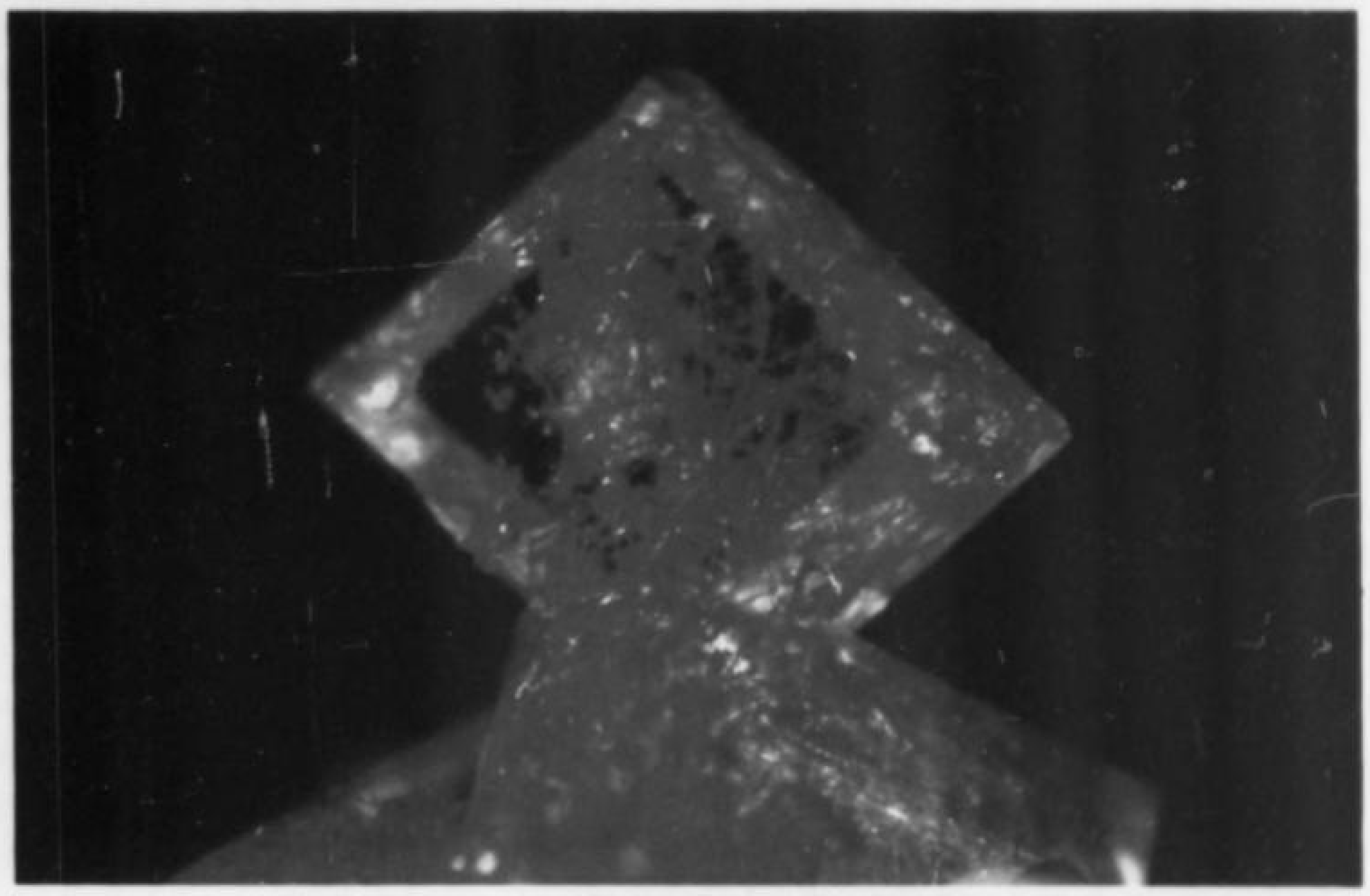
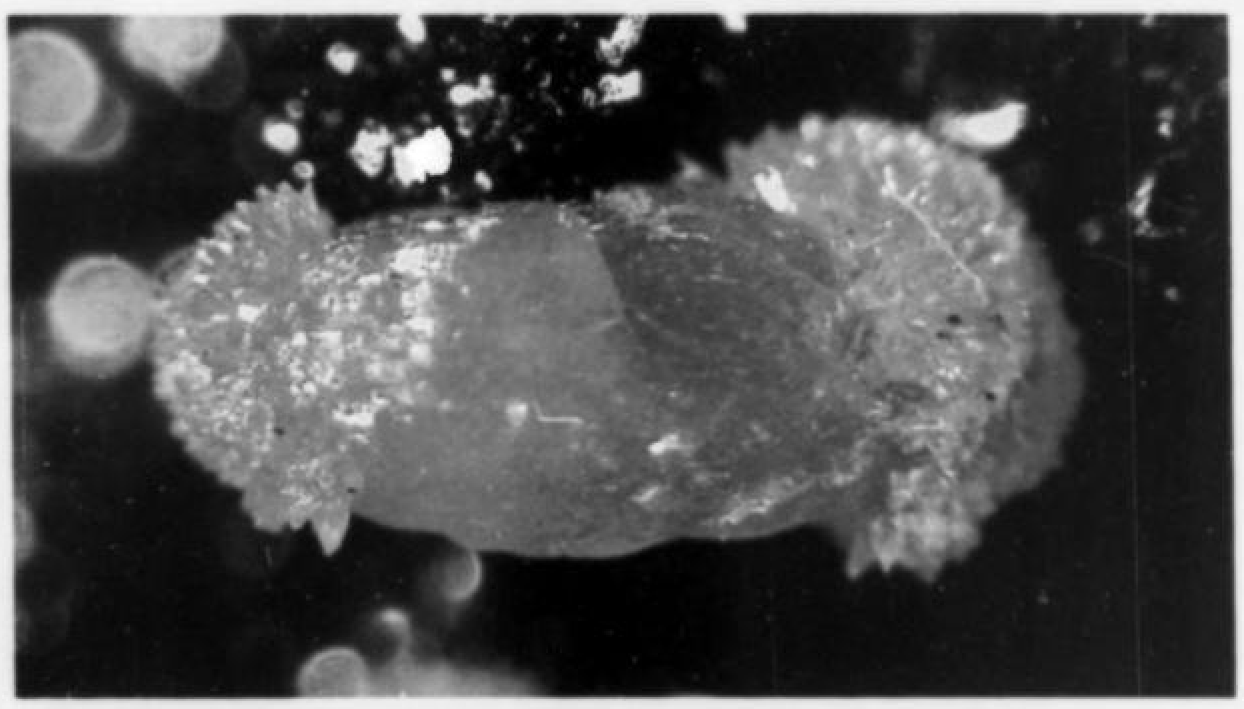


*Figure 9.* **Cuprite needles in gypsum from Ajo. Specimen and photo: Bill Hunt. (12x)**

*Figure 6.* **Blue-green paratacamite and yellow-green creaseyite from Tiger. Frank Valenzuela specimen, Arthur Roe photo. (52x)**



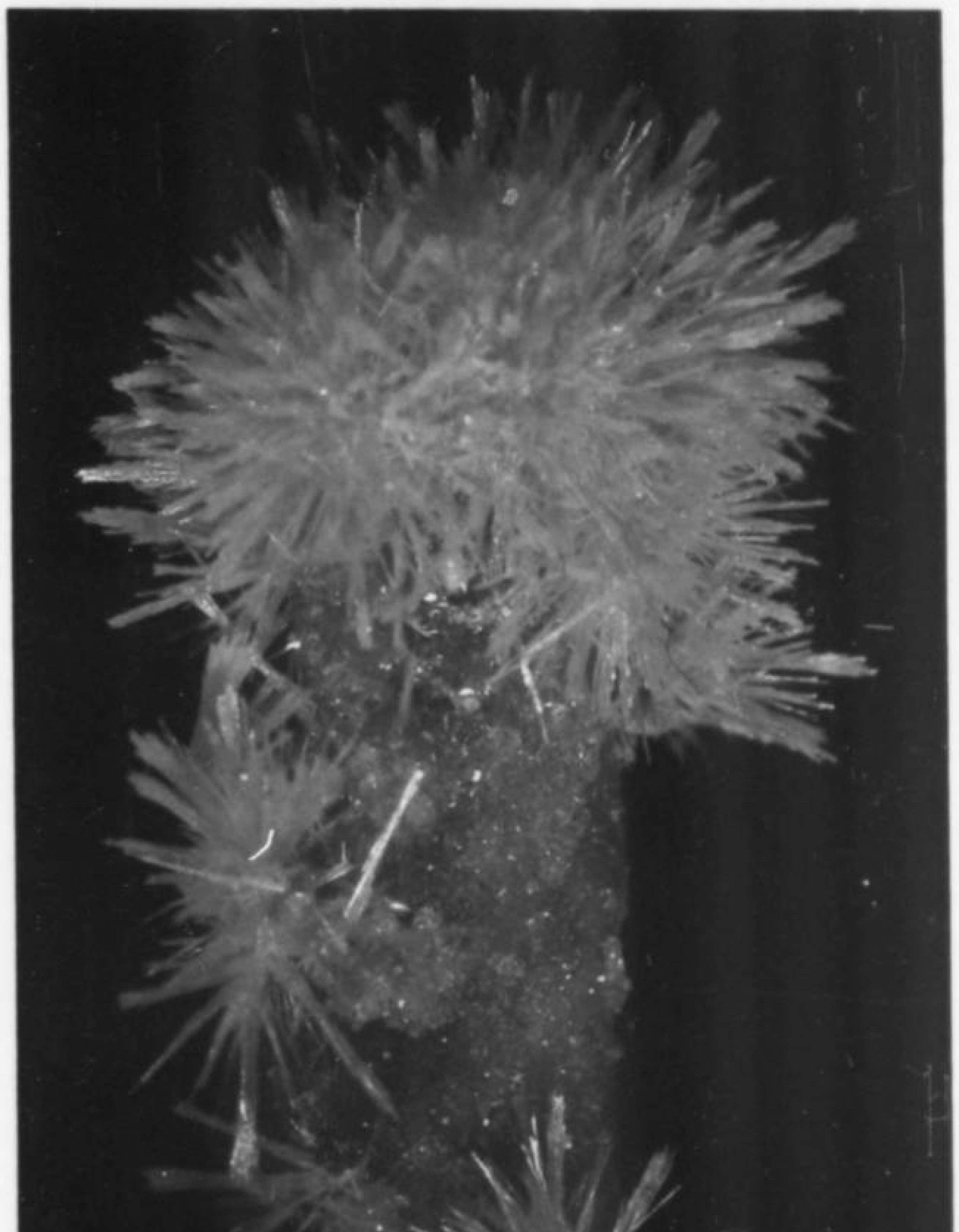


*Figure 10.* **Mimetite on matrix from the Rowley mine. Specimen and photo: Bill Hunt. (5x)**

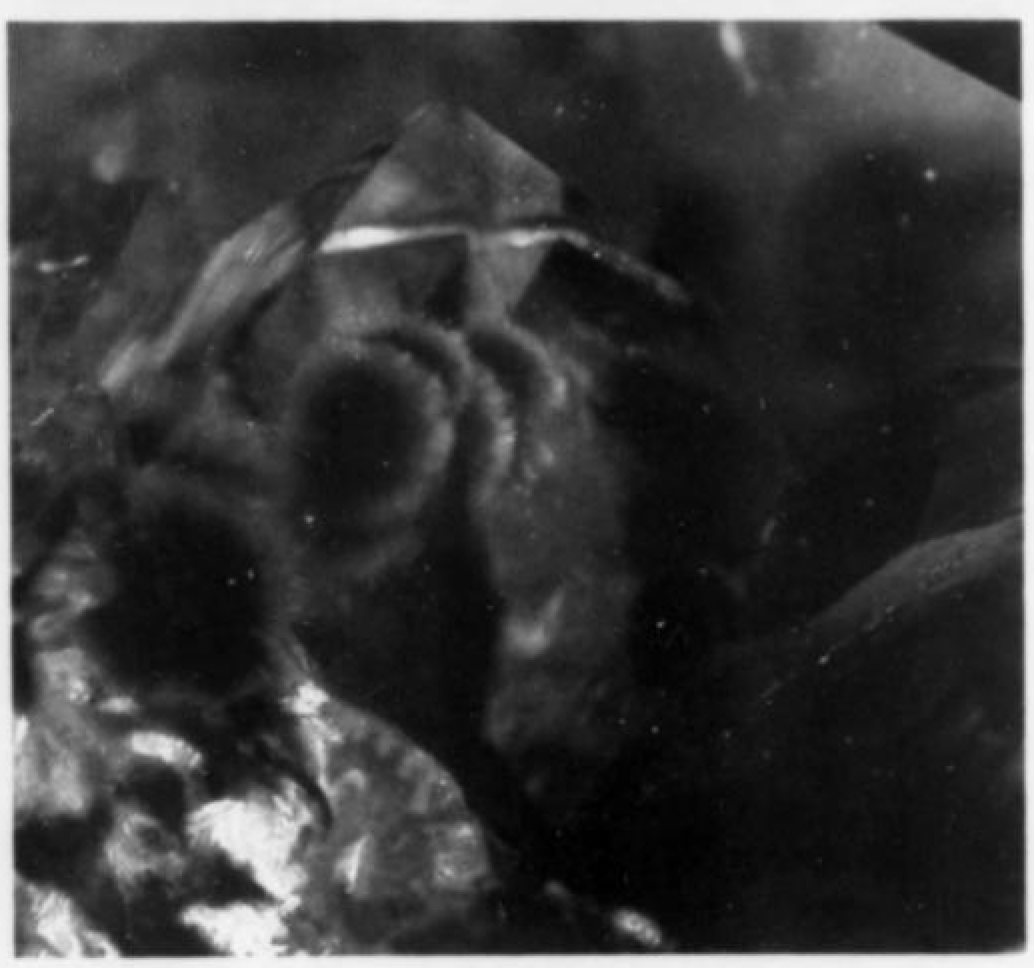


*Figure 7. (center left)* **Pyromorphite on descloizite from the Hardshell mine, Patagonia. Specimen and photo: Arthur Roe. (23x)**

*Figure 8.* **Shattuckite in quartz from the Eagle Eye mine. Specimen and photo: Bill Hunt. (8x)**

ing crystal. A few *chlorargyrite* crystals turn up occasionally.

Another mine above Gleeson—the Defiance—has, over the years, made many a micromounter ecstatic, and continues to do so. *Wulfenite* crystals recently found there are remarkably varied in habit: thin plates; banded; doubly terminated pyramids; pyramids with many terminations on one end ("many-headed"); and blocky caramel-colored ones mimicking those from Los Lamentos. In February, 1977, Herb Corbett and I found some acicular wulfenite on the dump there.

Several other localities have produced acicular *wulfenite;* Bill Hunt and his Phoenix cronies found some at the Great Southern mine in Yavapai County, and Will Wilkerson and Carlos Williams supplied some beautiful ones from the Mineral Park mine in Mohave County. I recently acquired the small H. S. Kiethly micromount collection, and found therein some unidentified, yellow, spear-like specimens from the Vulture mine near Wickenburg which turned out to be acicular wulfenite. There is a rumor that some have been found at Tiger, but so far these specimens have not come to the eye of this observer. (Paul Desautels tells me they have also been found at St. Hilaire, and in Russia.)

The Mineral Park mine, in addition to acicular wulfenite, has furnished some small but spectacular radiating spheres of *wavellite* on *copper.* Some other wavellite crystals there are 3 to 4 mm long and very well developed. Other wavellite, opaque white balls, sports *molybdenite* on the surface. Some orange *mimetite* with frizzly terminations have recently been captured and mounted.

All the mines in and near Bisbee are closed, the last operation there having terminated in 1975. One can still visit the Copper Queen and the Lavendar pit, however, thanks to tours conducted by miners formerly employed in the mines. No micros—or any specimens for that matter—are available inside the Copper Queen on the tours, although the dump outside the entrance (and up the stairs) yielded a few *malachite* and *azurite* specimens the last time I was there. Lots of old Bisbee material is still around in mineral shops and collector's basements, however. Bill Hunt provided some spectacular (and rare!) orange-yellow pyramidal *wulfenite* from Bisbee. An old *connellite* specimen from the University of Arizona's collection yielded micro connellite sprays on *cuprite,* some with well-formed *spangolite* nearby. Other Bisbee standbys recently obtained are: *azurite; malachite; malachite pseudomorphs after cuprite and azurite; cuprite* cubes, octahedra and dodecahedra and all combinations thereof; *chalcoalumite; quartz;* and many others.

Interesting things are happening at Tiger; an open pit is being dug at the site of the old Mammoth-St. Anthony mine. The (poor quality) amethystine *quartz* is being used as a flux at the nearby San Manuel smelter, and some *gold* is being recovered from it. So far no spectacular mineral finds have been made, for the pit is still too shallow to intercept the principal ore veins. We can hope, however! Frank Valenzuela, a long-time Tiger collector, found some *paratacamite* in the new diggings, together with sprays of fine yellow fibers of *creaseyite* (Fig. 6). Frank also found some spectacular *heulandite* on wormy blue-green *chrysocolla. Cerussite, caledonite, dioptase, mimetite, vanadinite, wulfenite, willemite,* and other Tiger standbys have also been unearthed recently.

Material from Tiger in the University of Arizona's collection showed some *vanadinite* altering to *descloizite* in the shape of an indistinct face cloaked in a hood. The yellowish material in the "face" gave a vanadinite X-ray pattern, and the irregularly hexagonal outer hood is brown *descloizite.*

Apparently very few mineral specimens are emerging from the nearby San Manuel mine because of the nature of the mining operation.

To jump to the western part of the state for a moment, the Silver district is still there for anyone with a four-wheel drive, a compass, and the courage (or foolhardiness) to explore the various underground workings. We have recently seen several flats of micros—*wulfenite, mimetite, cerussite, fluorite,* and other desirables from the Red Cloud mine (see the article in the previous issue), but that famous locality is now being commercially operated and is off-limits to collectors. Other neighboring dumps, including the Hamburg mine, have yielded additional specimens of essentially the same minerals.

Some localities in Arizona are reached easily, some with difficulty, and some only by the grace of God. Among the latter is the Table Mountain mine, only a few air miles (but a thousand or so by four-wheel) east of Mammoth. The road(?) apparently follows an earlier trail laid out by a drunken prospector chasing a wary goat up the hill. Once there, however (if you can forget that you have to go home by that same route), the findings are excellent: *dioptase* sprays abound; *willemite* (a few with nice phantoms); *duftite;* suspected *pseudomalachite; conichalcite; malachite;* and *plancheite* make the ride home easier. Just before we left, Pete Knudson, our chauffeur that memorable day, took a mighty whack at the large boulder I had been sitting on the last few minutes, thereby exposing the best find of the day, a glorious series of sprays of *dioptase* in a four-inch vug. I tried to claim it by virtue of squatter's rights, but the vote of the assembled multitude was three to one against me.

On the way home from Table Mountain we could have collected at the Copper Creek locality, notable for its Japan-law twinned *quartz* (some micro), *libethenite,* and other copper minerals. The quartz locality was pointed out by Knudson—a pinnacle south of the road, different from the other pinnacles by virtue of a ruminating black cow half way up the mound. (I hope it hasn't moved by the next time I go there.)

The Harquahala mine, in Yuma County, is not too difficult of access; Bill Hunt, Herb Corbett, Dick Thomssen and I visited it in February of 1977. The dumps were good though not overly productive, but a small existing trench was extended out and down and produced excellent *pseudomalachite, malachite, hematite, needle-like green pseudomorphs of whattheheckite,* and other associated minerals. There is said to have been much blasting since then, but micros still can be found.

A mile or so below Horseshoe Dam in Maricopa County is a wondrous zeolite locality. Bill Hunt led an eager group to the locality last year, and the digging, or rather the pounding, was most productive. The prize find, to my mind, was *herschelite* in milk-colored hexagons, some of them included in *analcime.* There were also flat *apophyllite* crystals; pink *phillipsite* in rounded aggregates; *gismondine; analcime; gmelinite; celadonite; chlorite*—altogether a most satisfactory locality. Three other accessible zeolite localities are the Malpais Hills, north of Mammoth (Millie and Bill Schupp have led successful expeditions to this locality, when the San Pedro River is low); a locality about six and a half miles below Superior on Route 177; and a road cut about three miles north of Clifton on the east side of the San Francisco River. This locality boasts *clinoptilolite, erionite, chabazite, levyne,* and *phillipsite,* among others.

The Tonopah-Belmont mine in Maricopa County produces an abundance of excellent micromounts. Among those we recently toted home are: *linarite; hemimorphite; cerussite; willemite;* octahedral *murdochite; pyromorphite; caledonite; brochantite;* and pseudomorphs of *minimum* after cerussite.

The McCracken mine, now covered (alas!), with 200 feet of road fill, has produced superb *fluorite,* some triumphantly impaled on *hemimorphite; willemite;* and *plattnerite.*

A few miscellaneous observations. A recent Tucson Gem and Mineral Society trip to the Twin Buttes open pit south of Tucson brought to light some nice hexagonal *calcite*—one of them almost small enough for a micromount. (I mounted it; it showed phantoms as well!); and some *apatite* (first time reported from there) on *barite* with phantoms. A new find of *copper in gypsum* from the neighboring Mission mine has excited interest. *Calciovolborthite* in good crystals has been found in the Copper Queen No. 9 mine in Yuma County. Spectacular *aurichalcite* is still coming out of the 79 mine near Hayden. Silky *mimetite* is being found at the Indiana-Arizona property, over the hill and east of the Silver Hill mine. Frances X. Sousa has found a few specimens of *chalcomenite* in Middlemarch Canyon, in the central Dragoon Mountains east of Pierce. Sidney Williams has unearthed a number of new tellurium minerals from the Tombstone area, and is busily characterizing them. Three of them, khinite, parakhinite, and dugganite, were reported last year. The Hardshell mine, near Patagonia, is producing good *pyromorphite* (Fig. 7), *descloizite,* and *mimetite* (Frances Sousa). The Grand Reef mine still has *linarite, caledonite, brochantite,* and *cerussite,* and recently has produced micro *silver* and clear yellow *mimetite* (Frank Valenzuela). The Ray mine is a recent source of superb twisted *copper, cuprite (chalcotrichite)* latticeworks on chrysocolla, *Libethenite,* and *chrysocolla* pseudomorphs.

Other recent finds include *chenevixite* from Alum Gulch near Patagonia; gorgeous *mimetite* from the Joker mine; *cornetite* again found at Saginaw Hill just southwest of Tucson (George Balfe); *gold* from the Dos Cabezos Mountains near Willcox; excellent *brochantite* from a prospect near Courtland, Cochise County (John Anthony); *azurite* perilously impaled on *malachite* from Morenci; good *cerussite* from the Flux mine; *fluorite* straddling *wulfenite* edges from the Rowley mine; zoned *vanadinite* from the Apache; dodecahedral *magnetite* from the Tucson mountains (Bill Devitt); and *carnotite* from the Anderson mine. Some alleged green "olivenite" from Ajo (given by Dick Graeme to Gene Wright, thence to yours truly) surprisingly turned out (by X-ray) to be *conichalcite;* some is included in barite. *Fornacite* has been supplied from the Tonopah-Belmont, Moon Anchor, Rawhide, and Eagle Eye mines. *Stilpnomelane*—apparently a new mineral for Arizona—was Bill Hunted from the Binghampton mine in Yavapai County. *Hemihedrite* had been reported at the Potter-Cramer and Rat Tail Claims in Maricopa County, and *wickenburgite* still inhabits the Potter-Cramer claim. *Rodalquilarite* has appeared at the Joe shaft near Tombstone.

No story of recent Arizona micromounts and the discovery thereof would be complete without mentioning the Amazon Wash, north of Wickenburg. The omnipresent Bill Hunt led a party to the locality to explore the many small prospects which dot the hillside. We came away with many excellent and unusual specimens including: yellow-capped orange *vanadinite* included in perfect quartz; *minium; jamesonite; barite; fornacite; phoenicochroite; hemihedrite;* and last but not least, some bright orange hexagonal crystals which fluoresce brilliantly in sunlight (but not in ultraviolet). Chemically, they appear to be mimetite, and the cause of the fluorescence is under investigation. One of the party got one thing more; the deepest of the shafts was dubbed the Broken Finger mine because John Anthony slipped on the dump and dislocated one of his very best fingers!

As you can see, there are lots more micros to be found in Arizona, but you'll have to furnish your own fingers to dislocate. Come and get 'em!

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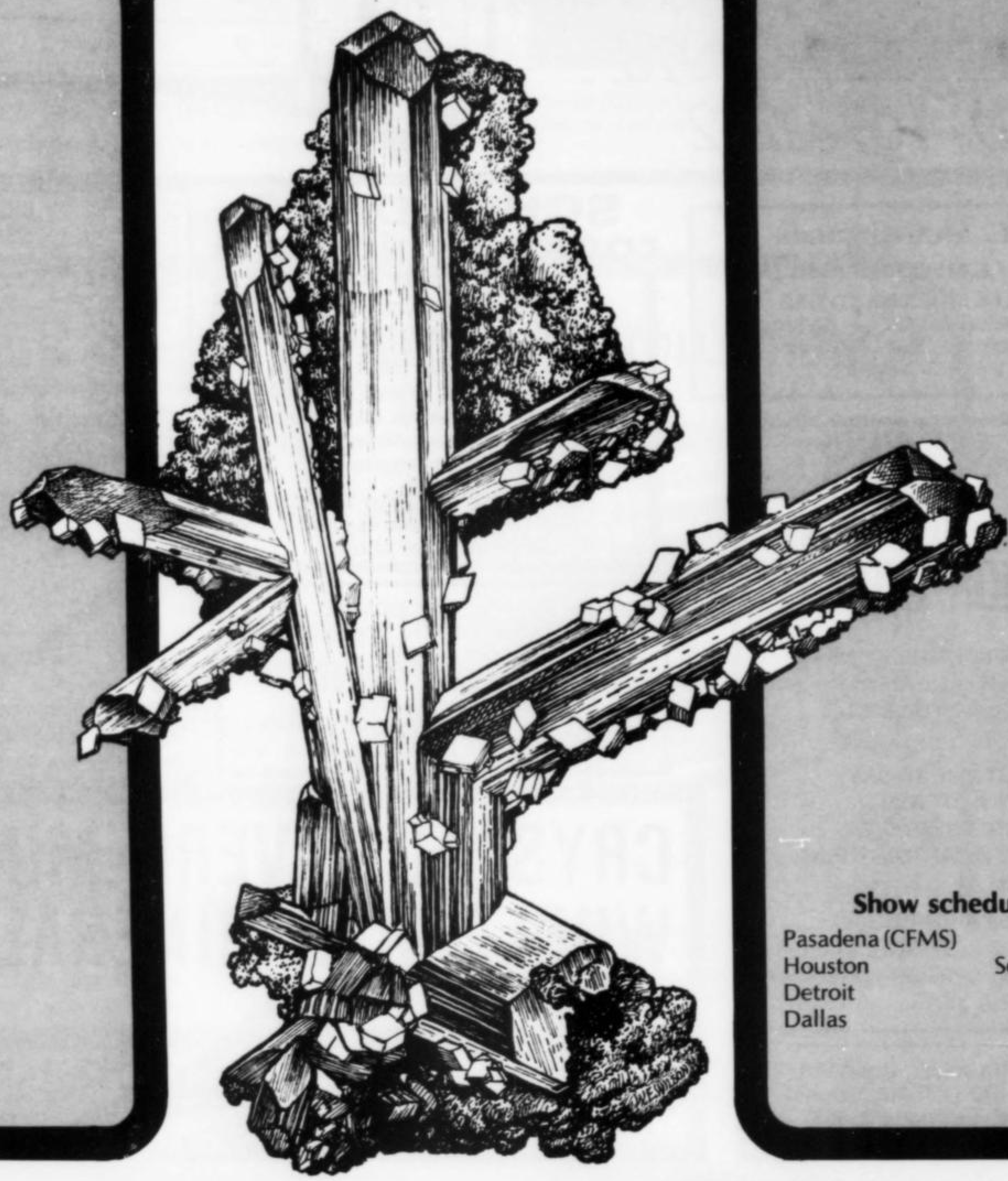

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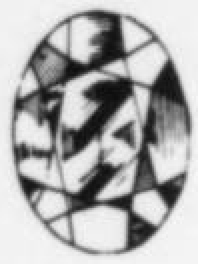

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