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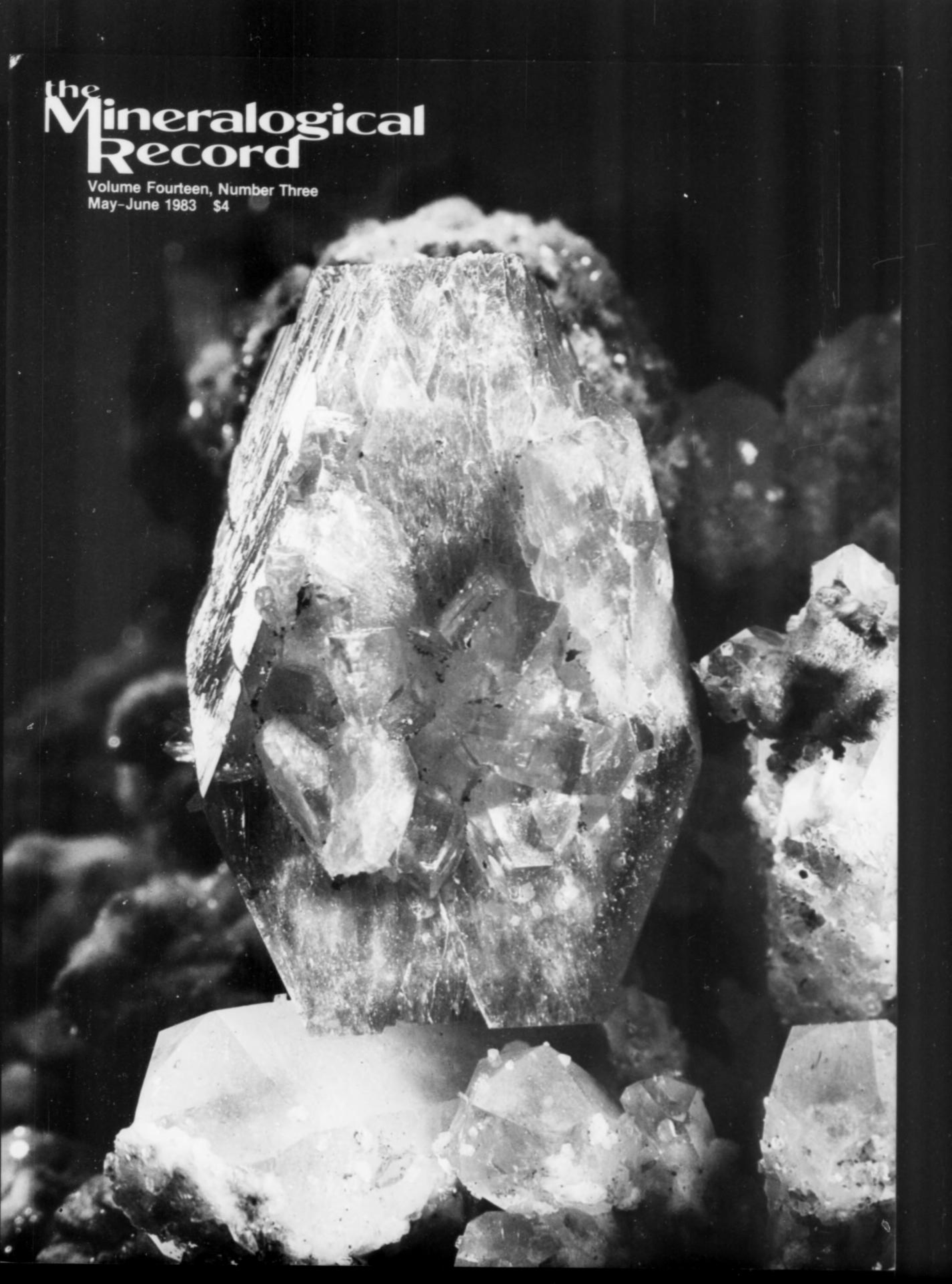


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COVER: LUDLAMITE from Trepča, Yugoslavia. The crystal, from the collection of the School of Mines, Paris, is about 1.7 cm tall. Photo by Olaf Medenbach. See *Notes from Mexico* in this issue for information on the new Mexican ludlamites.

GUEST EDITORIAL

Unethical Use of Mineral Names; A Commentary

The process leading to the publication of new mineral descriptions involves several steps. First, the mineral is discovered, then characterized, then submitted to the Commission on New Minerals and Mineral Names of the International Mineralogical Association (I.M.A.) for approval, and finally published. This sequence of events, firmly rooted in the procedures of the science, ensures the distribution of accurate mineral species knowledge in a responsible and fair manner.

A problem exists, however, in the distribution of specimens of the mineral itself. That problem is the unauthorized use of mineral names prior to publication and without the consent of the senior author. This problem is not new; it has existed for some time and has been discussed in several forums. Lately, however, unauthorized use of mineral names has been on the increase.

Although those mineral dealers who cater to the species collector are few in number, mistakes and unethical action by some of them have resulted in the distribution of erroneous information. This results in a number of problems, including but not limited to:

1. Improper spellings of mineral names subsequently picked up and used by others, thus propagating errors which diminish the accuracy of labeling, and confuse some collectors.

2. The distribution of materials which might not be valid minerals. Even if a species and a mineral name are approved by the I.M.A., the species is *not valid* until it is released by the senior author of the description. There are occasions where additional studies (undertaken while the potential mineral is under consideration by the I.M.A., or subsequent to approval) cause the author(s) to reconsider the proposal to the I.M.A. and not promulgate a new species after all. This writer has recently done just that and notified the I.M.A. that a mineral name approved 2½ years ago will not be published. The approval of a species and a name by the I.M.A. constitutes, in a real sense, only approval of the author's right to publish the new mineral. The final decision on accepting the mineral and accepting the I.M.A.'s approval lies with the author(s). They may decide to reject conclusions they reached in earlier studies.

3. The distribution of material which cannot be verified. Until the data which serve to characterize a mineral are published, there is usually no certain way to ascertain the validity of the identification of specific specimens. Although this is usually a matter of faith and trust between the collector and the dealer, it is germane to this discussion to point out to collectors that such premature distributions of material are wholly the responsibility of the mineral dealer. Scientists should not be asked to verify such materials.

The foregoing are but a few of the more obvious abuses and resulting problems. Others exist and *Record* readers need no reading of a litany. Of late there has been one more problem, somewhat more serious, and that is the premature use of mineral names which have *not* been approved by the I.M.A., and which therefore have no validity at all. Lotharmeyerite, recently published in the *Mineralogical Record* (vol. 14, pp. 35–36), was being sold by name at the Detroit Mineral Show, *prior* to its approval by the I.M.A. Two other compounds, which were disapproved by the I.M.A., were offered by name by a species dealer in a mailing in mid-January, 1983. Such actions are a distinct disservice to the science and a serious misrepresentation to the collector community.

It would be foolish to try to influence species dealers from the perspective of an ivory tower. Such influence must come from within the market. Much to their credit, several mineral species dealers have made attempts to establish a code of ethics, but it has not gained universal usage. Those species dealers who try to act responsibly frequently suffer a competitive disadvantage.

Much of the confusion and many of the problems resulting from premature use of mineral names can be resolved by two simple procedures:

1. Waiting for publication (or)

2. Writing to the author for permission to use a newly-learned mineral name. In many cases, a telephone call is all that is required.

Writing as one mineralogist with a track record of reaching out to the collector and commercial communities, I can offer a limited but experienced perspective. I fear that, if something is not done to curb irresponsible usage of mineral names, more mineralogists will withdraw further from communication with dealers and collectors. For my part, I have striven to build cooperation and it saddens me to see a few unethical persons tear it down. In almost all cases where mineral dealers have asked for release of a mineral name for commercial use, I have immediately granted it, carefully providing correct spelling, pronunciation, and general chemical composition. I shall continue to be as cooperative as possible, within the limits of practicality.

It is in the interests of strengthening bridges between the collector, commercial, and scientific communities to encourage responsible behavior. Few would argue with such a noble interest, but it requires active support; watching from the sidelines is not enough. Articulate and pointed criticism is what is needed now, and it can be very effective. For those species collectors who value their communication and interaction with the community of professional mineralogists, I urge them to sharply criticize and avoid patronizing mineral dealers (few in number) who use mineral names irresponsibly. I further urge them to support those dealers who are conducting their business along proper and ethical lines.

by **Pete J. Dunn**
Department of Mineral Sciences
Smithsonian Institution
Washington, D.C. 20560

notes from the EDITOR

GOLD ISSUE SOLD OUT!

As I write this (mid-January 1983), the dust has barely settled on the most enthusiastic stampede for an issue we've ever experienced. The press run for regular issues these days is 7500 copies, but for the special Gold Issue we upped that to 10,000 copies. Nevertheless, it sold out *within 6 weeks* (except for about 100 copies which we reserved for sale at our booth at the Tucson Show). I guess there's nothing like gold to get people's attention. (See Letters column for some reader reactions.)

People are bound to ask two questions when something like this happens: (1) "Why didn't you print more?" and (2) "Will you reprint it?" To answer the last one first: not at this time (although I wouldn't rule out the possibility that we might someday republish some new combination of old articles).

But how is the press run determined for special issues? Admittedly, we have to wing it. We printed 12,000 copies of the California issue, thinking that surely it would sell well considering the great localities and the large number of California subscribers we have. Not so. We still have several thousand copies in the warehouse. We printed about 9000 of the first three Arizona issues, and they required from a few months to a year to sell out . . . just about right. So we've settled on 9000 to 10,000 copies for special issues. We prefer not to have to store copies for more than a year or two.

Our sincere apologies to our subscribers outside of the U.S. who did not get their initial copy in time to order more. We do our best to keep that from happening, but in this case we underestimated; and reprinting more copies now would be too expensive.

GLOSSARY 1983

As announced in the January-February issue, the new edition of the *Glossary of Mineral Species* is now available. A count shows that it lists 2919 valid mineral species (in addition to several hundred commonly used varietal and obsolete terms). Looks like this will be the year that the number of accepted species breaks 3000. Author Mike Fleischer accumulated more than *800* new species names and changes in old species since the previous edition only 3 years ago. (Those readers wondering whether they might limp along on their earlier edition a while longer should keep this in mind.) Research into new species seems to be accelerating, rather than trailing off as one might expect after all these years. These are surprisingly interesting and exciting times for the Old Science of Mineralogy.

BOOK DONATIONS

The *Record* needs books for editing and article compilation purposes. Anyone having mineral-related books they would like to donate can receive tax advantages on the donation, and in addition would be doing the *Record* and its readers a valuable service. We could use the following:

Rocks and Minerals, vol. 27 through vol. 54
The Mineralogist, all volumes
The Mineral Collector, all volumes
Hintze's Handbook, all volumes

And any books, of any age, devoted to mineralogy or mineral localities.

COLLECTION COMPUTERIZATION

With home computers becoming more common every day, computerized cataloging for the collector is a subject of increasing interest. **Keith Pilcher** (*Tetrahedron Minerals,* P.O. Box 226, Paraparaumu, New Zealand) is preparing a computer newsletter for mineral collectors. He asks that anyone involved in this write to him with information on what they have accomplished via the home computer, as regards the cataloging of minerals. He will compile and publish the results along with a listing of interested parties' names and addresses so that all you mineral hacks can henceforth keep in closer touch.

NEW MINERALOGICAL SOCIETY FORMED

The Southern Great Basin Mineralogical Society has recently been formed as a vehicle for mineral collectors in Nevada (Clark, Esmeralda, Lincoln and Nye Counties), Utah (Beaver, Iron and Washington Counties) and Arizona (Mojave County). This region is one of the last American frontiers for the formation of a mineral-oriented group. It encompasses many interesting but relatively unknown localities, along with a lot of people who swear they are the *only* collector within a hundred miles!

Society goals include organized field trips, the compilation of locality data for the region, and the creation of an annual symposium. For more information contact: **Walter S. Lombardo,** 4728 Elm Avenue, Las Vegas, Nevada 89110, Tel. 702-453-5718.

EXPERTS ON OLD LOCALITIES NEEDED

The Louisville Free Library purchased the collection of Gerard Troost (1776–1850) in 1872. The collection, numbering nearly 14,000 specimens, has suffered much over the years, including a flood which destroyed many mineral labels and catalog numbers. The original catalog remains, however, and the curator needs the help of anyone who can accurately attribute specimens to early European localities such as Arendal, Norway; St. Andreasberg; Freiberg and the like. There are plenty of early U.S. specimens too. Anyone with such expertise, who might be passing through the Louisville, Kentucky, area, is asked to contact **Alan Goldstein,** 3430 Bryan Way, Louisville, KY 40220.

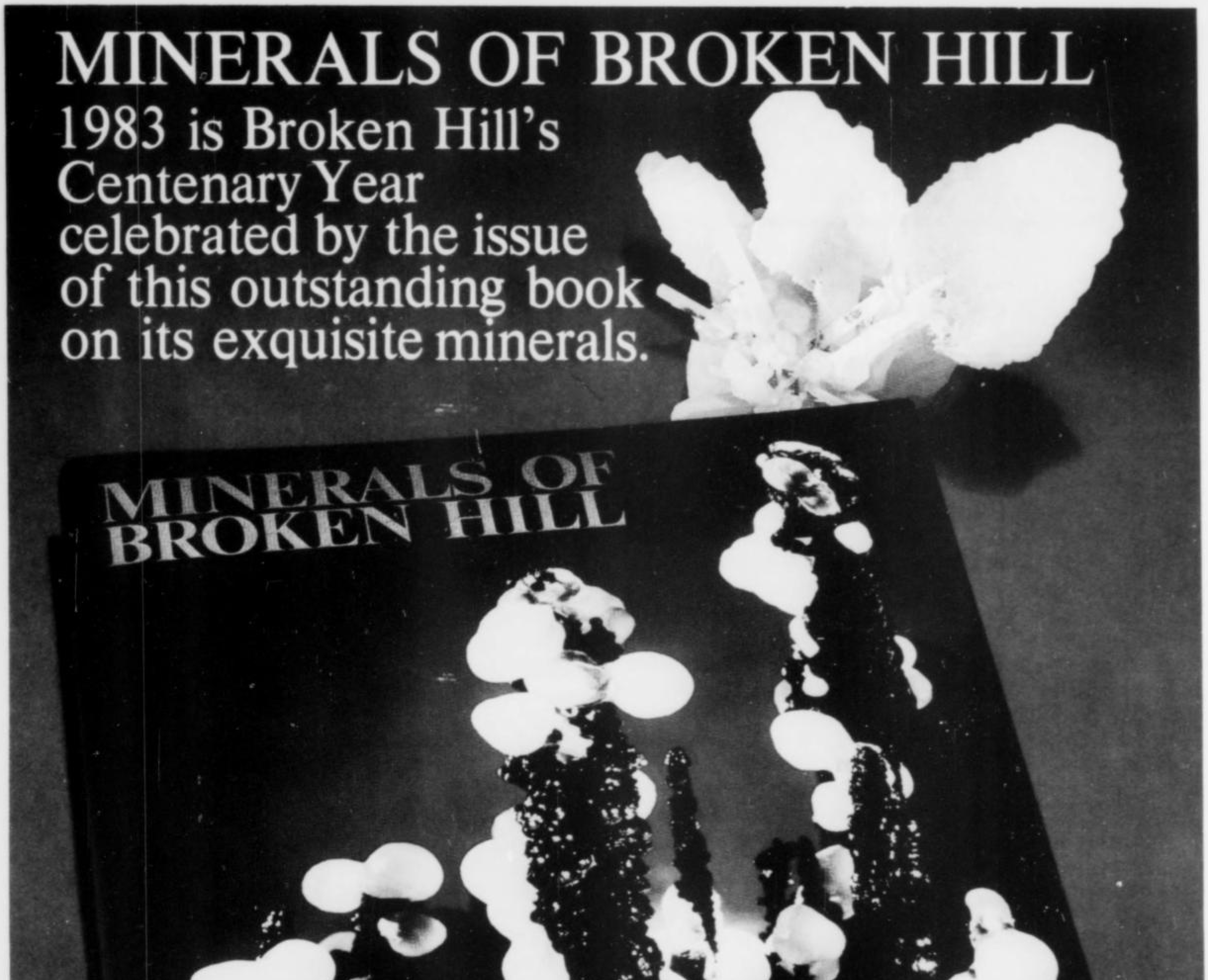
OUT-OF-PRINT COPIES OF THE RECORD

Sharon Cisneros of *Mineralogical Research Company* (704 Charcot Avenue, San Jose, CA 95131) has decided to take the big plunge and begin dealing in out-of-print copies of the *Mineralogical Record* in an organized and comprehensive fashion. She will keep a card-file for issues wanted, so be sure to send her your want-list if there are issues missing in your collection. She will also have available a list of prices offered for the various back issues, if you have some to dispose of. And she will prepare a continuously updated listing of back-issues she has in stock. So, whether you need one old copy or a complete run, or if you have some duplicates to sell, drop her a note.

NOTICES

Died, Richard N. Kelley, 42, in Rochester, New York, of cancer. Kelley, a native of Rochester, obtained his BS and MS degrees from Pennsylvania State University and his PhD in chemical engineering from Rensselaer Polytechnic Institute in 1969. He was a senior supervisor in the Synthetic Chemical Division of Eastman Kodak Company in Rochester, while also engaging in a part-time mineral business *(Crystal Gems)* and accumulating a very fine personal collection of English specimens. In 1975 he co-authored a book, *Entering Industry, a Guide for Young Professionals.* His research contributions earned him a place in *American Men and Women of Science* (15th edition, 1982). Though he maintained somewhat of a low profile in his mineral dealings, he was widely known and liked among mineral collectors and curators, and was recently instrumental in the dispersal of the famous Lazard Cahn collection.

J. Schlepp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Across the San Juan Mountains

by **T. A. Rickard**

Abridged and annotated by
Arthur E. Smith
9118 Concho
Houston, Texas, 77036

Annotated and illustrated by
Richard A. Kosnar
Route 6, Box 263
Golden, Colorado 80401

In 1902, the well-known mining engineer and author T. A. Rickard toured the mines of Colorado's San Juan Mountains on horseback. His travels, published in 1907 as "Across the San Juan Mountains," took him through many famous collecting sites.

First of Two Parts

On a superb morning in September, that month of many colors, four of us started on a ride among the mining districts of the San Juan, in southwestern Colorado.

We left Ouray early on the 5th of September, 1902, with the intention of visiting two mines in the vicinity – the American Nettie and the Bachelor. A mile below the town the trail ascends the precipitous sides of Gold Hill, and as our sure-footed mountain horses followed the zig-zag through the pines we found that each turn of the trail brought a steadily expanding vista.

On arrival at the **American Nettie** mine the superintendent, Mr. Kunz, permitted us to visit the underground workings. These have an aggregate length of 12 miles, and consist of a series of adits and drifts penetrating the top layers of the Dakota sandstone where it comes in contact with the overlying black shales of the Colorado series. The ore is found in irregular masses occupying chambers in the sandstone and impregnating the rock along stringers or small veins which serve as a guide in prospecting. In the cavities the ore consists chiefly of a sintery mass of oxidized material interspersed with ocherous ironstone, but when the ore is found impregnating the body of the sandstone it appears in the form of sulfides – pyrite, chalcopyrite, sphalerite and tetrahedrite.

The American Nettie has a new tramway, whose catenary curve sweeps from the high cliffs of Gold Hill, and, with undeviating line, bridges the abyss of the valley. It is a picturesque bit of engineering. A descent of 1,820 ft. is made in 4,200 ft.

On leaving the Nettie we followed the trail which took us around the northern ramparts of Gold Hill, downward into the valley, whence a road led to the Bachelor mine in Red Cañon. Two members of the party, who were unused to the mountain horse, marveled at his sure-footedness as we scrambled down talus slopes and threaded our way among loose blocks of fallen rock. It is my experience that a good "trail horse" will go almost anywhere that a man can go without using his hands, while the patient burro (donkey) will walk safely over ledges which bring a tremor to the hearts of those who are not mountaineers. All the exploratory work of the Rocky Mountain regions was done by "packing," that is, by the transport of supplies and machinery on the backs of animals. Both mules and donkeys are used in this service. When the former are employed they are strung out in a line and connected by rope. A man rides the leading mule and guides the whole cavalcade. Another man usually walks or rides in the rear. When burros (the word donkey being rarely heard in the mining regions) are engaged in packing they are not tied together, but each goes loose, and the owner drives them like a flock of sheep, differing only from the latter in that they have learned, from the narrowness of the trails, to walk in single file when that is required for safety. A mule will carry 250 pounds up grade and 350 pounds down, while a burro can manage to carry an average of 200 pounds. The mule requires to be fed, but the burro can eke out a precarious existence on the scant grass of the mountain slopes, and for this reason he has been most serviceable to the pioneer and the prospector; if the camel be named "the ship of the desert," then the patient long-eared friend of

Figure 1. **Loading ore at the Bachelor mine. (American Heritage Center, University of Wyoming.)**

Figure 2. **The Virginus mine in the Sneffels area. (American Heritage Center, University of Wyoming.)**

the miner might well be christened "the porter of the hills."

When we reached the **Bachelor mine** the noon-day meal was ready, so we accepted the invitation of Mr. George Hurlbut, the principal owner of the mine, to take luncheon before going underground. It will not be out of place to refer to the food which miners get in localities like these; it is surprisingly good, as a rule, even at properties which are a couple of miles above sea level and a corresponding distance from the main distributing points for provisions. The companies usually charge one dollar per day for board and lodging, where standard wages are $3 per shift. The fare which the miner gets three times a day is superior to that of the second-class hotel of the neighboring mining towns and far better than that which is the daily portion of workmen in other countries. There is always one weak spot – the coffee; partly because it is not prepared immediately before being served and partly because it is made from adulterated mixtures, and largely because the average mine cook does not know the taste of real coffee – at all events, it is a concoction out of keeping with the excellence of the remainder of the miner's fare and much better adapted for staining floors or removing boiler scale.

Many specimens of silver-bearing tetrahedrite have come from the **Bachelor mine**, and I have also had X-ray identified stephanite from the area. (RAK)

The Bachelor lode is closely associated with a clastic dike of peculiar character; the same lode follows the dike through the mines to the east, the **Khedive**, and to the west, the **Wedge**. The ore is quartz, carrying streaks of galena and gray copper (tetrahedrite). There is also some blende present. Inclusions of country (sandstone) give the vein a mottled look along its outer edge.

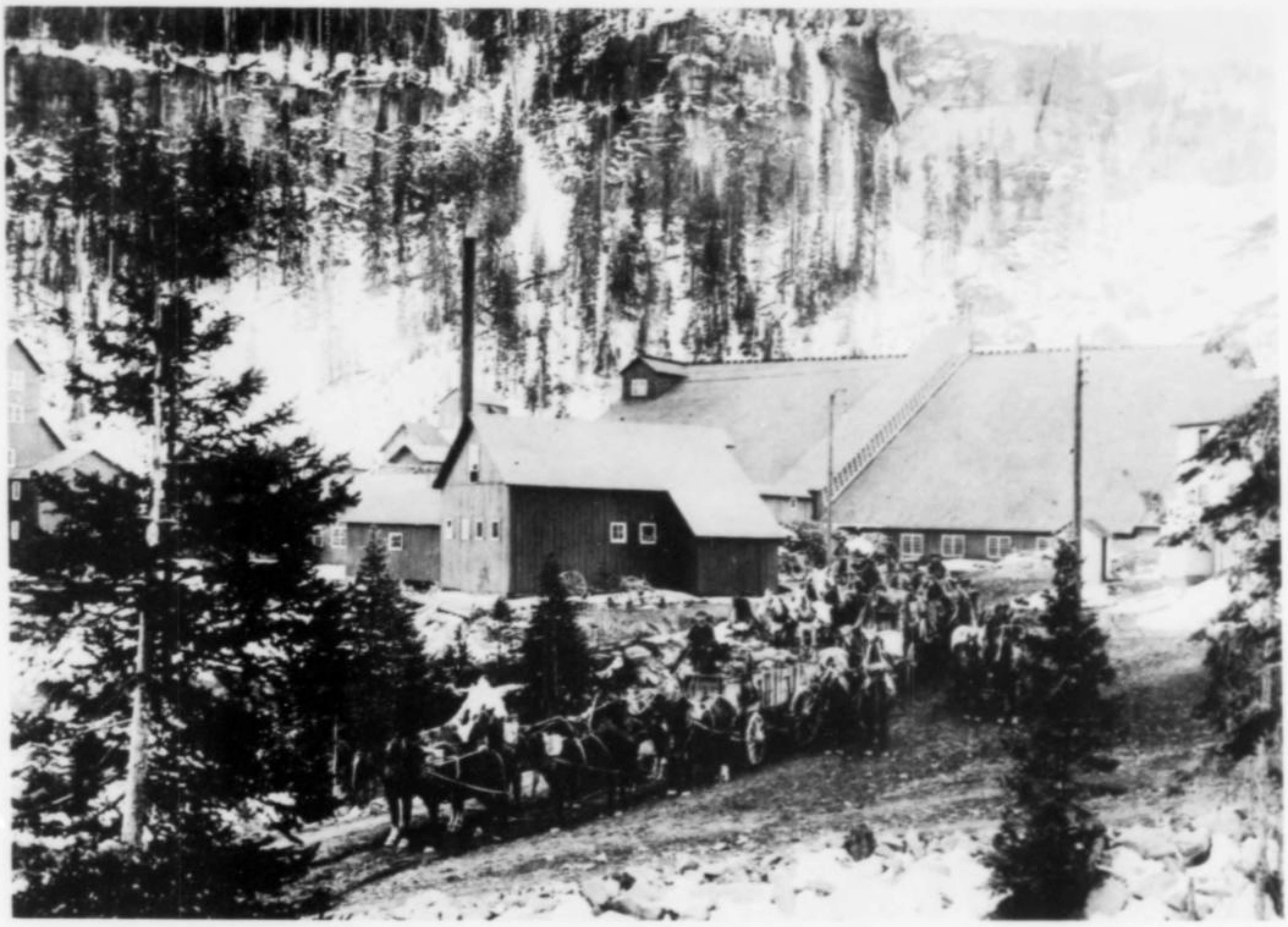


Figure 3. **The Camp Bird mine, early 1900's. (American Heritage Center, University of Wyoming.)**

The next day, September 6, our cavalcade clattered up the main street of Ouray en route to Telluride by way of the Mt. Sneffels range. Cloudless weather, not unusual after the rains of late August, made the ride up Cañon Creek to the Camp Bird mill a stimulating pleasure. Much of this road is cut out of the solid rock; in many respects it is a fine example of mountain engineering, and it is kept in good order because it serves as the avenue of traffic for two of the largest mines in Colorado – the Revenue and the Camp Bird.

We overtook a train of burros with a miscellaneous freight of planks, groceries and boxes of dynamite destined for a small mine on Mt. Potosi; these, with bulky packages that hid their ears and left only a view of active extremities, looked at a distance for all the world like a migrating colony of Brobdingnagian ants.

Advancing carefully along the *inside* of the road, whose outer parapet stood sheer over a precipitous cliff, we hurried our horses past the burro train and soon covered the six miles between Ouray and the Camp Bird mill, where Mr. W. J. Cox, the manager, gave us every facility for inspection.

The Camp Bird ore is one of the most docile. The total extraction of gold is fully, sometimes more than, 90 percent of the assay-returns from the crude ore. The latter carried about two ounces in gold at the time of our visit.

After partaking of Mr. Cox's hospitality we mounted again and began the ascent to the Camp Bird mine in Imogene basin. As we surmounted the first rise we found ourselves in a wide amphitheater of serrated ridges with a broad gap in the direction whence we had come.

The **Virginius**, a neighboring mine, has an adit – the Revenue tunnel – which strikes the vein at a point 2,400 ft. below the outcrop and 10,800 ft. above sea level. A shaft has proved the vein for 900 ft. below the adit, so that the total exploration on the vein extends for a vertical height of 3,300 ft., which is the deepest development attained by any mine in Colorado. The Virginius vein is remarkable in other respects also. It has been worked for more than 20 years. For the first 400 ft. in depth the vein was stoped continuously, although its width only ranged between a finger and a hand's breadth. The ore was chiefly gray copper – argentiferous tetrahedrite – and averaged 400 to 600 oz. silver per ton. At about 1,200 ft. down the shaft, which followed the vein, entered a poor zone, which extended for 300 ft. further. At the level of the Revenue adit another poor zone, about 150 ft. thick, was encountered. The new vertical shaft, sunk from the adit, has found good ore, 30 inches wide, at 550 ft.

The **Virginius mine** once produced some fair mineral specimens, but very little has survived. (RAK)

On arrival at the **Camp Bird mine** the superintendent, Mr. William Beaton, piloted our party through a portion of the workings. A production, up to date, of about $7,500,000 places the Camp Bird among the great mines of Colorado. It is also interesting as having been until lately the property of the man who opened it up, Mr. Thomas F. Walsh.

The history of the discovery of this celebrated mine is curious. The only outcrop on the vein for several thousand feet is in a small gully right at the head of Imogene basin. A claim was located on this outcrop in 1877, but nothing further was done because no ore of any value was exposed at this point. William Weston and George Barber, who were the owners, made a proposal to H. W. Reed and Caleb Reed that if they would run a cross-cut tunnel, which would cut the vein at about a depth of 150 ft., they could have the option of locating a new claim on whichever side of the cross-cut they

Figure 4. **Sampling gang and bosses, Camp Bird mine. (American Heritage Center, University of Wyoming.)**

In recent years the **Camp Bird mine**, owned by Federal Resources Corporation, has been consolidated with the **Revenue mine**. The mine has been in almost continuous operation since 1896, but was closed in early 1982. Mining of the replacement deposits in the Telluride conglomerate has, in the last few years, yielded excellent crystal specimens of black sphalerite, galena, chalcopyrite, chlorite, calcite, epidote, fluorite, milky quartz, pale pink rhodochrosite and manganocalcite. (AES)

chose. The cross-cut was run, and in due course intersected the vein. The Reed brothers drifted 50 ft. to the west and took up a claim on that side. This was then patented under the name of the Una claim. On the eastern side the Gertrude claim was pegged out by Weston and Barber, who, later on, sold it to the Allied Mines Company. This was in 1878. Subsequently the company extended a drift for 40 ft. into the Gertrude ground, but found no ore of any value; later still, another 10 ft. was driven, so as to make the distance 50 ft., and thus qualify for patent. This was in 1884. The ore in the last 10 ft. was *not* assayed because the work was only done to fulfill legal requirements and the first 40 ft. of the drift had carried no pay ore. But as a matter of fact the drift had at the last two or three feet, broken into rich ore; it remained there undetected until 1896, when Walsh broke some samples and had them assayed, thereby taking the decisive step toward becoming a millionaire. Moral: Never fail to test the ore of a drift which is penetrating into

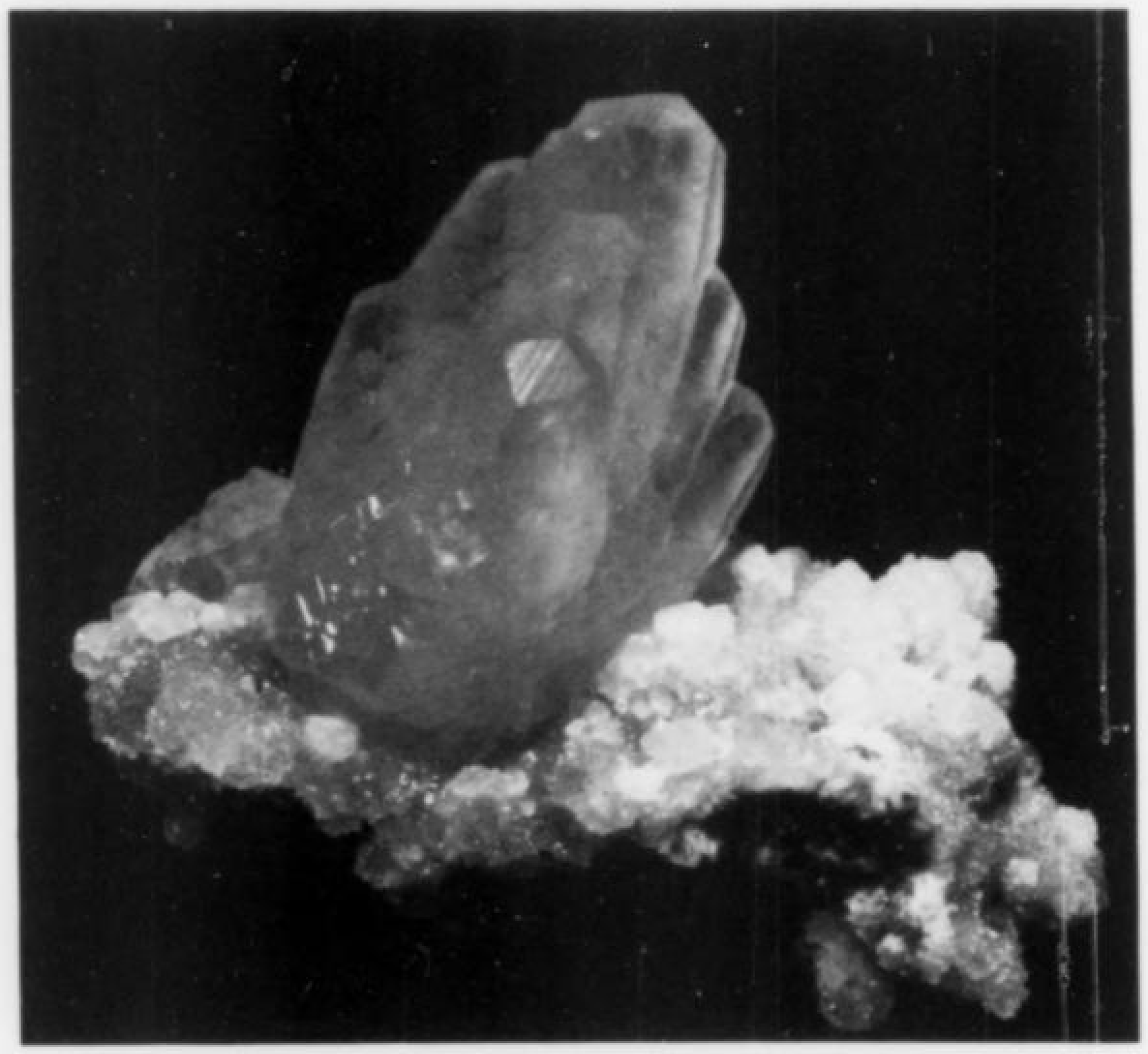


Figure 5. **Calcite crystals to 3.8 cm, on quartz, from the 630 Mud drift, 2100 level, Camp Bird mine, Ouray County, Colorado. Collected in 1976 by David Bergman. Kosnar specimen and photo.**

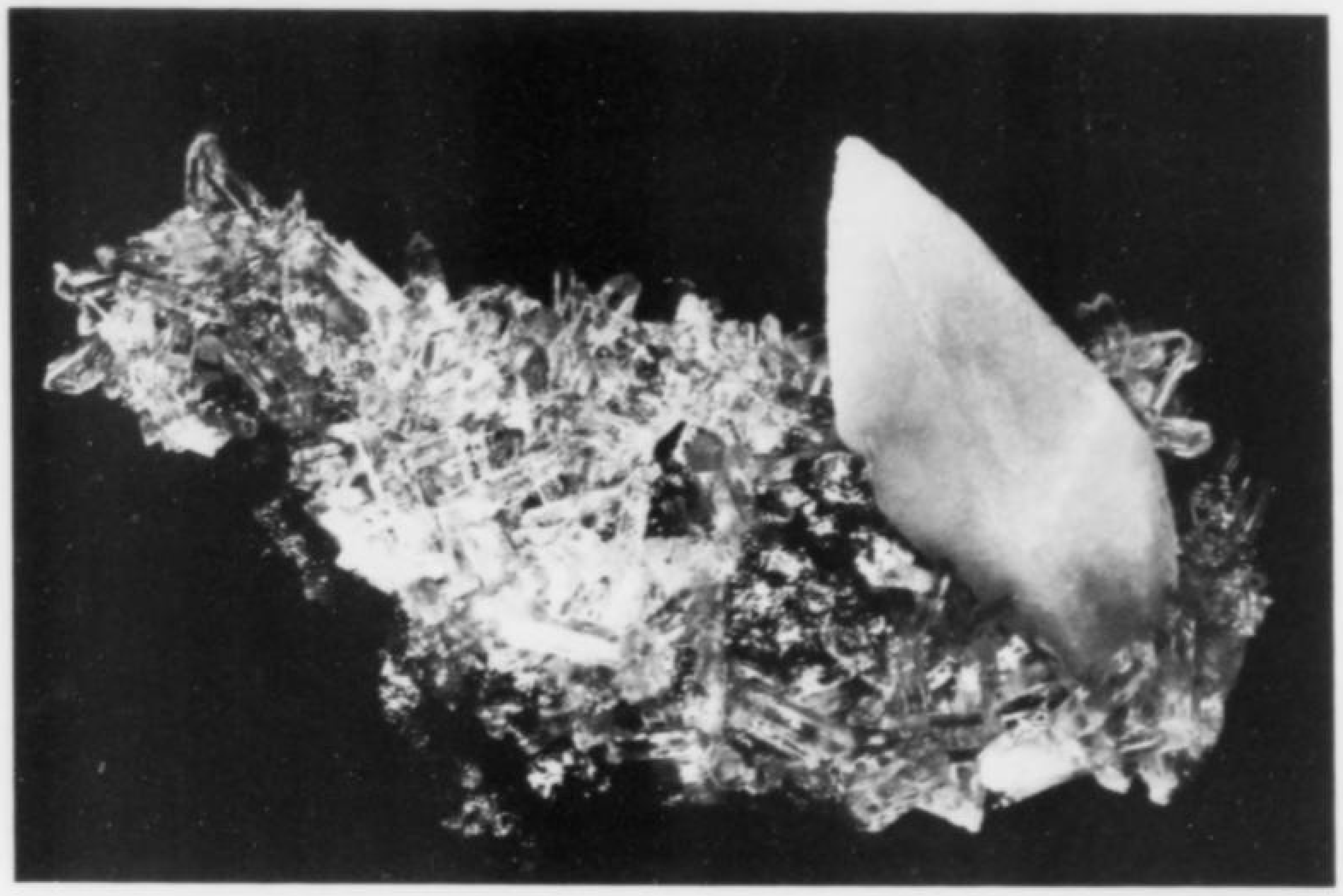


Figure 6. **Calcite crystal 4 cm long on pyrite and transparent quartz, from the 500 stope, 2100 level, Camp Bird mine. Collected in 1976 by Elwood Gregory. Kosnar specimen and photo.**

Figure 7. **Twinned chalcopyrite crystal, 3 cm in diameter, on white drusy quartz and black sphalerite from the 1100 stope, 2100 level, Camp Bird mine. Collected in 1977 by Elwood Gregory. Kosnar specimen and photo.**

new ground, and never assume that ore is poor because it *looks* like ore you know to be poor.

The rest of the story is well known. Walsh was an experienced miner who had met with some success both at Leadville and Rico. In 1896 he was manager of the pyritic smelter erected at Silverton for the treatment of the ores sent down from Red Mountain by the Yankee Girl and Guston mines. Walsh had, in 1894, organized the company which put up this plant. In the search for silicious ores he investigated the mines of the surrounding country, not only those in operation, but also the abandoned prospects. He acquired the Hidden Treasure mine, in Imogene basin—this was a low-grade silver-lead property, which has never done much. In July, 1896, he went to see how work was going on at the Hidden Treasure, and incidentally he noticed some pieces of pink spar amid the débris scattered at the foot of the cliffs, which form the upper limits of Imogene basin. This pink spar he took to be fluorite, and because it reminded him of Cripple Creek, where also he had mined with some success, he made a mental note of the occurrence. In the following September he revisted the locality and climbed up into the old Gertrude adit, from which he inferred the pink spar to have come. It was rhodochrosite; but no matter. It led him to take samples at the breast of the east drift. They were sent at once to Ouray to be assayed. The returns gave several ounces of gold per ton. More samples were taken and sent to Leadville for assay. The results were confirmatory, so he went to work quietly and began the steady consolidation of the adjoining property. Mr. Walsh's success was the reward following many years of most energetic search, a search backed by unusual experience in mining and extending over a large area which contained a great number of deserted old workings likely to prove remunerative under new economic conditions.

The main level of the Camp Bird is now over a mile in length, so that when we emerged from underground it became necessary to make haste in order to cross the range before dark. Ouray is 7,806 feet above sea level, the No. 2 level of the Camp Bird is at 11,510 feet, and the place where the trail crosses the divide is at an altitude of about 13,800 feet. The trail is a good one in summer, so that we did not require to lead our horses save in the steepest portions of the rise and in the abrupt descent on the other side. When we attained the summit a halt was called in order that we might take in the splendid panorama of mountains which lay outspread on either hand. Looking back over the course we had traveled we could see the shadows hastening to cover the valley of Cañon Creek and the sheltered corner among the hills where Ouray lay concealed; in the far northeast the dark mass of the Uncompahgre plateau loomed

Figure 8. **White cubic crystals of fluorite to 2 cm on calcite from the 630 Mud drift, 2100 level, Camp Bird mine. Collected in 1976 by David Bergman. Kosnar specimen and photo.**

Figure 9. **Cuboctahedral galena crystal 2.5 cm on edge with white calcite and black sphalerite crystals from the Gordon #2 orebody, Camp Bird mine. Collected in 1976 by T. Rosemeyer. Kosnar specimen and photo.**

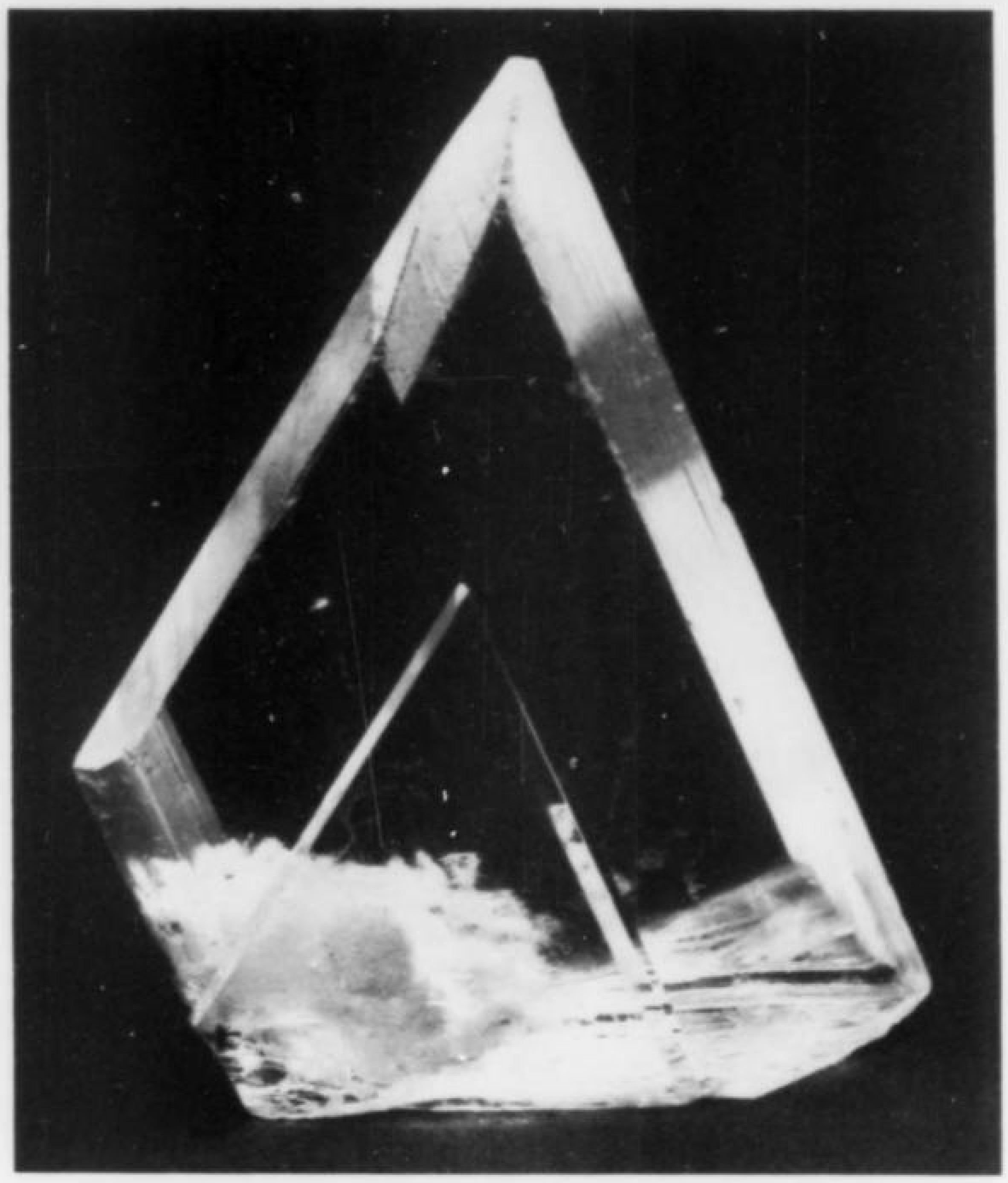


Figure 10. **Water-clear gypsum crystal 6.5 cm tall from the 1100 level, West 4 section, West Camp Bird vein, Camp Bird mine. Collected in 1974 by T. Yates. Kosnar specimen and photo.**

Figure 11. **Japan-law quartz twin 6 mm across from the 630 drift, 1700 stope, Walsh vein, 2100 level, Camp Bird mine. Collected in 1975 by David Bergman. Kosnar specimen and photo.**

purple in the fading light. Looking the other way the grim desolation of time-worn summits and crumbling crags reached down into the gloomy gorge of the San Miguel, which suddenly broadened into the sunlit valley of Telluride, checkered with cultivation and bright with the gleam of blue water. Beyond were green foothills, out of which arose the sculptured mass of Mt. Wilson, silhouetted against the setting sun, and further still, northwestward, rim upon rim of far-off hills fading into the bourne of distant Utah.

The descent to Telluride was tedious, for it meant leading our horses most of the way – and some horses are particularly slow to be led, however willing to be ridden; besides, the drop from the top of the range to the valley is just five thousand feet in the course of five miles. All the way down one passes mines and mills; of the latter, the new Tomboy mill in Savage basin loomed conspicuous through the dusk.

At first sight it seems curious to build a large mill at an altitude of nearly 12,000 feet, instead of choosing a site in the valley and transporting the product of the mine over an aerial tramway. On the whole, it may be said that the comparison of conditions affecting the operation of a mill in the valley and that of a mill at the mine is without decisive result and depends entirely upon local factors. One of these is the ability to secure a good mill-site at a reasonable price. Another possible factor is the snowslide. To a stranger the interruption and damage from this source would seem to present a very serious obstacle to the use of a tramway. It does, but to the same extent it affects all the operations in a precipitous snowy mountain region. Last spring the Smuggler-Union tramway was stopped for several weeks as a consequence of the damage done by a slide, and during the same season the Liberty Bell mine-buildings were swept away, so that the mill was idle for four months. In the latter case eighteen lives were lost, and the majority of these belonged to rescue parties who set out to the aid of those who were caught by the first slide. Successive avalanches entombed the rescuers.

As a rule, it is possible to predict the track of snowslides, because they commonly follow the line of destruction marked out by them in previous years, but as a matter of fact, the great injury to life and property due to snowslides is just the one which is caused by the unexpected slide which takes an entirely unsuspected line of descent. Such was the cause of the Liberty Bell catastrophe, for, of course, the buildings were erected at a spot confidently believed to be immune from such a danger.

Figure 12. **Black sphalerite crystals to 1.2 cm with quartz, chalcopyrite, dolomite and kutnahorite (X-ray identified) from the Gordon vein, 2100 level, Camp Bird mine. Collected in 1975 by David Bergman. Kosnar specimen and photo.**

The destructiveness of a snowslide must be seen to be appreciated; buildings and tramways are as toys before its fierce oncoming and men in the path of its descent are as straws in a whirlwind. In fact, most of the damage is due to the vacuum caused by the rapid motion of a mass of snow and the cyclonic disturbance which follows in its wake. I have often watched them descending a neighboring ravine, when myself out of all chance of danger. The thunder of its tempestuous descent first calls one's attention, and then one sees the mass of snow gathering underlying rocks, uprooting trees, amid a quickly gathering mist of snow particles driven fiercely by the whirlwind in the rear. The rushing mass will not stop at the bottom of the slope, but its momentum will carry it some distance up the opposite declivity, while all the forest trembles and the air is darkened with a snow mist.

The stretch of country covered by Marshall and Savage basins, and thence to the valley at Pandora, has seen many a snowslide. A long tale of woeful fatalities and romantic heroism could be told concerning these three or four miles of mountain land.

The **Smuggler-Union mine** is one of the largest in Colorado; it was discovered in 1875, when one of the claims, the Sheridan, was first located. A stray occurrence of the mineral sylvanite, the telluride of gold and silver, was the cause of the naming of the mining camp. The lode proved remarkably persistent in richness through the Mendota, Sheridan, Smuggler and Union claims, and

Figure 13. **Spinel-law twins of black sphalerite to 2.5 cm, with bright cuboctahedral galena and calcite from the 630 drift, 2000 stope, Walsh vein, 2100 level, Camp Bird mine. Collected in 1977 by James Points. Kosnar specimen and photo.**

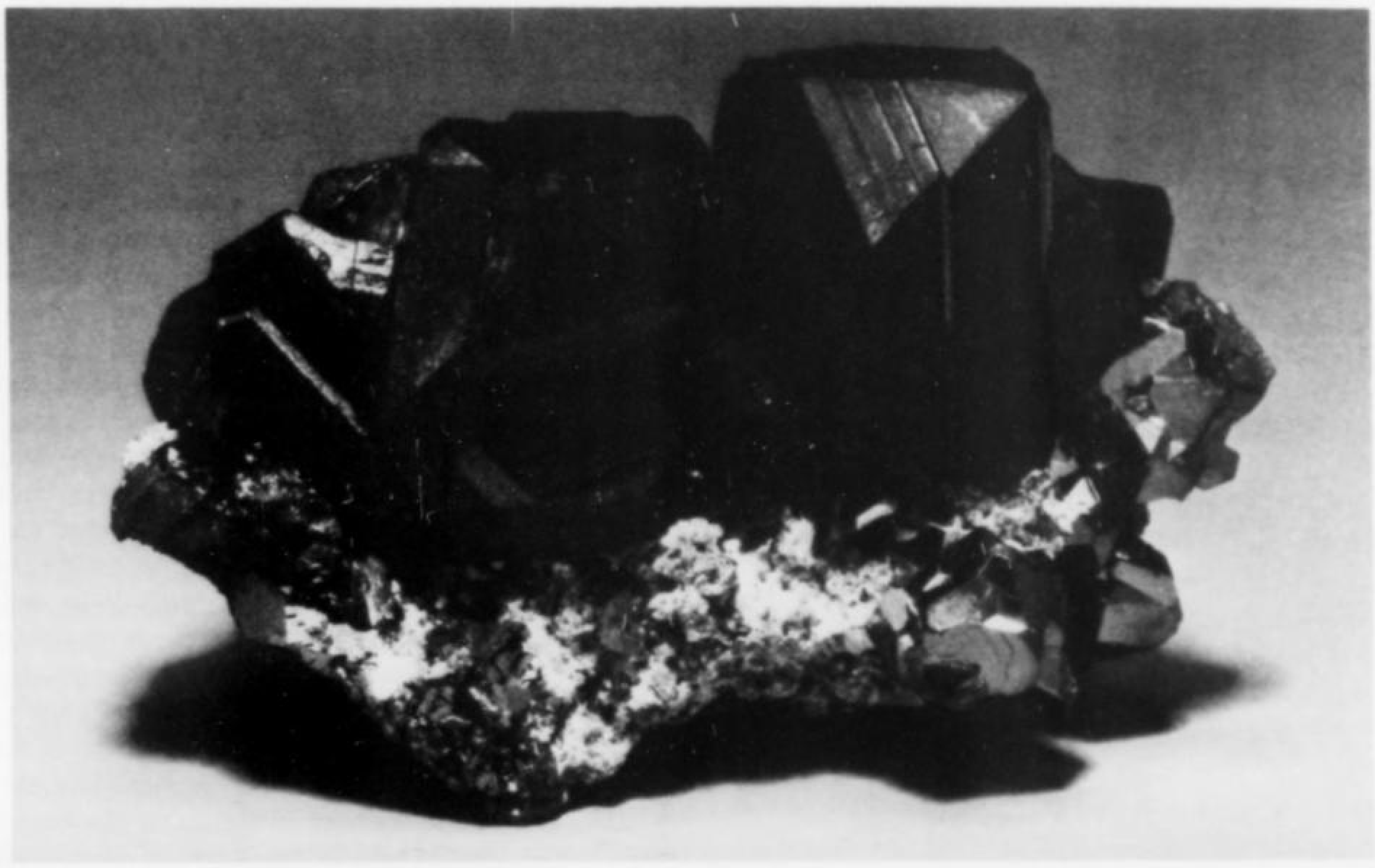


Figure 14. **Miners at the Smuggler-Union mine near Pandora, Colorado. (American Heritage Center, University of Wyoming.)**

beyond them into other mines; it has been traced for over four miles on its strike and it has been continuously stoped along one portion for a length of 5,000 feet. The Smuggler lode has yielded altogether about $12,000,000.

The Smuggler vein is notably banded; the hanging wall is usually well-defined and carries a casing, immediately underneath which a persistent quartz-leader is generally to be seen. This leader is the first part of the vein to show oxidation. The footwall is "frozen" with quartz stringers, which merge into the country. The general structure of the vein suggests multiple fracturing with but slight actual displacement, and shattering of the rock without much actual crushing. Vugs, or crystal-lined cavities, are frequent; they are due to crustification, or crystal-lined growth, around the sides of spaces separating pieces of broken rock.

The lode yields a wonderful array of fine crystals of quartz, siderite, calcite, argentite, rhodochrosite, gold and silver. The transparency of most of these, especially the quartz and the siderite, suggests an extremely slow process of crystallization. Siderite, the carbonate of iron, occurs in handsome yellow crystals encrusting both quartz and calcite. Calcite was the last mineral to be precipitated, and it is found lying upon the quartz which lined the geodes or vugs. Rhodonite, the silicate of manganese, occurs in irregular bands, usually on the footwall or else in the main body of the pay-ore. Rhodochrosite, the carbonate of manganese, is occasionally seen in rose-red crystals. Gold is found in crystalline aggregates forming specimens of great beauty. Wire gold also occurs. In the upper workings the native gold is purer.

We spent a couple of days at Telluride, visiting the mines in the vicinity. Two of our party went up to the **Contention mine,** and avoided a long ride over road and trail by getting into one of the buckets of the tramway which makes a bee-line up the mountain

The **Smuggler mine** was located in 1876 by J. B. Ingram (not 1875 as stated by Rickard). Ingram had noticed that the adjacent **Sheridan** and **Union** claims exceeded the legal maximum size of a mining claim by about 500 feet. Being an enterprising soul, he quickly took advantage of the oversight by staking a claim on ground between the two. He made a fortune, and by 1900 over *35 miles* of drifts and workings had been excavated in the Smuggler-Union mine. Some of the most beautiful gold specimens ever to come from Colorado were found here.

In October of 1875, John Fallon located the first lode mine in the area, the **Sheridan mine** (named after General Philip Sheridan of the Union Army). By 1878 an 80-acre townsite named Columbia had been laid out, and it was later chosen to be the San Miguel County Seat. Postal officials, however, had trouble with misdirected mail due to another town named Columbia in California, and so, in 1887, Columbia, Colorado, was renamed Telluride. Actually the name is not especially appropriate; tellurides of any kind are very rare in the area. (RAK)

Both the **Tom Boy** and the **Smuggler mines** became part of the **Idarado mine** in 1953. The Idarado mine was opened to exploit deposits in Red Mountain Pass, on the road between Ouray and Silverton. Mining began in 1946, and continued until 1981. The Idarado is noted in particular for the large milky quartz crystals, rhodochrosite, and other minerals found there. (See the articles by Jack Murphy, "(Mining history of) the San Juan Mountains of Colorado" and "Mineral collecting at the Sunnyside and Idarado mines," in the November-December 1979 issue of the *Record*.) (AES) side. The aerial voyage was made speedily and safely, if not very comfortably.

On the 8th of September we started for Silverton. We took the recurrent zig-zag of the Bridal Veil trail, and in an hour reached the top of the waterfall, whose filmy traceries had originated the name. The beauty of the waterfall is gone, a sacrifice to utilitarian engineering, which has taken the water to supply power to the Smuggler-Union mill. The pipe-line climbs to the place where once the waterfall flung itself into space, and the penstock stands where it paused for breath before its leap into the sunlit ravine. As we halted at the head of the trail, the San Miguel valley lay outspread with panoramic spaciousness.

When we resumed our ride, we found ourselves on a trail threading a pine forest. In sheltered spots the wild flowers of summer still lingered, and the trail crossed busy rivulets, whose voice was the only sound disturbing the quiet of regions strangely devoid of life. Emerging from the pines, we found ourselves on the treeless waste above timber line, and followed an easy ascent along the bare, rounded slopes at the head of an amphitheater of ridges. It was a lifeless desolation, bleak and still, until suddenly a series of salutes rang out, to be echoed grandly from peak to peak. These were the blasts from mine-workings which we had not seen; they marked the noon hour. It was time for "croust" (literally crust), as the Cornish miners call the meal which divides their working time; so we off-saddled beside the first stream and ate our luncheon while the horses nibbled the scant, dry grass. It seemed good to be there under that serenely blue sky and amid an air that made "the world seem young and life an epic." Those who do not know the exhilaration of these high altitudes have not realized what perfect vitality means. On resuming the ascent, we were soon amid loose slopes of débris, over which the horses went with no more difficulty than ourselves, although the increased rarity of the air told on them very obviously. The trail was lost, and on choosing the lowest ridge to the south, we found ourselves eventually where we did not expect to be; that is, overlooking the little mining town of Ophir, which I knew to be out of our course to Silverton. We looked from a razor-back ridge far down a precipitously steep slope into a distant little green valley; a white road marked the center of it, and a cluster of dwellings, like match-boxes, seen so far, marked the settlement of Ophir. This is not Solomon's treasure-house, but as the slanting sunlight touched the clusters of yellow aspens upon the lower slopes of the valley we found reason enough for the fitness of the name.

Retracing our steps into the basin from which the ridge arose, we crossed to the eastern side, and finding a trail, ascended a crumbling ridge, from which we could see the whole complex of mountains stretching from Red Mountain to Silverton and far beyond. We were 13,200 feet above sea level. It did not take long to regain our wind, and shortly the four of us were picking a way down the further side, winding in and out of those semi-circular basins which are so characteristic of the high country just above the timber line. It was wearisome pulling unwilling horses over talus slopes, so we soon halted for a breathing space and took in the view. An amphitheater of rugged peaks formed our background; tiers built up of successive extrusions of andesite looked out upon a vast lifeless desolation of gray summits and dun-colored ranges, from which rose three flaming peaks, red as torches to anarchy. These, the Red Mountains, are a landmark throughout the region. Their color is due to the solfataric action of thermal waters upon the iron sulfides disseminated through andesitic rock. At the foot of these iron-stained ridges are situated the famous **Guston** and **Yankee Girl mines**, which were so prolific about fifteen years ago. The origin of the lodes is connected with that of the peculiar red summits, in that both are traceable to the activity of acid waters which have precipitated rich silver minerals on the one hand, and, on the other hand, have removed the more soluble portions of the andesite, depositing additional silica, so that the resulting quartzose country has withstood erosion sufficiently to survive in the form of red summits, which now serve as beacons to the prospector.

We reached Silverton before dark.

Silverton exhibited a condition of bustling activity; the country tributary to it, up and down the Animas and along its numerous tributary streams, has recently undergone a good deal of that new development which is essential to the maintenance of production in a mining district. In fact, by reason of the energetic development, particularly of gold mines, which has been going on ever since the fall in the price of silver in 1893, the surrounding region is to-day one of the most prosperous mining tracts within the Rocky Mountain area.

The mountains around Silverton were first invaded by the pioneers in 1871, when the Little Giant vein was discovered by Miles T. Johnson. In 1872 an arrastra was put up, not far from the present site of the large modern plant of the Silver Lake mine. At that time the nearest trading station was at Conejos, in the San Luis valley. Until 1873 the Indians had legal control over the region, but this was ended peaceably by the Brunot treaty.

Early on the morning of September 9 our party of four rode down the wide main street en route for the Golden Fleece mine, near Lake City, about 40 miles distant. Just outside the town one passes the entrance to Cement creek. Here there is a new pyrite smelter which is close to the site of the old Green smelter, erected by Judge Green, of Cedar Rapids, Iowa, in 1874. The machinery for that early metallurgical establishment came on burroback from Colorado Springs, over 300 miles, Colorado Springs being at that time the terminus of the railway.

As we rode along the right bank of the Animas, we passed the North Star mill, where John J. Crooke employed the old Augustin process, roasting silver ore with salt and leaching the resulting chloride with hot water, finally precipitating the silver on copper.

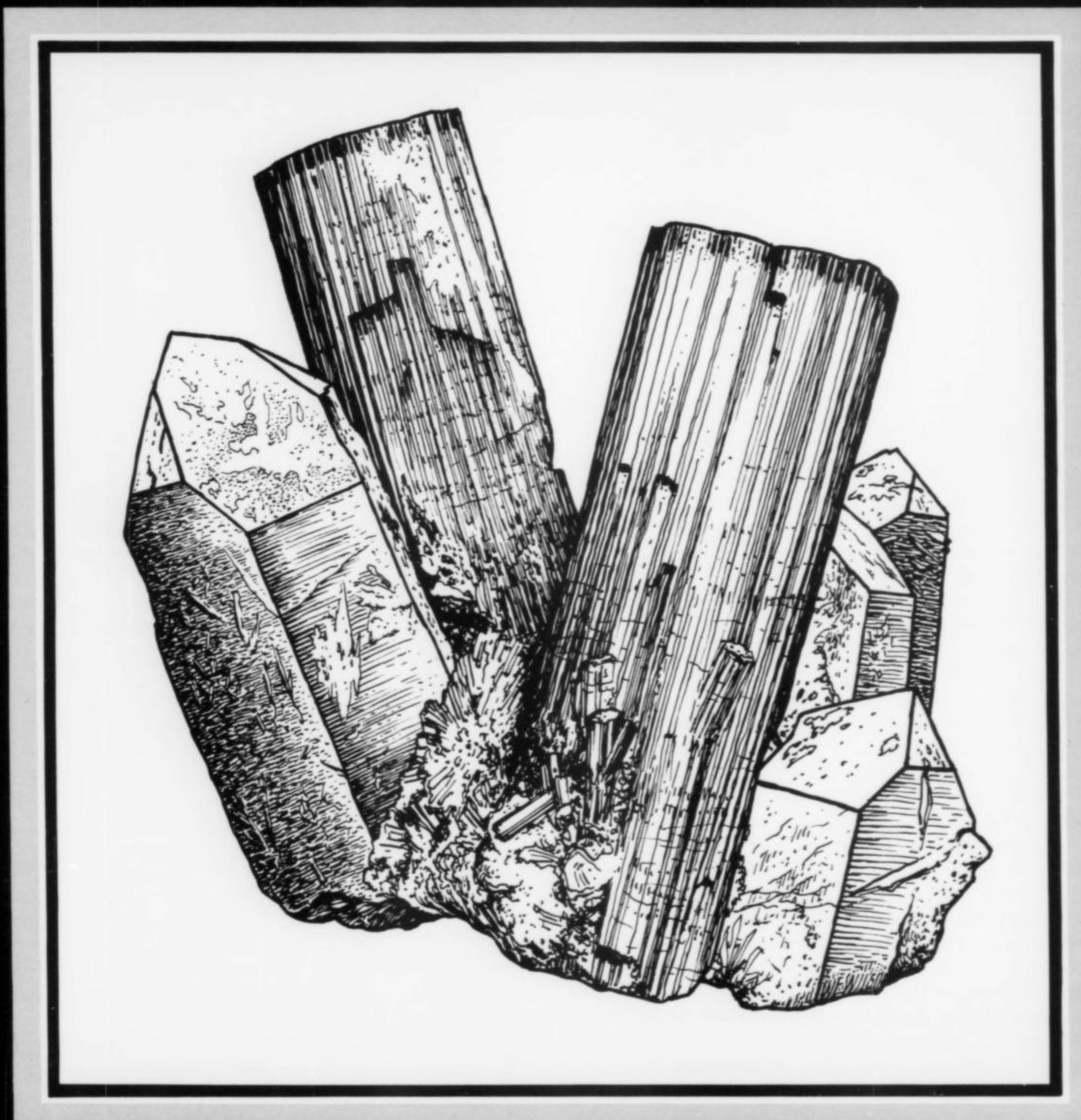
Further up one comes upon the Stoiber residence, "Waldheim," a 30-room house, with all modern appointments, built by the former owners of the Silver Lake mine. Just beyond, in Arrastra basin, one can see the Silver lake mill and the tramway, which extends in swinging lines to the mine beside the lake at 12,250 ft. above sea level. One of the spans of this Bleichert tram clears a distance of 2,200 ft. In a total length of 8,400 ft., the upper section of the tram descends 2,100 ft., and has only 19 supporting towers. The lower section – from the old mill to the new mill – is 6,200 ft. long, with a fall of 659 ft. The tram from the Iowa mine climbs the neighboring bluffs, and a little further up the Animas the North Star tram reaches the river from near the top of Sultan Mountain, a height of nearly 13,000 ft., making a descent of over 3,200 ft. Silverton itself is situated at 9,300 ft. above sea level.

The North Star tram is 2⅓ miles long, and connects the mill on the right bank of the Animas with a loading station at the entrance of an adit at 12,900 ft. above sea level.

These numerous aerial ropes, spanning the intermountain spaces like great spiders' webs, are an important feature of mining in the San Juan region. We had already, on the previous days of our trip, seen the tramways of the American Nettie, Bright Diamond, Grand View, Camp Bird, Smuggler Union, Columbia, Liberty Bell mines, besides others, the names of which we did not know, so that with the group of three just referred to, near Silverton, we had, in the aggregate, observed a good many examples of this kind of mountain engineering.

(To be continued)

Mineral Masterpieces



Blue-capped elbaite on quartz and cleavelandite, Pala, California

This specimen features the largest tourmaline crystal (8 x 3 inches) from the Tourmaline Queen mine

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Cubanite
from chibougamau, québec

by **André Lévesque**
Musée de Géologie
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Along with the finding of serandite at Mont St-Hilaire and weloganite at the Francon quarry, cubanite crystals from Chibougamau can be added to the list of rare and exceptional minerals to come out of Québec in recent years. Judging by crystal size and perfection, Chibougamau cubanite is probably the world's finest.

INTRODUCTION

The province of Québec holds the attention of professional and amateur mineralogists alike owing to the great variety of its mineral localities. Among the better-known localities are the Demix quarry at Mont St-Hilaire; the Jeffrey mine at Asbestos; the Francon quarry at Montréal; and the Niobec mine near Chicoutimi.

In 1974, the Geological Museum of Laval University, Québec City, was given a sample of "pyrite" from the Henderson no. 2 mine of Campbell Chibougamau Mines, Ltd.

Examination showed the "pyrite" to be twinned crystals of cubanite ($CuFe_2S_3$) on a surface of clear calcite crystals. The rarity of cubanite coupled with the perfection of the crystals and their imposing size made this acquisition particularly remarkable. The crystals on this original sample are already larger and of better quality than those from such outstanding localities as the Morro Velho gold mine, Minas Gerais, Brazil (Lucio and Gaines, 1973) or the Strathcona mine, Sudbury, Ontario (Anderson, 1982). Following the initial acquisition, the Geological Museum has obtained several additional superior samples. However, as the cubanites come from an active underground mine, the recovery of new material is sporadic and dependent on the development program pursued by Campbell Chibougamau Mines, Ltd.*

LOCATION AND ACCESS

The Chibougamau mining district lies 700 km north of Montréal. It covers an area of 24,000 square kilometers, bounded by latitudes 49° and 50°N, and longitudes 74° and 76°W. The district is accessible by road from Montréal via Senneterre, from Québec City via Lake St-Jean, by Canadian National Railway, and by air.

*Owing to the weak base-metal market, the Henderson no. 2 mine was shut down in September of 1982.

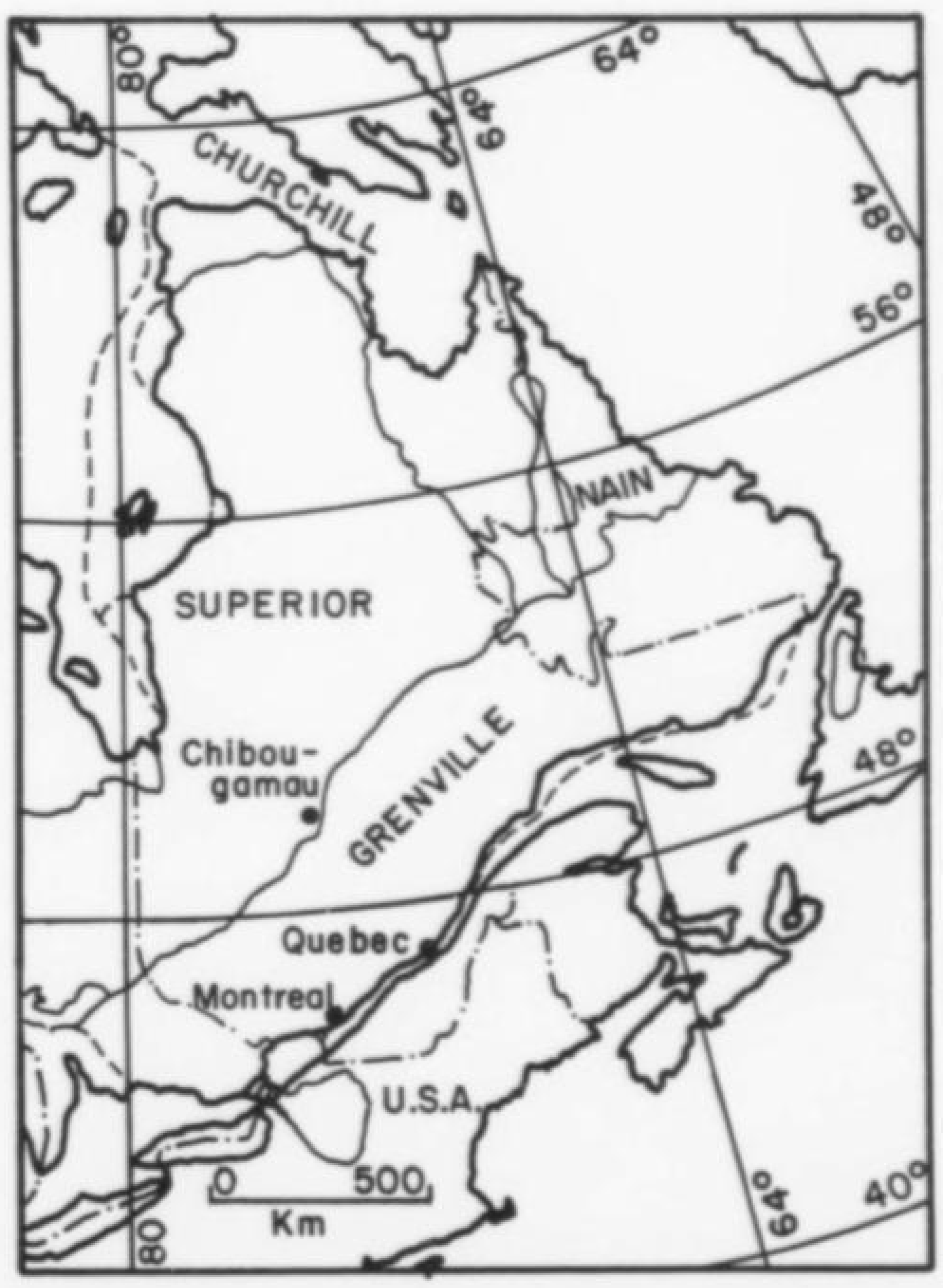

***Figure 1.* Location of the Chibougamau district with respect to the main geological provinces in the eastern part of the Canadian Shield.**

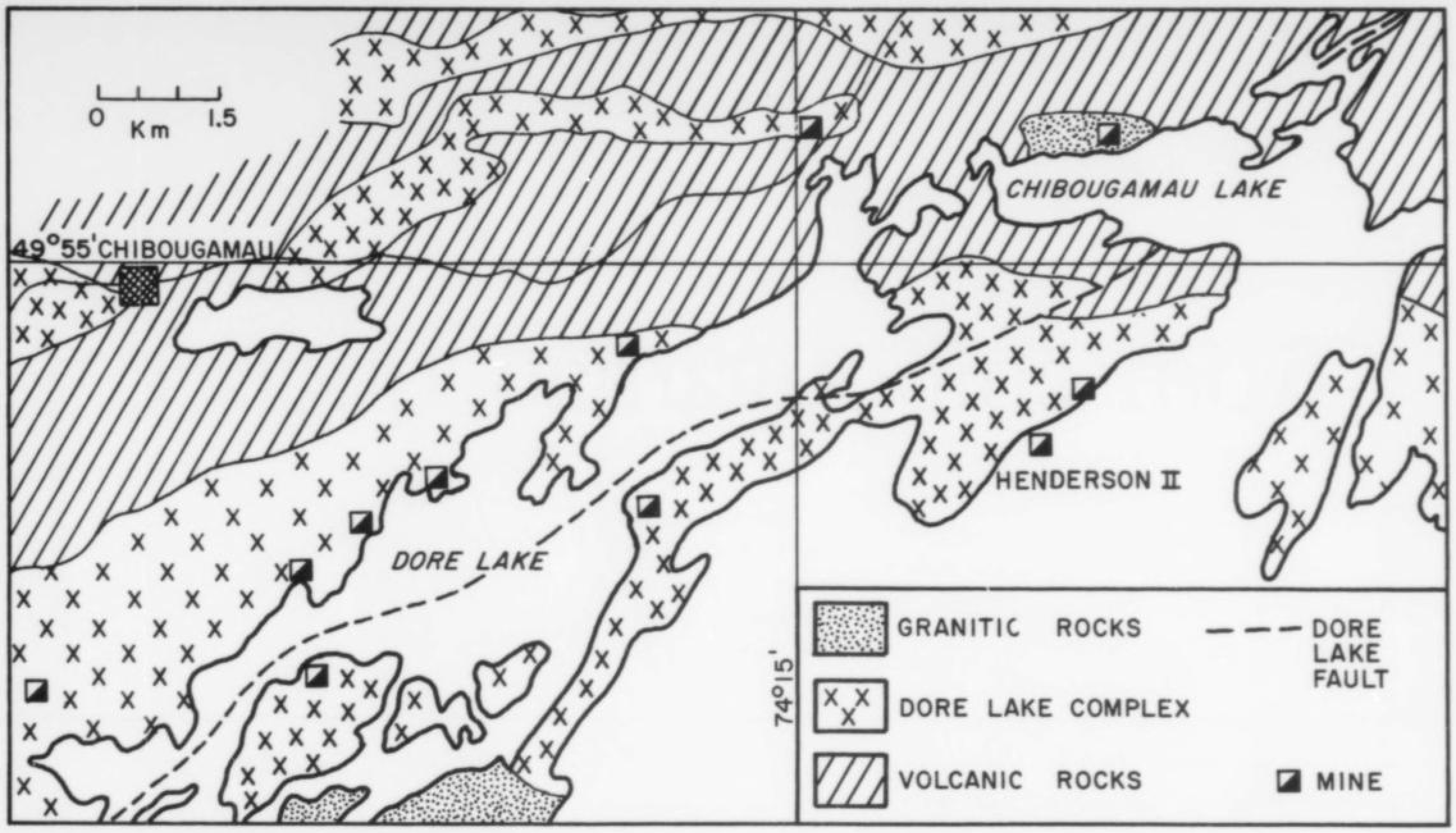

Figure 2. **Geological map of the Chibougamau district showing the principal mines (after Lang, 1979).**

The Henderson no. 2 mine is located on the northwestern edge of Lake Chibougamau, 11 km east-southeast of the town of Chibougamau (Fig. 2).

HISTORY

The history of the Chibougamau mining district is extensive. The district lies on the route between Hudson Bay and Lake St-Jean used by trappers, missionaries, and explorers in the 17th and 18th centuries. It was not until 1870 that James Richardson of the Geological Survey of Canada noted signs of mineralization on the eastern shore of Portage Island in Lake Chibougamau. In 1903, Peter McKensie found deposits of copper, gold and asbestos. Additional shows were found in the 1920's and 30's when the only access was by canoe – an arduous trip of two to three weeks that included many difficult portages.

In 1949 a 240-km-long road was completed that connected the district with Lake St-Jean. The road made possible intensive mineral exploration that led to the establishment of the Opemiska copper mines in 1953 and the Campbell Chibougamau mines in 1955. The Henderson no. 2 mine, a division of Campbell Chibougamau, was opened in a copper-silver-gold orebody in 1960.

GEOLOGY AND ORE DEPOSITS

The Chibougamau district lies at the eastern end of the Abitibi greenstone belt of the Superior province of the Canadian Shield. The Grenville front passes 50 km east of the Henderson no. 2 mine. Most of the rocks in the Chibougamau mining district are of Archean age. This ancient basement is composed of east-striking belts of volcanic and sedimentary rocks which were folded and metamorphosed during the Kenoran orogeny, dated at 2,500 million years ago (Stockwell, 1964). Greenschist facies metamorphism prevails in the district, although locally the amphibolite facies has been attained. Tight folding and steep dips prevail. Granitic and gneissic complexes are found locally.

Outliers of Proterozoic sedimentary rocks are present in the Chibougamau district. They consist of nearly flat-lying "Cobalt-type" sandstone, conglomerate, and tillite that unconformably overlie the Archean basement. They occur as isolated remnants preserved in grabens. Near faults or at the Grenville front the sedimentary rocks dip steeply and may be folded tightly.

Broadly speaking, the greenstone belt constitutes an east-striking synclinorium that has been folded isoclinally. Later superimposed folds with north-striking axes produces domes and basins. No less than five systems of faults and shear zones have been recognized in the Chibougamau district alone.

HENDERSON NO. 2 MINE

(The following discussion is taken from Dompierre, 1972, Duquette, 1972, and Allard *et al.*, 1979.) The copper-silver-gold orebody of the Henderson no. 2 mine is found in the lowest member of the Doré Lake complex, the so-called "anorthosite zone." This zone is overlain by a complex series of mafic and ultramafic rocks that includes gabbroic anorthosite, gabbro and pyroxenite. Rare primary layering in the anorthosite strikes northeast and dips northward at 45°. It is perpendicular to the main shear zone, a regional feature at least 2.7 km long. Ore occurs in the main northeast-striking shear zone and in subsidiary fractures that strike northeast and dip southward at 45° The parallelism of part of the main shear zone to the Grenville front and to late structural features associated with the front suggests that the formation of the main shear zone and the Grenville front are related.

Primary mineralization is chiefly pyrite, pyrrhotite and chalcopyrite. An oxidized zone 300 m thick contains secondary chalcocite and native copper.

Three stages of alteration are recognized at the Henderson no. 2 mine. The first is a pervasive greenschist facies regional metamorphism that affected the anorthosite. The second is a hydrothermal alteration associated with the mineralization and confined largely to the shear zone and related fractures. The third is a surface-controlled alteration caused by the circulation of ground water which has produced the thick oxidized zone.

Numerous faults filled with gouge are found in the main shear zone. Most are parallel with the shear zone, but some cut across it from wall to wall. Some of these are open and have euhedral crys-

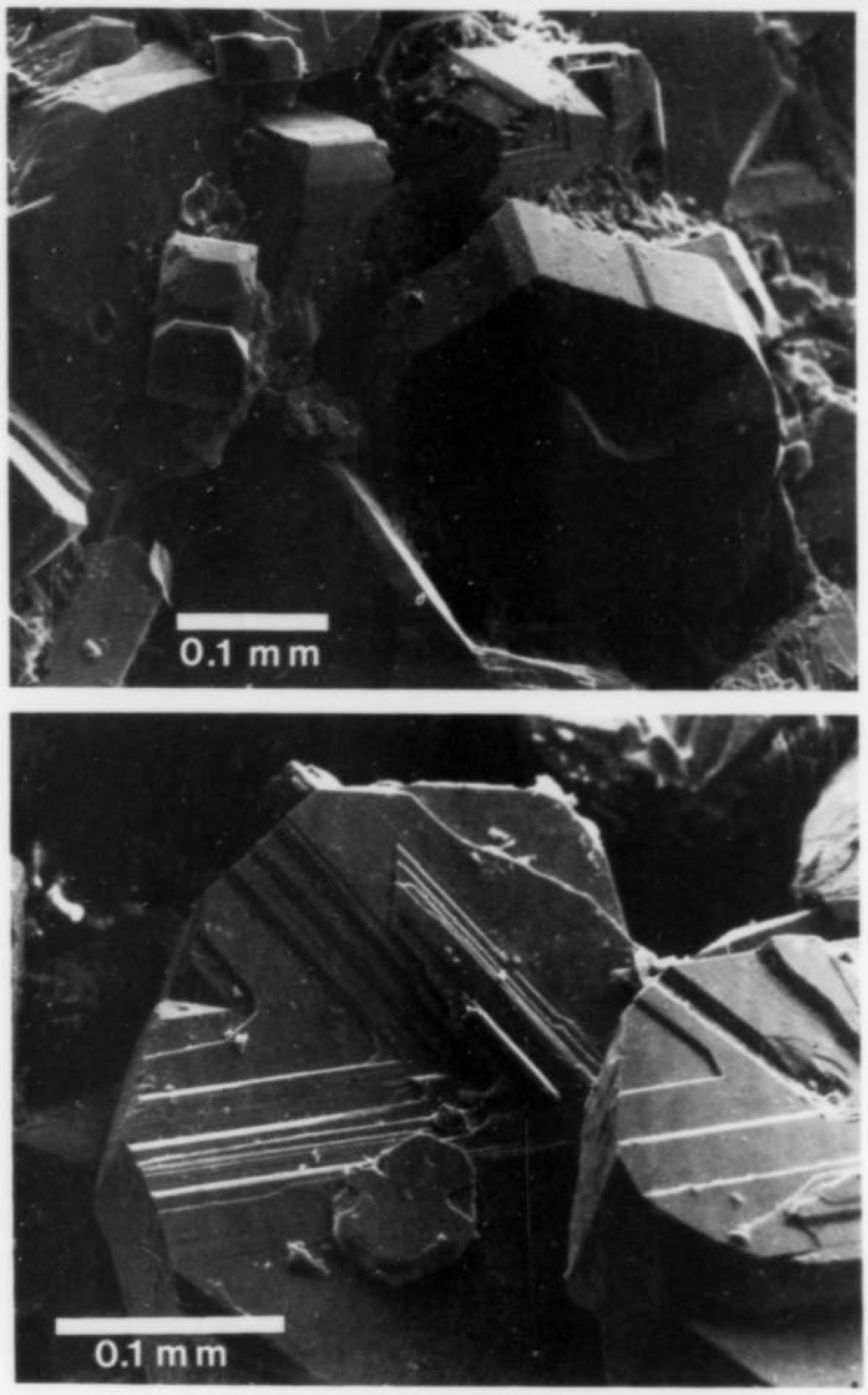

***Figure 3.* Scanning electron microscope photographs of pseudohexagonal twinned cubanite crystals showing *g*{101}, *c*{001}, *m*{110}, *l*{130}, *b*{010} and *p*{131}.**

tals of calcite, cubanite, pyrite, sphalerite and siderite on their surfaces. The splendid crystals of cubanite are far and away the most interesting. Such crystals occur sporadically on all levels of the mine.

CUBANITE

Cubanite occurs as euhedral crystals with transparent calcite on fault surfaces, an unusually esthetic association. The cubanite crystals, up to 3 cm long as measured on {001}, have a glossy yellow color and metallic luster that are indistinguishable from those of pyrite.

The hardness of cubanite is 3.5 on the Mohs scale, and its density is 4.1 g/cm^3. Cubanite is one of the few sulfides that are strongly magnetic. It has a parting along {110} and another along {1$\bar{3}$0}, but no cleavage. Its fracture is conchoidal. In polished section under reflected light, cubanite is anisotropic. It is attacked by HNO_3.

Cubanite is orthorhombic and belongs to the rhombic dipyramid class 2/m 2/m 2/m, space group Pcmn. Its three mutually perpendicular crystallographic axes are each two-fold symmetry axes; each lies in a plane of symmetry. There is a center of symmetry.

The unit cell has the following dimensions (Å): a: 6.467(1), b: 11.117(6), c: 6.231(2), Z = 4 (Szymanski, 1974a).

Whereas cubanite is orthorhombic, a high-temperature polymorph is known. This polymorph, which forms above 210°C, occurs commonly in exsolution with chalcopyrite (Szymanski, 1974b). All cubanite examined from Chibougamau is orthorhombic. X-ray studies of cubanite by Cabri *et al.* (1973) show that heating causes its transformation to the orthorhombic polymorph. The change is irreversible in the laboratory.

The morphology of the cubanite crystals is typical of the rhombic-dipyramidal class, with prism faces *m*{110}, *l*{130} and *g*{101}; pinacoids *b*{010} and *c*{001}; and the rare dipyramid *p*{131}. Most of the crystals have a tabular aspect in that their thicknesses are limited by the *c* axis.

The five strongest diffraction lines measured on Chibougamau material by means of a Gandolfi camera are (Å): 3.21(100), 1.865(60), 3.49(60), 3.23(50), 3.00(40). A microprobe analysis, using a chalcopyrite standard, gave Cu = 23.19, Fe = 40.83, S = 35.34, total = 99.36 percent. This corresponds to the formula $Cu_{0.99}Fe_{1.99}S_{3.00}$.

All cubanite crystals from Chibougamau are twinned and doubly terminated. They are composed of two, four or six individuals. Some specimens are made up of six individuals which lend a characteristic pseudohexagonal habit on (001). On these specimens the twin plane is {110} and the (110) and (1$\bar{1}$0) planes intersect at 60°. The composition plane is (110). Such cyclical twins are common in many orthorhombic minerals. Well-known examples include aragonite, cerussite, enargite, cordierite and chrysoberyl.

In rare examples, twins composed of two individuals have a tabular aspect in that their thickness is determined by the *b* axis (Fig. 6).

The cubanite crystals from Chibougamau resemble those reported from two other well-known localities: the Morro Velho

***Figure 4.* The largest and finest cubanite twin yet recovered, about 3 cm (1⅕ inches) in size. Photo by the author.**

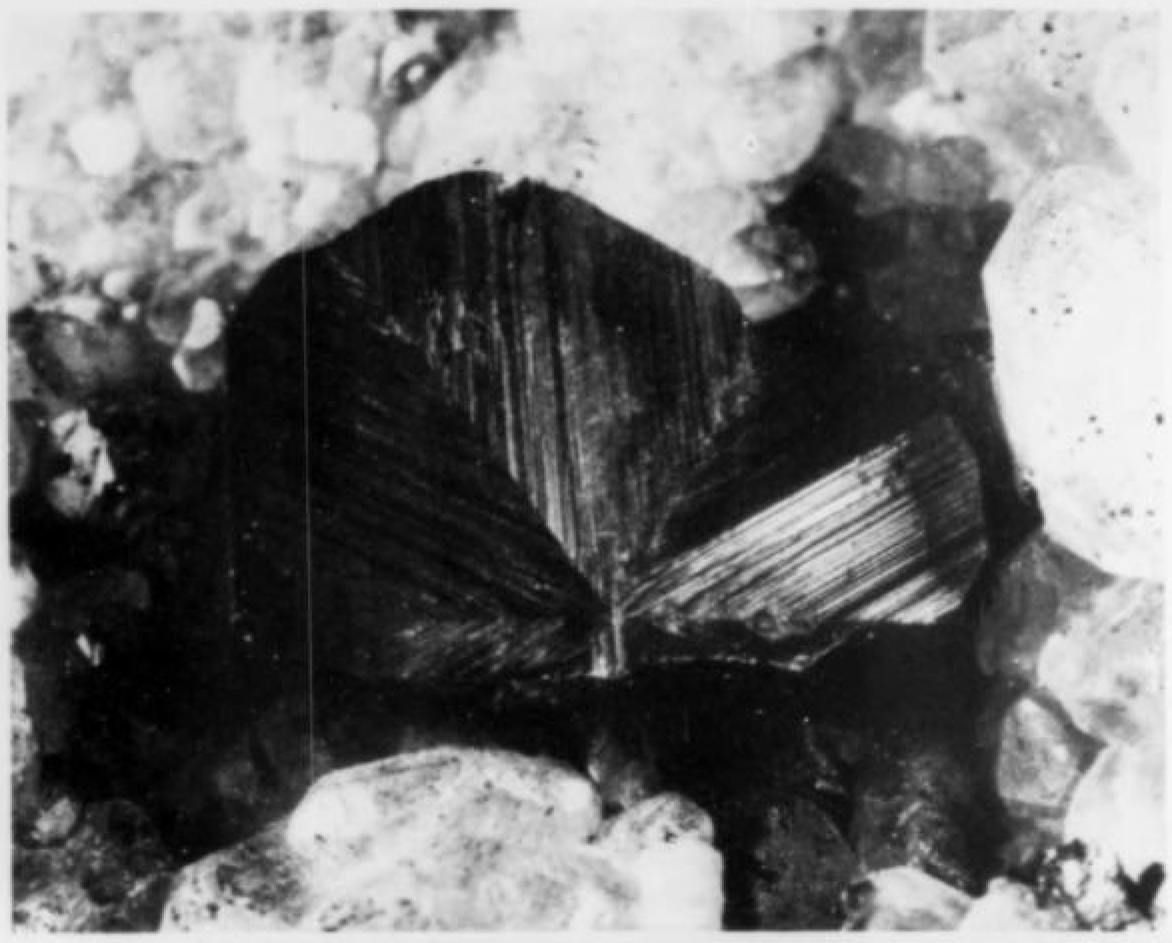

Figure 5. **A twinned cubanite measuring 2.5 cm (1 inch) on calcite crystals. Photo by the author.**

gold mine, Minas Gerais, Brazil, and the Strathcona mine, Sudbury, Ontario (Anderson, 1982). Whereas the Strathcona cubanite crystals share the same habit as those from Chibougamau, those from Brazil are highly elongated. The sizes of the Brazilian cubanite crystals are measured in millimeters. Some flattened cubanite crystals from Strathcona are up to 3 cm across.

In most deposits where cubanite has been reported, the mineral is a minor constituent associated with pyrite, chalcopyrite or pyrrhotite. An exception is Broken Hill, Australia, where the metallic ore is 70 pecent cubanite; many metallic minerals are pseudo-

Figure 6. **Twinned cubanite crystals to 1.2 cm with gray rhombohedral calcite. Note the twin (lower left) composed of only two individuals. Specimen collected in 1982. Photo by the author.**

Figure 7. **A cubanite twin 2.2 cm across on calcite matrix (reinforced). Photo by the author.**

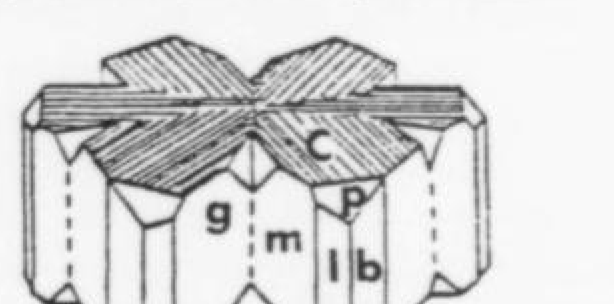

Figure 8. **Idealized crystal drawing of cubanite showing prisms *m*{110}, *l*{130} and *g*{101}; pinacoids *b*{010} and *c*{001}; and dipyramid *p*{131}.**

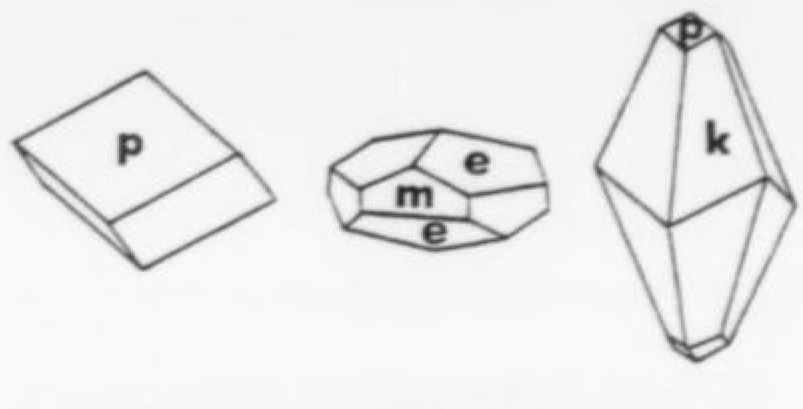

Figure 9. **Chibougamau calcite crystal forms.**

morphs after cubanite. No pseudomorphs after cubanite have been found at Chibougamau.

Since 1974, the Geological Museum of Laval University has received about 25 samples of cubanite from the Henderson no. 2 mine. Several are in the museum's permanent collection. Others have been exchanged with the National Museum of Canada, the Royal Ontario Museum, the Geological Survey of Canada, l'Ecole des Mines de Paris and selected Canadian and American private collectors.

Judging by the perfection and size of its euhedral crystals, the Chibougamau cubanite is probably the finest yet found anywhere.

ASSOCIATED MINERALS

Other minerals found with cubanite on fault surfaces in the Henderson no. 2 mine, in their order of abundance, are: calcite, pyrite (in part pseudomorphic after marcasite), sphalerite and siderite.

Calcite

Euhedral calcite, everywhere associated with cubanite, occurs in three habits: simple rhombohedrons, combined rhombohedrons and hexagonal prisms, and scalenohedrons (Fig. 9).

The largest crystals, measuring to 3 cm, are scalenohedrons which commonly contain brown "phantom" interiors. Most of the calcite is white to gray, although commonly the smaller crystals are perfectly transparent. Cubanite, as large crystals or groups of small ones, generally occurs on a matrix of calcite, giving rise to particularly attractive samples.

Pyrite

Pyrite forms simple cubes as much as 2 cm across. In some samples, handsome masses of radial iridescent pyrite pseudomorphic after marcasite and as much as 7 cm in diameter is found with cubanite and calcite.

Sphalerite

Rare, small (1 to 3 mm), euhedral black tetrahedrons of sphalerite are, in places, associated with cubanite on calcite.

Siderite

Light yellow rhombs of siderite less than 1 mm across occur on a few cubanite-bearing samples.

ACKNOWLEDGMENTS

Repeated visits underground were made possible by the cooperation of the staff of the Henderson no. 2 mine, and especially Gilles Pilote, Raymond Fournier and Patrice Bolduc. The X-ray diffraction was performed by Richard Filion. Jean-Francois Wilhelmy and Jean-Pierre Tremblay took the SEM photomicrographs, and Richard Martineau drafted the maps.

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Baveno Italy

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Minerals have been collected at Baveno for more than two centuries. The locality, which gave its name to the mineral bavenite and to the Baveno law for orthoclase twins, has produced some of the world's finest orthoclase crystals.

INTRODUCTION

Baveno is situated on the western shore of Lake Maggiore in the province of Novara, Italy, about 80 km north of Milan. Quarries on the northeast slope of Mt. Mottarone have, for more than 400 years, produced a pink granite known as Baveno granite. Pockets in this granite have yielded 48 mineral species thus far, with additional unknowns awaiting identification. Baveno is famous among collectors primarily for orthoclase and quartz which are found there in attractive specimens.

Baveno is also the type locality for the minerals bavenite and bazzite, and has recently yielded two more new species, cascandite and jervisite.

HISTORY

Based on historical research, it appears likely that the Baveno quarries were opened in the early 1500's. No earlier historical documents, nor any earlier buildings constructed of Baveno granite have been located.

Baveno granite has certain characteristics which make it suitable as a building stone, however it is not used as extensively today as it once was. By the end of the 1800's there were nearly 40,000 Baveno granite columns forming part of the various architectural works of Milan (Barzano, 1853). It has been widely used in other countries as well; the monument to General Gomez in Cuba, the columns of the Aboul Abbas mosque in Alexandria, Egypt, and the urn in the Thiaucourt chapel in France (dedicated to American soldiers killed in World War I) are all made of Baveno granite.

The first publication to deal with Baveno granite and its minerals was written by the abbot Ermenegildo Pini in 1779. Since then many articles have been written on the geologic structure and the various mineral species.

Collecting at Baveno was best previous to 1920 or so, when more than ten quarries were in operation. Today it is more difficult, partially because fewer quarries are open, but also because the methods of quarrying have changed. Only three quarries remain open: the Oltrefiume quarry (formerly the Montecatini quarry) at the town of Baveno, the Cirla quarry in Feriolo, and the Giacomini quarry (formerly the Diverio quarry) in Agrano (Omegna).

Good collections of Baveno minerals may be seen in Milan at the Natural History Museum and at the Mineralogy Institute of the University of Milan. Each of these collections contains about 1000 specimens. Samples in the Natural History Museum were acquired in part through the personal collecting and research of the various curators over the years. Others were received as gifts, particularly those from the Borromeo Museum in 1913, from Edi and Francesco Mauro in 1950 and 1952, and from Giuseppi Scaini in 1972. Other material was acquired from 1915 to 1926 when the Italian Geo-Mineralogical Institute was active. The Institute was headed by Eugenio Bazzi (after whom bazzite was named) and others for the purpose of supplying museums, schools and universities with scientifically documented and guaranteed specimens. Most of the specimens in the Mineralogy Institute of the University of Milan are from Bazzi's personal collection.

Figure 1. **The Baveno quarry overlooking Lake Maggiore.**

GEOLOGY

Baveno granite comprises the eastern portion of the Lake granites plutonic massif, which extends from Biella to Lake Maggiore. The Baveno granite is more than 9 km long and 2 to 3 km wide on the average. The most widespread facies is a white granite which adjoins the Montorfano granite on the north and the Alzo granite to the south. The pink facies is more localized, only 5 km long and a few hundred meters wide. The pink color is due to trace amounts of iron in the orthoclase.

The Baveno granite is high in alkalies and calcium and low in magnesium. It is part of a pre-existing metamorphic unit known as the Eastern Strona gneiss and is also related to mica schists of the Lakes formation.

Petrographically the pink and white granites are identical: quartz (about 33 percent), potassium feldspar (32 percent), plagioclase (31 percent) and black mica. Accessory minerals include muscovite, zinnwaldite, fluorite, fayalite, allanite, apatite, zircon, hematite, magnetite and titanite (Gallitelli, 1936c).

The chemistry of the Baveno granite is somewhat more complex than the above analysis indicates. Quite a number of rare elements occur in minerals in the pegmatite pockets but not in the granite mass itself; these include sulfur, copper, tin, cesium, rubidium, boron, beryllium, molybdenum, tungsten, yttrium, barium, strontium, scandium and the rare earth elements.

Potassium-argon age dating has placed the age of the Baveno granite at the end of the Carboniferous period about 290 million years ago.

Pegmatite pockets occur entirely within the granite body ("interior pegmatites") and generally have lenticular or irregular shapes. They occur unconnected to each other, though in some areas they are somewhat concentrated. The maximum pocket size is about 50 cm, however a pocket was found in 1969 at the Diverio quarry which measured 1.3 by 1.8 by 2.4 meters. It contained only large crystals of quartz and orthoclase.

MINERALS

Albite $NaAlSi_3O_8$

Albite is among the most common minerals at Baveno, where it occurs as distinct crystals and also as epitaxial overgrowths on orthoclase. Crystals are white and dull-lustered, rarely transparent and colorless, and reach a maximum size of about 5 mm. Albite twins are common, whereas pericline twins and Carlsbad twins are

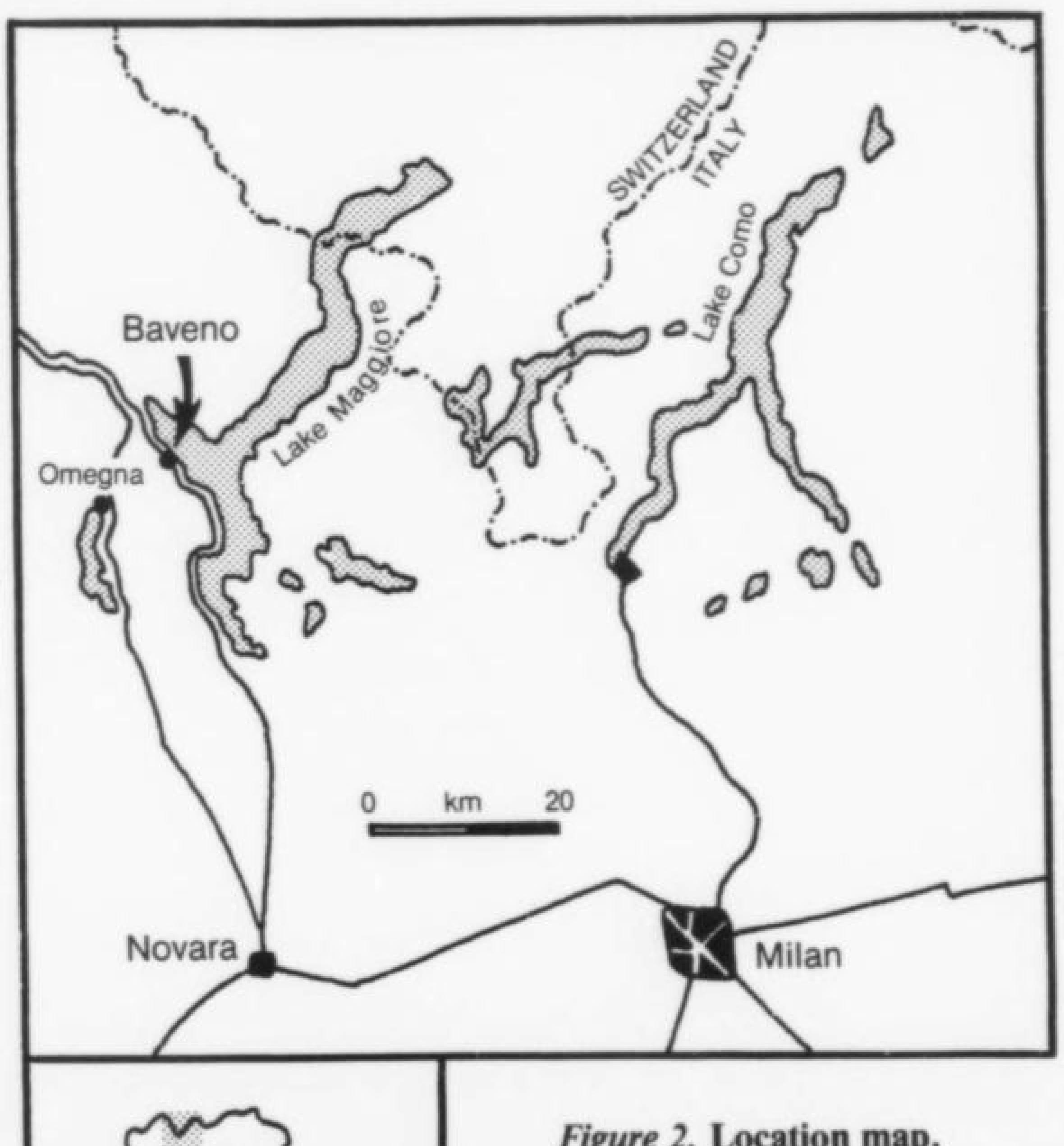

Figure 2. **Location map.**

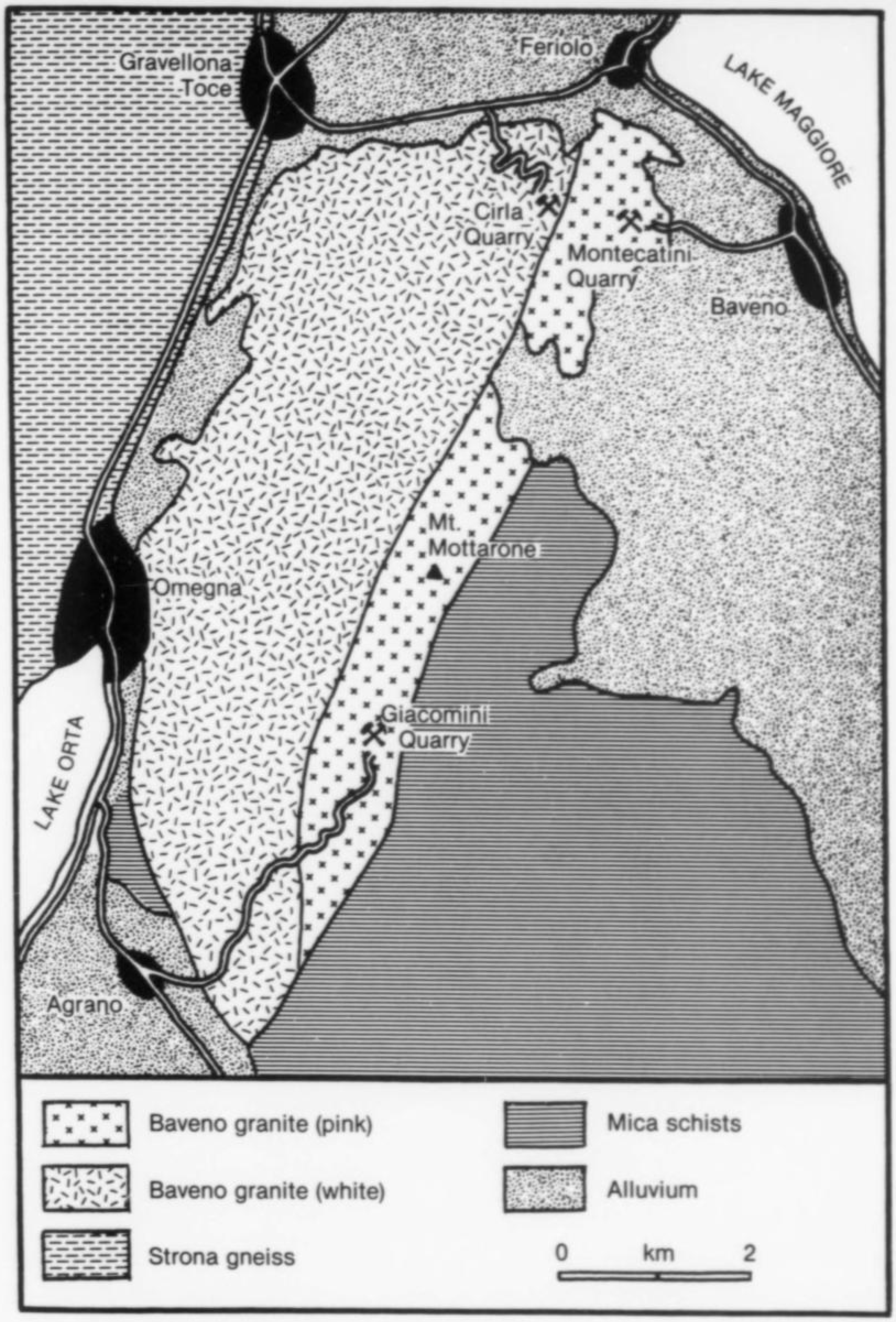

Figure 3. **Geology in the Baveno area.**

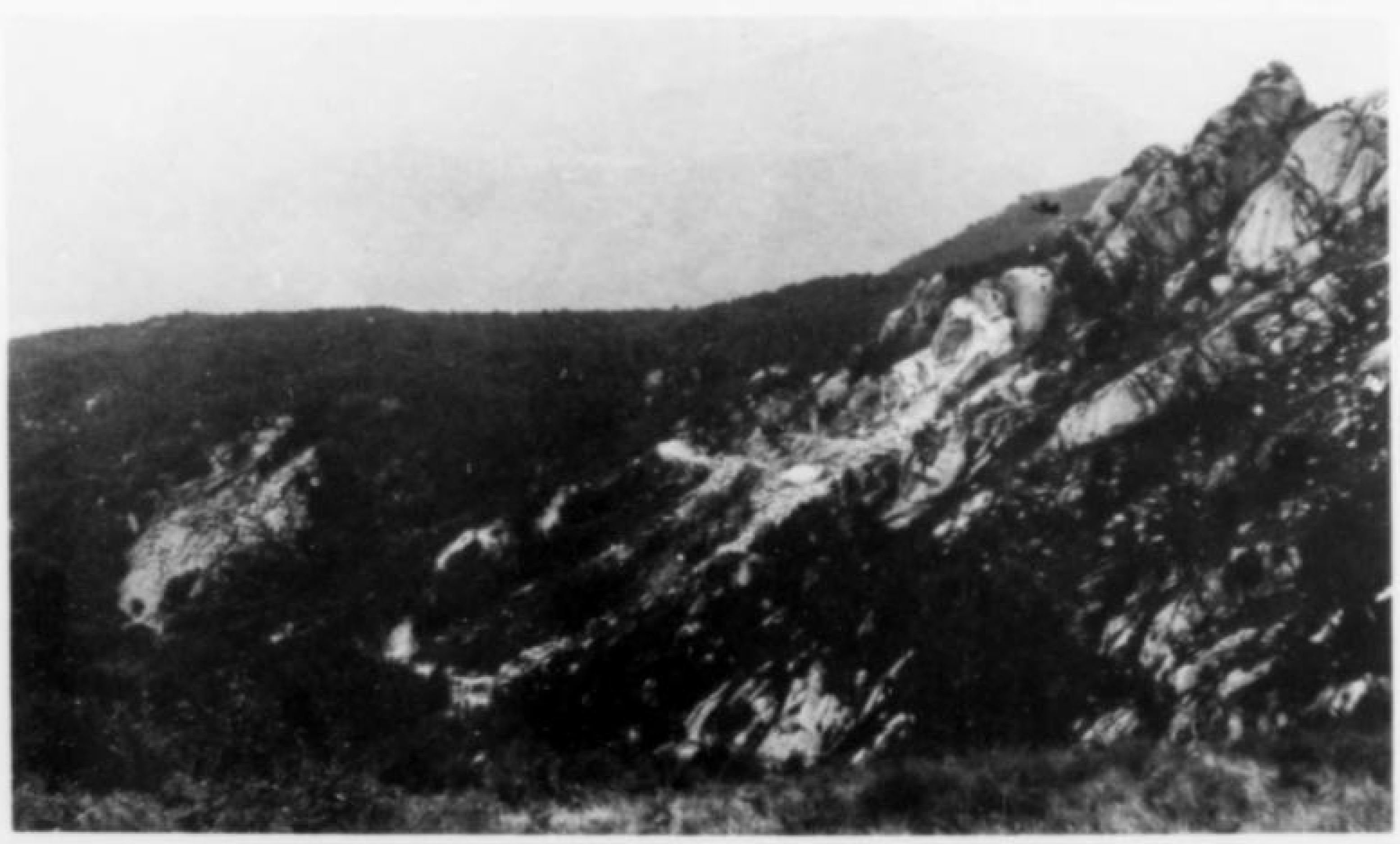

Figure 4. **Diverio quarry (left) and the new Giacomini quarry (right), opened in 1981.**

Figure 5. **The Giacomini quarry in 1982.**

Figure 6. **The Diverio quarry, type locality for the recently described new species jervisite and cascandite.**

more unusual. The habit is typically flattened (Streng, 1887).

Albite is most common as an overgrowth on orthoclase, always forming on the same face of the orthoclase crystal, according to the Baveno twin law (Scacchi, 1873). It forms as a continuous layer on {010} and {130} faces, and as a druse of separate crystals on the {110} faces. The two minerals also tend to have their vertical axes in common, with the {010} face of orthoclase parallel to the $\{0\bar{1}0\}$ face of albite (Pagliani, 1937).

Paragenetically albite was obviously formed later than orthoclase, and can be seen to have healed broken crystals.

Allanite $(Ce,Ca,Y)_2(Al,Fe)_3(SiO_4)_3(OH)$

Allanite occurs as black, elongated crystals with a submetallic luster and reaching 1 cm in size. More commonly it is found as rounded masses to 2 mm and as speckles on albite, quartz and orthoclase. It also forms small spherules to 1 mm having a radial structure, and dull granules to 1.5 mm as inclusions in beryl (de Michele, 1968; Grill, 1937b).

Anthophyllite $(Mg,Fe)_7Si_8O_{22}(OH)_2$

Anthophyllite occurs associated with and as an alteration product of fayalite. It forms very small (to 2 mm), radially fibrous ro-

Figure 7. **Pockets at the Diverio quarry where a number of fine specimens were collected.**

Figure 8. **A pocket found in 1969 at the Diverio quarry, measuring about 1.8 by 2.4 meters.**

settes of a whitish-yellow color and silky luster.

Apatite group

Minerals of the apatite group occur rarely as small (1 to 5 mm), transparent, bluish white to pink or colorless prismatic crystals on orthoclase. Some crystals form flat hexagonal tablets (Strüver, 1871).

Arsenopyrite FeAsS

Arsenopyrite occurs as pale gray granules lining narrow cavities.

Axinite group

Axinite was found in the Baveno granite in 1867. It forms druses of small (0.5 mm), imperfect brown crystals on quartz or feldspar. The individual crystals tend to have rounded edges and to form rosettes (Nova, 1979; Strüver, 1867; Messina, 1940; Streng, 1887).

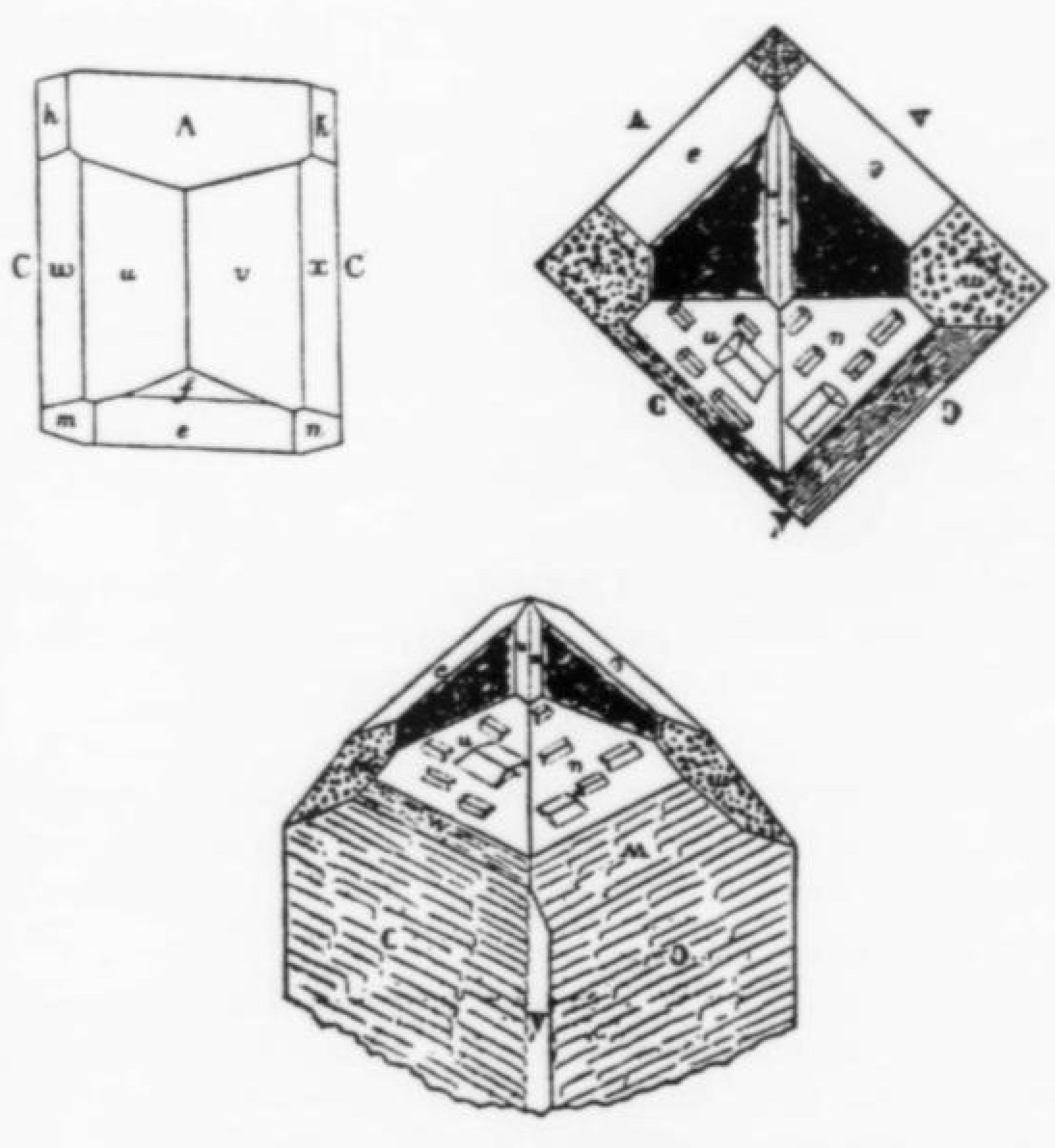

Figure 9. **Albite crystal (left) and albite overgrowths on orthoclase (right and bottom) (Scacchi, 1873).**

Babingtonite $Ca_2(Fe,Mn)FeSi_5O_{14}(OH)$

Babingtonite occurs frequently in the Baveno granite as well-formed crystals sometimes completely covering orthoclase and quartz crystals. Crystals are black with a sub-metallic luster; they average 3 to 4 mm in size, though some large crystals to 1.4 cm are known. Limonite pseudomorphs after babingtonite have also been found (Gallitelli, 1935a; Vom Rath, 1868; Strüver, 1866).

Barite $BaSO_4$

Recently barite has been observed as thin seam fillings in granite (de Michele, 1976).

Figure 10. **Drusy babingtonite covering quartz and orthoclase crystals about 10 cm across. Claudio Albertini specimen.**

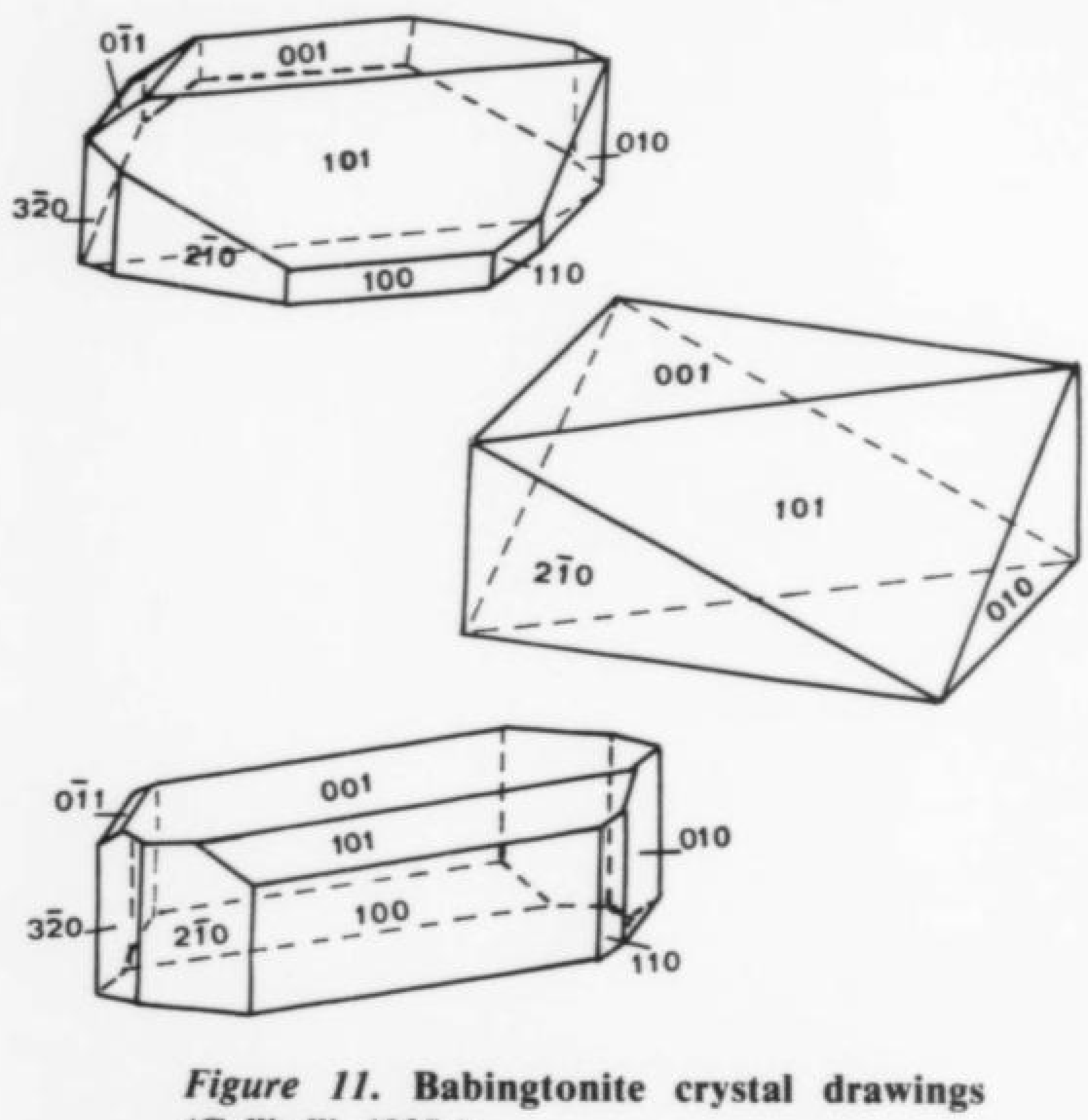

Figure 11. **Babingtonite crystal drawings (Gallitelli, 1935a).**

Bastnaesite (?) $(Ce,La)(CO_3)F$

The questionable species *weibyeite* was tentatively identified by Artini (1915) as occurring at Baveno, but the material is most likely bastnaesite. Artini described small (to 0.3 mm), rhombic bipyramidal crystals of a yellowish to brownish color on quartz (the color probably due to hematite inclusions). Faces are bright but curved. There was insufficient material for a complete analysis.

Bavenite $Ca_4Be_2Al_2Si_9O_{26}(OH)_2$

Baveno is the type locality for bavenite. Artini (1901) described radiating tufts of white needles and radial spheroids to 2 cm on orthoclase or quartz. The crystals are monoclinic but twinned to simulate orthorhombic symmetry.

Figure 12. **Acicular bavenite crystals on a 4-cm feldspar and quartz group from near Omegna. Claudio Albertini specimen.**

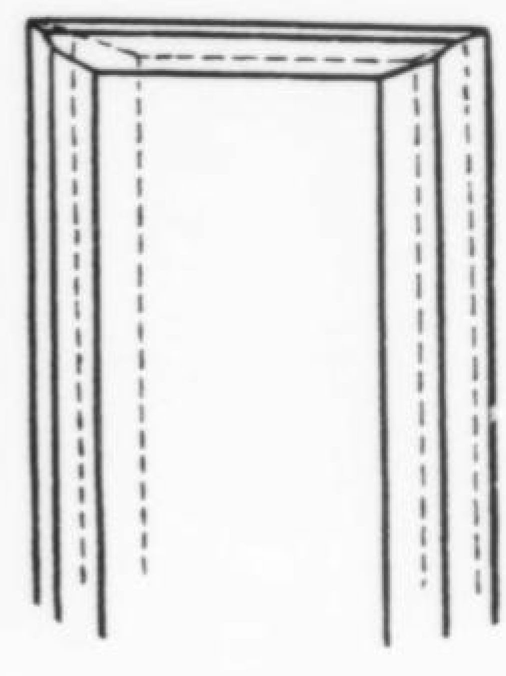

Figure 13. **Bavenite crystal drawing (Artini, 1901).**

Bazzite $Be_3(Sc,Al)_2Si_6O_{18}$

Bazzite, the scandium analog of beryl, was first described by Artini (1915) as small (to 2 mm), sky-blue hexagonal prisms and bundles. The Baveno occurrence commonly includes associated muscovite rosettes (Bertolani, 1948).

Beryl $Be_3Al_2Si_6O_{18}$

Beryl forms aggregates of imperfect, radially structured groups of blue, glassy prisms to 6 cm, commonly coated by iron oxides. It occurs in aplite veins (de Michele, 1966, 1968).

Calcite $CaCO_3$

White or yellowish calcite occurs in various forms as crystals on quartz and orthoclase. Flat hexagonal prisms predominate; lamellar aggregates may reach 10 cm in size.

Cascandite $CaScSi_3O_8(OH)$

Cascandite is a recently described species from Baveno known on only a single specimen from the Diverio quarry. It is a pyroxenoid related to minerals of the pectolite-wollastonite group, and forms radiating violet masses (Mellini *et al.*, 1980a, 1980b, 1982).

Cassiterite SnO_2

Cassiterite is very rare at Baveno, occurring as small (to 5 mm) twinned crystals of brown color and bright luster (Artini, 1920).

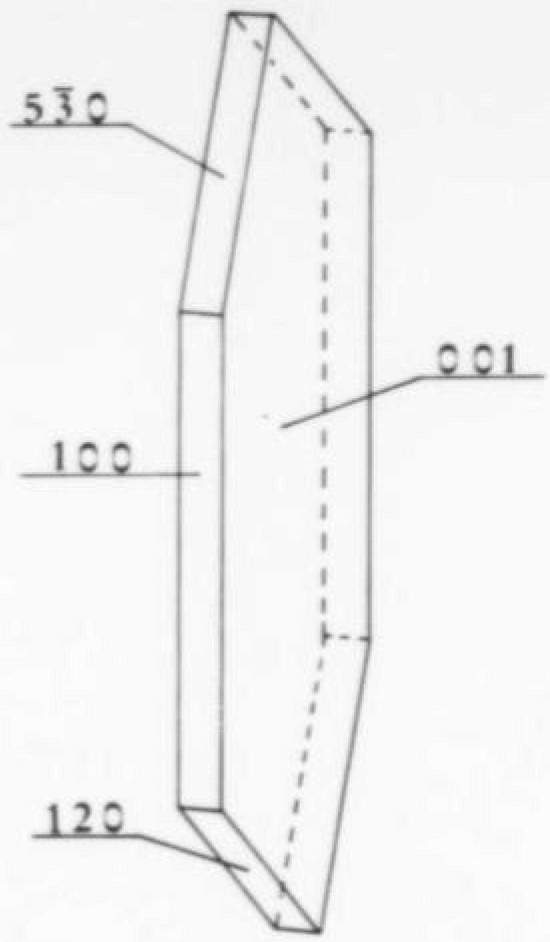

Figure 14. **Cascandite crystal drawing (Mellini *et al.*, 1982).**

Chabazite $CaAl_2Si_4O_{22}\cdot 6H_2O$

Chabazite occurs as small (4 mm), transparent, colorless or pale yellow rhombohedrons (Pagliani, 1948; Strüver, 1866).

Chalcopyrite $CuFeS_2$

Chalcopyrite forms small irregular masses of typical brass-yellow color.

Chlorite group

Chlorite-group minerals form patinas and cavity fillings of flaky green material.

Chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4\cdot nH_2O$

Chrysocolla occurs as small, green crusts and masses formed as an alteration of chalcopyrite.

Clinochlore $(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$

Small, dark green, earthy masses tentatively identified as a ferroan clinochlore have been observed near fayalite.

Cordierite $Mg_2Al_4Si_5O_{18}$

To date, cordierite has been found at only two locations in the Baveno granite: at the commune of Baveno and at Omegna. It occurs as greenish black, hexagonal prisms to 1 cm in quartz veins. Some crystals have been superficially altered to muscovite (Albertini, 1980).

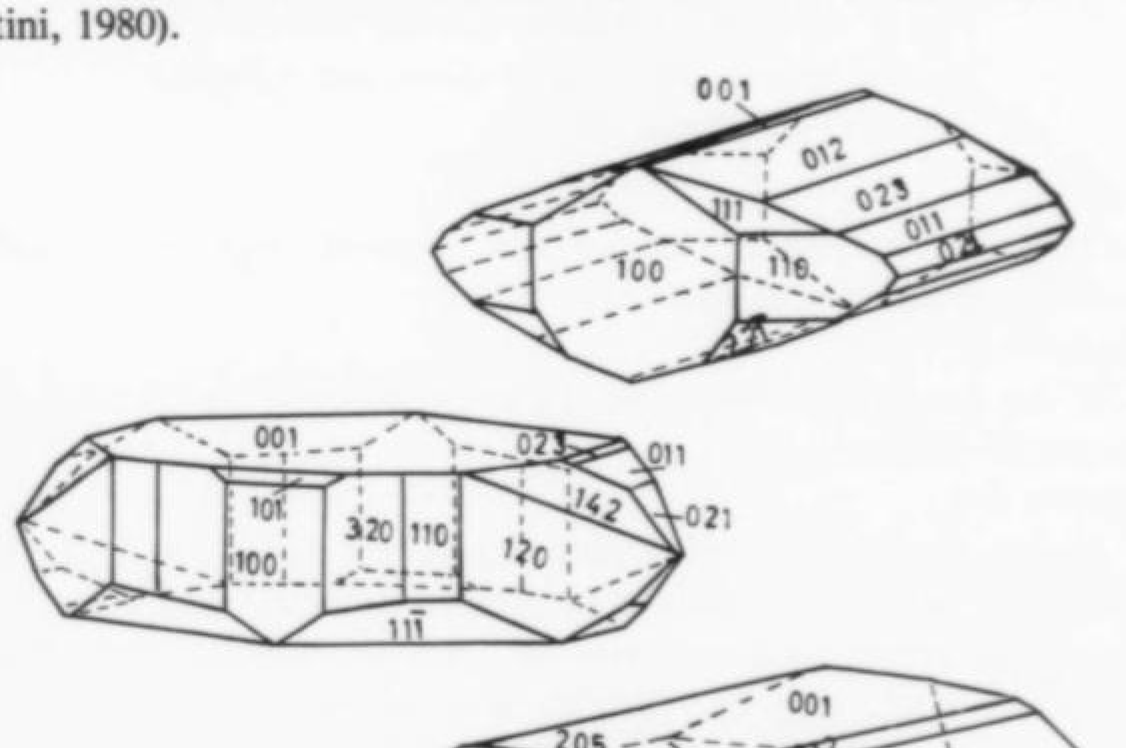

Figure 15. **Datolite crystal drawings (Messina, 1940).**

Datolite $CaBSiO_4(OH)$

Kengott (1855) described datolite crystals from Baveno, but since that time the material has become rather rare. Oil-green to yellow crystals up to 8 cm in size were found, though colorless to pale yellow crystals in rosettes reaching a few millimeters are more common (Messina, 1940; Molinari, 1884).

Epidote $Ca_2(Al,Fe)_3(SiO_4)_3(OH)$

Epidote occurs as small, greenish acicular prisms in bundles and crusts on crystals of orthoclase and quartz.

Fayalite $FeSiO_4$

Fayalite has been found as rare, tabular, imperfect crystals, but is more common as poorly formed black patches to 15 cm in aplite. It ranges from dull and magnetic to lustrous and only faintly magnetic. Surface alteration to limonite is typical. Small areas may be translucent and reddish brown in color. A fairly high manganese content has been observed (Grill, 1935, 1937a).

Fluorite CaF_2

Fluorite at Baveno occurs in a variety of forms and colors. Size ranges from a few millimeters to large octahedrons measuring 7 cm (2¾ inches). Color ranges from colorless to various greens, pink, violet and yellow. Color zoning is common.

The most common forms are the cube, octahedron and dodecahedron, alone or in combination. But the tetrahexahedron, trisoctahedron, hexoctahedron and trapezohedron have all been observed. Sub-parallel and parallel growths are common.

Typical associations are quartz, orthoclase and mica, and other minerals such as hematite, laumontite, epidote and hyalite opal are commonly found encrusting the fluorite crystals. Inclusions of acicular green tourmaline were found in one crystal.

Fluorite occurs in hydrothermal veins as well as pegmatite pockets, and in one such vein in 1974 some peculiar crystals exhibiting an alexandrite effect were collected; in sunlight they appear green, whereas under incandescent light they appear violet (Balzac, 1917; Pagliani, 1936).

Figure 16. **Gadolinite crystal (arrow), 1.2 cm, on white orthoclase. Claudio Albertini specimen.**

Gadolinite $Y_2FeBe_2Si_2O_{10}$

Gadolinite was described from Baveno for the first time in 1865, and at that time it was a new species for Italy. It occurs as large (to 1.5 cm), brown or yellowish green, prismatic crystals commonly showing some alteration. Baveno gadolinite contains an unusually

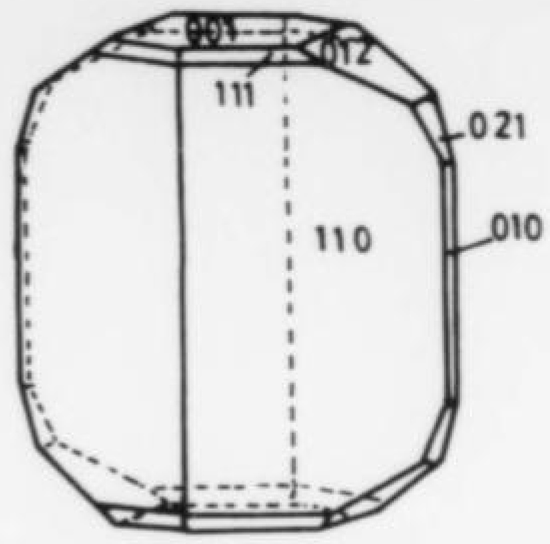

Figure 17. **Gadolinite crystal drawing (Pagliani, 1941).**

high amount of beryllium (to 10 percent). In addition, the following elements have been found: Sc, La, Ce, Pr, Nd, Sm, Gd, Dy, Er, Yb and Nb (Fagnani, 1949, 1950; Grill, 1937b; Pagliani, 1941).

Hematite Fe_2O_3

Hematite occurs as aggregates of small, lustrous black plates and as earthy red coatings on other minerals.

Heulandite $(Na,Ca)_{2-3}Al_3(Al,Si)_2Si_{13}O_{36} \cdot 12H_2O$

Heulandite is found as small (2 to 3 mm), transparent crystals sometimes associated with stilbite, perched on crystals of quartz and orthoclase (Pagliani, 1948; Artini, 1902).

Jervisite $NaScSi_2O_6$

Jervisite is a new species recognized on the same specimen as cascandite. It forms small, yellowish needles resembling tourmaline (Mellini *et al.,* 1980a, 1980b, 1982).

Kaolinite $Al_2Si_2O_5(OH)_4$

Kaolinite forms masses of microscopic plates filling cavities in granite.

Laumontite $CaAl_2Si_4O_{12} \cdot 4H_2O$

Laumontite, though rare in well-preserved crystals, is probably the most common zeolite at Baveno. It forms white to pinkish, pearly crystals to 6 cm and has been known to contain beryllium (Pagliani, 1948). It alters by dehydration to the variety *leonhardite.*

Magnetite Fe_3O_4

Magnetite occurs as small grayish black masses formed as an alteration product of fayalite. Associations include fayalite, quartz, feldspars and siderophyllite (Gallitelli, 1936a).

Molybdenite MoS_2

Twisted, irregular molybdenite laminae to 1 cm in size have been found as concentrations in quartz and orthoclase (Gallitelli, 1935c).

Muscovite $KAl_2Si_3O_{10}(OH)_2$

Muscovite is perhaps the least abundant mica found at Baveno. It forms masses of small laminae, spheroidal masses of talcose aspect and dull green color, and rims on zinnwaldite crystals. Grill (1935) described an occurrence of the variety *pinite,* and it has been recently found as partial to complete pseudomorphs after cordierite.

Opal $SiO_2 \cdot nH_2O$

Hyalite opal has been found as encrustations and botryoidal masses, always colorless and glassy, coating quartz and feldspar.

Orthoclase $KAlSi_3O_8$

Orthoclase is the most interesting mineral found at Baveno. Baveno-law twins are common. Manebach and Carlsbad twins occur as well, including Baveno-Manebach combinations. Crystals are opaque, ivory-white to pink, and have a porcelaneous luster. Crystal in excess of 20 cm (about 8 inches) are known, though 3 to 4 cm is more common. Many small crystals of colorless, transparent albite are commonly perched epitaxially on selected faces of orthoclase crystals (Pini, 1779; Barzano, 1853; Streng, 1887; Leuze, 1892).

Prehnite $Ca_2Al_2Si_3O_{10}(OH)_2$

Prehnite occurs as yellowish to light green crusts on feldspar and

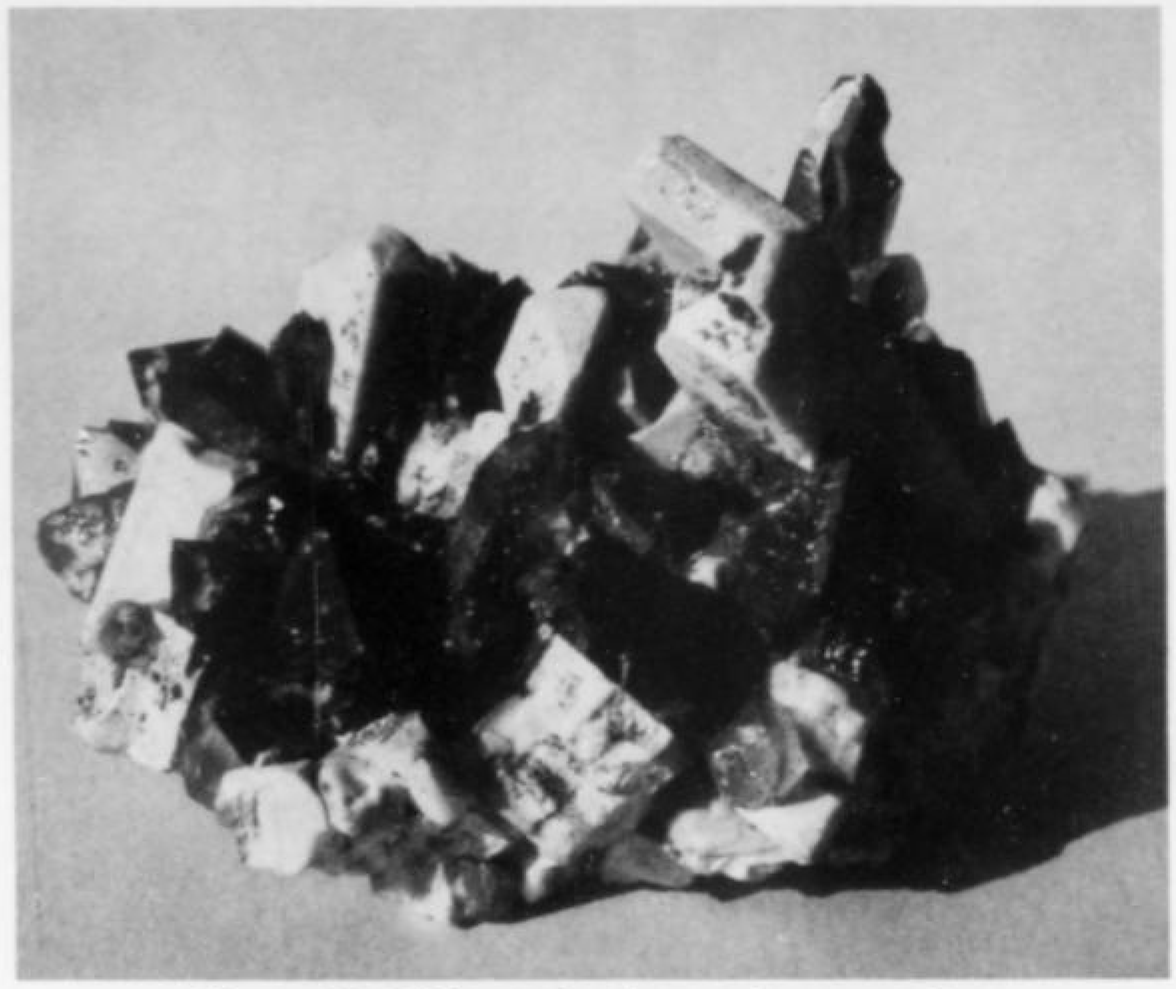

Figure 18. **White orthoclase and quartz, 5 cm tall, from Baveno. Claudio Albertini specimen.**

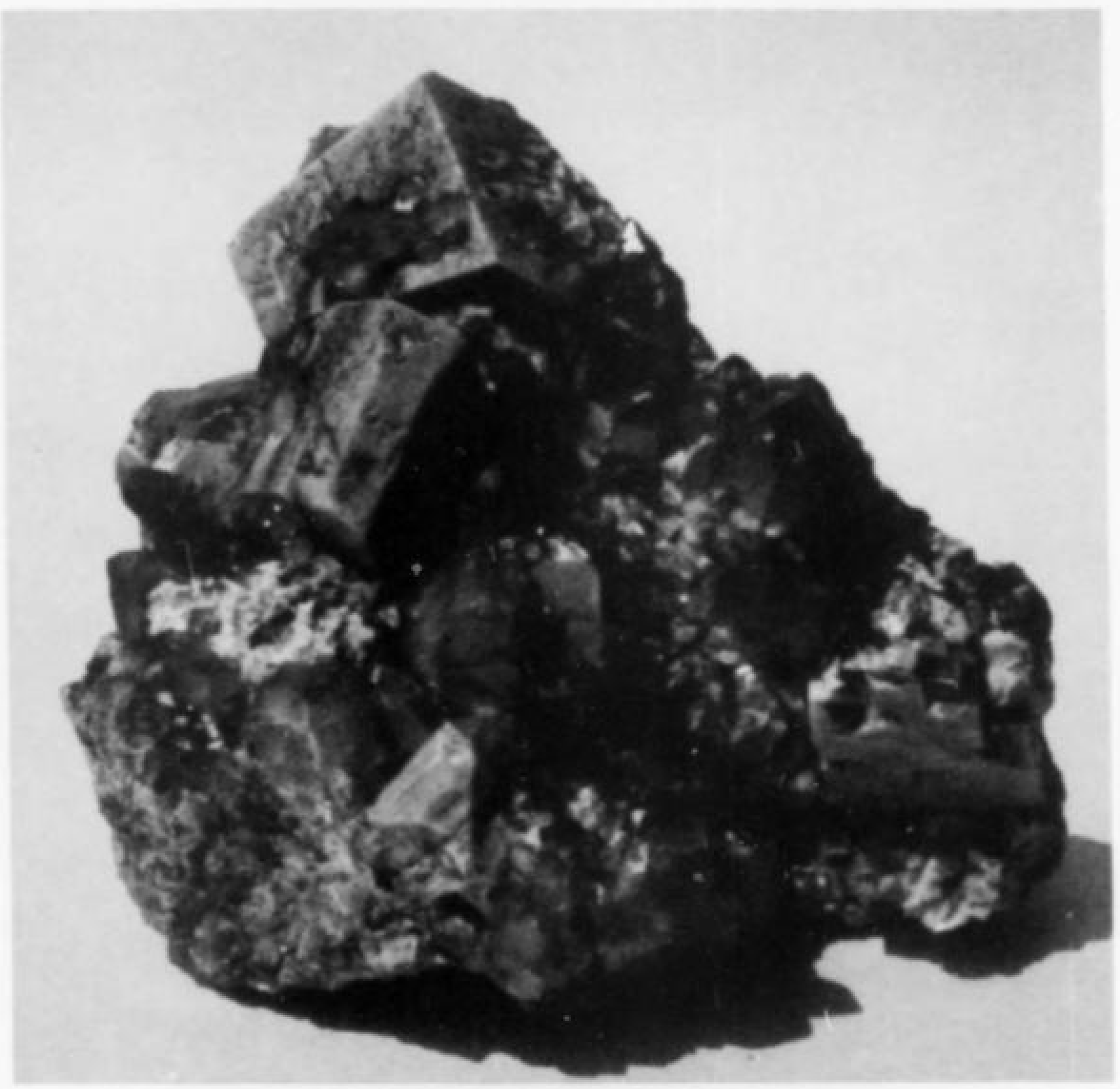

Figure 19. **Pink orthoclase crystals and quartz, 16 cm across, from near Omegna. Claudio Albertini specimen.**

as small (1 mm), tabular, colorless or greenish crystal groups and rosettes on quartz and orthoclase.

Pyrite FeS_2

Pyrite occurs as small, cubic crystals commonly having a black alteration coating.

Quartz SiO_2

Quartz is perhaps the most common pocket mineral at Baveno, commonly forming single crystals perched on orthoclase. Associations are many, and coatings of various minerals including hematite, opal, chlorite, fluorite and babingtonite have been observed. Crystal size varies from a few millimeters to several tens of centimeters, though rarely more than 3 cm. Most crystals are a little turbid and commonly range in color from milky to dark smoky; amethystine, pink and lemon-yellow colors have been noted as parts of less colored crystals (Gallitelli, 1935b).

The simple aspect of the crystals suggests that Baveno quartz is poor in forms, but this is not the case. Goniometric measurements

Figure 20. **Orthoclase Baveno twin 6 cm tall, intergrown with a smoky quartz crystal, from Baveno. Claudio Albertini specimen.**

Serpentine group

Tentatively identified as small, yellow or reddish masses around fayalite.

Siderophyllite $KFe_2Al(Al_2Si_2)O_{10}(F,OH)_2$

Siderophyllite has been identified as the "black mica" mentioned by earlier authors. It occurs with quartz and feldspars, and was first mentioned by Pini (1779). In typical granite it forms small (0.5 mm), lustrous black laminae, but in the pegmatite areas it forms brownish red crystals to 5 cm in diameter. Most commonly it is greenish black in color, and grass-green in thin flakes (Gallitelli, 1936b).

Stilbite $NaCa_2Al_5Si_{13}O_{36}\cdot 14H_2O$

Stilbite is rather common as small (to 2 mm), prismatic, grayish white crystals and as fibrous, radial, sheaf-like yellow masses (Pagliani, 1948).

Titanite $CaTiSiO_5$

Titanite occurs as small, imperfect crystals brownish to gray-violet in color and rarely a pale blue. Some crystals are coated by small, epitaxial crystals of albite (Artini, 1920; Grill, 1937b).

Tourmaline group

Crystals of the tourmaline group are rare in the pink Baveno granite but somewhat more common in the white granite. Typically it forms black acicular crystals imbedded in granite, but has also been observed as very thin, bluish needles on and in quartz and feldspar (Messina, 1940; Artini, 1902).

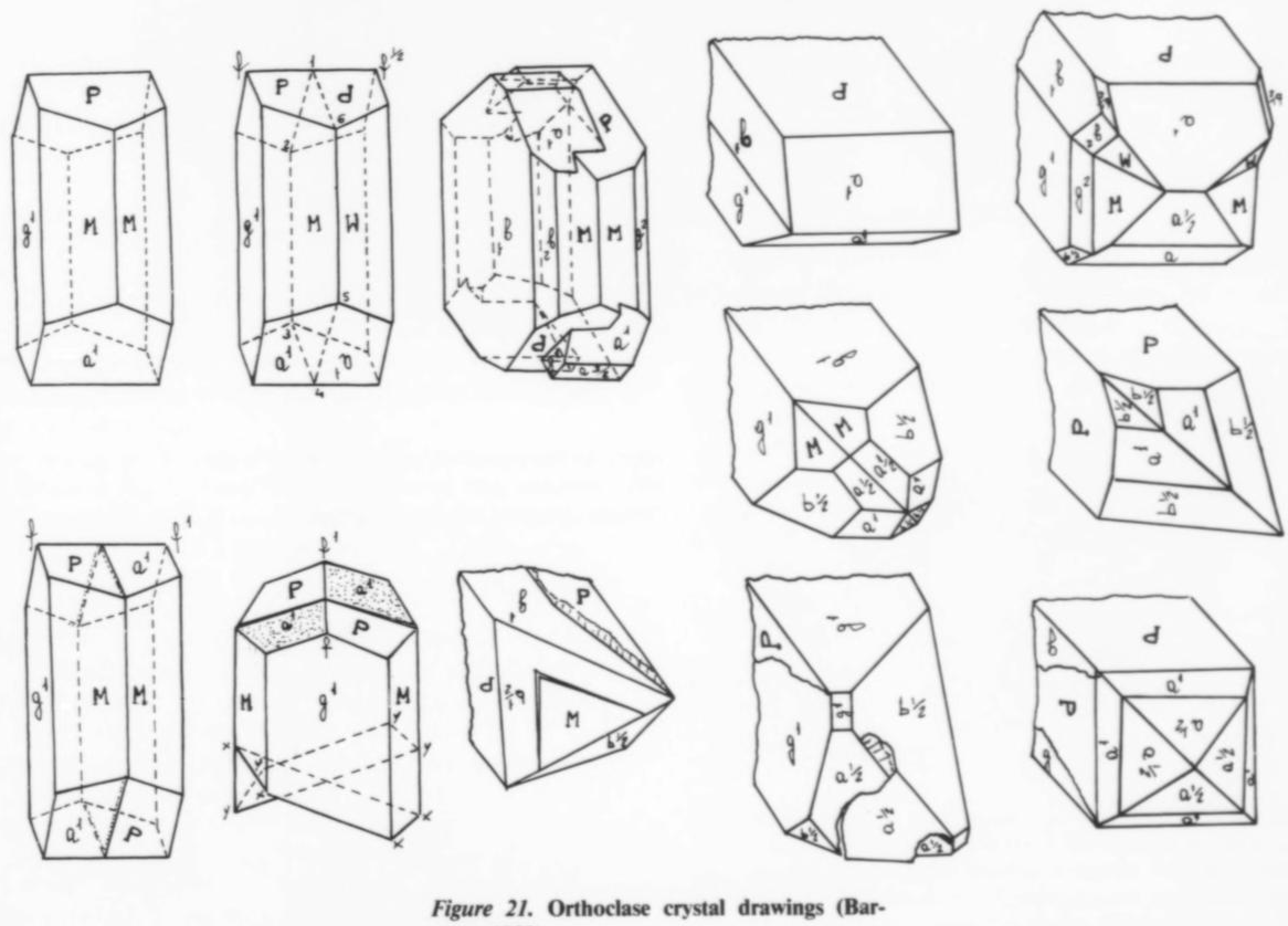

Figure 21. **Orthoclase crystal drawings (Barzano, 1853).**

have identified about 70 forms, and virtually all crystals are twinned on the Dauphiné law (Becker, 1869; Streng, 1887).

Scheelite $CaWO_4$

Scheelite has been found rarely in small (to 5 mm), pale yellow crystals on feldspar (Strüver, 1866; Artini, 1902).

Uraninite UO_2

Uraninite has been found as a black granular accessory mineral in the Baveno granite.

Zinnwaldite $KLiFeAl(AlSi_3)O_{10}(F,OH)_2$

Zinnwaldite is quite common at Baveno, as small rosettes and

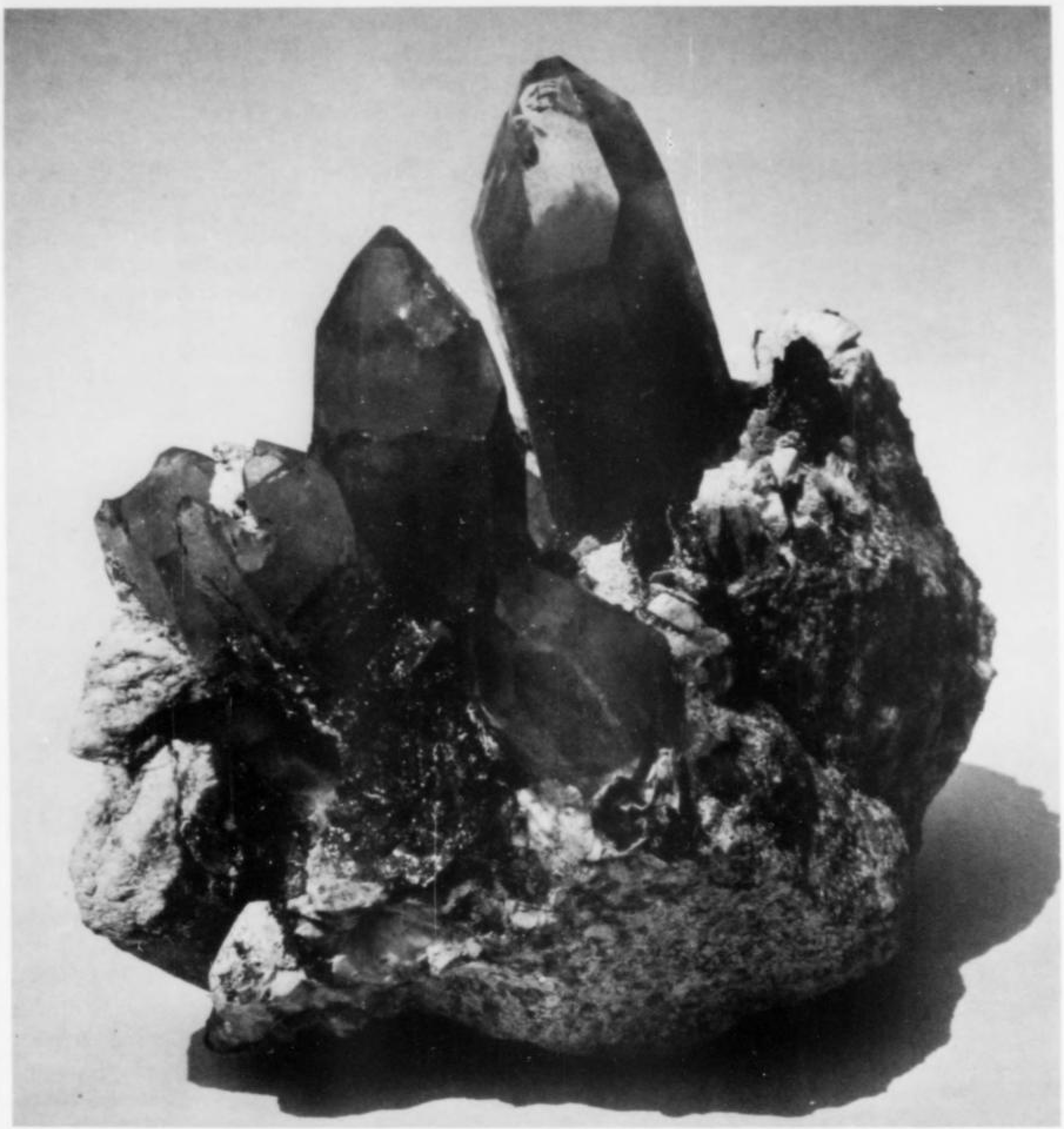

Figure 23. **A 24-cm quartz crystal group from Baveno. Claudio Albertini specimen.**

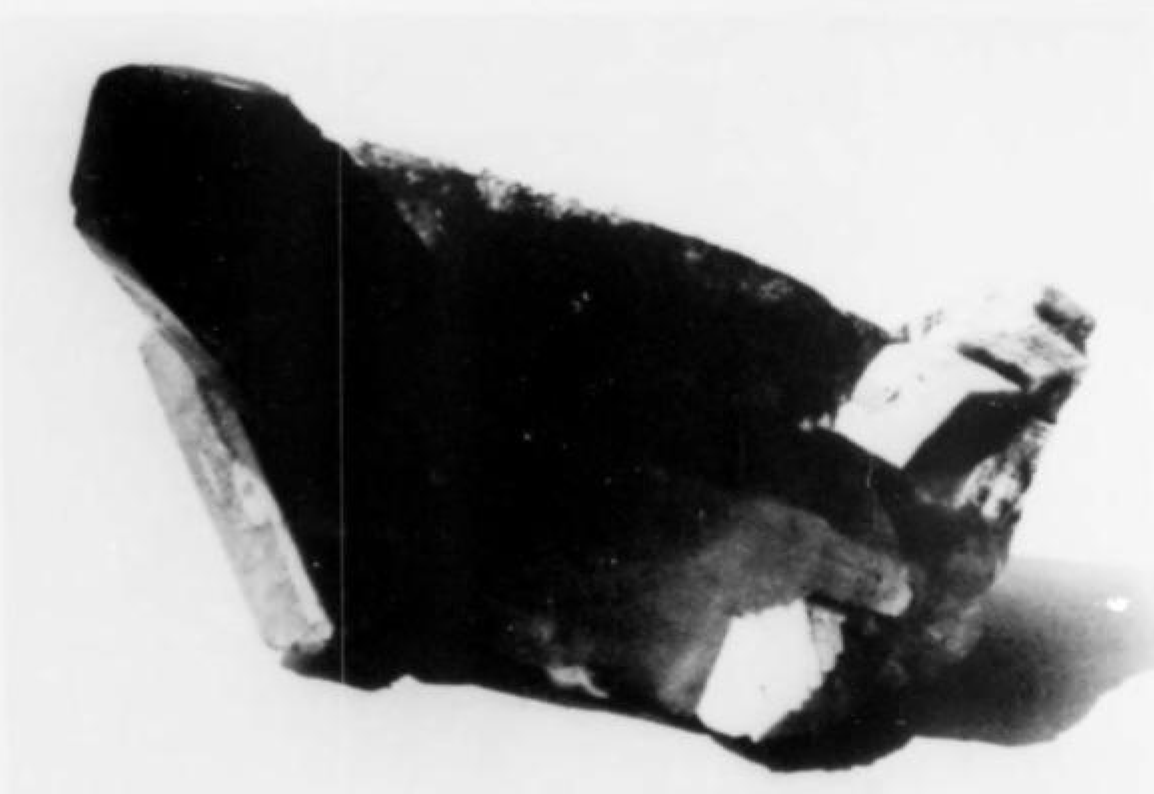

Figure 24. **Smoky quartz specimen 10 cm long, with orthoclase and hyalite opal, from near Omegna. Claudio Albertini specimen.**

laminae sometimes coated by other micas or chlorites. Colors range from green to brown and violet-pink, commonly zoned. Rarely perfect hexagonal crystals have been found. Crystal size is commonly about 1 cm, though crystals to 7 cm have been found (Gallitelli, 1936b).

Zircon ZrSi

Zircon occurs in microscopic crystals as an accessory mineral in the Baveno granite (Veniale, 1965).

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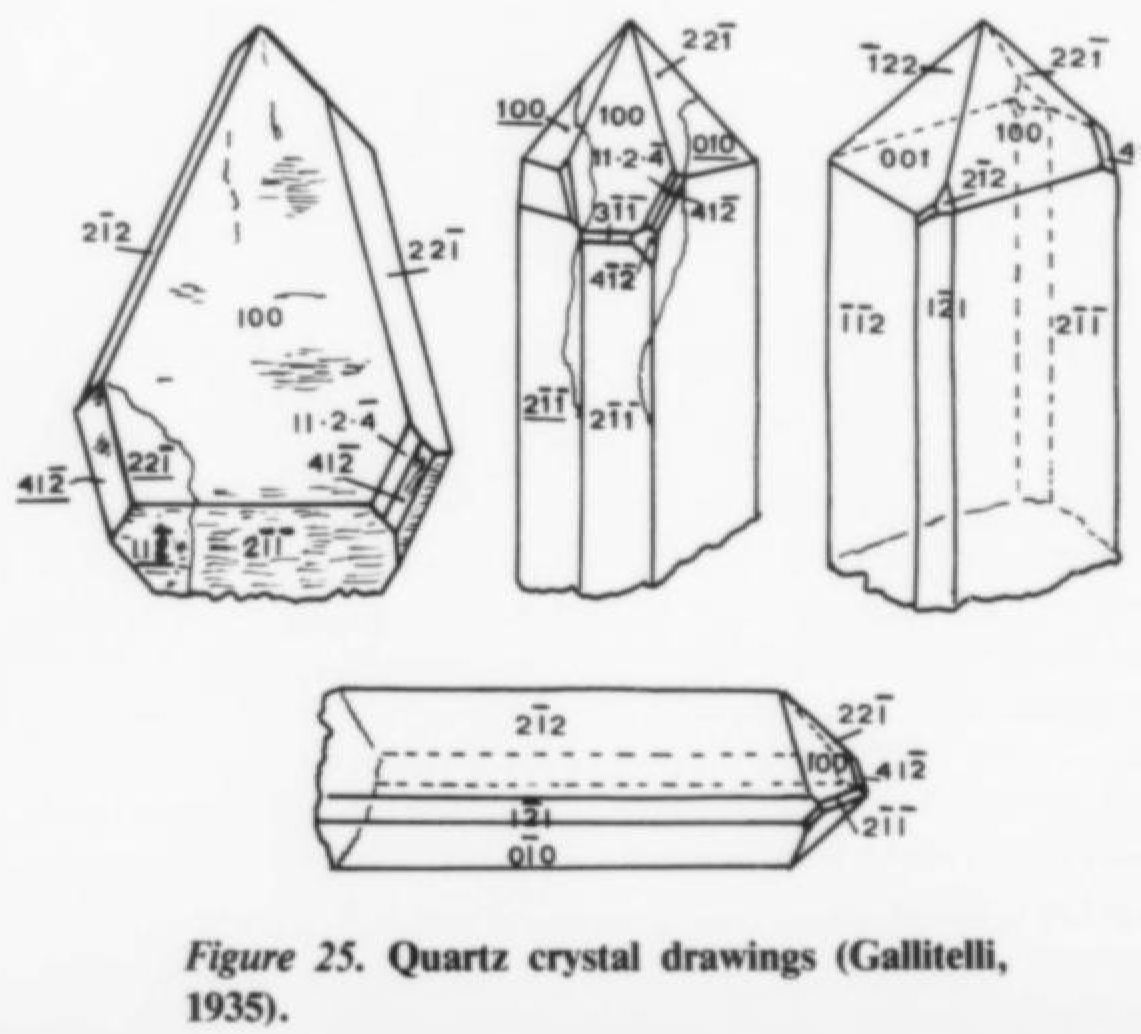

Figure 25. **Quartz crystal drawings (Gallitelli, 1935).**

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Notes from Mexico

by **Bill Panczner**

Last time I reported briefly on the new find of ludlamite at the San Antonio mine, Santa Eulalia district, Chihuahua, and promised more information. To tell the whole story it is first necessary to back up about three years; *Industrial Minera Mexico S.A.*, one of the two mining companies active in the district, had located orebodies several hundred feet below the surface. To reach these they began sinking two large haulage ramps down to the ore levels. The first ramp was started at the west camp near the pueblo of San Guillermo. The other began at the San Antonio mine in the east camp, about 8 miles away. Before even reaching the ore these two ramps have intersected some very interesting mineral occurrences.

Figure 1. **Gypsum crystals up to 10 feet long in the Santo Domingo cavern, Santa Eulalia district, Mexico. Panczner photo.**

Figure 2. **Bob Jones measuring a gypsum crystal in the Santo Domingo cavern. Panczner photo.**

6 feet away, are causing some of the larger crystals to begin breaking up. Mining officials have reluctantly allowed the removal of some of the crystals from two smaller side-rooms. Specimens were sent to museums and universities in Mexico, though a limited amount of material did reach the collector market.

Discoveries in the east ramp proved interesting as well. On the fifth level a small pocket of brilliant, lemon-yellow wulfenite on mimetite was found, with wulfenite crystals up to about ¼ inch in size. However, the big excitement was waiting on the tenth level.

On November 10, 1982, the first shift of miners set off a round of explosives at the

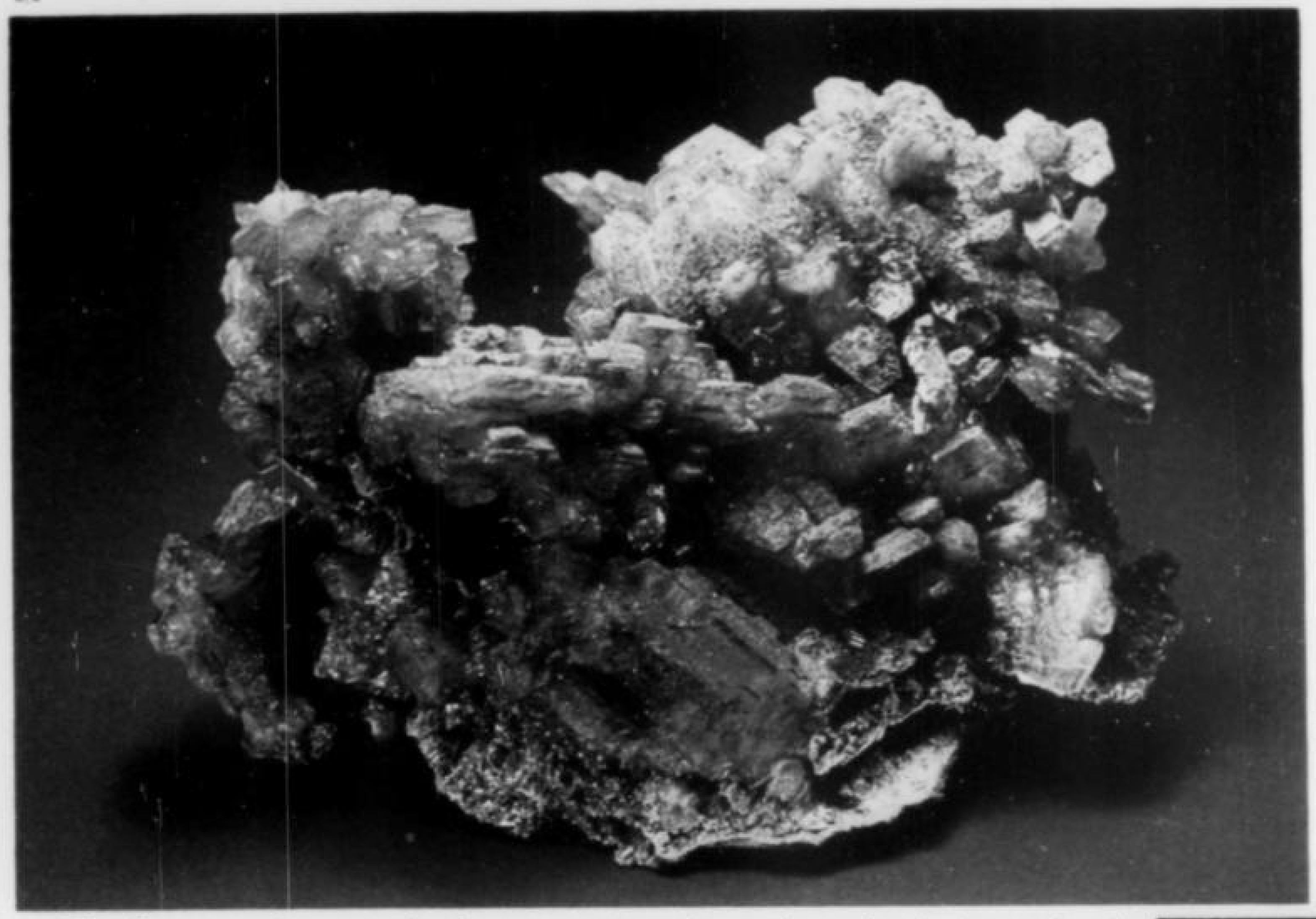

Figure 3. **Ludlamite crystal from the San Antonio mine, 10th level; the crystal is 1⅜ inches tall. Delma Perry specimen, Artrox.**

The first surprise came in the west ramp when miners broke into what is now known as the "Caverna de Santo Domingo." This is a gypsum crystal cave of major proportions, measuring over 300 feet long by 30 feet wide and a maximum of 45 feet from floor to ceiling. The floor is heavily lined with gypsum crystals, some of which are over 10 feet long! (I was able to visit the mine shortly after the cavern was discovered, and have since returned nine more times to completely document this extraordinary occurrence for the book I'm preparing on Mexico.)

The mining company has protected the cavern and has sealed off all entrances. Unfortunately, vibrations from heavy truck traffic on the ramp only

Figure 4. **Large group of ludlamite crystals, 3 inches across, from the San Antonio mine. Delma Perry specimen, Artrox.**

Figure 5. **Two single crystals of ludlamite showing smaller individuals in parallel growth, from the San Antonio mine. The left crystal is 3 inches tall. Panczner specimens.**

advancing face of the spiral ramp. Since it was near the end of the shift, inspection and mucking were left for the second shift to take care of after the heavy dust had settled. Subsequently the second shift arrived; the first miner on the scene had begun scanning the blast area for loose rock, when the beam from his lamp fell into a pocket sparkling with brilliant green crystals.

He lost no time in checking out the basketball-size vug, which proved to be lined with large crystals of ludlamite, undoubtedly the finest ever found anywhere. On the bottom of the vug were four crystals lying loose, perhaps shaken free by the blast. He picked them up and put them in his shirt, noticing that two crystals were as large as his finger. Not having any collecting tools handy to free the remaining specimens, he hurried back to his tool box a few hundred yards up the ramp. On his return he was astonished to find that the pocket had already been cleaned out by other miners! As the rest of the crew arrived and mucking began, a few more specimens were found amid the blast debris.

A total of about 50 specimens were taken from the vug, and another two or three dozen from the floor debris. The crystals range in size from micromount up to about 3½ inches, some with complex parallel growth. Some crystals have partial coatings of manganese oxides and pyrite. Additional but smaller ludlamite vugs were encountered over the next few days, but nothing like the first one. And there has been something of an increase in rarity for these specimens *since* they were collected . . . a significant number have been accidentally destroyed (not by me!) during the course of cleaning and preparation.

Shortly after the ludlamite pockets were hit, a major watercourse was intersected which flooded the lower levels. As of this writing the mine is being pumped out, and work will begin again in a few months. What lies waiting to be found near the watercourse? Only time will tell. But safety problems have forced the mining company to prohibit all non-employees from entering the area.

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Figure 6. **Radiating bundles of ludlamite crystals from the San Antonio mine; the specimen is 2 inches tall. John Whitmire specimen.**

What's New in Minerals?

by **Wendell E. Wilson**

TUCSON SHOW 1983

Tucson, the behemoth of mineral shows, is history once again and, like the biblical creature, "the mountains yield food for him" and he grows bigger each year. In 1982 the show expanded to include equipment manufacturers, taking over virtually the entire Tucson Community Center and doubling its floor space. This year the show expanded to four days instead of three, and garnered a whopping 18,574 paid attendance (not to mention over 700 school children and their teachers who were admitted free). Despite this high attendance, the extra show day allowed the crowd to be spread thinner and a more relaxing atmosphere to prevail.

Show displays were once again spectacular. Betty Roberts' "Distinguished Gathering" case brought together a whole clan of mind-bending dioptase specimens from Tsumeb, on loan from some of the finest collections in the world. This case consistently drew more seasoned connoisseurs (generally several at a time, speaking to each other in hushed tones) than any other case at the show. Next year the favored pocket will be represented by blue-capped pink tourmaline from the Himalaya mine, Pala, California.

Other impressive displays included the 667-carat Muzo emerald crystal (with a case all to itself), old German specimens from the Smithsonian, cerussites from the Sorbonne collection in Paris, and many excellent cases of specimens from private collections. Harvard University displayed specimens from an Alpine cleft-type deposit discovered in Massachusetts, and the Colorado School of Mines displayed Leadville minerals and memorabilia.

This year's show was, unfortunately, rather low on new mineral discoveries. In the category of "world's best," one new discovery did turn up: sellaite crystals to more than an inch, from the Brumado mine in Brazil (available from Carlos Barbosa in the Desert Inn). The name sellaite surely does not ring any bells in the minds of most collectors; this is because all previous occurrences were far from noteworthy. However, these new crystals are lustrous, gemmy, colorless, and of interesting crystal form. Sellaite, MgF_2, is the magnesium analog of fluorite (chemically) but is structurally related to the rutile group. The article in this issue by Cassedanne and Resende provides more information.

An old locality became prolific again in time for this year's show: the famous celestite locality in Sakoany, near Majunga, Madagascar. Celestite from Madagascar is well known as large and beautiful blue crystals thickly lining geodes. Dozens of fine specimens were available from several dealers (including Krotki Iron Mines, Hawthorneden, Don Olson, Roxanne Kremer and Mark Rogers), and ranged in price from $20 for a miniature to several hundred dollars for a cabinet specimen. It was a fine opportunity for collectors to shop around for the best price and quality on one of these old classics.

Several flats of some interesting autunite (Or was it uranocircite? Labels differed) were available from Hawthorneden and A. L. McGuinness. The crystals, square tablets up to about ¼ inch in size and a greenish yellow in color, occur scattered in a thick layer on matrix. Thumbnail to cabinet sizes were available, from $4 to about $200, but the material has a tendency to exfoliate and requires stabilization with an acrylic spray. The locality was given as Luzy, Saône et Loire, France.

The Touissit mine in Morocco continues to produce. This year, Vic Yount brought in some large and superb cerussite V-twins up to several inches in size. Though lacking the gemmy transparency of earlier V-twins, these have larger size and razor-sharp crystal form, with or without a large re-entrant angle. (Vic gave a highly entertaining slide lecture Saturday night regarding his 34 trips to Morocco over the last 13 years, and it was very interesting indeed to see at last what the mysterious Touissit locality actually looks like.) Also new in Vic's stock was a selection of azurite from Bou Beker, Morocco.

Don Pearce (178 Calumet Avenue, Calumet, MI 49913) opened early at the Desert Inn with a large and fine array of Michigan copper, and some nice silver specimens too. Particularly attractive was a lot of copper consisting of herringbone to arborescent crystals similar in habit to the silver from Batopilas, Mexico. They were marked "Lake Superior," and one might at first think this meant something like Lake Superior *district* or perhaps *near* Lake Superior. But no, it means what it says . . . the specimens were collected underwater *in* Lake Superior, near Eagle Harbor, Michigan. The exposure (if it can be called that) consisted of a ledge of copper accessible only with the aid of scuba gear; Don has a photo showing the waterspout produced by the charge of dynamite which broke loose the ledge. Several thousand pounds of crystallized copper were collected from this ledge (in 1971). One specimen weighing about 100 pounds shows fine herringbone copper over one face measuring about 20 inches across, and large, blocky crystals on the reverse face. Small cabinet specimens were reasonably priced at under $200, and Don says he has more of this material at home. The crystals were removed from enclosing calcite by acid treatment and, as in the case of Batipolas silver, the calcite protected the crystals from damage.

Mitch Abel had some interesting, pale yellow hydroxylapatite from a find made south of Eagle, Colorado in late 1982. The

Figure 1. **Large slabs of crystalline copper shortly after removal from an offshore deposit in Lake Superior near Eagle Harbor, Michigan (1971). Don Pearce photo.**

Figure 3. Golden barite on sulfur from the Machow mine, Tarnobrzeg, Poland. The group is 2 inches across; Van Scriver's Minerals specimen.

Figure 2. Rose quartz on smoky and colorless quartz from the Sapucaia mine, Minas Gerais, Brazil. The specimen is 3⅛ inches tall; Carlos Barbosa specimen, now in the Martin Zinn collection.

Figure 4. Two V-twins of cerussite intergrown to form a three-armed group. The specimen, a little over 4 inches across, is from the Touissit mine, Morocco. Victor Yount specimen.

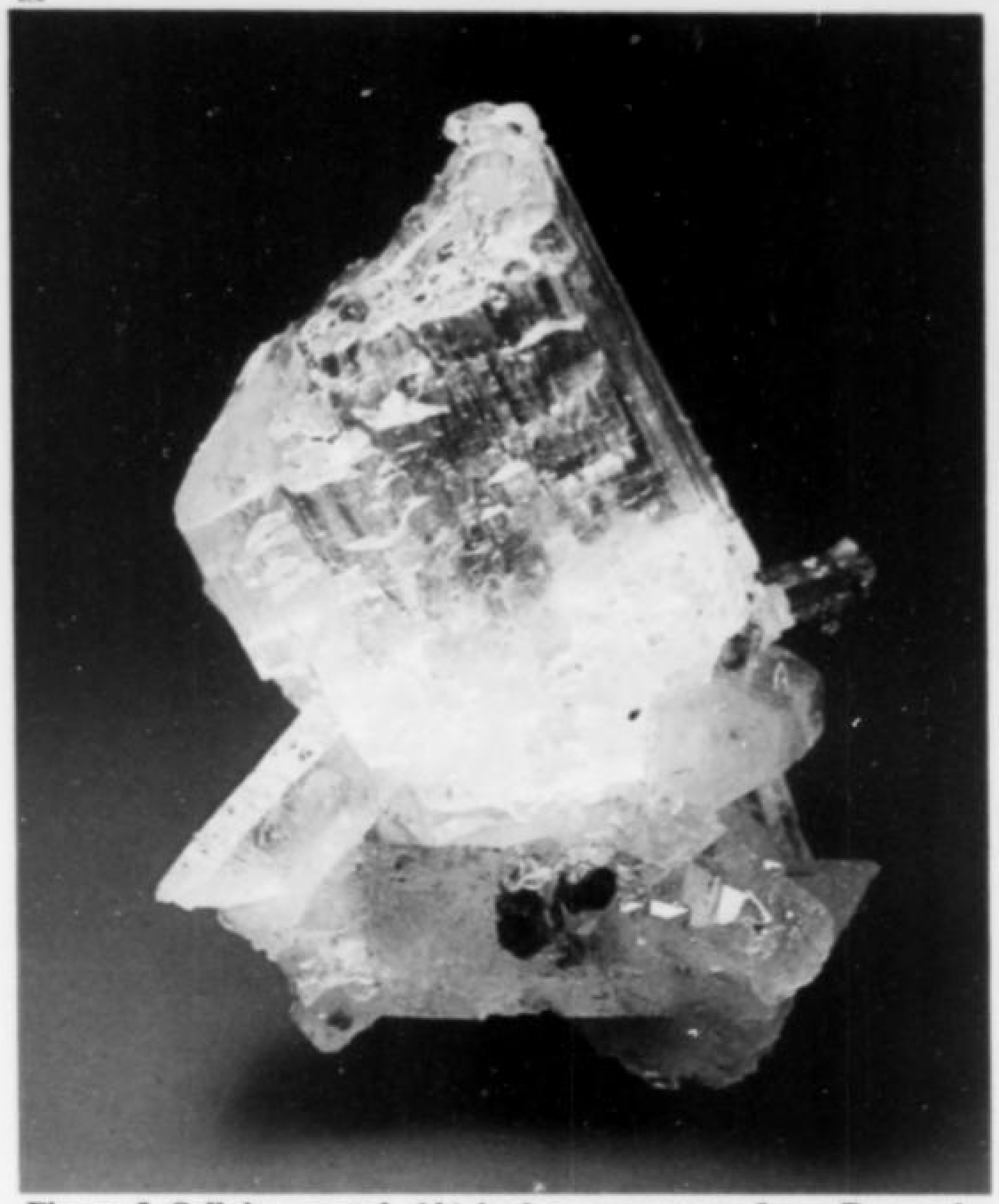
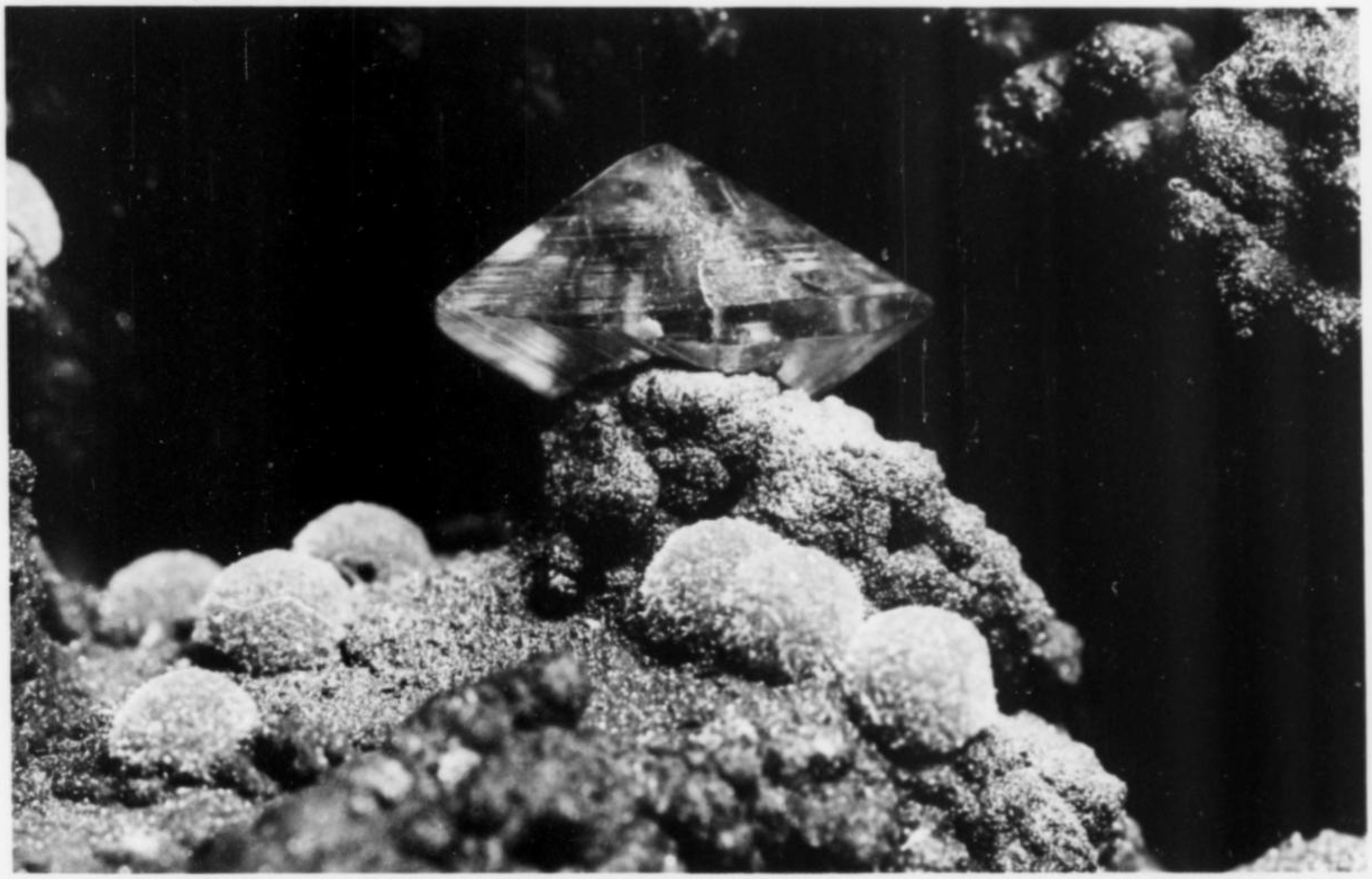


Figure 5. Sellaite crystal, 1¾ inches, on quartz from Brumado, Bahia, Brazil. Carlos Barbosa specimen.

Figure 6. Amethyst crystal 6½ inches tall, the best ever found at the old locality of Little Deer Hill near Stow, Maine. Russell Behnke specimen.

Figure 7. First place winner in this year's slide competition: wulfenite crystal (⅕ inch) and malachite from Whim Creek, Australia. Photo by David Baker.



crystals are generally 12-sided prisms capped by a pinacoid and hexagonal pyramid, measuring up to an inch long and ½ inch wide. They occurred in a pegmatite, associated with large, crude smoky quartz crystals to 12 inches, feldspar crystals to 8 inches and titanite crystals to 1 inch. Several dozen fine crystals were recovered, most without matrix.

Many other interesting items turned up at the show. Wayne Sorensen (at the Desert Inn) offered for sale the last remaining lot of fine green pyromorphite from the Bunker Hill mine in Idaho. Prices were very reasonable, and quality was high. Van Scriver's Minerals carried some new golden barite from the Machow mine, Tarnowbrzeg, Poland. Several dealers carried some fine examples of the thin, platy hematite crystals from Monte Calvario, Biancavilla, Catania, Italy which were reported here in the January-February issue . . . prices ranged from $25 to $100 for these sharp and brilliant specimens. Wright's Rock Shop offered some new gypsum from Mexico: long, transparent crystals of a unique oil-green color, in attractive groups. Sharon Cisneros (*Mineralogical Research Co.*) carried some rare new species including loudounite, richelsdorfite, balangeroite and gobbinsite, as well as some new scorodite crystals from Mapimi.

Russ Behnke did not have a booth or selling room this year, as usual, and people had to catch him on the wing. Hunting him down is always worth the effort, however, and this year he brought (among other things) a superb amethyst crystal from the old Kunz locality of Little Deer Hill, near Stow, Maine. This one (shown here) is probably the best ever found there, measuring 6½ inches tall. It was collected in the dead of winter in 1967 by Cliff Trebilcock (wearing snowshoes at the time). The locality, known since the 1880's, produced many fine gemstones but few good crystal specimens.

WINNERS

One thing that never seems to diminish at Tucson is the number of competitions held. The *Mineralogical Record Tucson Tennis Tournament* (First Annual) produced some real winners: Ken Roberts (men's singles), Barbara Shelton (women's singles), Wayne Leicht and Barbara Shelton (mixed doubles), and David Byers and Don Zowader (men's doubles). Our thanks to the Sheraton, which provided court time and even resurfaced the courts in anticipation of our tournament! Next year promises to be even bigger, and more fun, thanks to our energetic Tournament Director Gale Thomssen.

The *Mineralogical Record Slide Competition* yielded winners as well: David Baker (1st place), Eric Offermann (2nd and 5th), Mike Pabst and Art Reno (tied for 3rd), and Ben Chromy (6th).

TGMS awards went to Francis Sousa (thumbnail), Cal Graeber (miniature), Les Presmyk (small cabinet) and Perkins Sams (large cabinet) in the cerussite species competition. Kent England won the McDole trophy this year, and Kerith Graeber won the Lidstrom trophy for best single specimen (a pyrargyrite from Guanajuato, Mexico).

And, finally, the Friends of Mineralogy award for the best article of the year (1982) in the *Mineralogical Record* was given to Robert J. King for his article on the Boltsburn mine.

RECORD AUCTION

This year we tried something different. About 70 specimens were reserved from among the 310 auction donations, and these were auctioned off during the Saturday night program as usual. The other 240 specimens were made available through a silent auction during the course of the show. We had never done this before and weren't sure what the response would be, but our worries were put to rest by large and enthusiastic crowds. Everyone had a great time and urged us to do it again next year, and so we will. It allowed more people to take part and have a chance at some fine specimens, especially those who prefer the informality of a silent auction or who were unable to attend Saturday night. And it helped to relieve an increasingly severe time shortage on Saturday night; auctioneer Gary Hansen was then free to bedevil the audience at will, without having to keep an eye on his watch!

Of course, none of this highly successful show would have been possible without (1) the gracious accommodation of the Tucson Gem and Mineral Society, (2) the generous donations to the auction made by many people (see following list of donors), and (3) the hard-working show staff of the *Mineralogical Record:* Bill Basbegill, Ron Bentley, Julian and Ruth Blakely, John and Pat Carlon, Paul Desautels, Tom and Diane Gressman, Terry and Marie Huizing, Dick Hull, Ed Huskinson, Bob Jones, Tony Kampf, Bernie Kozykowski, Don Olson, Pat Pacoe, Marshall Sussman, Dick and Gail Thomssen, Carol Valen, Mary Lynn White, John White, Wendy White, Kendahl White, Leslie White and Carolyn Wilson. My special thanks to Howard Worner, an editor of the *Minerals of Broken Hill* book, who spent considerable time at our show booth autographing copies. See you all next year!

CORRECTION

It was stated in this column in the January-February issue (p. 53) that Rich Whiteman of *Red Metal Mineral Company* operates the White Pine mine in Ontonogan County, Michigan. This came as quite a surprise to the White Pine Copper Company, the actual operator of the mine. I apologize for the error. Mr. Whiteman has operated other mines in the area under lease, but not the White Pine mine.

ANNUAL LIST OF DONORS TO THE *MINERALOGICAL RECORD*

Presented here is a listing of everyone, according to our records, who donated to the auction this year or made cash donations to the *Mineralogical Record* during the last 12 months or so (except a few who wished to remain anonymous). If you made a donation and are not listed here, or if you did not get a letter of acknowledgment (usable for tax purposes), please write to me and I will rectify the matter.

I know all the readers of the *Mineralogical Record* will join with me in saying thanks to these generous people who help to keep our magazine going year after year.

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Geode Industries Inc. (New London, IA)
Geological Enterprises (Ardmore, OK)
Gochenour's (Tustin, CA)
Golden Minerals (Golden, CO)
Harvey Gordon (Reno, NV)
Pat and Mike Gray (Midpines, CA)
Jon Haag (Tucson, AZ)
Robert Haag (Tucson, AZ)
Hales Gems (Deming, NM)
Jack Halpern (San Francisco, CA)
Lance Hampel (Germantown, WI)
Gary Hansen (St. Louis, MO)
Tim Hanson (Socorro, NM)
J. Richard and Roelle Harris (Calgary, Alberta)
Kevin Harris (Delta, UT)
Harvard University (Cambridge, MA)
Dick Hauck (Bloomfield, NJ)
Hawthorneden (Eldorado, Ontario)
Hinshaw Rock & Gem (Lebanon, OR)
Hollywood Bookshop (Hollywood, CA)
John Hufford (Omaha, NB)
Henry Hunt (Bouse, AZ)
John Jaszczak (Parma, OH)
Jeweltrain (Fremont, CA)
Jewel Tunnel Imports (Arcadia, CA)
Jim's Gems (Wayne, NJ)
Dick Jones Mineral Co. (Casa Grande, AZ)
Jule Art (Cape Coral, FL)
Burton Jurgl (Carson, CA)
Johannes Keilmann, Munich Show
Joe Kielbaso (Tipp City, OH)
Kohl Enterprises (McKinleyville, CA)
R. A. Kosnar (Golden, CO)
Roxanne Kremer (Rosemead, CA)
Kristalle (Laguna Beach, CA)
Krotki Iron Mines (Los Angeles, CA)
La Jolla Gems and Minerals (La Jolla, CA)
The Lesnicks (Tucson, AZ)
D. L. Lewis (Salt Lake City, UT)
Little Switzerland Mining Museum (Little Switzerland, NC)
Steve Loftin (Nashville, TN)
Jack Lowell (Tempe, AZ)
L. T. Creations (Salida, CO)
Sandy and Gloria Ludlum (Columbus, OH)
Luis Leite (Portugal)
Lyko Gems and Minerals (El Paso, TX)
Mason Lapidary Equipment (Marysville, WA)
McGregor and Watkins (Hot Springs, AR)
A. L. McGuinness (San Mateo, CA)
Mike Madsen Minerals (Grand Junction, CO)
John Mediz (Globe, AZ)
Mid-Continent Minerals (Middletown, OH)
Middle Tennessee Minerals (Carthage, TN)
Mary and Gardner Miller (Missoula, MT)
Mineral Kingdom (Houston, TX)
Mineralogical Research Co. (San Jose, CA)
Mountain Gems & Minerals (Portland, OR)

Muchow's Minerals (Sparks, NV)
Geary Murdock (Idaho Falls, ID)
Murphy's Gems and Minerals (Helotes, TX)
New Mexico Minerals Exploration Corp.
Dan Novak (Denver, CO)
Herbert Obodda (Short Hills, NJ)
Eric Offermann (Arlesheim, Switzerland)
Don Olson (Grafton, WI)
Paul Otto (Thousand Oaks, CA)
Pala International (Fallbrook, CA)
Tom Palmer (El Paso, TX)
Panczner Associates (Tucson, AZ)
Francis Paul (Hoosick Falls, NY)
Don Pearce (Calumet, MI)
Perky Minerals (Burbank, CA)
Neal Pfaff (Columbus, OH)
Reo Pickens (Waukegan, IL)
Keith Pilcher (Paraparaumu, New Zealand)
Ralph E. Platt (Encampment, WY)
Plumbago Mining Corp. (Rumford, ME)
Potomac Museum Group (Burtonsville, MD)
Frederick Pough (Reno, NV)
Harris Precht, Jr. (Hamilton, OH)
Precious Gem Investor Magazine (El Sobrante, CA)
D. Prince (Houston, TX)
The Rancher (Delta, UT)
Ray-Tech Industries
Red Metal Mineral Co. (Hancock, MI)
Renowned Mining and Minerals (Albuquerque, NM)
Riverhill Gems (Louisville, KY)
Ken and Betty Roberts (Twain Harte, CA)
Rock and Gem Magazine (California)
The Rock Farm (San Marcos, CA)
The Rock Hut (Leadville, CO)
Mark and Jeanette Rogers (Yucaipa, CA)
Randolph Rothschild (Baltimore, MD)
Bruce and Jo Runner (Delhi, CA)
Rick and Deanna Russell (Cincinnati, OH)
Howard Schlansker (Norwall, MA)
Ernie Schlichter (Sudbury, MA)
Schneider's Rocks and Minerals (Poway, CA)
Bill and Milly Schupp (Tucson, AZ)
Seibel Minerals (Tehachapi, CA)
Charles Seward (Escondido, CA)
Shales Minerals (Los Angeles, CA)
David Shannon (Mesa, AZ)
David Shaw (Norcross, GA)
The Showcase (Sudbury, ME)
Michael Siegel (Freeport, NY)
D. R. Simmons (Queensland, Australia)
John Sinkankas (San Diego, CA)
Don Smarjesse (Dearborn, MI)
Ron Sohn (Dayton, OH)
Wayne Sorenson (Osburn, ID)
Southwestern Minerals (Albuquerque, NM)
Southwest Products (Yuma, AZ)
Mike Sprunger (Leamington, UT)
Starr Gems (Tucson, AZ)
J. E. Stevens
Suzanne Straith (San Francisco, CA)
Marshall and Ruth Sussman (Evanston, IL)
Sean Sweeney
Edward Swoboda (Los Angeles, CA)
Wayne Thompson (Phoenix, AZ)
Treasure Tunnel (Durango, CO)
Ulrich's Fossil Fish (Kemmerer, WY)
Frank Valenzuela (San Manuel, AZ)
Van Nostrand Reinhold Co.
Van Scriver's Minerals (Garden Grove, CA)
Vasconcelos, Ltd. (Governador Valadares, Brazil)
Virginia Mining Co. (Truth or Consequences, NM)
Watt's Fine Minerals (Miramonte, CA)
Weber's Minerals (Encinitas, CA)
Wegner Quartz Crystal Mines (Norman, AR)
Western Minerals (Tucson, AZ)
Wheelen Manufacturing Co. (Lemmon, SD)
John Whitmire (Yuma, AZ)
David Wilber (Ouray, CO)
Wendell Wilson (Tucson, AZ)
Worldwide Resources (Golden, CO)
Wright's Rock Shop (Hot Springs, AR)
Victor Yount (Warrenton, VA)
Martin Zinn (Evergreen, CO)

Sellaite from the Brumado mine

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In late 1979 a pocket was opened at the Pedra Preta quarry, Brumado, Brazil, which yielded superb, gemmy crystals of the rare mineral sellaite. These crystals, some to 5 cm in length, are easily the finest known for the species.

THE DEPOSIT

The Brumado mine consists of several quarries exploiting a very large magnesite deposit. The main quarry, Pedra Preta, is semi-elliptical in shape, 550 by 700 m in size and elongated in a north-south direction. Open pit mining has proceeded to a depth of about 200 m.

Magnesite is the principal ore, of which about 1.2 million metric tons are produced annually; 2000 metric tons of talc are produced as well.

From the collector's viewpoint the Pedra Preta open pit is not usually mineralogically attractive. The ore is massive, banded or spotted, coarse-grained, and white or yellowish gray to reddish gray in color. However, the finest specimens known of novacekite and metazeunerite crystals were found in this quarry several years ago (see Cassedanne and Cassedanne, 1978), and large, curved crystals of tremolite to 20 cm occur near the bottom of the pit. The world's finest magnesite crystals, ranging up to a remarkable 30 cm in size, also come from the Brumado mine, and excellent talc crystals and crystals of dolomite to several centimeters have been found at Pedra Preta. The geology of the area has been described by Bodenlos (1954).

SELLAITE

Sellaite formed as a druse or coating of crystals on translucent quartz and magnesite crystals, later spalling off (perhaps as a result of shock waves from blasting) and eventually being found loose in the pocket. The pocket itself was discovered in the southern part of the 768 (elevation) level, and measured 50 by 60 by 120 cm. It appears to have formed in a schistosity plane in massive magnesite, and was partially lined with crystals of magnesite, dolomite, quartz and dravite. At the pocket bottom were the loose sellaite crystals, suspended in a magnesite sand with several quartz and dravite specimens. The pocket yielded eight crystals 3 to 5 cm in size, 20 crystals between 1 and 3 cm, and numerous smaller crystals and crystal fragments.

The sellaite crystals are transparent to gemmy, containing flawless areas and also inclusions to several millimeters of greenish brown dravite, quartz and translucent magnesite crystals. The tetragonal crystals consist of a prism, sometimes elongated, and a pyramidal termination with growth features and rounded edges. Observed forms include the pyramid {102}, the prism {110}, and poorly developed {120}, {130}, {230}, {250} and {350}. The crystals are generally elongated along the *c* axis, and occur in groups of parallel crystals with pitted faces.

Identified by X-ray diffraction, Brumado sellaite shows two poor cleavages {110}and {100}, no twinning, a Mohs hardness of 5.5, density of 3.15 ± 0.01, indices of refraction ω = 1.390 and ϵ = 1.378 (both ± 0.001 in Na light), birefringence of 0.012, and are uniaxial positive. In comparison to crystals illustrated by Goldschmidt (1922), Lacroix (1962) and Raade and Haug (1981), Brumado mine crystals are relatively simple in habit.

Worldwide sellaite occurrences fall into several different categories (listed below); the Brumado mine occurrence represents a new type for the species.

1. Volcanic fumaroles and ejecta blocks, as at Vesuvius and Etna.

2. Mesothermal to epithermal fluorite veins with barite and sulfides, as at the Font Sante mine, France (Solety, 1965; Remy *et al.*, 1974; Wilson, 1977).

3. Pneumatolytic assemblages in pegmatites with cassiterite, as at Nertschin, Transbaikalia, Soviet Union.

4. Cavities in soda granite with ekerite, as from the Oslo region (Raade and Haug, 1980).

5. Evaporite beds, as in the potash deposits of Bleicherode, south of the Harz Mountains in Germany.

6. Hydrothermal or syngenetic-exogenous (?) deposits of complex origin, rich in chlorine and containing saccharoidal dolomite or limestone, as at Carrara, Italy, and Gebroulaz, France (Bordet *et al.*, 1964).

7. A large metamorphic magnesite deposit containing quartz, tourmaline and dolomite, at Brumado.

Pierre Bariand of the Sorbonne Museum (personal communication) reports that previously the best sellaite crystals came from the area of the Glacier de Gebroulaz, near Chalet du Saut, north of Modane, Savoy, France. The French crystals are several millimeters

Figure 1. **Large, colorless, transparent crystal of sellaite 4 cm in length. (All photos by J. Cassedanne.)**

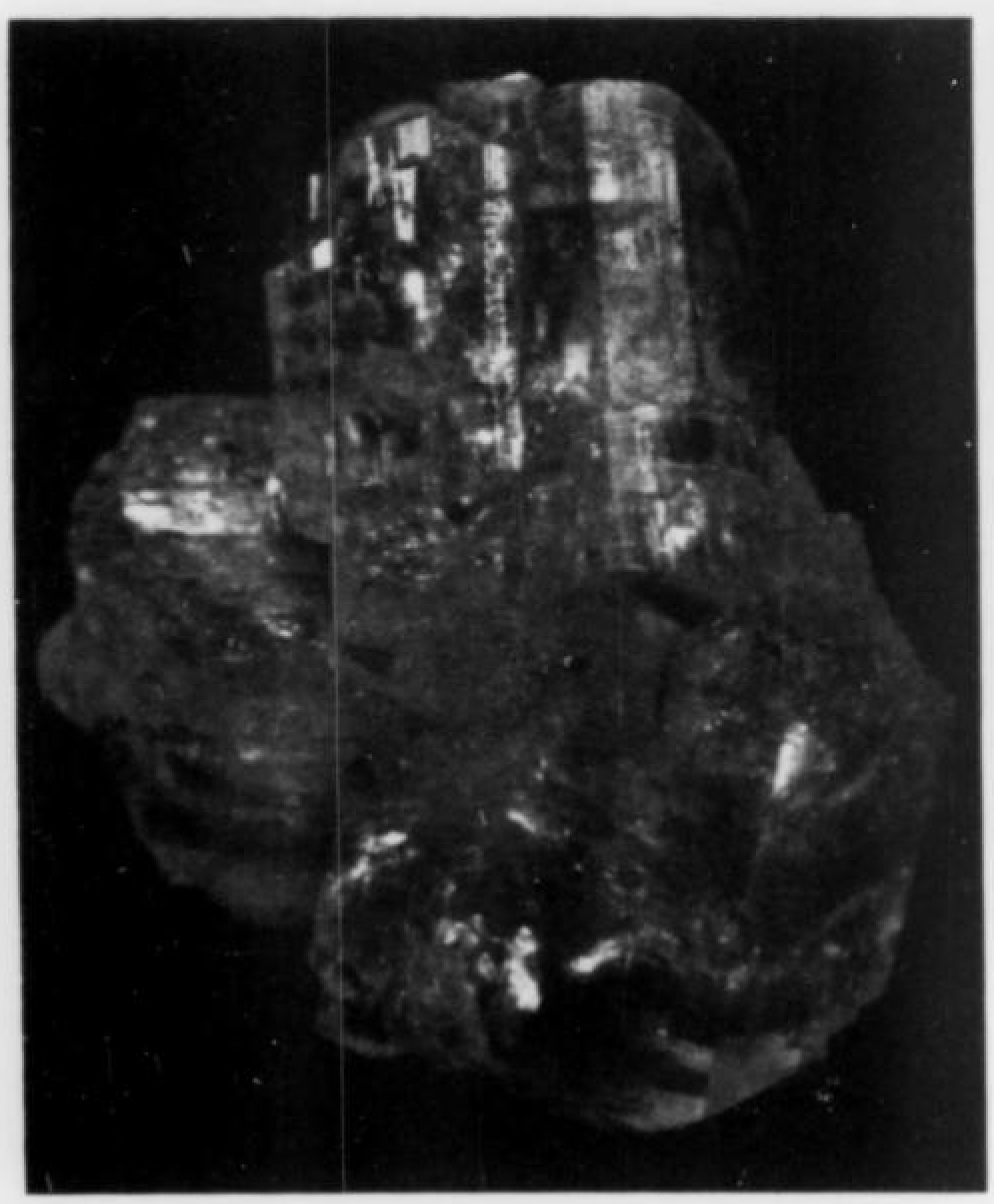

Figure 3. **A group of colorless sellaite crystals 3.5 cm in length.**

in size and occur with dolomite, magnesite, sulfur, fluorite, albite, quartz and celestite (Lacroix, 1962). At the Font Sante mine sellaite occurs as compact masses and clusters of imbedded, acicular gray or brownish white crystals (Wilson, 1977). In comparison to all other occurrences, Brumado mine sellaite appears to be the outstanding discovery.

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Figure 2. **A fine, small sellaite crystal (center) perched on a specimen of quartz and dravite measuring 5 cm.**

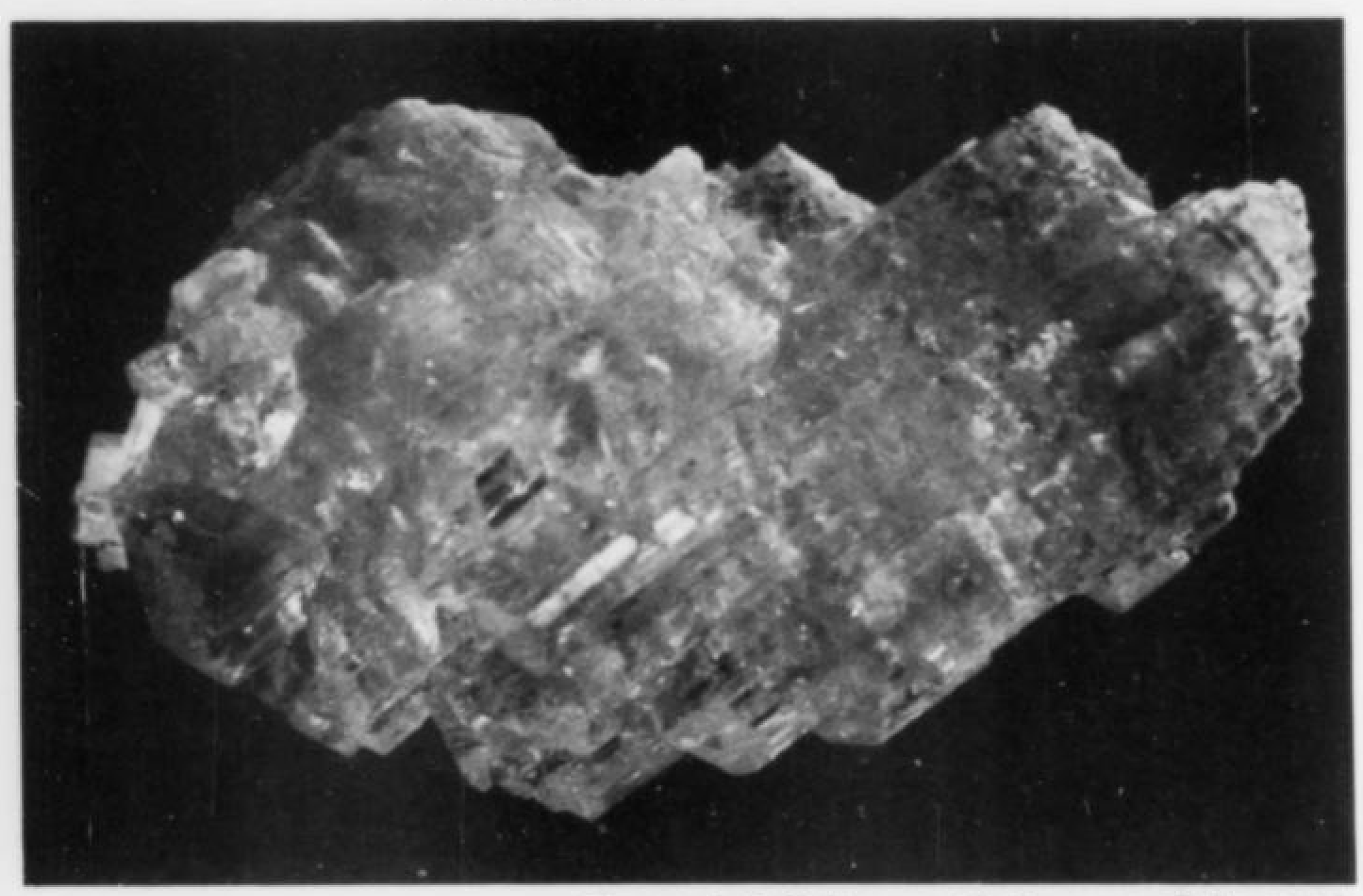

Figure 4. **Sellaite crystals in a parallel growth measuring 8.5 cm.**

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minerals of the Buckwheat Dolomite franklin, new jersey

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The world famous zinc deposits of Franklin and Sterling Hill (Ogdensburg), New Jersey, have been the subject of intense scrutiny by scientists for almost two centuries. Most research has centered on the origin of the Franklin–Sterling Hill orebodies and the unique mineral assemblages contained within them. However, one aspect of Franklin mineralogy which has received scant attention is the occurrence of well crystallized minerals filling cavities in porous masses of dolomitic limestone.

INTRODUCTION

Dolomite limestone occurred as replacement bodies in the marble of the Buckwheat open pit. Collectors refer to this material as "sugary dolomite" but for the purposes of discussion only, we prefer to use the name "Buckwheat dolomite." Our usage is strictly informal. We will use the term Buckwheat dolomite as a field term with no formal stratigraphic nomenclature applicable.

This article documents the minerals found in this occurrence principally through the use of scanning electron microscopy (SEM). Identification of species was verified by X-ray diffraction (Gandolfi) techniques. Additional data were obtained using an electron microprobe equipped with an energy-dispersive spectrometer (EDS). An updated list of the species found in the Buckwheat dolomite is provided in Table 1.

**Present Address:*
The Metropolitan Museum of Art
New York, New York 10028

GEOLOGY

The geology of the Franklin–Sterling Hill area was described by Spencer *et al.* (1908) in the Franklin Furnace Folio included in the *Geological Atlas of the United States.* A reproduction of Spencer's Geologic Map of the Franklin Mining District appeared in Charles Palache's monumental work *The Minerals of Franklin and Sterling Hill, Sussex County, New Jersey* (1935) and is reproduced here in Figure 1.

A glance at this map shows that the Franklin–Sterling Hill orebodies are located at the contact between the Precambrian Pochuk gneiss, now known as the Median gneiss, and the Franklin marble. The orebodies are entirely enclosed within the marble. Frondel and Baum (1974) state that the Franklin marble is part of a series of sedimentary rocks which were intensely folded and regionally metamorphosed to the sillimanite grade during the late Precambrian, about 950 million years ago. They describe the geologic structure of the area as essentially an overturned isoclinal fold and the orebodies as synclinal hooks or pendants. The

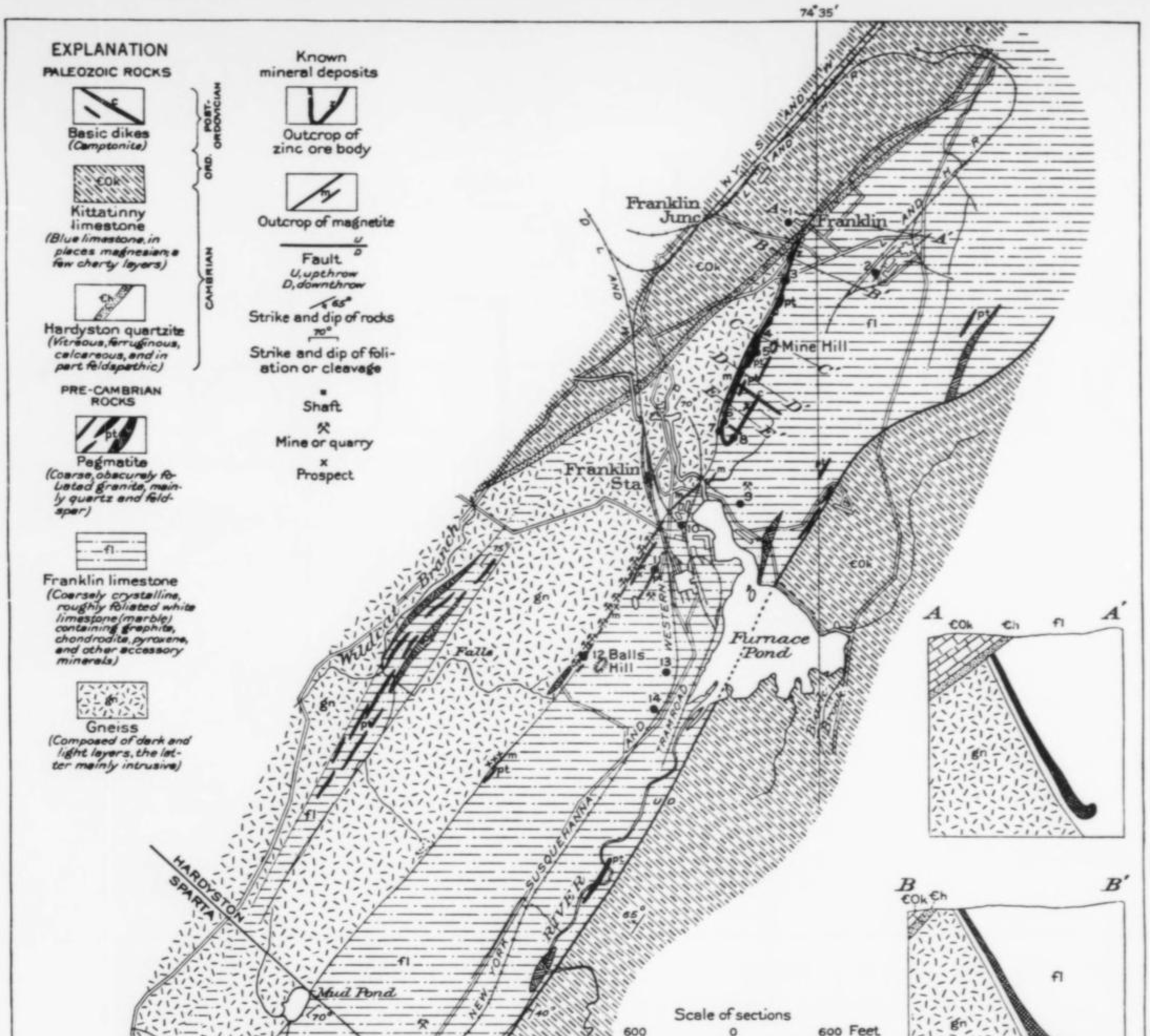


Figure 1. **Geologic map of the Franklin mining district, showing sites of principal mineral localities (Spencer *et al.*, 1908).**

Franklin marble and associated gneisses were intruded in later Precambrian time by post-metamorphic granitic and pegmatitic dikes. The Precambrian metamorphics are overlain to the west by the Cambrian Hardyston quartzite and the Ordovician Kittatinny limestone. The area was subject to faulting and minor folding in the Late Paleozoic and by the intrusion of basic igneous dikes (camptonite dikes on the map).

Very little information is available on the geologic setting of the Buckwheat dolomite alluded to in this study. Referring to the point on Spencer's map labeled No. 6, Palache (1935) states, "In the west wall of the Buckwheat open cut was exposed a veinlike mass of grey dolomite containing in its cavities crystals of quartz, dolomite, albite, sphalerite, pyrite, millerite and goethite." This occurrence was mined out prior to Palache's study, but large boulders of the dolomite can still be collected on the Buckwheat Dump.

MINERAL DESCRIPTIONS

The following are brief descriptions of the species which occur in cavities in the dolomite. The purpose of this investigation was to ascertain the species present as well as produce photo-documentation of these species. Presented in Table 1 is a list of species reported from this occurrence by various authors as well as those identified during the course of this study. Of 41 previously reported minerals, we have confirmed 22 species, 4 of which were visually identified due to paucity of material for analysis. Comments regarding this discrepancy of numbers will be discussed following the mineral descriptions.

Figure 2. **Albite twinned on the albite law. Colorless, 2 mm long.**

Albite $NaAlSi_3O_8$

Albite occurs as colorless to white crystals, always twinned according to the albite law (Fig. 2). Associated species: quartz and microcline.

Anatase TiO_2

Only a single specimen of anatase is known from the Buckwheat dolomite. It consists of a dark blue crystal, approximately 0.5 millimeters along [001], on dolomite. The specimen is in the collection of Ralph Thomas. Identification was visual. It should be stated that many purported anatase crystals which we have examined from the Buckwheat dolomite can be identified undoubtedly as brookite on the basis of crystal morphology. We have seen blue brookite crystals, so color is not diagnostic.

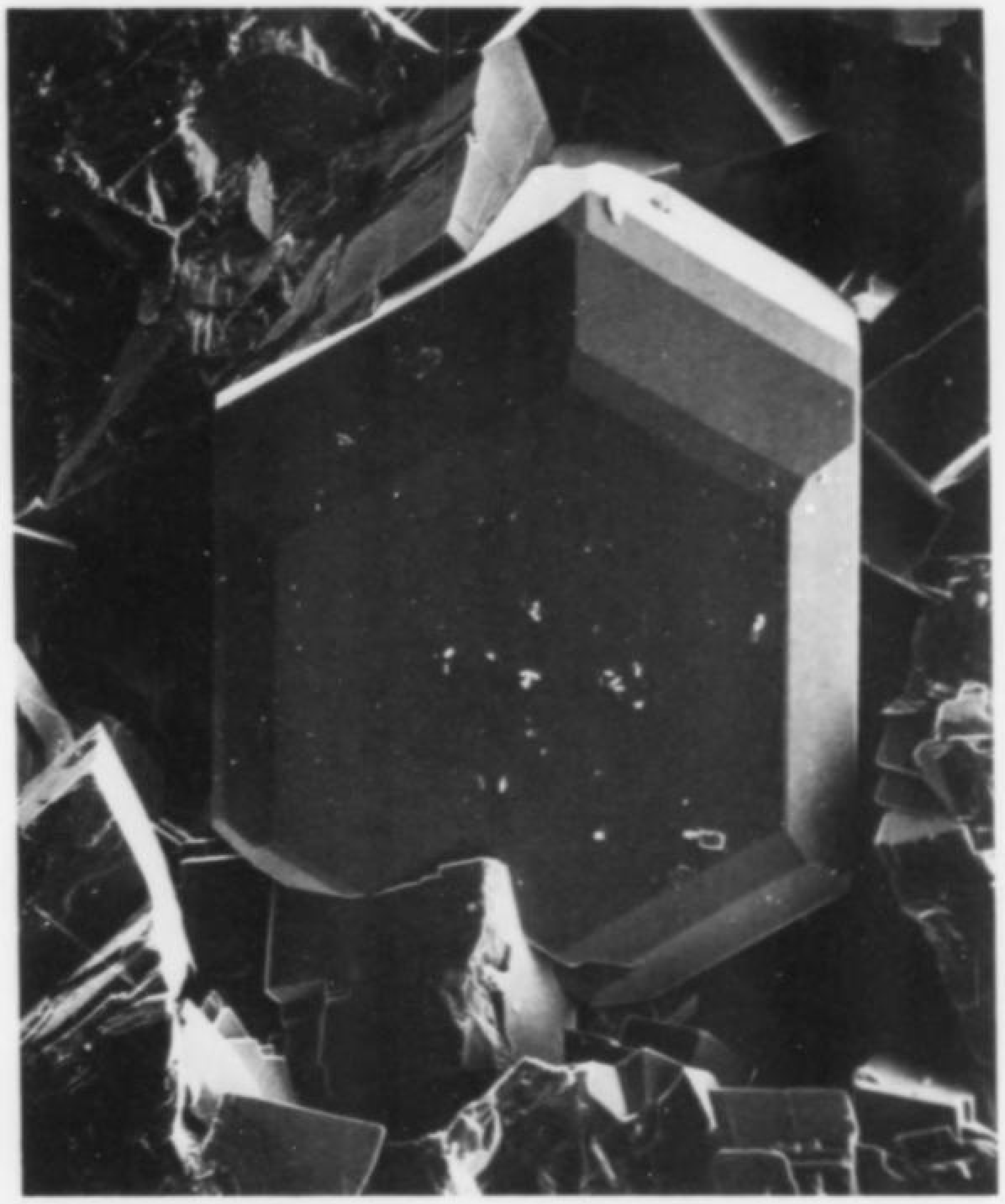
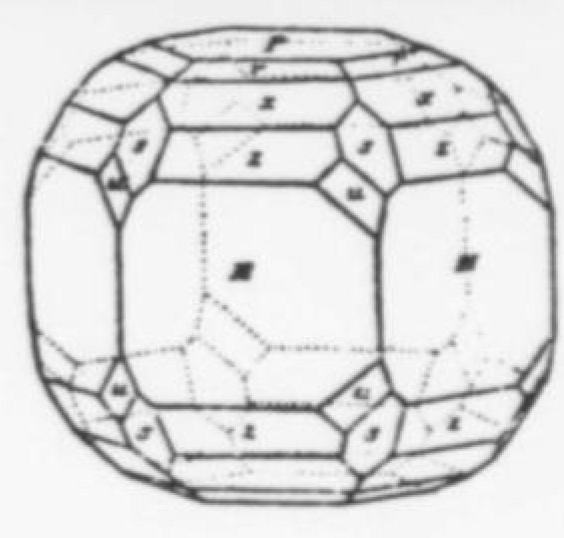


Figure 3. **Apatite – tabular, hexagonal, colorless crystal, approximately 600 micrometers in diameter. Inset: crystal drawing exhibiting similar morphology (Goldschmidt, 1916–23).**



"Apatite"

The exact species in the apatite group is unknown but is most probably fluorapatite, $Ca_5(PO_4)_3(F,OH)$. Palache (1935) reported the analysis of a Franklin apatite which is clearly fluorapatite. Apatite from the Buckwheat dolomite is found rarely as colorless to slightly pink to blue, tabular, hexagonal crystals. Associated species are usually chlorite in spherical aggregates and goethite needles enveloping rutile needles. Figure 3 shows a tabular crystal on dolomite.

Arsenopyrite FeAsS

A prismatic crystal of arsenopyrite in dolomite was kindly provided for examination by Alice L. Kraissl. It is quite a rare occurrence. Identification was made visually.

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

Two specimens of aurichalcite are known, in the collections of Andrew Dilatush and Alice L. Kraissl. On both specimens the aurichalcite consists of extremely thin blue-green plates on dolomite. Due to the paucity of available material, only a visual identification could be made.

Figure 4. **Brookite – two habits occur on this specimen. A preponderance of tabular, prismatic crystals up to 130 micrometers long with a few equant crystals in the lower right-hand corner.**

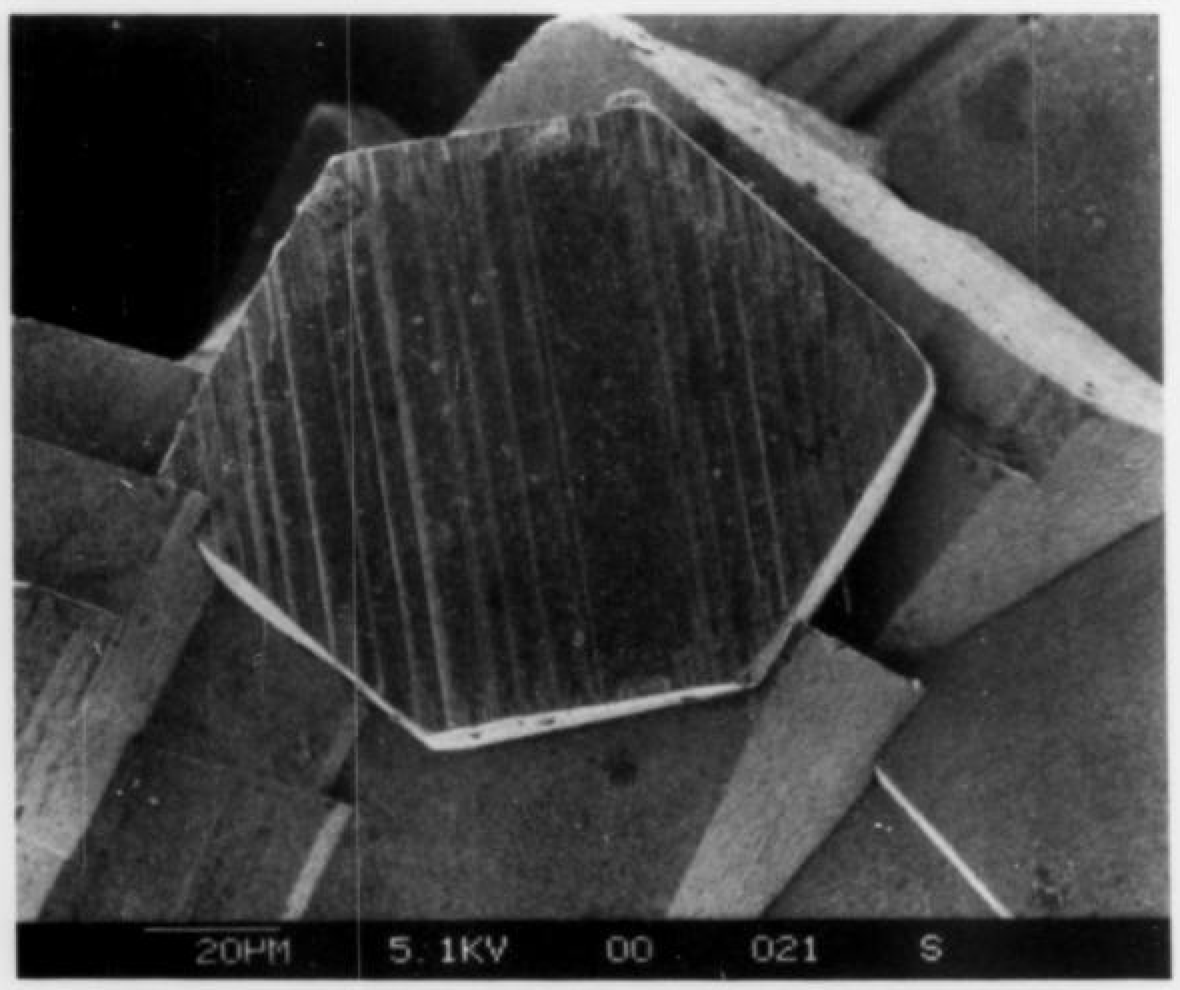


Figure 5. **Tabular, dark-brown brookite crystals exhibiting pseudo-hexagonal habit. The scale bar is 20 micrometers.**

Brookite TiO_2

Brookite was first confirmed by Gordon (1951) on the basis of crystallographic measurements. He considered it quite rare. Recent collecting by Helen and Joseph Warinsky (Warinsky, 1979) has shown that brookite is not rare but only uncommon in occurrence. Because of the small crystal size (less than 0.5 mm) they are easily overlooked. They occur in black, brown, yellow, wine-red and dark blue crystals. The crystals are usually prismatic and striated (Fig. 4)

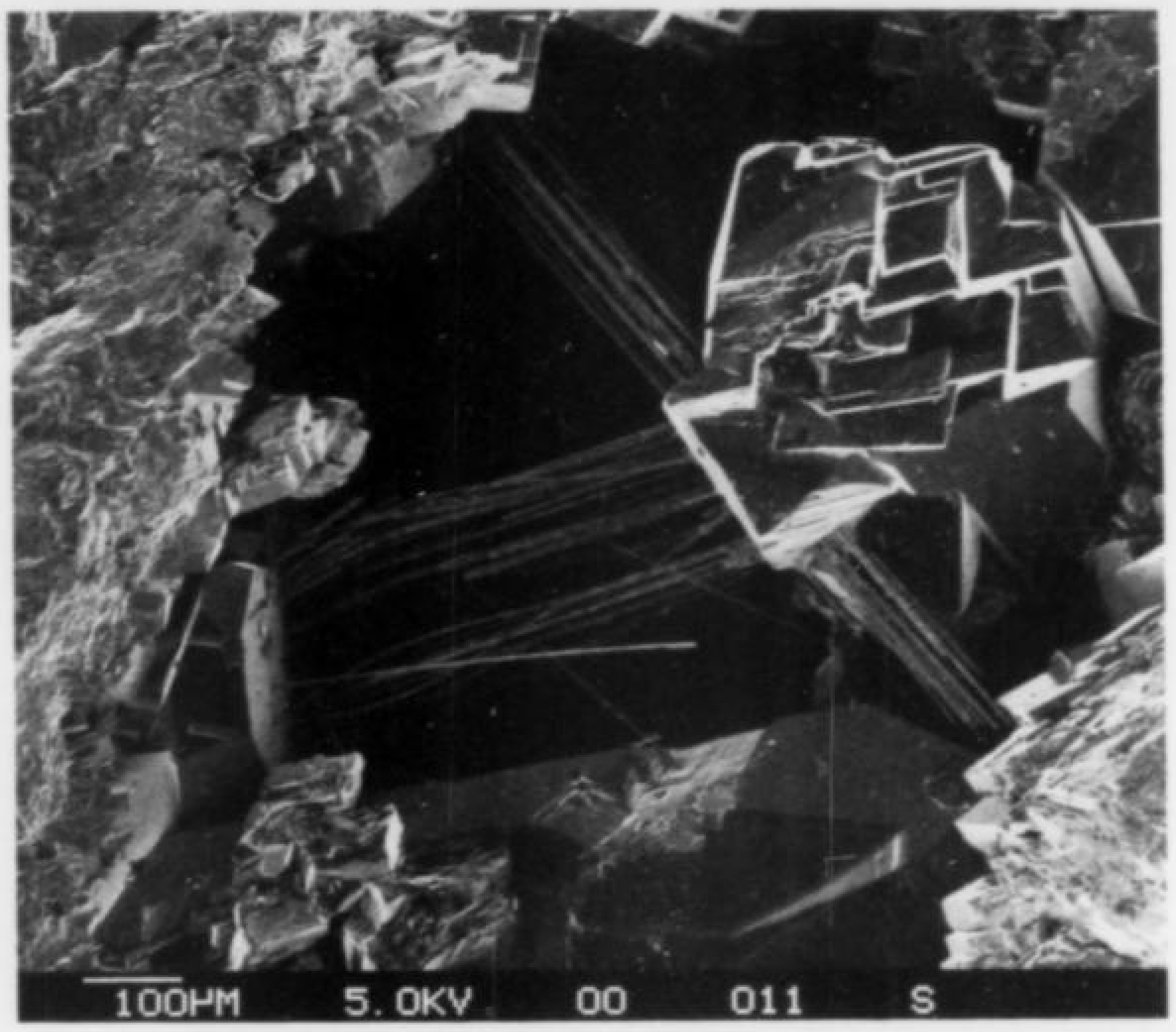
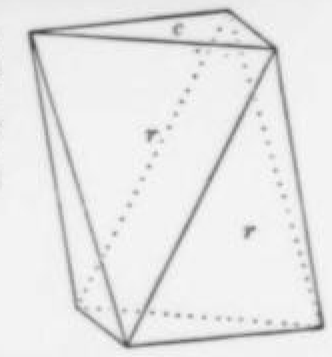


Figure 6. **Brookite-rutile intergrowths, tabular brookite crystals nucleated around rutile needles. The scale bar is 100 micrometers.**

but equant crystals are also known (Figs. 4 and 5). Much of the brookite is associated with its polymorph, rutile, in the form of needle-like crystals (Fig. 6). Although at some localities the polymorphs of TiO_2 (namely rutile, brookite and anatase) have been found together on the same specimen, at Franklin only brookite and rutile are found to coexist. It is our observation that brookites are much more readily found in dolomite which is more weathered than the "normal" Buckwheat dolomite. This weathered dolomite is characterized by large amounts of green chlorite and goethite. Cavities in this type of material usually yield brookite as brilliant, opaque, black equant crystals. "Normal" Buckwheat dolomite which contains rutile needles and pink microcline crystals should also be carefully scrutinized for brookite.

Figure 7. **Pseudo-octahedral crystals of calcite, 700 micrometers in diameter. The crystals are white in color. The octahedral aspect is the result of the combination of the rhombohedron and pinacoid. See inset (Palache, 1935).**



Calcite $CaCO_3$

Calcite in dolomite cavities occurs in a myriad of crystal habits. Figure 7 illustrates crystals that resemble octahedrons but are actually a combination of the rhombohedron (6 faces) and the pinacoid (2 faces) (Knoll, 1972). The two forms are nearly equal in their development, thus producing a pseudo-octahedron. These pseudo-octahedrons are almost always associated with graphite and dolomite. Calcite crystals are frequently found alone on dolomite rhombohedrons or commonly in pockets of dolomite rhombohedrons as disc-like crystals in which are included goethite sprays. Hemimorphite in radiating groups of platy crystals is also found in this assemblage.

Figure 8. **Pseudo-hexagonal stacked plates of gray-green chlorite, 50 micrometers in diameter, with goethite needles.**

Figure 9. **Chlorite, a rosette of intergrown, pseudo-hexagonal plates 100 micrometers in diameter.**

"Chlorite" complex iron–magnesium silicate

An unidentified member of the chlorite group is commonly found as exceedingly small, rosette-like aggregates of gray-green, pseudo-hexagonal plates (Figs. 8 and 9). Oxidation of the ferrous iron to the ferric state imparts a rusty, orange-brown color to some specimens. Typical associates include goethite, rutile, brookite, sphalerite, hemimorphite, calcite and quartz. Muscovite can easily be mistaken for chlorite, especially in assemblages containing brookite and rutile. The distinguishing factor is the stark white color of the thin muscovite flakes.

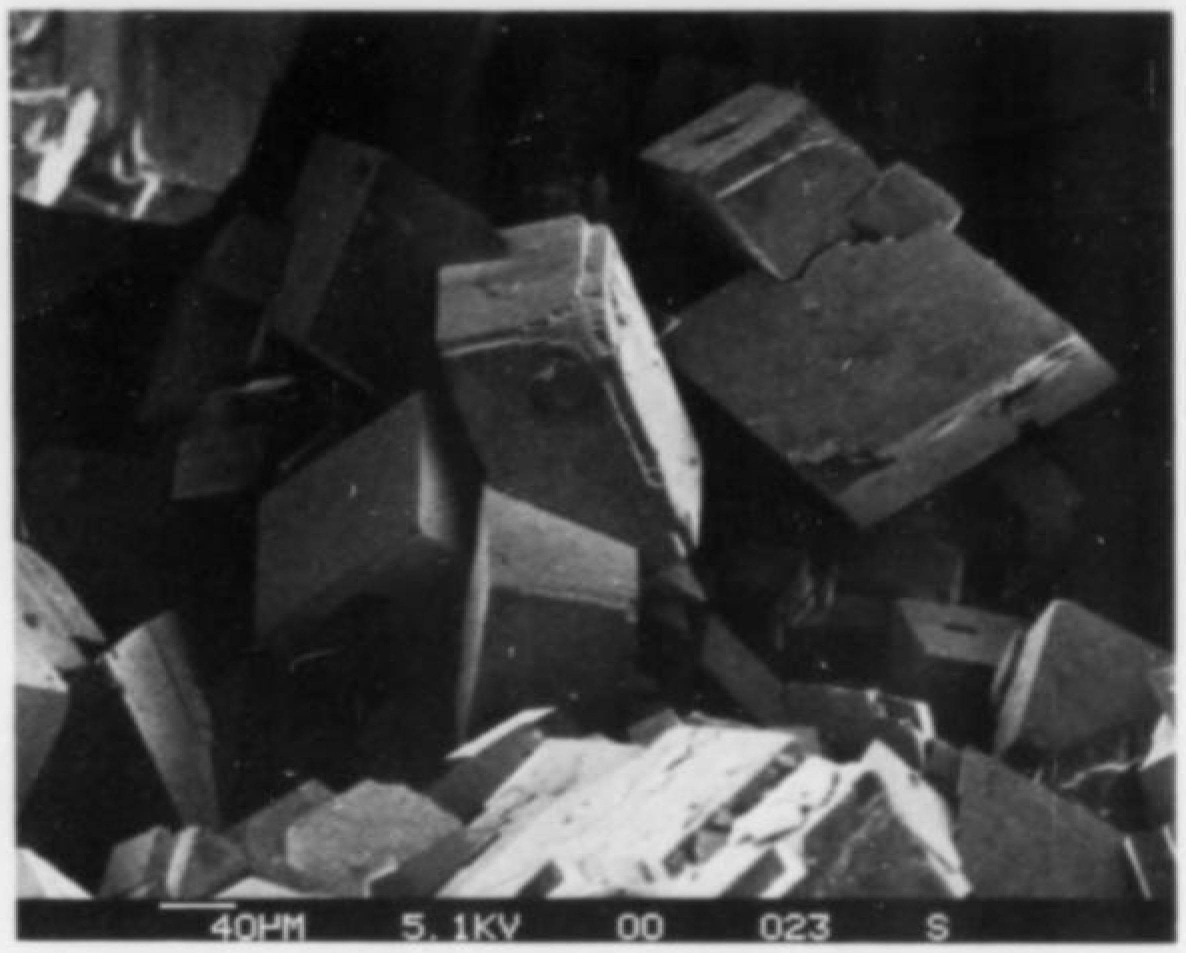


Figure 10. **Intergrown rhombohedrons of dolomite. Dolomite, usually white or colorless, is the host mineral upon which all other minerals crystallized. The scale bar is 40 micrometers.**

Dolomite $CaMg(CO_3)_2$

Dolomite crystals form the matrix for all of the species described here. While dolomite usually occurs as saddle-shaped, curved crystals, this is not the case at Franklin. Well-formed, isolated or step-like stacking of euhedral rhombohedrons are most commonly observed (Fig. 10).

Fluorite CaF_2

We have found two specimens of fluorite. The first consists of a 1-millimeter transparent cube on dolomite in the collection of Andrew Dilatush. The second consists of 3- to 4-millimeter amethyst-colored crystals composed of the cube and hexoctahedron. This second specimen is in the Gerstmann Franklin Mineral Collection. Fluorite appears to be rare in the dolomite at Franklin.

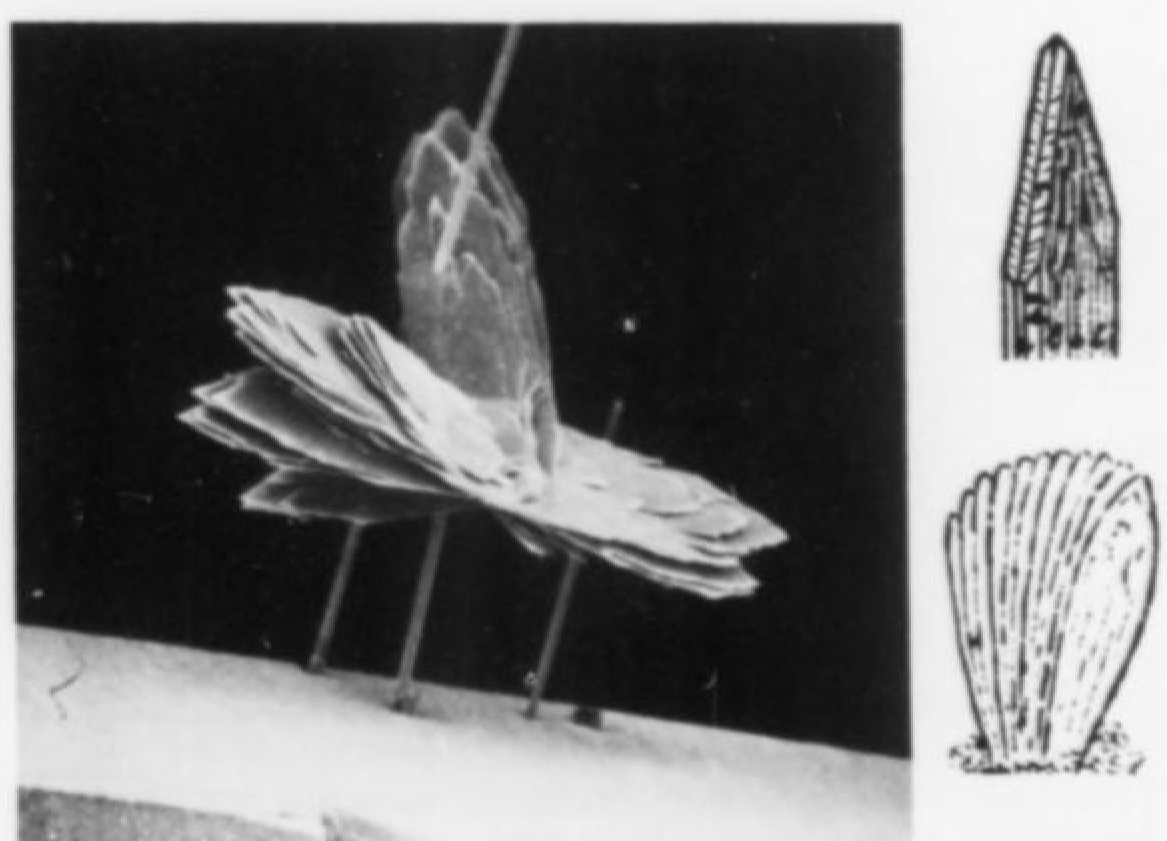


Figure 11. **Goethite – composed of slightly divergent platelets nucleated around rutile needles. Both species are perched on dolomite. The goethite is 120 micrometers in diameter. See inset (Goldschmidt, 1916–23).**

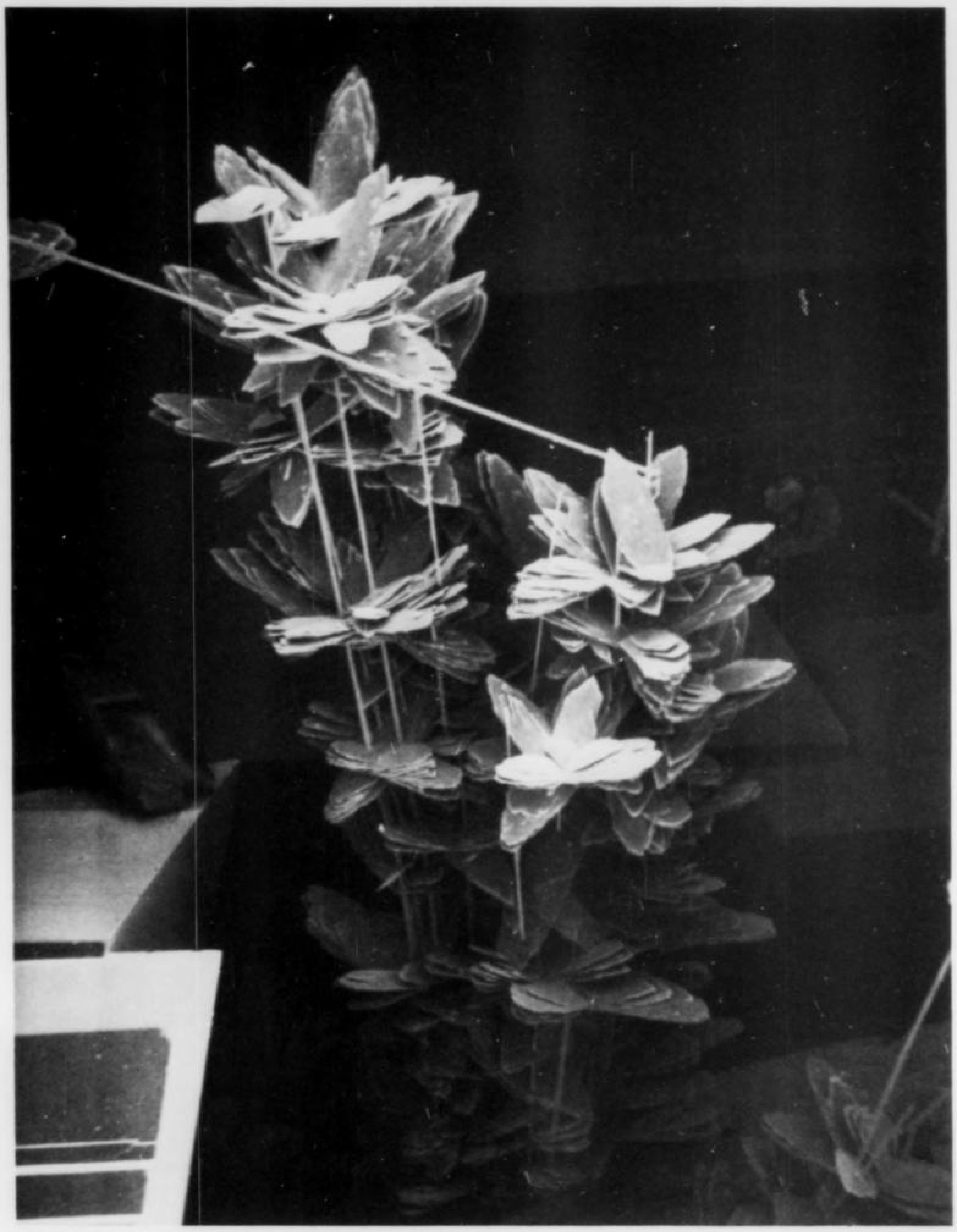


Figure 12. **Goethite – composed of light brown, divergent platelets nucleated on rutile. The rutile measures 600 micrometers long.**

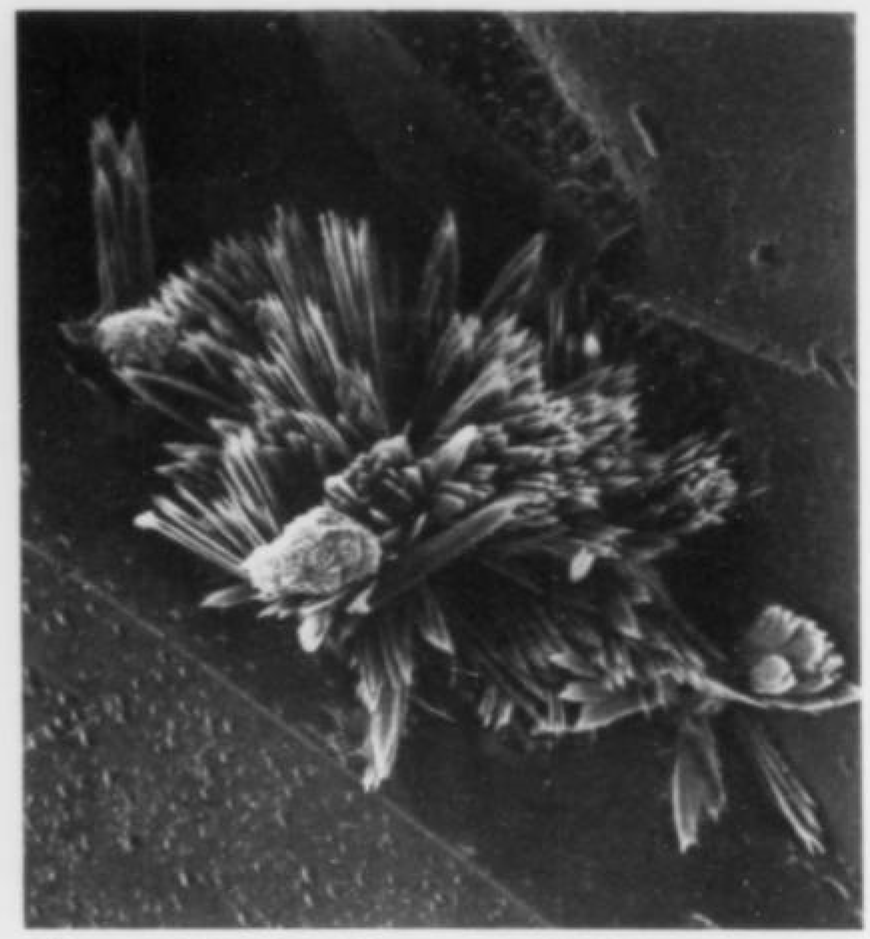


Figure 13. **Goethite – a radiating group of bladed crystals growing on a dolomite rhomb. The grouping is 200 micrometers in diameter.**

Figure 14. **Goethite-hematite – a goethite spray composed of extremely fine, hair-like crystals, 100 micrometers in diameter, growing around a nucleus of botryoidal hematite (dark red to black).**

Goethite FeO(OH)

Goethite occurs in a number of different habits: as slightly divergent platelets nucleated on rutile needles (Figs. 11 and 12), as radiating groups of bladed crystals forming around a sphere-like aggregate of hematite (Fig. 15), and as extremely fine, hair-like crystals surrounding a spherical hematite core (Fig. 14). Goethite is one of the most common minerals found in the dolomite.

Graphite C

Graphite crystals (sometimes pseudo-hexagonal in outline) are usually found in dolomite cavities without associated species; but quartz, hemimorphite, and pseudo-octahedral calcite are sometimes associated.

Hematite Fe_2O_3

Hematite most commonly occurs as spherules sprinkled on dolomite. The spherules are frequently surrounded by the hydration product, goethite. Hematite occurs uncommonly as isolated rosettes of platy crystals.

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

Hemimorphite typically occurs in radiating, divergent sprays of colorless, transparent crystals (Fig. 17). Only occasionally are isolated blades observed in which the hemimorphic nature is readily

Figure 15. **Goethite-hematite – goethite crystals somewhat coarser than those usually collected. The spherule is hematite and is 250 micrometers in diameter. The goethite crystals are 60 micrometers in length.**

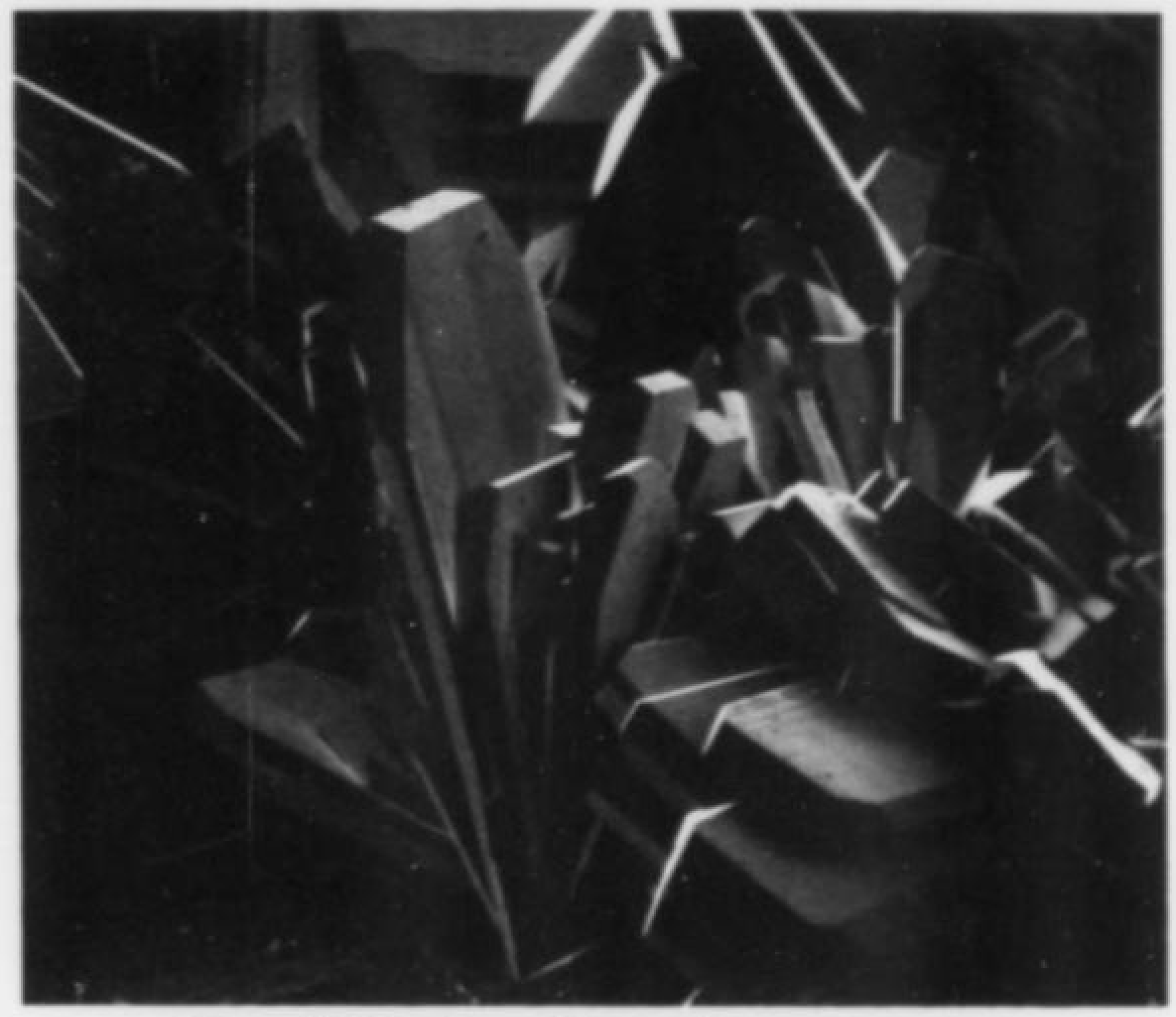


Figure 17. **Hemimorphite – a divergent spray of bladed crystals. The longest is 700 micrometers.**

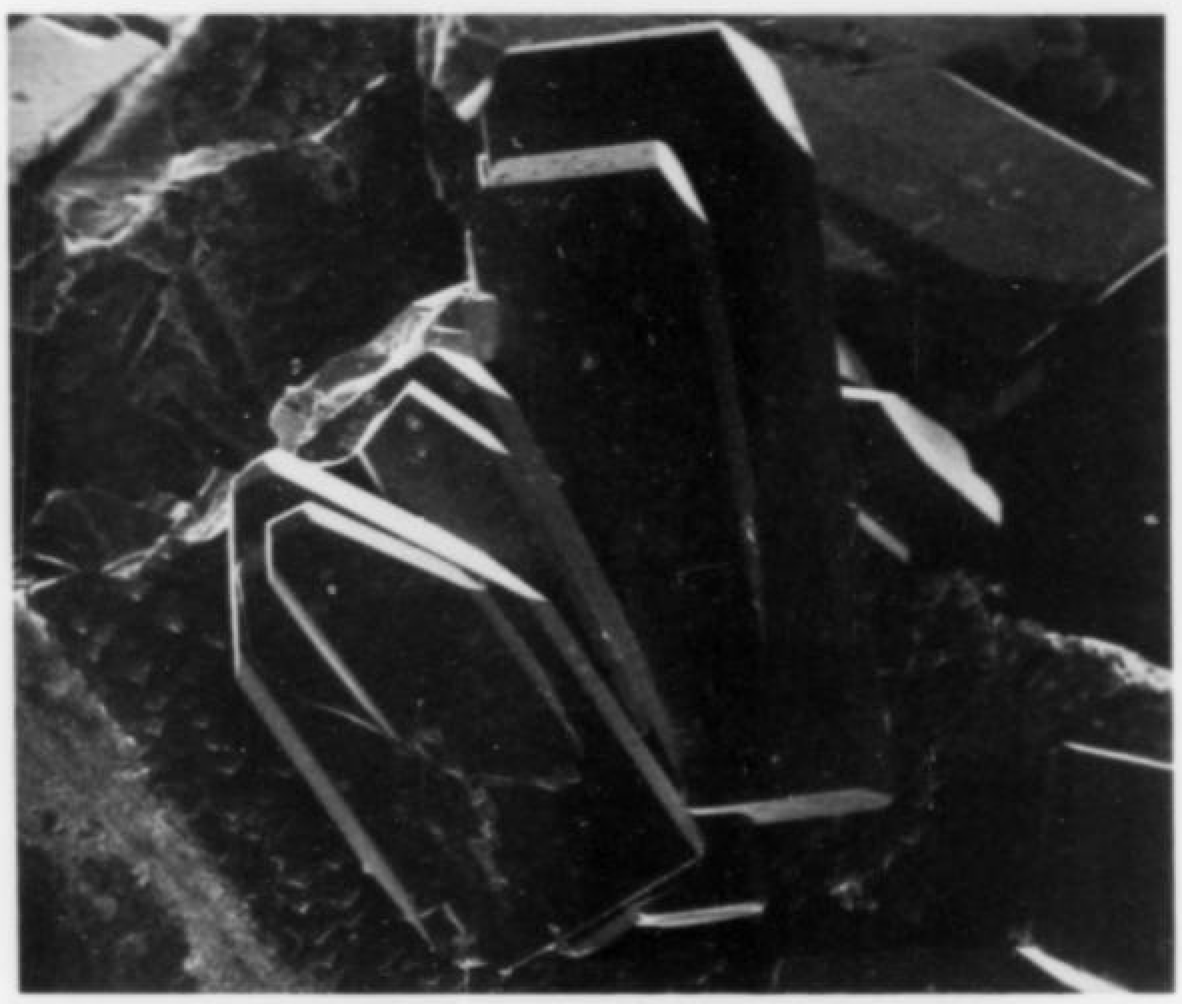


Figure 16. **Hemimorphite – these hemimorphite crystals are notable in that their hemimorphic nature is readily apparent. These colorless crystals are a maximum of 350 micrometers long.**

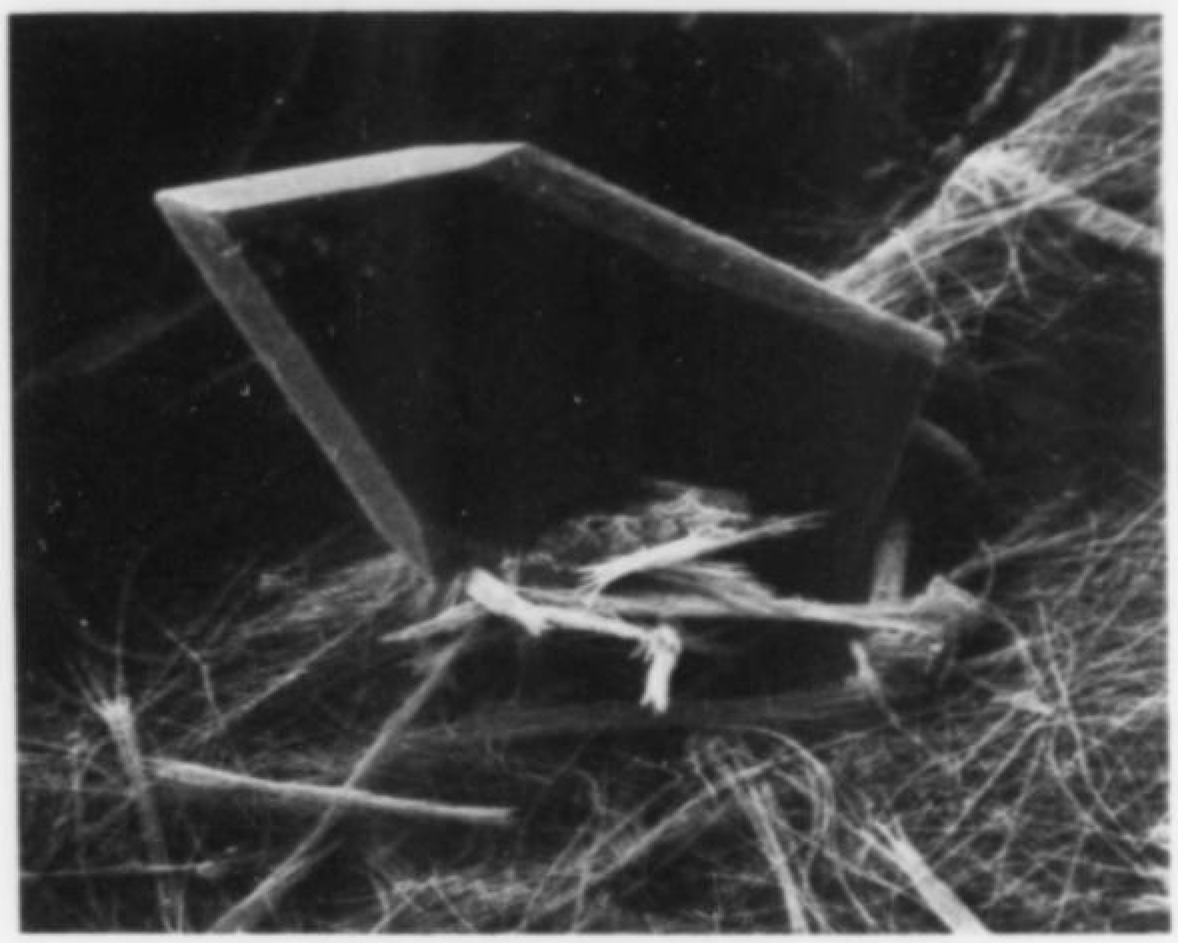


Figure 18. **Hemimorphite – this crystal exhibits the hemimorphic symmetry. The crystal rests in "mountain leather." The exact mineralogical nature of this "mountain leather" has not been determined. The crystal is 15 micrometers long.**

evident (Figs. 16 and 18). Associated species include sphalerite, quartz, chlorite and platy calcite crystals.

Marcasite FeS_2

Marcasite is found in rosettes of pseudo-hexagonal platy crystals. Under high magnification an unknown mineral can be observed partially coating the crystals (Fig. 19). Marcasite is rather uncommon.

Microcline $KAlSi_3O_8$

Microcline occurs in pink, parallel groupings of blocky crystals (Fig. 20). Associated minerals include sphalerite, rutile, brookite, quartz and albite.

Muscovite $KAl_2Si_3O_{10}(OH)_2$

Muscovite occurs as stark, snow-white, exceedingly thin plates coating cavities in dolomite. Associated minerals include rutile, brookite, sphalerite and pyrite.

Pyrite FeS_2

Pyrite is found as golden yellow crystals, frequently tarnished (in particular the pyritohedron face). They may be surficially altered to iron oxides (goethite and/or hematite). Crystal forms noted include the pyritohedron (with sphalerite), cube-pyritohedron, cube, dodecahedron (modified by the octahedron and trapezohedron) and octahedron. Of all the crystal forms noted, only the cube and pyritohedron occur on elongated crystals. Pyrite is almost always alone on dolomite, but may sometimes be found with sphalerite or quartz. Figures 21 through 24 illustrate the diversity of habits.

Quartz SiO_2

Although quartz is one of the most common minerals found on earth, its occurrences at Franklin are limited primarily to the dolomite cavities, where it is quite common. Quartz is rarely found in the orebody. This species provides striking crystals, including some crystals with the rare "s" $(11\bar{2}1)$ faces (Fig. 25) and also beautiful rutilated quartz (Fig. 26). It is not unusual for some of the rutile needles in the quartz to be curved.

Figure 19. **Marcasite – a parallel grouping of tabular plates of dark brown marcasite crystals with an unknown coating. The grouping is 160 micrometers in diameter.**

Figure 21. **Pyrite – octahedron modified by the pyritohedron. The crystal is 500 micrometers across. See inset (Goldschmidt, 1916–23).**

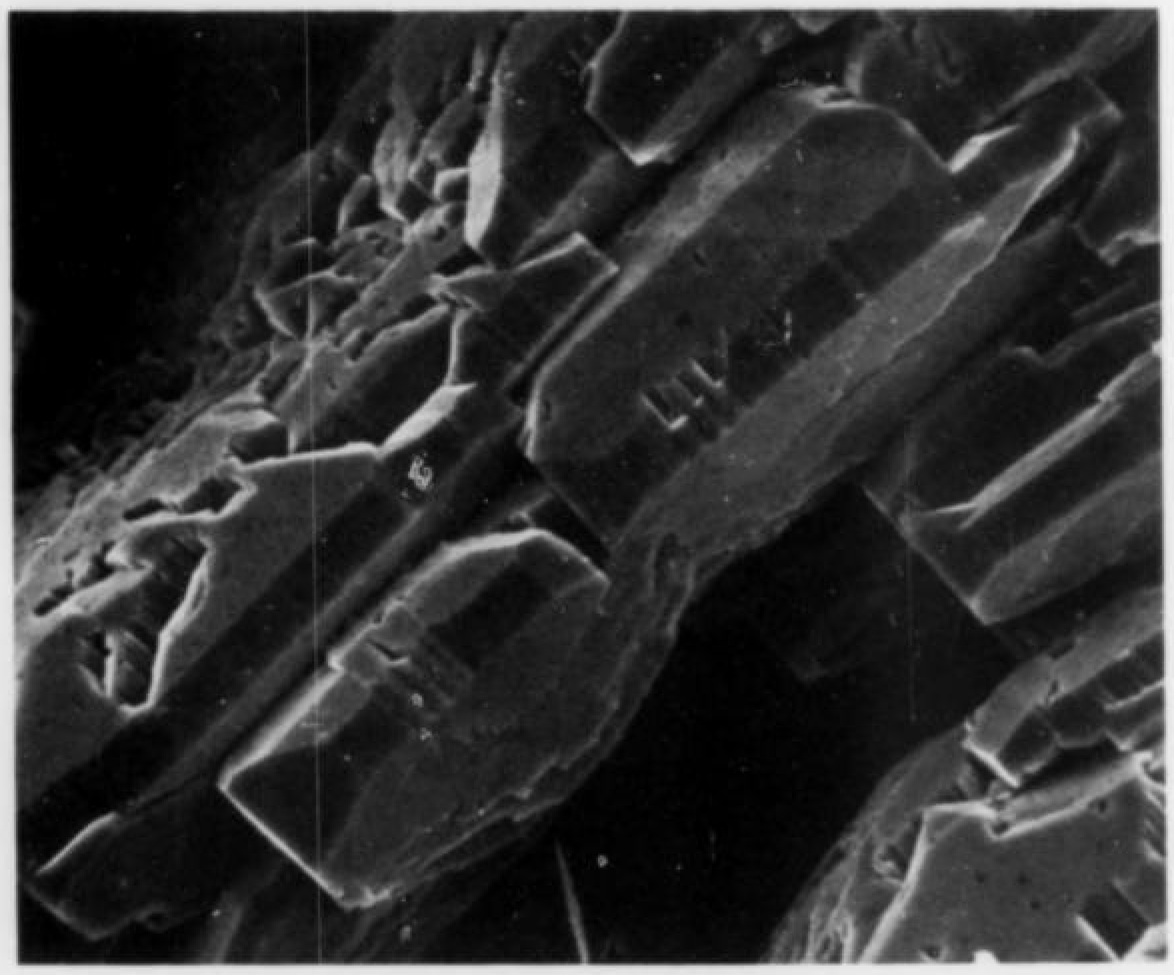


Figure 20. **Microcline – a parallel grouping of microcline crystals. The crystals are pink and are approximately 10 micrometers long.**

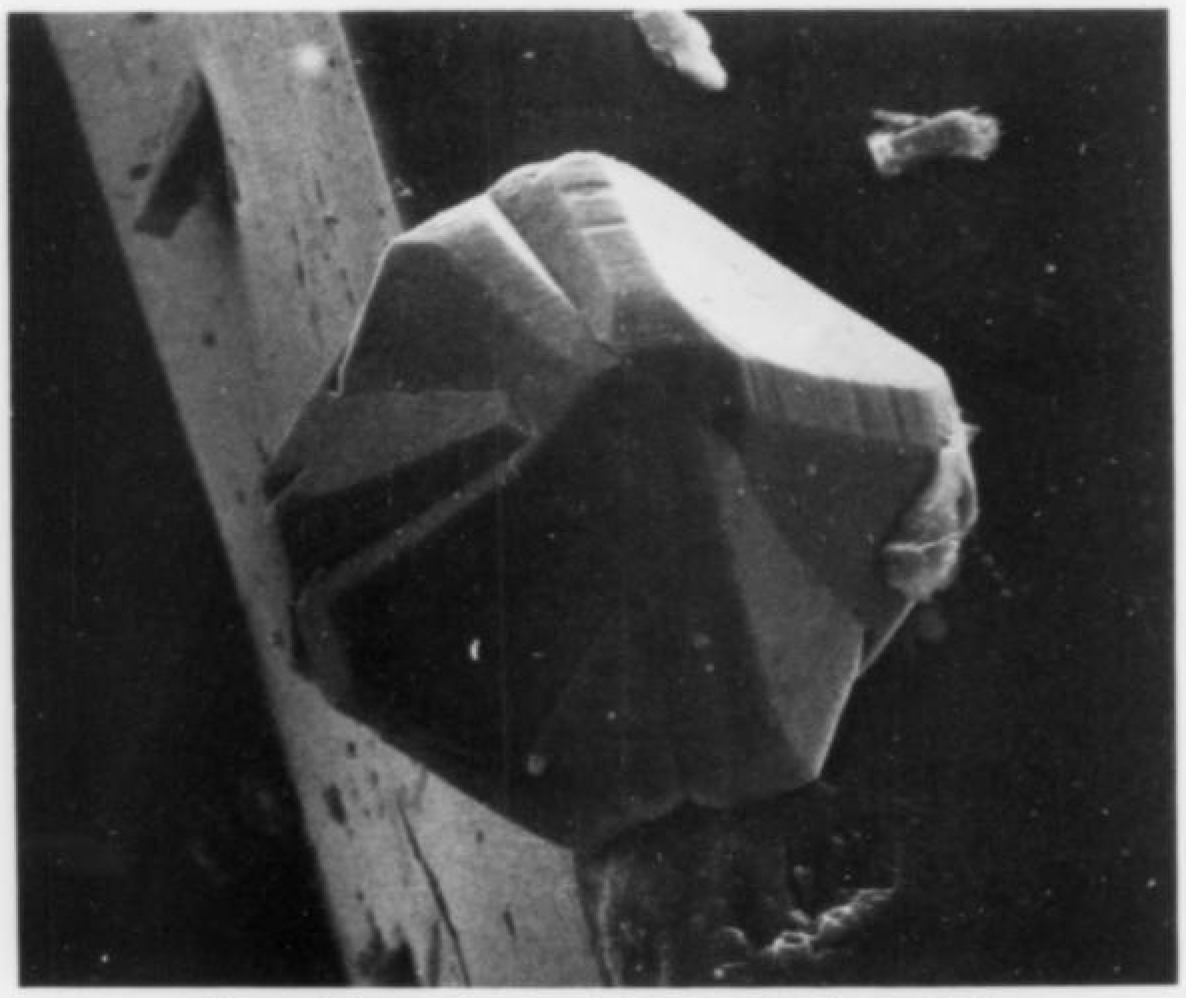


Figure 22. **Pyrite – an intergrowth of two individuals. The crystals are dominantly octahedrons modified by the cube and dodecahedron. Crystals of this type are usually embedded in the edges of dolomite rhombohedrons.**

Rutile TiO_2

All metallic, radiating crystals found in the cavities, whether black, golden brass or bronze in color, have proven to be rutile, based upon X-ray diffraction examination of selected samples. No millerite has been verified from the dolomite cavities despite a careful search. Energy-dispersive analysis of rutile samples reveals, in addition to major titanium, small amounts (less than 1 percent by weight) of chromium. Rutile needles are usually terminated but the terminations are only visible at extremely high magnification (Fig. 28). Specimens containing rutile should always be carefully examined for the presence of its polymorph, brookite. Rutile apparently crystallized quite early in the sequence, as it usually is found not only directly upon but penetrating into the host dolomite. Quartz, smithsonite, brookite, goethite and muscovite are common associates.

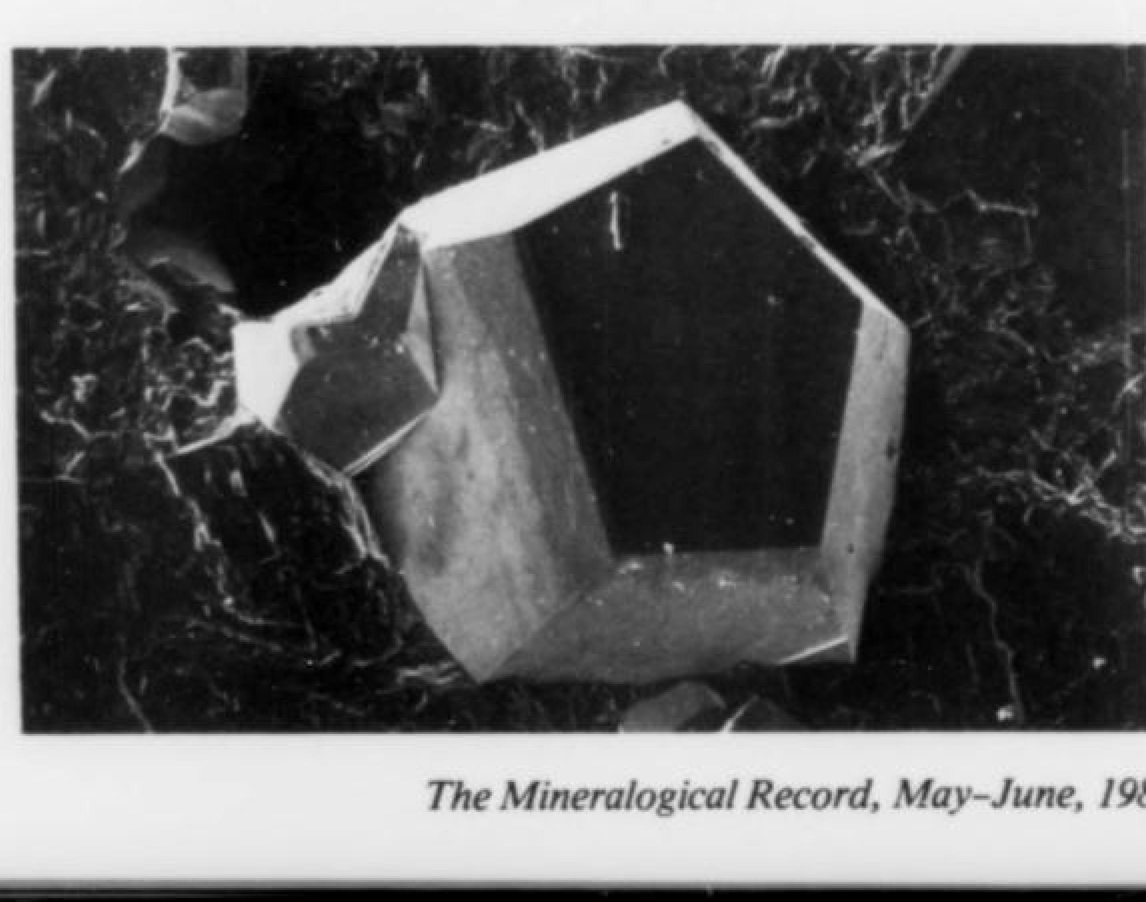


Figure 23. **Pyrite – a pyritohedron. The crystal is 800 micrometers in diameter. See inset (Goldschmidt, 1916–23).**

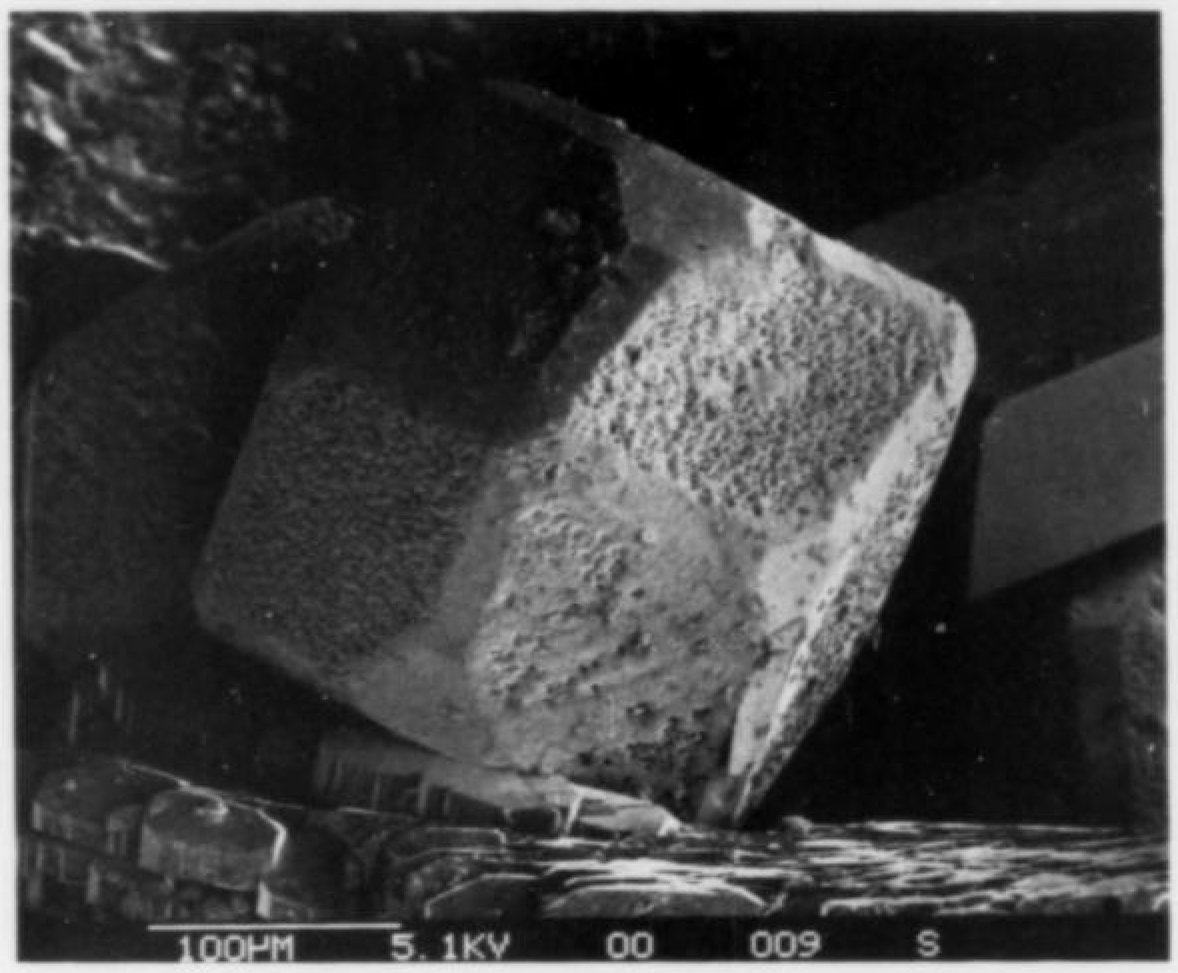


Figure 24. **Pyrite – a rare dominant form for pyrite is the dodecahedron. It shows octahedral and trapezohedral modification. The scale bar is 100 micrometers.**

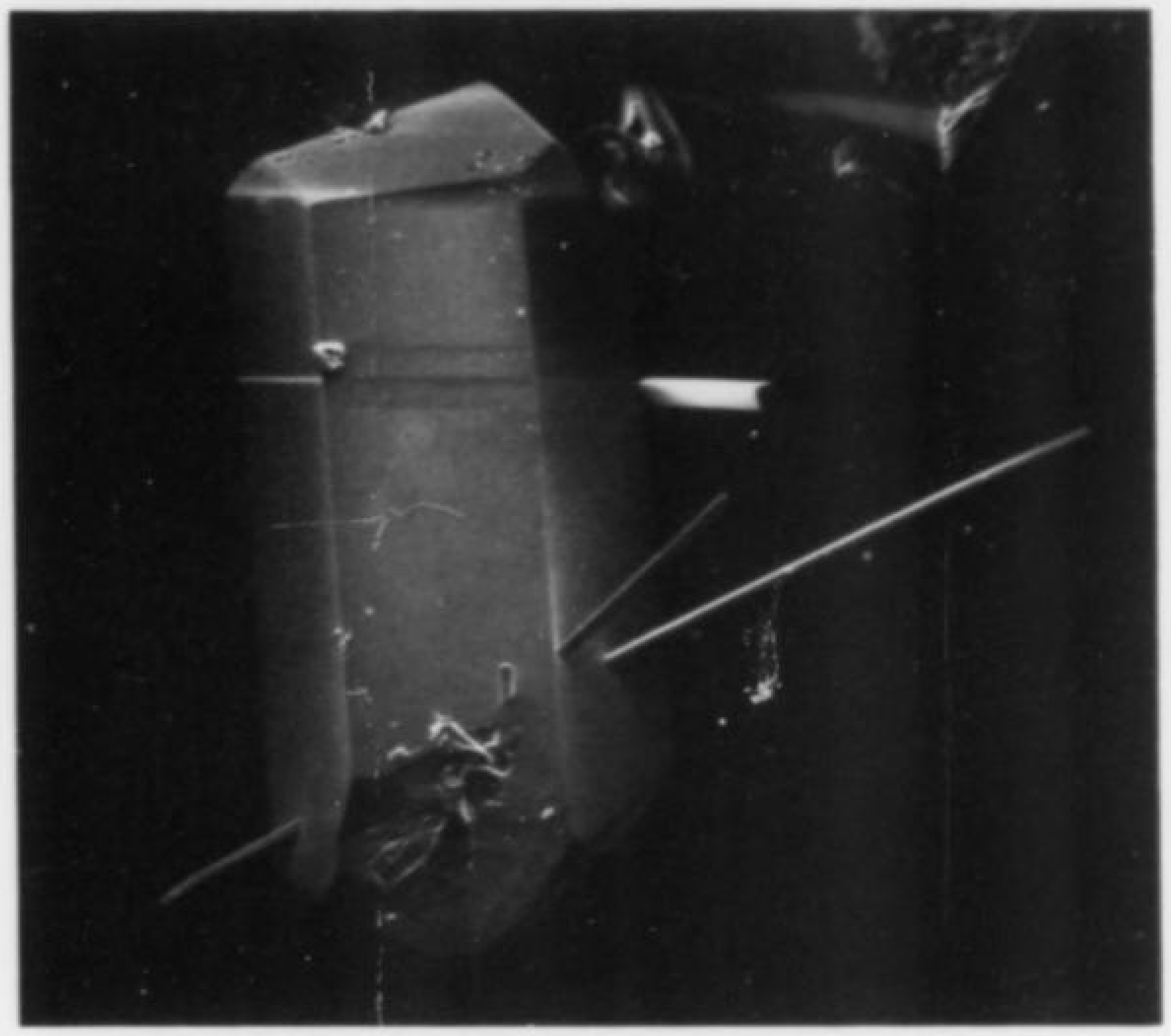


Figure 26. **Quartz – doubly-terminated, prismatic quartz crystal with rutile inclusions (rutilated quartz). The quartz is 370 micrometers long.**

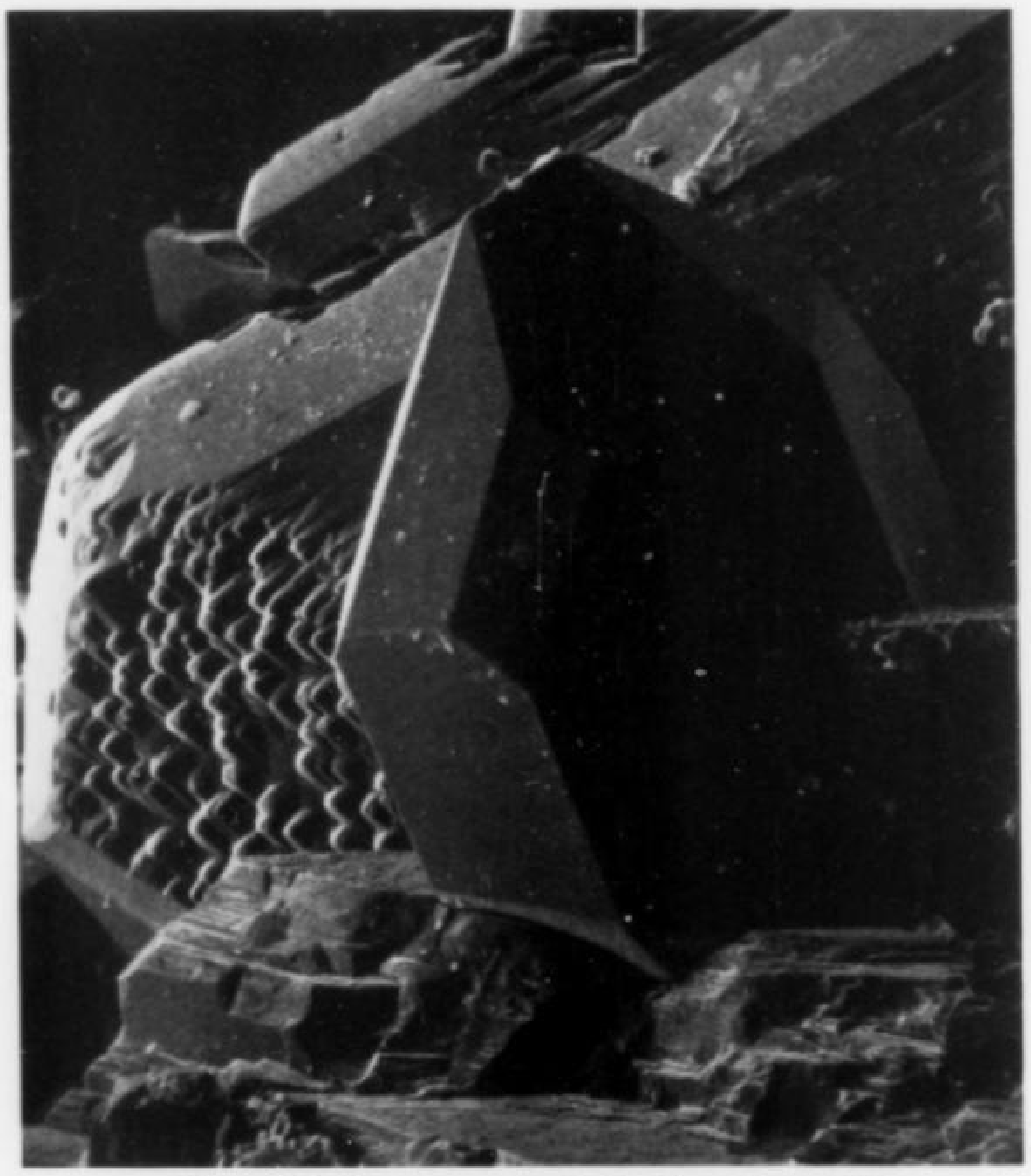


Figure 25. **Quartz – a typical prismatic crystal showing the *s* face (parallelogram) which is typical for specimens found in this dolomite. The quartz is 100 micrometers tall.**

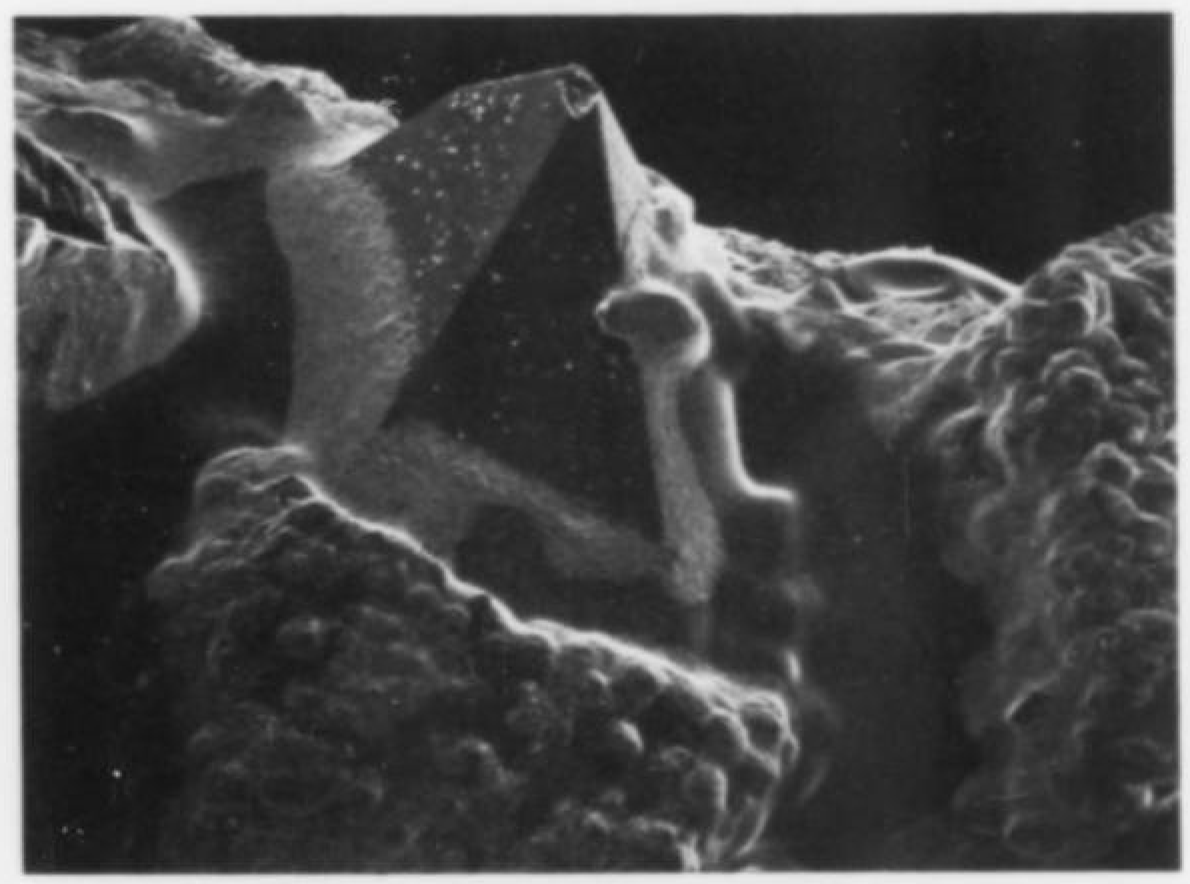


Figure 27. **Smithsonite overgrowth on a quartz crystal. The quartz is approximately 1 mm in diameter.**

Smithsonite $ZnCO_3$

Smithsonite occurs in several different habits: (1) as "caps" or overgrowths on dolomite (Figs. 29 and 30) (the dolomite may break away, revealing a smithsonite mold or cavity after dolomite); (2) as rosettes or hexagonal single crystals growing around rutile needles (Figs. 31 and 32); and (3) as coatings completely covering and par-

Figure 28. **Rutile – a terminated, prismatic black crystal of rutile. The rutile is 140 micrometers long.**

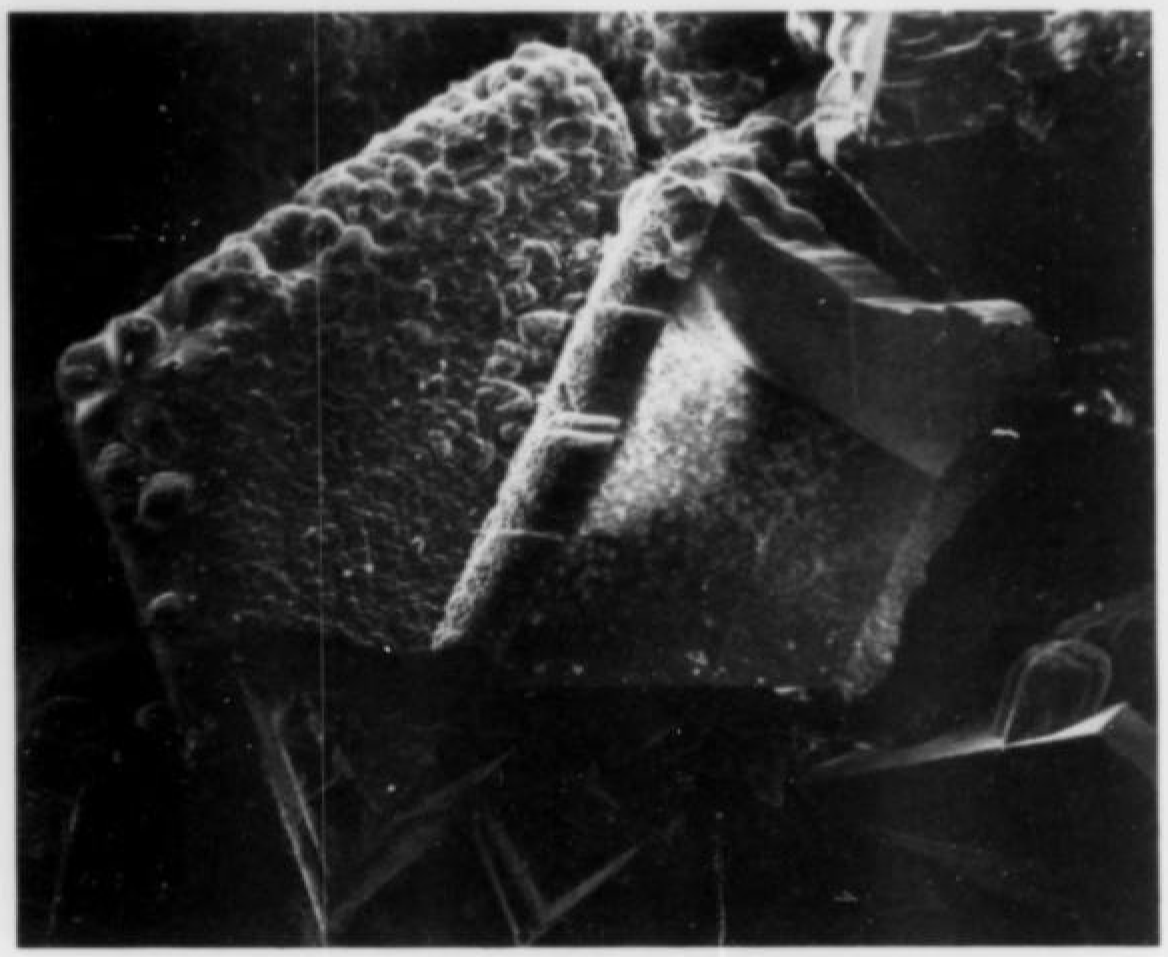


Figure 29. **Smithsonite – smithsonite overgrowths on dolomite rhombohedrons. Illustrated here is a cavity after dolomite which formed when the dolomite core broke away. The smithsonite crystals are colorless and are 1 mm in diameter.**

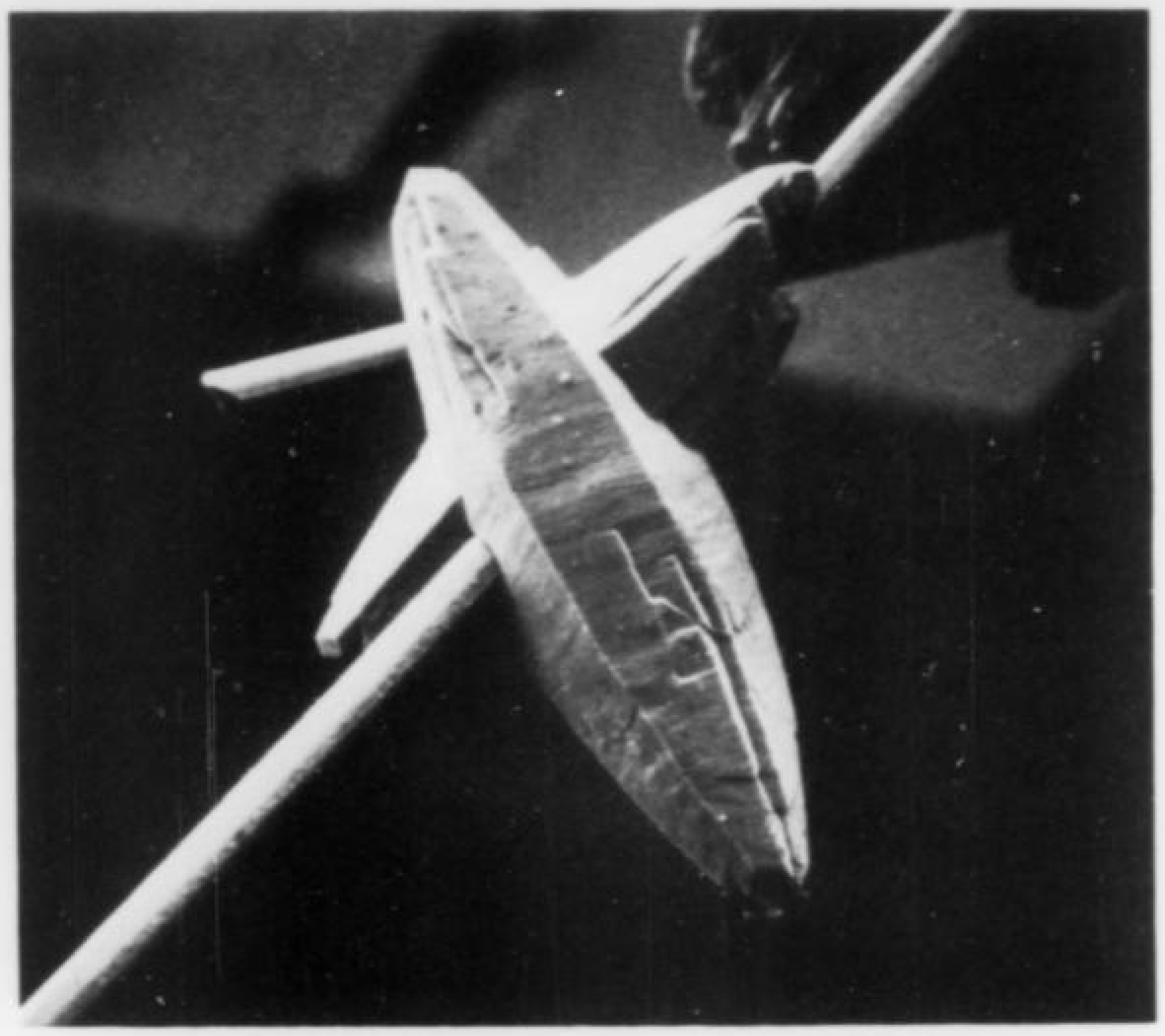


Figure 32. **Smithsonite – a tapering, doubly-terminated crystal of smithsonite growing around a rutile needle. The smithsonite is 100 micrometers long.**

Figure 30. **Smithsonite – a parallel grouping of smithsonite in sheave-like aggregates as overgrowths on dolomite. Each smithsonite aggregate is 600 micrometers long.**

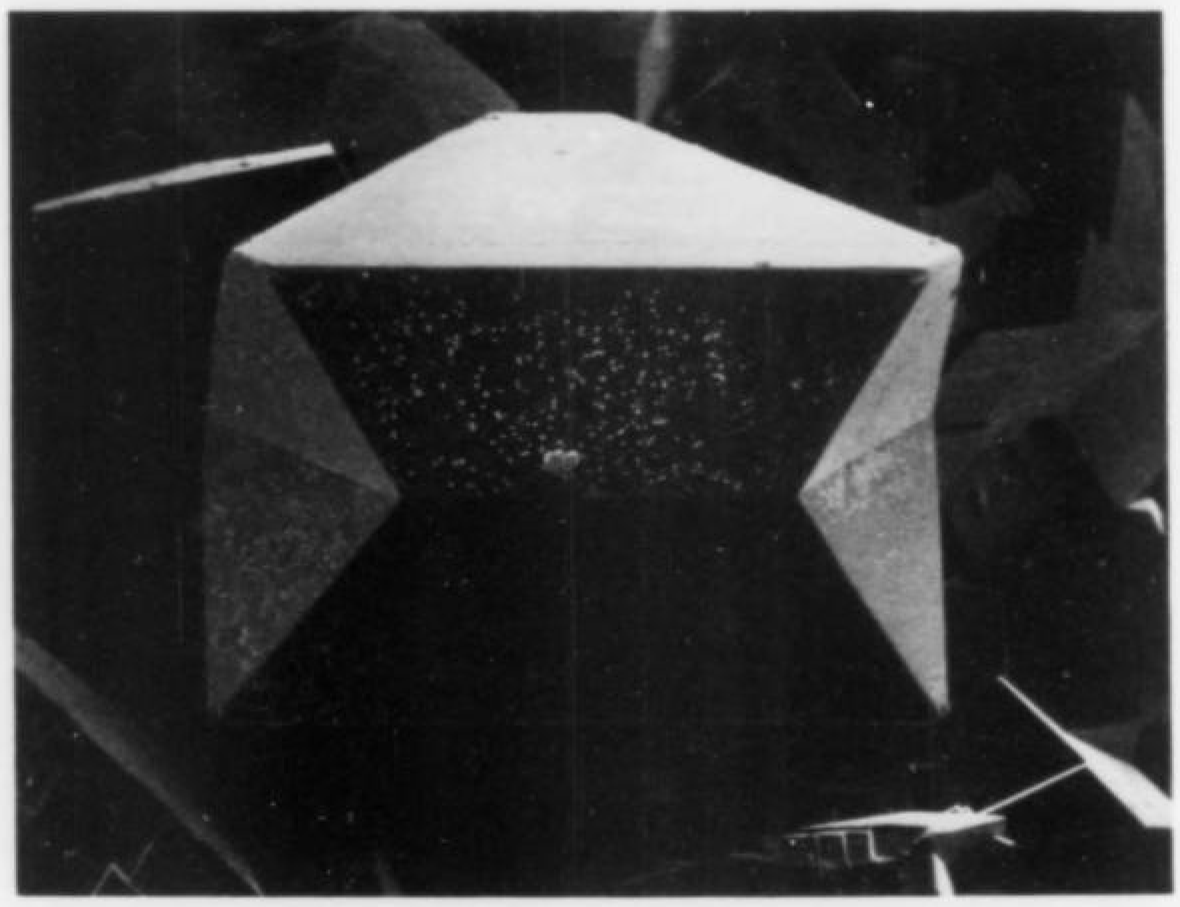


Figure 33. **Sphalerite – a spinel-law twin. The twin is 1.4 mm across.**

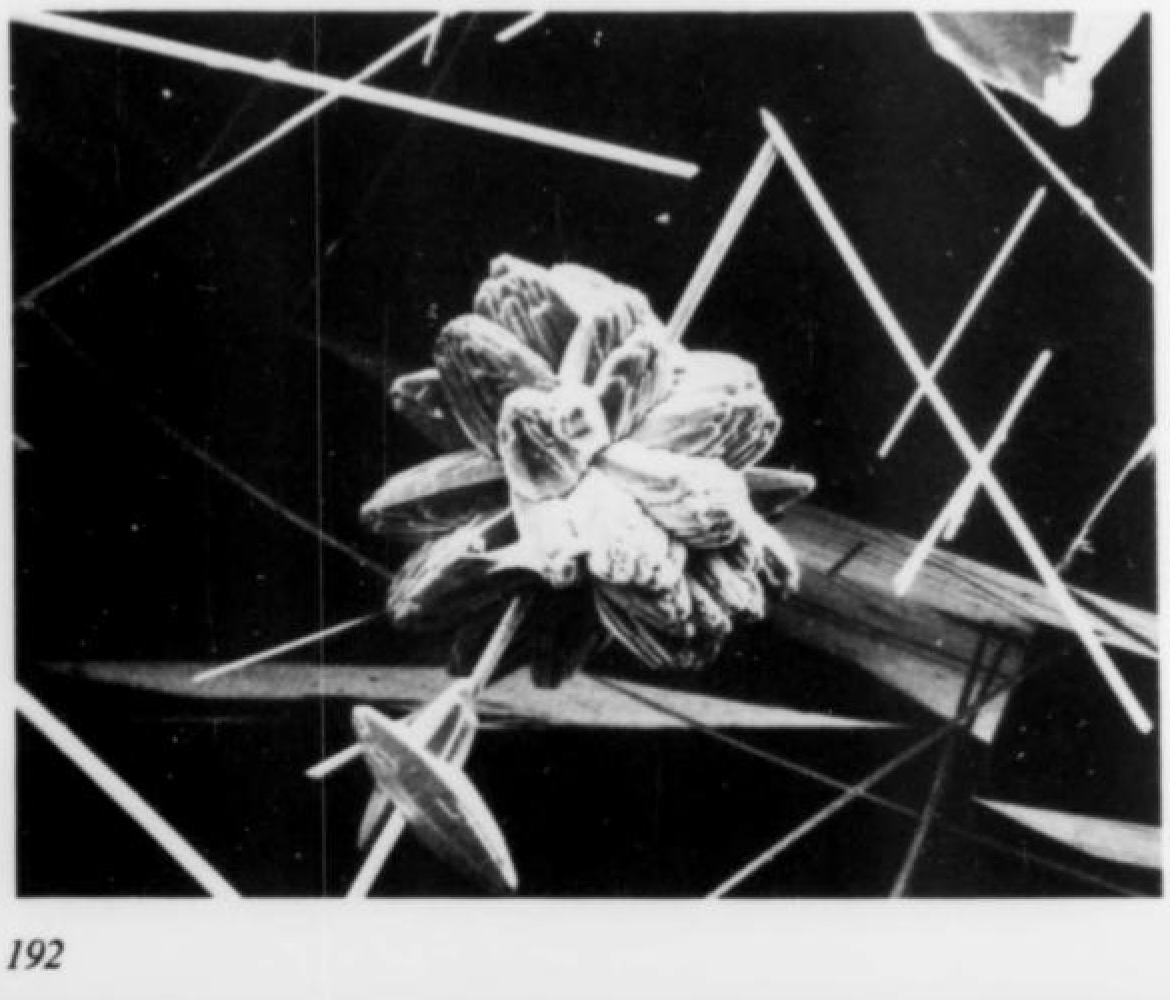


Figure 31. **Smithsonite-rutile – a rosette-like grouping of smithsonite crystals on rutile needles. The rosette is 130 micrometers across.**

tially replacing crystals of sphalerite. This alteration is only a thin veneer, however; broken crystals reveal an unaltered core of sphalerite. Smithsonite is also observed as an overgrowth on quartz (Fig. 27).

Sphalerite ZnS

Sphalerite is considered to be one of the most esthetic species to be found in this occurrence. It is of particular interest mineralogically as well, because it commonly exhibits vivid spinel-law twinning, sometimes in complex groupings. It is found in light to dark brown, orange, reddish orange, oil-green and almost black single or twinned crystals up to 5 mm. Sphalerite has been found as cavernous crystals; others have been collected that are round due to partial dissolution. Associated species are dolomite, quartz, rutile, pyrite, microcline, brookite, calcite and hemimorphite (see Figs. 33 and 34).

Figure 34. **Sphalerite—a complex, multiply twinned fouling of sphalerite crystals, twinned by the spinel law. The largest plate is 2 mm wide.**

COMMENTS

Table 1 presents an attempt to collate all previous lists of Buckwheat dolomite minerals in order to compare and contrast them with the results of this study. It lists all minerals previously listed from the Buckwheat dolomite, and also the authors of each list. We report 18 X-ray verified species as well as an additional 4 identified visually. Of the additional 19 species cited in the literature, we feel that six (barite, celestite, greenockite in massive coatings, gypsum, stilpnomelane and talc) are likely future additions to our list. All of these minerals have been found in other assemblages within the deposits. The remaining 13 minerals seem doubtful for the following reasons: anglesite is unlikely to be found due to the absence of galena; bornite and chalcopyrite are unlikely because of a decided lack of availability of copper; heulandite and stilbite are probably misidentifications of the mineral hemimorphite; orthoclase is likely misidentified microcline; millerite has been diligently searched for and has yet to be verified; siderite seems unlikely due to the fact that the carbonates appear in large quantities as the minerals dolomite and calcite; finally ilmenite, manganite, pyrrhotite and zircon are unlikely on the basis of chemistry and mineralogical environment.

CONCLUSION

Extremely well-crystallized, millimeter-sized minerals are currently available on the Buckwheat dump, located on Evans Road in Franklin, Sussex County, New Jersey. Once the collector is familiar with the Buckwheat dolomite, he can easily collect a sackful of material which can later be taken apart to find exquisite minerals tucked away in hidden cavities. The reader is urged to visit the Franklin-Kiwanis Mineral Museum on Evans Road, where a fee of $1.50 is charged to collect on the dumps. A tour of the museum and its mine replica will be very rewarding. The museum is open to the public on Fridays and Saturdays from 10 a.m. to 4 p.m. and Sundays from 12:30 to 4:30 p.m. Summer hours are Wednesday through Sunday. It closes for the season on November 15th. In addition, a visit to the Gerstmann Franklin Mineral Museum, located at 14 Walsh Road (near Franklin High School), will provide additional mineralogical pleasures.

Table 1. **Minerals occurring in dolomite veins, Franklin, New Jersey.**

Species	*Palache (1935)*	*Gordon (1951)*	*Frondel (1972)*	*Thomas (1967)*	*Kraissl (1979)*	*Present Study*
Albite	X	X	X	X	X	X
Anatase			X			X
Anglesite				X		
"Apatite"		X		X		X
Arsenopyrite					X	X
Aurichalcite					X	X
Barite				X		
Bornite				X		
Brookite			X	X	X	X
"Byssolite"				X		
Calcite	X	X		X		X
Celestite				X		
Chalcopyrite				X	X	
"Chlorite"				X	X	X
Dolomite	X	X	X	X	X	X
Fluorite						X
Goethite	X		X	X	X	X
Graphite			X	X	X	X
Greenockite				X		
Gypsum				X		
Hematite	X		X	X	X	X
Hemimorphite		X		X	X	X
Heulandite			X	X		
Ilmenite				X		
Manganite				X		
Marcasite	X				X	X
Microcline					X	X
Millerite	X	X	X			
Muscovite						X
Orthoclase		X				
Pyrite		X	X	X	X	X
Pyrrhotite				X		
Quartz	X	X		X	X	X
Rutile			X	X	X	X
Siderite				X		
Smithsonite					X	X
Sphalerite	X	X	X	X	X	X
Stilbite			X	X		
Stilpnomelane				X	X	
Talc				X	X	
Zircon			X	X		

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Red Montgomeryite
and associated minerals from the Tip Top Pegmatite with notes on kingsmountite and calcioferrite

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INTRODUCTION

Specimens covered with bright red-orange montgomeryite were recently mined at the Tip Top pegmatite near Custer, South Dakota. The crystals were found in September-October of 1981 and several hundred specimens were recovered.

The X-ray powder diffraction pattern of these red crystals is in excellent agreement with that of montgomeryite, $Ca_4MgAl_4(PO_4)_6(OH)_4 \cdot 12H_2O$. However, in the recent description of kingsmountite, $(Ca,Mn)_4(Fe,Mn)Al_4(PO_4)_6(OH)_4 \cdot 12H_2O$, in which Fe^{+2} and Mn^{+2} replace the Mg of montgomeryite (Dunn *et al.*, 1979), it was suggested that other end-members might be possible. Given the uncommon color of the Tip Top crystals, we decided to examine them carefully to determine if they were a new species or a color variant of montgomeryite. The specimens are not only of interest for the montgomeryite but also for the minerals associated with it. One of the authors (TJC) is presently studying the mineralogy of the Tip Top pegmatite in detail.

CHEMISTRY

Montgomeryite from the Tip Top pegmatite was chemically analyzed using an ARL-SEMQ electron microprobe utilizing an operating voltage of 15 kV and a beam current of 0.15 μA. The data were corrected using standard Bence-Albee factors. The standards used were montgomeryite (for Ca, Mg, P, Al) and manganite (for Mn). The analysis yielded: CaO:19.1, MnO:0.5, MgO:3.5, Al_2O_3:17.1, P_2O_5:36.6, with H_2O:23.2 percent by difference. Calculation of the formula, on the basis of six phosphorus atoms, and the known composition of montgomeryite-group minerals, yields: $(Ca_{3.97}Mn_{0.08})_{\Sigma 4.05}Mg_{1.01}Al_{3.89}(PO_4)_{6.00}(OH)_{4.06} \cdot 12.94H_2O$, in good agreement with the idealized formula for montgomeryite, $Ca_4MgAl_4(PO_4)_6(OH)_4 \cdot 12H_2O$. We calculate all Mn as Mn^{+2} here, but note with interest that this sample has an apparent deficiency of aluminum and an excess of divalent cations. It is tempting to hypothesize that the manganese is present as Mn^{+3} in substitution for aluminum, especially in view of the red color of this montgomeryite, so common in minerals with Mn^{+3}. Although we cannot offer conclusive proof that the manganese is present as Mn^{+3}, (especially considering the Jahn-Teller effects of Mn^{+3}, and our estimated error for microprobe determinations), we consider it quite likely that, based on the color, this red montgomeryite does have some small amount of Mn^{+3} inasmuch as kingsmountite has appreciable Mn^{+2} and is uncolored. The very intimate association of robertsite (containing approximately 3.6 percent Al_2O_3), which is coeval, suggests that there was abundant Mn^{+3} in the geochemical environment at the time of formation.

OPTICAL DATA

Optically, the Tip Top montgomeryite crystals are biaxial (−) with indices of refraction $\alpha = 1.572$, $\beta = 1.579$, $\gamma = 1.582$ (all ± 0.001), measured in Na light, using a spindle stage. They have 2V = 75°, $r < v$, strong, with orientation $X \wedge c \cong +60°$, $Z = b$. The crystals are pleochroic with X = light orange-brown, Y = very pale magenta-pink, Z = very pale orange-brown. The crystals show color zoning and strong zonal extinction. The indices of refraction and orientation of this montgomeryite are very close to those of the original montgomeryite as given by Larsen (1940).

OCCURRENCE

Red montgomeryite occurs in a newly excavated portion of the Tip Top pegmatite. The new workings cut into the outer-intermediate zone which consists of giant crystals of perthite and triphylite, large masses of quartz, minor muscovite, beryl, albite, fluorapatite and columbite-tantalite. This portion of the pegmatite

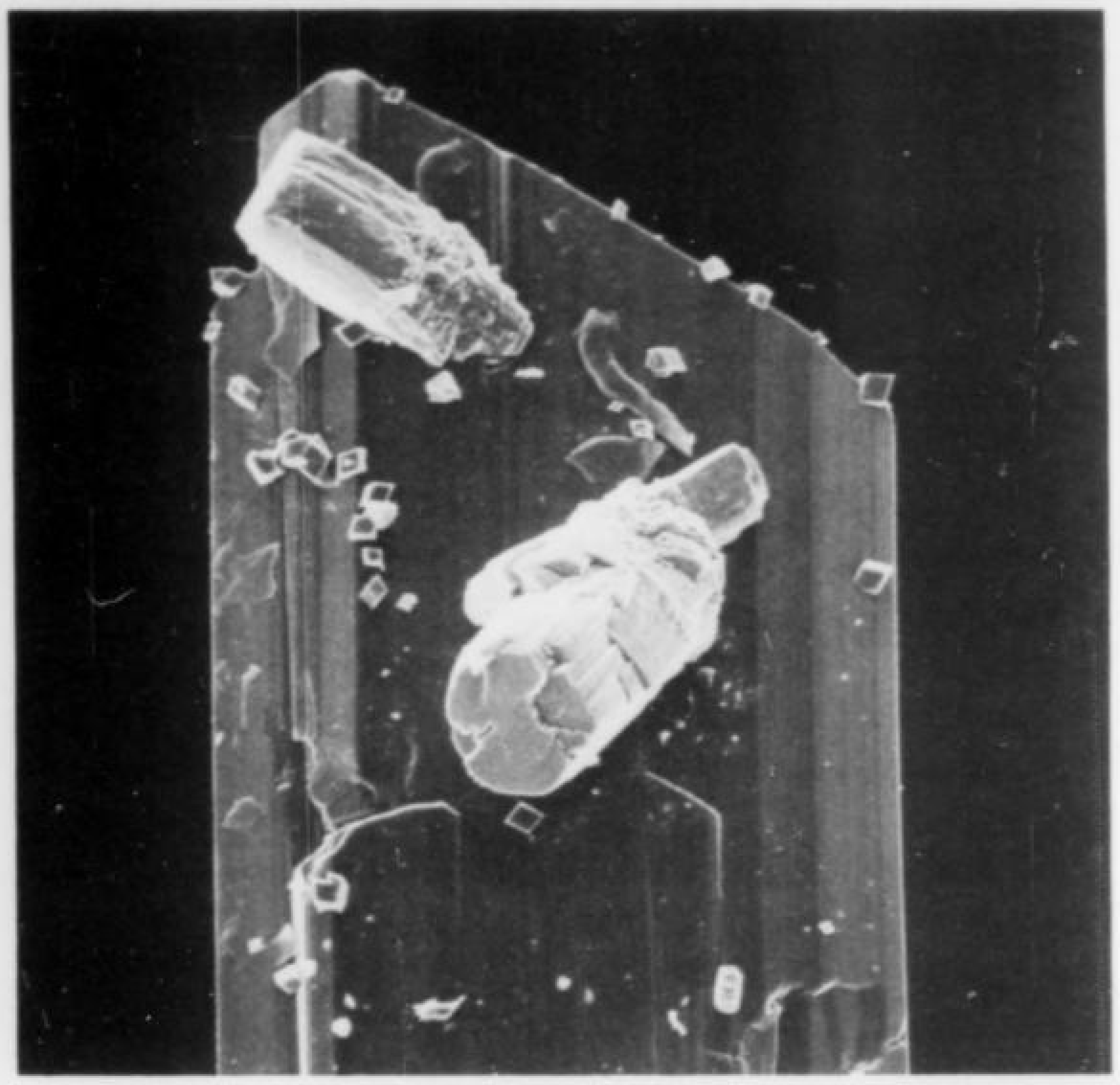


Figure 1. **Prismatic crystal of montgomeryite with two small robertsite crystals from the Tip Top pegmatite, South Dakota. Width of the montgomeryite crystal is approximately 0.6 mm.**

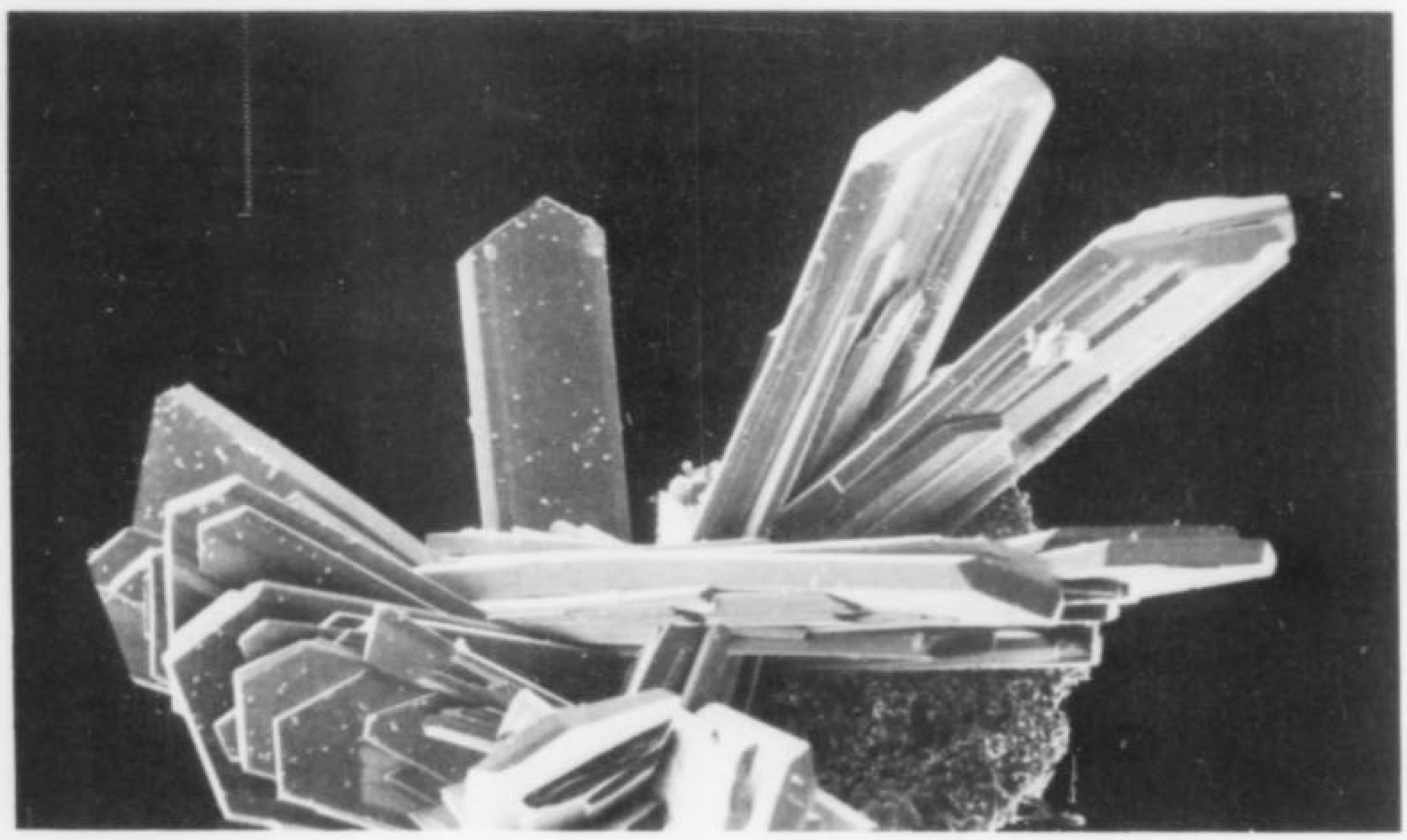
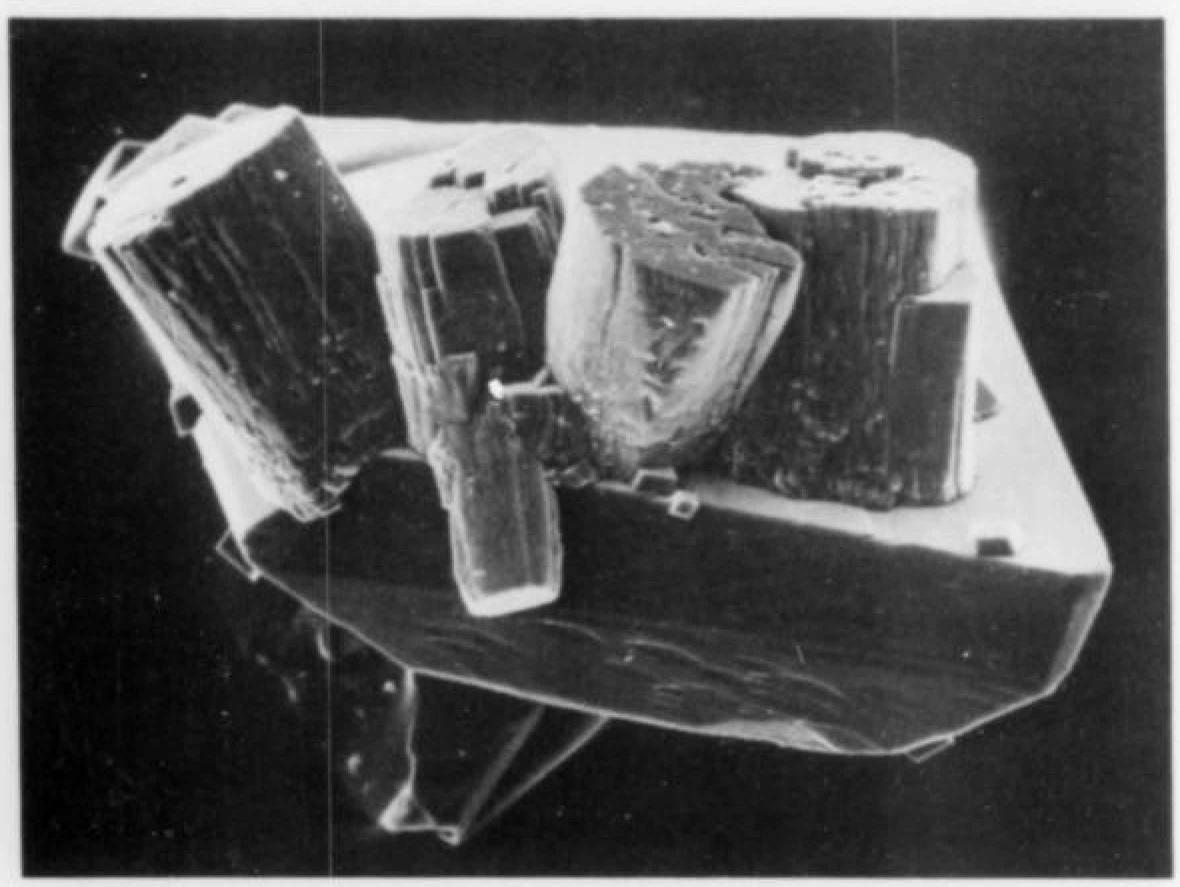


Figure 2. **Cluster of red montgomeryite crystals from the Tip Top pegmatite, South Dakota. The crystals are approximately 1 mm in length.**

Figure 3. **Barrel-shaped robertsite crystals on montgomeryite from the Tip Top pegmatite, South Dakota. The montgomeryite crystal is approximately 0.3 mm across.**



is dissected by numerous large and small-scale fractures, which are probably tectonic in origin. These fractures served as conduits for very large stage hydrothermal fluids and low-temperature groundwater solutions. The fractures are commonly lined with montgomeryite, whitlockite, robertsite, englishite, fairfieldite, carbonate-apatite, mitridatite and other phases. These minerals are found primarily along fracture surfaces in perthite, quartz, beryl, albite and, in some cases, triphylite.

PARAGENESIS

The red montgomeryite occurs as bladed crystals indistinguishable in habit from those found near Fairfield, Utah, except that the Tip Top crystals are markedly elongate, parallel to *c*. Montgomeryite commonly occurs as bright red-orange to pink radial clusters and divergent fascicles up to 6 mm in diameter and occasionally as single crystals to 3 mm. Crystals are commonly zoned and on a few specimens the montgomeryite is bright red at the base and gradually grades to pink, yellow, green-yellow or colorless near the termination. The bright red-orange color is in sharp contrast to the light green of the montgomeryite from Fairfield, Utah, which provided material for the structure determination of Moore and Araki (1974). Clusters of bright red montgomeryite on white quartz or albite are striking in appearance.

Numerous specimens were examined by the authors and the various associations were noted. Whitlockite, $Ca_9(Mg,Fe)H(PO_4)_7$, which occurs as water-clear, colorless to lavender, rhombic crystals, formed before, during and after montgomeryite. In some cases, montgomeryite is completely covered by a druse of water-clear whitlockite, and is also commonly implanted directly on perthite, quartz, albite or triphylite. It is sometimes found on olive-green crusts of mitridatite, $Ca_3Fe_4^{+3}(PO_4)_4(OH)_6 \cdot 3H_2O$, or white to colorless, compact radial aggregates of carbonate-apatite. It appears that montgomeryite formed at the same time as deep red, prismatic, occasionally twinned crystals of robertsite which are delicately sprinkled on montgomeryite and whitlockite. One specimen shows robertsite totally encrusting montgomeryite crystals. SEM photomicrographs of montgomeryite, robertsite and whitlockite are shown in Figures 1, 2, 3 and 4.

Other minerals which are definitely younger than montgomeryite include fairfieldite, $Ca_2(Mn,Fe^{+2})(PO_4)_2 \cdot 2H_2O$, and englishite. Fairfieldite occurs as individual white plates and lamellar aggregates to 5mm, typically perched on montgomeryite clusters. Some of the fairfieldite has been altered to an undetermined brown pseudomorph. Englishite was identified by X-ray powder diffraction examination of white pearly spherules and hemispherules associated with most of the above-mentioned minerals. Englishite was formerly known only from the phosphate deposit near Fairfield, Utah, so this represents the second occurrence of the species, and the first pegmatite occurrence. The color, luster and texture of this englishite are very similar to that of some uralolite and, hence, englishite may have occurred previously in a pegmatite environment but been overlooked.

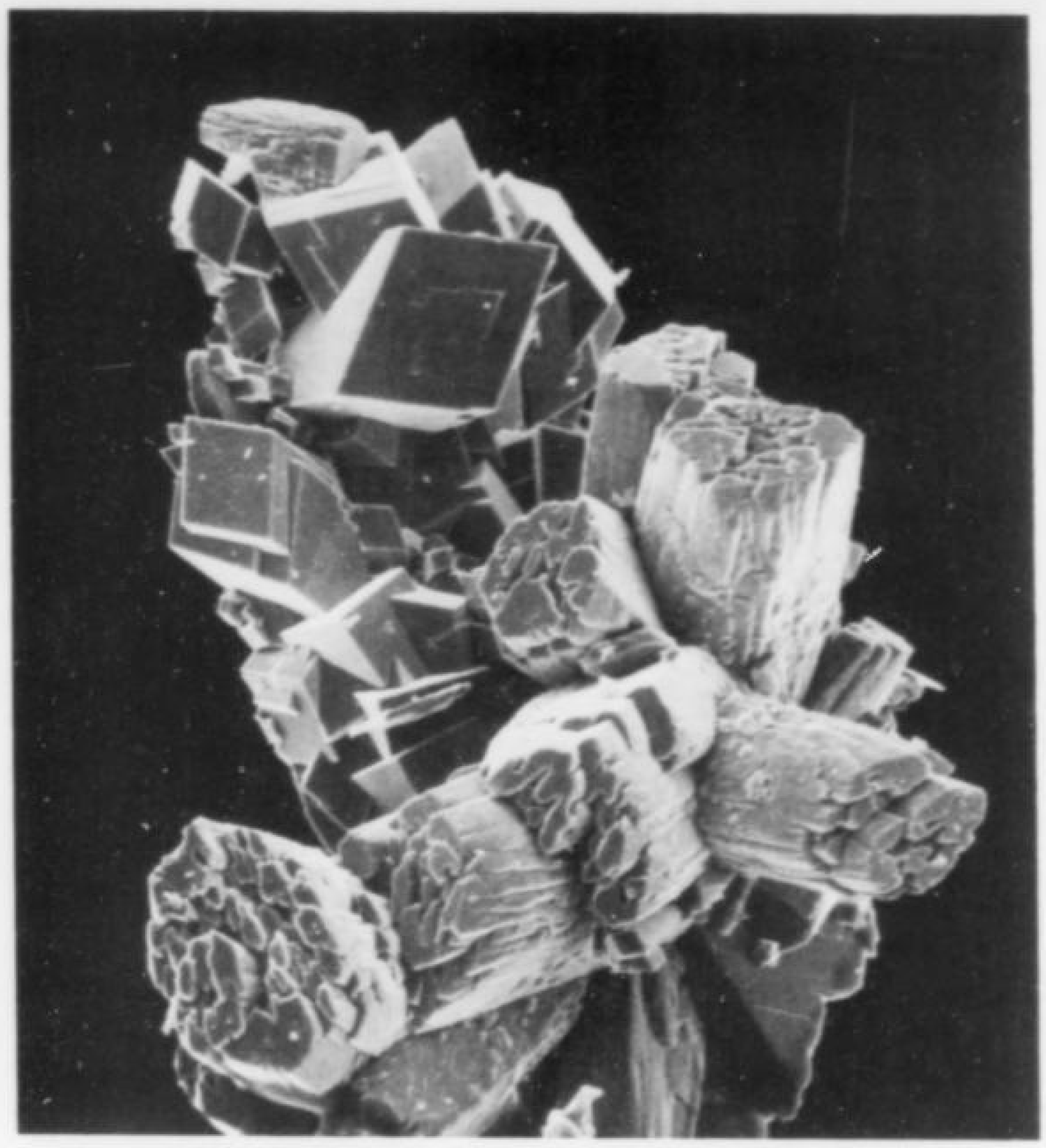


Figure 4. **Rhombohedral whitlockite and barrel-shaped robertsite crystals from the Tip Top pegmatite. The crystals measure approximately 0.1 mm.**

CALCIOFERRITE

As part of this study, we noted that the X-ray powder diffraction pattern of calcioferrite is very similar to those of montgomeryite and kingsmountite, which suggests that calcioferrite might be the Fe^{+3} analog of montgomeryite. If the chemical analysis of calcioferrite (given in Palache *et al.*, 1951) is recalculated on the basis of six phosphorus atoms, it yields:

$$(Ca_{3.31}Fe_{0.36})_{\Sigma 3.67}(Mg_{0.83}Fe_{0.17})_{\Sigma 1.00}$$
$$(Fe^{+3}_{3.29}Al_{0.71})_{\Sigma 4.00}(PO_4)_{6.00}(OH)_{3.34}\cdot 12.61H_2O.$$

This is in good agreement with the theoretical composition of the Fe^{+3} analog of montgomeryite, ideally $Ca_4MgFe^{+3}_4(PO_4)_6(OH)_4\cdot 12H_2O$. Although we have not re-examined type material, we offer this interpretation of calcioferrite as an interim formula.

HAGENDORF KINGSMOUNTITE?

Recently, Mücke (1981) and Mücke *et al.* (1981) discussed the occurrence of a kingsmountite-like material from the Hagendorf pegmatite, near Waidhaus, Bayern, Germany. The phase which they described was observed by one of the authors (PJD) several years ago, during the characterization of parascholzite (Sturman *et al.*, 1981), but not described. It is younger than the parascholzite/scholzite crystals which it encrusts. Preliminary analytical data indicate that it is possibly a highly ferrian kingsmountite or perhaps a new end-member in the montgomeryite group. Calculation of cations, based on six phosphorus atoms, yields: $Ca_{3.68}(Mn^{+2}_{0.56}Mg_{0.21}Fe^{+2}_{0.15})_{\Sigma 0.92}(Fe^{+3}_{2.11}Al_{1.89})_{\Sigma 4.00}P_{6.00}$. However, solid solution among Ca/Mn/Fe/Mg/Al/Fe^{+3} is extensive and the above partitioning of Fe^{+2}:Fe^{+3} is rather arbitrary. We can offer no rigorous formula for this Hagendorf material, but note that it is probably either a highly ferrian kingsmountite, or a new member of the montgomeryite group with the end-member formula $Ca_4MnFe^{+3}_4(PO_4)_6(OH)_4\cdot 12H_2O$. The closeness of the Al:Fe ratio, combined with the error inherent in the microprobe analyses of highly hydrated phosphates, suggest that these crystals from Hagendorf will remain of ambiguous nomenclature.

Subsequent to the original description, montgomeryite was described from the Etta pegmatite in Keystone, South Dakota by Moore (1964). The two additional occurrences noted here (montgomeryite from Tip Top and a montgomeryite-group mineral from Hagendorf) suggest that it might be a more common mineral in pegmatites than was previously recognized.

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The authors thank Charles Key and Vernon Stratton for some of the specimens used in this study. Thanks are also extended to Dan Carda, Amos Lingard and Briant Davis for their advice. We are particularly grateful for a critical reading by Richard Erd.

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Pyrobelonite

from Franklin, New Jersey

by **Pete J. Dunn**
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INTRODUCTION

In his monograph on the minerals of Franklin and Sterling Hill, Palache (1935) described two occurrences of descloizite, one from each deposit. The material from the Franklin despoit was restudied because of its intense red color and uncommon morphology. It was called to the author's attention by Alice Kraissl of River Edge, New Jersey, who generously provided material for study. This material was found to be pyrobelonite, thus providing a third occurrence of that species.

Pyrobelonite is a well-characterized mineral. It was originally described from Långban, Varmland, Sweden, by Flink (1919) and its crystallography was subsequently investigated by Strunz (1939) and Richmond (1940). The morphology of Swedish pyrobelonite was described by Bachmann (1953) and the crystal structure was published by Donaldson and Barnes (1955). X-ray data for

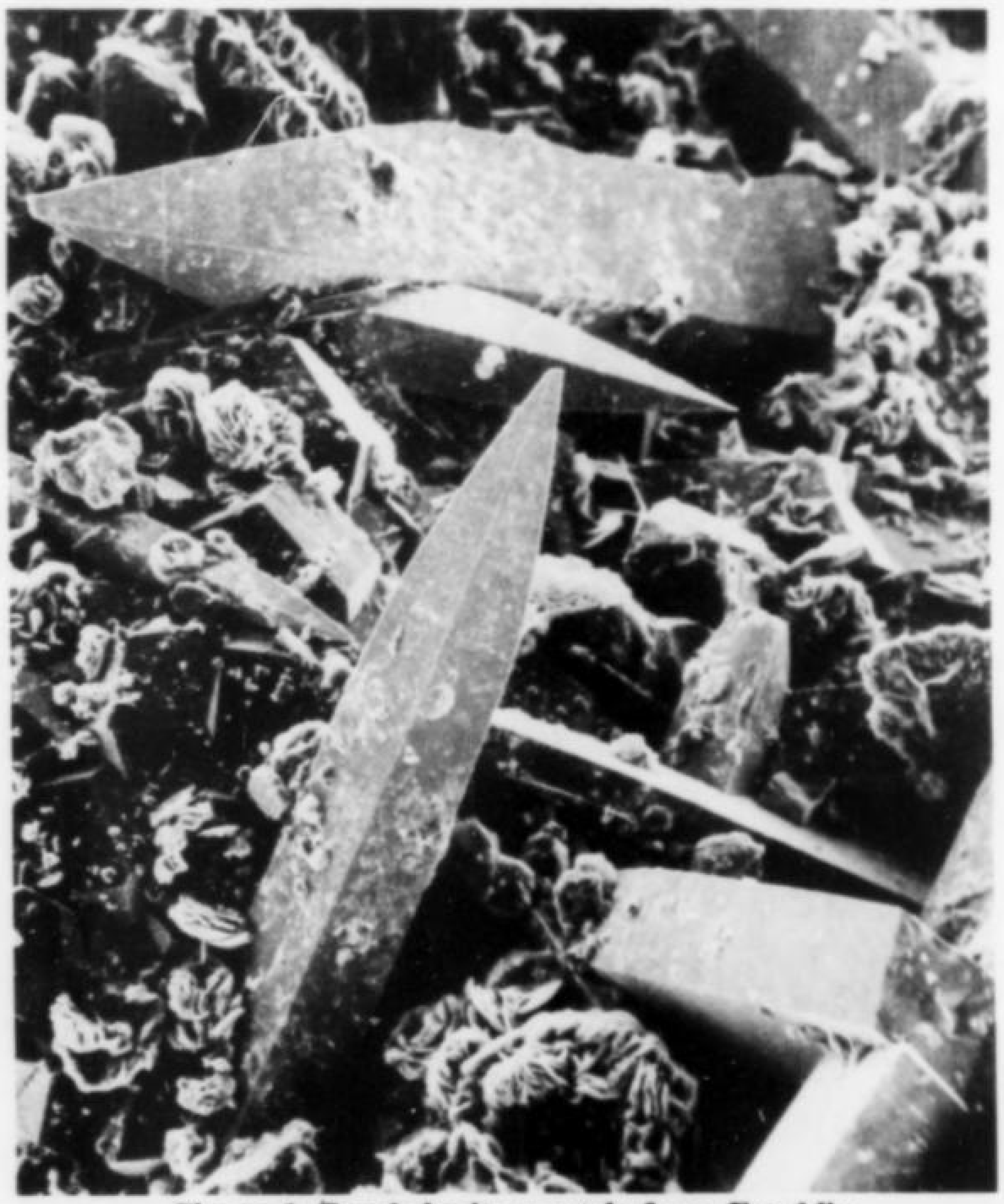

Figure 1. **Pyrobelonite crystals from Franklin, New Jersey. Alice Kraissl Collection. Length of longest crystal is approximately 300 microns.**

Långban pyrobelonite were given by Moore (1968), Welin (1969), and Barnes and Ahmed (1969). A second occurrence of pyrobelonite from Tŷ Coch, Glamorgan, Wales, was noted by Criddle and Symes (1977) who also provided much optical data. The Franklin occurrence is especially noteworthy in that the paragenesis is markedly different from those previously reported.

DESCRIPTION

Franklin pyrobelonite is bright red, very similar in hue to microcrystals of proustite, but lacking a semimetallic luster. The crystals are well-formed, prismatic in habit, and appear to taper to a dipyramid; but the tapering is gradual, giving the crystals a pointed appearance (Fig. 1). The habit of this Franklin pyrobelonite is quite unlike that of Långban material (Flink, 1919), a crystal drawing of which is conveniently reproduced in the *System of Mineralogy*, seventh edition, volume 2, p. 815. Franklin pyrobelonite was verified using X-ray powder diffraction techniques; the data are in excellent agreement with those published by Moore (1968) for Långban pyrobelonite.

CHEMISTRY

Franklin pyrobelonite was chemically analyzed using an ARL-SEMQ electron microprobe utilizing an operating voltage of 15kV and a sample current (measured on brass) of 0.025 μA. A wavelength-dispersive microprobe scan indicated the absence of any elements with atomic number greater than 9, except those reported here. The standards used were synthetic V_2O_3 (for V), hornblende (Si, Fe, Ca), manganite (Mn), synthetic ZnO (Zn), and PbO (Pb). The data were corrected using a modified version of the *MAGIC-4* program of the Geophysical Laboratory. The resultant analysis is approximately 1 weight percent low, presumably because it was performed on an unpolished crystal. The analysis yielded: CaO: 0.3, FeO: 0.3, ZnO: 0.4, MnO: 18.7, PbO: 54.3, SiO_2: 2.2, V_2O_5: 20.3 weight percent, with water from theory = 2.3 weight percent, sum = 98.8 percent. Calculation of the formula, on the basis of three cations, yields:

$$(Pb_{0.93}Zn_{0.02}Ca_{0.02}Fe_{0.02}Mn_{0.01})_{\Sigma 1.00}$$
$$Mn_{1.00}[(VO_4)_{0.86}(SiO_4)_{0.14}]_{\Sigma 1.00}(OH)_{0.86},$$

in close agreement with the theoretical composition of pyrobelonite, $PbMn(VO_4)(OH)$.

OCCURRENCE

Franklin pyrobelonite occurs with an assemblage described by Palache (1935, page 110, last paragraph) as noteworthy for its unique and well-formed hodgkinsonite crystals. Palache mentions that it was found in 1927 as a vein assemblage. The paragenesis consists of willemite-franklinite ore (notable for the absence of calcite) which is encrusted with a druse of light brown garnet. Euhedral tephroite crystals, together with clinochlore and willemite prisms, appear to have grown simultaneously with the garnet, which persisted and partly coated both tephroite and willemite. Pyrobelonite crystals (Fig. 1) were next formed and are distributed randomly on the matrix, except for a tendency for preferential growth upon the terminal faces of tephroite crystals. Hodgkinsonite formed subsequent to pyrobelonite and overlies pyrobelonite. These hodgkinsonite crystals, illustrated by Palache (1935, Fig. 172a and 172b), are markedly different from common hodgkinsonite crystals (Dunn and Bostwick, 1982). Barite is the final phase formed, partly coating younger phases with white subtranslucent crystals of pseudo-cuboctahedral habit.

ACKNOWLEDGMENTS

The author appreciates the insight and impetus given to this problem by Alice Kraissl. The project was funded, in part, by a grant from Mrs. E. Hadley Stuart, Jr. I thank the Franklin Mineral Museum for continued assistance.

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Letters

GOLD BUGS

Dear readers,

Normally we try not to get carried away publishing complimentary letters. However, the recent Gold Issue spurred an avalanche of fan mail the like of which we haven't seen since the Tsumeb Issue was published in 1977. Such enthusiasm gives a real boost to your hard-working staff; below are some excerpts: *Ed.*

The November-December issue was pure gold!

Marie Huizing
Editor, *Rocks & Minerals*

You are to be congratulated for composing such an exceptional issue.

Michael J. Holdaway
Editor, *American Mineralogist*

This is a great issue!

Louis Cabri
Canada Centre for Mineral and Energy Technology, Ottawa

I plan to put one of these (Gold Issues) on display in the office, to show people what it is all about!

J. Douglas Scott
Kidd Creek Mines Ltd., Toronto

The phrase "super fantastic" is inadequate to describe the Gold Issue. All involved in its presentation are to be highly commended. The color photography is particularly outstanding. Still charged up just thinking about the issue, which arrived a couple of hours ago. Hopeful that a few extra copies are still available . . . please send me 30. Everyone who has seen my copy was impressed, and most want a copy of their own. Am afraid to do any more displaying for fear my "supply" would soon be exhausted! No rush on this order, but please don't let it get misplaced when the "avalanche" of requests for additional copies starts flooding your office.

Arthur F. Eadie
Eadie Engineering Co., Taft, CA

Please send me two extra copies of the Gold Issue . . . I am sure I will wear out that many copies by the time I have finished enjoying it.

L. R. Haggard
Seattle, WA

You hit the jackpot this time in producing the best issue I have ever seen. I used to work in the gold mines . . . the Sixteen-to-One and others. This issue starts my blood running wild!

Maurice McKinney
Cambria, CA

The issue—as if you didn't know—is magnificent.

James Merrett
Dallas, TX

Superb! The best issue yet. I plan to give a copy to William B. Clark, retired from our California Division of Mines and Geology who is the author of *Gold Districts of California* . . . currently it is out of print for the fourth time!

Eleanor M. Learned
Curator, Mineral Museum
Calif. Div. of Mines and Geology
San Francisco

Please send me 20 copies of the Gold Issue. As a geologist and longtime employee of the Homestake Mining Company, the nation's oldest gold mining concern, I believe many of our management personnel would be most interested in this issue. Congratulations and thanks to all of you for a truly outstanding effort!

S. W. Rose
Reno, NV

Outstanding! It rivals the best you have ever done (Tsumeb).

David Polanshek
Greenbrae, CA

Fabulous!

James W. Grandy
Hamden, CT

Truly magnificent!

Kenneth Canning
Burlington, MA

Beautiful!

Mary Louise Reed
Benton, IL

Just great.

Patrick J. Brady
Glendora, CA

Gorgeous.

Laura M. Marble
Midland, TX

Wonderful stuff!

Steve Catlin
Houston, TX

Spectacular!

Mrs. Philip Mollicone
Augusta, ME

I am sure you have heard it a million times already, but the Gold Issue was superb!

Sharon Cisneros
Mineralogical Research Co.

(Not quite a million, but who's counting? Ed.)

A triumph—a real masterpiece.

Veryle Carnahan
Whittier, CA

Beautiful! Exciting! What a lift on a dreary day!

Jacqueline Bulat
Downers Grove, IL

Received our Gold Issue today . . . all we can say is "Wow!" This issue would impress even those not involved in mineral collecting.

C. K. Lilly
Las Vegas, NV

I must congratulate you on your splendid Gold Issue. Once again *M.R.* comes through with a thinking man's (and woman's) issue that respects the intelligence of the serious mineral collector.

Bruce Cutler
St. Paul, MN

It was a superb issue and friends are asking for more.

Wayne Downey, Jr.
Huntingdon, PA

Superb. As a subscriber I deeply appreciate the outstanding ability of the *Record*'s writers and those who conceive and formulate the magazine.

Stanley P. Wisniewski
Greenfield, WI

Printing the cover title in metallic gold was a nice touch. A great issue.

Ken Hollmann
Center Rutland, VT

Congratulations on your Gold Issue. It is a delightful document, and it pictures the widest spectrum of gold specimens I have ever seen. You are doing an outstanding job with the *Record* and I for one appreciate your effort.

Verne Reckmeyer
Boulder, CO

I appreciate this beautiful issue, and feel that it alone is worth the price of my subscription.

Mrs. Grady L. Dunn
Ozark, AL

Bound to be a real collector's item. Send me six extra copies.

D. B. Hoover
Lakewood, CO

I love it!

Patsy C. Hogg
Phoenix, AZ

Now we can all be gold bugs.

Michael J. Novotny
Youngstown, OH

This has to be the classiest issue of *any* magazine ever published.

Fred A. Buchanan
Key West, FL

Now wait a minute, Fred . . . there was *one issue of National Geographic, back in 1929, that was pretty good.* *Ed.*

Congratulations to all concerned on the Gold Issue, a pleasure not only to look at but also to read.

There was a recent (1980) discovery, or rediscovery, of gold in Torquay, Devon, England. Sir Arthur Russell knew of and recorded its existence in the 1920's. It occurs in calcite veins in Devonian limestone. Some beautiful specimens of dendritic and wire gold up to 75 cm (30 inches!) have been taken out. A report in a recent issue of *Mineralogical Magazine* states that two palladium arsenide-antimonides were found with the gold. The site has now been designated a "Site of Special Scientific Interest" and no more collecting is allowed.

P. Thorman
Devon, England

Congratulations on the Gold Issue . . . one of the best yet and sure to become a collector's item. One question: on page 380 of that issue is a leaf gold from Tuolumne County, California. On the cover of Vol. 11, no. 2, is "the Seaweed" gold, also listed as from Tuolumne County. However, in Vol. 10, no. 3, p. 188, there is a photo showing those two specimens and one other, all listed as from the Red Ledge mine (which is in Nevada County). Which is correct?

Gregory Crenko
Bethlehem, Pennsylvania

The localities as listed in the Gold Issue are correct. Only the third specimen in the Vol. 10 photo is from the Red Ledge, and incidentally is the same specimen as shown on p. 376 of the Gold Issue. *Ed.*

A fantastic Gold Issue. We are all fortunate in being able to benefit from the generosity of those who contribute funds for color plates.

A point merely for correctness: the location given in Figure 5, p. 394, should read "Sonora" instead of "Sonoma."

Allen C. Mitchell
Sonora, California

I think the Gold Issue will be one of the classics of all time. Tsumeb, Colorado, Arizona, etc. have a tremendous appeal to collectors, but gold appeals to *everyone.* And the quality of photography was superb. As a collector for over 40 years, I can appreciate the razor-sharp crystals on some specimens, but the overall vibrancy of the golds, from the tiny to the large, was overwhelming. I have never aspired to owning specimens as shown but the next best thing is to be able to admire them in print. Keep up the excellent work.

Martin Plotkin
Massapequa Park, New York

GROUND-HOG DAY GAINS GROUND

Dear Sir,

Every dog has his day, so I wish to offer my help in making February 2 a day for Ground Hogs and Rock Hogs alike (as suggested in the Jan.-Feb. issue, p. 61). As a Pennsylvanian, I am well versed in this special day, and I feel that it could be well suited to mineral collectors.

Like mineral clubs, ground hog lodges exist in order to further public awareness and goodwill. The most renowned group is of course the Slumbering Lodge of Punxatawney, Pennsylvania, with its grand ground hog, Punxatawney Phil. Before dawn on February 2, members dressed in top hats and tails gather to watch for Phil as he awakens from his hibernation. Emerging from his burrow, he sniffs the air and looks about. Should Phil see his shadow, he retreats to his hole for six more weeks of winter; otherwise, he forages about, and spring has officially arrived. The day's activities continue with much merriment, and the ceremonial dunking of new members in the local stream.

Convincing myself that we mineral collectors are a more civilized group, I suggest the celebration of Rock Hog Day, with festivities to be held in Washington, D.C. We could begin the day with a parade originating at the Smithsonian and concluding at the Washington Monument. Pebble Piglets twirling picks and shovels will lead the formation, to be followed by the Army Corps of Engineers' Bulldozer Band playing "Rock of Ages." Next would come a 20-mule team carrying master-of-ceremonies, James Watt. Crystallography classes could be held, using the Monument to demonstrate the use of contact goniometers and having cross sections made of it for petrographic study. By placing large transducers in the reflecting pool, a giant ultrasonic cleaner would be made available for dunking specimens which we got soaked for the previous year. Culminating the day's activities would be our mascot, Potomac Pete, emerging from a geode and forecasting future mineral finds, the next "in" species, and whether to retail or keystone at Tucson.

Bryon Brookmyer
Harrisburg, Pennsylvania

COLLECTING THE *RECORD*

Dear sir,

It is very hard to express just how much I enjoy and learn from each issue. The ads themselves are often works of art, beautifully photographed and showing the finest specimens. I have a complete collection of the *Record,* and just noticed an item in a list sent out by *Mineralogical Research Co.* offering a complete set for sale at $800.00. Who would have imagined that a magazine subscription could become an investment? You and the staff have created, from tentative beginnings, something of permanent value. Years from now, when most of us will have collected our just rewards, your magazine will be a *record* of what was seen, collected and studied during the last third of the twentieth century . . . truly something to be very proud of.

William F. Chester
Somerville, New Jersey

FERROAXINITE

Dear sir,

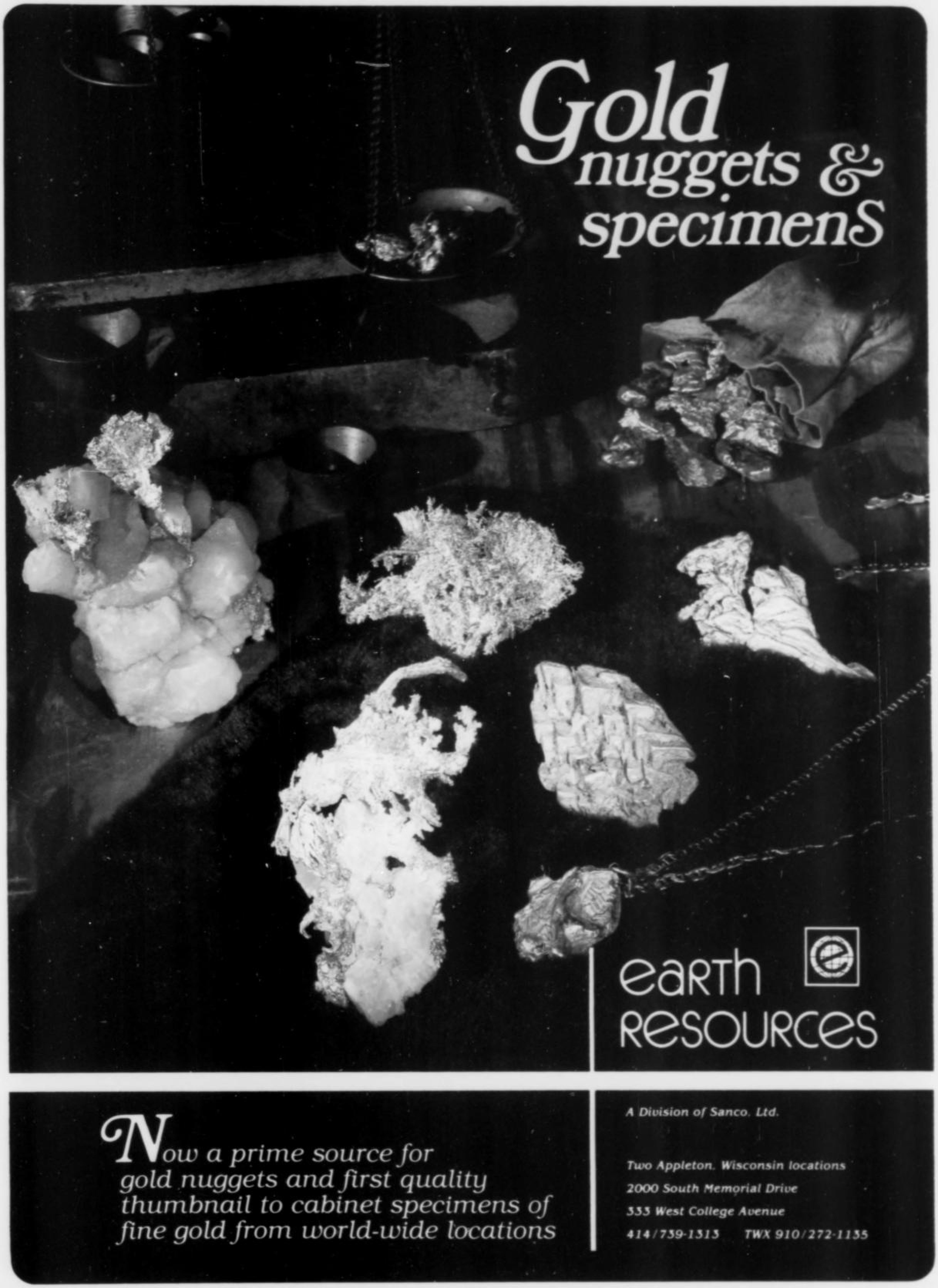
You are to be complimented for the fine magazine you put out for us mineral collectors. Before the *Record* was born, there infrequently appeared some fine mineral articles in magazines devoted primarily to lapidary. One such article, written by John Sinkankas on a "Spectacular strike of red axinite in Baja California," appeared in the July 1965 issue of *Lapidary Journal.* I think this article is important enough to warrant being included in the reference list in the *Record* article by Pohl *et al.* (on the ferroaxinite from New Melones Lake, California, Vol. 13, no. 5).

Ben Chromy
Saratoga, California

ERRATA

On p. 399 of the Gold Issue, under "Calaverite," Bacon Hall was located not on the Riverside Campus but on the Berkeley Campus.

ADVERTISERS INDEX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