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*Continued on p. 287

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Articles

Departments

COVER: "AMAZONITE" MICROCLINE with smoky quartz from Lake George, Colorado, collected by Clarence Coil in 1976 and now in the Denver Museum of Natural History collection. Size: 13 cm. Photo by Harold and Erica Van Pelt, Los Angeles. Our cover photo is also on this year's Denver Show poster, as shown at left.

Guest Editorial:

THE PRESERVATION OF TYPE MINERAL SPECIMENS

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This editorial focuses on the new formal definitions of type mineral specimens published in this issue on the pages immediately following. These new definitions were approved by the Commission on New Minerals and Mineral Names, and the Commission on Museums, of the International Mineralogical Association, and they supercede those suggested by Embrey and Hey in 1970 in their fine and stimulating discussion (*Mineralogical Record,* **1**, 102–104). It is our view that *all* the available type material should be preserved in professionally curated institutions.

A unique activity has arisen in the mineral collector and dealer communities in the last decade, and has been increasing of late. This activity is the dealing in, and collecting of, type mineral specimens, both real and purported. It is not a new matter; collectors have had such materials in the past, but present practices have worsened matters considerably. The problem has arisen as a result of natural instincts. Most appealing to the collector are specimens which have some special uniqueness, such as rarity or pedigree, and are objects of envy. The collector, frequently wanting to own a "most-special" specimen, has been tempted to acquire one of these purported "types" if he can. Some in the commercial community, seeing a potential market, have sought to fill the requests: a normal business reaction. They in turn have been tempting uninformed scientists to sell or trade such specimens. The validity of what has been traded and sold as "type" material is questionable: some specimens *might* be type material; most likely are not. There has been a lot of sloppiness with the use of the word "type." Some of it has been innocent; some not. Where currency and specimens change hands, honor is sometimes left behind. We are well aware that the vast majority of mineral dealers are reputable and honest businessmen, but we are compelled to address behavior detrimental to the science, even if it's from a small minority.

The problem has not been wholly with those who seek to acquire such specimens; scientists share equally in the responsibility. It should be noted that if the mineral scientists who describe new species, and the curators having responsibility for what is in their hands, refuse to provide any type material to dealers or private collectors the problem would be solved. Clearly, the solution to this problem requires help from all parties.

The scientific community has some additional responsibilities in this matter, and they have not been well attended to in the past. These responsibilities are:

(a) an obligation to define the terms used for such specimens,

(b) an obligation to see to it that scientists deposit such material in non-private, institutional repositories to safeguard it, and,

(c) an obligation to educate collectors, dealers, and scientists about the importance of these minerals being held *only for science*.

The first and second of these obligations is met in this issue and in professional journals in which we present the new formal definitions and criteria for type specimens. The third obligation is the purpose of this guest editorial.

True type mineral specimens, *i.e.*, those used in the original description of a mineral species, are of fundamental importance. They are proof of the species' existence and provide future researchers with authentic material for further studies. We should all be aware that no mineralogical study is the final one. As new techniques are made available, we search for more and newer kinds of information. The type specimens are the *standards* for our science; they must be carefully guarded and preserved.

Major and minor public collections owe much to the mineral collector. The authors recognize this fact, encourage collectors, and do not wish to seem too critical. Yet it is necessary to influence the collecting urge, when it conflicts with the best interests of our science of mineralogy. The active collecting of type specimens by private individuals harms the science, and must be discouraged. Collectors, too, owe a great deal to professional mineralogists, many of whom give of their time and expertise in teaching, lecturing, writing articles, and providing general encouragement.

Much as it is important that people not destroy specimens (*Mineralogical Record,* **17**, 226), it is likewise important that collectors and dealers not compete for the very few which are *critical* to science.

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**Chairman, Commission on New Minerals and Mineral Names, International Mineralogical Association.

Yes, we *are* suggesting that some specimens be "off-limits" to collectors; adopting this suggestion is the most responsible, voluntary action that collectors and dealers can take. The science really needs the cooperation of the collecting fraternity in this area in which a good and positive influence can be effective and of value to us all.

It is asking a lot to expect collectors to stop acquiring type material without providing a rationale for doing so. We have two good reasons for doing so: (1) **Types are the *most important specimens* in the science.** That is an unqualified assertion, and a *critical* one. Type specimens belong *only* in repositories where they are safeguarded by formal policy and professional curatorial practices. And (2), in private hands there are no constraints, and the possibility for abuse and innocent, whimsical, or irresponsible distribution or subdivision, or loss is ever-present.

Type specimens in private hands cannot later be confirmed as types by *any* analytical technique or any technique whatsoever because it is the types themselves which must serve as standards against which all other specimens are verified by comparison. Consequently, their scientific value relies on ironclad guarantees of authenticity by professional curating. We recommend that those purported "type" specimens which have passed into private hands be considered tainted, to have highly questionable pedigree, and to have lost their integrity for scientific purposes. This is recommended because accidents or the motives of acquisitiveness and profit might conceivably compromise the integrity of the specimens, and because scientists are unable to determine later which of the purported types are genuine and which are not. These privately owned specimens have lost their integrity for scientific purposes.

Type specimens that are deposited in professionally curated public institutions are usually given special care and different rules apply to them than to ordinary mineral specimens. Removal or dispersal of type material from professionally curated public institutions must be discouraged by every means possible. Curators should never dispose of type material unless it is done to ensure that all of the type specimens of a given species are not kept in one place to safeguard against local disasters. Even then, if possible, more than one curator should be involved in the decision process. Such distributions should be made only to other suitable repositories. New or inexperienced curators should be instructed that **type specimens are sacrosanct and *not* available for exchange under any circumstances whatsoever.**

In summary, we appeal to collectors, curators, dealers, and scientists to end the trade (commercial and otherwise) in purported type mineral specimens. We urge people to be highly critical of those who would endanger the science of mineralogy by such trade. There are *millions* of specimens out there, but we are asking that only a miniscule portion be set aside and unconditionally reserved for science. This is an easy way for everyone to make a very positive contribution to the protection of the science of mineralogy.

FORMAL DEFINITIONS OF TYPE MINERAL SPECIMENS

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INTRODUCTION

Type mineral specimens are reference samples for the definition of mineral species. The biological sciences have a long-established system of type specimens, but the formal designation of such samples is a relatively recent matter in mineralogy. Indeed, for a vast number of minerals, some first discovered in antiquity, and many others as recently as this century, there exist no type specimens at all. In many such cases, the best available information comes from designations such as "original material" on museum catalogues, and on some old labels. Interpretations of labels, however, even if they are in the handwriting of the original describer, should always be treated with utmost caution.

Embrey and Hey (1970) provided a thoughtful discussion of the problems associated with type specimens, and the practices of our colleagues in the biological sciences, and proposed an argument for distinguishing seven kinds of type specimens. We recommend a reading of their text for a perspective on the matter.

The effort of Embrey and Hey (1970), intended as a discussion

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paper, did much to generate informal debate and discussion within the curatorial community and the mineralogical world in general. Some of the type designations suggested by Embrey and Hey (holotype, cotype, and neotype) were rather widely accepted. The Commission on Museums (COM) had (circa 1976–78) adopted, in part, these definitions as the background basis for the COM project on the listing of type specimens. Unfortunately, in the compilation of data for this project, only a few curators used this suggested nomenclature. The lack of formal, rigorous definitions, and the absence of international adoption, or even the sanction of professional societies, made use of these terms inconsistent at best, and contradictory at worst.

Accordingly, the definitions presented here were drafted and circulated to the Commission on New Minerals and Mineral Names, I.M.A., and to the Commission on Museums, I.M.A., for discussion and consideration. After a review period, they were revised, and recirculated to both Commissions for formal voting. The following statements and definitions, in italics, were approved by both Commissions:

NOMENCLATURE DESIGNATIONS FOR TYPE MINERAL SPECIMENS

The following kinds of type specimens are those accepted and approved by the Commission on New Minerals and Mineral Names and the Commission on Museums of the International Mineralogical Association. It is emphasized that the designation of type material of a mineral species is the responsibility of the senior author of the original description of that species. In the case of "old" species for which no types were designated by the senior author, qualified, tentative designations may be given by the curator(s) having custody of the originally studied material. It is most important in cases such as this, *that the curator acts with the utmost responsibility and caution. If there is any doubt that certain material represents the material originally described, no type designation should be conferred. Curatorial designations are not binding on the Commissions; they may be revised if controversy requires their review. In such cases, review will be by the Commission on Museums, I.M.A.*

DEFINITIONS

Holotype: *A single specimen (designated by the author) from which* all the data *for the original description were obtained. Where portions of such a specimen have been sent to other museums for preservation,* the author *will designate each of these as "part of the holotype."*

Cotype: *Specimens (designated by the author) as those used to obtain quantitative data for the original description. Specimens examined only visually should* not *be considered cotypes.*

Neotype: *A specimen chosen by the author of a redefinition or reexamination of a species to represent the species when the holotype or cotypes cannot be found. It must be shown that every attempt has been made to locate the originally described material. Neotypes can also be designated when* examination *of all holotypes and cotypes has shown that the definitive unit cell parameters and chemical composition cannot be experimentally determined. All neotypes require the approval of the Commission on New Minerals and Mineral Names of the International Mineralogical Association.*

Both holotypes and cotypes are possible, and even advantageous, for a mineral species. The use of "holo" here is to indicate all of the necessary data *were obtained from the holotype specimen. If the author of a new mineral description chooses to designate additional samples as cotypes, this is permissible. Such cotypes are designated only if they were used to obtain* quantitative, *but not necessary, data. Thus, a mineral species may be represented by a holotype and one or more cotypes and/or neotypes.*

DISCUSSION

We present some examples to illustrate these definitions:

Mineral-A was described in such a manner that *all the necessary data* were obtained from one specimen; that specimen is the holotype.

Mineral-B could be defined only if more than a single specimen were used to provide the *necessary* quantitative data. These specimens are cotypes and there is no holotype.

Mineral-C was defined by data derived from a single specimen which is, of course, the holotype. If additional data which were not *necessary to define* the species were obtained from other specimens, these additional specimens are cotypes. These cotypes might have provided data to indicate the variability of the chemical, optical, crystallographic or other data for the species.

Mineral-D required redefinition, but none of the original type material could be found. In such cases, a neotype specimen may be designated by an investigator, but only with approval of the Commission on New Minerals and Mineral Names, I.M.A.

Investigators are encouraged to deposits all type specimens in nonprivate, institutional, professionally-curated, research-oriented museums, and to clearly designate the type status of each specimen, using the definitions presented here. It is the responsibility of the scientist to deposit such material directly to the museum, with appropriate supporting documentation. To maintain the guarantee of authenticity, type specimens should never be handled or owned by non-scientists.

REFERENCE

EMBREY, P. G., and HEY, M. H. (1970) Type specimens in mineralogy. *Mineralogical Record*, **1**, 102–104.

famous mineral localities:

THE ICHINOKAWA MINE

Japan

●

Peter Bancroft
3538 Oak Cliff Dr.
Fallbrook, California 92028

Enormous stibnite crystals, universally considered to be the world's best, were discovered in the Ichinokawa mine more than a hundred years ago. Though collected only briefly during the 1870's and 1880's, giant stibnite crystals from this single deposit are displayed in public and private mineral collections throughout the world. Even today Ichinokawa stibnite crystals head the list of Japanese minerals most desired by foreign mineral collectors.

LOCATION

The Ichinokawa mine is located approximately 7 kilometers east of Saijo, a modern mid-sized city on Shikoku Island in Japan's Ehime prefecture (formerly Iyo Province). Many Ichinokawa stibnite crystals are identified by labels listing the origin simply as Iyo. This is correct only if the reference is to Iyo Province. The city of Iyo is approximately 50 km southwest of the Ichinokawa mine and has no connection whatsoever with the mine.

HISTORY

Antimony (*shirome*) from Iyo Province was known as early as 698 A.D. when it was presented to Emperor Monmu. In the year 749 the Great Buddha of Nara was cast with 227 tons of copper and 4 tons of antimony (in lieu of tin)—the antimony presumably came from Iyo Province.

Ancient Japanese documents reportedly refer to men from Kurdara in central Korea as performing mining tasks at Ichinokawa in the earliest days. Later antimony mining was by *Kanazumi* (Japanese miners). Early attempts to remove antimony ore from this area were probably made from surface operations which yielded relatively small amounts of metal. These references indicate the Ichinokawa deposit was actually worked as early as the seventh century A.D. The oldest authenticated stibnite crystal from the Ichinokawa deposit was in the collection of Kiuchi Sekitei and is mentioned in his book *Unkon-shi* (1773).

It isn't until 1679 that records again refer to the mining of antimony at Ichinokawa, this time on a large scale. In that year Sogabe Chikanobu "discovered" *shirome* on his land and began to develop the deposit as a full-fledged mine. Throughout the next 70 years the Sogabe family opened eleven sections with mine crews averaging 20 workers. Great difficulty was experienced in refining the ore, and fluctuations in the price of antimony forced the mine to close. The mine reopened in 1841 with the Komatsu clan in charge.

During the Meiji Period (1876–1905) the Ichinokawa mine expanded its operations until it was one of the largest metal mines in Japan. As the value of antimony increased the mine prospered but it was also beset with troubles. Fortune-seeking prospectors paid little attention to mine boundaries and tried to establish their own claim on Ichinokawa land. Claim disputes lasted for more than ten years and the problem was so serious that this period was referred to as "the time of mine strife" (*Oyama-sōdō*). In 1890 the *Oyama-sōdō* was resolved when local residents formed a commission of about 50 directors to manage the mine.

The Ichinokawa mine's "first golden age" occurred in the years 1882–1897. It was then that the richest veins were developed. An average of 1831 tons of stibnite was mined each year by a mine crew numbering 1000 men and women. Antimony refineries were built at nearby Doba and Kitahama. It was during this time that most of the famous Japanese stibnite specimens were collected. The second golden age occurred during World War I when 200 workers were employed. New antimony veins were discovered which produced some small stibnite crystals but none like the great crystals of former years. A hydroelectric power house and an ore dressing plant were built at Gomahara to handle increased ore production.

The Ichinokawa became known as a "war mine" (*sensō-kōzan*)

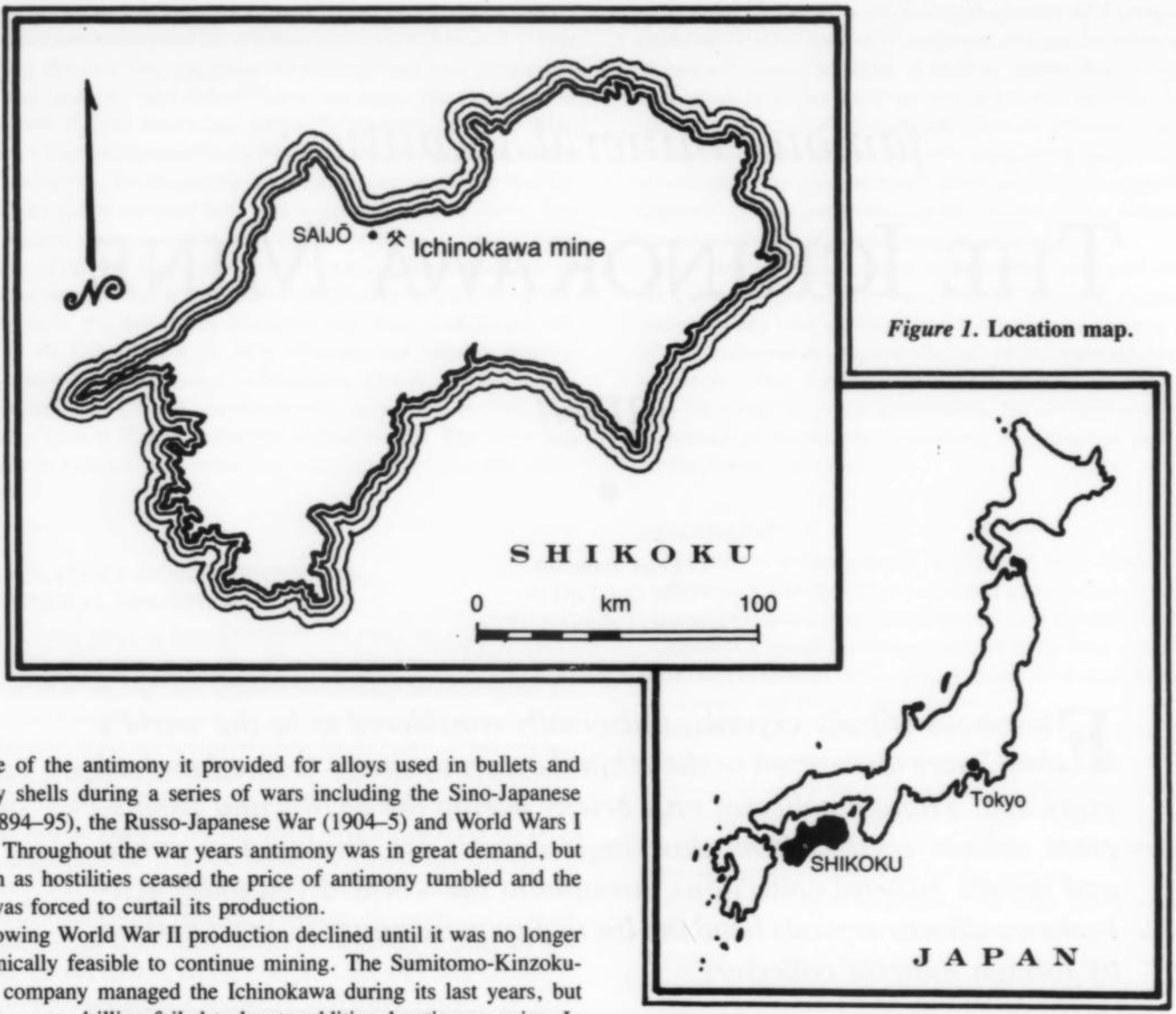


Figure 1. **Location map.**

because of the antimony it provided for alloys used in bullets and artillery shells during a series of wars including the Sino-Japanese War (1894–95), the Russo-Japanese War (1904–5) and World Wars I and II. Throughout the war years antimony was in great demand, but as soon as hostilities ceased the price of antimony tumbled and the mine was forced to curtail its production.

Following World War II production declined until it was no longer economically feasible to continue mining. The Sumitomo-Kinzoku-Kōzan company managed the Ichinokawa during its last years, but extensive core drilling failed to locate additional antimony veins. In 1957 a mine spokesman announced "the mine is finished."

Pumps and machinery were pulled, portals were sealed with cement and every remnant of Ichinokawa village, where once 1000 miners and their families lived, was hauled away. The mountain was replanted with trees and shrubs. Only the little elementary school remains as a caretaker's home. One room was set aside as a mine museum dedicated to Ichinokawa's 300 years as Japan's greatest antimony mine.

GEOLOGY

The mines at Ichinokawa straddle the Median Tectonic Line, southwest Japan's greatest fault system. Within the mine area the Median Tectonic Line separates overlays of Cretaceous period Izumi sandstones and conglomerates from the Sambagawa metamorphosed series of graphite and black phyllite schists. Quartz veins bearing stibnite lodes occur in fracture zones. The most important lodes are the Tsuru-Kame (10 m thick with a strike length of 1300 m in a N60–80°E direction and a down-dip length of 300 m from 70° to vertical; the Senga (10 m thick with a strike length of 720 m in an E-W direction and a down-dip length of 250 m from 70° to vertical; the Ohshiki-Asahi (20 m thick with a strike length of 350 m in an E-W direction and a down-dip length of 380 m at 20° south; the Saiwai (unknown thickness with a strike length of 90 m in an E-W direction and an unknown down-dip length at 80° south; and the Imamura (20 m thick with the strike length of 80 m in a N 40° E direction and a down-dip length of 60 m at 20° south. The ore grade of all these lodes was 20% antimony. A 1200-m adit served as the main haulage tunnel. During its lifetime the Ichinokawa mine produced 36,700 tons of antimony concentrate which converted to 19,053 tons of pure antimony.

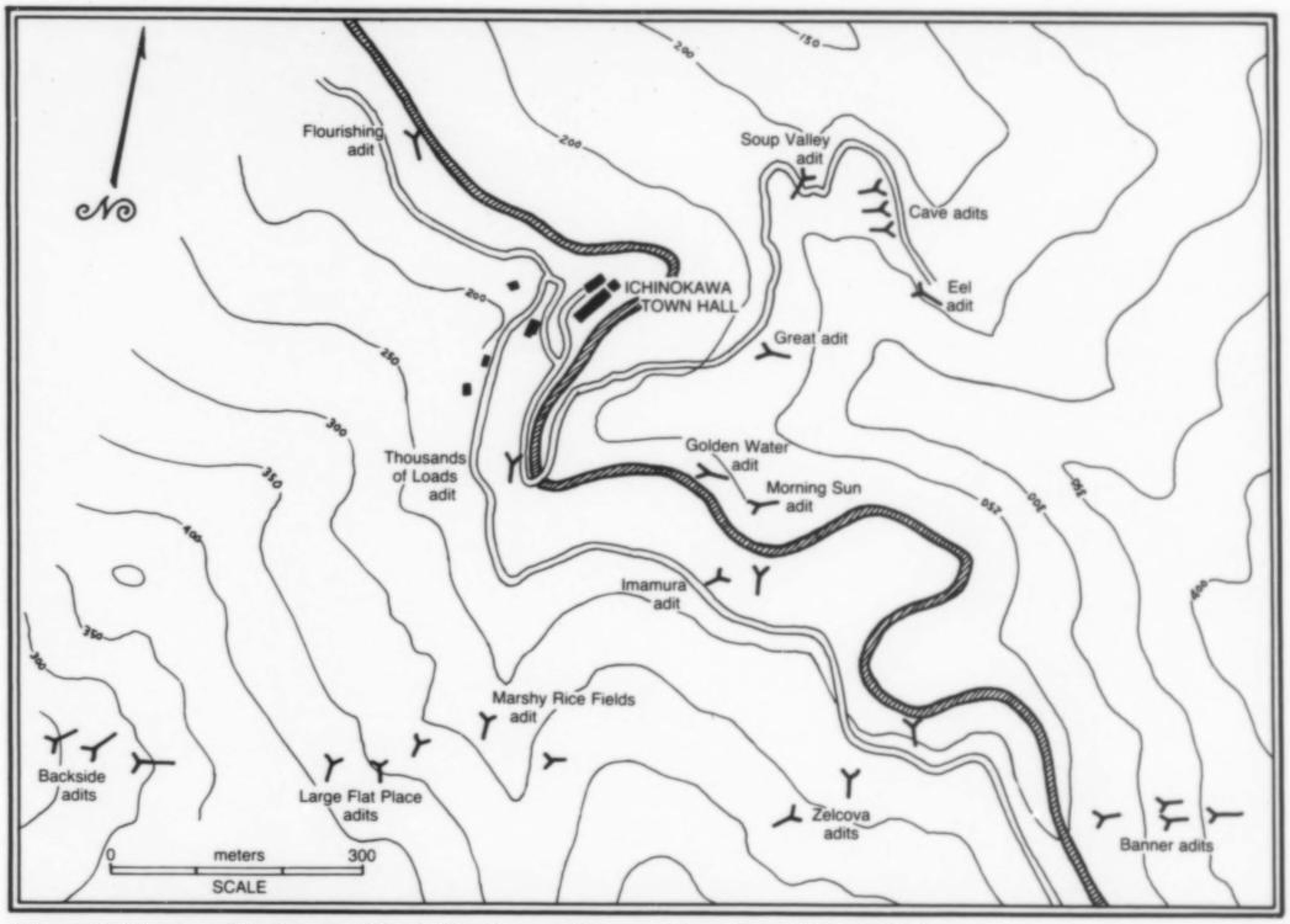


Figure 3. **Topographical map of the Ichinokawa mine area (courtesy of Isamu Itō).**

Figure 4. **Cross-section of Ichinokawa mine workings, from a drawing by Takuji Ogawa made in 1899.**

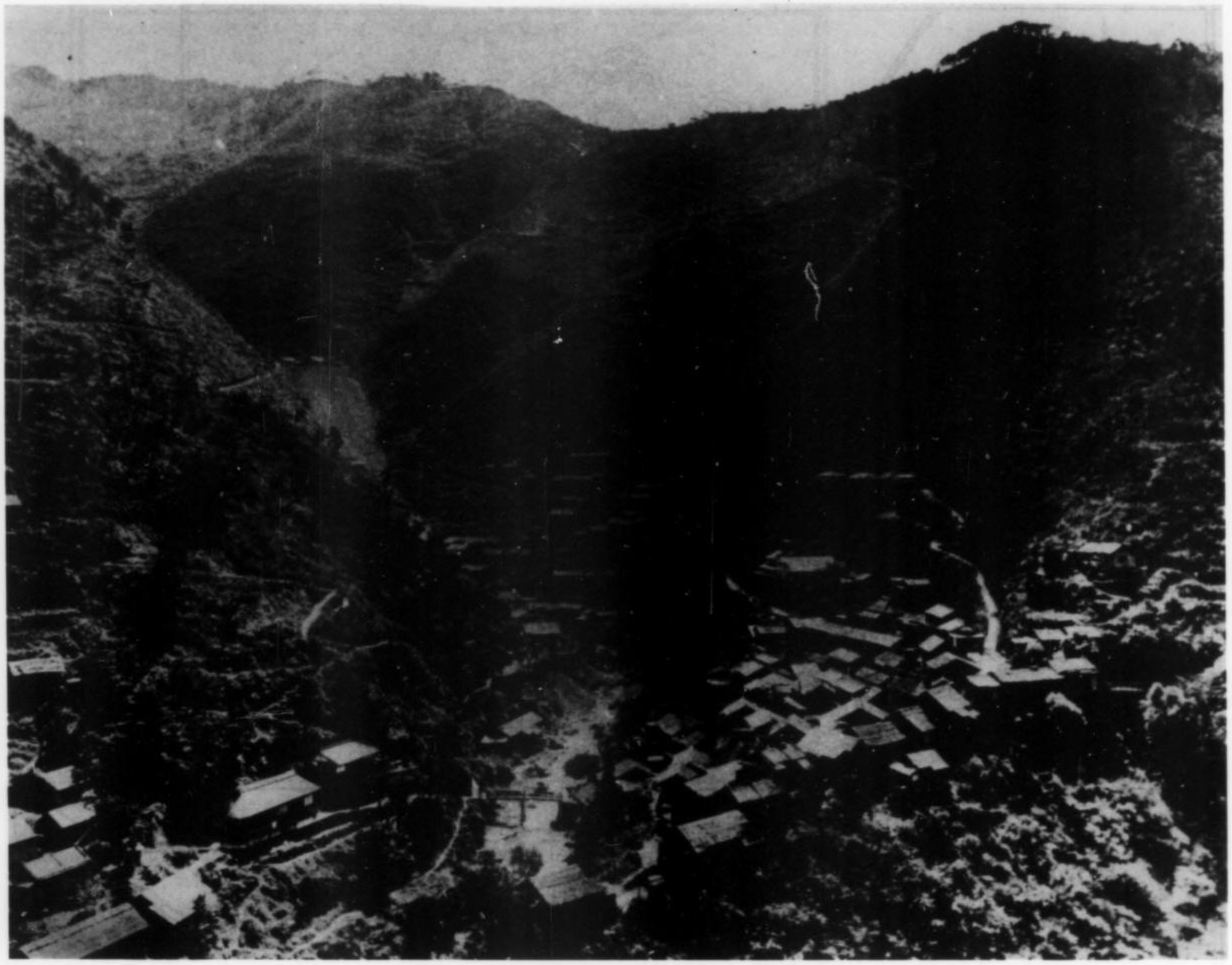


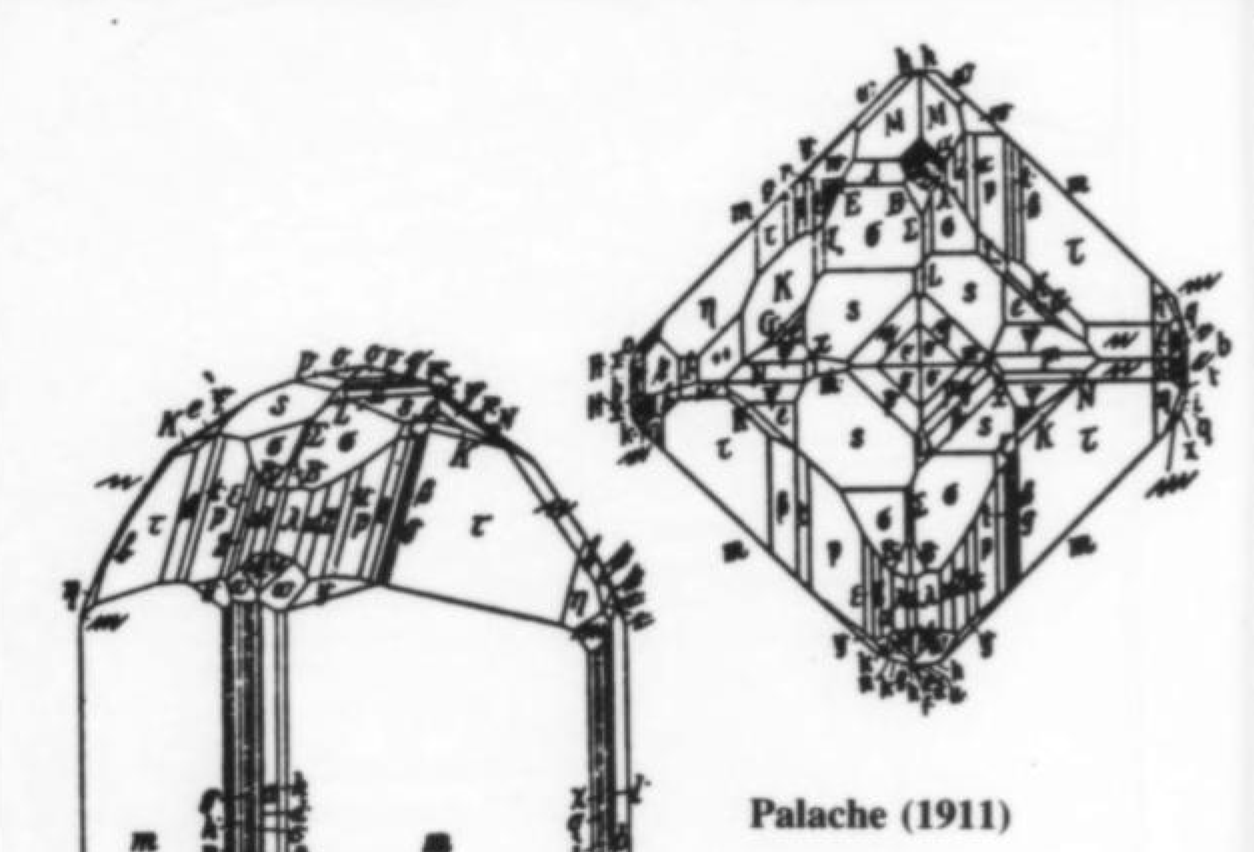
***Figure 5*. Ichinokawa mine village in 1905 (Ichinokawa Mine Museum photo).**

STIBNITE

Ichinokawa stibnite occurs as elongated lead-gray prisms topped with an amazing assortment of terminal faces. Undamanged crystals generally exhibit well developed {110}, {010} and {111} faces. Many stibnites are heavily striated. Nearly all are lightly tarnished with an iridescent bluish cast. Stibnite crystals are extremely soft (hardness 2) and flexible, making it difficult to obtain crystals without some damage. A perfect brachypinacoidal cleavage (gliding plane) permits flexibility and may result in some naturally formed crystals being twisted or curved without weakening the overall structure.

Crystals were found in vugs where veins had widened. Oversized stibnite crystals grew freely within these pockets, but crystals which contacted the opposite wall lost their terminal faces. Most crystals grew as radiating groups from a common base, but some pockets were found full of "confused groups" of crystals which extended in all directions. Secondary quartz solutions dusted many stibnite bases with bright whitish or graying quartz crystal druses. Rarely, a third growth of tiny calcite crystals formed over the quartz. For the most part, stibnite prisms and terminations remain free of secondary deposition.

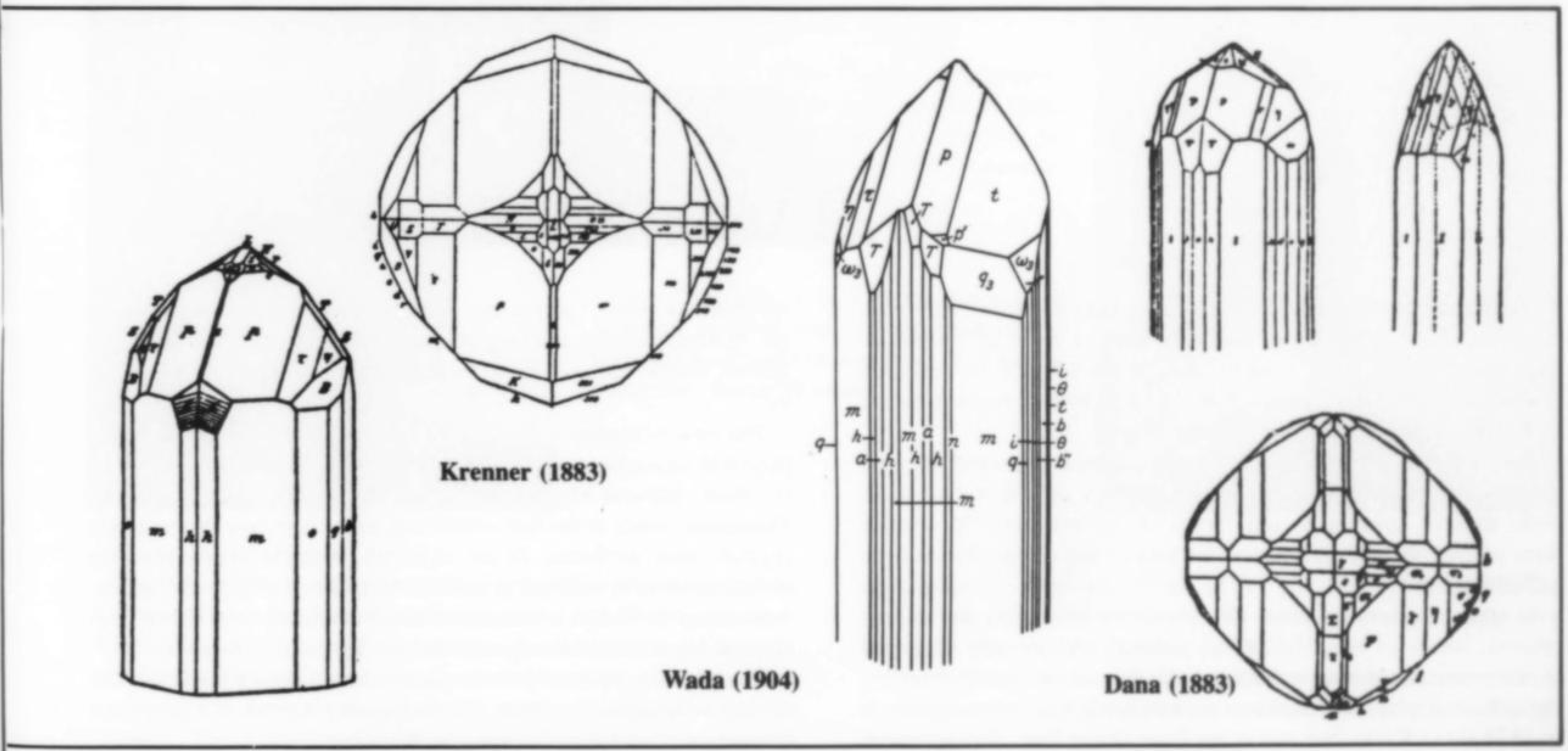
Japanese mineralogists were intrigued with the morphology of Ichinokawa stibnite crystals. More than 65 different crystal forms were recorded by J. Iwasaki, N. Fukuchi, Y. Ohtake, M. Nishamura, T. Kimura and D. Tanaka. Additional forms were discovered by the American E. S. Dana, the Austrian J. S. Krenner and the German



Palache (1911)

Figure 6. **Male and female miners at Ichinokawa in 1922 (Ichinokawa Mine Museum photo).**

Figure 7. **Stibnite crystal forms from Ichinokawa (Goldschmidt).**



Krenner (1883)

Wada (1904)

Dana (1883)

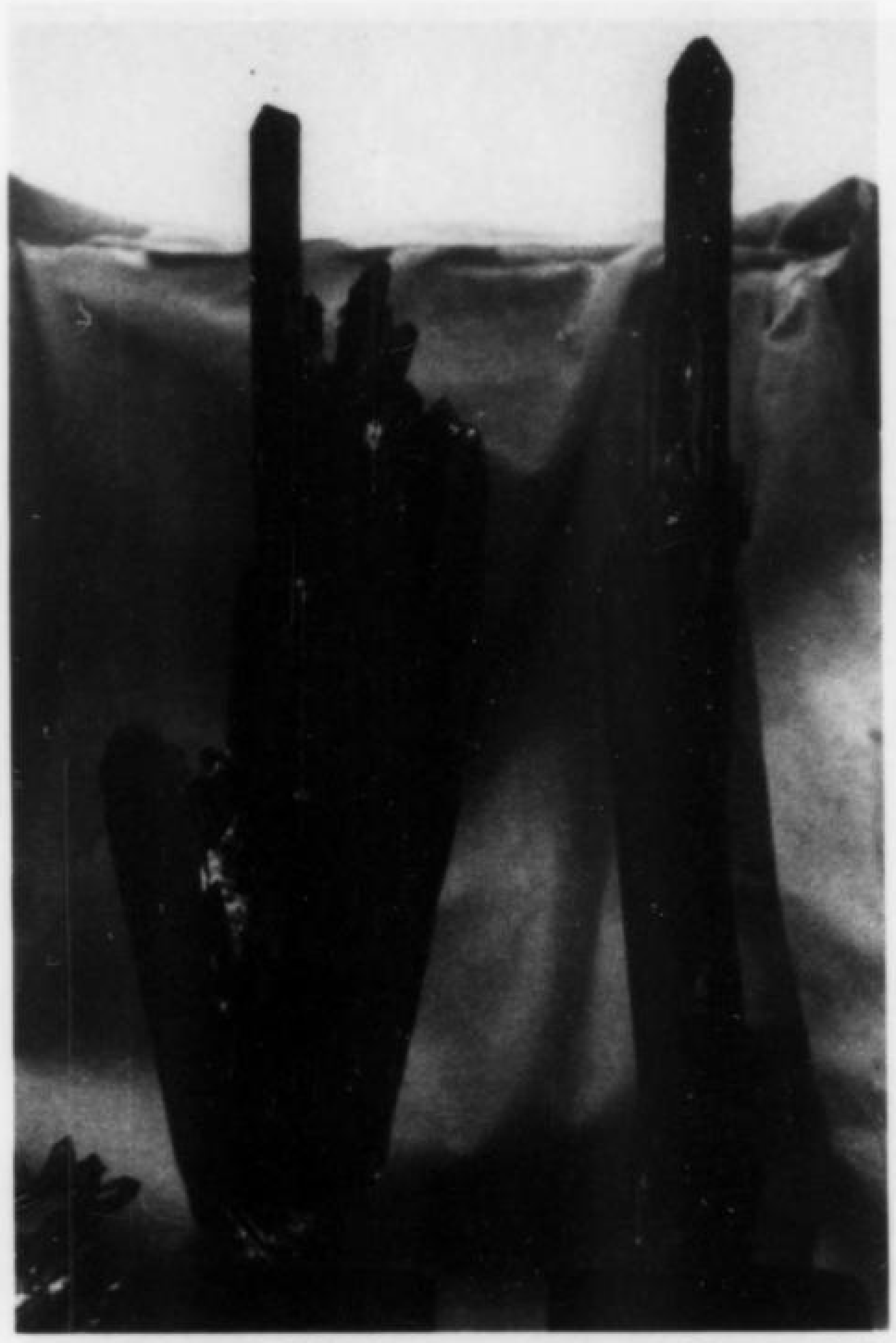


Figure 8. **Stibnite crystal groups, 48 cm and 53 cm tall. Yale University collection; photo by Bob Jones.**

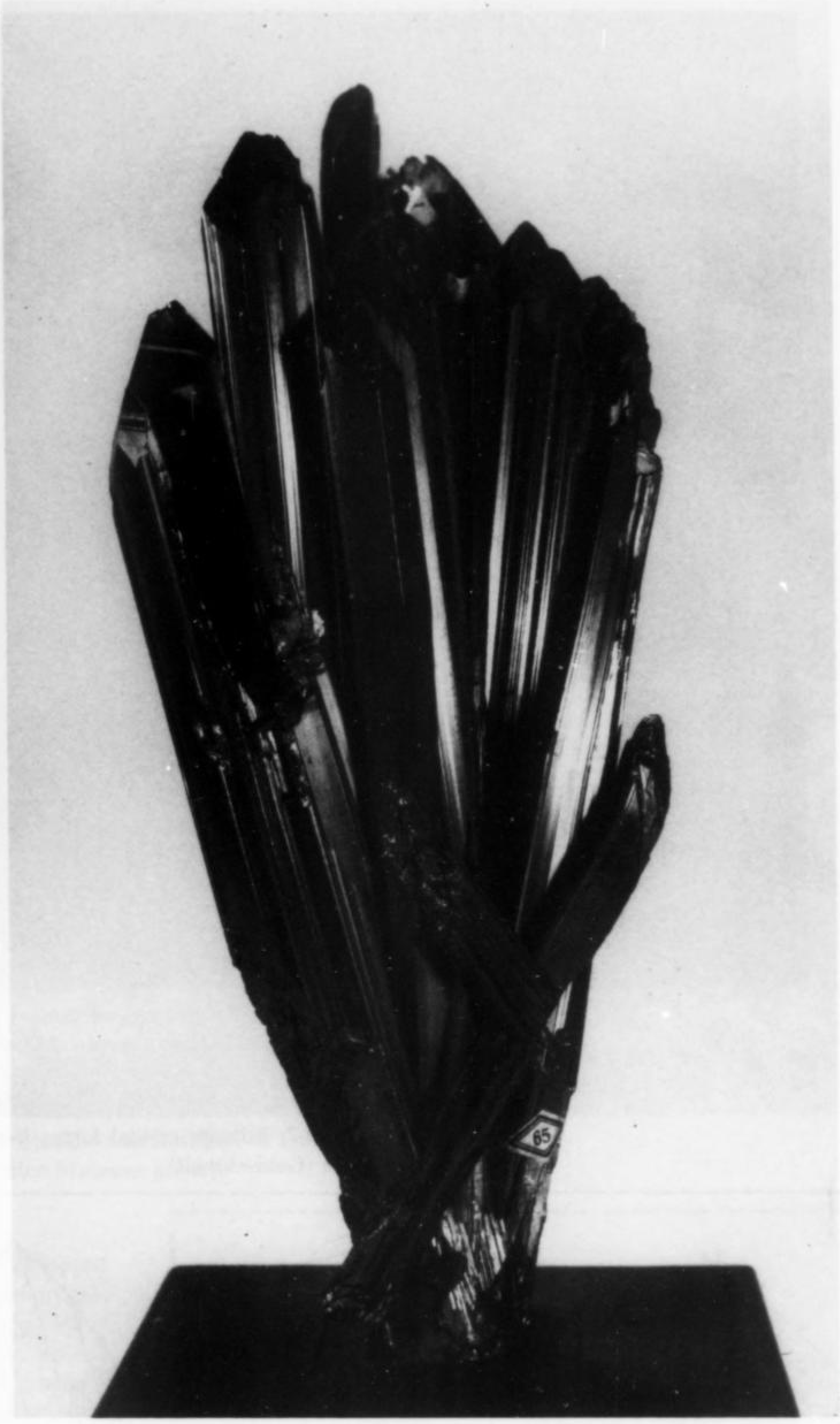


Figure 9. **Stibnite crystal group, 10 x 25 cm, from Ichinokawa. Wada Collection, photo by I. Sunagawa.**

G. Seligmann until more than 160 forms had been identified. However, Japanese researchers believe that a number of recorded forms are duplicates because some crystal faces are too large to be measured precisely by an optical goniometer, and the crystals themselves are often bent or twisted by later external forces.

Removing stibnite crystal groups without damage proved to be an arduous task forcing frustrated miners to break off single crystals in order to have anything to sell. Trays of approximately 20 crystals were offered for sale in Japan at the turn of the century for as little as $100 per tray.

In spite of enormous losses of stibnite crystals during the mining process, scores of beautiful prisms survived and are now displayed in museums and private collections throughout the world. Possibly the earliest display of Ichinokawa crystals were those winning awards in 1876 at the Kyōto Fair and at the Paris Grand Fair. A magnificent specimen of stibnite containing about 120 crystals was displayed at the Mineral Society meeting in London on October 23, 1883, by Samuel Henderson, a London mineral dealer. The piece weighed 68 kg.

The best Ichinokawa stibnite crystals remaining in Japan are displayed in major museums including the University of Tokyo Museum, the Ikuno Mineral Museum in Hyōgo Prefecture (which houses the Tsunashiro Wada collection containing more than two dozen single crystals, each exceeding 20 cm in length, with the largest reaching an incredible 60 cm; Wada is referred to as the "founder of Japanese mineralogy"), Tokyo's National Science Museum, the Ehime Prefectural Museum in Matsuyama, and the Saijo City Museum.

The literature does not refer to other minerals from Ichinokawa and there is no available evidence that outstanding crystals of any species other than stibnite ever occurred at this mine.

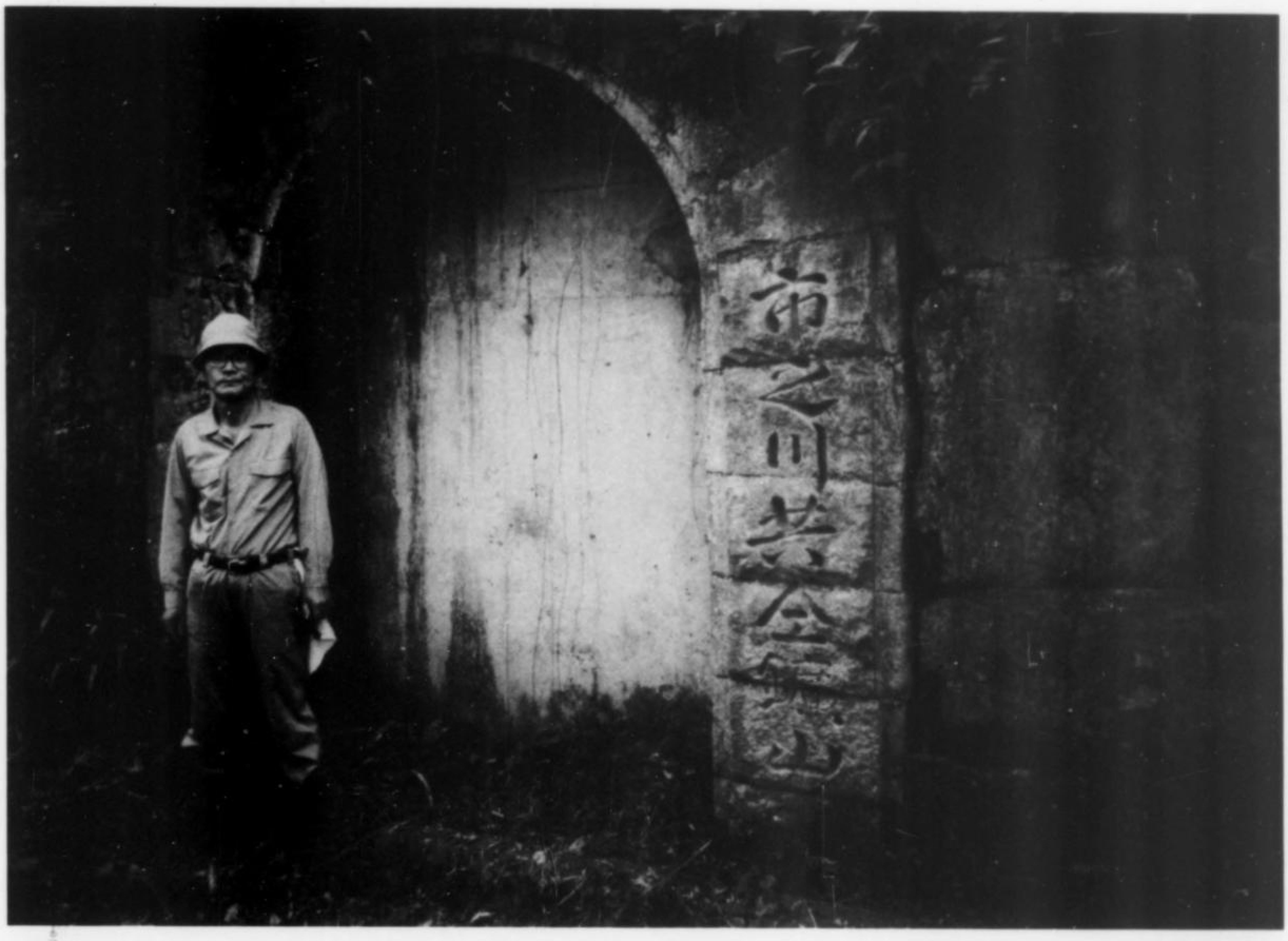


Figure 10. **Isamu Itō at old main entrance (Senga-kō—Thousands of loads section). Inscription: "Ichinokawa co-op mine, January, the year of the 23rd Meiji" (1890). Bancroft photo.**

Figure 11. (left) **Daiyu Tanaka, exceptional mineral collector and early curator of Saijo City Museum who willed his collection to the museum in 1953. (Saijo City Museum photo).**

Figure 12. (right) **Sunao Siomi, Saijo City Museum curator with exceptionally thick Ichinokawa stibnite crystal from the Tanaka collection. Bancroft photo.**

The Wada Collection lists one of its largest groups of stibnite crystals as coming from the Yokohi antimony mines at Ichinokawa. Some other collections show a similar locality for their stibnites. Records indicate the "Yokohi mines" are, in fact, located on one of the four main veins at Ichinokawa. "Yokohi" means "horizontal vein" in Japanese. The Yokohi vein was explored during the earliest years of the Ichinokawa mine and, in the 1870's and 1880's, it produced the best stibnite crystals. The Yokohi vein workings were part of the area which our party briefly explored in 1986.

Fine stibnite crystals of lesser importance have been reported from the Tsuju mine in Aichi Prefecture and the Nakase mine in Hyōgo Prefecture.

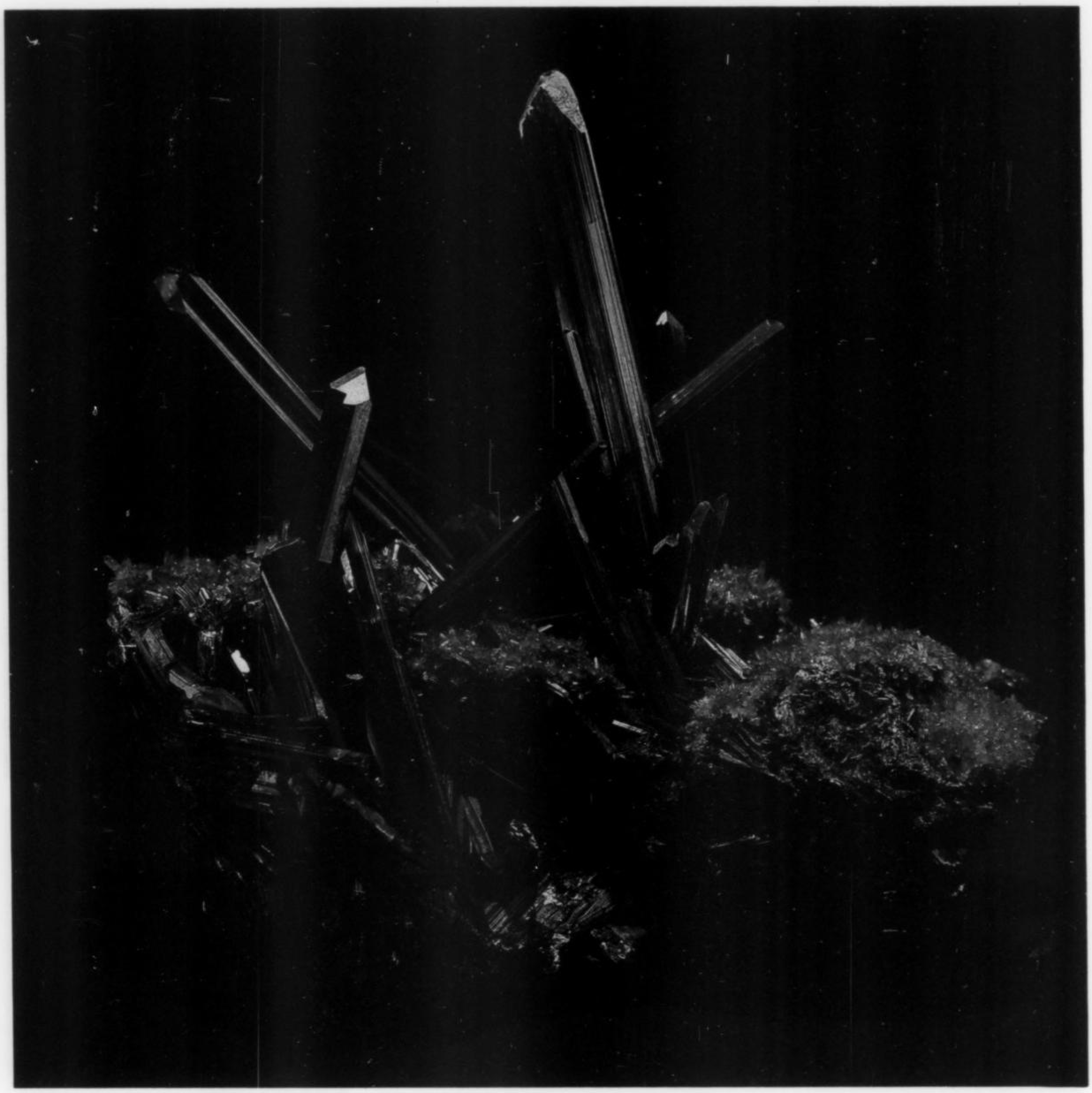


***Figure 13*. Stibnite group, 15 cm, from Ichinokawa. Smithsonian collection, photo by Dane Penland.**

THE ICHIONOKAWA MINE IN 1986

I had planned to visit the Ichinokawa mine in 1982 to take photographs and gather data for my forthcoming book *Gem & Crystal Treasures*. However, details necessary for the trip could not be resolved prior to the book's publication in 1984.

In August, 1986, a letter was received from the Honorable Tomio Kuwabara, Mayor of Saijō City, saying his staff would escort our party to the Ichinokawa mine but "we can't enter the mine portals because they are covered in concrete."

The following September our party arrived at the Ichinokawa mine schoolhouse. Early photographs of the mine show denuded hills in all directions and hundreds of houses and buildings. Climbing out of our cars and jeeps we were unprepared for the scene before us. We were surrounded by mature forests clogged with underbrush. Nothing resembling a great mine remained. All machinery, buildings and even the dumps were gone. It was as though the Ichinokawa mine had never existed. Only the schoolhouse and a parking lot at road's end were left.

We were immediately surrounded by reporters from five newspapers and two television crews. It seemed that our visit to the long abandoned antimony mine was of considerable local interest.

Our guide, Isamu Itō, was the mine caretaker who had spent a week clearing the old trail up the mountain to various portals, all of which

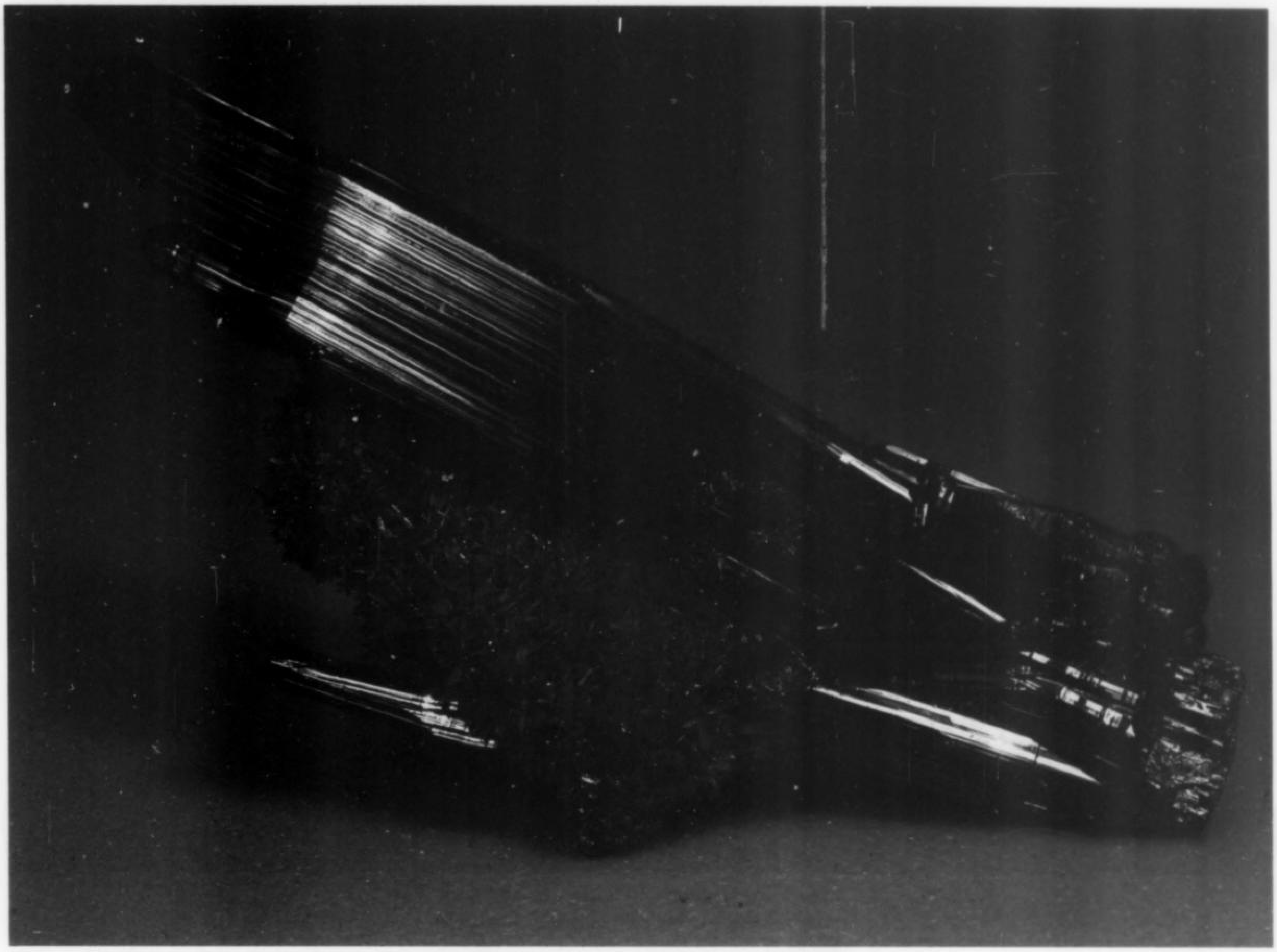


Figure 14. **Stibnite crystal, 5" on matrix from Ichinokawa. Yale University collection, Bob Jones photo.**

had been cemented shut. We asked if there was a possibility that somewhere a cave-in had opened a surface crack into the old mine, or if there was an air vent which had not been sealed over. Itō said he had seen a small hole in some rocks while he was clearing the trail. After a series of false attempts we located a tiny vine-covered opening. Slipping inside we crawled through slime and rock falls until we stood upright in an old gallery. Tiny lime stalactites hung in eerie silence, dripping occasionally onto the muddy floor. Supporting walls of carefully stacked rock extended down long drifts. Cave-ins were observed in all directions and large sections of the ceiling appeared dangerous, forcing us to hurriedly take a few photographs and then leave. Japanese miners of a century ago had been very thorough. We found not a trace of stibnite.

CONCLUSIONS

Extensive exploration of the Ichinokawa antimony deposit during the years 1955–1965 revealed no significant remaining ores. During more than 1200 years of exploitation, mining had been extensive and thorough. All underground and surface mining facilities have been removed, and antimony processing plants at nearly all locations have been closed and dismantled. There is every indication that reactivation of this mine is unwarranted.

The great stibnite crystals of earlier years were discovered in massive antimony veins, and because no veins of size and richness remain, it must be concluded that attempts to collect quality stibnite crystals within the mine would be fruitless.

Figure 15. **After hours of searching this tiny opening to the old workings was located. Bancroft photo.**

***Figure 16.* Century-old neatly stacked rock wall still supporting mine ceiling. Bancroft photo.**

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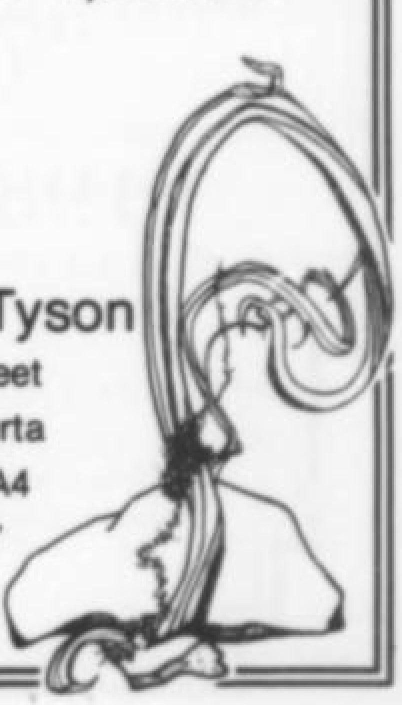

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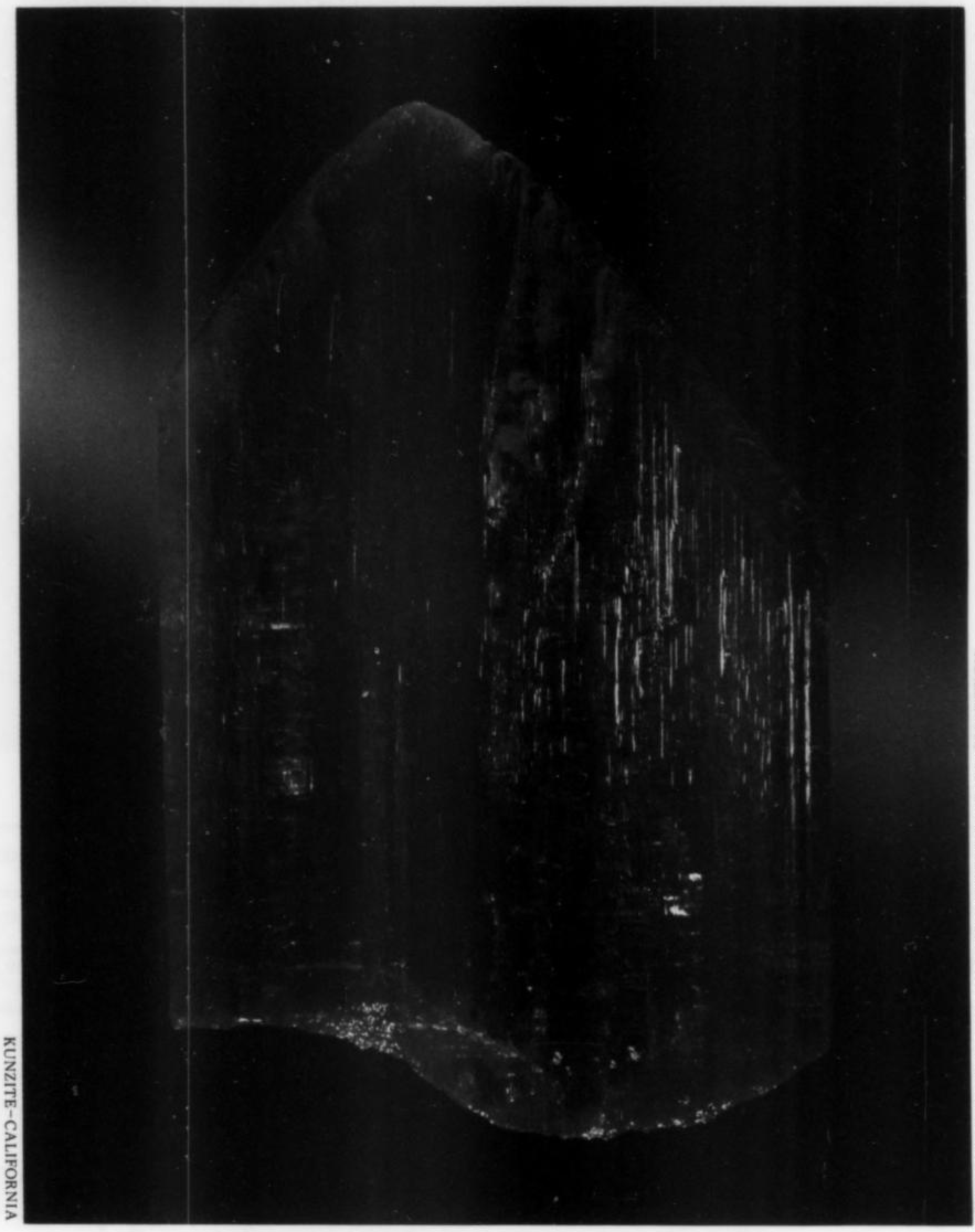

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Mineralogy of the Bandora Mine

SOUTH MINERAL CREEK, SAN JUAN COUNTY, COLORADO

•

Martin Jensen
P.O. Box 545
Crystal Bay, Nevada 89402

In one of the most picturesque Rocky Mountain settings, a series of magnificent vugs has, until recently, remained well-hidden within old stopes of an abandoned silver/lead mine. In the summer of 1981, the pockets were discovered, and have since produced some of the finest chalcopyrite and quartz specimens ever found in the Colorado mineral belt.

INTRODUCTION

The Bandora mine, in the famous Silverton mining district, is located in southwestern Colorado about 60 airline km north of Durango. The nearest town, Silverton, is a small settlement of about 900 full-time residents, having been founded around 1873, primarily as a mining community. It is situated in the bottom of a picturesque valley at 2863 meters (9305 feet), with nearby mine dumps, wooden mine buildings and aerial tramways dotting the steep mountainsides in almost every direction. Tourism is the modern-day industry, especially during the summer months when the restored Durango-to-Silverton narrow gauge railroad regularly brings hundreds of visitors to the town each day. Another popular vacation activity is the exploration of old mines and ghost towns by means of the locally abundant jeep rental facilities.

To reach the Bandora mine, one travels north out of Silverton on highway 550, the main all-weather route from Durango to Montrose (both of which have rail and air facilities). At a distance of about 3.5 km from town is the South Mineral Creek campground turnoff. A well maintained gravel road leads 7 km to the campground site. From here, the road is strictly four-wheel drive up to the mine, a distance of 3 km.

The mine workings comprise an area of about 150 x 350 meters on the northwest-facing slope of the valley drained by the South Fork of Mineral Creek and are included on the USGS *Ophir, Colorado,* $7^1/_2$ minute quadrangle. The individual portals and prospects can be easily spotted on the valley wall by the presence of yellow-orange dumps in contrast to the light greens of the indigenous shrubs and pine trees. Elevation ranges from 3318 to 3385 meters from the lower to the upper portals, with nearby towering peaks reaching altitudes of 4213 meters (13,692 feet).

The climate is characteristic of a high alpine region, with brief but beautiful summers and long severe winters. During late June and early July, the state flower, the columbine, produces deep purple to blue teacup-size flowers in proliferation on the damp meadows.

Origin of the name "Bandora" has not been well established. There is an abandoned operation at nearby Telluride called the Pandora mill and perhaps a modification of this similar name occurred. The property has always been called Bandora, as is shown by most maps and published documents, except for a brief period in the early 1950's when it was being operated as the Esmeralda Lease.

HISTORY

Historical accounts dealing with the operation of the Bandora property over the years are scattered and make detailed descriptions somewhat difficult to compile. The earliest noted documentation of the deposit is made in the July 14, 1883, edition of the *La Plata Miner*, a newspaper of the day:

> We walked over the croppings of the vein for several hundred feet and found ore in the grass roots of several places.

The following year, a more lengthy article was run in the *Silverton Democrat*:

> The Bandora mine is situated on the South Fork of Mineral Creek about 10 miles from Silverton and is the property of Wm. Sullivan.* Two levels have been run on the property besides four other openings on the surface of the vein, that

---

*William Sullivan was also the sheriff of Silverton at the time.

Figure 1. **View to the southwest of dumps and an ore hopper at the Bandora; Rolling Mountain (4213 m) in center, South Mineral Creek in lower left.**

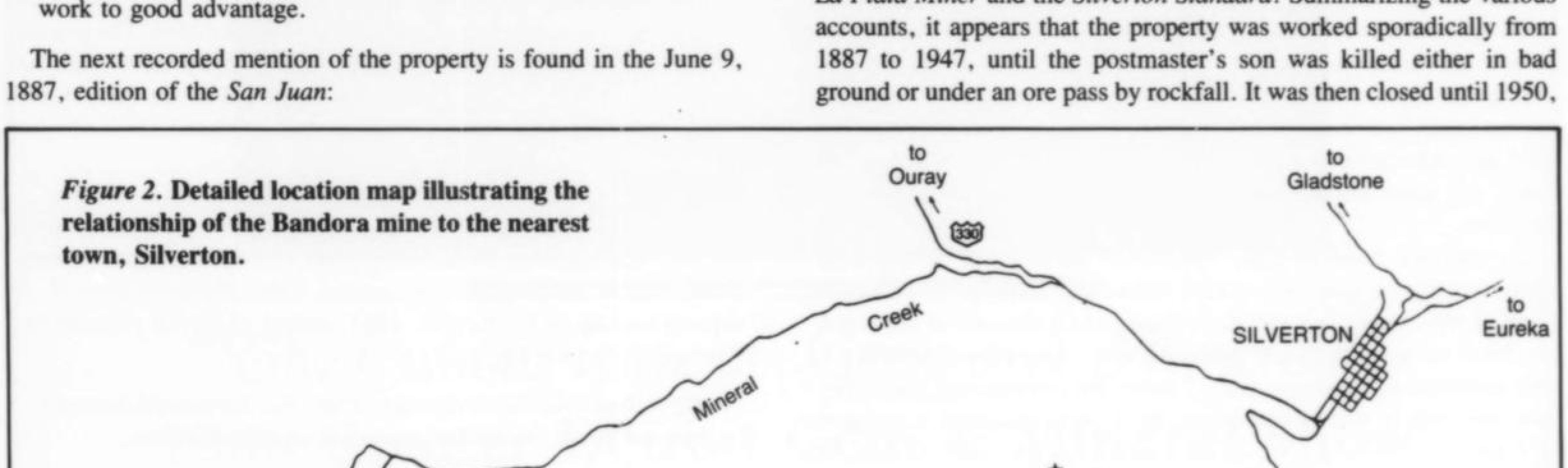
> show 15–40 inches of pay ore. The No. 1 level is in on the vein 90 feet and shows from 8–12 inches of mineral. The No. 2 level is a crosscut of 38 feet and a drift of 50 feet and carries an average width of pay streak of 20 inches. A sample lot of two tons sampled at Comstock's gave 40 oz. silver, $^3/_4$ oz. gold, and 10% lead. About 50 tons on the dump, Mr. Sullivan estimates at $2,500. We have seen this property and believe it to be all that it is represented. The property is well situated to work to good advantage.

The next recorded mention of the property is found in the June 9, 1887, edition of the *San Juan*:

> Wm. Sullivan took up a pack train loaded with supplies for the Bandora, Thursday. The drift on this mine is in 120 feet, the breast of the drift showing 5–15 inches of galena ore which will average over $60 to the ton. Work is being pushed night and day and five feet is run every twenty-four hours.

Records for the subsequent 60 years are very scarce, with the only data being provided in brief articles from two local newspapers, the *La Plata Miner* and the *Silverton Standard*. Summarizing the various accounts, it appears that the property was worked sporadically from 1887 to 1947, until the postmaster's son was killed either in bad ground or under an ore pass by rockfall. It was then closed until 1950,

Figure 2. **Detailed location map illustrating the relationship of the Bandora mine to the nearest town, Silverton.**



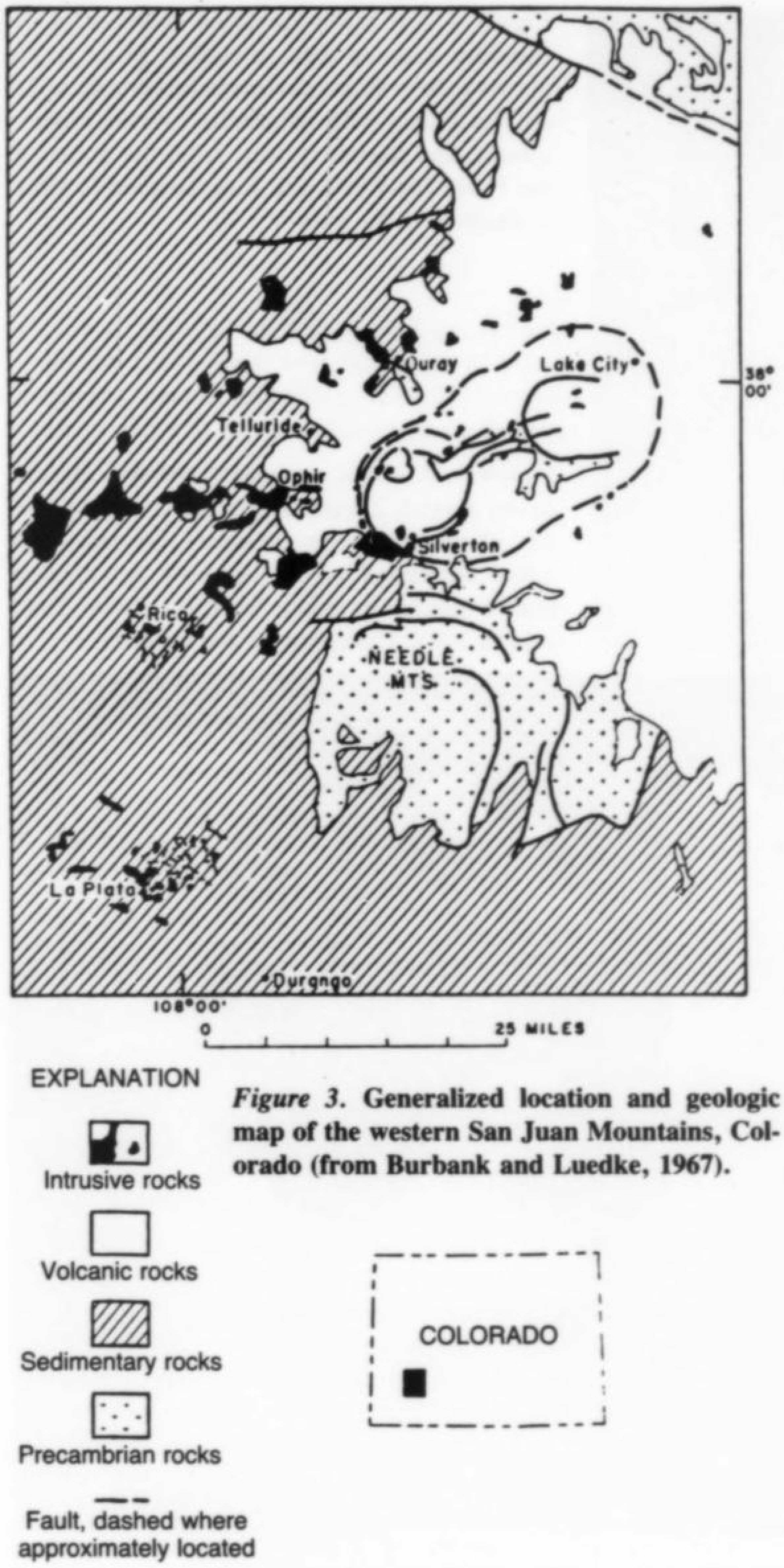


***Figure 3.* Generalized location and geologic map of the western San Juan Mountains, Colorado (from Burbank and Luedke, 1967).**

at which time the John J. Sullivan Brokerage Company in Denver (owned by a relative of William Sullivan) arranged a leasing agreement with N. C. Maxwell and Associates. Through a split-check sublease basis, Ludwig Benigar, T. E. Burgess, and John Mohney of Silverton carried out operations on the 4th level and were producing ore with a net value of $12 per ton after payment of royalties and trucking charges (King and Allsman, 1950). At that time, average assays of samples from the Little Todd vein indicated a content of 54 ounces silver, 0.42 ounce gold, 0.5 percent lead, and 10.6 percent copper per ton (ibid.; see also Parington, 1896).

Subsequent details of the history are unknown up through 1981, when Bakers Park Mining and Milling Company of Howardsville leased the property and conducted a limited exploration program. The Standard Metals Corporation of Silverton later acquired the lease in 1983. But, with the bankruptcy of Standard Metals in 1984, the property returned to the Sullivan family, where it remains in the J. J. Sullivan Trust to this day. Eight patented and six unpatented claims comprise the historical property.

GEOLOGY

The Bandora mine is located on a series of parallel, northwest-trending mineralized fractures which crop out within sandstones of the Cretaceous Dakota Formation in close proximity to the Tertiary Rolling Mountain monzonite intrusive. Conformable Mesozoic sediments, consisting of the Jurassic Dolores Formation through the Cretaceous Mancos shale, occur as relatively flat-lying and undisturbed beds in most of the region drained by South Mineral Creek. To the immediate west of the mine, a small Tertiary igneous stock intrudes the sediments and comprises the slopes of Rolling Mountain. More recent bedded rhyolite tuffs of the Eocene San Juan series overlie both the sediments and the monzonites and form the highest peaks and ridges. Further details of the geology of the Silverton region as a whole will not be discussed but may be found by consulting the references listed by Murphy (1979).

The only structures in the Bandora area are several well defined faults of limited displacement, most likely formed as the result of emplacement of the Rolling Mountain intrusive. Subsequent mineralization and alteration are clearly Tertiary, but their relationship to either the monzonite intrusive or the later episodes of volcanic activity associated with the development of the nearby San Juan caldera complex remain unresolved (Burbank and Luedke, 1967).

Two parallel veins have provided the majority of ore produced, the Bandora vein and the Little Todd vein, the latter being located the farthest to the northeast. Adits providing access to the veins have been run on four separate levels, evenly spaced about 20 meters above one another. Of the at least eleven adits observed on the property, five are caved.

MINERALOGY

In general, well crystallized minerals occurred along almost all veins of the Bandora property. From primary to secondary species, aesthetic pieces were extraordinarily common. The Little Todd vein must be considered as the most productive locality, yielding the most attractive specimens. The other veins also provided desirable pieces, but were subordinate when compared to the Little Todd occurrence.

Because a few mineral specimens had made their way to the mineral market during the years when active mining was being conducted, it was curious that collectors had not been to the locality until the author's visit in 1981. Larger pieces indicative of pocket mineralization were present on the dump at the time and it was simply a matter of going back into the workings a short distance to see the fresh cavities in place. While most individual locations remain accessible as of this writing, even fair to poor specimens are really no longer available due to recent intense collecting by others.

Primary Minerals

Simple sulfides are the only primary species which have been observed at the Bandora mine. The occurrences are restricted to vein deposits unrelated chronologically to the wall rock quartzites, which themselves are unmineralized. A total of only 13 species have been recognized so far.

On the south wall of the valley, a small adit has been driven beneath a large talus slope which locally contains boulders of float consisting of massive tetrahedrite, pyrite, quartz, and rhodonite. This occurrence, however, is probably not related to the Bandora deposit and will not be discussed here.

Chalcopyrite $CuFeS_2$

Of all the minerals found at the Bandora, chalcopyrite surely is the most desirable and highly sought after from the collector's point of view. Fine specimens with large chalcopyrite crystals nestled amongst quartz crystals were common and easily collected during the days of the author's visits.

Chalcopyrite crystals were discovered primarily in pockets in the Little Todd vein, where they occurred typically as interpenetrant twins,

Figure 4. **The finest specimen collected at the Bandora mine to date, a cabinet piece 12 cm across with brilliant chalcopyrite crystals to 2.8 cm associated with sphalerite, pyrite, galena, quartz, and barite. It came from the pocket in the Little Todd vein and was removed in 1981. Collection of the author.**

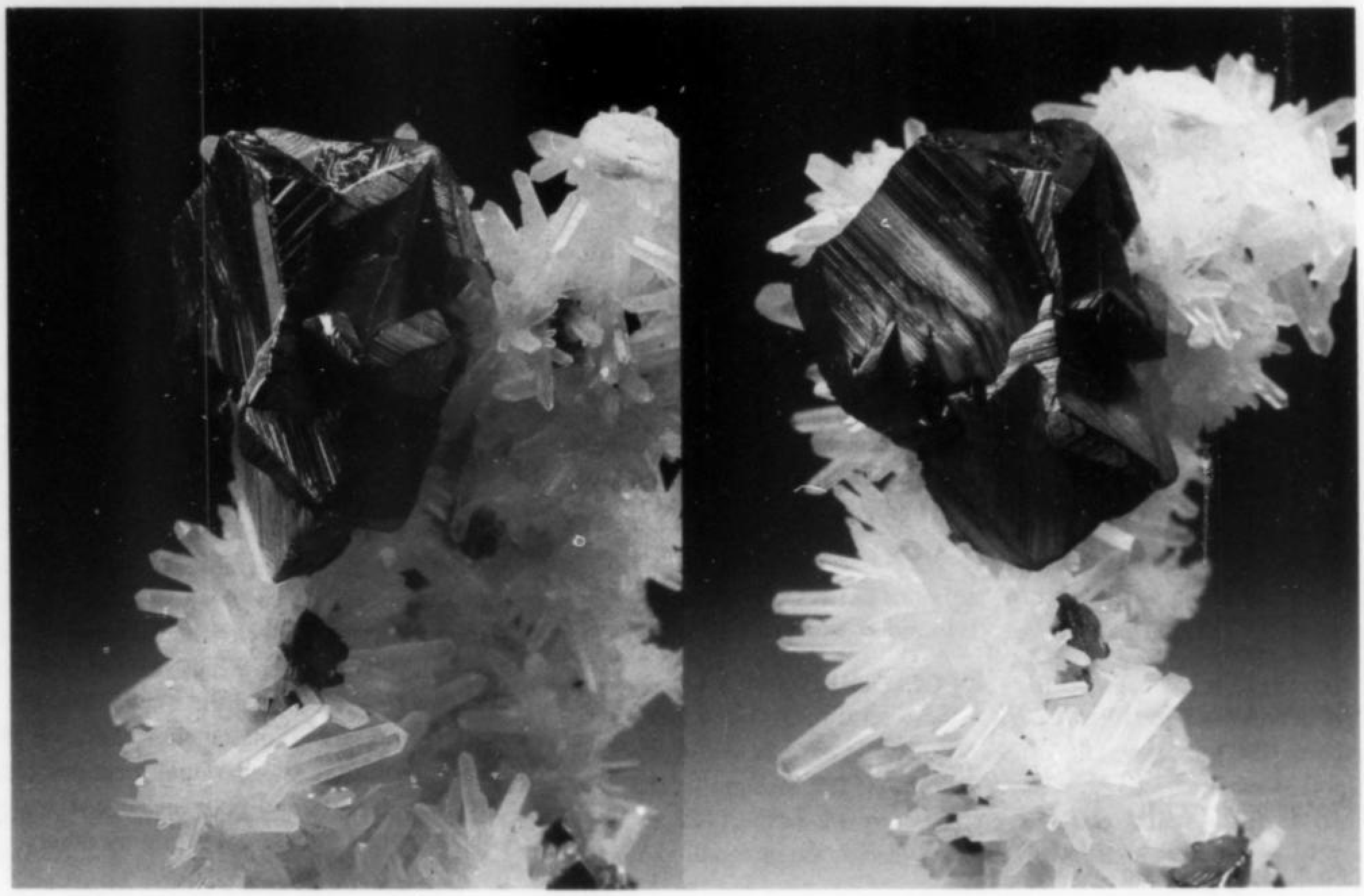


Figure 5. **A large, complexly twinned chalcopyrite crystal, 2.6 cm across, perched on a matrix of nested quartz crystals 8 cm tall, with minor associated barite. The piece is typical of floater specimens taken from the Little Todd vein in 1984. Collection of the author.**

with extreme examples of cavernous twinning being observed. Although the crystals are very euhedral, the surfaces of faces become quite irregular with increasing size. The dominant forms noted on all crystals are the positive disphenoid, in combination with two first order prisms. Average size of the crystals is about 1.5 cm, but larger examples up to 2.8 cm are known. When first removed from the pocket, some crystals exhibit a somewhat dull and dark color due to a thin coating of iron oxides. A brief soaking in warm oxalic acid easily removes the film to reveal clean crystal surfaces. Most crystals then have good luster, but still possess a slightly tarnished golden-brown appearance because of abundant fine striations. In rare instances, specimens have been found without these minute striations; these crystals have a bright gold color and highly brilliant luster.

At least 95% of the specimens have quartz crystals as a matrix for the chalcopyrite. Sphalerite is a common associate, with lesser barite and galena also being observed. Thumbnails up to large plates measuring almost 30 cm in length were obtained from the Little Todd vein. Rarely, growths of quartz crystals in blocky casts up to 10 cm after anhydrite were noted, with adhering chalcopyrite and sphalerite crystals, making quite unusual specimens.

A subordinate yet noteworthy occurrence of chalcopyrite is present at the "Quartz portal" (described here under "Quartz"), where small brassy crystals to 2 mm occur as inclusions in quartz crystals. Only a few examples have been found to date.

Galena PbS

The occurrence of galena within the veins of the Bandora is widespread but minor. Although production statistics for lead and silver reflect relatively large concentrations of the ore mineral, disseminated grains within the vein quartz are all that are currently preserved within the remaining vein exposures. One account, from an older gentleman who had been visiting the mine area for years, of a 5-cm galena cleavage from one of the lower dumps, would seem to lend credence to the presence of richer deposits during the days of active mining.

Crystallized galena was found within the large specimen-producing pocket, but only as dull, modified cubes never exceeding 1 cm in maximum dimension. The crystals themselves are intimately associated with chalcopyrite and sphalerite and probably occur on the

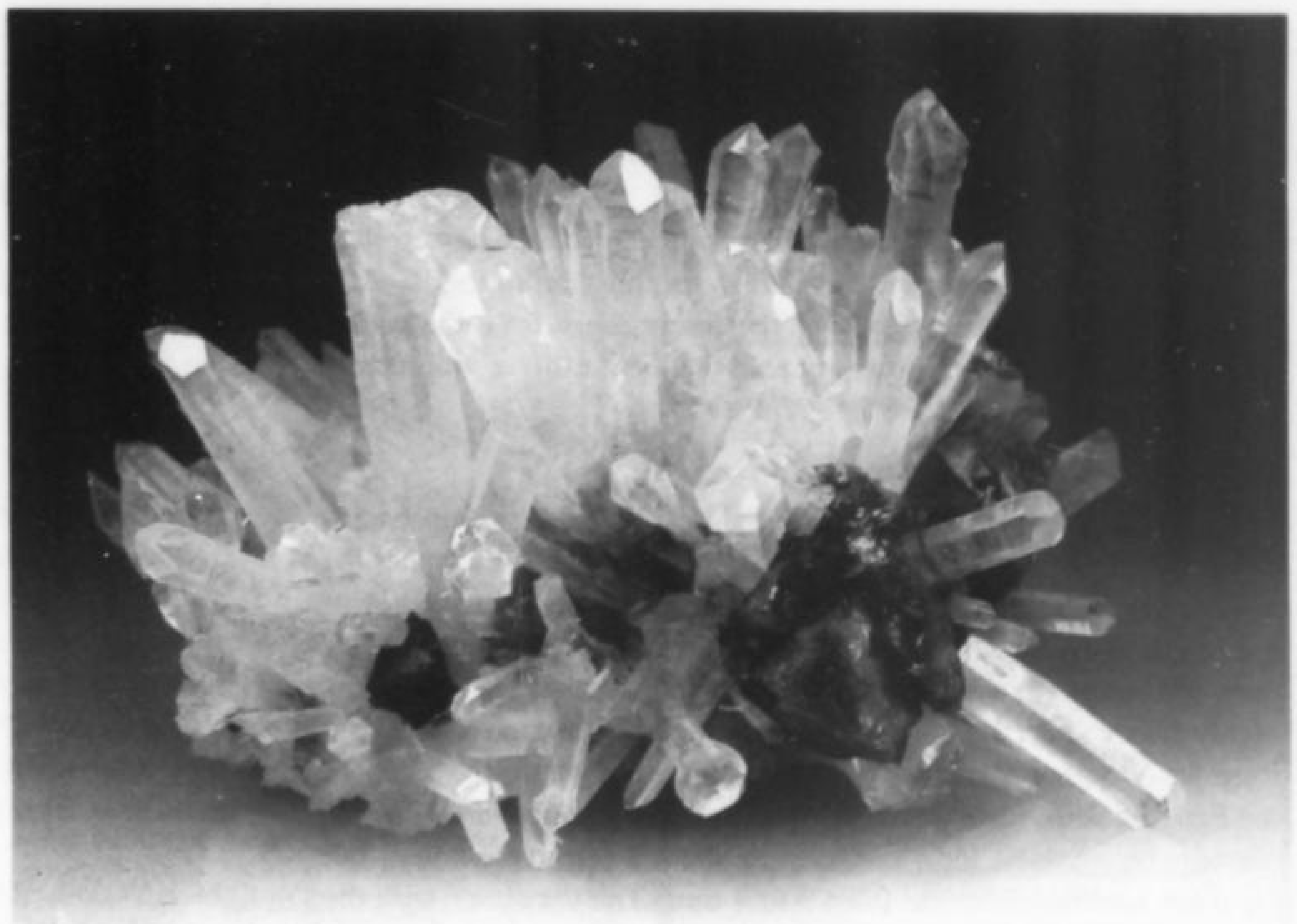


Figure 6. A large miniature, 4.5 cm across, from the Little Todd vein consisting of many sceptered quartz crystals in association with chalcopyrite and sphalerite crystals. Collection of the author.

majority of specimens, having often been overlooked because of their small size and dull luster.

Galena also occurs as rare, lustrous cubes up to 2 mm, as inclusions in quartz crystals at the "Quartz portal" (see below).

Pyrite FeS_2

Pyrite is unusually scarce at the Bandora, having been noted only as small granular crystalline masses within the large specimen pocket of the Little Todd vein. It appears to have been the last sulfide mineral to form, occurring typically as thumbnail-size floater groups of lightly tarnished but highly lustrous modified cubes. Individual crystals reached about 6 mm in size and are commonly stacked in contorted and irregular arrays.

Sphalerite ZnS

The second most desirable mineral after chalcopyrite, from the pocket in the Little Todd vein, is sphalerite. The two species occurred together on at least 90% of the specimens and yielded very attractive associations. Although not as large as the chalcopyrites, the sphalerites are commonly very sharp and possess a good luster. Individual crystals are pseudo-octahedrons, dark black in color, and reach sizes of up to 1.2 cm. When nestled amongst the white quartz crystals, the black of the sphalerites and brassy yellow of the chalcopyrites make very attractive pieces.

In rare instances, epitaxial intergrowths of chalcopyrite within sphalerite crystals were noted. The chalcopyrite occurred in small, symmetrically arranged, pyramid-shaped growths parallel to cleavage planes of the sphalerite, similar to the cleats on an athletic shoe.

Secondary Minerals

Secondary minerals from the Silverton-Ouray region are somewhat scarce, but the Bandora mine, chiefly the Bandora vein, represents an exception. The locality is therefore of substantial interest to most Colorado collectors for, in addition to the fine specimens of the primary minerals, showy pieces of the secondary species were also obtainable.

Azurite $Cu_3(CO_3)_2(OH)_2$

Azurite is present within both the Little Todd and Bandora veins as an alteration product of chalcopyrite. Light blue spongy masses to 2 mm and darker blue stains to 5 mm occur sparingly on massive vein quartz, associated predominantly with malachite, but are never seen as well crystallized specimens.

Cerussite $PbCO_3$

Surprisingly fine specimens of cerussite were collected from two dangerous areas along the trend of the Bandora vein. The occurrences are well exposed, but localized pockets of specimen-quality pieces are not common. The best specimens consist of stout glassy cerussites perched upon a matrix of small quartz crystals. The extremely fragile nature of these pieces, however, has made collecting a very difficult task, and few top-quality pieces have been preserved.

Two different habits of cerussite occur, rarely in direct association with one another. The most abundant are snow-white masses of jackstraw crystals, with individual needles reaching lengths of almost 2 cm. The jackstraw cerussites occur both within small pockets of soft, dark brown-red limonite (reminiscent of Flux mine, Arizona, specimens), and as thick mats resting upon small slabs of quartz crystals.

The more blocky, glassy crystals, being composed of elongated sixling twins, occur only with the quartz association, and are present rarely as individuals to 1.5 cm. The more common size is about 4 mm, with a typical matrix containing many separated bunches of crystals. These crystals all possess a very bright luster with a light tan color, and would be considered fine cerussite specimens for any locality.

Goethite alpha-FeO(OH)

Brown-orange deposits of goethite are present throughout the mine workings as coatings and stains upon earlier-formed vein minerals. Along the Bandora vein, especially rich deposits of goethite, as limonite, have developed, providing the matrix locally for cerussite, pyromorphite and wulfenite.

Pyromorphite $Pb_5(PO_4)_3Cl$

Odd, apple-green, cylindrical casts associated with wulfenite were discovered in a nearly inaccessible area along the Bandora vein and were at first thought to be pyromorphite. An element scan later with a Tracor Northern 5500 energy dispersive X-ray (EDX) analyzer proved this assumption to be correct. Only a few thumbnail-size specimens were found, from wet clay-filled vugs within limonitic vein material. After a long soaking in water to remove the dark brown mud, semi-lustrous crystal casts were produced. The casts themselves are elongate, up to 1.5 cm in length, and have somewhat frayed terminations. Several casts may occur together interpenetrating one another at various orientations such that a small floater group is formed. Associated with each group are thin, glassy, yellow-orange wulfenite crystals to 3 mm.

Silver Ag

Hopes were always high of encountering native silver wires in the pocket on the Little Todd vein but, in the end, only one specimen was found. It is currently in the possession of Robert Stouffer of Ouray and consists of a hand specimen of slightly corroded quartz crystals associated with a very large tarnished chalcopyrite crystal. The silver is present as a blackened curving wire about 1.5 cm long bridging a gap between the quartz and the chalcopyrite, and is of interest as representing the only known wire silver specimen from the locality. Judging from the large quantity of specimens taken from the pocket and the nearby workings, it is probable that native silver will remain a very rare mineral from the Bandora.

Wulfenite $PbMoO_4$

The presence of wulfenite in the Bandora vein must be emphasized as being a very noteworthy occurrence, for it is doubtful whether the species has been even rarely observed in any of the other mines of the Silverton-Ouray region. This, coupled with the fact that the Bandora wulfenites are actually quite nice crystals, makes the specimens highly sought after. Crystals from deep orange-red through pale yellow were found rather abundantly in many locations along the trend of the Bandora vein, from thumbnail groups up to large hand specimens coated with crystals. Individuals up to about 8 mm were noted, but the more common size was from 3 to 4 mm. The drawback with the majority of specimens, unfortunately, is that the crystals are more attached to the associated brown mud than to the underlying matrix and, when washed, tend to fall away. On the few specimens which remained intact, the wulfenite occurs as very lustrous, thin, yellow-orange plates displaying slight {110} second order prism modifications. For Colorado, these specimens are certainly handsome and easily hold their own with other wulfenites from the state.

Gangue Minerals

Barite $BaSO_4$

Barite occurs as an uncommon late stage constituent of the minerals comprising the specimen-producing cavities in the Little Todd vein. Cream-white platy rosettes to 8 mm were found resting upon quartz crystals and make for an attractive association on many specimens. Although minor, this type of occurrence is typical for the color and habit of barite from the Silverton and Ouray mining districts.

Kaolinite $Al_2Si_2O_5(OH)_4$

A whitish clay mineral, unanalyzed but presumably kaolinite, was found on many specimens collected from the pocket in the Little Todd vein. By washing and rinsing in water, the unsightly clay is easily removed, thus exposing the sharp crystals beneath.

Quartz SiO_2

Quartz crystals from the Bandora mine are beautiful and were plentiful in a variety of forms and modifications. From the pocket on the Little Todd vein, whitish quartz crystals comprise the matrix for the sulfide minerals, both as simple euhedral crystals and as scepter overgrowths. In general, the simple crystals range from 1 cm up to 3 cm (rarely 6 cm) in length and were commonly very sharp, but very slightly dull. The scepters on the other hand, were totally lustrous and transparent. Both normal and reverse scepters have been found, locally in great numbers, always on matrix, associated with the sulfides. The largest scepters found are on a hand-size plate which consists of numerous stout, white-clear crystals to 4 cm (collection of the author).

A small adit (called the "Quartz portal") to the northeast of the Little Todd workings, across from the waterfall, has been driven on a vertically dipping quartz vein rich with vugs. The largest of the pockets yielded huge slabs up to 100 kg of whitish quartz crystals to 7.5 cm. The matrix of the slabs, quartzite, was typically quite thin so that fine plates of erect and distinct crystals were obtained. Although the pocket was full of wet mud and the crystals had a heavy goethite coating, a water washing and hydrochloric acid cleaning has revealed the fine crystals in their true state.

Unconfirmed Minerals

Acanthite Ag_2S

Although no actual samples of acanthite have been preserved from any of the Bandora veins, assay data and production accounts of high silver values must likely be reflecting the presence of a simple silver sulfide. Galena from the deposit surely contains some silver, but it is highly improbable that the content is great enough to account for the high total silver vaues. Native silver also occurs very rarely, but it must have its origins from a primary phase, such as argentite.

ACKNOWLEDGMENTS

Most, if not all, of the credit for bringing the Bandora mine as a mineral locality to the attention of mineral collectors should go to Dave Hembree, formerly of Silverton, Colorado. He had access to many mines at a time when renewed activity was at its peak, and enabled many collections to become graced with fine Colorado specimens. Charles Motchenbacher, the author's collecting partner, participated unrelentingly in the careful collecting of Bandora specimens and is here thanked for his confidence and coolness during that one long-past, tense moment. His tireless search for reference data and literature is also generously appreciated. Those wishing to obtain good specimens from the locality may write to him at 4500 Mira Loma, #124, Reno, Nevada 89502. Tom Horton, of Ouray often freely provided jeeps for the haulage of specimens down from the mine; his kindness and warmth are unsurpassed. Tom Rosemeyer and Robert Stouffer of Red Mountain Exploration in Ouray purchased specimens and bought "cold ones" during the warm Rocky Mountain summer afternoons spent in the Longbranch discussing huebnerite. Benjy Kuehling of Ouray is acknowledged for support with equipment. Wendell Wilson kindly supplied the photographs of the specimens. Kerri Olson kindly performed the typing of the manuscript.

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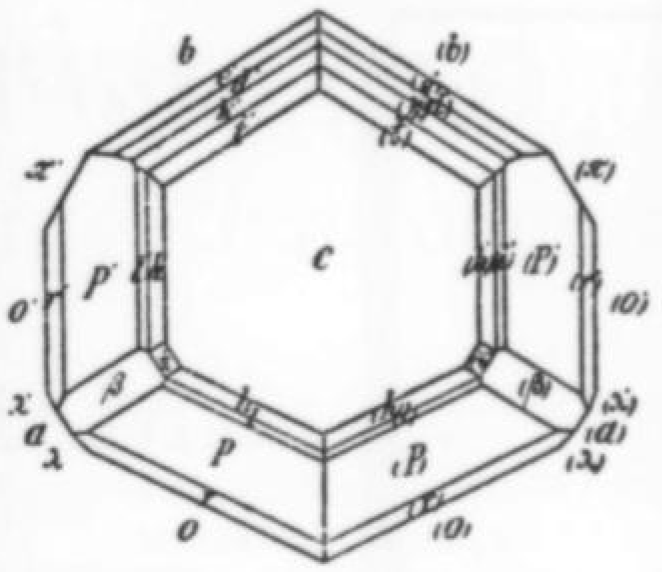
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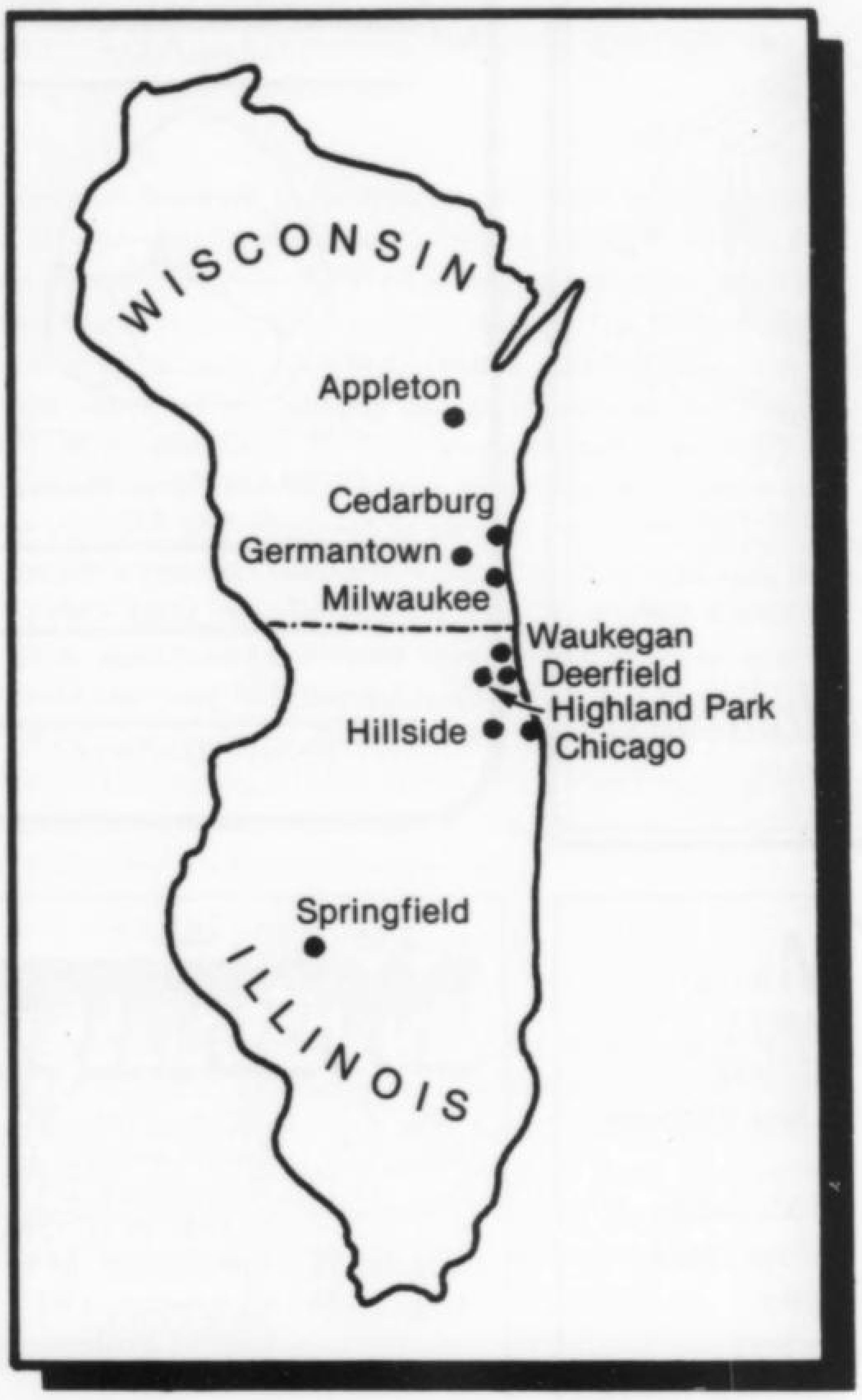
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CHERNIKOVITE

a new mineral name for $(H_3O)_2(UO_2)_2(PO_4)_2 \cdot 6H_2O$ superseding "hydrogen autunite"

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ABSTRACT

Chernikovite, $(H_3O)_2(UO_2)_2(PO_4)_2 \cdot 6H_2O$, is a new name proposed for a mineral originally found in the USSR. A second occurrence from Brazil and a third from the USSR are also recorded.

The type material from the USSR forms thin, transparent, mica-like plates, elongated along [010], with a perfect (001) and an imperfect (100) cleavage. The color is pale yellow, the luster vitreous and the ultraviolet fluorescence intense yellow-green. Optically the mineral is uniaxial (−) with $\epsilon = 1.569$ and $\omega = 1.583$. The mineral is tetragonal with unit cell parameters a = 7.030(6) and c = 9.034(8)Å; the strongest X-ray lines are [d in Å (I)(hkl)] 5.51(90)(101), 4.99(100)(110), 3.82(80)(102), 3.54(100)(200) and 3.26(100)(201).

The Brazilian material occurs at Perus, São Paulo, as inclusions in autunite and meta-autunite, which line fractures in granites and granitic pegmatites. It is optically lemon-green and slightly pleochroic, uniaxial (−) or slightly biaxial, $\epsilon = 1.570$ and $\omega = 1.580$. The unit cell parameters are a = 7.016(3) and c = 9.055(4)Å; the strongest X-ray lines are 9.00(100)(001), 3.78(90)(102), 3.50(70)(200), 3.27(80)(201) and 2.77(70)(103, 202).

Synthetic chernikovite consists of microscopic square and octagonal plates, uniaxial (−), with $\epsilon = 1.568(1)$ and $\omega = 1.579(1)$. Chemical analysis gives $UO_3 = 65.08$, $P_2O_5 = 16.03$, $H_2O = 19.33$, total 100.44 weight %. Cell parameters are a = 7.020(5) and c = 9.043(5)Å; the strongest X-ray lines are 9.032(100)(001), 3.799(90)(102), 3.511(70)(200), 3.270(80)(201) and 2.765(70)(103, 202). The calculated density is 3.264 g/cm^3 for the synthetic material and for the Brazilian chernikovite, and 3.258 g/cm^3 for the Soviet chernikovite. Chernikovite is probably isostructural with meta-ankoleite, uramphite and abernathyite. The original name for chernikovite, "hydrogen autunite," is misleading and is now discarded.

INTRODUCTION

The name "hydrogen autunite" was proposed for a synthetic product studied by various authors, e.g., Lienau (1898), Frondel (1950) and Ross (1955). A naturally occurring substance from the USSR was identified with this material by Chernikov (1958). A second occurrence from Brazil was described by Camargo (1971), and a third occurrence from the USSR was recorded by Kashirtseva and Valueva (1979). The I.M.A. Commission on New Minerals and Mineral Names never approved "hydrogen autunite," and the name is not reported in the *Glossary of Mineral Species* (Fleischer, 1987). Since the name "hydrogen autunite" is misleading, it is here proposed to change the name of the mineral to chernikovite as a tribute to A. A. Chernikov. Both the mineral and its new name were approved by the I.M.A. Commission on New Minerals and Mineral Names. This note presents a compilation of pertinent mineralogical data on chernikovite.

OCCURRENCE AND PARAGENESIS

Neither Chernikov (1958) nor Kashirtseva and Valueva (1979) gave any indication of the exact location of the Soviet occurrences. The mineral studied by Camargo (1971) was found at a quarry in the Perus district, 25 km north of the city of São Paulo, Brazil, as inclusions in autunite and meta-autunite. Other secondary uranium minerals associated with Brazilian chernikovite are uranophane, uranophane-beta, phosphuranylite, torbernite, metatorbernite, haiweeite, and uranian opal. These minerals occur on fractures and joint surfaces of tourmaline-bearing granites and granitic pegmatites. The Soviet chernikovite studied by Kashirtseva and Valueva (1979) is associated with autunite, meta-autunite, and sodium autunite, and appears on fissures within quartz syenite and around fossil wood contained in conglomerates.

HABIT AND PHYSICAL PROPERTIES

The Soviet chernikovite (Chernikov, 1958) forms thin, transparent, mica-like plates, elongated along [010], with a perfect (001) and an imperfect (100) cleavage. Its color is pale yellow, the luster is vitreous, and there is an intense yellow-green ultraviolet fluorescence. The Brazilian chernikovite (Camargo, 1971) occurs mainly as oriented and neatly zoned inclusions in autunite and meta-autunite (Fig. 1a). The inclusions commonly display rod-like forms in parallel orientation with the host and on the whole exhibit a hieroglyph-like aspect (Fig. 1b). There are also small plates with irregular or geometrical contours, whose size does not exceed 10 µm (Fig. 1c). Inclusions of chernikovite are observed growing parallel to autunite cleavages (Fig. 1d). The synthetic chernikovite described by Ross (1955) consists of microscopic square and octagonal plates. The calculated density for the ideal formula is 3.264 g/cm^3 for the synthetic material, 3.258 g/cm^3 for the Soviet chernikovite, and 3.264 g/cm^3 for the Brazilian chernikovite.

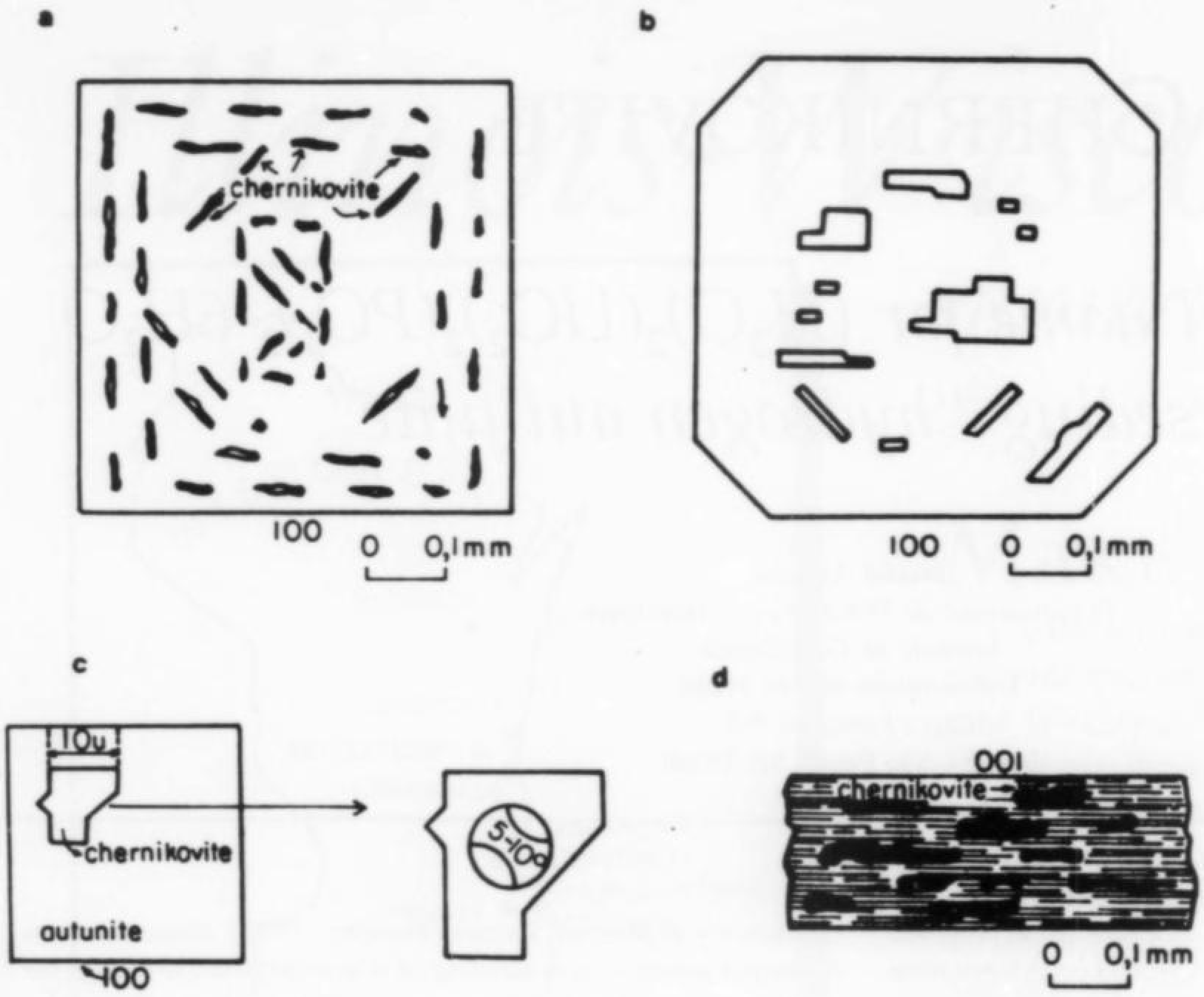

Figure 1. **(a) Oriented inclusions of chernikovite in autunite. Note the zoned pattern of the inclusions. (b) Hieroglyph-like inclusions of chernikovite in autunite. (c) Idiomorphic plate of chernikovite in autunite. (d) Inclusions of chernikovite oriented parallel to the (001) autunite cleavage (Camargo, 1971).**

OPTICAL PROPERTIES

Chernikovite is uniaxial negative. The Brazilian material is lemon-green and slightly pleochroic. The largest plates may be anomalously biaxial, with $2V \approx 5$–10° (Camargo, 1971). Table 1 presents refractive indices recorded for natural and synthetic chernikovite. Brazilian chernikovite can be easily recognized as an inclusion by its refractive indices, which are lower than those of the autunite and meta-autunite hosts (Camargo, 1971).

CHEMICAL DATA

Chemical data for the synthetic material (Ross, 1955) are listed in Table 2 and are consistent with the ideal formula $(H_3O)_2(UO_2)_2(PO_4)_2 \cdot 6H_2O$. Of the total hydration water 9.28 weight % is lost at 110°C (Ross, 1955). Spectrographic analyses of the Soviet samples (Chernikov, 1958) yield abundant U and P, and traces of other elements which are considered to be impurities. Infrared spectrographic data for Brazilian autunite with meta-autunite and chernikovite inclusions are available, and these indicate the presence of phosphate and uranyl ions and water. No impurity peaks were observed (Camargo, 1971).

CRYSTALLOGRAPHY

The X-ray powder diffraction data of chernikovite (Table 3) can be indexed on a tetragonal unit cell having the probable space-group *P4/nmm*. The cell content is $(H_3O)_2(UO_2)_2(PO_4)_2 \cdot 6H_2O$ with $Z = 1$. However, the cell parameters, refined by least-squares, given in Table 4, may actually represent a pseudo-cell. By analogy with the meta-autunite group minerals studied by Ross and Evans (1964), the *c* dimension may be doubled and the space group of the pseudo-cell would then be *P4/ncc*. On the other hand, if the cell relationships in chernikovite are the same as those in meta-autunite (I) (Ross, 1963), the true cell would be generated by rotating the pseudo-cell 45° about the *c*-axis and the space group would thus be $P4_222$.

Powder diffraction patterns of chernikovite exhibit, on account of its easy (001) cleavage, a very strong (001) reflection, located between the (002) peak of autunite and the (001) peak of meta-autunite; when the three minerals occur together, identification of the phases is very easy (Camargo, 1971). The 9 Å peak of autunite often mentioned in the literature may actually correspond to admixed chernikovite, as clearly shown by Camargo (1971) in the case of Brazilian material.

Calculations using the Gladstone-Dale relationship for the ideal formula, the calculated density and the recorded refractive indices, using constants reported by Mandarino (1976), yield $K_P = 0.176$ for the synthetic material, $K_P = 0.177$ for the Soviet and Brazilian chernikovite, and $K_C = 0.168$ for the three materials. Hence $1-(K_P/K_C)$ is -0.0476 for the synthetic material, and -0.0536 for the Soviet and Brazilian chernikovite indicating good compatibility in all cases (Mandarino, 1979).

NOMENCLATURE AND RELATIONSHIP TO OTHER SPECIES

The name chernikovite honors Dr. A. A. Chernikov, of the Institute of Mineralogy, Geochemistry and Crystallochemistry of Rare Elements, Moscow, USSR, who first described the naturally occurring mineral (Chernikov, 1958). The name "hydrogen autunite" should be discarded for several reasons:

(1) The mineral contains $(H_3O)^+$ ions and not simply H^+.

(2) Its degree of hydration is the same as that observed for minerals of the meta-autunite group, whereas the name autunite is reserved for minerals with 10 to 12 molecules of H_2O. The name "hydrogen autunite" therefore violates this usage.

(3) The name "hydrogen autunite" has also been used for other natural (Belova, 1975) and artificial compounds (Harris and Scott, 1949; Weiss *et al.*, 1957; Moroz *et al.*, 1973). These incompletely studied substances have different properties including refractive indices, densities and *c* dimensions of their unit cells. Such compounds may actually be polymorphs of chernikovite (Moroz *et al.*, 1973); alternatively, they may represent compounds with different degrees of hydration (as suggested by Chernikov, 1958) or phases where the

***Table 1*. Refractive indices for chernikovite.**

	1	2	3
X = ϵ	1.568(1)	1.569	1.570
Z = ω	1.579(1)	1.583	1.580

1. Synthetic (Ross, 1955).
2. USSR (Chernikov, 1958).
3. Perus, São Paulo, Brazil (Camargo, 1971).

***Table 2*. Chemical data for chernikovite (wt. %).**

	1	2
UO_3	65.29	65.08
P_2O_5	16.20	16.03
H_2O	18.51	19.33
Total	100.00	100.44

1. $(H_3O)_2(UO_2)_2(PO_4)_2 \cdot 6H_2O$.
2. Synthetic (Ross, 1955).

two $(H_3O)^+$ ions are substituted by one $(UO_2)^{+2}$, as may be the case with trögerite and "hydrogen uranospinite" (Shchipanova *et al.*, 1971). A specimen of the type material (studied by Chernikov, 1958) is deposited in the A. E. Fersman Mineralogical Museum of the Academy of Science of the USSR in Moscow (Chernikov, personal communication).

Chernikovite has an X-ray powder diffraction pattern similar to those of the minerals meta-ankoleite $[K_2(UO_2)_2(PO_4)_2 \cdot 6H_2O]$, uramphite $[(NH_4)_2(UO_2)_2(PO_4)_2 \cdot 6H_2O]$, and abernathyite $[K_2(UO_2)_2(AsO_4)_2 \cdot 6H_2O]$ and to the synthetic products $(NH_4)_2(UO_2)_2(AsO_4)_2 \cdot 6H_2O$ and $K(H_3O)(UO_2)_2(AsO_4)_2 \cdot 6H_2O$ studied by Mrose (1953) and Ross and Evans (1964). These compounds may be isostructural with chernikovite. An unnamed mineral, referred to as the phosphorus analog of trögerite and to which the formula $(UO_2)_3(PO_4)_2 \cdot 8H_2O$ has been ascribed, was reported by Belova *et al.* (1963). The powder diffraction pattern, represented on card 26-887 in the JCPDS file, is apparently from a mixture of two phases, one of which had peaks indexed, while the other shows peaks which could not be indexed. The material whose peaks have been indexed is possibly the natural analog of the synthetic compound $(UO_2)_3(PO_4)_2 \cdot 8H_2O$, cited by Belova *et al.* (1963), and the other probably corresponds to chernikovite.

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***Table 4*. Unit-cell parameters for chernikovite.**

	1	2	3
a(Å)	7.020(5)	7.030(6)	7.016(3)
c(Å)	9.043(5)	9.034(8)	9.055(4)
V(Å³)	445.6	446.5	445.7
c:a	1.288	1.285	1.291

1. Synthetic (Ross, 1955; JCPDS 8-296).
2. USSR (calculated from the data of Chernikov, 1958).
3. Perus, São Paulo, Brazil (calculated from the data of Camargo, 1971).

***Table 3*. X-ray diffraction data for chernikovite.**

1		2		3		hkl*
d(Å)	I/I_o	d(Å)	I/I_o	d(Å)	I/I_o	
9.032	100	8.89	40	9.00	100	001
5.556	50	5.51	90	5.59	60	101
4.971	40	4.99	100	4.96	60	110
4.542	5	—	—	4.51	5	002
4.360	30	4.29	50	4.34	50	111
3.799	90	3.82	80	3.78	90	102
3.511	70	3.54	100	3.50	70	200
3.270	80	3.26	100	3.27	80	201
2.964	60	2.96	60	2.96	50	211
2.765	70	2.77	40	2.77	70	103, 202
2.576	30	2.57	40	2.58	10	113, 212
2.488	30	2.49	50	2.49	30	220
2.397	40	2.40	60	2.40	30	221
2.267	20	2.27	60	2.26	30	004, 301
2.216	30	—	—	2.22	30	310
2.163	50	2.16	70	2.17	30	104, 213, 222, 311
2.075	40	2.09	70	2.08	30	302
—	—	2.01	50	—	—	312
1.902	20	1.906	40	1.900	20	204, 321
1.844	30	1.850	40	1.847	10	303
1.789	30	1.795	50	1.786	20	313, 322
1.755	20	1.749	20	1.753	20	105, 400
1.722	20	1.727	20	1.722	20	401
1.697	30	1.680	20	1.699	20	115
1.633	30	1.642	30	1.630	20	323, 402
1.61–1.57	30	1.618 1.570	30 50	1.590	30	314, etc.
1.546	10	1.550	20	1.543	20	421
1.477	10	1.473	10	1.478	5	106, 324, 413, 422
1.439	10	—	—	1.441	10	116
1.401	20	1.401	10	1.401	15	315
1.383	10	1.381	40	1.385	10	206, 404, 431, 501
1.359	10	—	—	1.360	10	216, 414, 511
1.338	5	1.335	10	1.339	10	334, 432, 502
1.288	5	—	—	1.288	5	226, 424, 521
1.270	10	1.271	10	1.271	10	107, 306, 433, 503
1.249	20	1.245	10	1.248	10	117, 316, 513, 522
1.221	5	1.221	20	1.223	5	335
—	—	1.201	10	—	—	530
1.194	30	1.192	20	1.193	20	217, 326, 434, 442, 504, 523, 531
		1.172	50			
		1.109	20			
		1.097	20			
		1.064	20			
		1.021	10			
		1.006	10			

*For the *P4/nmm* cell.
1. Synthetic (Ross, 1955; JCPDS 8-296).
2. USSR (Chernikov, 1958).
3. Perus, São Paulo, Brazil (Camargo, 1971).

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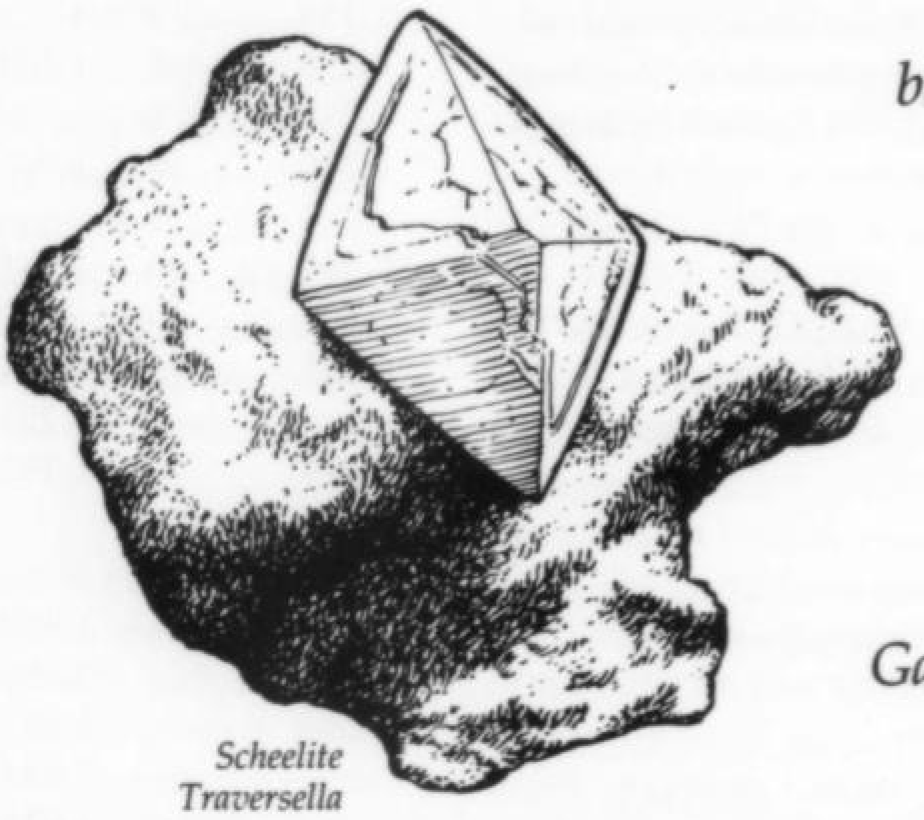

Scheelite Traversella

CALCIUM ARSENATE MINERALS

new to the Getchell mine, Nevada

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INTRODUCTION

The Getchell mine, Humboldt County, Nevada continues to be a source for rare and interesting minerals. In a recent locality description of this well-known mine Stolburg and Dunning (1985) noted several unidentified calcium arsenate minerals coating fractures in massive realgar and calcite samples. These arsenates were first qualitatively analyzed in 1985 by energy dispersive X-ray analysis but were not fully identified until recently when X-ray diffraction analyses were completed. These arsenates include guerinite, haidingerite, pharmacolite and weilite.

NORTH PIT AREA

The samples examined in this study were collected by the author during 1967 from the walls of the Getchell North pit. At that time the pit measured about 50 meters wide, 100 meters long and nearly 10 meters deep. The lowest part of the pit was covered with about a meter or so of water. Talus consisting of a black, carbonaceous shale and quartz mixture was found to extend nearly to the water's edge. Masses and veins of calcite and realgar with some orpiment were found throughout this debris. The wallrock contained abundant white to gray coatings of what was later determined to be several calcium arsenate minerals, mostly picropharmacolite. Judging by the appearance of these coatings they were most probably deposited by descending acidic waters reacting with the wallrocks.

IDENTIFICATION

The hand-size samples were carefully reduced in size for optical and SEM/EDS examination. The basic mineral content of these samples is realgar and calcite with minor orpiment, fluorite and a few galkhaite crystals. When split, these samples revealed masses of clear, acicular crystals along the fractures across the realgar and calcite. Some of these crystal masses, however, were found to be nearly white. X-ray diffraction of the clear crystals proved them to be pharmacolite while the white crystals were found to be a mixture of pharmacolite and haidingerite.

Other samples, when broken, revealed masses of a clear to pearly white mineral with a platy habit coating grain surfaces of both realgar and calcite. This mineral was later identified by X-ray diffraction as guerinite. It is usually found in close association with pharmacolite but not often in intimate contact. The hand samples generally are composed of a core containing a mixture of calcite, realgar and some orpiment. Near the surface a thin, yellow-orange, fine-grained mineral was noted which appeared to be an alteration of the underlying realgar. This mineral was confirmed by X-ray to be pararealgar, which has been observed at Getchell for many years generally misidentified as orpiment.

Coating this thin veneer of pararealgar was a layer several millimeters thick composed of a white, fine-grained mineral. X-ray analysis proved this white mineral to be a mixture of picropharmacolite, pharmacolite, gypsum and the rare arsenate weilite.

MINERALS

Arsenolite As_2O_3

Minute, sharp octahedrons of arsenolite, up to 0.6 mm, were identified by EDS and crystal habit. They occur imbedded in a smectite-like mineral on massive realgar, usually associated with pharmacolite and guerinite.

Coloradoite HgTe

Several single grains of coloradoite, about 20 microns in diameter, were discovered during an SEM/EDS examination of realgar from the North pit.

Ferrimolybdite $Fe_2^{+3}(MoO_4)_3 \cdot 8H_2O$ (?)

Bright lime-yellow masses of pure ferrimolybdite have been identified on an old museum sample from the Moly pit at Getchell (S. Pullman, personal communication, 1987).

Guerinite $Ca_5H_2(AsO_4)_4 \cdot 9H_2O$

This rare calcium arsenate was first described by Nefedov (1961) from two museum samples, one labeled "wapplerite" from the Daniel mine, Schneeberg, East Germany, and the other labeled "pharmacolite," from Riechelsdorf, West Germany. In 1964 Pierrot described a third locality for guerinite from Sainte Marie-aux-Mines, France. Parker and Troy (1984) reported the first U.S. occurrence for guerinite from the Sterling Hill mine, Ogdensburg, New Jersey.

At Getchell, guerinite has been found on ore samples in the North pit as clear, pearly scales less than 0.5 mm, and as subhedral crystals coating both calcite and realgar grains. Abundant pharmacolite is usually found in close association. To date, about a dozen small samples containing guerinite have been preserved from the original realgar-rich samples. Both EDS and X-ray powder diffraction were used to identify the mineral.

Haidingerite $CaHAsO_4 \cdot H_2O$

Thin, white coatings and masses of haidingerite associated with pharmacolite (from which it was derived by dehydration) occur near the surface of specimens from the North pit area. It was identified by its X-ray pattern. Only a few small samples have been preserved.

Pararealgar AsS

Pararealgar was recently described as a new mineral from several localities in British Columbia, Canada (Roberts *et al.*, 1980). They

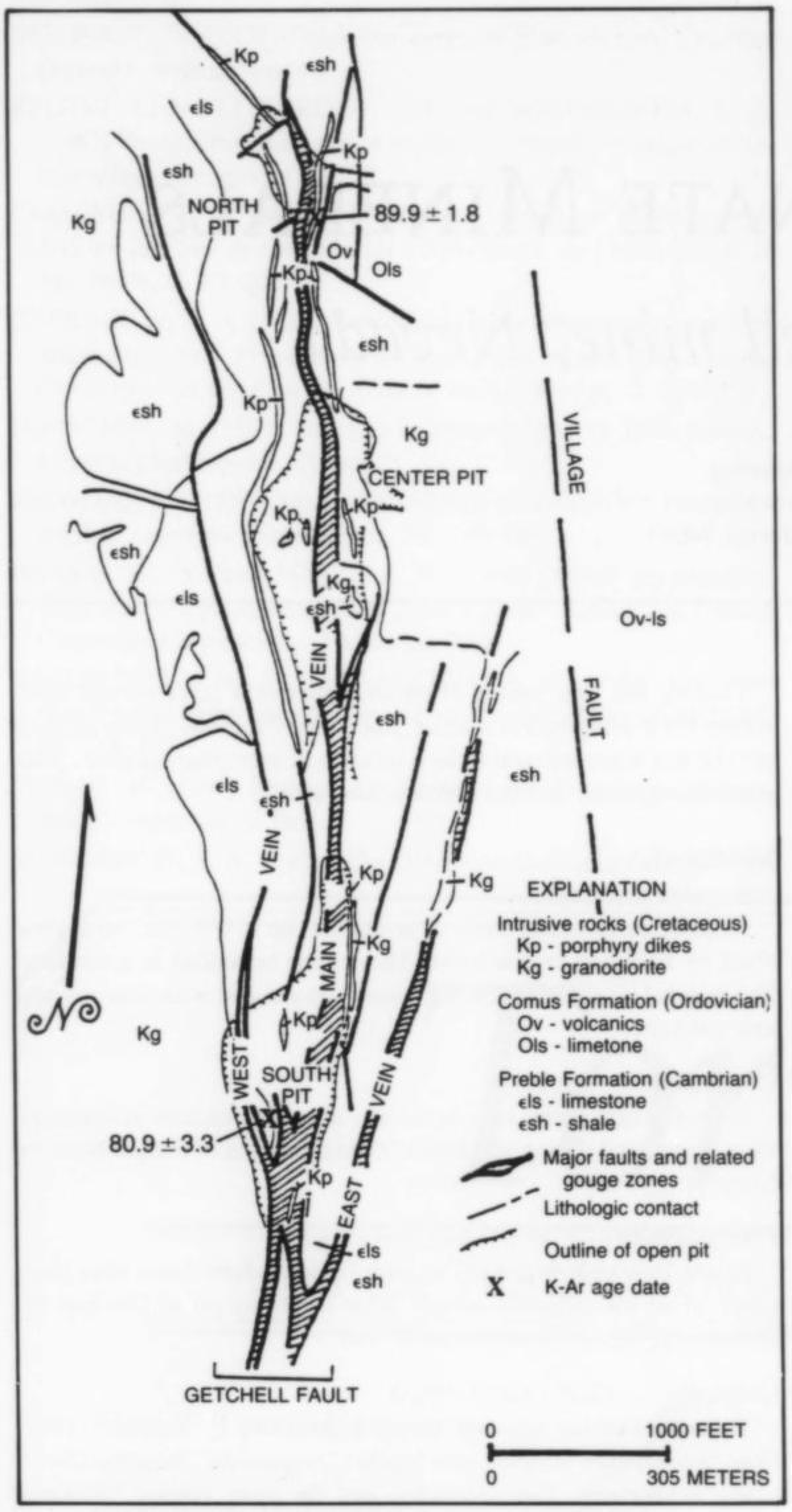

Figure 1. **Geologic map of the Getchell mine showing the location of the North, Central, and South Pits (Berger, 1980).**

also reported that it occurs in two realgar specimens of the National Mineral Collection, Geological Survey of Canada (#16058) which are labeled Golconda mine, Humboldt County, Nevada. This occurrence is most likely the Getchell mine near the town of Golconda.

Generally, the Getchell pararealagar has been observed as a pale orange-yellow coating on realgar which has been exposed to weathering. For many years, this material has been erroneously referred to as orpiment. In ore samples from the North pit area, pararealgar occurs as a thin halo around realgar. Usually a thin layer of weilite, haidingerite and picropharmacolite will be found on the pararealgar layer.

Pharmacolite $CaHAsO_4 \cdot 2H_2O$

Pharmacolite occurs as dense groups of radiating, acicular, subhedral crystals coating both realgar and calcite grains along fracture surfaces. Clusters of crystals are common along seams where small voids have formed. The crystals vary from transparent to white and present an attractive contrast against the red realgar background.

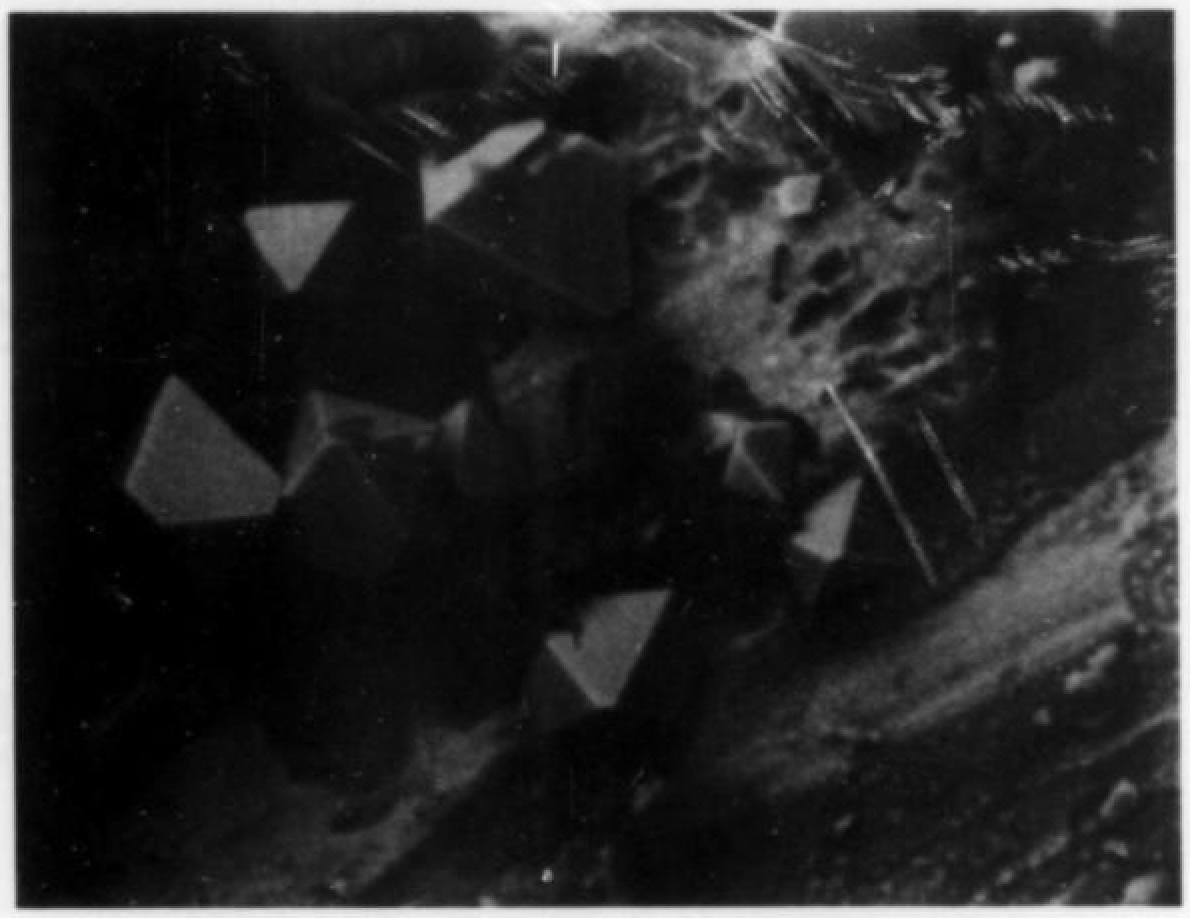

Figure 2. **Minute arsenolite octahedrons, to 20 microns, on realgar associated with a smectite-like mineral. G. Dunning photo and specimen.**

Figure 3. **Complex aggregation of thin subhedral guerinite crystals, colorless to white with a pearly luster. Field of view 0.24 x 0.3 mm. G. Dunning photo and specimen.**

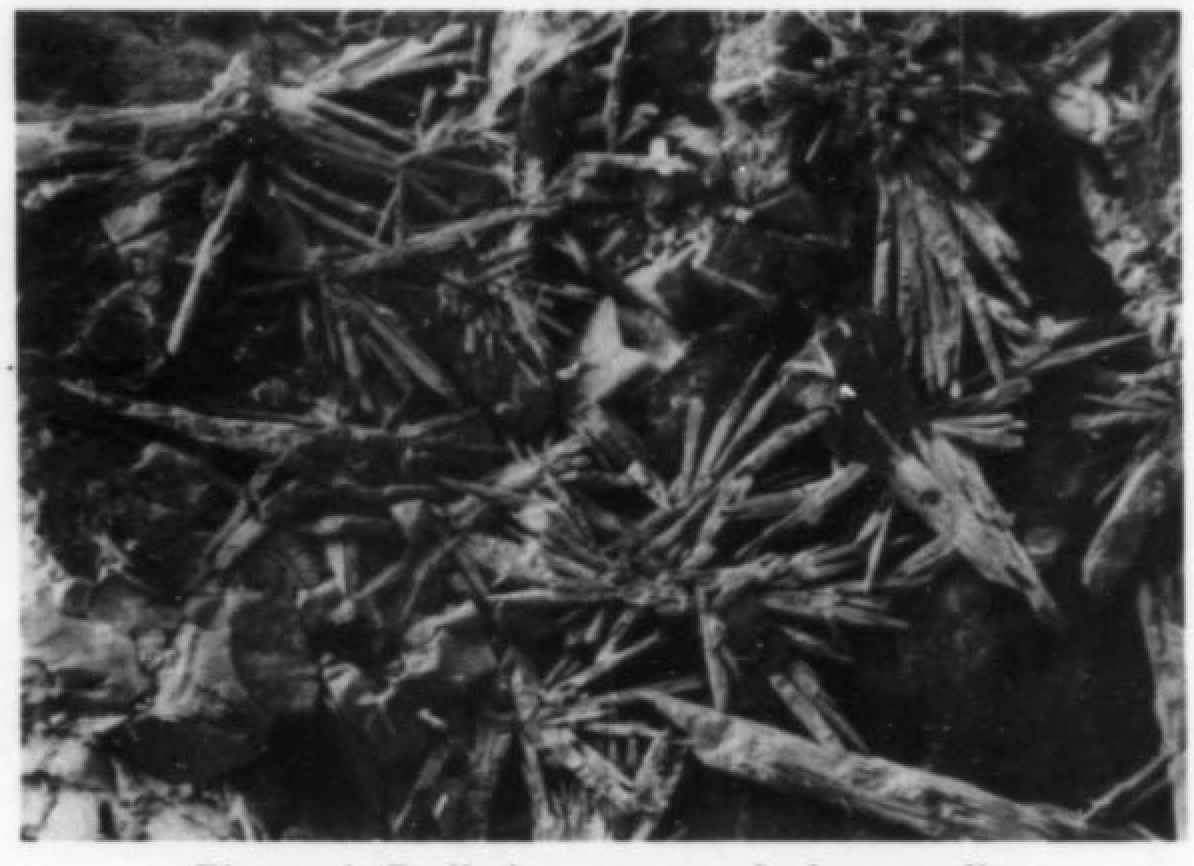

Figure 4. **Radiating groups of pharmacolite crystals to 0.4 mm coated with a thin film of haidingerite. G. Dunning photo and specimen.**

***Figure 5.* Cluster of acicular, colorless pharmacolite crystals, 5 mm in length. G. Dunning photo and specimen.**

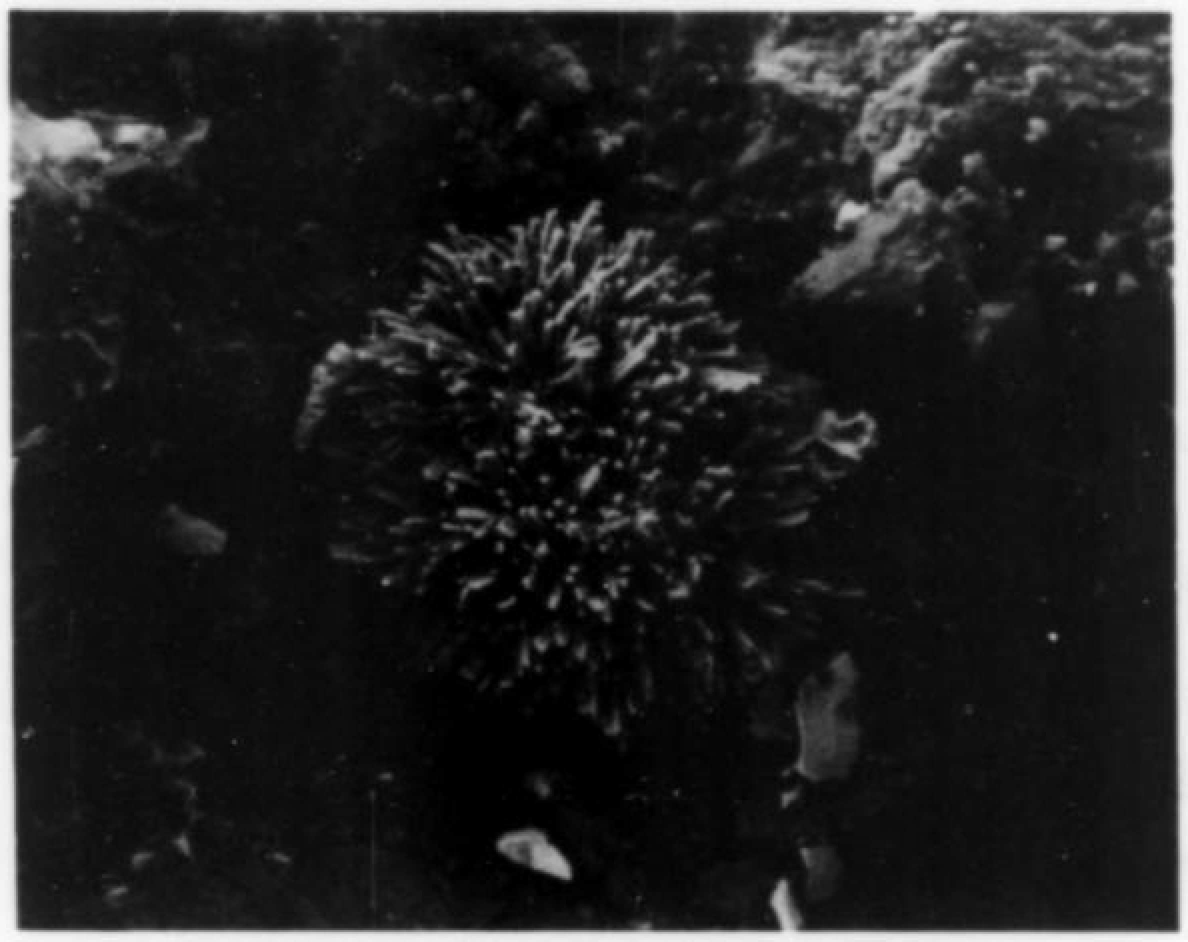

***Figure 6.* A radial-orientated group of white picropharmacolite needles attached to realgar. The group is about 0.1 mm in diameter. G. Dunning photo and specimen.**

Picropharmacolite $H_2Ca_4Mg(AsO_4)_4\cdot 11H_2O$

Picropharmacolite occurs abundantly at the west end of the North pit as coatings along fracture surfaces where acidic waters have percolated through the realgar-rich carbonaceous shales and quartz. It is generally subcrystalline and forms dense, white coatings less than 5 mm thick and also thicker botryoidal coatings; it shows a resemblance to cauliflower. Under the SEM, these coatings are seen to be composed of minute, bladed, subhedral crystals and grains less than 0.2 x 9 microns. Occasional groups of crystals with a radiating structure occur on the surface.

Weilite $CaHAsO_4$

Weilite was discovered and identified in 1959 by F. Permingeat. He entrusted the detailed study to Herpin and Pierrot, who published their results in 1963. The mineral was found on several museum specimens originally collected from the oxidized zone of arsenic-rich veins at unspecified deposits in both France and Germany, possibly at Sainte Marie-aux-Mines, France, and at Schneeberg, East Germany.

***Figure 7.* A white crust of weilite on picropharmacolite and pharmacolite. Base rock is carbonaceous shale. Sample is 2.5 x 4 cm. G. Dunning photo and specimen.**

At Getchell, weilite was identified by X-ray diffraction as a constituent of the outer white layer on picropharmacolite from the North pit area. It is very fine-grained and its formation is probably the result of a long-term dehydration of both pharmacolite and haidingerite.

DISCUSSION

The relatively high pH of descending solutions through the rocks surrounding the North pit was most likely responsible for the oxidation of both realgar and orpiment, and when these solutions contacted the calcite, they formed a series of calcium arsenates. The calcium arsenates at Getchell are difficult to recognize as individual species due to their tendency to occur admixed with other arsenates of similar composition and color. For instance, much of the white coatings from the North pit has been long considered to be picropharmacolite. Actually, these coatings are composed of mixtures of pharmacolite, haidingerite, weilite, gypsum and picropharmacolite. Table 2 com-

***Table 1.* Minerals found at the Getchell mine, Nevada.**

Elements
  Gold
  Graphite
Sulfides
  Chalcopyrite
  Cinnabar
  Coloradoite
  Marcasite
  Orpiment
  Pararealgar
  Pyrite
  Realgar
  Stibnite
Sulfosalts
  Galkhaite
  Getchellite
  Laffittite
Oxides
  Arsenolite
  Ilsemannite
Arsenates
  Guerinite
  Haidingerite
  Pharmacolite
  Picropharmacolite
  Weilite
Molybdates & Tungstates
  Ferrimolybdite
  Scheelite
Gangue Minerals
  Barite
  Calcite
  Chabazite
  Fluorite
  Gypsum
  Magnetite
  Quartz

Table 2. **Comparison of calcium arsenate minerals (*Getchell species in bold).**

Mineral	Composition	Crystal System	Color	Habit	Type Locality	References
***Guerinite**	$Ca_5H_2(AsO_4)_4 \cdot 9H_2O$	Monoclinic	Colorless	Spherulites, rosettes of acicular, wedge-shaped xls	Daniel mine, Schneeberg, East Germany; also at Riechelsdorf, West Germany	3, 8, 10, 17, 20
Ferrarisite	$Ca_5H_2(AsO_4)_4 \cdot 9H_2O$	Triclinic	Colorless	Acicular crystals	Gift mine, Sainte Marie-aux-Mines, France	3, 10
Vladimirite	$Ca_5H_2(AsO_4)_4 \cdot 5H_2O$	Monoclinic	Pale rose	Acicular, radial aggregates	Kovouaksi, Jouva, USSR	20
Sainfeldite	$Ca_5H_2(AsO_4)_4 \cdot 4H_2O$	Monoclinic	Colorless	Flattened rosettes of radiating crystals	Gabe Gottes vein, Sainte Marie-aux-Mines, France	14, 20
Phaunouxite	$Ca_3(AsO_4)_2 \cdot 11H_2O$	Triclinic	Colorless	Acicular, fan-shaped aggregates	Gabe Gottes vein, Sainte Marie-aux-Mines, France	4
Rauenthalite	$Ca_3(AsO_4)_2 \cdot 10H_2O$	Monoclinic or Triclinic	Colorless, snow-white	Rounded, irregular spherules; minute crystals	Rauenthal vein, Sainte Marie-aux-Mines, France	20
***Picropharmacolite**	$Ca_4MgH_2(AsO_4)_4 \cdot 11H_2O$	Triclinic	Colorless, white	As needles and concentric, mammillary incrustations	Riechelsdorf, West Germany	2, 11, 19
Irhtemite	$Ca_4MgH_2(AsO_4)_4 \cdot 4H_2O$	Monoclinic	Colorless, pale rose	Silky spherulites	Irhtem and Bou Azzar, Morocco	21
***Pharmacolite**	$CaH(AsO_4) \cdot 2H_2O$	Monoclinic	Colorless, white	As silky, acicular clusters of crystals; also botryoidal	Wittichen, West Germany	9, 12, 13, 15
***Haidingerite**	$CaH(AsO_4) \cdot H_2O$	Orthorhombic	Colorless, white	Fine-grained botryoidal to fibrous coatings	Joachimsthal, Bohemia	6, 7, 9
***Weilite**	$CaHAsO_4$	Triclinic	White	Porcelaneous, powdery incrustations	Sainte Marie-aux-Mines, France	16

pares some of the physical properties of these calcium arsenates and their associations. Although picropharmacolite is quite common in the North pit area, its dehydration product, irhtemite, has not yet been found there.

Three additional arsenic sulfides which have yet to be discovered at Getchell are uzonite, As_4S_5 (Popova and Polyakov, 1985), duranasite, As_4S, and alacranite, As_8S_9 (Popova *et al.*, 1986). All three have been found associated with realgar at their respective type localities.

CONCLUSIONS

The Getchell orebody still has the potential for producing additional mineral species including sulfides, sulfosalts and arsenates. Their discovery, however, will require much work using the microprobe, X-ray diffraction and the SEM. Additional calcium arsenates certainly could be present in both the Central and South pits in addition to the North pit.

The Getchell mine is now under lease to extract additional gold from the existing dumps by cyanide leaching. At present, collecting is not permitted and it is uncertain how this current development will affect future mineral collecting and preservation at this famous mine.

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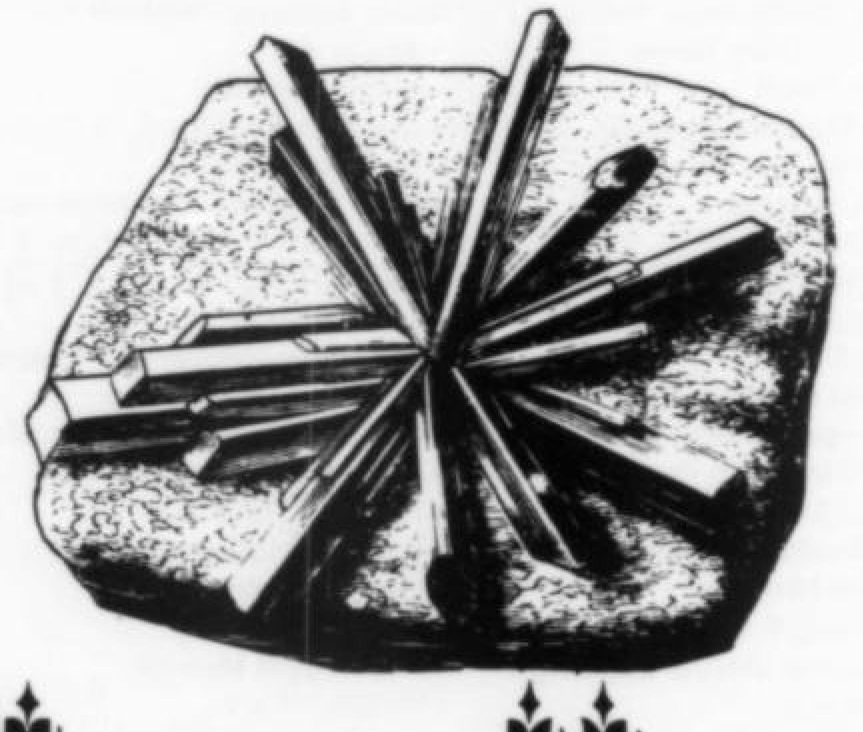

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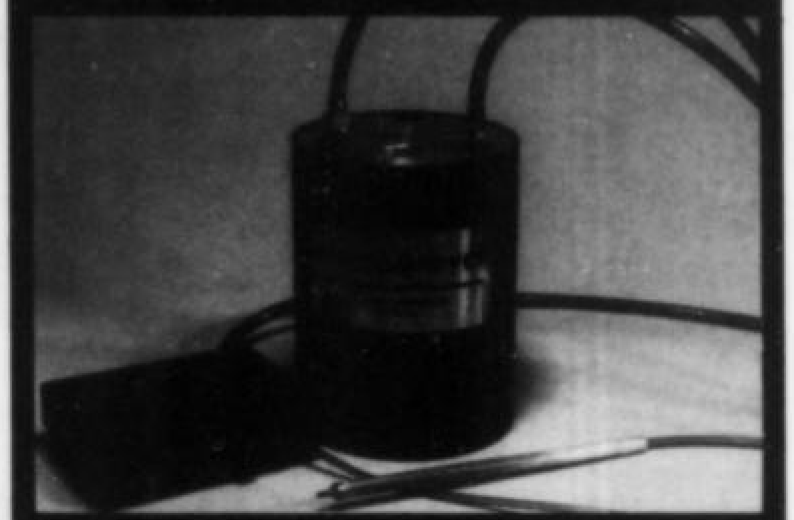

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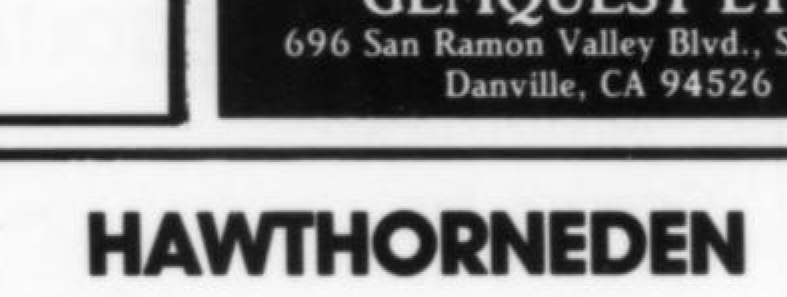

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The Denver Museum of Natural History has provided Coloradoans with numerous fine displays of important earth science collections, most notably a collection of gold specimens from Breckenridge, since first opening its doors to the public in 1908. These collections and the museum building itself have been expanded and augmented, right up to the present day.

HISTORY

The idea for a natural history museum in Denver was first proposed in 1892 by a pioneer naturalist named Edwin Carter. Many of Denver's most prominent citizens later convened in December of 1897 to consider Mr. Carter's plan: that a fireproof museum building be erected, that he should receive the sum of $10,000 for his extensive collection of stuffed and mounted birds and mammals, and that he be appointed Curator for life at a salary of $150 per month. Carter was rather advanced in years, so the latter provision was not liable to be a long-term commitment for the museum.

The Colorado Museum and Library Association was formed in 1898, with a constitution and by-laws patterned after those of the American Museum of Natural History in New York. Shortly thereafter, John T. Mason promised to donate his large butterfly and moth collection, and John F. Campion pledged his impressive collection of gold specimens from Breckenridge, Colorado.

Carter's proposal was formally accepted in 1899, but he died a year later, before ground had even been broken for the building. The City of Denver contributed $16,000 and a suitable site, and the museum association raised another $25,000 by personal subscription. The museum itself was formally incorporated in 1900 as the Colorado Museum of Natural History. It was renamed in 1948 to give proper credit to the City of Denver, which owns the property and the building.

When construction of the museum's first exhibition building was finally completed in 1908, the museum had accumulated 3,400 specimens of mounted animals, rocks and minerals. Campion, who had become the first president of the board of trustees, followed through with his pledge and transferred his remarkable gold collection to the new museum around 1909. During the dedication ceremony he observed that ". . . a museum of natural history is never finished. A completed museum is a dead museum, and that result, of course, the people of Colorado do not want."

Following Campion's philosophy, the museum has not stopped growing since that time. Other donations of specimens began to come in, including the mineral collections of Mary Kimball Pratt, Ettienne Ritter, R. C. Hills, Sadie House, Henry Porter and, in recent years, a portion of the extensive study collection of E. William Heinrich. Museum staff have made their own collecting excursions, bringing back a wealth of mineral and fossil specimens.

To accommodate the growing collections, additional wings were added to the museum building periodically over the years, resulting in a modern, attractive ediface which just last year underwent another major expansion. Today the museum boasts over 465,000 square feet of exhibit and office space, with large new atrium areas and an enormous new Tyranosaurus skeleton mounted in an unusual pose (standing on one foot, striking out with the other).

More than 47 million visitors have passed through the museum's doors since it first opened 80 years ago. Today it is the seventh largest natural history museum in the United States, internationally known for its lifesize ecological habitat dioramas, its mineral collection, dinosaur skeletons and more than 300 other exhibits. Total museum holdings currently exceed 200,000 objects.

THE MINERAL COLLECTION

The mineral collection currently numbers approximately 16,000 cataloged specimens (not including micromounts) of which 2500 are on public display. The display collection is tastefully presented in the Coors Mineral Hall, which opened January 3, 1982. The new mineral hall, financed by a $300,000 grant from the Adolf Coors Foundation, was designed by Jack Murphy, the museum's curator of geology, and Alan Espenlaub, manager of the Exhibits Division. The display area consists of a winding, carpeted pathway along which minerals are

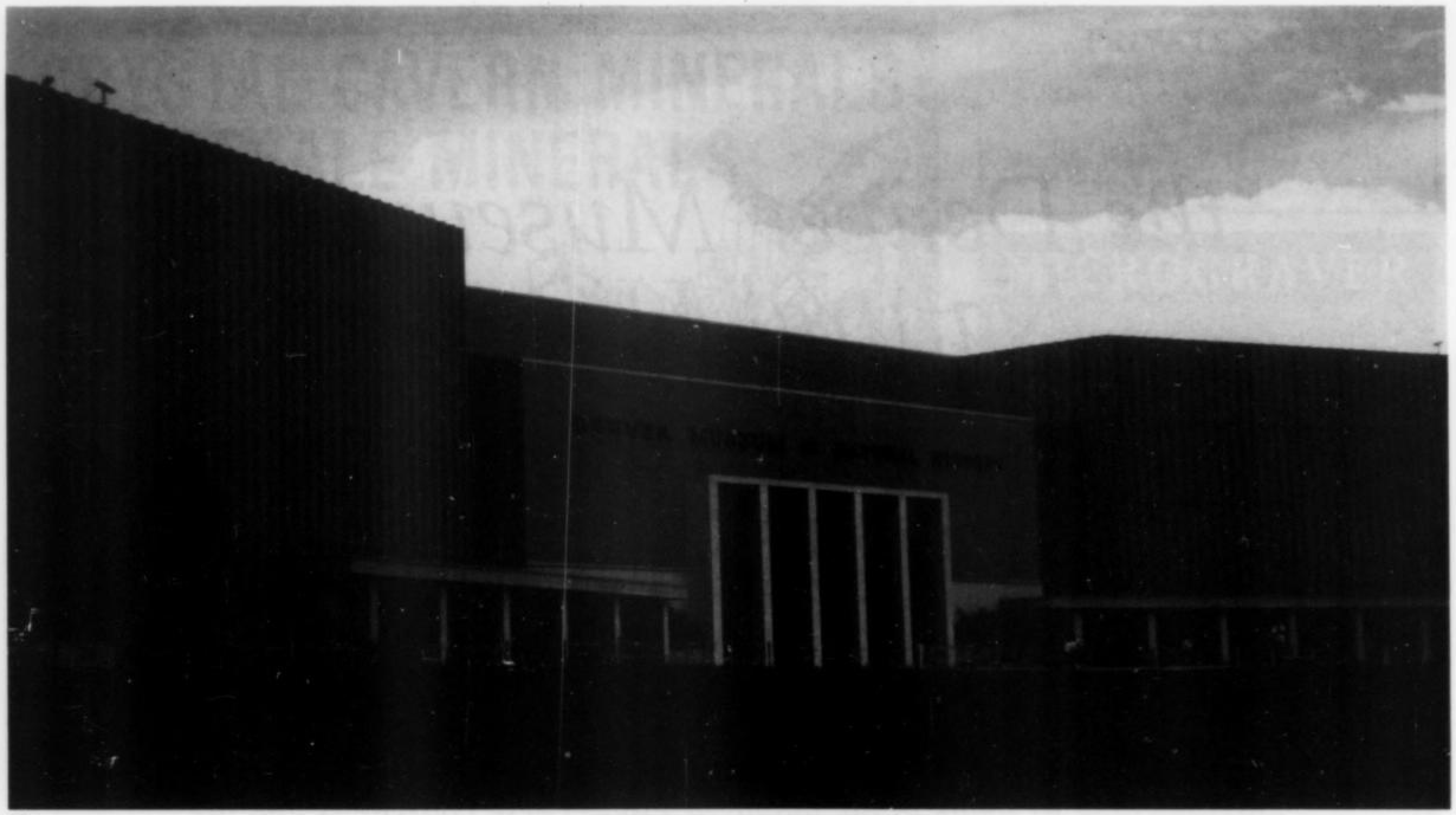

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Figure 1. **The Denver Museum of Natural History, in Denver's City Park.**

exhibited in four main sections: (1) an introductory earth science educational area, (2) minerals from worldwide localities and fluorescent minerals, (3) gemstones, and (4) minerals from Colorado.

As one proceeds through the exhibition area, a number of pleasing methods of display are evident. Individual specimens are not lined up in rows on glass shelves, but are displayed on wooden bases of various heights. Each case is isolated from the rest in a way that minimizes distractions. Strategically placed openings in the walls which separate the display pathways allow a glimpse at upcoming displays. This clever device encourages the observer to seek out new wonders along the sinuous pathways ahead.

The worldwide collection is displayed according to Dana's system of classification. One would expect to discover very fine specimens in a museum situated in a "mineral state," an expectation that is fulfilled. The worldwide collection, for example, has an impressive cabinet specimen of wolframite from Panasqueira, Portugal, and an excellent neptunite with the classic, thick, doubly terminated, mirror-bright crystals on white natrolite from the Gem mine, San Benito County, California. An exceptional Indian mesolite appears to be suspended in black space and captures your attention from several meters away. From the Calumet mine, Michigan, is a choice cabinet specimen of quartz, a cluster of crystals with a pale smoky tinge, on green epidote. Another standout is a muscovite on albite crystals from Northern Territory, Australia. It is considered by some to be one of the finest examples of its kind.

The Colorado mineral displays are the core of the collection. In a case entitled "Colorado Minerals" is an extraordinary group of cabinet specimens which alone are worth the price of admission to see. The collection's finest amazonite (see the cover of this issue) has large, sharp, deep blue-green crystals accented by albite overgrowths and small smoky quartz crystals. This piece was collected by Clarence Coil at Crystal Peak, Park County, and acquired by the museum in 1976. After contemplating the amazonite and recalibrating one's mental absolutes for this mineral, the eye turns toward a deep red, 10-cm semi-transparent rhodochrosite crystal. Found in the early 1960's at the Home Sweet Home mine near Alma, it illustrates how incredible the finest Colorado rhodochrosites can be. The color of this piece cannot be totally reproduced on film—one must experience these magnificent crystals with the unaided eye. Companions of the rhodochrosite and amazonite include a superb chalcopyrite from the Camp Bird mine and a galena from the Galena Queen mine; the galena shows 10-cm cubes in association with white quartz.

Within a darkened, circular alcove is the gold and silver collection. A blue-velvet-lined display contains about 100 Breckenridge gold specimens from the John F. Campion gold collection. This case is illustrated in a recent issue of the *Mineralogical Record*)vol. 18, no. 1, p. 59) along with other Campion specimens (p. 54–56). Campion was a businessman and mine owner from Denver who established a policy of specimen preservation in his mines. These mines produced some of America's finest crystallized leaf gold, which occurred in the rich veins on Farncomb Hill near Breckenridge in Summit County, Colorado. The golds, originally embedded in a soft limonite-calcite matrix, are on the most-desired list of many an avid collector. Sizes range from thumbnails to 20-cm cabinet pieces. Although these are the best pieces in the Campion collection, many more are currently held in storage. Photographs of the prominent cabinet specimens have appeared in numerous past publications. When viewing the Campion case it is worthwhile to carefully examine the small specimens as well. A number of these thumbnails have aesthetic octahedral crystallized aggregates. These pieces are not of the "classic" Breckenridge leaf form but look more like some crystallized California golds. The gold and silver room also contains a thick, heavy wire of gold in limonite matrix from the Ground Hog mine, Battle Mountain, Gilman District, Colorado (illustrated in vol. 7, no. 6, p. 284).

Colorado's largest crystallized gold specimen—Tom's Baby—is also to be found here, in its own vault display. It is a slab of intergrown leaves weighing 103 troy ounces (reduced from its original weight of 135 troy ounces, when it broke into a number of pieces during a final cleaning). A photograph of this specimen appeared in Thomas J. Hurley's *Famous Gold Nuggets of the World,* published in 1900, and

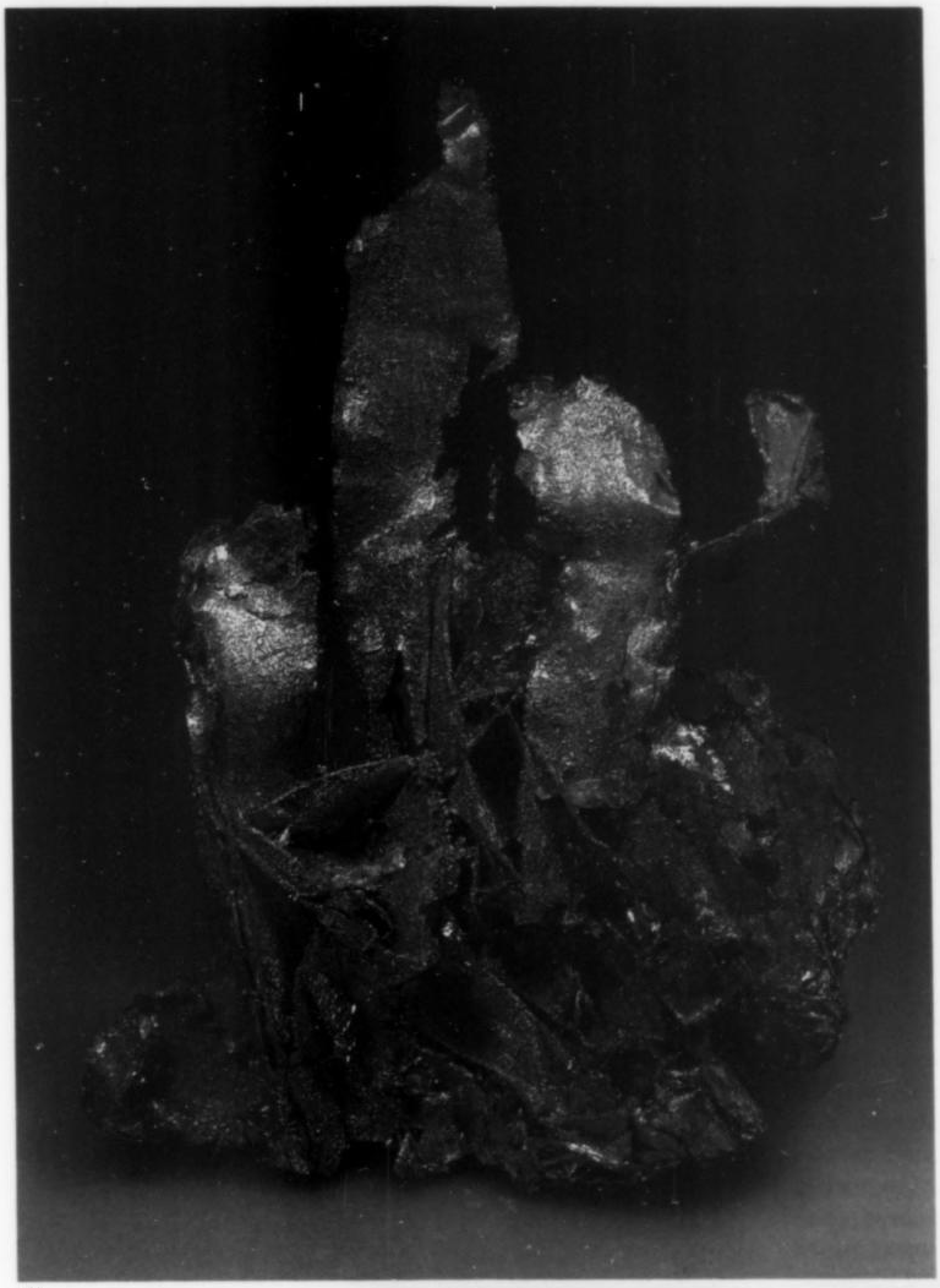

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Figure 2. **One of the largest Breckenridge golds from the Campion collection, 20 cm tall.**

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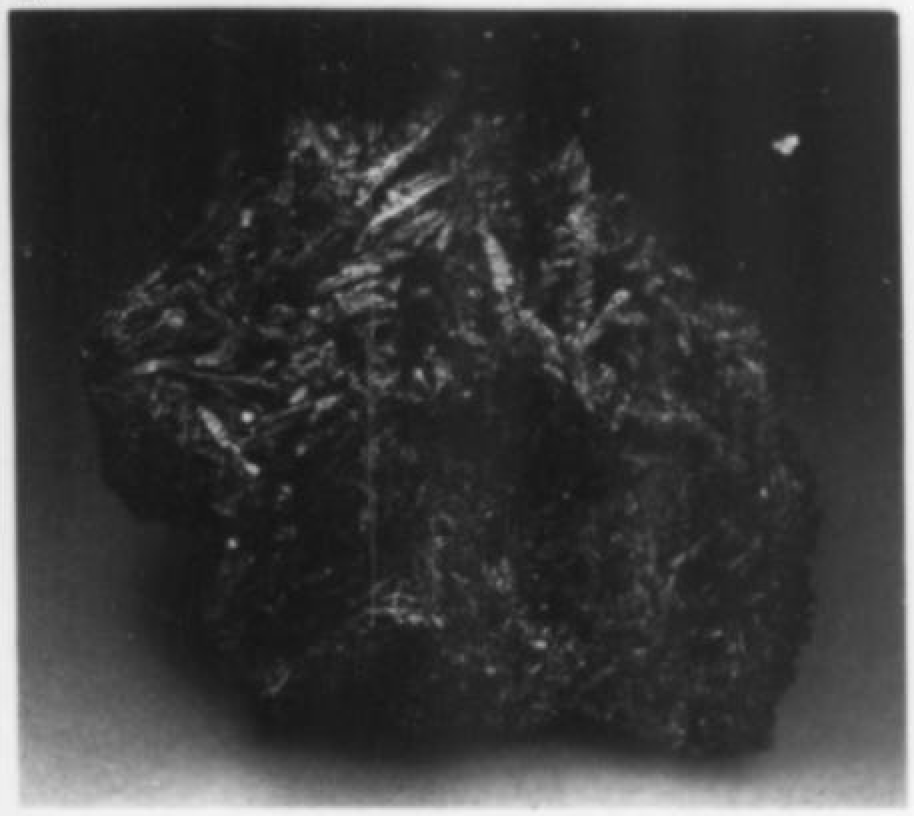

Figure 3. **Silver specimen, 13 cm, from the Commodore mine, Creede, Mineral County, Colorado.**

Figure 4. **Two fine thumbnail specimens (to 2.3 cm) of Breckenridge gold from the Campion collection.**

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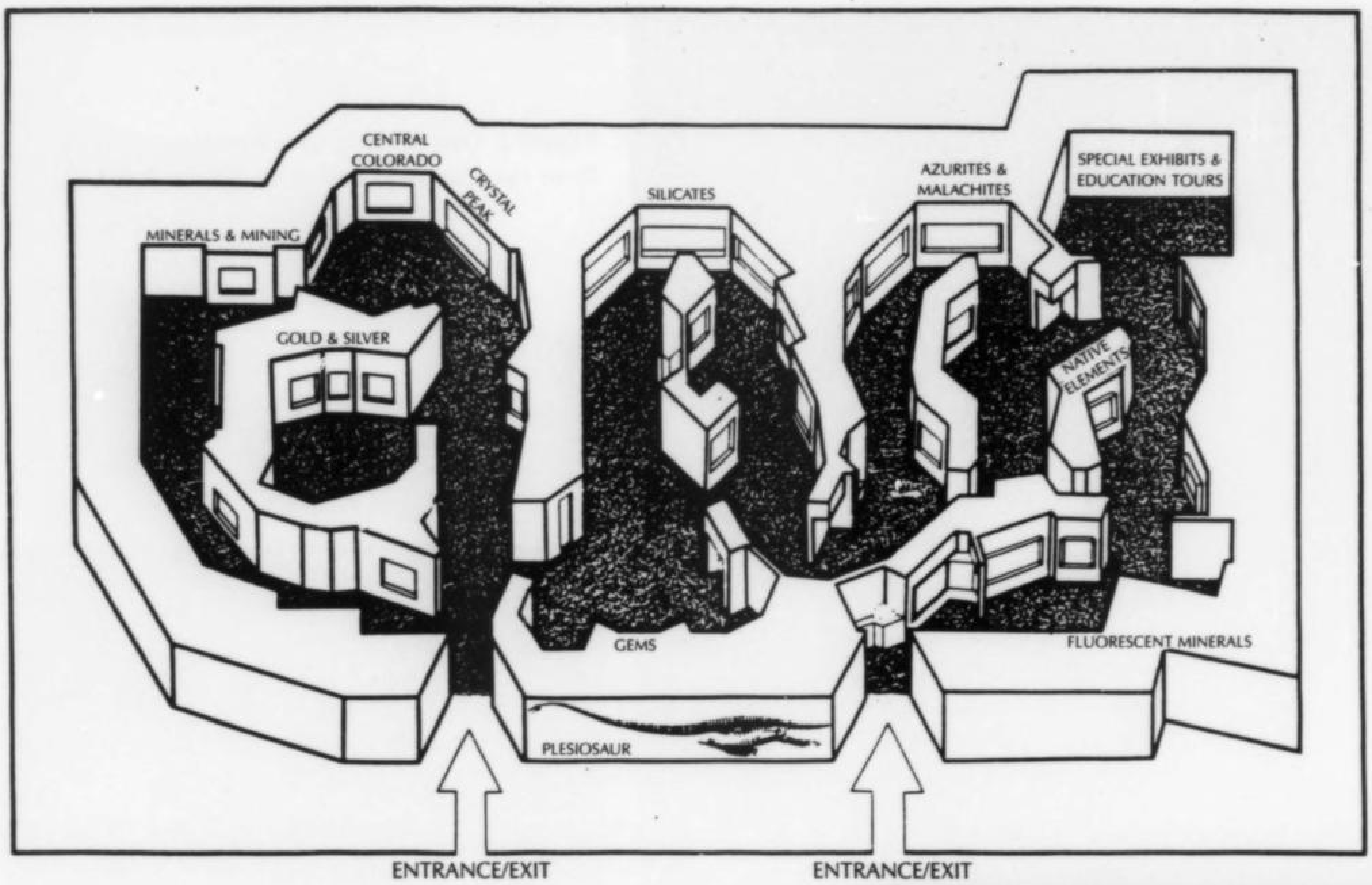

***Figure 5*. Floor plan of the mineral hall.**

in an 1899 issue of *Mining Reporter*. After 1900 its location was unknown until it was rediscovered in a Denver Bank vault, where it was kept for security reasons through World War II.

One of the creative display ideas at the Denver Museum of Natural History is the mineral diorama. These cases closely resemble the ecological dioramas for which the museum is famous, except that stuffed and mounted animals are absent, and instead the rocks show mineral outcrops. The effect is exciting, even for seasoned collectors, and especially for many lay persons who do not have in their conceptual framework the idea that these wondrous, aesthetic crystals could have originated naturally from the earth. Jack Murphy has done a splendid job in duplicating the way a crystallized cavity looks. A number of dioramas are on display, including an amazonite crystal cavity which was excavated by Jack Murphy and others.* This 2 x 3-meter exhibit contains a large background painting of the view looking southeast, across Crystal Peak and the valley where Florrisant is located, to Pikes Peak on the horizon, complete with a soaring eagle. The crystal pocket looks freshly opened and contains some excellent deep blue-green

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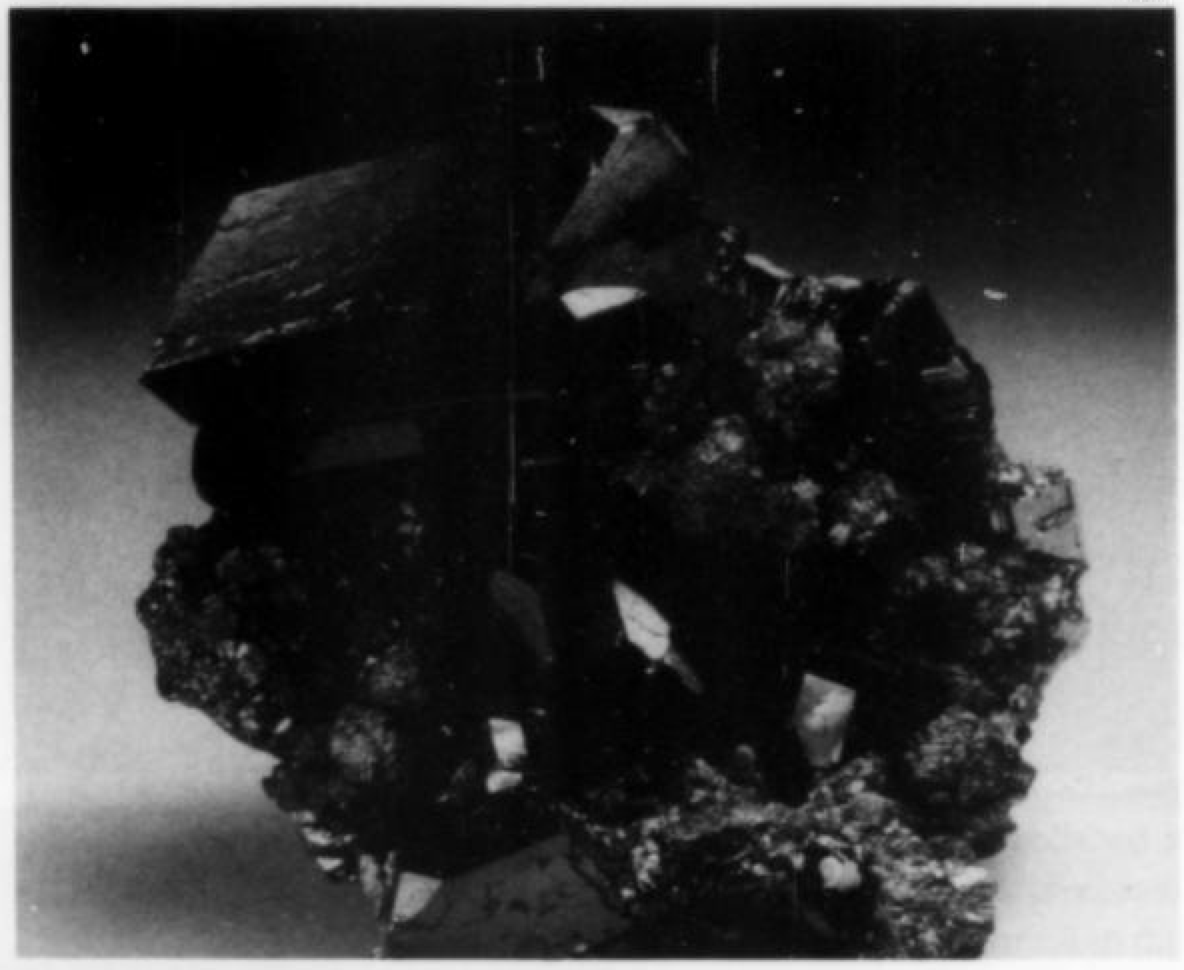

***Figure 6*. Wolframite crystals to 4.4 cm from Panasqueira, Portugal.**

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***Figure 7*. Tetrahedrite crystals, nearly all showing penetration twins, in a 12-cm group from the Longfellow mine, Red Mountain Pass, San Juan County, Colorado.**

The Cavern Diorama

The Denver Museum has a long tradition of constructing underground mineral environments and was among the first to install a cavern diorama using actual specimens.

In 1911 Museum Director J. D. Figgins envisioned a new display for the small growing institution—when he learned of fantastic cave formations encountered during silver mining operations at the El Potosi mine near Chihuahua, Mexico. These were being destroyed as mining advanced. Joseph Phillips, a well known Colorado mining man, was responsible for bringing them to the Museum's attention, and for removal and shipping of the cavern materials until 1913.

The limestone caves in the Santa Eulalia mining district were famous for their association with high grade silver ore and their stunning crystallized formations. William Foshag of the U.S. National Museum noted that a cave discovered in the El Potosi mine in 1912 "was remarkable for the wonderful beauty of its calcite and gypsum crystal growths. It was the habit to illuminate this cavern with a multitude of candles and for sheer brilliance and delicacy it probably surpassed anything yet discovered."

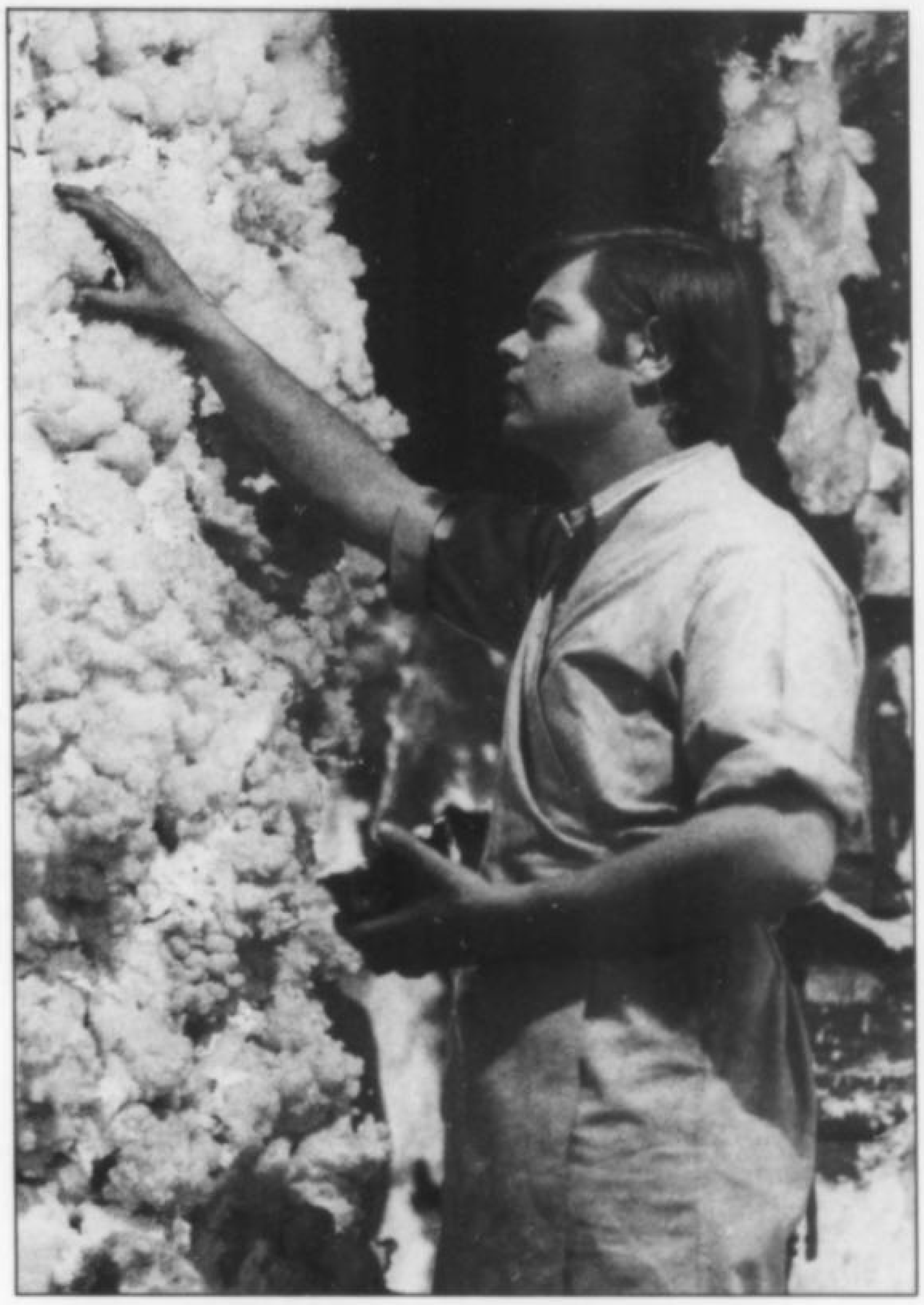
Two Museum patrons, Grant B. Schley of New York and Dennis Sullivan, president of the Denver National Bank, sponsored the acquisition of the fine crystallized calcite, aragonite and gypsum specimens for the cave reconstruction.

The El Potosi crystal cavern display was installed in the basement exhibit hall of the Museum and opened to the public in 1913. A background mural painted by staff artist Mary Chilton Gray was added in 1947. Superior specimens were placed on exhibit within the mineral collection. Similar crystals were also on display for many years at the American Museum of Natural History in New York.

The El Potosi Cavern display was a highlight of the Geology Hall and the only exhibit of its kind in any U.S. museum. If the cave had not been associated with active mining operations, it probably would never have been acquired since there is a strong American ethic against collecting and damaging limestone caves. The Museum has always considered the El Potosi cavern a conservation effort that preserved noteworthy specimens for future generations to study and enjoy.

In 1951 the cave exhibit was removed from exhibition due to construction of the west building addition. The hundreds of delicate crystallized specimens were placed in storage and plans were made to reinstall the cave in a larger new exhibit space.

In 1959 the Museum had the opportunity to collect spectacular gypsum crystals from the Naica mine, also in Chihuahua, Mexico. The Naica mine has long been known among mineralogists and collectors as a world famous locality for exceptional crystals of gypsum lining the walls and floors of caves. The "Cave of the Swords" is the best known locality. Here remarkable colorless bladed gypsum crystals attain lengths up to five or six feet. A reconstruction of a large cluster of these crystals has been on exhibit in the mineral hall in the National Museum of Natural History in Washington, DC for a number of years.



Curator Jack Murphy working on the gypsum wall from the Naica mine. Denver Museum of Natural History photograph.

The Museum's collecting activities at Naica in the 1960's occurred in the Xochitl Cavern, not the Cave of the Swords. Permission to collect selected crystals for the Museum cave exhibit was granted by the mine superintendent, Howard Keller, who felt they should be preserved in a museum instead of being collected and sold as specimens, a common practice around active mines.

The decision was made to present a composite exhibit and place the wall of Naica gypsum crystals on the far left wall of the reconstruction and the El Potosi calcites and aragonites on the remainder.

Reinstallation of the new cave began in a 20 x 25 foot area and a large mirror was installed that dramatically increased the apparent depth of the cavern. The display proceeded for several years and was completed by the writer, his staff and volunteers in 1975.

The cavern continues to be a focal point of the geology exhibits and is part of the introduction to the new Coors Mineral Hall opened in 1981.

Museum visitors mainly respond to the exhibit on an aesthetic level as it brings forth the awe inspiring nature of caves and it arouses curiosity about the unusual crystallized formations. New labels carry a conservation message about today's ethic against vandalizing caves by collecting specimens.

Jack A. Murphy, Curator of Geology

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*Surface float that led to the discovery of the Amazonite and smoky quartz pocket was found in the fall of 1981 by Jerry and Thelma Hurianek and John and Barbara Slagel (Barbara is Clarence Coil's daughter). They contacted Murphy, knowing that he was looking for a pocket to reconstruct in the mineral hall. Murphy and the Hurianeks subsequently visited the spot together and set about digging, not knowing what an exceptional treasure lay below. The pocket was informally nicknamed "Thelma's left hand pocket" since her right hand was injured and bandaged at that time, and she was digging with her left hand using a little curved screwdriver. Thelma is the one who first dug into the pocket and she and Jerry saw to it that it was donated to the Museum, knowing it would be preserved for future generations to enjoy.

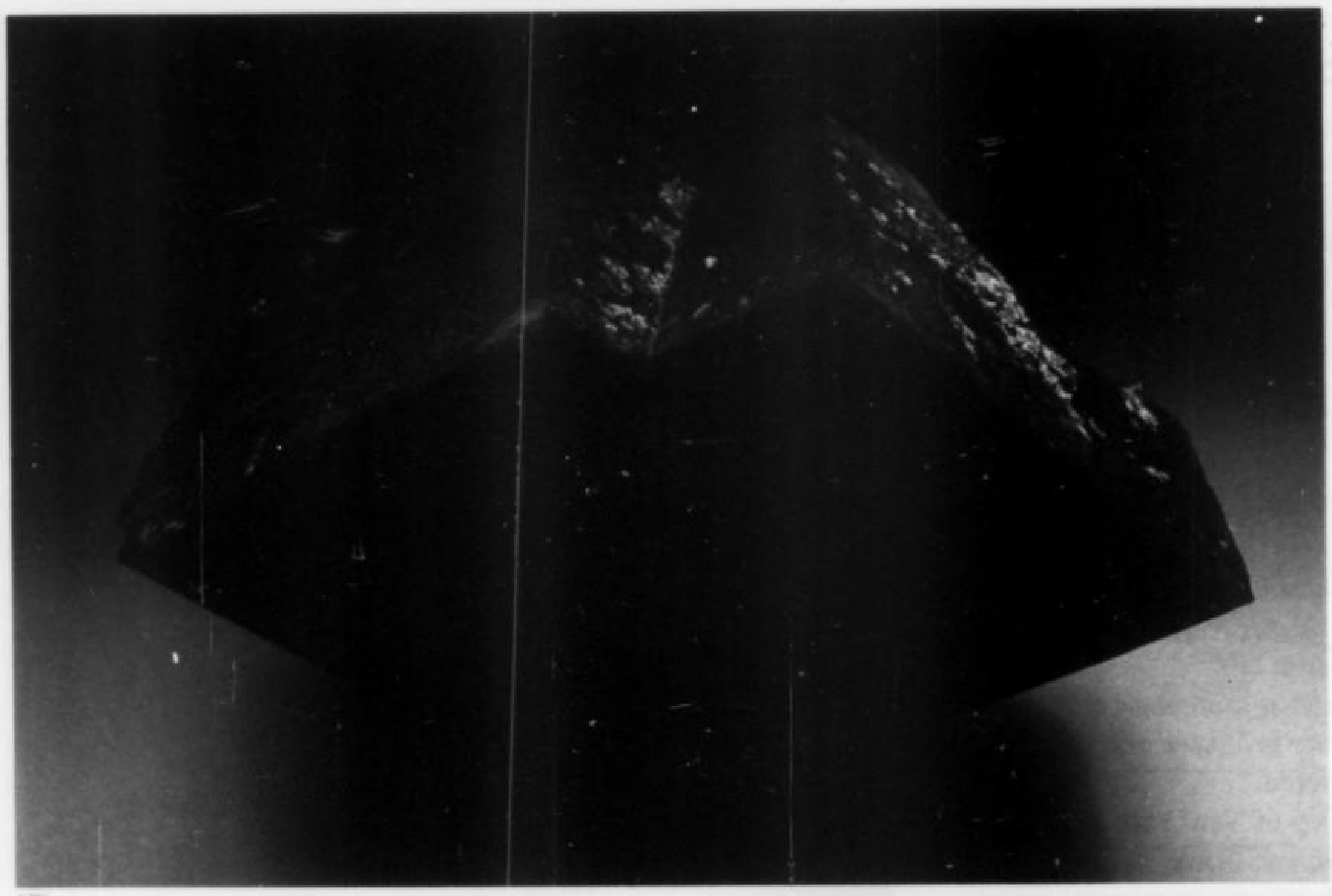

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Figure 8. **Enormous rhodochrosite crystal, 12 cm, from the Home Sweet Home mine near Alma, Colorado.**

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Figure 9. **Chalcopyrite crystal group, 7.3 cm, from the Camp Bird mine, Ouray County, Colorado.**

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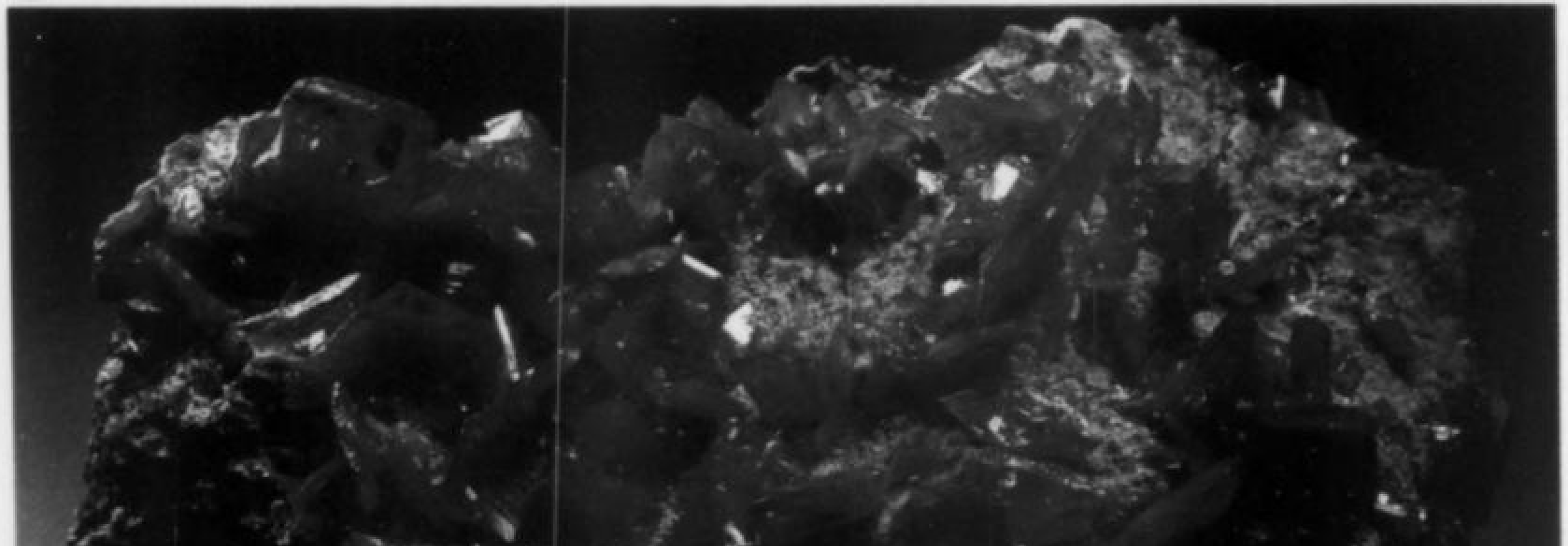

Figure 10. **Old-time cabinet specimen, 13-cm, of wulfenite from Tiger, Arizona.**

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Figure 11. Neptunite crystals to 4.1 cm from the Benitoite Gem mine, San Benito County, California.

Figure 12. Breckenridge gold leaf with crystallized surface, 4.1 cm, from the Campion collection.

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Figure 13. Large plate of rhodochrosite crystals, 14 cm, from the N'Chwaning mine, near Kuruman, Cape Province, South Africa.

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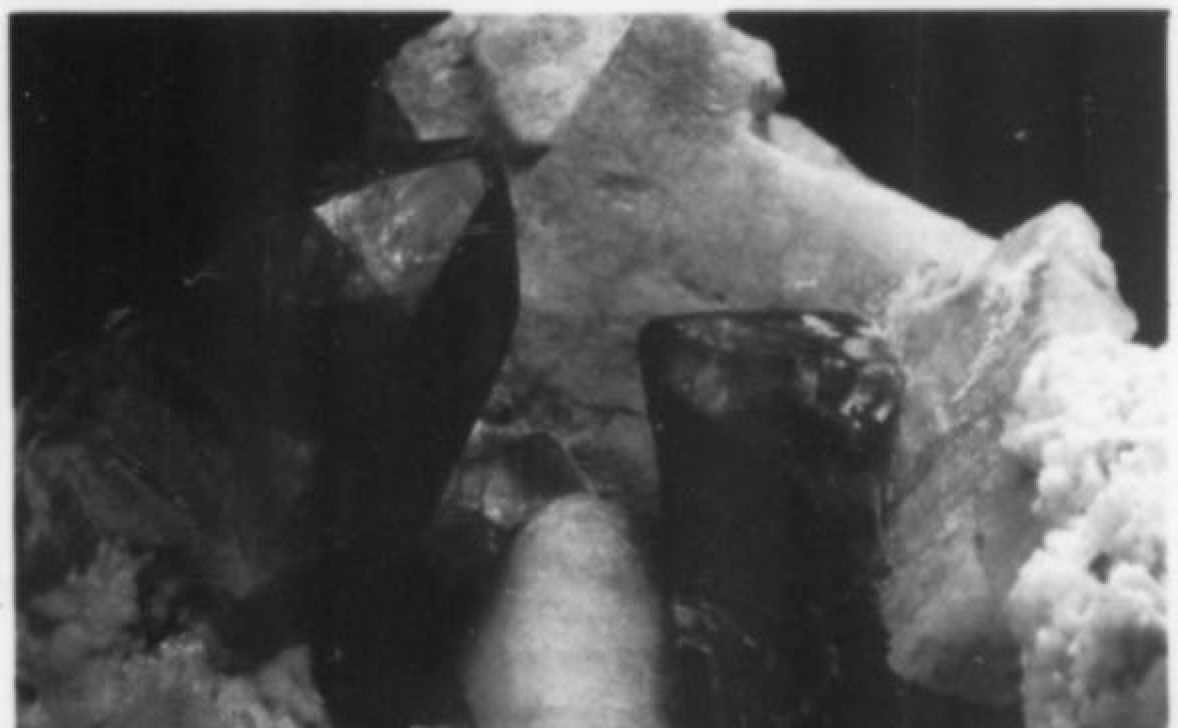

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Figure 14. Smoky quartz and pure fluorite (4.2 cm) on feldspar from Mt. Antero, Colorado.

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Figure 15. **Exhibit cases in the mineral hall.**

amazonite crystals and smoky quartz crystals. The careful attention to detail in this setting creates a very realistic scene and gives the viewer the pleasure of seeing a pocket just as it looked when first discovered.

Near the west entrance to the Coors Mineral Hall is a much larger diorama showing a 7 x 7-meter cave of meter-long selenite crystals and cave formations from the El Potosi mine, Santa Eulalia, and Naica, Chihuahua, Mexico (see inset). These magnificent specimens acquired over many years, fill a realistic cave that winds back out of sight, like something from Jules Verne's *Journey to the Center of the Earth*. A clever use of light and space creates the illusion of a very deep cavern. Additional dioramas are due to open in 1989. These will include a large Eagle mine pyrite cavity, and an Idarado mine quartz-filled fissure measuring nearly 1 x 2 meters.

An extensive, well-cataloged micromount collection has been developed at the museum through donations, including the recently acquired Paul Seel micromount collection. Total micromounts exceed 5000 specimens.

A visit to the Denver Museum of Natural History, with its creative mineral displays and outstanding Colorado collection, is a must for the serious collector. A 20-minute drive from the airport will bring the visitor to City Park, with its beautiful gardens, ponds and a view of the Rocky Mountains to the west. A thorough study of the Coors Mineral Hall will be a pleasant experience that will enhance one's knowledge of the finest crystals from Colorado and other worldwide localities. The museum is open 9 a.m. to 4:30 p.m. daily, except Sundays, when it opens at noon. Admission is charged.

ACKNOWLEDGMENTS

My thanks to Jack Murphy for his help and hospitality, to Robert Cobban and Cris Haglund for reviewing the manuscript and making useful suggestions, and to Wendell Wilson for providing photography.

Notes from Germany

Thomas Moore

HAMBURG SHOW

Say Germany to an American who hasn't been here, and chances are he'll get stereotypically *south* German, Swiss, and Austrian images: restlessly rolling hills with slanting meadows, black forests of conifers at parade-rest; beer and pretzels and game meats and *Lederhosen*; perhaps, in the distance, mysterious white Alpine eyries where Heidi and Hitler hid. Such visions of things "German" probably have been reinforced during the postwar years, since most American troops who have been stationed here have known chiefly this southern, Bavarian/Swabian zone which was assigned to the U.S. during the war's last throes. But north of Frankfurt, north of the Ruhr and the Harz, in the British sphere of influence, and coming up to Hamburg (urban embodiment of the north as Munich is of the south), there's a different story and imagery altogether. Don't think of ruddy-necked, xenophobic Bavarian farmers against backdrops of *Sound of Music* daisies, baroque Catholic churches, Alpine redoubts; think rather of flat green plains, villages of stark brick with flat stairstep-gabled housefronts; thatched-roof cowsheds sloping so low as almost to touch the marshy ground; of worldly Protestant merchants and traders, of windmills on the horizon and routes to the sea. Up here among the fretted canals and long, straight roads there's a feeling of commerce and cosmopolitanism and, as the Elbe is neared, whiffs of salt air, herring and fishnets, and of meerschaum pipes; there are ghosts of the seventeenth-century maritime wars of England and Holland and Spain.

For a field collector of minerals, the north of course is comparatively barren ground—for how can a flat coastal plain with overtones of heath and peat bog compete with a much-crumpled geosyncline? Such is the reason why Hamburg, although West Germany's largest city, half again the size of Munich, has a much smaller collector community than Bavaria's and a mineral show much younger and only a third as large as the Munich titan. But after too many fold valleys and onion-domed cuckoo-clock villages, a run up through these ascetic plains is actually bracing. And in the Hamburg mineral show I found what looks like an up-and-comer, not negligible even by Munich's standards.

The show was held in a huge room in Hamburg's all-purpose, conventionally modernistic *Messehalle*, just next door to another chamber where an office-equipment show (far outdrawing the mineral show at the ticket booths outside) was already in progress. The featured display was the meteorite collection of Robert Haag of Tucson, here making its first European appearance. With the aid of a translator, Haag did a brisk trade in small meteorite specimens and related literature. His personal collection of hulking iron and stone beasts shared a display alcove with many more meteorites, tektites and detailed explanatory material provided by Hamburg University, whose meteorite collection, Haag said, is the third or fourth best in Europe. Although inclined to be somewhat scornful of mineral-collector enthusiasms vs. his own ("*these* rocks are from *outer space*, man"), Haag had plenty of his own sort of arcane information to share. For instance, did you know that 90% of the people in the very fast-growing meteorite hobby are under 35, or that it is not unusual for one of these collectors to pay $10,000 for, say, a rare carbonaceous chondrite? Tell *that* to your accuser when next you are called decadent in your spending habits.

Easily the most newsworthy piece of *our* kind of arcana at this show was one that the German mineral magazine *Lapis* recently covered in their December issue. But Herr Gerhard Loock of the gemstone firm GEMTEST/Edelsteinlabor (D-5840 Schwerte) did tell me that I was welcome to convey the information to *Mineralogical Record* readers. Herr Loock had a small cache of 30 or so extraordinary floater groups of yellow gem chrysoberyl, *not* from Brazil, but from a group of small pegmatite prospect pits near the town of Orissa, in East India. Having sighted some tantalizing shards one day in Jaipur, Loock made three more trips to India over two years before emerging with these marvelous thumbnail-sized sixling twins and a few single prisms. He tried at first, unsuccessfully, to sell them all as a lot, and is now selling individual pieces for $300 to $1000: not unreasonable prices (bear in mind too that I'm converting DM sums to dollars at the present preposterous rate), since the sixling forms are textbook-ideal, and all specimens are at least part gemmy. Their beautiful yellow color entirely lacks the green of the Brazilian chrysoberyls for which otherwise they could easily pass (as the photos here, loaned by Rupert Hochleitner, clearly show). And as a garland to ring the best of the chrysoberyls in their small glass case, Loock had strung a rainbow of six very fine spinel octahedra from Sri Lanka, in pink, orange and blue, the largest one 2.5 cm on edge.

Dr. Christian Agthe (Breubergweg 11c, 1 Berlin 20) was showing a dazzling convocation of a couple of hundred specimens, from thumbnail to large cabinet size, of the choice marcasite clusters that have been dug for some years from limestone quarries around the town of Misburg near Hanover (see Wendell Wilson's account, vol. 15, no. 2, p. 118, of earlier lots of these). The "crystals" are typical spearhead aggregates, some perpendicularly twinned in fourlings, many with oriented micro-sized pyrite crystals. The sharp marcasite blades are still, as Wilson described them, "piled and intergrown in attractive groups." And one of the best things about them is that they seem—for marcasite—stable; a thumbnail that I have owned since 1978 is still quite intact (though its luster is slightly dulled), showing no signs of decomposition. The older quarries where the specimens have been found in the past are now closed, but the Portland Cement Works plans to open a new operation in Misburg this May, so more pieces should be expected, and let's hope that their prices remain moderate (Agthe's highest was $225 for a majestic 25-cm group).

Among the top-quality things from the most exciting current localities that I saw in Hamburg, the fifty or so outstanding Chinese cinnabars at Horst Burkart's stand were most notable (his *Morokko Mineralien* dealership being the one, so far, with the best stocks of these). Another dealership that I have mentioned before, *Kristallkeller Nürnberg* (Hefnerplatz 8, 8500 Nürnberg 1) shone this time with a fine assortment of contemporary things: e.g., three part-gemmy twins of the elusive chrysoberyl-variety-alexandrites from Novello Claims, Ft. Victoria, Zimbabwe, the biggest of them 3 cm across and priced at $375; several of the striking skeletal gold octahedra, in singles and groups, from Santa Elena, Venezuela (see "What's New in Gold?," vol. 18, no. 1), the best of them for $1200; immense rootbeer-brown zircons from Sieland Island, northern Norway; and a couple of 10 x 10 cm pale milky pink kunzites from Laghman, Afghanistan.

Speaking of these last, the offerings of gem silicates from the pegmatites of Pakistan and Afghanistan were once more, as in Munich, generous. Having in earlier Notes given this suite of minerals somewhat short shrift, I will now describe, as indicative of their general

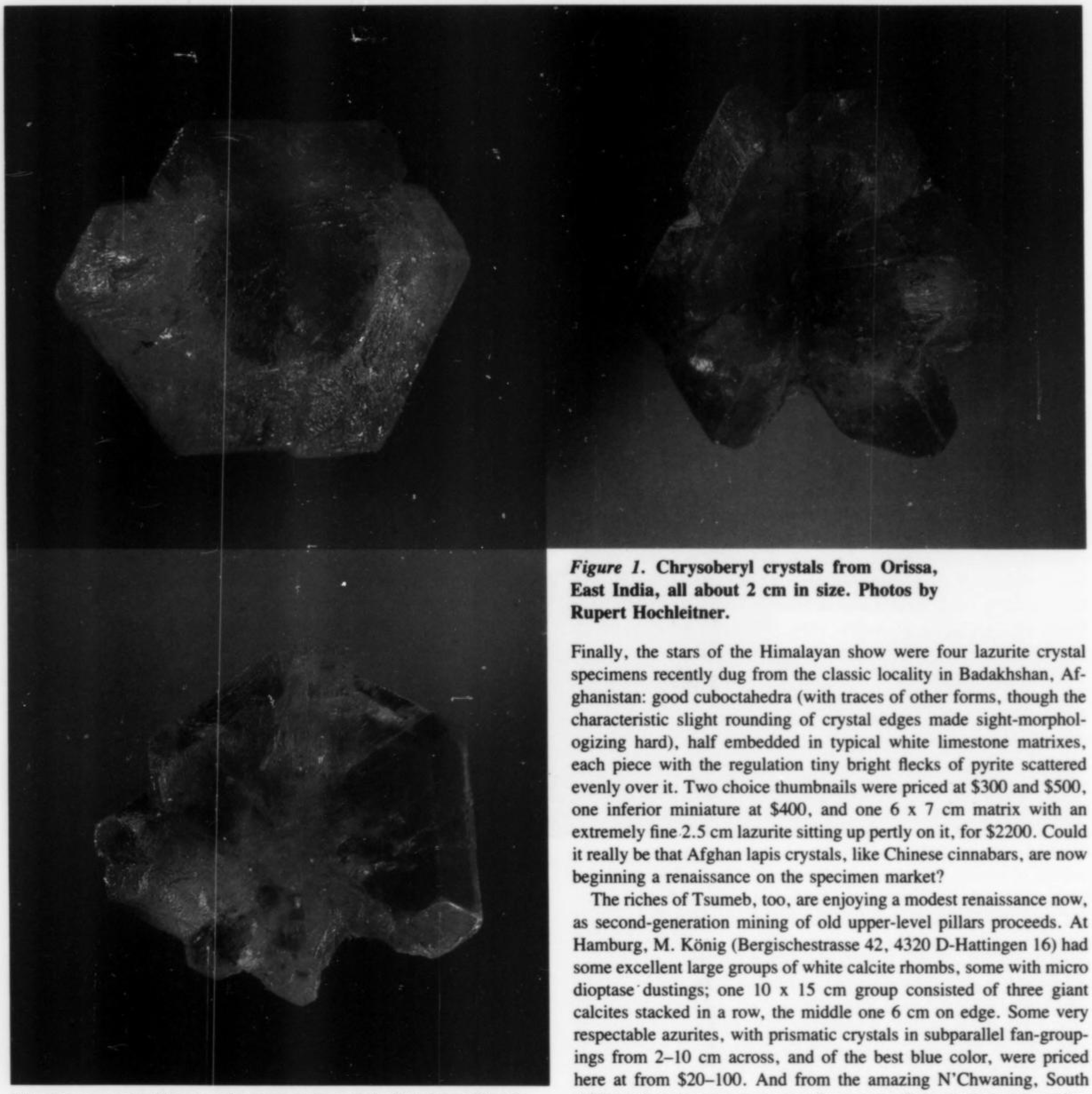

***Figure 1.* Chrysoberyl crystals from Orissa, East India, all about 2 cm in size. Photos by Rupert Hochleitner.**

abundance, some of those to be seen at the stand of Andreas Weerth (Rosswandweg 11, D-8183 Rottach-Egern), who visits the perilous regions in question at least once annually. One of his small showcases was densely jammed with bright black uvite matrix specimens, the crystals up to 4 cm across the tops of their sharp trigonal terminations, the matrixes a coarse white quartz/feldspar/muscovite mixture, from Haramosh, Pakistan; prices for these were in the $60–250 range. From the Gilgit region of Pakistan there were several fine, blocky, sherry-orange gem-quality topaz crystals, one of them 9 x 9 cm and completely gemmy ($1000). From the same locality there were also a few good thumbnails and miniatures of fishtail twins of green titanite (see the brief mention in vol. 18, no. 6, p. 431)—they were quite Alpine-looking, and indeed the best of them, a brilliant 3 x 4 cm piece for $225, was an interloper from Felbertal, Austria. One oddball specimen worth noting, from a locality given only as the Koona Valley, Afghanistan, was an 8 x 8 cm matrix of coarse pegmatite with areas of attractive drusy albite, on which sat three very sharp, submetallic black, doubly terminated prisms of tantalite to 2 x 2 cm—price $1000. Finally, the stars of the Himalayan show were four lazurite crystal specimens recently dug from the classic locality in Badakhshan, Afghanistan: good cuboctahedra (with traces of other forms, though the characteristic slight rounding of crystal edges made sight-morphologizing hard), half embedded in typical white limestone matrixes, each piece with the regulation tiny bright flecks of pyrite scattered evenly over it. Two choice thumbnails were priced at $300 and $500, one inferior miniature at $400, and one 6 x 7 cm matrix with an extremely fine 2.5 cm lazurite sitting up pertly on it, for $2200. Could it really be that Afghan lapis crystals, like Chinese cinnabars, are now beginning a renaissance on the specimen market?

The riches of Tsumeb, too, are enjoying a modest renaissance now, as second-generation mining of old upper-level pillars proceeds. At Hamburg, M. König (Bergischestrasse 42, 4320 D-Hattingen 16) had some excellent large groups of white calcite rhombs, some with micro dioptase dustings; one 10 x 15 cm group consisted of three giant calcites stacked in a row, the middle one 6 cm on edge. Some very respectable azurites, with prismatic crystals in subparallel fan-groupings from 2–10 cm across, and of the best blue color, were priced here at from $20–100. And from the amazing N'Chwaning, South Africa mine there were a very few more of the orange sturmanites mentioned in my last Note, though priced considerably higher here than at Munich; and a few excellent thumbnails and small miniatures of glistening black gaudefroyite, the new complex borate resembling manganite, also found at N'Chwaning.

For most of the seven hours I had to kill between the show's closing and the departure of my night train to Kaiserslautern, I walked around this lovely city where I had not been for seven years, with pauses at regular intervals to grade a set of my students' papers that I'd brought along (it's wonderful what a series of stops in *Bierstube* can do for freshman grade-point averages), and, even though I fell asleep on the train and missed my changing-stop at Mannheim, and arrived home two hours late, I'm heartily glad to have made my first visit to the Hamburg show my final fall-season mineral happening, at least for purposes of these Notes. Until next spring, Happy New Year to all.

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What's New in Minerals?

Displays at the 1987 Franklin-Sterling Mineral Exhibit

by **Richard C. Bostwick**

The abundance and variety of local minerals displayed at the Franklin, New Jersey, show are astonishing, considering the size of the show and the narrow focus of its exhibits. By tradition, the minerals and associated memorabilia are all from the Franklin area, which includes the Franklin and Sterling Hill orebodies and the Franklin marble which encloses them, or they are from an area comparable in some way and therefore of interest. (In Franklin all minerals are divided into two categories: "Franklin minerals" and "foreign minerals"; the latter includes prehnite from Paterson, N.J. as well as cuprosklowdowskite from Zaire.)

Rules for exhibitors, the above restrictions notwithstanding, are simple: show what you want. Most cases have liners of some description; labels are handwritten, printed, typed, typeset, engraved in plastic, or even clipped out of mineral publications. Memorabilia, particularly from the New Jersey Zinc Co., is encouraged, and cases are now and again lined with photos of the mines and miners, or letters from collectors and scientists.

This year in the main display there were 22 4-foot "Federation Cases" of Franklin minerals, and one case of "foreign"; in a separate darkened room were five cases of the area's notorious fluorescent minerals. The exhibitors included seven ex-miners, thirteen collectors, five institutions, and the local mineral club (The Franklin-Ogdensburg Mineralogical Society, Inc., or FOMS).

Reflecting the extraordinary diversity of the local mineral deposits, the displays and their contents can be categorized and sub-categorized at length. There are the expected world classics: crystals of rhodonite, franklinite, willemite, and zincite. Next are the less familiar specialties, well-crystallized minerals relatively unknown outside of Franklin, including phlogopite, gahnite, sphalerite, hemimorphite and members of the pyroxene, feldspar and garnet groups. Then there are rarities galore, minerals unique to Franklin or nearly so; while some are aesthetically unappealing and obscure, others are visually striking and highly distinctive. Most displays are mixtures of the classic and the rare, but there are also thematic exhibits, generally ordered by species, locality or chemistry. Eccentric or offbeat materials leaven the whole, while lurking in the background are the eye-catching shockers which have earned Franklin the title of "The Fluorescent Mineral Capital of the World."*

Notable among the many **franklinite** specimens on display were a group of shiny, sharp 2 to 3-cm octahedra on a blood-red zincite matrix, in the Paterson Museum's "Franklin Classics" case, and a 10-cm modified octahedron with blebs of zincite in calcite, from Sterling Hill, exhibited by Chester Lemanski, Jr. Franklinite was also one of the three minerals chosen for the FOMS case, put together with showmanship and skill by Stephen Misiur; forms from the simple octahedron to the complex, highly modified dodecahedron were displayed together. Most distictive in this group was John Cianciulli's carefully trimmed Sterling Hill "log" of calcite about 10 cm long, studded with three clean octahedra up to 4 cm.

Franklin **rhodonite** crystals abounded. The Morris Museum showed its impressive 10 x 17-cm group of blocky pink crystals in white calcite, while Chester Lemanski, Jr.'s somewhat larger specimen was notable for several tabular crystals of good color in the 7–10 cm range. Smaller (1 cm) bladed crystals of intense deep pink, from an open vein, were exhibited by John L. Baum, while John Kuzma's case was distinguished by several rhodonites, including the above types, a fourth with **marsturite** of the type on the cover of the *Mineralogical Record*, vol. 17, no. 2, and a fifth with small crystals altering to gray brushy clumps of **johannsenite.** In contrast, the American Museum's Broken Hill case contained a fine example of deeply colored, gemmy rhodonite imbedded in galena.

Zincite crystals have never been large or in plentiful supply; the extraordinary piece accorded a full page in Dr. Peter Bancroft's *Gem & Crystal Treasures* is probably the world's best, and the entire specimen is under an inch in size. Nevertheless good examples could be seen at Franklin, most of them the typical blood-red 1 to 2-cm pyramids, half exposed along the C axis, lying flat in thin zincite veins. Noteworthy specimens were displayed by John L. Baum and the Paterson Museum.

The development of **willemite** at Franklin and Sterling Hill, as reflected in color and form, is perhaps the most extensive and variegated of any mineral from any locality. Colors include white, gray, black, green, yellow, orange, blue, and an enormous range of reddish browns, brownish reds, tan and flesh tints grouped under the varietal name "troostite." Most local collections boast large sub-collections of willemite, crystallized and massive, as may be seen in the Kraissl-Lemanski Collection at the Franklin Mineral Museum, and at the Gerstmann Museum. Nearly every case at this year's Franklin-Sterling Mineral Exhibit contained at least one willemite, but the only display with no other mineral was that of Richard Hauck. His Sterling Hill classics included a sharp, clean, doubly terminated 1 x 5-cm orange-tan "troostite" prism in white calcite matrix, a larger flesh-colored troostite about 5 x 12 cm, and an exceptionally well-formed mahogany-brown crystal, nearly equant and over 4 cm long, in pale pink calcite. Other unusually fine troostites were shown by John Kolic and Chester Lemanski, Jr. The most striking of Mr. Hauck's Franklin willemites was small, with several 6-mm colorless, flawless, equant crystals; others of unusual merit included 1-cm transparent uranium-green prisms in a vug, and a 3 x 5-cm plate of gemmy dull-surfaced pencil-like crystals in parallel growth, mottled pale orange and green in color. Similar Franklin specimens of gemmy pale yellow prisms 5 cm or more in length, typically with the faces slightly dulled, were exhibited by Jim Chenard and John Kuzma. Perhaps the finest Franklin willemite there was recently acquired by the Morris Museum; like those above, the crystals are pale yellow prisms about 6 mm in diameter, but differ in having sharp pyramidal terminations and undulled faces. This unusual piece is a 2.5-cm flattened cluster of parallel crystals, with their bases mounted in silver.

Radiating willemite, a local specialty noted for its bright and per-

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*Cavilers take note: while that slogan was instituted by the admittedly biased New Jersey legislature, it has not to my knowledge been successfully challenged. Those with a broad and deep comprehension of local minerals hold that the word "Fluorescent" is superfluous, the claims of Tsumeb *et al.* notwithstanding. Numerically at least there is backing for this; the Franklin area does have more mineral species than any other (over 300), including the highest locality totals for unique species and species-first-described. (Another incentive for attending the Franklin-Sterling Mineral Exhibit is that only in the show program are those lists regularly updated and published, along with a fluorescent mineral check-list.)

sistent phosphorescence, usually develops in the middle of thin dolomite-lined veins which are broken across to expose the willemite. The Paterson Museum displayed a remarkable 8 x 15-cm piece, one face covered with white 2 to 3-cm rosettes. Good smaller examples with rosettes 3 to 5 cm across were exhibited by Al Smith and John L. Baum.

Among the less well-known local classics are two close relatives of franklinite, **gahnite** and **spinel**. A fine 2.5-cm octahedron of dark green gahnite from Sterling Hill graced John Kuzma's case, while Wilfred Welsh's display of minerals from the Franklin marble included a dark blue spinel 4 cm on an edge from Amity, New York.

Sphalerite, in general a rare mineral at Franklin, has nevertheless been found there in sharp, complex "oil-green" crystals over 1 cm in size. One of the most memorable examples is John L. Baum's, wherein the sphalerite crystals are associated with etched pale blue **fluorite** in a specimen bearing a startling resemblance to Cave-In-Rock, Illinois, material. Also of note was Dr. Philip Betancourt's large chunk of calcite, richly decorated with sphalerite crystals to 2.5 cm.

Phlogopite from the Franklin marble occurs in well-formed, pale brown, doubly terminated crystals, often rather large, in a coarse-grained calcite matrix. Don Pfister's 3-cm crystal was conspicuous for its sharpness, completeness and lack of damage, while Dr. Betancourt's 15-cm crystal took the prize for gigantism.

White crusts of "maggot ore," aggregates of **hemimorphite** blades with the terminal faces forming coxcomb ridges, were abundant at Sterling Hill a century ago, while other finds have been made since in the Mud Zone, an area of oxidation extending more than 200 meters below the surface. Stephen Misiur presented a grouping of hemimorphite old and new, with an older example over 30 cm long. A sparkling, snow-white, undamaged 13-cm example was conspicuous in Don Pfister's case.

Andradite is the most abundant garnet at Franklin, found throughout the calc-silicate lenses in the zinc orebody, generally as brownish yellow to dark brown dodecahedra. Rutgers exhibited a case of garnet crystal specimens from the Rowe Collection, most of them from Franklin. Finest among these was a 7 x 8-cm piece labeled **grossular**, with well formed brown crystals to 3 cm. Dr. Betancourt's 20-cm matrix group of glossy dark reddish brown andradite crystals to 4 cm also commanded attention, while the Paterson Museum showed a largely intact 10-cm crystal. The most aesthetically pleasing andradite was Don Pfister's example of lustrous, sharp, dark brown, 1-cm crystals in a matrix of pale orange calcite.

One of the more unexpected Franklin specialties is well formed green **microcline** crystals, which could be taken for New Hampshire or Colorado material except that they are generally worked out of calcite, and associated with rhodonite, willemite, franklinite, and so on. The Paterson Museum's case included a good 5 x 6-cm example.

The apatite group is well represented in the Franklin area, and includes the rare, recently described species **johnbaumite** and **turneaureite**. Most well crystallized apatite from the Franklin area is **fluorapatite** from the Franklin marble, where bluish green prismatic crystals attain lengths over 30 cm. A well formed terminated section of such a crystal, about 10 x 15 cm in size, was shown by Lee Lowell. Dave Wellbrock and Don Pfister both displayed smaller, complete examples carefully worked out of matrix, with crystal sizes on the order of 1 x 8 cm.

Pyroxene crystals of unusual habit and size were found at Franklin and Sterling Hill, and in the Franklin marble. "Jeffersonite," now properly called acmite-augite, was abundant in the old surface workings at Sterling Hill, where weathered but well-formed crystals over 30 cm long had been etched out of the surrounding calcite by groundwater. Harvard's case of described and type specimens included a classic described "Jeffersonite." Also worthy of note was Dr. Betancourt's nicely formed 6-cm crystal of dark brown manganoan diopside from the Franklin orebody.

There are certain Franklin-area species which, although rarely if ever crystallized, occur in richly colored fine-grained masses locally prized for display and the making of cabochons. Such are **sussexite** and **friedelite** from Sterling Hill: the former was found there in the North Orebody in lavender to lilac-pink masses weighing over a kilogram, and the latter in thick veins of a deep maroon hue. A fine rich mass of pinkish sussexite was displayed by Al Smith, while an 11 x 14-cm "beefsteak" friedelite was on show courtesy of the Paterson Museum.

Much of the attention of Franklin-Sterling Hill collectors is focused on the rare species. With a few exceptions these do not display well, in the sense that hand specimens are not visually arresting. Obviously much of Franklin's greatness depends on its singular and scarce minerals, and it should be emphasized that to the mineralogist, micromounter and species collector Franklin is both a fascinating, enigmatic puzzle and an inexhaustible source of knowledge. When Franklin is approached with the reverence it deserves, the rewards are considerable.

At this show the reverent, and those leaning that way, could have done worse than start with the cases of John Kolic and Stephen Sanford. John is an intelligent and sharp-eyed miner with over 15 years experience underground at Sterling Hill, and more than a few of the recent mineral discoveries there can be credited to him. His sherry-colored, transparent, 6-mm crystals of **kolicite** quite fittingly may be the best in existence. There is also a most attractive **allactite**: fans of rich wine-red 1 to 3-mm allactite blades scattered across drusy pale-pink rhodochrosite. Consider also his **magnussonite**, a glossy, dark greenish brown vein 3 cm thick in Sterling Hill ore; it is the richest piece from here or Sweden. Typically, he found them all himself.

Ex-miner Stephen Sanford (now manager of the Franklin Mineral Museum) generally takes a thoughtful approach to displaying, and this year his theme was "**Arsenic** at the Franklin Mine." The case included fine specimens of nickeline and rammelsbergite from the Trotter mine nickel arsenide assemblage, apatite group members hedyphane and turneaureite, and many of the diverse arsenates and arseniosilicates found in veins at Franklin: allactite, sarkinite, yeatmanite, manganberzeliite, caryopilite, gageite, chlorophoenicite, and one of the few confirmed specimens of magnesium-chlorophoenicite.

Also catering to the knowledgeable, the Harvard Mineralogical Museum drew from its enormous resources the **type specimens** of bannisterite, woodruffite and hydrohausmannite, as well as described specimens of "jeffersonite," sussexite, franklinite, manganpyrosmalite, manganberzeliite and friedelite. Species collector Joseph Cilen's case included many rarities, such as fluckite, otavite and the recently described new mineral wendwilsonite. For the informed collector this was a rich and bountiful feast.

The one case of "foreign" minerals at this year's show was placed by the American Museum of Natural History. As a lead-zinc-manganese deposit of some complexity, and with substantial silica, **Broken Hill**, New South Wales, has a number of minerals also characteristic of the Franklin area. These include well developed rhodonite, bustamite, bannisterite, manganpyrosmalite and manganoan hedenbergite. The rhodonite and hedenbergite both provoked some awe and envy.

One of the odder Franklin classics is native **copper**. Widespread in the ore and calc-silicate assemblages at Franklin, and virtually absent at Sterling Hill, copper is found in films, irregular masses and plates, which although generally rather small can attain sizes of 20–30 cm and weights of 5 kg or more. At this year's show John Baum had a fine 17-cm plate of copper, and Steve Misiur an assortment of coppers in different associations—willemite, hodgkinsonite, and so on. The most remarkable Franklin copper is Richard Hauck's. It is currently on exhibit at the Franklin Mineral Museum. An irregularly shaped mass over 25 cm high, it is associated with at last 10 other minerals which are distinctly Franklin; these include ganophyllite, roeblingite, crystals of clinohedrite and the rare sulfate charlesite (recently distinguished from ettringite, and named for Charles Palache). This comparatively infamous piece has a history of underground theft and many changes of owner, and is reputedly the first specimen to change hands in Franklin for a sum in four figures.

Among the many unusual mineral suites from the Franklin mine, perhaps the best known is the assemblage of lead silicates from a unique altered calc-silicate body first sampled through the Parker Shaft in the 1890's. Of the many rare minerals found there, two were conspicuous at this year's exhibit. Rich, lilac, 6 x 8-cm masses of **barysilite** were displayed by Jim Chenard and John Kuzma, while **roeblingite** was accorded more detailed treatment in the F.O.M.S. case. This mineral occurs in nodules which rarely attain the size of 10 cm or more, but which in general are less than 4 cm; its white porcelaneous appearance exerts a peculiar fascination for Franklin collectors, as evidenced by the hand-rubbed sheen on any pieces not locked away. The F.O.M.S. case included a 2-cm vein (very much rarer than the nodules) in franklinite-hancockite matrix, several typical 2 to 4-cm nodules with a dull pinkish red rind of altered hancockite, and a remarkable free-standing 8-cm mass, crusted with other rare minerals and endowed with a history almost as tangled as that of the Hope Diamond. The appearance of roeblingite is commonly compared to that of coconut meat; hence, for emphasis, the organizer of the display had included a "roeblingite-like coconut nodule."

This same F.O.M.S. case included, in the franklinite section, a gloriously faked crystal on a wholly inappropriate matrix of gray dolomite. The locality given was "John Cianciulli's imagination." It is thought by some that such outbursts of levity are a necessary antidote to the earnest commitment required of the true Franklin collector; it is certainly true that past exhibits have included such treasures as a genuine Sterling Hill toilet seat and the classic "willemite-green apple." The enigmatic character of much local material also encourages the searcher for sermons in stone, serious or otherwise. Al Smith, a retired shift boss with a long career at the Sterling mine, has displayed at the Franklin-Sterling Mineral Exhibit since its inception in 1958; among his fine crystals and other conventional specimens he is particularly proud of the "globular zincite crystals," dark red against a white calcite matrix which has been carefully worked away to reveal a 5-cm frontal silhouette of Bugs Bunny's head and ears. Also given pride of place in his display is a large slab of bright green willemite with a funnel-shaped pattern of black franklinite grains. It is labeled as follows:

Gem Willemite
Franklinite
Formation-of-Tornado
Franklin-N.J.
1931

Given Franklin's official title and its general reputation as the Mecca of fluorescent mineral worshippers, it is ironic that until quite recently there had been no **fluorescent minerals** display at the Franklin-Sterling Mineral Exhibit. The gargantuan 12-meter-long display at the Franklin Mineral Museum is on view from mid-April through mid-November, and the smaller but extremely fine Warren Miller collection can be viewed year 'round at the Gerstmann Mineral Museum; the show had seen no regular displays of fluorescent minerals other than those provided through the 1970's by UVP, Inc. and Raytech as part of their promotional efforts for their ultraviolet lamps. (The high cost and brief life of shortwave filters had of course discouraged amateurs. It is pleasant to relate that the new generation of these filters is advertised to have a useful life measured in thousands of hours. It should also be noted that UVP, Inc. loans the majority of the ultraviolet display lamps used in the exhibit.)

This year's fluorescent mineral display consisted of four 4-foot "Federation Cases" and one larger case, on tables in a darkened room. The cases were each dedicated to a single mineral or an inseparable pair: margarosanite, wollastonite, esperite, sphalerite and willemite-and-calcite. While the sphalerite specimens, with their varied orange, yellow-orange and blue responses under longwave ultraviolet light, were all from Warren Miller's collection, the other four cases combined the best pieces from another twelve collections. The cumulative effect was staggering, even to veterans. The fluorescent colors of these minerals are so bright, and the patterns so striking, that one must be either color-blind or overly sophisticated to avoid being impressed. Key specimens in the wollastonite and esperite cases were loaned by John L. Baum, and are among the best and largest known. Esperite, unique to Franklin, has one of the brightest mineral fluorescences, strong lemon-yellow under shortwave ultraviolet; Baum's piece is about 20 cm square, and nearly solid. Wollastonite has a more varied fluorescence, generally orange at Franklin, but ranging through orange-yellow to yellow at Sterling Hill; here the Baum wollastonite was from the first and finest occurrence at Franklin, with areas 10 cm or more across on a 30-cm piece, associated with red-fluorescing calcite and green-fluorescing willemite. Margarosanite, in contrast, fluoresces a vivid blue, and is considerably rarer than the other minerals mentioned; devotees will appreciate the difficulty in assembling a 4-foot exhibit of this mineral even with ten collections on tap. The centerpiece of this case was a 17-cm mass of red-fluorescing manganaxinite with 2 to 3-cm islands of margarosanite dotting its surface; even Nick Zipco, one of the few remaining Franklin miners, and one with a collection of legendary proportions, was heard to remark that the manganaxinite-margarosanite piece had its merits. The fourth and largest case consisted entirely of willemite-and-calcite specimens: a great deal of red and green, green and red, red and green. Evident when viewed on this scale was the impressive range of metamorphic textures found in Franklin ore, ranging from the familiar Buckwheat Dump lean ore (green dots on red) to the less usual medium-grained and coarse-grained ore, and the flow patterns and veins associated with plastic movement, fracturing and healing. So bright and eye-catching are willemite and calcite together that even the non-fluorescent associated minerals attract attention: perhaps the most admired piece in the case was Richard Hauck's zincite in calcite, with zincite in finger-like shapes like a hand of zincite plunged in calcite, a black hand amid flames under ultraviolet, and the Red Hand of Ulster, heraldic on a white field, in daylight.

Make no bones about it; Franklin minerals are funny-looking, outlandish, obscure, startling, and occasionally spectacular. They are also unique, astonishingly varied, and worthy of every mineral collector's study. Their uniqueness and variety can be best appreciated by experiencing them in context, and the first weekend of October, in Franklin, is incontestably the best time and the finest opportunity to do so.

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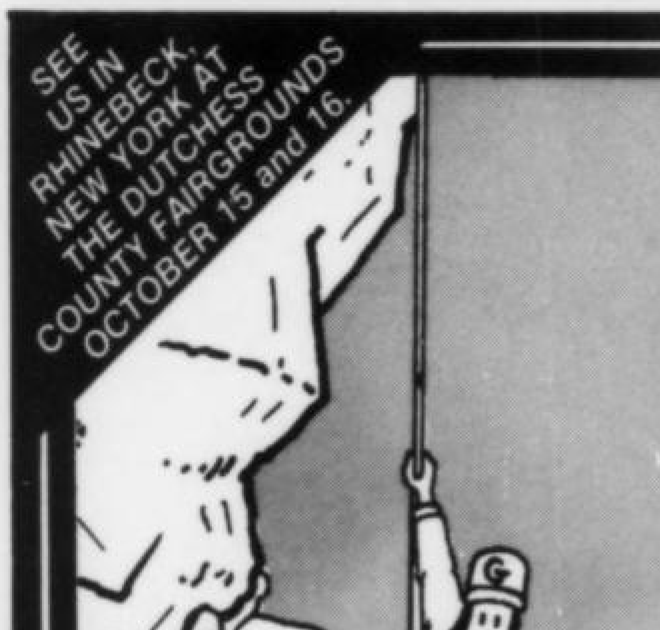

Willard Lincoln Roberts

February 12, 1923 — March 23, 1987

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During the early phases of my calling, I named and described some new species of minerals. I usually christened them in honor of people who alerted me to their peculiar physical characters, and for people—mostly professional mineralogists—toward whom I was fondly disposed. Among these species was *robertsite*, dubbed after Willard Lincoln (Bill) Roberts; it is a splendent jet-black platy species with the crazy formula $Ca_6(H_2O)_6[Mn_9^{+3}O_6(PO_4)_9]\cdot 3H_2O$, with a curious sheet in brackets. That's right! A basic aquated calcium-manganic oxyphosphate hydrate! Of course, our initial published formula was wrong because it was deciphered by wet chemical and electron probe analysis—both giving, at best, empirical ratios but telling no chemistry. Eventual structural analysis of isotypic mitridatite (the Fe^{+3} analogue) cleared up that problem later, allowing all atoms to be counted. And just recently, the strange sheet in brackets was found as a component in långbanite, a structure type of quite different paragenesis.

First some acknowledgments: it is only through the help of extensive anecdotes and historical briefings that I could assemble a fabric from a mosaic, thanks to Mrs. Susan (Roberts) Peterson, Bill's most intrepid offspring in the field and with minerals; and Pete Larson, one of the staff of Black Hills Institute of Geological Research (Hill City, South Dakota) whom Bill inspired and which institute is one of several Bill founded. Their stories are interlaminated with other tidbits, including my own recollections, so reminiscent of the beautiful laminar structure of robertsite-mitridatite. I shall begin with Bill's curriculum vitae and conclude with some human-all-too-human anecdotes and short stories.

Willard Lincoln Roberts, the son of Dr. Willard Whittington and Elsie (Atkinson) Roberts, was born February 12, 1923 (whence his middle name!), in Epworth, Dubuque County, Iowa. At around five years of age, he was pleasantly imprinted by specimens of galena cleavages from grandfather Atkinson. The wheel began in motion, and observations of Keokuk geodes in nearby rock gardens led to Bill's early "expeditions" to local ravines in search of fossil "clams" (brachiopods) and "petrified honeycomb" (corals). Rapid City, South Dakota, became the new family home in 1934, greatly enlarging his world of natural objects with the extensive occurrences of metamorphic and igneous rocks of Precambrian age, especially the hundreds of pegmatites which were uncovered and were being worked. The Pahasapa area is still recognized as one of the great pegmatite provinces of the world and an inspiration over the years for countless amateur and professional papers. During the war years, lithium (spodumene), tantalum (mainly in columbite-tantalite), beryllium (beryl) and mica (muscovite) were king.

Willard Lincoln Roberts
1923–1987

Just before the advent of U.S. involvement in World War II, Bill was a student and gymnastics instructor at the South Dakota School of Mines and Technology (SDSM&T) in Rapid City. Bill served three years with the 8th Air Force in England and France, and studied field and physical geology at Biarritz American University. But, like *Scuffy* *the Tugboat,* he was meant for bigger things, and studied philosophy under Lord Bertrand Russell at King's College, Cambridge, England.

After returning to the U.S., he studied law and business administration and soon held diverse positions in Rapid City, such as Clerk of Courts, Assistant City Manager, and Executive Aide to the mayor. During this period he was also engaged in numerous uranium (including his discovery of extensive carnotite deposits in the southern Black Hills), tungsten and pegmatite mining activities. Bill managed the Helen Beryl Mining Corporation ("the biggest little pegmatite in the world") for several years. Bill also read law for three years under the supervision of Judge W. W. Soulé, and prepared for the state bar. Unfortunately, in 1949, the State Legislature passed a bill requiring a university law degree. (Indeed, this may well have been a gain for science!) In the 1960's, numerous positions at the Museum of Geology at SDSM&T led to his appointment as Senior Curator of Mineralogy and Invertebrate Palaeontology, a position he held from 1976 to the time of his death.

Bill taught mineralogy, prepared special exhibits, procured and preserved specimens and co-authored several papers on new minerals from Black Hills pegmatites such as černyite, fransoletite, sinkankasite, tinsleyite and walentaite. Over 100 minerals new to the Black Hills pegmatites were first announced by him, and certain occurrences became personal favorites. These include the Tip Top mine, famed for its lustrous jahnsites, collinsites, robertsites, segelerites, leucophosphites and a host of new and peculiar beryllophosphates; the Big Chief, with as many equally unusual phosphates; the Bull Moose, with its enormous pods of graftonite, triphylite and sarcopside, and exquisite crystals of claret-colored phosphosiderites; and literally scores of other pegmatites, all perfectly committed to his memory with names like Victory, Hot Shot, Sitting Bull, Skookum, Nickel Plate, High Climb, Buster, Townsite, Rainbow #4, Tin Mountain, and Peerless.

Perhaps Bill's most lasting achievements for the mineralogical confraternity were two books, for both of which he was senior author. The first, "Mineralogy of the Black Hills" (1965) *SDSM&T Bulletin 18,* 268 p., was co-authored with George Rapp, Jr. This is the book I used as my initial "assistant" while tramping through woebegone parts of the Hills. It was, and still is, a little exquisite lode of information. The more ambitious project, *The Encyclopedia of Minerals* (1974), an 831-page monster put out by Van Nostrand Reinhold Company, was also co-authored by Dr. Rapp, and Dr. Julius Weber. Actually, Bill organized the greater body of factual information for each species and Dr. Weber produced the exquisite color photomicrographs. This book is practically unique, and has contributed more to the edification of philoliths worldwide than most specialty publications.

In 1946, he married Jean McPhail, his constant companion on field trips and at mineral shows. They have four children, William James (Ryde, New South Wales, Australia), Susan Jean (Mrs. Robert Peterson, Crystal Lake, Illinois), Janelle Mignon (Mrs. Daniel Marshall, St. Joseph, Missouri) and Robert Bradley (Rapid City, South Dakota), ten grandchildren and one great grandchild.

Bill published over a score of professional papers and was intimately associated with various mineral societies. One of his personal satisfactions was turning young rockknockers into serious-minded collectors and professionals as well. Founder of the Black Hills Mineralogical Society, Fellow of the Mineralogical Society of America, former Director of the Friends of Mineralogy, he was guide, inspiration and spark for scores of students. Jean's sad death after prolonged and cruel suffering was a consequence of her bronchial asthma, probably aggravated by earlier exposure to fly ash from a nearby industrial plant. Bill's grief at the loss of his beloved companion and helpmate shortly thereafter broke his heart.

When I was in the field with Bill, I would grab everything in sight and pummel the dumps to pebble piles. But he had many clever (and instructive) answers to practically every query I had. Each pegmatite had its curious personality, and Bill saw all of them in the Hills. At Tip Top, one of his favorite haunts and a place of many of his discoveries, I excitedly showed him what I thought was surely a new species, well-crystallized, deep purple, extremely pleochroic crystals. He took one look and said, "Aw, it's leucophosphite—all over the place. You could pave your driveway with it." (Tip Top leucophosphite does not reveal its etymology.)

Mineral collectors and mineralogists alike have personal ways of thinking about minerals so that they can identify them on sight. Some are hooked on color, others on cleavage, yet others on associations (paragenesis), a few on chemistry. My cue is a rare ability to exploit luster; Bill's I am convinced was paragenesis. This is all the more remarkable when I realized that Bill was especially weak in chemistry and his physics was not much better. So how did he do it? Was it the product of endless comparison from poring over endless collections? Certainly not! There were no good collections besides his own at that time in the Black Hills. I postulate one thing: Bill had an eidetic memory for mineral associations. Just as with Mozart, whenever he heard a tune, it was imprinted for life. Such eidetics are haunting. They have little knowledge in the "basics," yet instantly see something that even a specialty trained "Perfesser" couldn't see in the field.

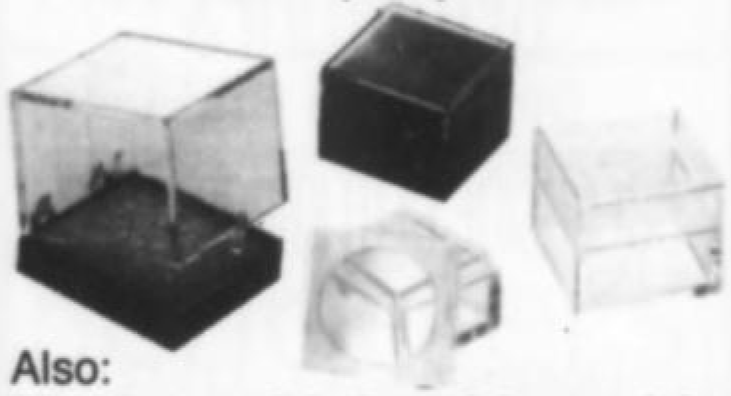
Yet Bill was never given to the existential prattle to which I often succumbed. Like many present-day students, he would take a more Voltairean view of "working in the garden of life." A pragmatist, Bill was not going to knock himself out for any hopeless cause or objective. Yet there are not too many things more absurd than going out and collecting peculiar minerals, most of which are quite useless. Pointless fugues? Nonsense! I saw his magnificent collection several times. As a consolation, we should never forget those precious words of that eccentric genius Oscar Wilde: "All art is quite useless."

That's it! Bill was not a scientist. In fact, he never pretended to be one. Bill was an artist.

I have often been asked by the curious about Bill's appearance. Well, he was certainly unique. A short man, he was built between a bison and a mountain goat, both of which roam the Hills: powerful chest, muscular arms doubtless accentuated by his early career in athletics: "pumping iron," tennis, gymnastics and wrestling. He always wore his "uniform" of specially made pants, the tops of which nearly reached his chest, held up by broad suspenders. He often had a cigarette in his mouth, but it was rarely lit, so he wasn't much of a smoker. Here was a man, indeed, as unique and individualistic in his appearance as in his passions.

Pete Larson of the Black Hills Institute of Geological Research sent me a remarkable letter from one who was nourished and eventually situated by Bill, as well as were Jim Honert, Neal Larson, Bob Farrar, Tom Campbell and others. In the letter he emphasized Bill and Jean as teachers and wellsprings of inspiration and encouragement. He stressed the bitterness which increased with Bill's age, that he was neither encouraged nor recognized by SDSM&T, the very school of his dedicated activities, because he lacked a higher degree! This, after he and Jean donated countless specimens to the school's museum, built up and organized the collections from a shambles, and were among the very few at that institution who "spread the word." Without murmuring a cry or a complaint, Bill continued his curatorial duties to the end, and an honorary Ph.D. was granted him by that institution *after* his death.

As it is today, the mineral museum at SDSM&T is a fitting testimony to both Bill and Jean Roberts, and their love of choice mineral specimens. Paraphrasing the famous comment on Sir Christopher Wren, the architect of the monumental St. Paul's in London: if you would inquire what they did, look around you.

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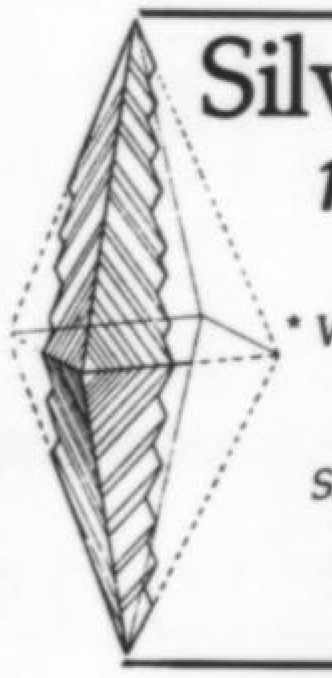

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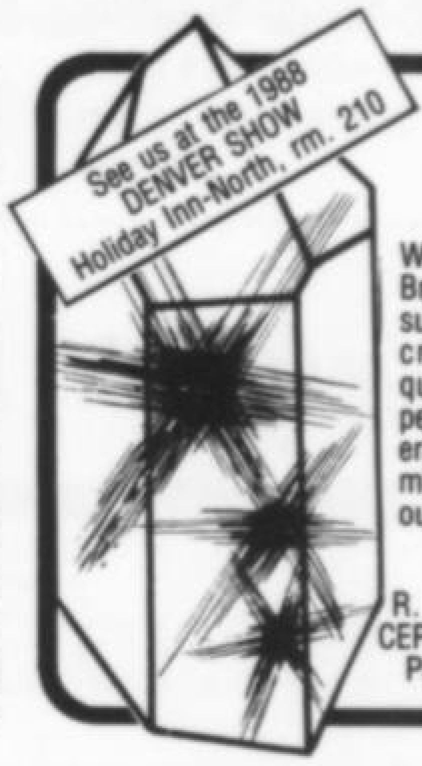

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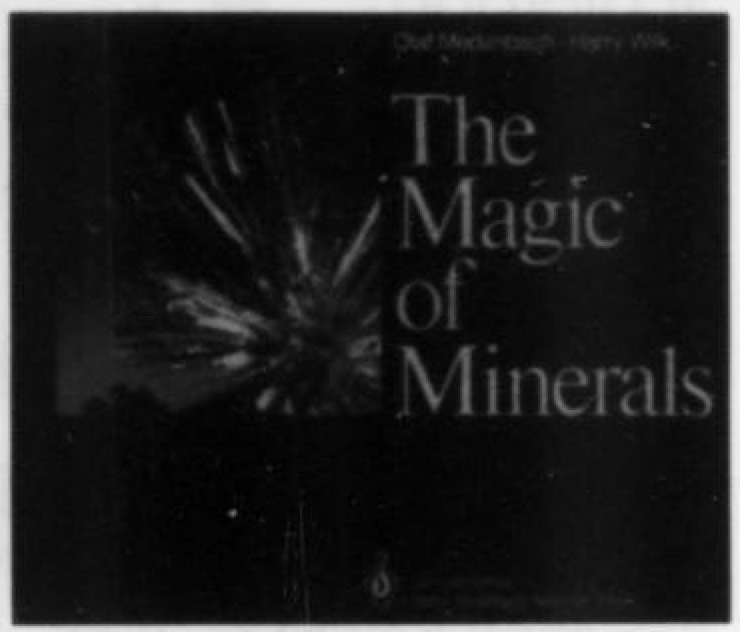

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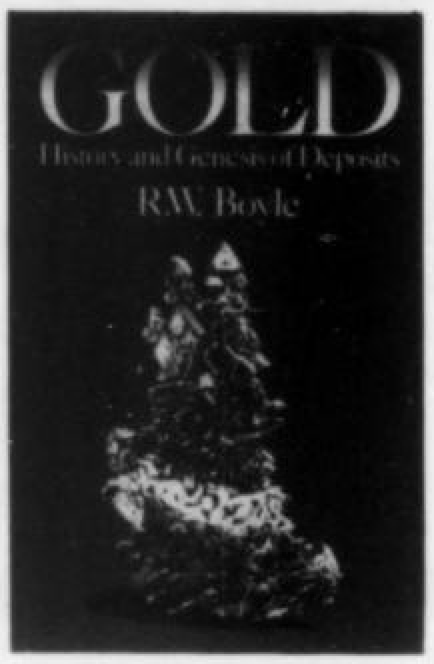

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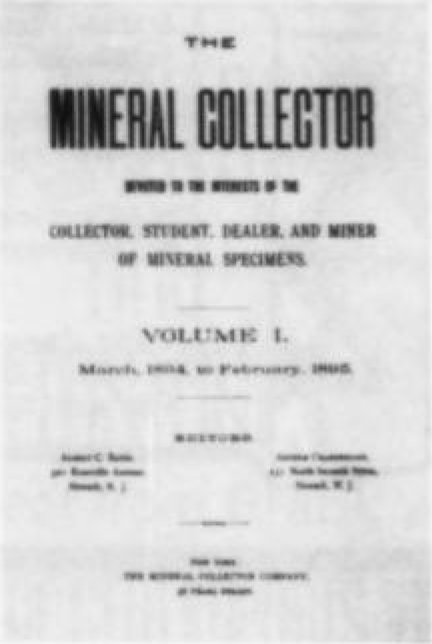

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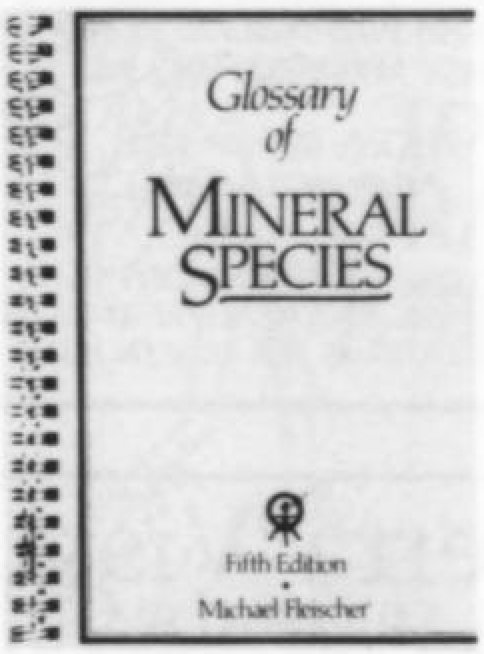

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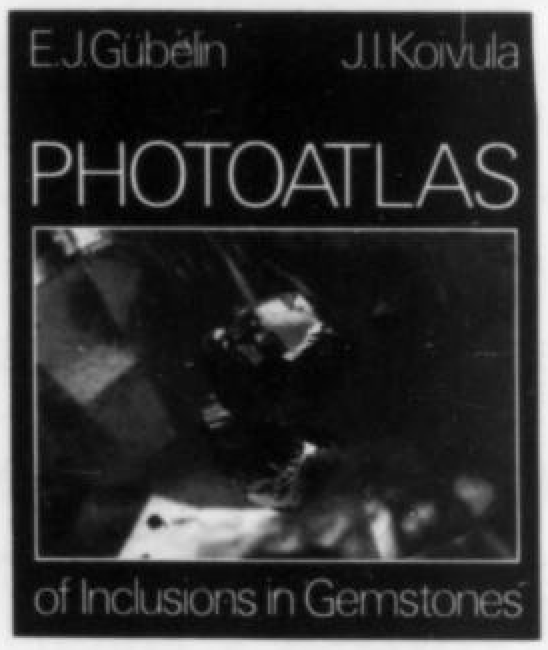

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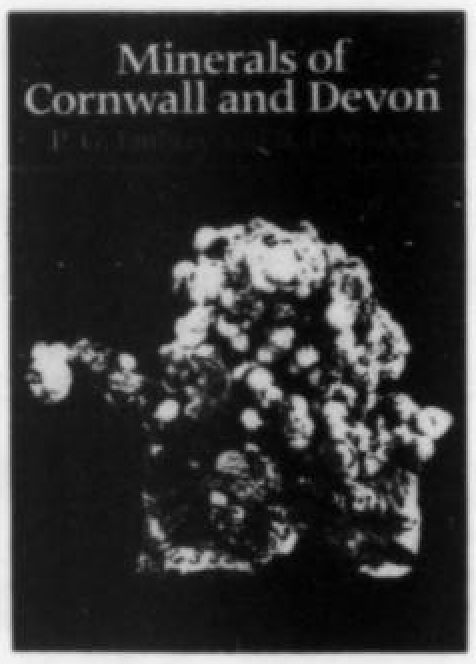

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Advertisers Index

. . 277
. . 262
. . 282
. . 270
. . 262
. . 276
. . 287
. . 247
. . 283
. . 282
. . 283
. . 246
. . 281
. . 281
. . 283
. . 283
. . 247
. . 283
. . 262
. . 262
. . 252
. . 286
. . 239
. . 282
. . 260
. . 286
. . 281
. . 286
Cover-3
. . . 281