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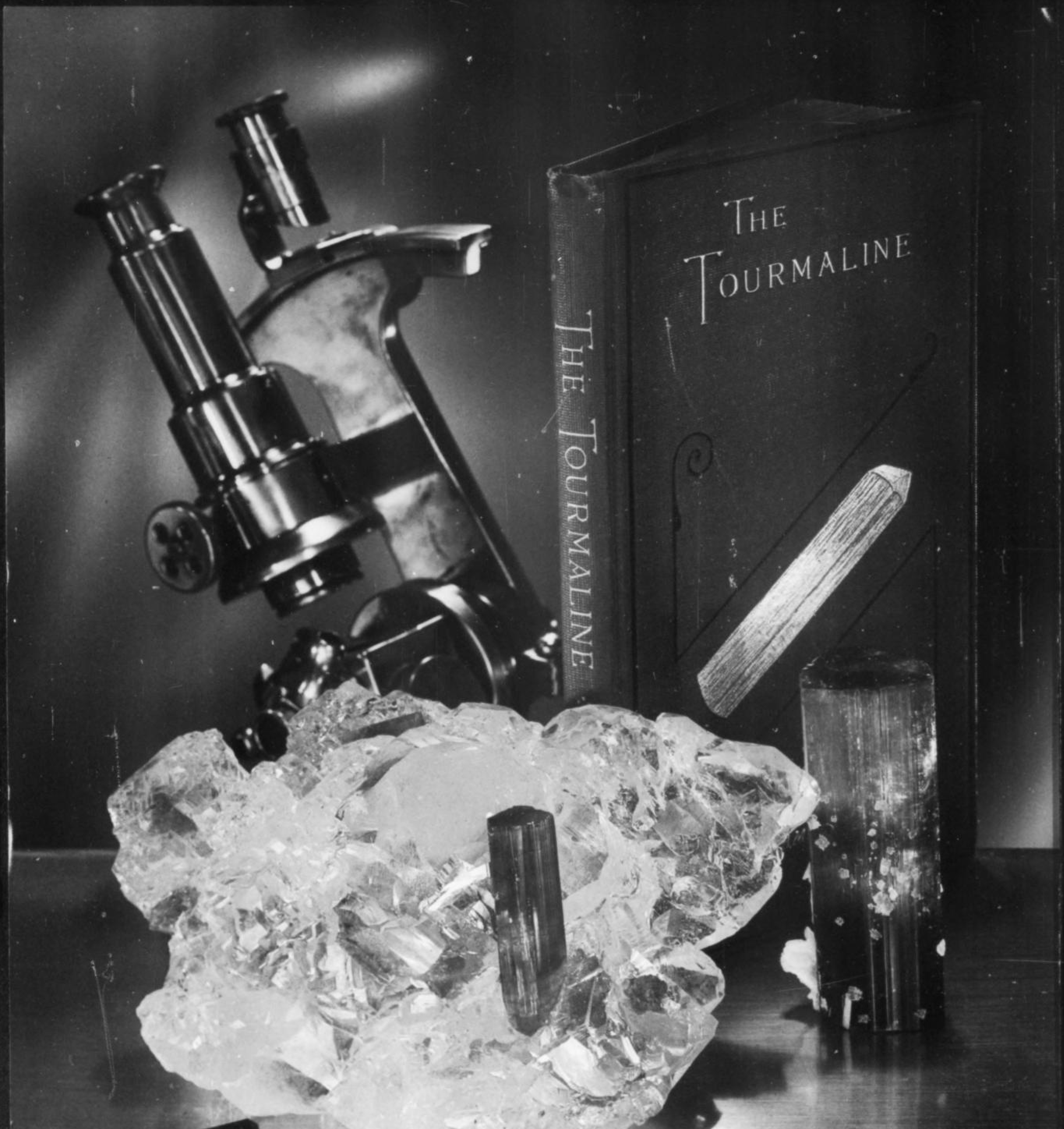
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COVER: Barite from Elk Creek, South Dakota. The crystal is 2 inches tall. Lee Burnet specimen; photo by Wendell E. Wilson.

notes from the EDITOR

YOU THINK *WE'RE* CRAZY . . .

Mineral collectors, as some of you may have guessed, do not have a corner on collector-mania. Those who need convincing of this (and who are in Los Angeles around the time of the Pasadena Show) are encouraged to visit the gun and knife show at the Los Angeles County Fairgrounds in Pomona. Here are some items culled from their mailer: "GUN KNIFE MILITARIA WESTERN SHOW – Gems & Minerals – Rocks – Edged Weapons – Antique and Modern Firearms – Custom Knives – Swords – Wells Fargo – Military Memorabilia – Western Memorabilia – Bronzes – Bowie Knives – U.S. Military Vehicles – Western Art – Civil and Indian War Artifacts – Knife Artisans – Country Western Music Festival – Dance Hall Ladies – Indian War Troopers – Free Admission to Active U.S. Military – Buy-Trade-Sell-Display – The Wild West Still Lives – Big Chili Cookoff, $3000 in prizes, no-holds-barred-anything-goes-in-the-pot! – Do Come In Costume Contest – Mustache and Beard Contest – Five Great Bands, Continuous Entertainment – 14th Year – 3500 tables!"

Thirty-five *hundred* tables?! U.S. military *vehicles?!* We've got nothing on these guys. If you survive the chili, you can spend many many hours walking and looking at this unbelievably large, varied and enthusiastic show. Show-goers who collect military and western memorabilia (including clothes and all associated accoutrements) commonly *wear* their collections to the show. It is not unusual to pass a Nazi SS officer in full regalia, a World War I doughboy, a whole troop of western cavalry soldiers, Vietnam green berets (complete with *all* weapons), one of Pancho Villa's men (weighted down with bandoliers and pistols of course), Civil War officers and soldiers from both sides, grizzled prospectors and trappers, and innumerable other types from countless countries and time periods. Because women have not had many traditional roles in warfare, there is a predominance of dance hall girls among collectors of the female persuasion. And the sheer size of the show makes the mineral shows in Munich and at the Tucson Community Center look rather small by comparison.

I can't imagine any collector of anything not having a great time at this show, and those mineral collectors with a side-interest in western and mining memorabilia should find it particularly interesting. But the main focus is weapons, any and all kinds, so if it bothers you to be standing in line at the ticket booth behind someone with a bazooka over his shoulder (or worse), better forget it. In addition, you also might wish to pass if you are vulnerable to new collecting interests, because you'll be inundated with them. Samurai swords? Custom powder horns? Antique firemens' water buckets? Ancient Persian war helmets? Kentucky longrifles? Don't look if you value your bank account! One last thing: wear comfortable shoes, and do watch out for that chili.

The show is held twice a year, May 18-20 and November 9-11 in 1984. Write for their unique brochure: Great Western Fair, P.O. Box 65, North Hollywood, CA 91603. To reach the fairgrounds, take the San Bernardino Freeway to the Ganesha Offramp.

COLORADO-I SETS RECORD

Readers may be interested to know that a copy of the first Colorado issue (vol. 7, no. 6) was sold at silent auction at the recent Denver Show for $320 . . . it would have gone higher but for a predetermined cut-off time. It should still be possible for diligent collectors to obtain a copy on the open market for somewhat less (if they're lucky enough to find one at all), but be advised that that particular issue, for some reason, seems to be The One as far as rapid price escalation goes. The previous best guess as to its market value was $70 to $100. Incidentally, a complete set of the *Mineralogical Record* currently appears to be worth about $1000.

NOTICES

Died, Russell MacFall, 80. MacFall held a Master's Degree in journalism from the University of Chicago, and worked as editor for *The Chicago Tribune* for 32 years. He retired in 1971 but continued writing for a number of publications and serving as consultant for the *Congressional Quarterly* in Washington, D.C. His seven books deal primarily with his interest in mineralogy, geology and paleontology, and include *Minerals and Gems, Gem Hunter's Guide, Wyoming Jade* and *Fossils for Amateurs.* Since 1979 he held the post of honorary curator at the San Diego Natural History Museum, and was a past president of the Midwest Federation of Mineralogical and Geological Societies. **WEW**

Died, Myron Holloman, 68, of a heart attack. During his 15 years as a mineral dealer, Myron and his wife Elizabeth handled countless outstanding specimens, particularly minerals from the Viburnum Trend (Sweetwater and Brushy Creek mines), Missouri. He was self-educated in mineralogy and became knowledgeable in many aspects of mineralogy, gemology and lapidary. His love of good minerals and a good story will be missed. **Marshall Koval**

FRIENDS OF MINERALOGY AWARD

The Friends of Mineralogy was incorporated in 1972 "to operate exclusively for scientific and educational purposes in the field of mineralogy, including . . . to promote the dissemination of information about minerals, mineral localities, collections, and mineralogical investigations." Consistent with this purpose, FM has been affiliated with the *Mineralogical Record* since its founding. To further mineralogy and give added support to the magazine the Friends of Mineralogy instituted an award of a lifetime subscription to the *Mineralogical Record* for the senior author of the best article to appear therein each year beginning with volume eleven.

The Award Committee is a standing committee chaired by the Vice President. It comprises a group of five nonboard members from across the country who agree to review all of the articles in the current volume and to select a short list of semifinalists. From the lists and from individual nominations submitted by members at large the Chairman prepares a ballot for a vote of the committee. The Chairman votes only to break a tie vote. FM members interested in serving on the Award Committee or wishing to express a preference for the winning article are urged to contact the Vice President, currently

Peter Modreski
U.S. Geological Survey
Denver Federal Center
Box 25046, Mail Stop 905
Denver, Colorado 80225

The Chairman reports the results to the President and informs the winner. The winner, we hope, will be able to attend the Tucson Gem and Mineral Show and be present at the FM annual meeting on Saturday afternoon and at the *Mineralogical Record*'s Saturday night proceedings, so that he can be introduced and presented with his award. These arrangements are also the responsibility of the Chairman.

The first Friends of Mineralogy Award was presented to Richard A. Bideaux at the 1981 annual meeting for his article "Famous mineral localities: Tiger, Arizona," which appeared in the first Arizona issue (vol. 11, p. 155–181). The committee members were impressed with the thoroughness of the article and the high percentage of original observations. It isn't merely a review of the literature interspersed with photographs and crystal drawings! Everyone involved with developing the award program was pleased that Bideaux's Tiger article set an appropriately high standard for the award.

The 1982 award was won by Richard W. Graeme for his monograph "Famous mineral localities: Bisbee, Arizona." It appeared as the third Arizona issue (vol. 12, p. 258–319) and is the only article in the *Mineralogical Record*'s fourteen years of publication to fill an issue completely. Dick Bideaux introduced the winner and his wife at the FM meeting and later that evening with these words:

> Richard W. Graeme was born December 13, 1941, in Bisbee to a family whose mining tradition reaches back four generations. He is married with two children. After graduation from Bisbee High School he worked for ten years in Bisbee as an underground miner. For the last five of these, he attended Cochise College, while continuing to work the "graveyard" shift. He then attended the University of Arizona College of Mines from which he graduated in 1972 with a degree in Geological Engineering. For the next two and a half years he was Resident Geologist at the Copper Queen mine until Phelps Dodge Corporation closed all the mines at Bisbee. He was transferred to Ajo as Mine Planning Engineer and later promoted to General Mine Foreman. He left Ajo in 1979 after nineteen years with PD and is now General Superintendent of Sharon Steel's Continental Mine at Hanover, New Mexico.
>
> Dick cannot remember when he wasn't interested in minerals. He began collecting underground in Bisbee as a child. His article is based on a file of 3,500 cards dating back to 1952 and required two years to write, even with his wife Nina's help. Explaining why he wrote the article he quotes his son: "People who have knowledge and don't share, but die with it, have cheated those who come after them."

Arizona's hold on the Friends of Mineralogy Award was broken in 1982 when Robert J. King's article "The Boltsborn mine, Weardale, County Durham, England" (vol. 13, p. 5–18) was judged best amid stiff competition. Dr. King is a leading British collector with a definitive representation of Lancashire minerals among his 12,000 specimens. Regrettably, he could not be present in Tucson to personally receive his award.

I wish to acknowledge with thanks the following FM members who served as Award Committee members: Sharon Cisneros, Rock Currier, Tony Kampf, Gloria Ludlam, Don Phillips, Kay Robertson, George Robinson, Alex Speer and John White. We believe that these initial selections set an appropriately high standard for the award and hope that the award's existence will help to encourage others to put pencil to paper and contribute their knowledge to the literature of mineralogy.

Carl A. Francis

DIRECTORY OF MICROMOUNTERS

The *International Directory of Micromounters* is published biennially (in "even" years) by the Baltimore Mineral Society at the time of its annual Micromount Symposium in September. The 12th edition will be published in September of 1984. In order for it to be as correct and up-to-date as possible, the following information is needed.

1. The full name, address and zipcode of each micromounter who wishes to be listed without charge and who was not (or who does not remember if he/she was) listed in the 11th edition. We will do the checking if you are not sure. If a listing is to be for both husband and wife, please also furnish the wife's first name.

2. The new (and old) address and/or name of each person listed in the 11th edition who has moved and/or changed his or her name since it was published.

3. Identification of each person listed in the 11th edition whose mail is undeliverable at the address shown therein. Furnishing the face of one or more envelopes returned by the post office would be an easy method of doing this.

4. The zipcode (postal code) of each Canadian micromounter – and the equivalent for each English one – listed without it in the 11th edition.

5. If you are a member of a group, club or society which has at least five members who are active micromounters, please send – or ask your secretary to send – an up-to-date list of your micromounter members showing not only the name and address of your organization but also indicating which one of them is the best contact person. We began this club listing with the 10th edition of the Directory but have a long way to go before being even close to complete.

6. The full name and address of each dealer in micromounts, micromount material and/or tools who would like to be listed without charge in the Directory of Dealers which is a part of the Directory of Micromounters, together with a statement as to whether or not you have periodic lists available. If each such dealer who uses the Directory for business purposes would comply with item 3, above, from time to time by contacting the editor named below, it would be most helpful.

The cost by mail of each copy of the 12th edition will be $3.00 in United States funds for all who reside in the United States and Canada; for residents of all other countries the mail costs are higher so the price will vary accordingly. All information and checks for copies to be mailed should be sent, and made payable, to the editor: Randolph S. Rothschild, 2909 Woodvalley Drive, Baltimore, Maryland 21208, U.S.A.

R. S. Rothschild

the mines and minerals of Darwin California

by **Craig S. Stolburg**
3231 Woodmont Drive
San Jose, California 95118

The Darwin district has been a source of lead, silver and tungsten for over 100 years, and nearly 100 different mineral species have been found there. Its long history and interesting mineralogy have made the area popular with California mining historians, economic geologists and mineral collectors.

INTRODUCTION

The Darwin mining district lies in central Inyo County, California, between the Coso Mountains on the west and the Argus Mountains on the east. The district, at an elevation of 5000 feet, occupies the southernmost tip of the Inyo Mountains. Due to Darwin's location, it is a typical desert mining town characterized by scant rainfall, frequent strong winds and extremes of temperature. The area is prone to flash flooding during spring and winter rains, as little or no vegetation is present to prevent the runoff. Vegetation includes sagebrush, Mormon tea, creosote bush, joshua trees and assorted cactuses. After the spring rains, one can find the normally barren looking landscape dotted with California golden poppies creating in some areas a spectacular panorama of color.

HISTORY

Major deposits of oxidized silver-lead ores were first discovered at Darwin in October of 1874 (L. Lowrance, personal communication, 1982) and between 1875 and 1880 the near-surface ores were mined extensively. Between 1875 and 1877 three smelters were built near Darwin: the Cuervo with a capacity of 20 tons per day, the Defiance with a capacity of 60 tons and the New Coso with a capacity of 100 tons (Goodyear, 1888).

The richness of the surface ores was demonstrated by the metal production from two of the earliest mines in the district. In May of 1875 the Lucky Jim and Christmas Gift prospects were purchased by the New Coso Mining Company. By April 1, 1877 these two mines had a combined production of 226,672 ounces of silver and 1,920,261 pounds of lead (Robinson, 1877) with a total value of $410,350. During 1875 two other major operations commenced production; these were the Defiance and Independence mines and by 1883 they had yielded bullion worth $1,280,000. Within five years, the mines were producing very little bullion due to the exhaustion of the easily mined near-surface high-grade ores (Goodyear, 1888). This era of low activity lasted until World War I. Due to financial problems, many of the mines were consolidated in the hope of improving profitability. Unfortunately the low prices for silver and lead did not stimulate renewed interest in the district until 1936. That year saw the formation of the Darwin Lead Company and increased mining activity.

By the late 1930's all the major mines had been consolidated under single ownership; they included the Christmas Gift, Promontory, Lane, Columbia, Independence, Defiance, Essex and Thompson mines. In 1943 a group of investors acquired control of the Darwin Lead Company and began production under the name Darwin Mines.

In 1939 the silver-lead deposits in and around Darwin were evaluated by the Anaconda Copper Company. However, the ore reserves identified did not warrant the acquisition of the Darwin Mines at that time. Anaconda desired to negotiate a lease-purchase option on the property so as to undertake a full scale exploration program to substantiate the presence of ore reserves large enough to warrant purchasing the mine. After World War II, in an era of substantially increased metal prices, Anaconda Copper Company acquired the assets of the Darwin Mines Company from Signal Oil Company, Shirley Parker and Arthur Theis (G. Wilson, personal

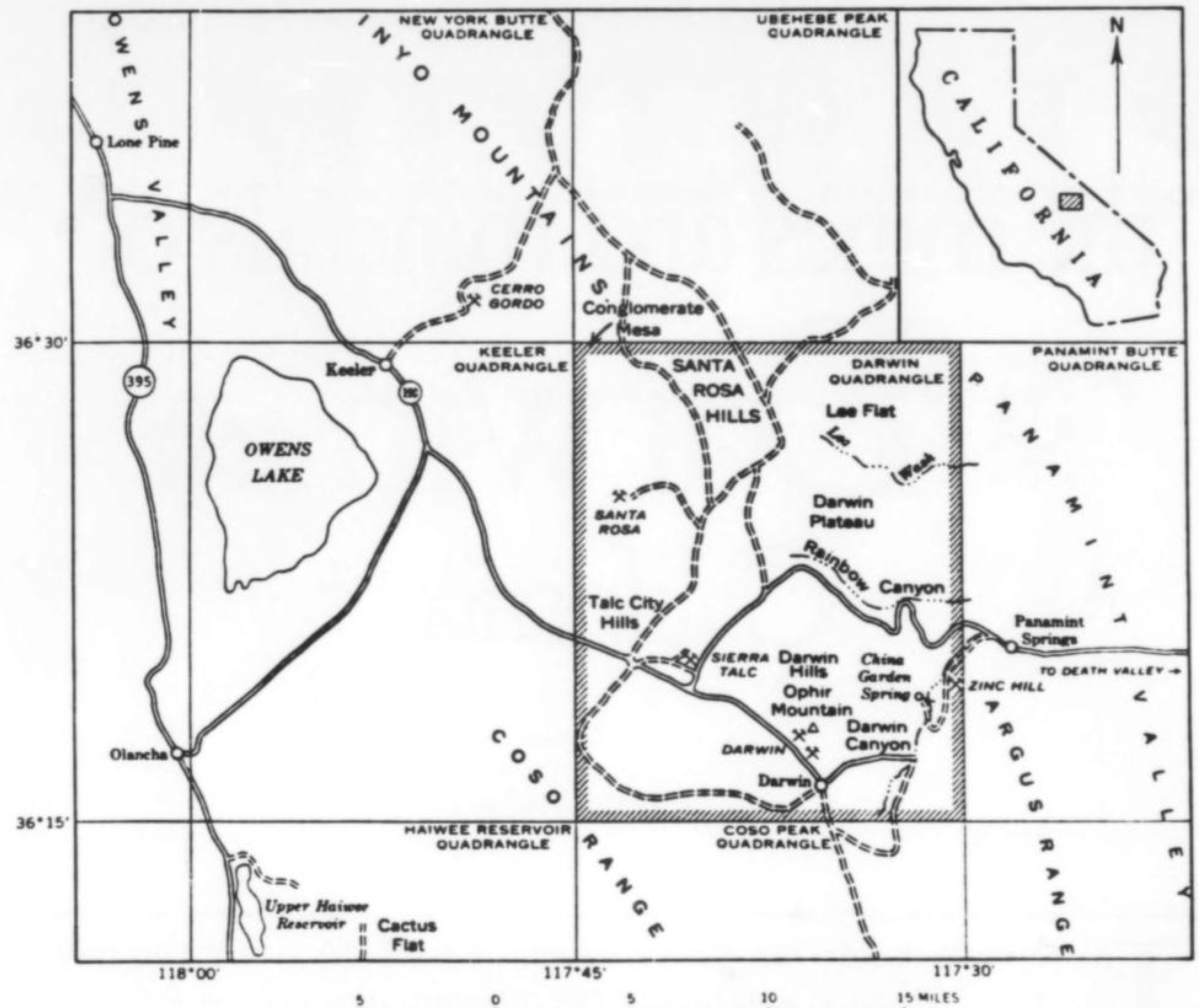

Figure 1. **Generalized map of the Darwin area (Hall and MacKevett, 1962).**

communication, 1982). Since 1945 the major production from the district has come from the Defiance, Essex, Independence and Thompson mines.

The Darwin mining district was founded on silver and lead mining, however tungsten played an important part in reviving production from several mines. Scheelite was recognized in the mines in the eastern part of the district about 1915, however, these deposits were not developed until 1940 (Hall *et al.,* 1958). The principal production of tungsten was in 1941 and 1942 by the Pacific Tungsten Company. In 1971 Monticeto Minerals Company acquired a lease to process the mine tailings of the Anaconda operation for tungsten, but was unsuccessful and by 1978 the mill had been dismantled.

The current status of mining in Darwin centers on Anaconda Minerals Company and their tailings reprocessing operation now underway. They are in the process of recovering silver from the vast tailings piles left from previous milling operations. All underground mining in the area has ceased, but continued mineral exploration both above and below ground keeps the hope of renewed mining activity alive.

A few years ago Anaconda Minerals Company started a major hazard removal program connected with their Darwin Mines operation. This program took the form of fencing off some mine tunnels and shafts, and backfilling of other mine shafts, such as was done to the Promontory mine. The company felt that the danger of unauthorized entry and possible injuries was sufficient incentive to close the entrances to the old mines (G. Wilson, personal communication, 1982).

Several years ago a number of Darwin residents gathered together to form the New Coso Heritage Society, headquartered in Darwin. Their purpose was to preserve the mining and historical heritage of the town. Today they have a mining museum displaying a large number of historical artifacts from Darwin's past.

GEOLOGY

General Geology

The geology of the Darwin area has undergone many geological investigations, starting with Adolph Knoph's classic work in 1914. Others who followed added upon this work; they included Waring and Huguenin (1919), Kelley (1937), Tucker and Sampson (1938), Norman and Stewart (1951), and Hall and MacKevett (1958, 1962). Only an overview of these extensive investigations will be presented here.

The Darwin district is underlain by a sequence of Paleozoic sedimentary rocks more than 8,000 feet thick which is intruded by the Darwin stock of biotite-hornblende-quartz monzonite and overlain locally by Cenozoic volcanics and sediments (Hall and MacKevett, 1958). The sedimentary rocks include limestone, silty limestone, shale and siltstone, which are divided into the Lee Flat limestone of Mississippian and Pennsylvanian age and the overlying Keeler Canyon formation of Pennsylvanian and Permian age.

The Darwin stock intrudes the Keeler Canyon formation on the east side of the Darwin mine area. Heat and fluids from the stock have metamorphosed the limy sedimentary rocks to calc-silicate rocks, calc-hornfels and marble within 4,000 feet of the stock. The metamorphosed rocks tend to be light in color, white to greenish white, and with fine to medium grain size. They contain

	Age			Lithologic unit	Thickness (feet)
CENOZOIC	QUATERNARY	Recent		Alluvium, including fanglomerate, playa deposits, and minor lake beds	
		Pleistocene		Olivine basalt flows, fanglomerate, and Darwin Wash lake beds of Hopper, 1947	0-600
	TERTIARY(?)	Pleistocene or Pliocene		Coso formation of Schultz, 1937	
		Pliocene(?)		Andesite, basaltic pyroclastics, basalt flows, pumice	910+
MESOZOIC	Cretaceous(?)			Hypabyssal rocks—andesite porphyry and alaskite dikes	
	Cretaceous			Batholith of Hunter Mountain, batholith of the Coso Range, and related intrusive rocks—mainly quartz monzonite but includes granodiorite, syenodiorite, gabbro, leucogranite, and aplite	
PALEOZOIC	Permian		Owens Valley formation	Limestone-conglomerate member—includes limestone conglomerate, siltstone, and calcarenite	180+
				Shale member—brick-red and yellowish-brown shale; subordinate siltstone and limestone	200
				Lower limestone member—mainly fine-grained calcarenite; some thick limestone lenses, shale, and siltstone	2,800
	Permian and Pennsylvanian		Keeler Canyon formation	Upper member—calcilutite and fine-grained calcarenite with lesser shale and limestone-pebble conglomerate	1,700
				Lower member—thin-bedded limestone with intercalated limestone-pebble conglomerate	2,300±
	Pennsylvanian(?)			Rest Spring shale—dark-brown fissile shale, minor siltstone. The Rest Spring shale is present only as fault slivers in the northwest part of the quadrangle. It is the stratigraphic equivalent of the upper part of the Lee Flat limestone	0-50+
	Pennsylvanian(?) and Mississippian			Lee Flat limestone—thin-bedded medium-gray limestone; equivalent to the upper part of Perdido formation and to the Rest Spring shale	520+
	Mississippian			Perdido formation—limestone and bedded chert	330
				Tin Mountain limestone—fossiliferous thin- to thick-bedded limestone with chert lenses and nodules	430
	Devonian			Lost Burro formation—coarse-grained white and light-gray marble; dolomite and limestone in lower part of formation; minor quartzite and shale	1,770+
	Devonian and Silurian			Hidden Valley dolomite—light-gray, massive dolomite	1,000±
	Ordovician			Ely Springs dolomite—dark-gray dolomite with chert beds and lenses; some light-gray dolomite	920±
				Eureka quartzite—light-gray to white vitreous orthoquartzite	440
				Pogonip group—light- and medium-gray thick-bedded dolomite; some thinner-bedded dolomite and limestone	1,570+

***Table 1.* Geologic cross section of the Darwin area (Hall and MacKevett, 1958).**

predominantly diopside, grossular, idocrase and wollastonite and lesser amounts of feldspar, quartz, epidote and tremolite.

The Paleozoic rocks are folded into an overturned and, in part, inverted syncline that is disrupted by the Davis thrust fault and abundant steep faults. Ores of silver-lead-zinc occur in medium-grained calc-silicate rocks between the Darwin thrust fault on the west and the Darwin stock on the east. The ore is massive and is present in many veins, bedded deposits and irregular replacement orebodies.

Structural Geology

Structurally the Darwin Hills are an overturned syncline with an axial plane that dips about 50° W. Paleozoic rocks near the axis of this syncline have been intruded by a stock of Cretaceous biotite-hornblende quartz monzonite (Hall and MacKevett, 1962).

A considerable number of small open folds are superposed on the overturned limb of the syncline, and these folds have localized some of the principal orebodies in the Darwin area mines (Hall and MacKevett, 1962).

The Paleozoic rocks in the Darwin district are broken by four sets of faults. These are the Darwin tear fault, the Standard fault, the Water Tank fault and most importantly the Davis thrust fault. A fault control is apparent for nearly all the ore deposits, although it may be just one of several factors in localizing ore (Hall and MacKevett, 1958).

PARAGENESIS

Creation of the silver-lead deposits in the Darwin area resulted from intense alteration of the primary rocks and minerals. The mineralization of the area is divided into three stages: the first is an early stage of silication of limestone, the second is the later stage of sulfide mineralization, and the third is the post-sulfide stage. This sequence of formation is graphically presented in table 2.

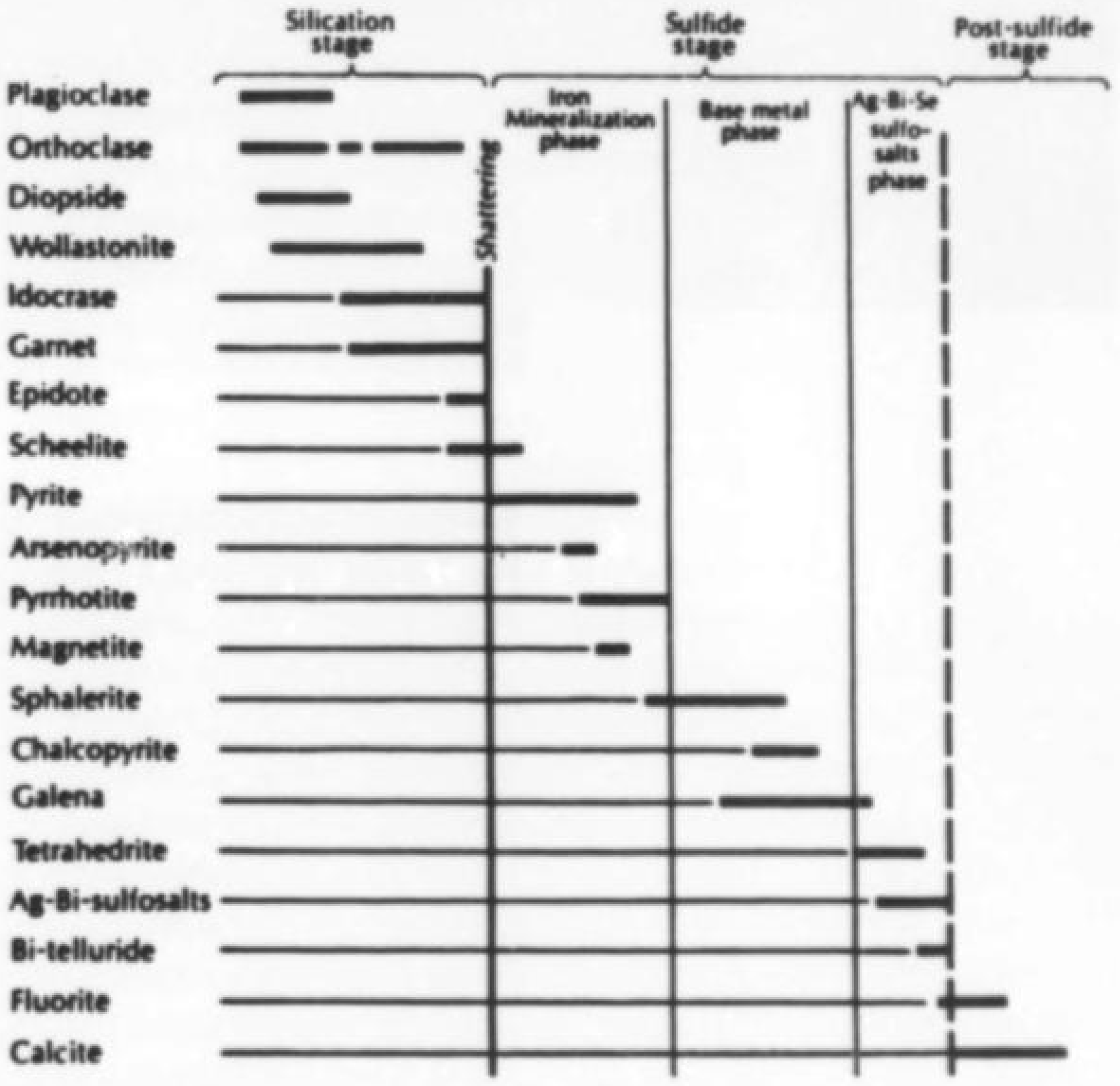

***Table 2.* Generalized paragenesis of the Darwin mineralization (Rye, Hall, and Ohmoto, 1974).**

The limestones were altered to a dense aphanitic calc-hornfels. Depending upon the purity of the limestones, two different mineral assemblages resulted. Those limestones having appreciable impurities were recrystallized to a very fine-grained rock containing orthoclase, oligoclase, diopside and quartz. Purer limestones were altered to a fine-grained wollastonite-diopside calc-hornfels. With further intense alteration, the wollastonite was replaced by andradite and idocrase, forming a coarse-grained idocrase-garnet-wollastonite calc-silicate rock (Hall and MacKevett, 1962).

The first ore mineral to form was scheelite, and this extended from the late silication stage into the sulfide mineralization stage. Between these two stages, extensive shattering took place and prepared the way for the deposition of the sulfide minerals. Pyrite was the first sulfide mineral to form. Sphalerite and chalcopyrite in many of the orebodies were replaced by galena, whereas tetrahedrite-tennantite formed contemporaneously with galena. Matildite, clausthalite and other silver-bearing sulfosalts have been demonstrated to have exsolved from galena (Czamanske and Hall, 1975).

Upon the completion of the sulfide mineralization, the stage of post-sulfide gangue mineralization began. Fluorite and calcite formed first. Once these were in place and erosion exposed the various deposits to oxidation, the development of the wide range of secondary minerals found in Darwin today was initiated.

Figure 2. **Lane mill about 1921. New Coso Heritage Society photo.**

Figure 3. **Defiance mine, showing the surface operation about 1936. Dr. V. C. Kelley photo.**

MINES

The mines in and around Darwin vary in size and production from small one-man operations to those of large mining enterprises. The number of mines located in the district is quite large. Therefore, only those mines of historical interest or producing exceptional and unique mineral specimens will be described. The other mines will be noted for the purpose of completing the list of Darwin area mines.

Bernon mine

This is one of the smaller mines, however its lack of production resulted from the fact that its ore could be mined more economically from the underground workings of the Thompson and Independence mines.

Christmas Gift mine

This mine was one of the earliest major ore producers in the district. The New Coso Mining Company purchased the mine in 1875 and proceeded to exploit the rich near-surface ores. The mine workings consist of 5 shafts, several adits and numerous open cuts. The main shaft has been sunk to a depth of 250 feet, with a winze extending 126 feet beyond the 250-foot level. The most active period of production was from 1875 through 1877, with intermittent mining through 1928 when the mine closed. Anaconda has fenced off the mine shafts as part of its hazard removal project.

Columbia mine

This is the earliest recorded mine in the district. Sometime in 1872 this mine was originally located as the Dragon mine, and was abandoned shortly thereafter. Once mining in the district picked up, the mine was relocated as the Columbia. Sporadic operations

Figure 4. **Essex mine in the foreground and the Independence mine buildings to the right in 1936. V. C. Kelley photo.**

Figure 5. **Darwin mines tram house in 1957. Mel Stinson photo.**

kept the mine in operation until the late 1890's when no additional ore could be found.

Custer mine

This mine is actually a group of mines, the largest on the north side of Custer Canyon. The mine is developed by an inclined shaft 400 feet long with a winze extending 240 feet below the 400 foot level. Directly opposite the main mine shaft on the south side of Custer Canyon is a small tunnel approximately 100 feet in length. Other open cuts and shallow shafts make up the balance of the mine workings. Production from the inclined shaft continued until 1949 when low metal prices forced the mine to close.

Darwin mine

This title is used to refer to the consolidated holdings of the Anaconda Minerals Company operation at Darwin. The mines contained within this heading include the Bernon, Defiance, Essex, Independence, Rip Van Winkle and Thompson mines. Each of these mines is interconnected by the 6300-foot-long Radiore tunnel. This tunnel was driven to provide economical access to the various mines for the purpose of hauling ore to the surface.

Darwin Antimony mine

This is the only antimony mine in the district. Production from the mine amounted to just over 100 tons of ore, all of which came out in the 1940's. Present workings consist of two shafts, an adit and several open cuts. The chief ore mineral was stibnite and this made up all the ore shipped. Since the late 1940's the mine has been inactive.

Defiance mine

Of all the mines in the district, this is the largest and deepest. The principal mine workings consist of a vertical shaft 1100 feet deep, an inclined ore haulage shaft and several surface adits. Production from the mine lasted from the 1870's until the late 1950's. With silver and lead prices at post-wartime lows, it became increasingly difficult to keep the mine operating at a profit, so by 1959 most operations ceased.

Durham mine

Originally located as a silver-lead mine, this property produced modest returns. Then, in the 1940's, the mineral scheelite was recognized as being present in high enough concentration to justify reopening the mine to support the war effort. By the time the mine ceased operations in 1944, it had produced a fair amount of high-grade scheelite. The mine followed a mineralized zone down to a depth of 250 feet, with a connecting drift on the 100 level to the Fernando mine.

Essex mine

Like its sister mine the Defiance, the Essex is a very large mine having reached a depth of 780 feet with many thousands of feet of workings on numerous levels. The vast majority of the high grade ore was removed from between the 200 and 400-foot levels during the late 1800's. Even as late as the 1930's high grade ore pods were being mined and stockpiled. Poor metal prices in the late 1950's forced the closure of the mine.

Fernando mine

This mine is situated adjacent to the Durham mine on the north and was opened to exploit the silver-lead deposits common to both mines. Like the Durham mine, an inclined shaft 125 feet in depth was sunk on the ore-bearing vein. During the 1920's ore shipped from the mine assayed some 30 ounces of silver per ton. With the shortage of tungsten during World War II, the scheelite encountered was mined along with that found in the Durham mine. Both mines have been inactive since the mid 1950's.

Independence mine

During the early history of the district, the Independence was part of the Defiance group of mines, and since has grown in prominence to represent one of the most important producers in the district. Based on the meager surface ore indications, it was not expected to be a large producer, but once the main orebody was intersected at depth below a tongue of the Darwin stock, its richness became evident. This orebody encompassed an area some 150 feet in width and over 200 feet in length. An estimate of the ore concentration for this occurrence has been calculated as representing a replacement of over 30 percent of the calc-silicate rock by silver-lead minerals. Mining has developed the ore to a depth of 600 feet. As with the other Darwin mines, operations ceased during the late 1950's.

Lane mine

This mine is best known not for its minerals or metal production, but for the ore processing facility known as the Lane Mill. This mill treated not only the Lane mine ore, but also ore from the Defiance, Independence and Lucky Jim mines as well. First constructed in 1898, it remained essentially unchanged until 1915 when it was modernized. Over the years, the mill capacity was enhanced until it reached a capacity of 200 tons per day. In 1942 the Imperial Metals Company moved the operation to the present site of the Anaconda operation overlooking the town of Darwin.

Lucky Jim mine

Within the district this mine ranks as one of the larger producers, as well as having the distinction of being one of the first truly large mining operations. The mine consists of a vertical shaft 860 feet deep with over 1½ miles of underground workings on 12 levels. Ore assayed by Anaconda has shown silver concentrations ranging from 1 to 70 ounces per ton. However, production from the mine has not taken place since the early part of the century. Anaconda has recently closed all the mine entrances as part of the hazard removal program.

Rip Van Winkle mine

This is one of the oldest mines in the district and is one of the few to have produced high grade silver ore from fissure veins. The mine was developed to a depth of 250 feet and ceased operations sometime in the 1880's. Presently the mine workings are inaccessible.

Thompson mine

Of all the mines in and around Darwin, this one is the best known. The mine workings are made up of a vertical shaft 1000 feet in depth, an adit and several open cuts. The underground workings run for many thousands of feet in all directions. For many years the Thompson mine was used as a haulage way for the production of the Essex and Independence mines. The large stopes present within the Thompson mine attest to the volume of the ore mined. The last time the Thompson produced ore was in the early 1970's when Monticeto Minerals Company mined scheelite and galena from the 400 and 1000-foot levels. Operations finally ceased in 1976 when it became unprofitable to continue mining.

Zinc Hill mine

Of all the mines in the district, this one stands out as being unique in that it produced zinc and very little silver or lead. At one time this mine was the largest zinc producer in California. The mine workings are divided between the lower and upper orebodies. The earliest ore removed came from the lower workings and was chiefly oxidized ore; ore mined after 1940 came from the upper workings, which was primarily sulfide ore. The mine has been idle since the 1950's.

Other mines

The following is a list of additional mines in the area from which silver, lead, zinc, copper, bismuth and tungsten minerals have come:

Acme (Colonel)
Alameda (Richardson)
Belle Union
Bruce
Buckhorn
Chipmunk
Darwin Zinc
Dividend
Empress
Fairbanks

Figure 6. **Thompson mine buildings showing the main adit to the left of the water tank, taken in 1957. W. Hall photo.**

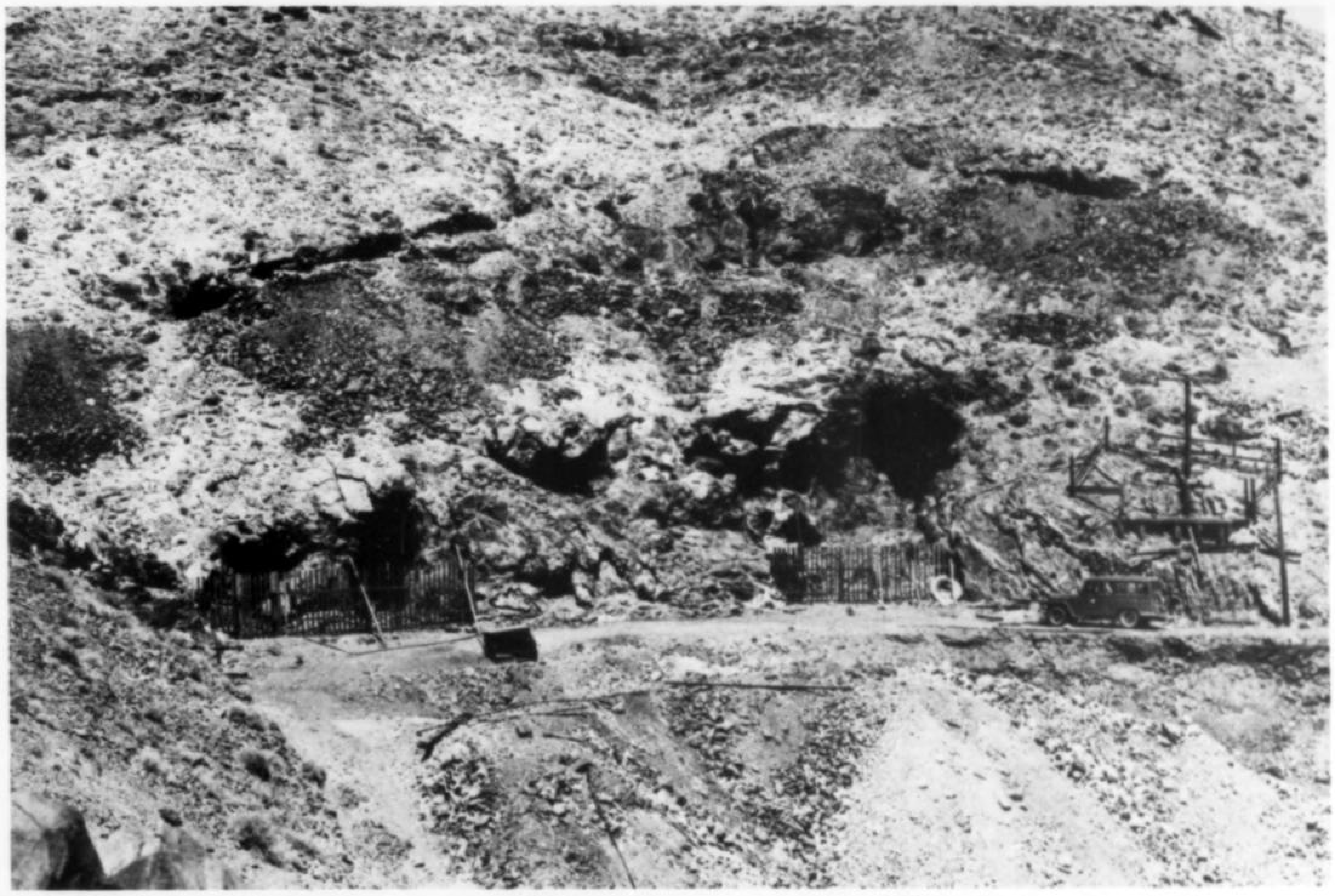

Figure 7. **Defiance mine around 1958. W. Hall photo.**

Geroux (Rio Tinto)
Hayward
Iriquois
Jackass
Keystone
Kingman
Lead Hope
Lee
Lone Pinyon
Lucky Lucy
Mayflower
Ophir Mountain
Promontory
Santa Ana
Santa Rosa
Silver Dollar
Silver Reid
Silver Spoon
Susquehana
Standard Group
St. Charles
Toga
Whipperwill
Wonder
Wynog

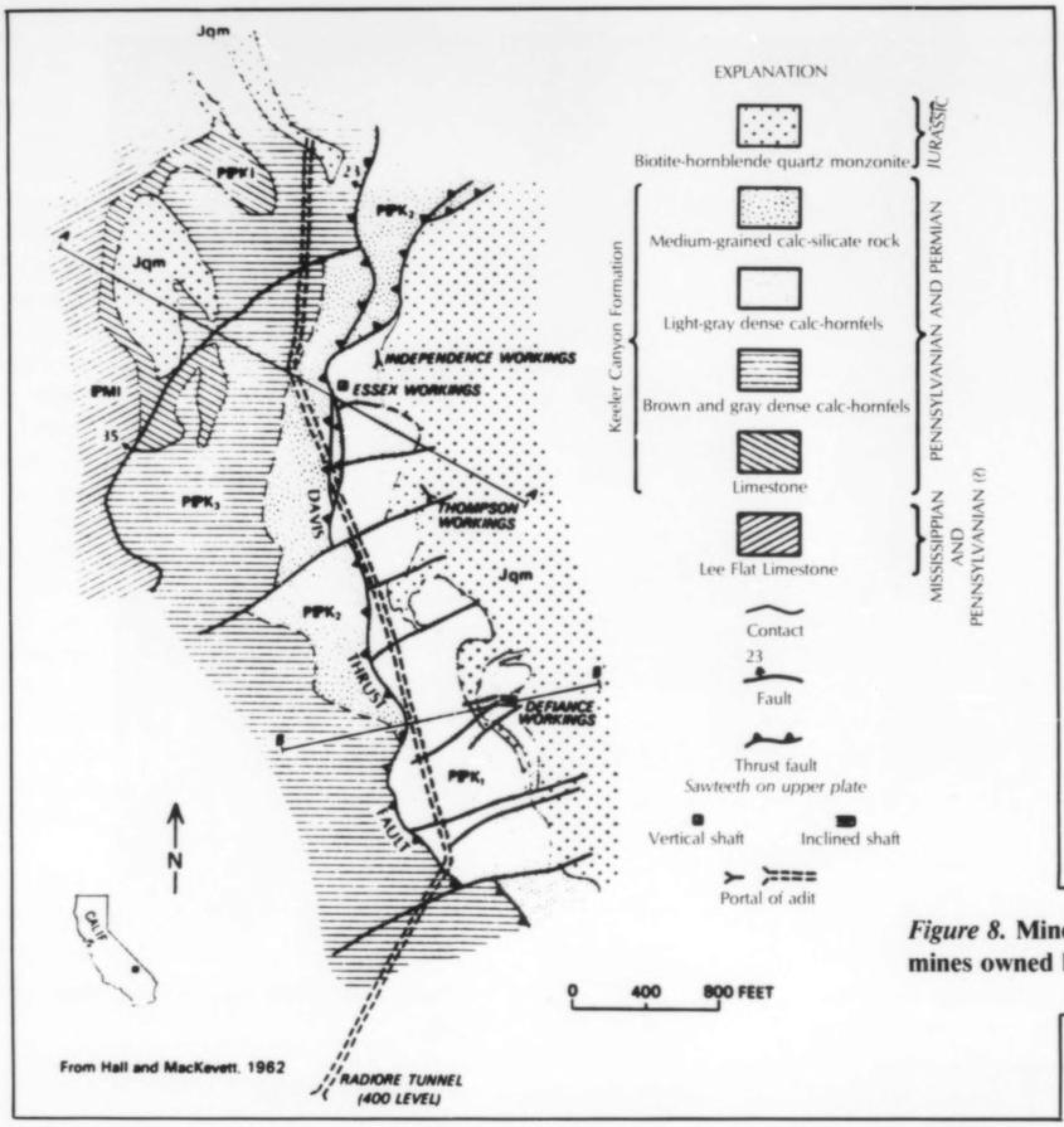

Figure 8. **Mine map showing the major Darwin mines owned by Anaconda.**

MINERALS

The Darwin area mines have produced a sizeable quantity of fine mineral specimens. The majority of these have come from a limited number of locations, most notably those closest to the town of Darwin. To date some 95 minerals have been collected and identified; most tend to be either microcrystals or massive ore minerals. Fortunately for the mineral collector there are notable exceptions and these will be highlighted. Mineralization within the district can be classified as being either hypogene or supergene in origin, as listed on Table 3.

Table 3. **Minerals from the Darwin district.**

Ore Minerals

Andorite
Arsenopyrite
Bismuth
Bismuthinite
Bornite
Chalcopyrite
Clausthalite
Cosalite
Enargite
Famatinite
Galena
Gold
Guanajuatite
Gustavite
Matildite
Pyrite
Pyrrhotite
Scheelite
Schirmerite
Senarmontite
Sphalerite
Stannite
Stibnite
Tennantite
Tetradymite
Tetrahedrite

Gangue Minerals

Andradite
Augite
Barite
Calcite
Clinochrysotile
Clinozoisite
Diopside
Fluorite
Idocrase
Jasper
Montmorillonite
Orthoclase
Paraspurrite
Quartz
Sericite
Titanite
Wollastonite

Sulfide Zone Minerals

Acanthite
Chalcocite
Covellite

Oxide Zone Minerals

Anglesite
Anhydrite
Antlerite
Aurichalcite
Autunite
Azurite
Bindheimite
Bismutite
Brochantite
Caledonite
Cerussite
Cervantite
Chalcanthite
Chlorargyrite
Chrysocolla
Conichalcite
Creedite
Crocoite
Cuprite
Goslarite
Gypsum
Hematite
Hemimorphite
Hydrozincite
Jarosite
Leadhillite
Limonite
Linarite
Malachite
Melanterite
Mimetite
Minium
Plumbojarosite
Pseudomalachite
Pyrolusite
Pyromorphite
Rosasite
Serpierite
Siderite
Silver
Smithsonite
Stibiconite
Stolzite
Sulfur
Tenorite
Valentinite
Vanadinite
Vivianite
Wulfenite

The following compendium of Darwin minerals is based on field collecting and information from the literature. As in any large, mineralogically rich area, Darwin minerals tend to be concentrated within specific geological formations. Much of the early ore removed from these formations was poorly documented as to mineralogy. As time passed and professional geologists and mineralogists undertook the task of recording mineral occurrences as they were found, a reasonably good picture of Darwin mineralogy began to emerge.

Acanthite Ag_2S

Found in the sulfide ores of the *Defiance mine* (Czamanske and Hall, 1975).

Adamite $Zn_2(AsO_4)(OH)$

Zinc Hill mine: small green cuproadamite crystals have been found in the lower workings (Crowley, 1975).

Andradite $Ca_3Fe_2(SiO_4)_3$

A mineral of contact metamorphic origin found throughout the tactite orebodies in the *Thompson* and *Essex mines,* as well as other mines within the Darwin Hills.

Andorite $PbAgSb_3S_6$

Thompson mine, 400 level: as 0.08-inch crystals in calcite from the A437 stope.

Anglesite $PbSO_4$

One of the most widely distributed supergene lead minerals in the district.

Defiance mine, 400 level: as microcrystals in oxidized lead ore.

Essex mine, 200 level: as coatings on galena.

Thompson mine, 400 level, 481 stope: massive galena almost completely altered to anglesite.

Empress mine: found as an alteration of galena.

Anhydrite $CaSO_4$

Specimens of gypsum from the 1208 oxide stope of the *Defiance mine* upon their removal from the mine alter to anhydrite (Mueller, 1974).

Antlerite $Cu_3(SO_4)(OH)_4$

Defiance mine: associated with oxidized copper minerals above the 400 level.

Arsenopyrite FeAsS

This mineral has been found in almost every silver-lead mine in the district (Hall and MacKevett, 1962).

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

A very common mineral found in many of the mines having an appreciable amount of secondary zinc ore.

Custer mine group: as excellent blue-green crystals from a small prospect tunnel opposite the Custer mine headframe.

Defiance mine: found throughout the upper workings, mostly above the 400 level.

Zinc Hill mine: collected from the upper workings as microcrystals associated with hemimorphite.

Figure 9. **Aurichalcite with calcite from the Custer mine measuring 3 inches across. Collection of the author.**

Autunite $Ca(UO_2)_2(PO_4)_2 \cdot 12H_2O$

Reported from the *Zinc Hill mine* area as small crystals (Hall and MacKevett, 1962).

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

Defiance mine: as massive material found in the oxidized ores along the Micky Sommers fault.

Barite $BaSO_4$

Silver Reid mine: most of the gangue is made up of massive barite.

Bindheimite $Pb_2Sb_2O_6(O,OH)$

Reported from several of the mines in the Darwin area (Hall and MacKevett, 1962).

Bismuth Bi

Essex mine, 400 level: material analyzed from this level has shown minute, white, strongly anisotropic inclusions in galena and andorite which have been tentatively identified as native bismuth (Hall and MacKevett, 1958).

Bismuthinite Bi_2S_3

Durham mine, Fernando fault: as bladed masses associated with scheelite in the north end of the Durham orebody (Hall and MacKevett, 1958).

Bismutite $Bi_2(CO_3)O_2$

Durham mine: much of the bismuthinite present has been altered to bismutite.

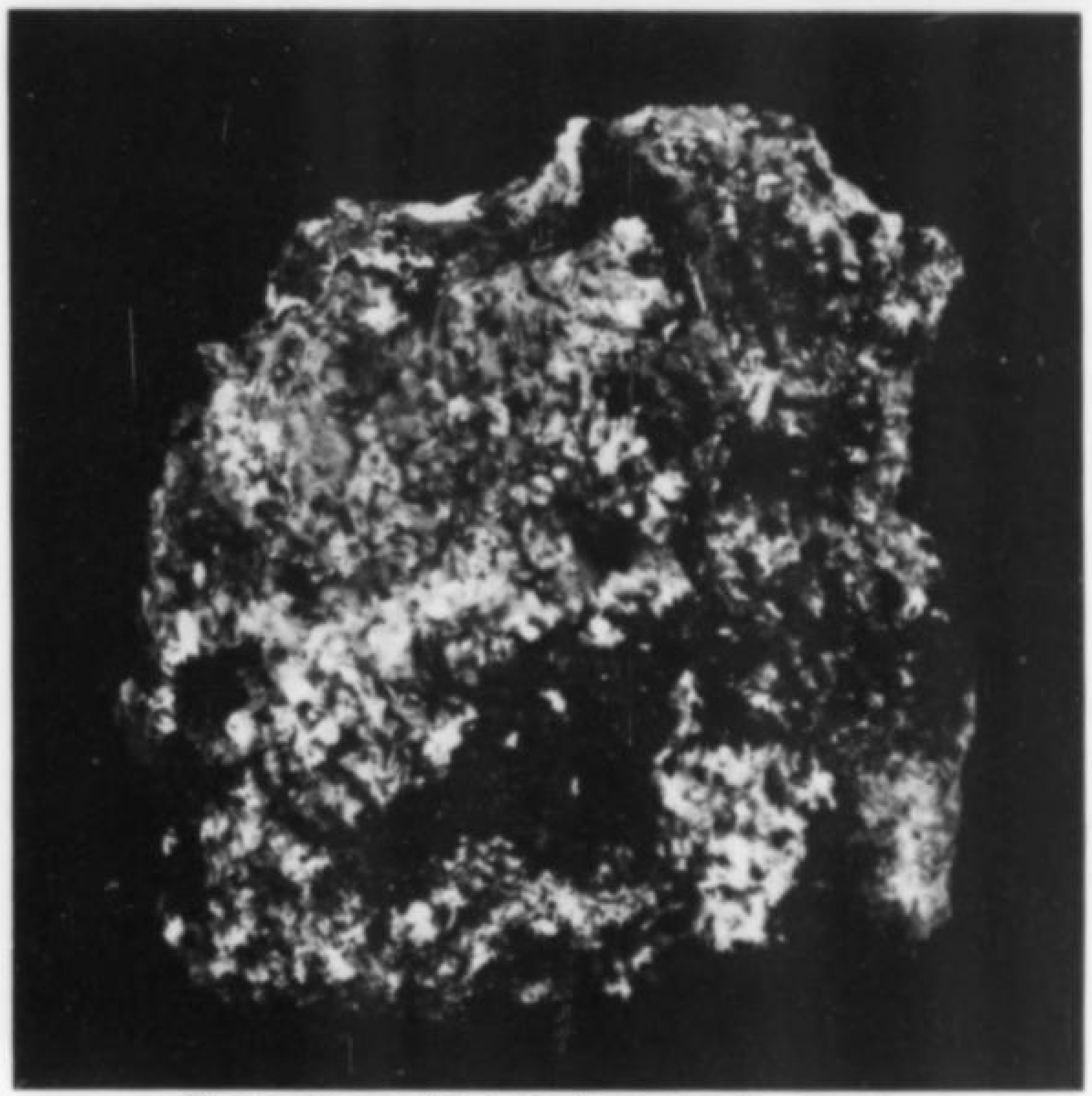

Figure 10. **Aurichalcite from the Custer mine, 2½ by 2 inches. Collection of the author.**

Bornite Cu_5FeS_4

Thompson mine: some of the unoxidized sulfide minerals contain masses of bornite and chalcopyrite.

Brochantite $Cu_4(SO_4)(OH)_6$

Lucky Lucy mine, located in Custer Canyon: has produced a sizeable amount of brochantite from its mine dumps.

Zinc Hill mine: as emerald green crystals in cavities within oxidized ore from the upper workings (Crowley, 1975).

Calcite $CaCO_3$

Found in great abundance throughout the mines of the district, however good specimens are hard to find.

Caledonite $Pb_5Cu_2(CO_3)(SO_4)_3(OH)_6$

Essex mine: associated with linarite as small turquoise-green crystals in oxidized ore from the mine dump.

Wonder mine: reported by Murdoch and Webb (1942).

Empress mine: material has been found at the north end of the deposit on the 4464 level.

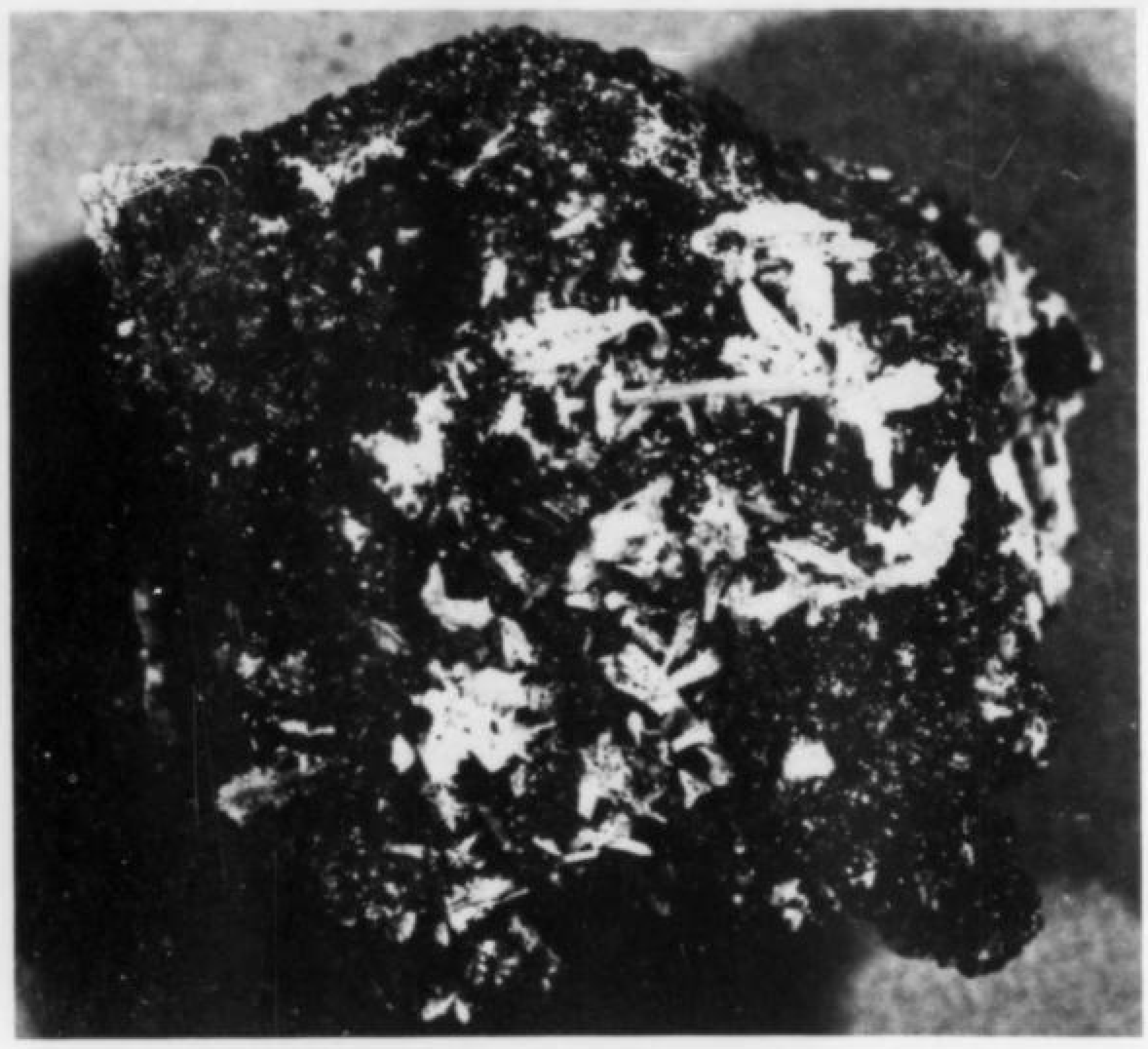

Figure 11. **Cerussite from the Thompson mine. Specimen and photo, Wayne Hall.**

Cerussite $PbCO_3$

This mineral constitutes the largest percentage of the oxidized lead ores mined in the district.

Defiance mine: has produced exceptional specimens from above the 400 level, as well as from the 1100 level.

Essex mine: white box-work crystals have been found in the near-surface stopes (J. Kennaberg, personal communication, 1982).

Thompson mine, 400 level, 481 stope: as microcrystals coating galena.

Cervantite SbO_4

Darwin Antimony mine: found as an alteration of stibnite on the mine dumps.

Chalcanthite $CuSO_4 \cdot 5H_2O$

Defiance mine, Radiore tunnel level: covering the upper part of several of the mine walls.

Chalcocite Cu_2S

Defiance mine, 570 level: as coatings on pyrite.

Thompson and *Essex mines:* reported from assays as a minor ore constituent in the sulfide orebodies (Hall and MacKevett, 1962).

Chalcopyrite $CuFeS_2$

Thompson mine, 3A level: a large mass of chalcopyrite was mined from here in the 1950's (J. Eastlick, personal communication, 1982).

Chlorargyrite AgCl

Thompson and *Essex mines:* as small crystals in oxidized ore (Hall and MacKevett, 1958).

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

This mineral is widespread in the mines of the district, although not generally found as spectacular specimens.

Clausthalite PbSe

Essex mine: X-ray analysis of ore samples taken from the mine indicates the presence of clausthalite (Hall and MacKevett, 1962).

Clinochrysotile $Mg_3Si_2O_5(OH)_4$

Defiance mine, 1100 level: as pale greenish yellow amorphous masses intergrown with montmorillonite (Hall and MacKevett, 1962).

Clinozoisite $Ca_2Al_3(SiO_4)_3(OH)$

This mineral is a common alteration product of the igneous intrusives in the Darwin district.

Conichalcite $CaCu(AsO_4)(OH)$

Reported from the upper workings of the *Zinc Hill mine* (Crowley, 1975).

Cosalite $Pb_2Bi_2S_5$

Found as small inclusions in silver-bismuth-rich galena (Czamanske and Hall, 1975).

Covellite CuS

Thompson mine: sooty coatings found on pyrite have been identified as covellite.

Creedite $Ca_3Al_2(SO_4)(F,OH)_{10}$

Although a rare mineral, it has been found as small white crystals in the *Thompson* and *Defiance mines* (Pabst, 1952), associated with pyrite, galena and fluorite.

Crocoite $PbCrO_4$

Reported as having been found in the *Darwin mines* (Hall and MacKevett, 1962).

Cuprite Cu_2O

Found in the oxidized lead ores in the *Darwin mines* associated with malachite (Hall and MacKevett, 1962).

Diopside $CaMgSi_2O_6$

All the mines in the Darwin Hills have substantial amounts of diopside present.

Defiance mine, 1100 level: as massive gangue material.

Enargite Cu_3AsS_4

Thompson mine, 500 level, 534 stope: as intermixed masses with galena and other sulfides.

Famatinite Cu_3SbS_4

Found in polished sections from the *Darwin mine* (Hall and MacKevett, 1958).

Fluorite CaF_2

Essex mine: large amounts of purple fluorite were mined along with the silver-bearing galena and many specimens can be found on the mine dumps.

Thompson mine, 3A level: as purple masses associated with massive galena and sphalerite.

Galena PbS

This is the predominant sulfide mineral found in the district; it occurs as coarsely crystallized cubes and masses as well as fine-grained "steel" galena.

Figure 12. **Gypsum crystal from the 500 level of the Thompson mine, approximately 2 inches tall. Collection of the author.**

Figure 13. **Gypsum crystal group measuring 5½ inches across from the 500 level of the Thompson mine. Collection of the author.**

Gold Au

In Darwin, gold has been recovered only as a trace element, however, an analysis of a high silver-bismuth-bearing galena which occurred in very small quantities in the *Thompson mine,* 400 level, assayed as much as 10 ounces of gold per ton (Hall, 1971).

Goslarite $ZnSO_4 \cdot 7H_2O$

Reported from the *Darwin mines* as well as others in the area (Hall and MacKevett, 1958).

Guanajuatite Bi_2Se_3

The analysis of several galena samples from the *Thompson* and *Essex mines* indicates the presence of guanajuatite (Hall and MacKevett, 1958).

Gustavite $AgPbBi_3S_6$

Reported as small inclusions in silver-bismuth-rich galena from the *Darwin mines* (Czamanske and Hall, 1975).

Gypsum $CaSO_4 \cdot 2H_2O$

Although this mineral is common to many of the mines in the area, exceptional crystals are limited to just a few locations.

Thompson mine, 500 level: as excellent water-clear, perfectly terminated crystals, these range in size from 1 to 6 inches in length.

Defiance mine, 570 level: just off the inclined shaft are found crystals of selenite up to 3 inches in a crumbly oxide mass with unaltered pyrite.

Hematite Fe_2O_3

Small crystals of specular hematite have been found in the Talc City Hills.

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

A common mineral closely associated with the other oxidized zinc minerals in the district.

Defiance mine: well crystallized specimens are found on the Radiore tunnel level near the main shaft.

Zinc Hill mine, upper workings: contain substantial amounts of hemimorphite.

Hydrozincite $Zn_5(CO_3)_2(OH)_6$

Zinc Hill mine: microcrystals of hydrozincite associated with hemimorphite are found in the lower workings.

Custer mine: as white microcrystals coating calcite from a small prospect tunnel opposite the main Custer mine headframe.

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

Widespread throughout the oxide zones of most of the mines in the district.

Leadhillite $Pb_4(SO_4)(CO_3)_2(OH)_2$

A rare mineral found in the upper oxide zone of the *Empress mine,* associated with caledonite and cerussite (J. Crowley, personal communication, 1983).

"Limonite" FeO(OH)

Custer mine: excellent pseudomorphs of limonite after pyrite are found on the dumps and inside the prospect tunnel opposite the main Custer mine headframe.

Defiance mine: limonite after pyrite specimens can be found near the entrance to one of the inclined shafts on the surface.

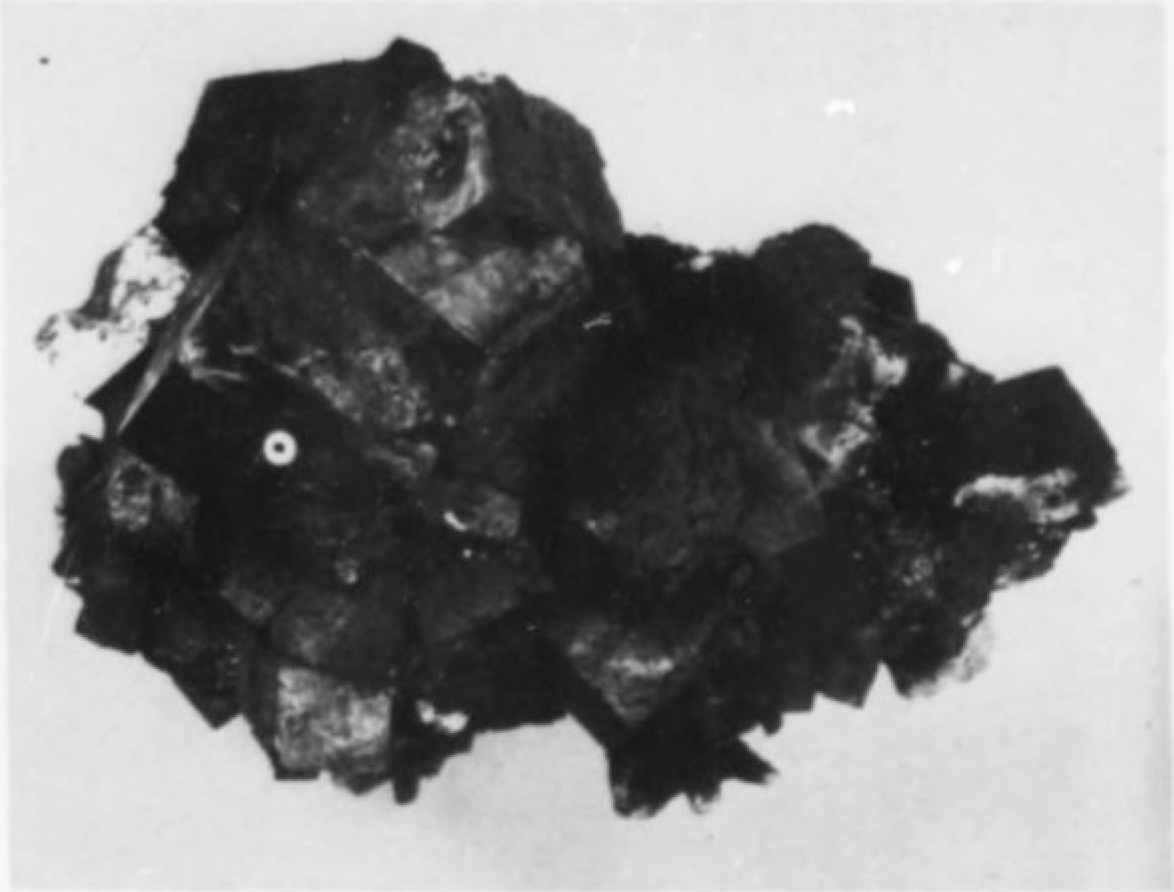

Figure 14. **Limonite after pyrite from the Custer mine, about 3 by 1¾ inches. Collection of the author.**

Linarite $PbCu(SO_4)(OH)_2$

Essex mine: as deep blue crystals lying flat on matrix, which were mined from the 100 level. Some specimens have caledonite associated with them.

Defiance mine, Radiore tunnel level: linarite specimens have come from a stope above the cap magazine.

Figure 15. **Linarite from the Essex mine, approximately 2½ by 1¾ inches. Collection of the author.**

Malachite $Cu_2(CO_3)(OH)_2$

Associated with the oxidized copper ores in the *Defiance mine.*

Zinc Hill mine: the upper workings produced a fair amount as massive material.

Matildite $AgBiS_2$

Essex mine: polished sections of galena have been analyzed and inclusions of matildite were identified (Hall and MacKevett, 1962).

Melanterite $FeSO_4 \cdot 7H_2O$

A common post-mining mineral found in many of the mines in the area.

Mimetite $Pb_5(AsO_4)_3Cl$

Zinc Hill mine: microcrystals of mimetite associated with wulfenite have come from the upper workings.

Defiance mine: reported by Pemberton (1983).

Minium PbO

Specimens of oxidized ore from the *Thompson* and *Essex mines* carry small amounts of minium (Carl Austin, personal communication, 1982).

Montmorillonite $(Na,Ca)(Al,Mg)_2Si_4O_{10}(OH) \cdot nH_2O$

Defiance mine: amorphous greenish yellow masses of montmorillonite have been identified associated with clinochrysotile (Hall and MacKevett, 1962).

Orthoclase $KAlSi_3O_8$

Defiance mine: observed throughout the mine associated with the replacement orebodies.

Paraspurrite $Ca_5(SiO_4)_2(CO_3)$

Reported in a calc-silicate body in a roof pendant near the town of *Darwin* (Colville and Colville, 1977).

Plumbojarosite $PbFe_6(SO_4)_4(OH)_{12}$

Thompson mine: considerable plumbojarosite was mined from the upper oxide zone (Carl Austin, personal communication, 1982).

Pseudomalachite $Cu_5(PO_4)_2(OH)_4 \cdot H_2O$

Reported from the *Darwin mines* (Hall and MacKevett, 1962).

Pyrite FeS_2

Essex mine, 400 level: large crystals to 1½ inches embedded in calcite.

Defiance mine, 570 level, near the inclined shaft: as crystals up to 3 inches.

Thompson mine, 3A level: as bright cubes in calcite, some up to 2 inches.

Pyrolusite MnO_2

Defiance mine: reported in samples collected from the 1208 oxide stope (Mueller, 1974).

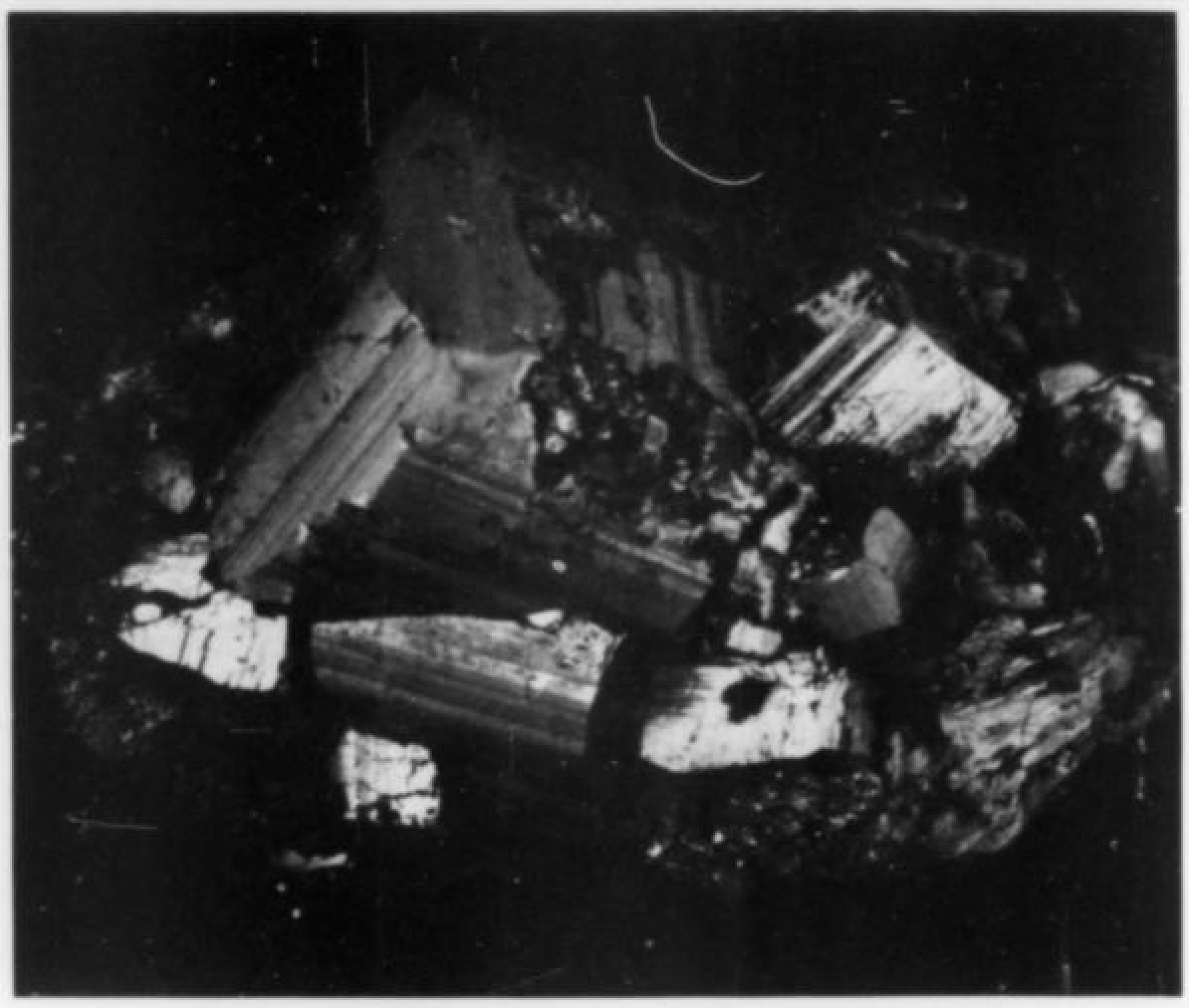

Figure 16. **Pyrite from the 570 level of the Defiance mine, about 3 inches across. Collection of the author.**

Pyromorphite $Pb_5(PO_4)_3Cl$

Reported from the *Darwin mines* (Hall and MacKevett, 1962).

Pyrrhotite $Fe_{1-x}S$

Thompson mine, 3A level: as massive material associated with galena.

Independence mine: found between the 500 and 700 levels below the Davis thrust fault (Hall, 1971).

Quartz SiO_2

A very common mineral in the orebodies within the district; un-

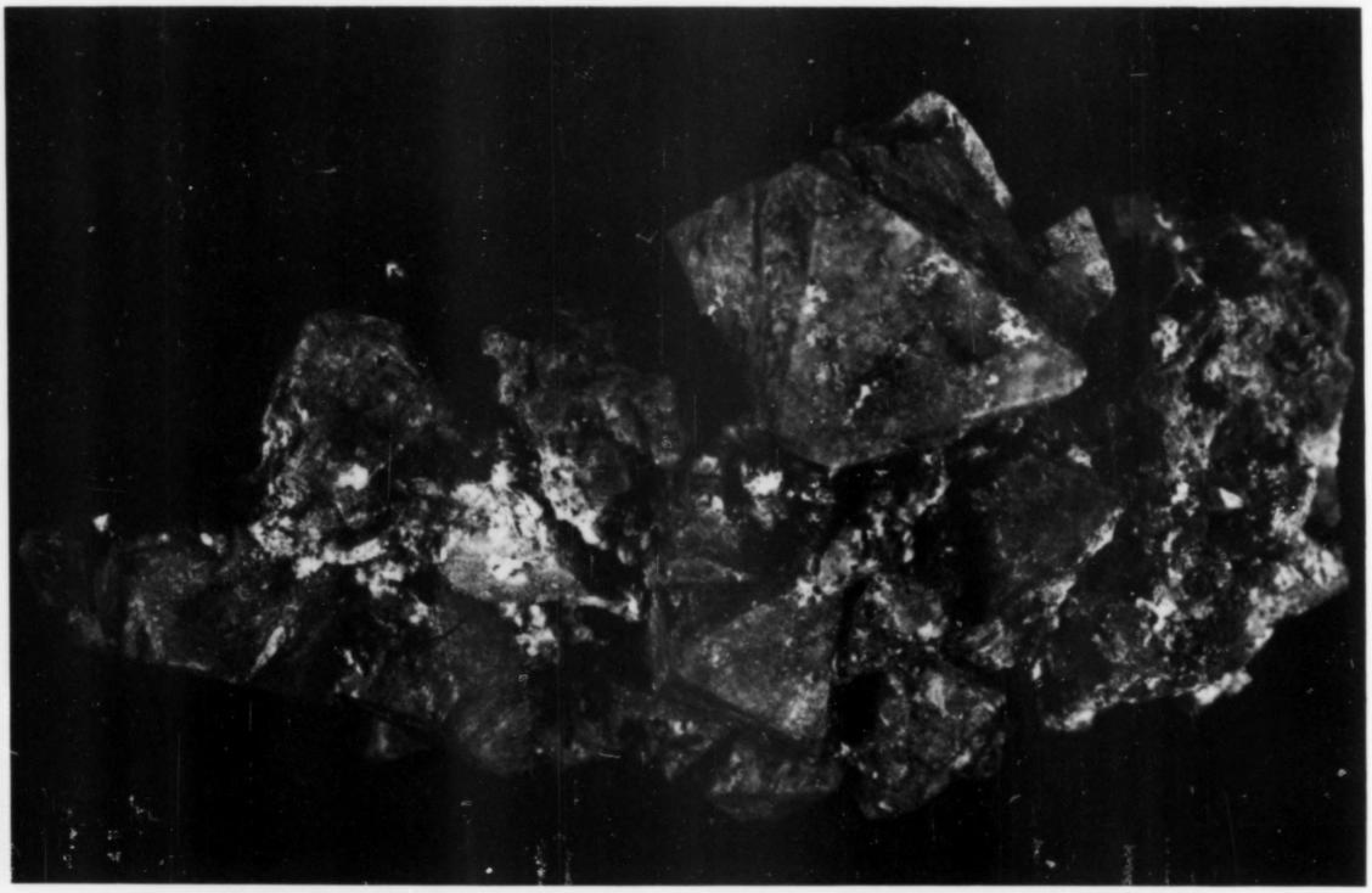

Figure 17. **Scheelite crystals from the Thompson mine; large crystal is 1 inch across, the entire specimen is 3⅛ inches across. Collection of the author.**

fortunately most crystals tend to be poorly formed and small. Common as jasper gangue material.

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

Zinc Hill mine: found associated with azurite and hemimorphite.

Scheelite $CaWo_4$

The mineral scheelite is found throughout the mines in the Darwin hills.

Independence mine: small scheelite crystals have been found loosely embedded in limonite.

Thompson mine, 100 level: material collected from a stoped area between the 100 and 200 levels contained subhedral and euhedral crystals measuring ⅜ to ¾ of an inch in a jarosite and calc-silicate matrix.

Schirmerite $AgPb_2Bi_3S_7$

Reported from samples of high silver-bismuth galena from the *Darwin mines* as small inclusions within the galena (Czamanske and Hall, 1975).

Senarmontite Sb_2O_3

Reported from the *Darwin Antimony mine* (J. F. Cooper, personal communication, 1982).

"Sericite" $(H,K)AlSiO_4$

Found as a common alteration mineral associated with the many fault zones in the Darwin Hills.

Serpierite $Ca(Cu,Zn)_4(SO_4)_2(OH)_6 \cdot 3H_2O$

Lucky Lucy prospect: as pale blue needles in a tactite matrix associated with brochantite.

Siderite $FeCO_3$

A specimen in the California Division of Mines collection was collected from the *Custer mine.*

Silver Ag

Native silver has been found on the 100 level of the *Thompson mine* (J. Eastlick, personal communication, 1982).

Smithsonite $ZnCO_3$

Zinc Hill mine: a significant portion of the upper workings orebody was made up of smithsonite. Botryoidal masses of light green to white smithsonite are found lining vugs and pockets within massive ore.

Sphalerite ZnS

Distributed in about the same abundance as galena in the mines of the Darwin area. Large tonnages were mined from the *Defiance, Independence* and *Thompson mines;* unfortunately all of the material was massive.

Stannite Cu_2FeSnS_4

Reported from the *Thompson mine* associated with matildite and galena (Hall and MacKevett, 1962).

Stibiconite $Sb_2O_6(OH)$

Found as an alteration mineral at the *Darwin Antimony mine.*

Stibnite Sb_2S_3

Darwin Antimony mine: this is the only occurrence of an antimony ore in the district. Stibnite is found as long, bladed crystals embedded in calcite. Some of the stibnite is altered to cervantite.

Stolzite $PbWO_4$

Reported from the *Thompson mine* (Tucker and Sampson, 1941).

Sulfur S

Found throughout the mines of the district, usually as a fine yellow powder. Occurs in the *Darwin mines* (J. Crowley, personal communication, 1983).

Tennantite $(Cu,Fe)_{12}As_4S_{13}$

Reported from galena samples collected from the *Darwin mines* (Kelley, 1937).

Tenorite CuO

Associated with the oxidized copper ores of the *Defiance* and *Thompson mines.*

Tetradymite Bi_2Te_2S

Thompson mine: as small inclusions in galena (Czamanske and Hall, 1975).

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

A silver-rich material collected from the *Darwin mines* indicates the presence of freibergite (Czamanske and Hall, 1975). Reported from samples collected from the *Darwin mines* (Carlisle *et al.*, 1954).

Titanite $CaTiSiO_5$

Found as fair sized crystals in the tactite orebodies in the *Thompson, Essex* and *Independence mines* (Kelley, 1937).

Valentinite Sb_2O_3

Reported from the *Darwin Antimony mine* (J. F. Cooper, personal communication, 1982).

Vanadinite $Pb_5(VO_4)_3Cl$

Reported from the *Darwin mines* (Hall and MacKevett, 1962).

Vesuvianite $Ca_{10}Mg_2Al_4(SiO_4)(Si_2O_7)_2(OH)_4$

A major constituent of the calc-silicate rocks most commonly associated with the intrusive contact zones.

Vivianite $Fe_3(PO_4)_2 \cdot 8H_2O$

Vivianite crystals on quartz have been reported from the *Darwin mines* (Murdoch and Webb, 1956).

Wollastonite $CaSiO_3$

One of the most abundant minerals contained in the calc-silicate rocks associated with the contact intrusives. Some crystals found reach 6 inches in length.

Wulfenite $PbMoO_4$

Thompson mine, 400 level, 481 stope: as bright orange microcrystals covering a limonite matrix.

Zinc Hill mine: the upper workings have produced some excellent microcrystals of wulfenite with mimetite.

Empress mine: as bright yellow crystals to about ⅛ inch in interlocking masses (J. Crowley, personal communication, 1983).

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minerals of the
Pereta Mine
Tuscany, Italy

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The Pereta mine, type locality for peretaite, was first exploited by the Etruscans in the First Century B.C. It has lately yielded superb stibnite crystals to 80 cm (31 inches) and some interesting secondary antimony minerals.

INTRODUCTION

Southern Tuscany contains a number of ore deposits, but the only ones of mineralogical interest are the antimony localities, where stibnite has weathered into a variety of secondary minerals.

The Pereta mine is located between Manciano and Grosseto just a few kilometers from the Mediterranean coast, in a relatively unexplored wilderness area near Maremma Grossetana. From the town of Scansano one takes the road south to the abandoned cinnabar mine at Cerreto Piano. About 4 km later the Giuseppe farmstead is passed, and the mine road leads off to the right, for about 2 km, to the mine. The deposit is located on the Turbone River, in Albegna Valley, a total of 8 km from Scansano and 2 km from the village of Pereta.

HISTORY

The sulfur zone near Pereta has been exploited intermittently since the First Century B.C., when it was worked by the Etruscans (Niccolai, 1972). Later the Romans, under Augustus, took over the workings during their war against Pyrrhus. Long periods of history are obscure, but it is known that the mine was worked under the Earldoms of the Aldobrandeschi family in 1274, and the Sforza family in 1450. The Grand Dukes of Lorena mined the deposit in 1735, as did Napoleon in 1816 and Grand Duke Leopold II in 1824. Mining was permanently halted in 1946 following the death of six miners from poisonous gas.

The area was originally mined for sulfur, especially during the French occupation, and during the war with Naples when the Sicilian sulfur mines were closed. Sulfur forms in seams associated with numerous fumaroles in the area. The geologist G. Santi visited the area in 1795 and noted that iron oxide and stibnite occurred mixed with the sulfur ore. Stibnite was considered a serious contaminant.

The first person to suggest mining for stibnite at Pereta was the Frenchman M. H. Coquand (1848), who began excavating a layer of quartz under the sulfur in 1840. Coquand obtained a high yield of relatively pure stibnite from geodes scattered throughout the quartz layer.

It happens that Coquand was also a mineral collector, and he recorded a great deal of interesting information. For example, he wrote in 1848: "In 1843 I discovered a geode containing stibnite in large, divergent crystals. I recovered hundreds of pounds of splendid crystal groups which surpass those in public exhibitions. The crystals are rhombic prisms terminated by four faces, like those illustrated by Häuy. One example measures 40 cm. I can say that the crystals in my collection are sufficient to impress even the most discerning mineralogists and crystallographers." A few of Coquand's specimens still exist in the university museums at Rome and Pisa, but unfortunately most have been lost.

In 1979 a large exploratory trench was excavated on the site; other than this, no work has been done in recent times.

GEOLOGY

The Pereta deposit, like other antimony deposits in Tuscany, appears to be of Pliocene-Quaternary age, and occurs in a Triassic complex of limestones (Dessau *et al.*, 1972). The limestones vary from clayey and marly calcareous varieties, some cavernous, to highly silicified types consisting almost entirely of silica. Stibnite mineralization seems to have favored the latter type, and has been

Figure 1. **Location map showing Tuscany, and the Pereta and Cetine mines (see article on the Cetine mine elsewhere in this issue).**

Figure 2. **Location map.**

classified as epithermal. Mineralizing solutions penetrated fractures and porous limestones until being blocked by impermeable clayey layers; stibnite was then deposited in vugs and fissures. Roedder found, from a study of fluid inclusions, that deposition probably took place at a depth exceeding 200 m. The deposit which resulted measures more than 300 m in length and extends to a depth of between 5 and 15 m.

Continued thermal activity at depth is still evident from heavy CO_2 emissions and sulfuric acid solutions which have contributed to the formation of the secondary mineral suite.

MINERALS

Barite $BaSO_4$

Barite occurs rarely at Pereta as small, white to brown tabular crystals.

Cervantite $Sb^{+3}Sb^{+5}O_4$, and **Stibiconite** $Sb^{+3}Sb_2^{+5}O_6(OH)$

These minerals occur as yellow to yellow-brown encrustations on stibnite. In the surface workings, crystals of stibnite to 15 cm were found completely covered with cervantite and stibiconite.

Cinnabar HgS

Cinnabar occurs in only a few stopes, always as massive material of little interest.

Fluellite $Al_2(PO_4)F_2(OH)\cdot 7H_2O$

Fluellite has been found as small, white, spherical concretions on quartz and stibnite, in association with minyulite (Menchetti and Sabelli, 1981).

Fluorite CaF_2

Fluorite is not common at the Pereta mine. Crystals range up to 1.5 cm in size, are generally colorless, and occur on quartz crystals.

Figure 3. **The Pereta mine in 1979; the pit intersects ancient workings.**

Figure 4. **White fluellite coatings on stibnite crystals (4 mm across). Scortecci specimen and photo.**

Goethite α-$Fe^{+3}O(OH)$

Goethite is rather rare, and occurs as small, rounded, iridescent concretions on quartz, sometimes associated with red valentinite.

Gypsum $CaSO_4 \cdot 2H_2O$

Though not especially common, tabular to long prismatic crystals of transparent gypsum in quartz geodes are not difficult to find. Crystal size varies from a few millimeters to about 3 cm.

Halotrichite $Fe^{+2}Al_2(SO_4)_4 \cdot 22H_2O$

Halotrichite is common at the Pereta mine as small, acicular crystals and white encrustations.

Kermesite Sb_2S_2O

Kermesite occurs as wine-red crusts on stibnite and quartz crys-

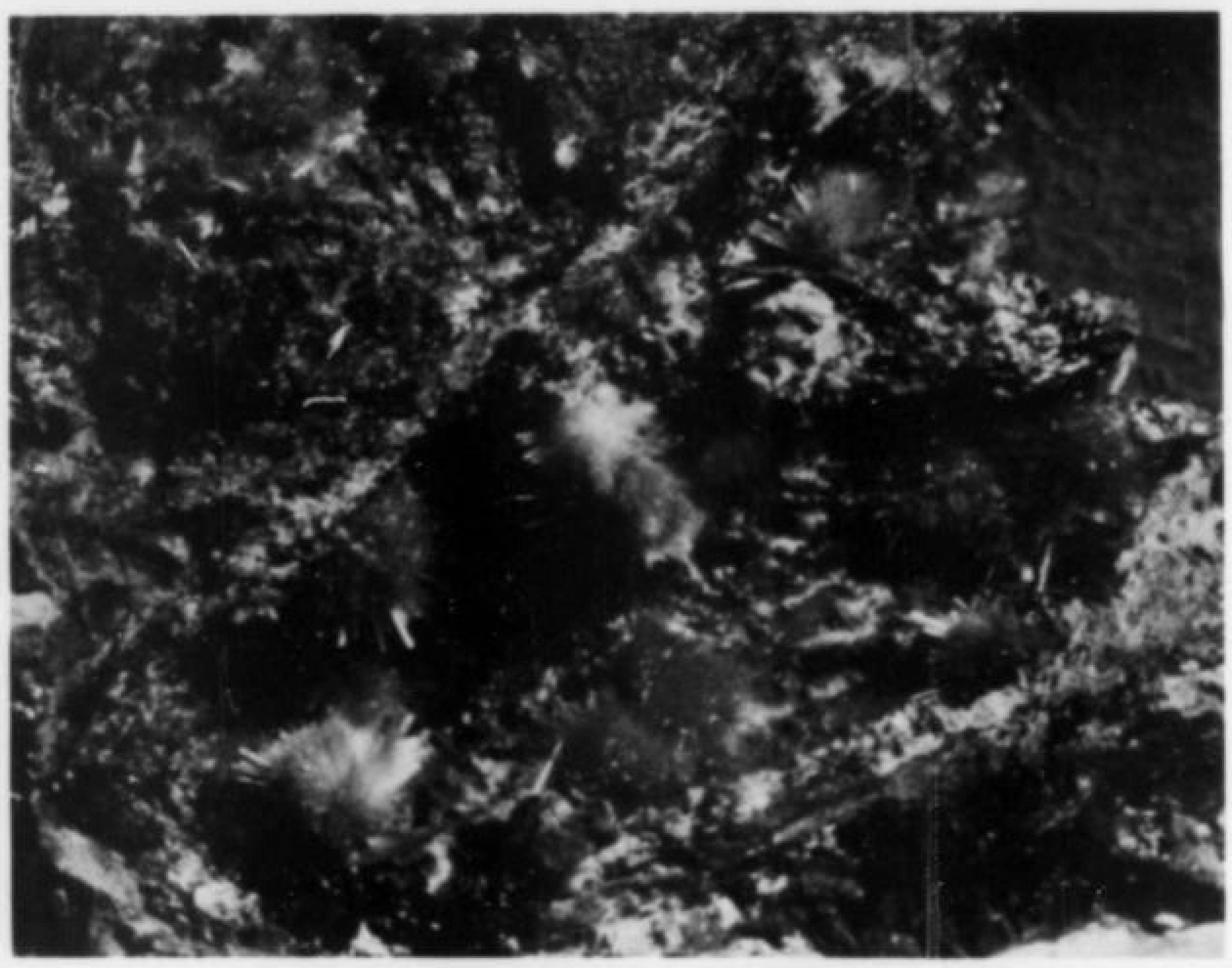


Figure 6. **Tufts of yellow klebelsbergite crystals about 5 mm across. Scortecci specimen and photo.**

Figure 5. **Red klebelsbergite crystals about 4 mm long. Scortecci specimen and photo.**

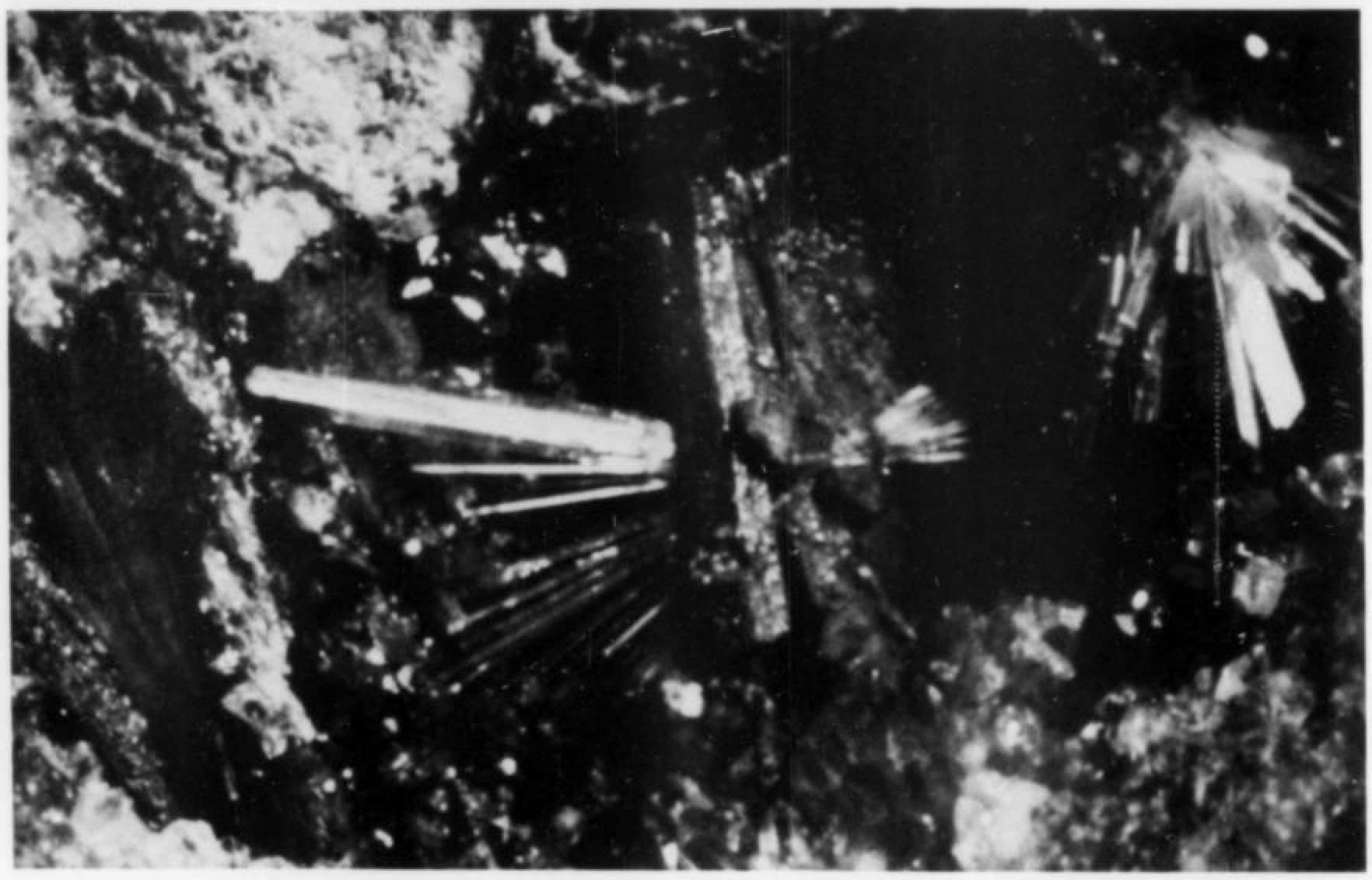
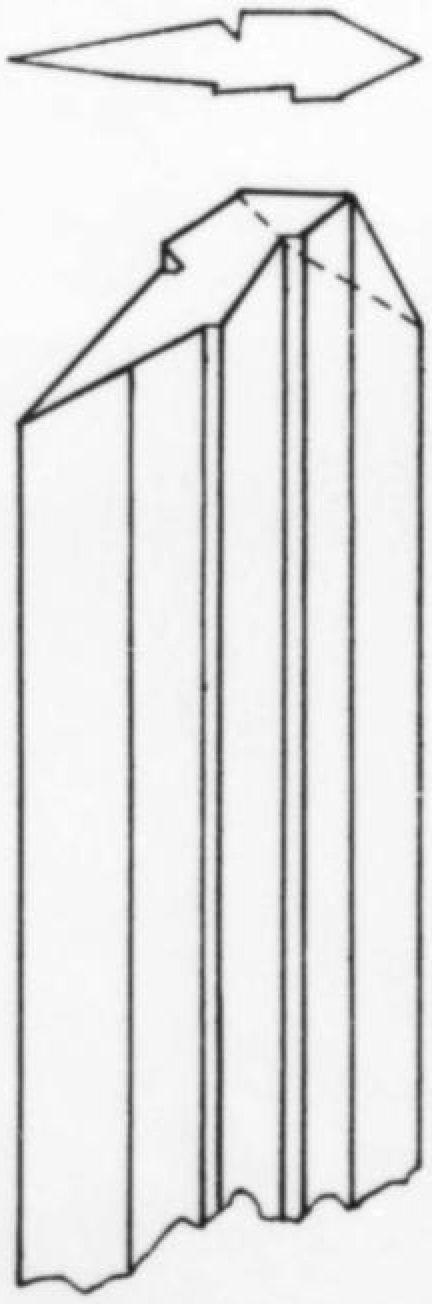
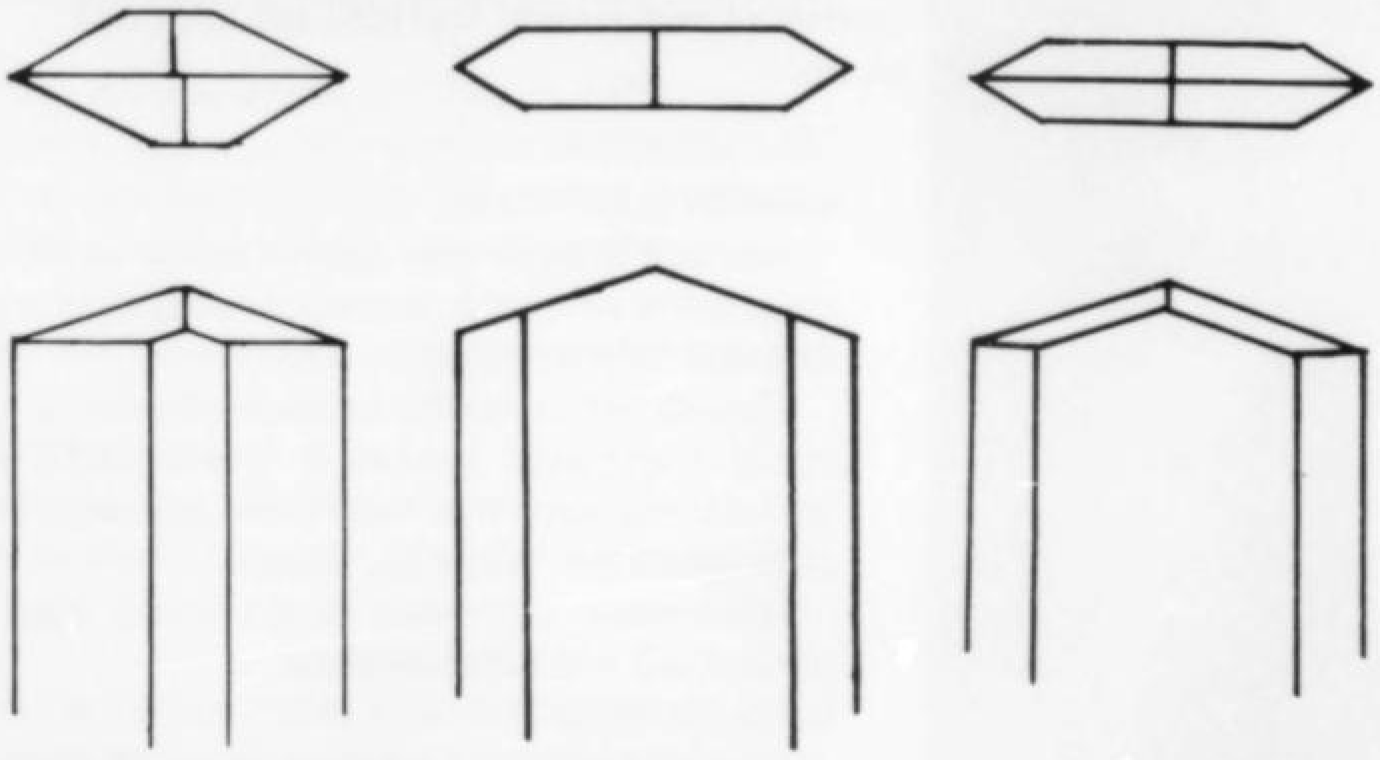


Figure 7. **Colorless klebelsbergite crystals to 4 mm on red, valentinite-coated stibnite. Scortecci specimen and photo.**

Figure 8. **Crystal sketches of klebelsbergite habits.**





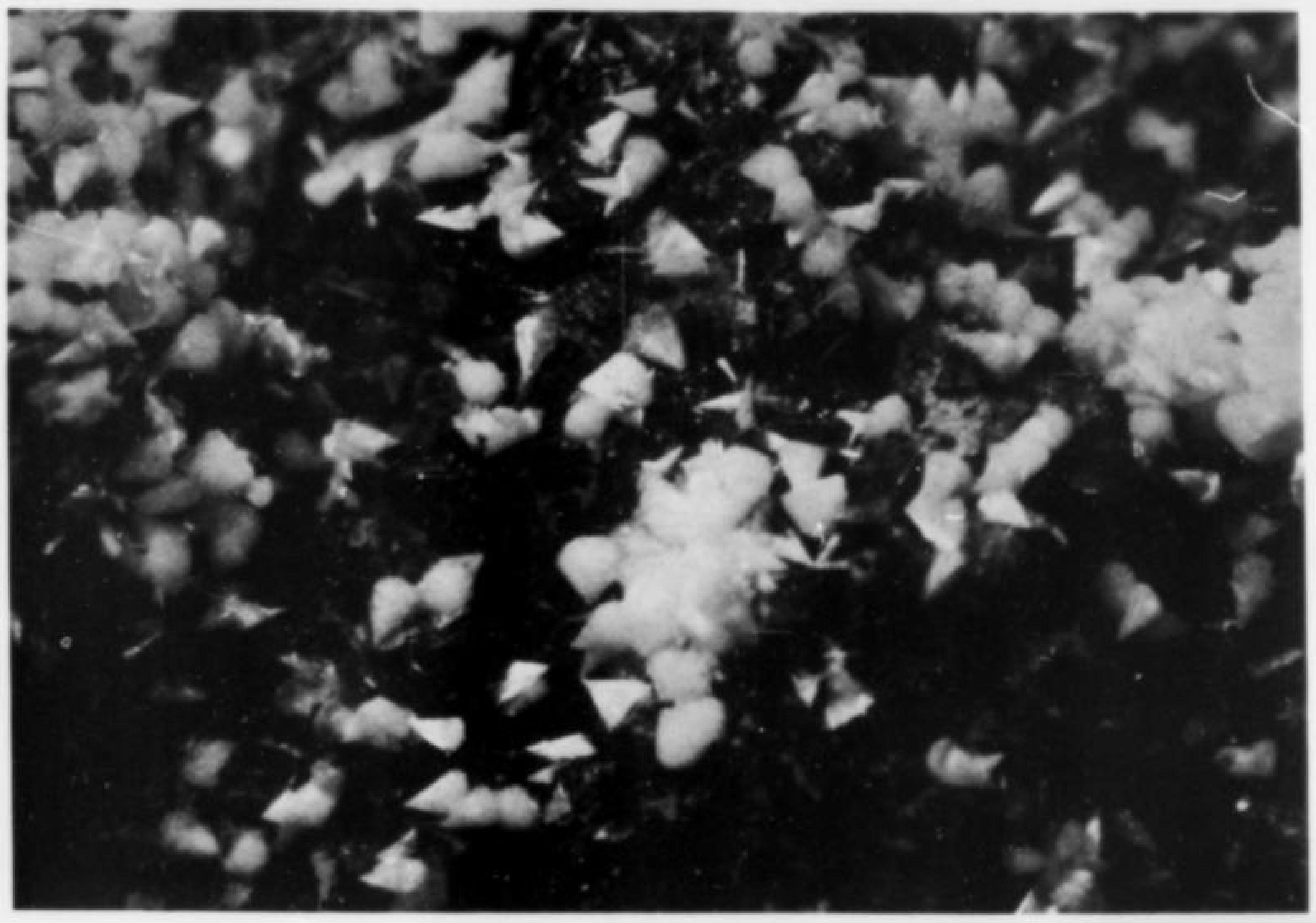


Figure 9. **White minyulite crystal sprays to 0.5 mm. Scortecci specimen and photo.**

Figure 10. **Colorless peretaite crystal 3 mm long, with a spray of acicular yellow klebelsbergite. Scortecci specimen and photo.**

tals. Nevertheless, most of what has been called kermesite is actually valentinite; kermesite is relatively rare.

Klebelsbergite $Sb_4^{+3}O_4(OH)_2(SO_4)$

Klebelsbergite is among the most interesting minerals at the Pereta mine. The first specimens were found by one of us (MT) on the dumps in 1978 (Cipriani *et al.*, 1980). Subsequently the mineral has been found in abundance, always in association with stibnite and sometimes with quartz.

Klebelsbergite occurs in prismatic crystals elongated on [100], transparent, white to yellow and rarely red, commonly flattened and striated parallel to the elongation, and measuring up to 2 cm in length. Virtually all crystals are well-terminated and form in radial aggregates. In a few of the yellow aggregates several of the crystals are markedly longer than the others.

Marcasite FeS_2

Marcasite occurs rarely as small, iridescent, metallic yellow crystals.

Minyulite $KAl_2(PO_4)_2(OH,F)\cdot 4H_2O$

Minyulite was found recently as very fine crystals associated with fluellite (Menchetti and Sabelli, 1981). It occurs as small, spherical aggregates of acicular, white to green crystals up to 4 mm in length on stibnite and quartz. The crystals are elongated on [001] and show well-developed {110} prism faces terminated by rounded faces.

Peretaite $CaSb_4^{+3}O_4(OH)_2(SO_4)_2\cdot 2H_2O$

Peretaite was first found at the Pereta mine by us in 1978; it was subsequently studied at the universities in Pisa and Firenze by Cipriani, Menchetti, Orlandi and Sabelli, who described it as a new species in 1980.

The first samples found consisted of spheroidal aggregates of tabular, white crystals to 2 mm across. Later samples, found during 1979, are well-formed, transparent, short prismatic to tabular on {100} and very thin. Most are colorless but a few are colored red by inclusions of valentinite. Though found in association with the abundant klebelsbergite, peretaite is very rare and only a few specimens are known. The crystals are generally between 1 and 5

Figure 11. **Peretaite crystals to 2 mm on stibnite. Scortecci specimen and photo.**

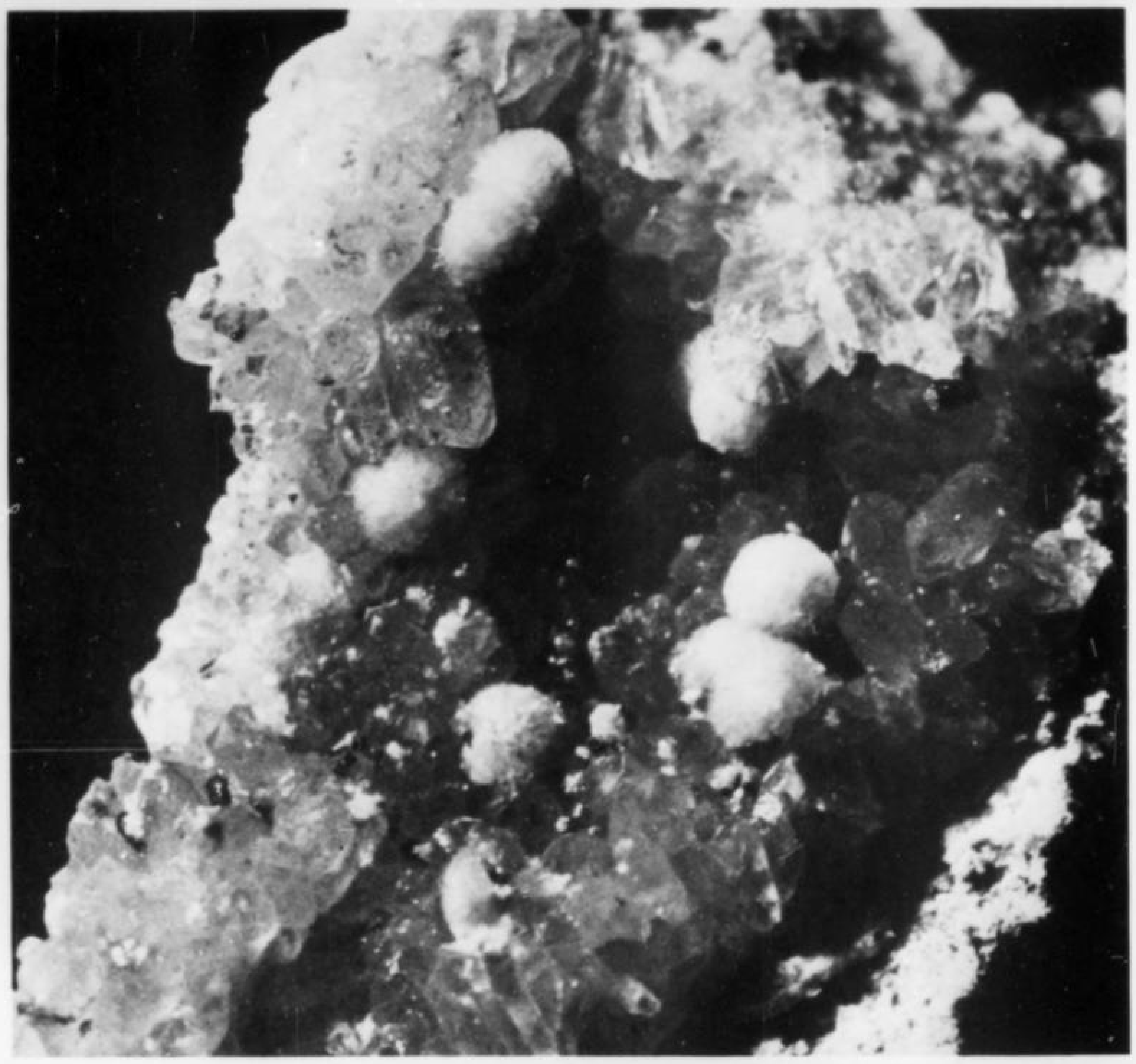


Figure 12. **Globular tufts of white peretaite 0.5 mm across on quartz. This is one of the first specimens ever found of the species, which we collected in 1978. Scortecci specimen and photo.**

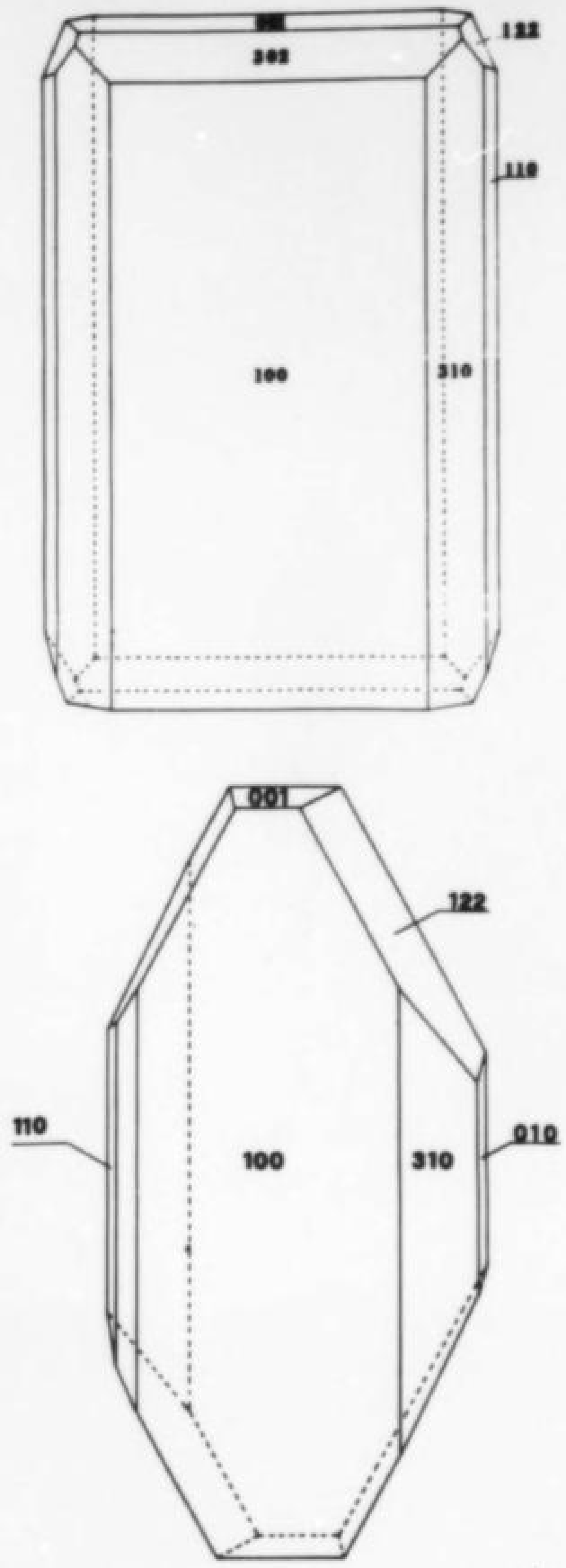


Figure 13. **Peretaite crystal drawings (Cipriani *et al.*, 1980).**

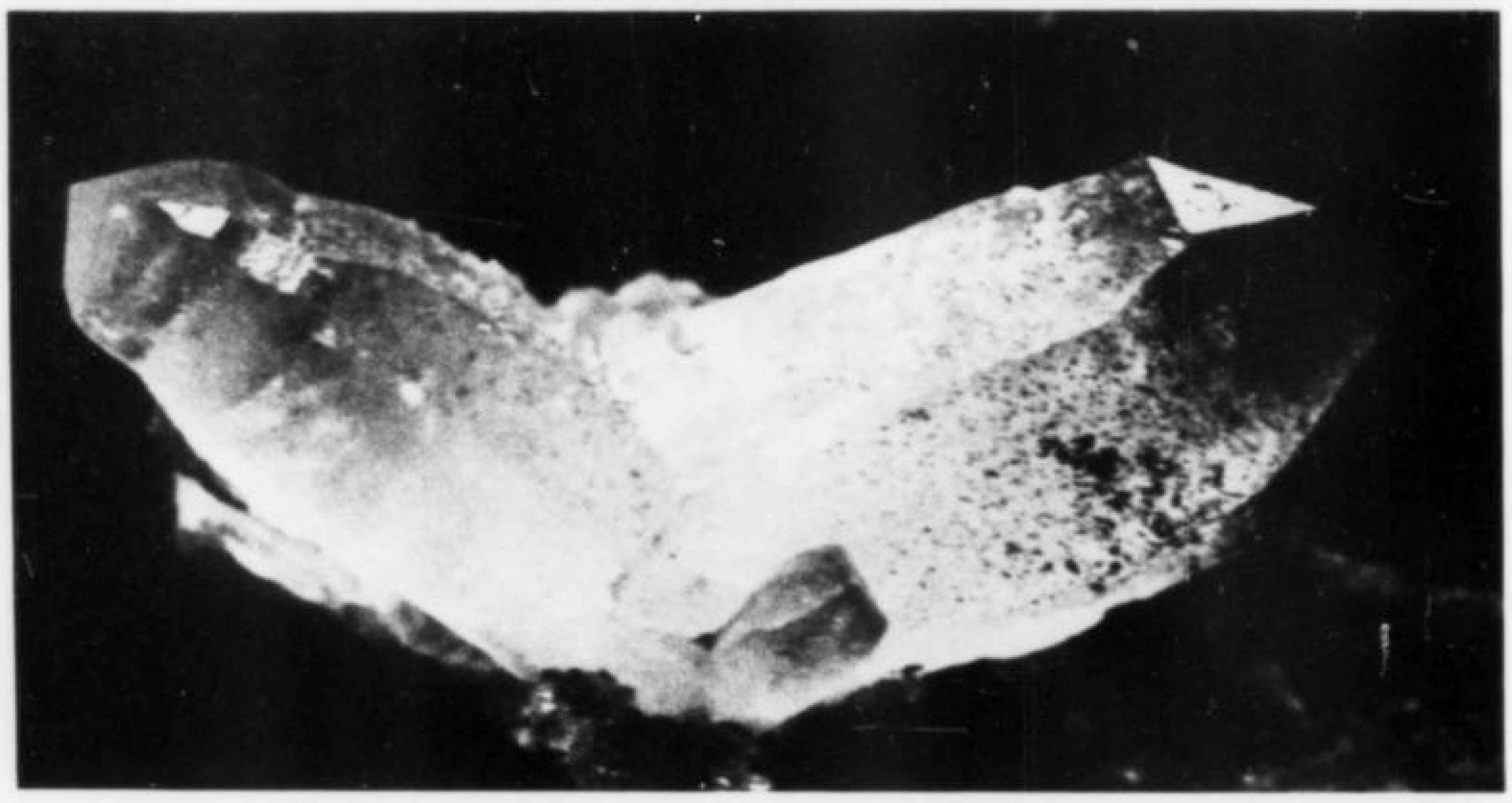


Figure 14. **A group of quartz crystals 3 cm across from the Pereta mine. Scortecci specimen and photo.**

mm in size. Associations include stibnite, klebelsbergite, quartz, calcite, gypsum, valentinite, pyrite, kermesite and sulfur. Some crystals have been found in cavities in columnar stibnite.

Peretaite is probably the result of sulfuric acid solutions reacting with stibnite and limestone.

Pyrite FeS_2

Pyrite occurs sparsely as small crystals to a few millimeters. Coquand (1848) reported finding samples having stalactitic and concretionary habits like those found at the nearby Tafone mine.

Quartz SiO_2

Quartz is common at the Pereta mine, where it is found as tapering crystals from a few millimeters to 5 cm in size. Quartz occurs intimately intergrown with stibnite, suggesting simultaneous crystallization.

Senarmontite Sb_2O_3

Senarmontite occurs in small (to 1.5 mm), transparent, lustrous, colorless to light brown octahedral crystals on quartz and stibnite. Associations include quartz (with which it is easily confused), klebelsbergite, valentinite and stibnite.

Stibnite Sb_2S_3

As mentioned in the history section, superb crystals to 40 cm (16 inches) were found in 1843, and crystals measuring 50 cm, but completely covered by valentinite, were found in 1979. Early writings mention a few crystals measuring up to 80 cm. The crystals are prismatic, sometimes hollow (the central cavity being lined with a variety of minerals including klebelsbergite and peretaite) and terminating in an open trough. Smaller crystals, well-formed and very lustrous, occur in quartz-lined vugs in the limestone.

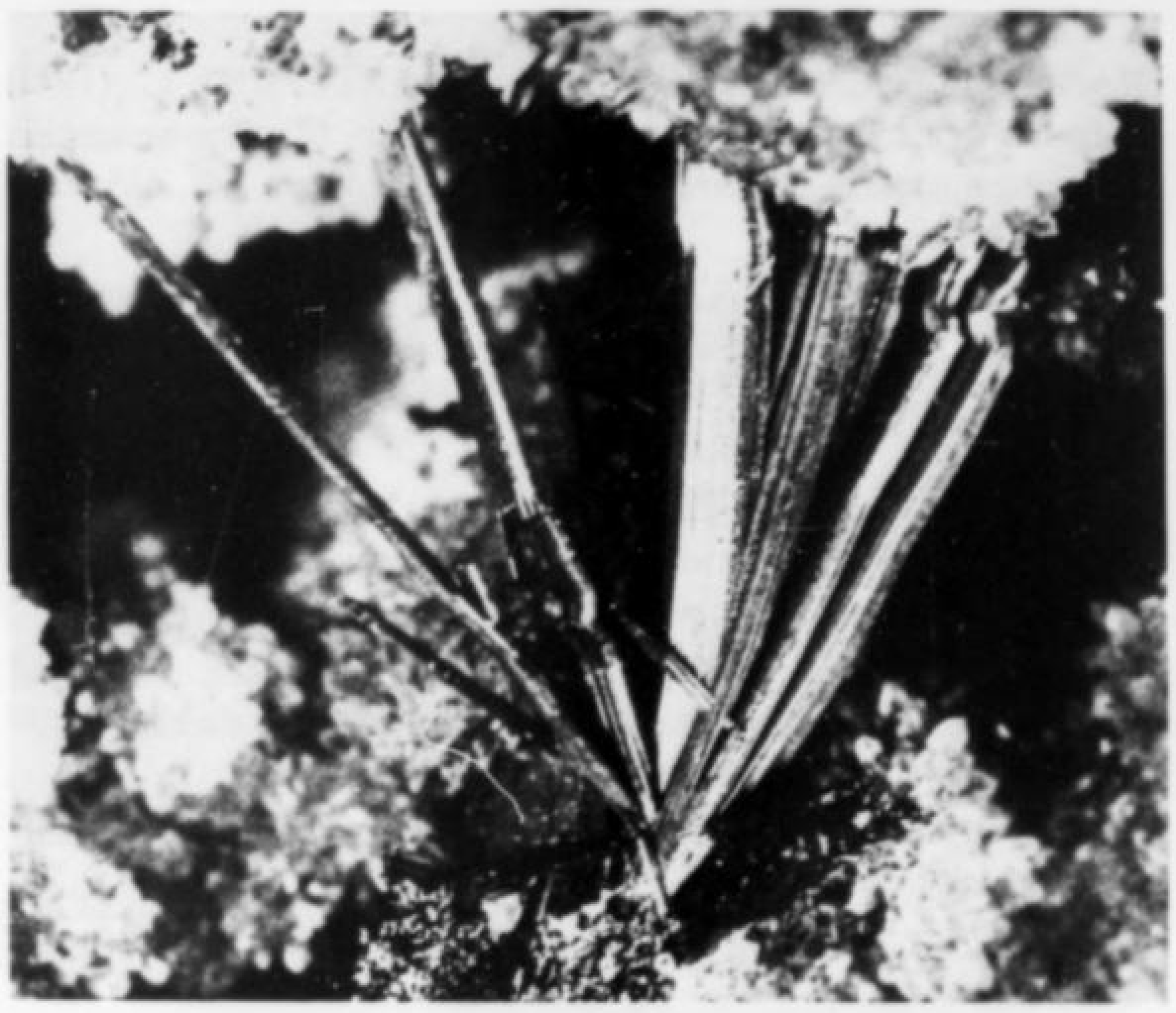
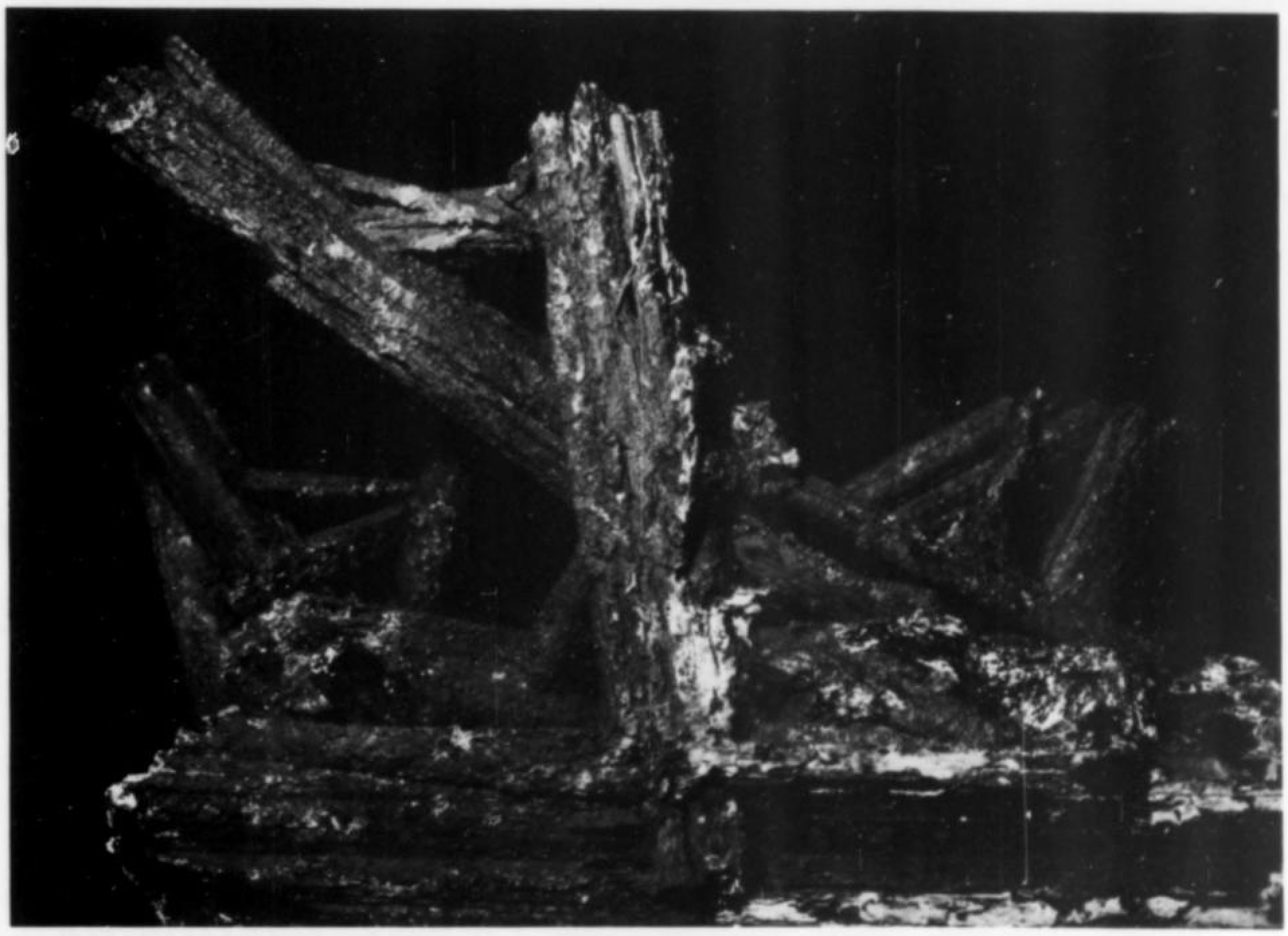


Figure 15. Lustrous stibnite crystals to 2 cm spanning a quartz-lined vug. Scortecci specimen and photo.

Figure 16. Red valentinite coating stibnite crystals 6 cm long. Tazzini specimen and photo.

Figure 17. Red valentinite coating large stibnite crystals to 15 cm. Scortecci specimen and photo.



A small amount of stibnite seems to have formed as a post-mining mineral deposited from fumarolic gases.

Sulfur S

Sulfur is very common as 1 to 4-mm, transparent, bipyramidal crystals which make attractive micromounts. Associations almost always include stibnite, valentinite and quartz.

Valentinite Sb_2O_3

Valentinite is common as red to white coatings and encrustations on stibnite, and also as pseudomorphs. Large stibnite crystals completely covered by red valentinite have been collected.

Other species

Additional species have been collected at the Pereta mine but these are awaiting study and characterization.

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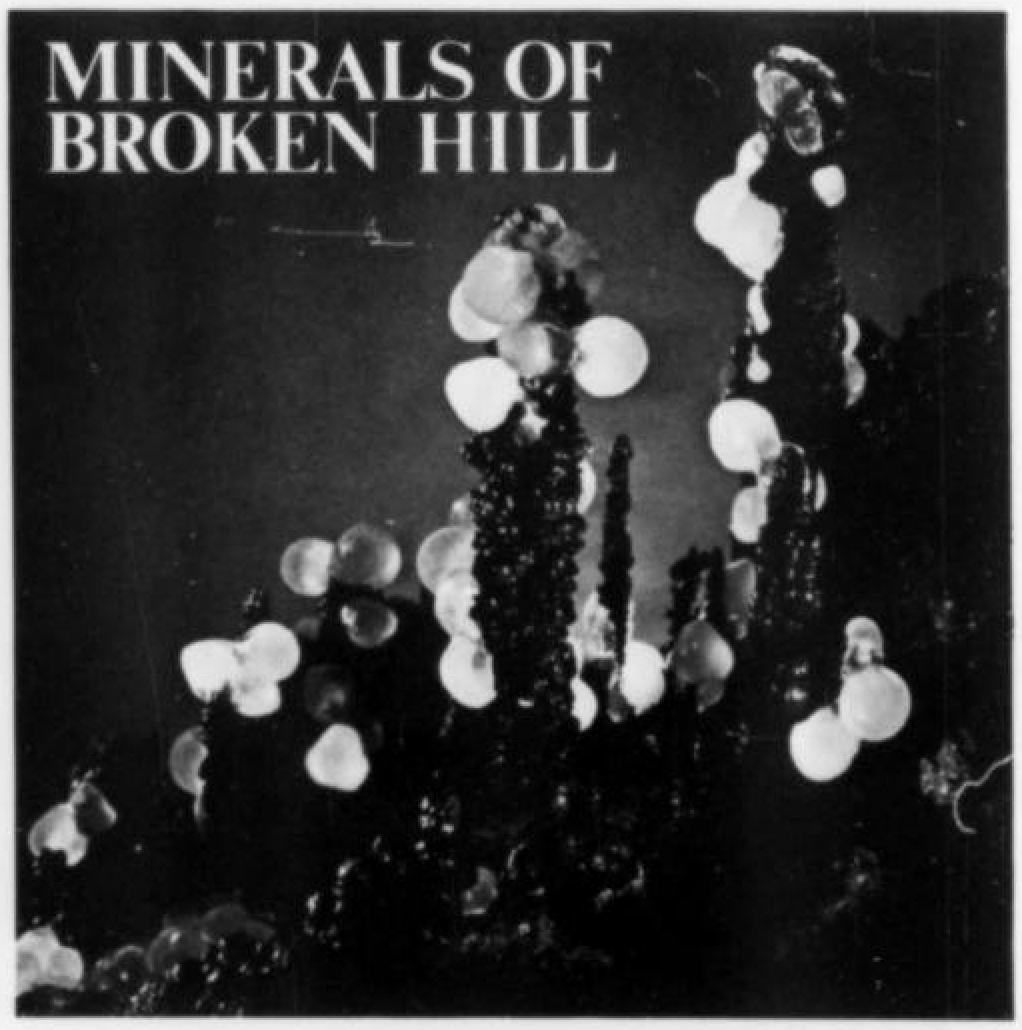

alteration minerals of the Cetine Mine Tuscany, Italy

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The Cetine mine in central Tuscany has been a source of antimony since 1878, and has yielded an interesting variety of secondary antimony minerals. It is the type locality for onoratoite.

INTRODUCTION

The Cetine mine is located near the village of Rosia in Tuscany, Italy, approximately 20 km southwest of the province capital of Siena, on the far eastern side of the Colline Metallifere. It is one of several antimony deposits in Tuscany, generally described as epigenetic mineralizations related to the late phase of the Pliocene-Pleistocene Apennine magmatism. Mineral deposition was controlled by a system of faults which acted as channelways for the original fluids which deposited the sulfides. Silica (in the form of alpha-quartz and chalcedony) is an important constituent in the gangue of all antimony deposits of Tuscany. Detailed information can be found in Dessau (1952), Stea (1971) and Klemm and Neumann (1976).

GEOLOGY

The local geological sequence in the Cetine area begins with quartzitic phyllitic terrains, Paleozoic to Triassic, belonging to the so-called Tuscan basament. They are overlain by the strongly weathered Triassic evaporite formation known as the "Calcare Cavernoso." An allochthonous terrain commonly lies tectonically over the dolomitic limestone of Calcare Cavernoso; it is predominantly composed of shales and argillaceous limestones. Ore at the Cetine mine consists of stibnite in small pods disseminated within the highly silicified Calcare Cavernoso.

HISTORY

Underground mining operations commenced in 1878 and continued for about 20 years. Mining thereafter continued on a reduced scale until 1920 when the mine was closed. In 1938 it was reopened and the orebody was enlarged by new adits and new lower levels. Active mining continued until almost the end of World War II, and in 1948 the mine was finally closed for good.

The area has been a popular site among many Italian and foreign collectors, because it is the only occurrence of the mineral onoratoite. Few adits in the mine are presently accessible to collectors. Because of the unsystematic working of the mineralized zones, many shafts have been filled and several tunnels have collapsed. Access to the underground workings is to be discouraged for safety reasons and, in any case, the onoratoite occurrence is now more or less exhausted.

MINERALOGY

The main goal of this paper is to review the previously described Cetine mine minerals and to document recently identified species. It should be noted that this article is only an introduction to and not a complete account of the Cetine mine mineralogy.

The minerals most common at the Cetine mine (stibnite, quartz, calcite, gypsum, sulfur, cervantite and stibiconite) were described by Artini (1894), Pelloux (1901) and D'Achiardi (1901). Pelloux (1901) mentioned valentinite but, on the basis of the original description, this species resembles onoratoite more than valentinite. D'Achiardi (1901) and Zaccagnini (1953) mentioned kermesite as red coatings on other minerals; this species is also in doubt because none of the samples of reddish alterations checked in this study showed any kermesite. Three other species were listed by Manasse: melanterite and fibroferrite in 1908 and millerite in 1911. In recent years mineral collectors have reported the presence of other minerals. Scortecci (1980), for instance, presented a description of the following species (in addition to those mentioned above): cin-

Figure 1. **Location map of the Cetine mine and Pereta mine, Tuscany, Italy. (See the article on the Pereta mine elsewhere in this issue.)**

nabar, hexahydrite, marcasite, metavoltine, pyrite, roemerite and siderite.

Repeated trips to the mine, plus the aid of several mineral collectors, resulted in the accumulation of a study collection of interesting specimens of secondary minerals (mainly alteration products of stibnite). The species which were collected occur as tiny crystals and masses of interest only to mineralogists and micromounters.

For mineral identification, X-ray powder diffractometer was employed in most cases. The single-crystal method was used in other cases, either by the rotation or the Weissenberg technique, or both; a number of mineral species have been identified from cell parameters determined and through a search of crystal data. No chemical, microprobe, TGA or other analyses were carried out.

The following list includes newly identified species and also the most interesting minerals previously reported in the literature.

MINERALS OF THE WESTERN SIDE OF THE MINE

Workings are most extensive in the western portion of the mine. Shales and argillaceous limestones prevail here, and the vuggy limestone of the Calcare Cavernoso formation is also present with little silicification. Stibnite and its alteration products are scarce, while hydrous sulfates of Fe, Mg and Al are abundant.

Alunogen $Al_2(SO_4)_3 \cdot 17H_2O$

Alunogen is a rather uncommon mineral at Cetine. It has been observed in several specimens, but only from a few locations in the mine. It occurs as rounded aggregates of randomly oriented minute crystals, colorless, transparent and with a flaky habit. Alunogen can be observed in close proximity to or even in association with halotrichite and epsomite.

Figure 2. **An adit of the Cetine mine. Photo by G. Brizzi.**

Figure 3. **A typical view in the underground works of the Cetine mine. Photo by G. Brizzi.**

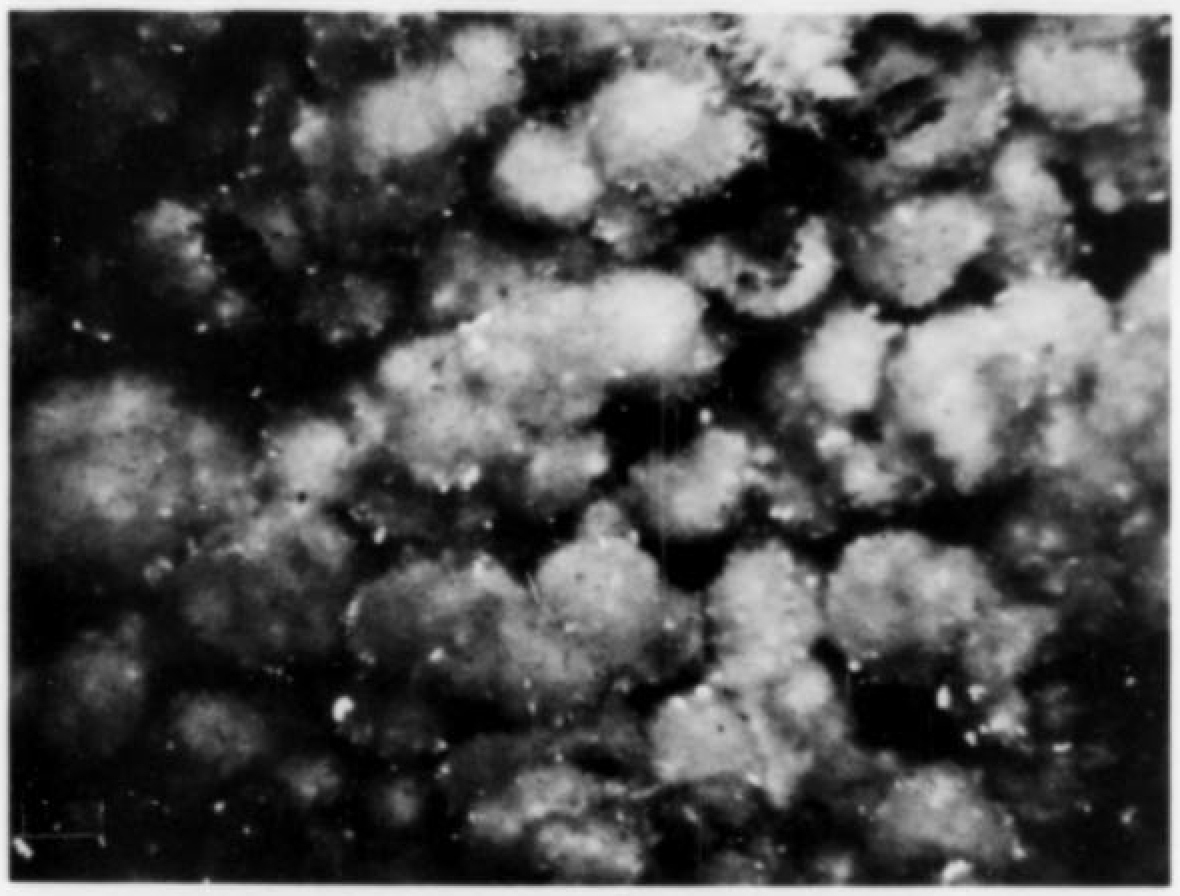

Figure 4. **White spherical aggregates, about 1 mm across, of alunogen crystals. Photo by A. Santucci.**

Copiapite $Fe^{+2}Fe_4^{+3}(SO_4)_6(OH)_2 \cdot 20H_2O$

This mineral was found in the lower levels of the mine as granular, earthy masses implanted mainly on iron-gray to black shales, which frequently occur on this side of the deposit. Its color, ranging from dull greenish yellow to lemon-yellow, stands out against the dark gray of the matrix. Individual crystals were not observed.

Epsomite $MgSO_4 \cdot 7H_2O$ and **Hexahydrite** $MgSO_4 \cdot 6H_2O$

Epsomite is commonly encountered in the mine. It forms showy aggregates of wispy wavy fibers, white with a silky luster, reaching as much as 20 cm in length. Sometimes epsomite is associated with small amounts of hexahydrite. This occurs especially in those levels of the mine where relative humidity is likely to be low, and where an incipient alteration by dehydration of epsomite takes place.

Ferrinatrite $Na_3Fe^{+3}(SO_4)_3 \cdot 3H_2O$

Ferrinatrite is among the rarest minerals at the Cetine mine; only a few specimens have been collected. It occurs as grayish white

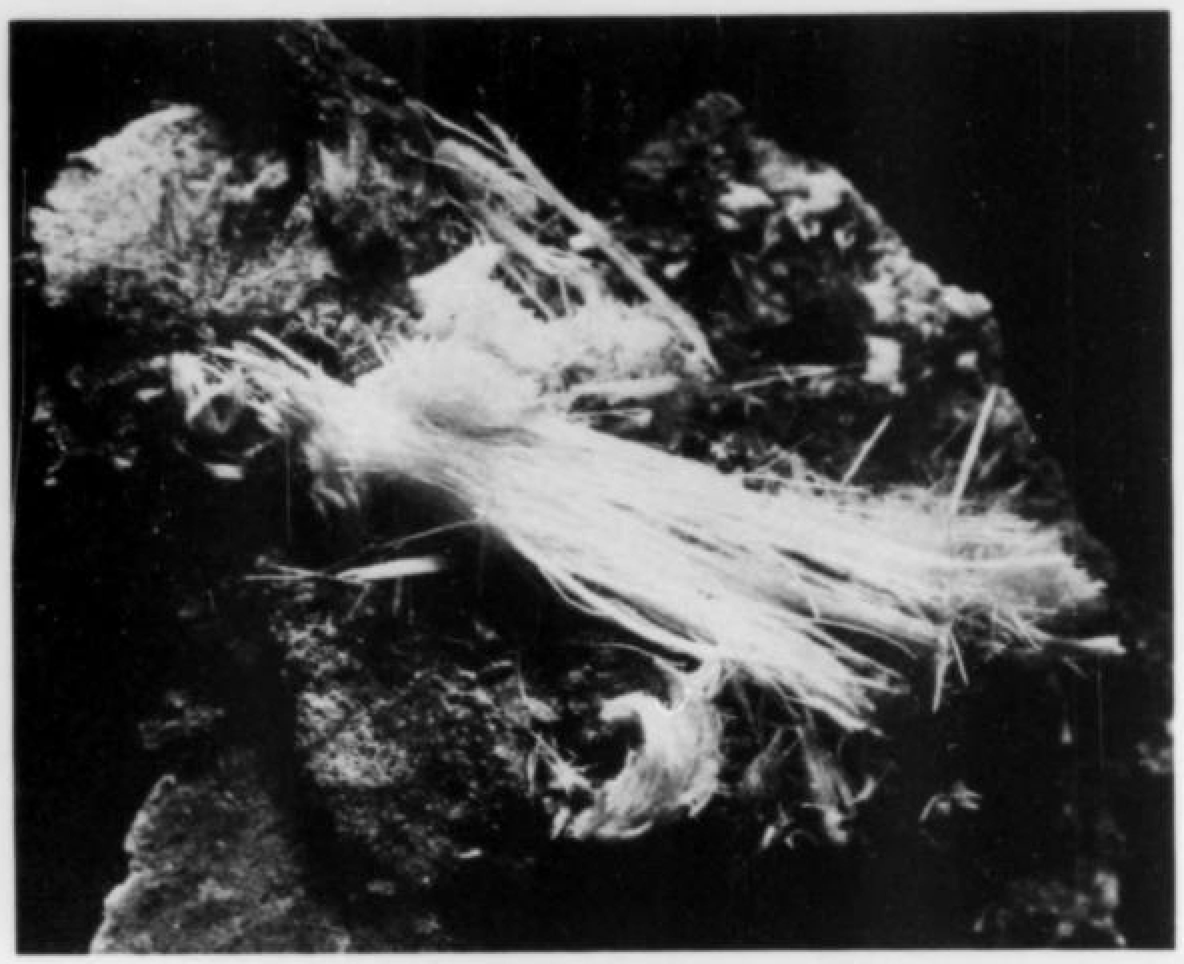

Figure 5. **A specimen (6 cm across) exhibiting a sheaf of white epsomite fibers. Photo by G. Brizzi.**

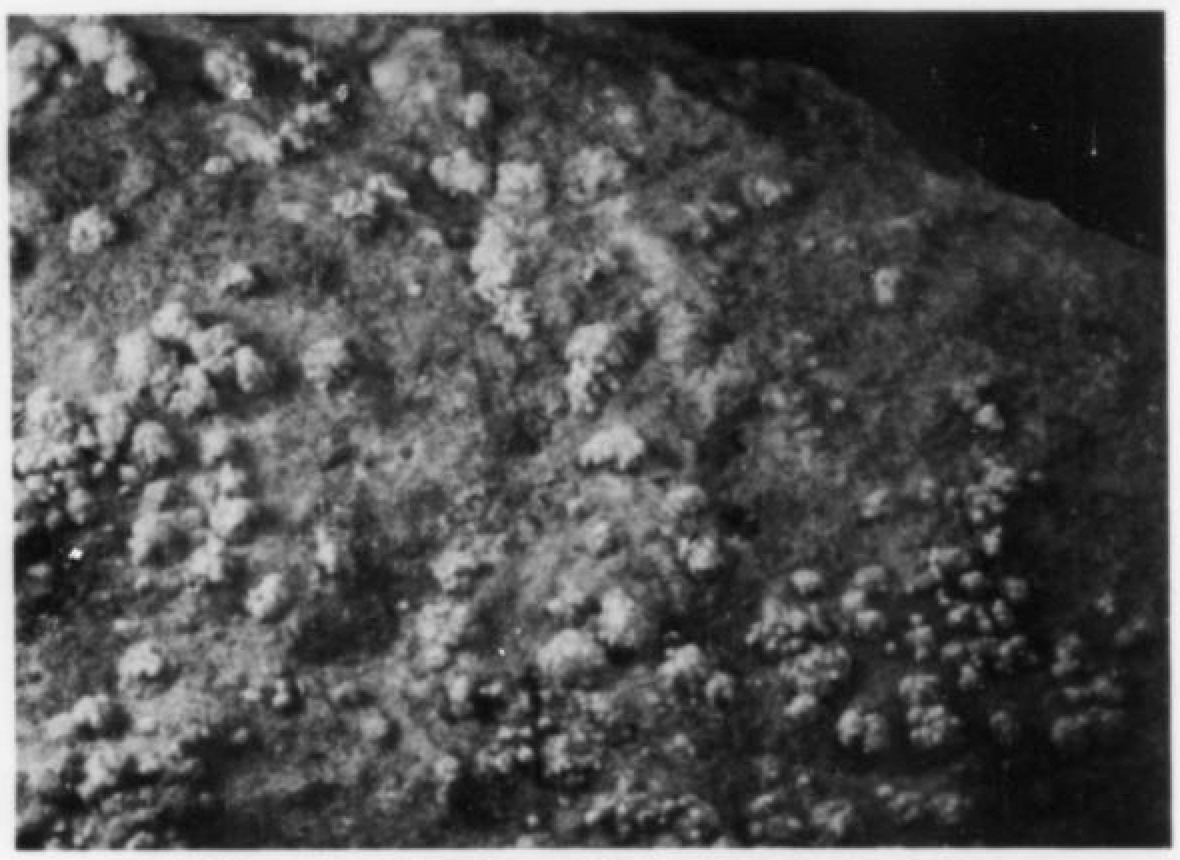

Figure 6. **Grayish white aggregates of ferrinatrite crystals on chalky limestone, 10 cm long. Photo by G. Brizzi.**

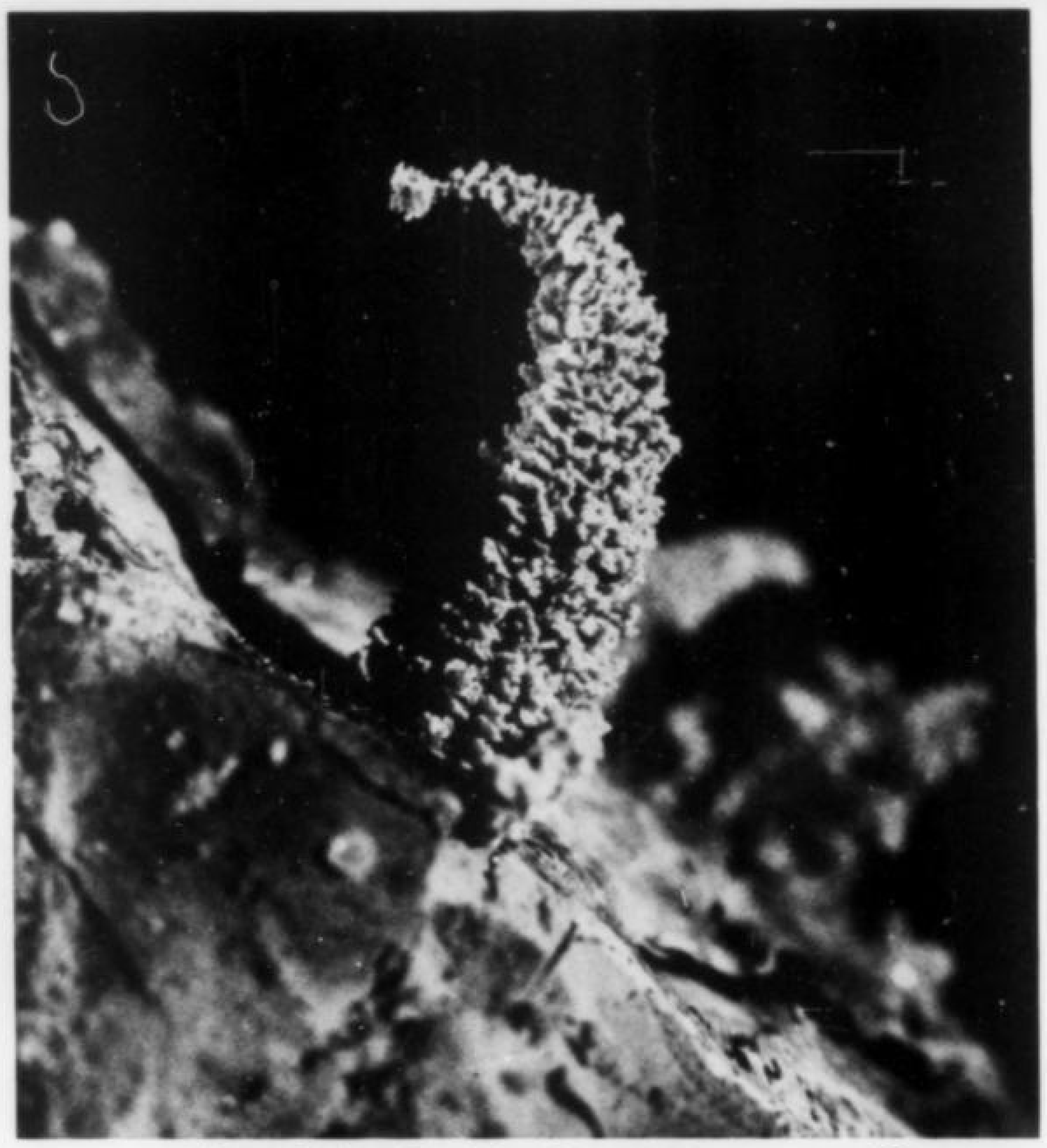

Figure 7. **A yellowish arborescent aggregate (12 mm long) of fibroferrite crystals, implanted on gray shale. Photo by A. Santucci.**

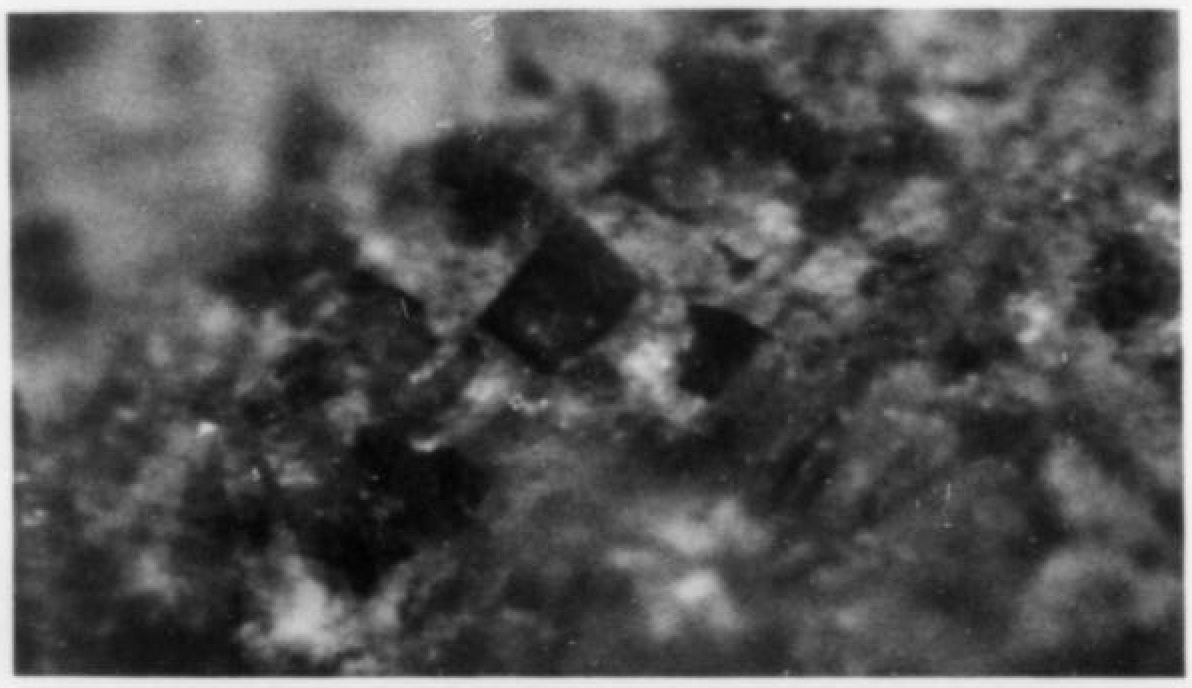

Figure 8. **Violet cubic crystals of fluorite (edge about 0.3 mm) on a chalky matrix. Photo by A. Santucci.**

microcrystalline groups, always associated with gypsum. In Italy only one other occurrence of this mineral has been reported: in fumarolic deposits at Vesuvius (by several authors from 1915 to 1926).

Fibroferrite $Fe^{+3}(SO_4)(OH)\cdot 5H_2O$

Fibroferrite appears widely disseminated as yellowish or greenish gray encrustations. The macroscopic appearance is earthy, with frequent curious arborescent concretions. These aggregates are composed of groups of very thin silky crystals, from subparallel to divergent; they commonly grow on each other in a roughly helicoidal habit.

Fluorite CaF_2

Only one specimen of this mineral was found. It occurs as minute cubes (up to 3 mm) and cuboctahedrons aggregated together and embedded in a friable matrix consisting mainly of gypsum. Crystals are colorless or white to irregularly violet in color.

Halotrichite-Pickeringite $(Fe,Mg)Al_2(SO_4)_4\cdot 22H_2O$

These species are disseminated throughout the western side of the mine, where iron sulfates are abundant. They occur as white

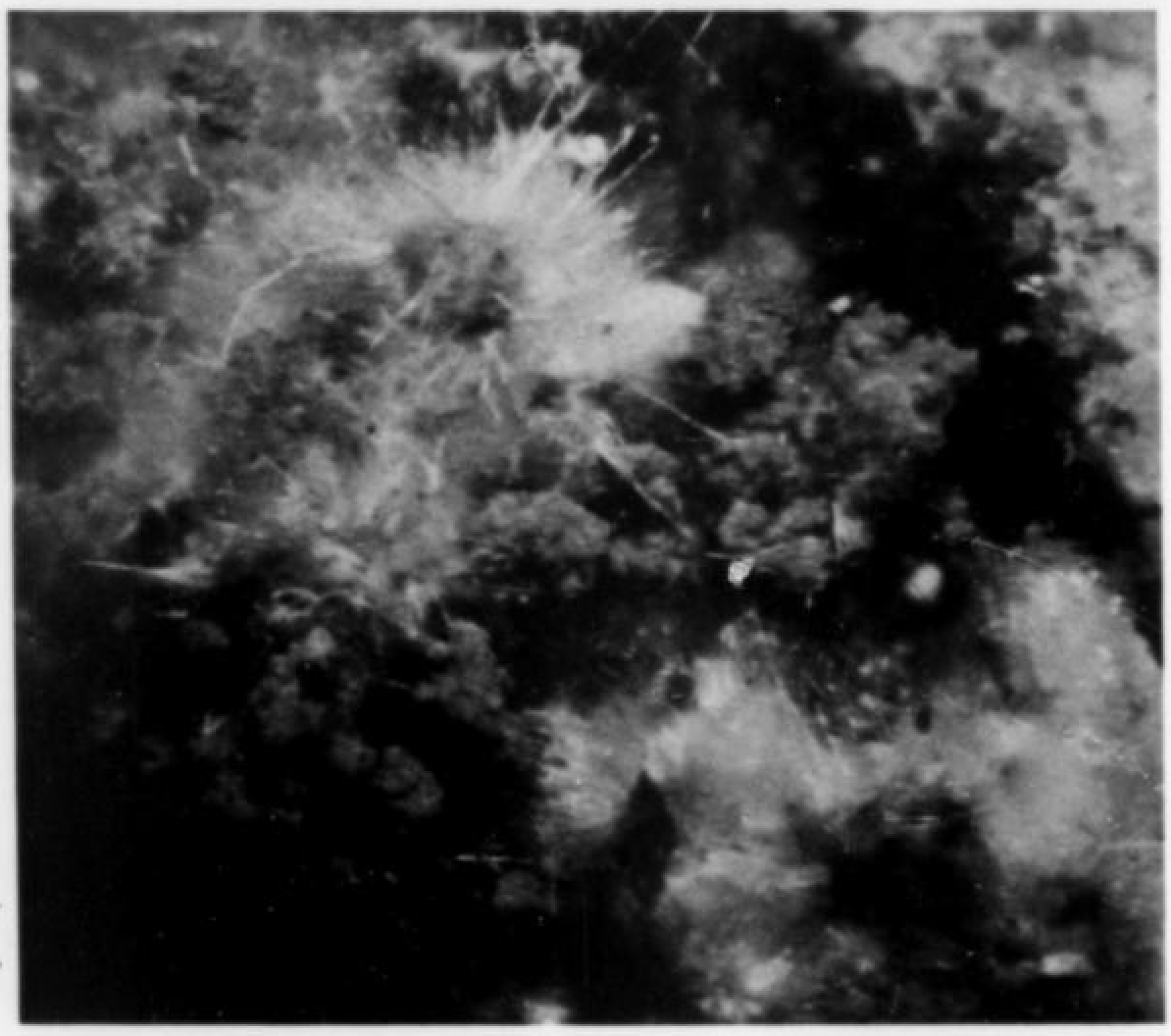

Figure 9. **White tufts of halotrichite with earthy aggregates (up to 0.5 mm) of overgrown metavoltine (yellow). Photo by A. Santucci.**

radiating tufts of slender needles forming mammillary felted masses. These coatings typically occur on pale green encrustations yielding a powder pattern very similar to that obtained from the white fibers. For this reason, and also on the basis of comparison with the patterns of halotrichite and pickeringite quoted in the JCPDS powder data file, it seems likely that the iron end-member (halotrichite) is more abundant than the magnesium end-member (pickeringite).

Jarosite $KFe_3^{+3}(SO_4)_2(OH)_6$

Although it is not abundant at this locality, jarosite can be found in several different forms. Most commonly it occurs as brownish yellow aggregates of minute, translucent crystals, or as a yellowish powdery coating on the limestone. Reddish brown crystals, isolated or grouped, sometimes well-formed, have also been observed. X-ray patterns showed no evidence of natrojarosite.

***Figure 10.* Well-formed pseudo-octahedral crystals of jarosite (up to 0.3 mm). Photo by A. Santucci.**

Melanterite $Fe^{+2}SO_4 \cdot 7H_2O$

Melanterite is widespread throughout the mine, mainly in the lower levels. It occurs as encrustations up to several centimeters thick, in various shades of green, and frequently coated by wide and rounded "carpets" of halotrichite tufts.

Metavoltine $K_2Na_6Fe^{+2}Fe_6^{+3}(SO_4)_{12}O_2 \cdot 18H_2O$

Metavoltine is also encountered frequently in the mine. It is present as lemon-yellow spherulites growing directly on limestone or dark gray shale, or over other minerals such as sideronatrite. Frequently small aggregates can be observed with intergrown needles of halotrichite. Metavoltine was not found as individual crystals. The chemical formula reported is from Fleischer (1983); the chemical composition of metavoltine is not well defined, because of some crystal-chemical problems still unsolved, as pointed out recently by Scordari (1981).

Millerite NiS, **Pyrrhotite** FeS, and **Siderite** $FeCO_3$

These minerals are considered together because they were found only in a limited zone at the end of an intermediate-level tunnel in the mine.

Millerite is a very rare mineral at the Cetine mine. It forms in the

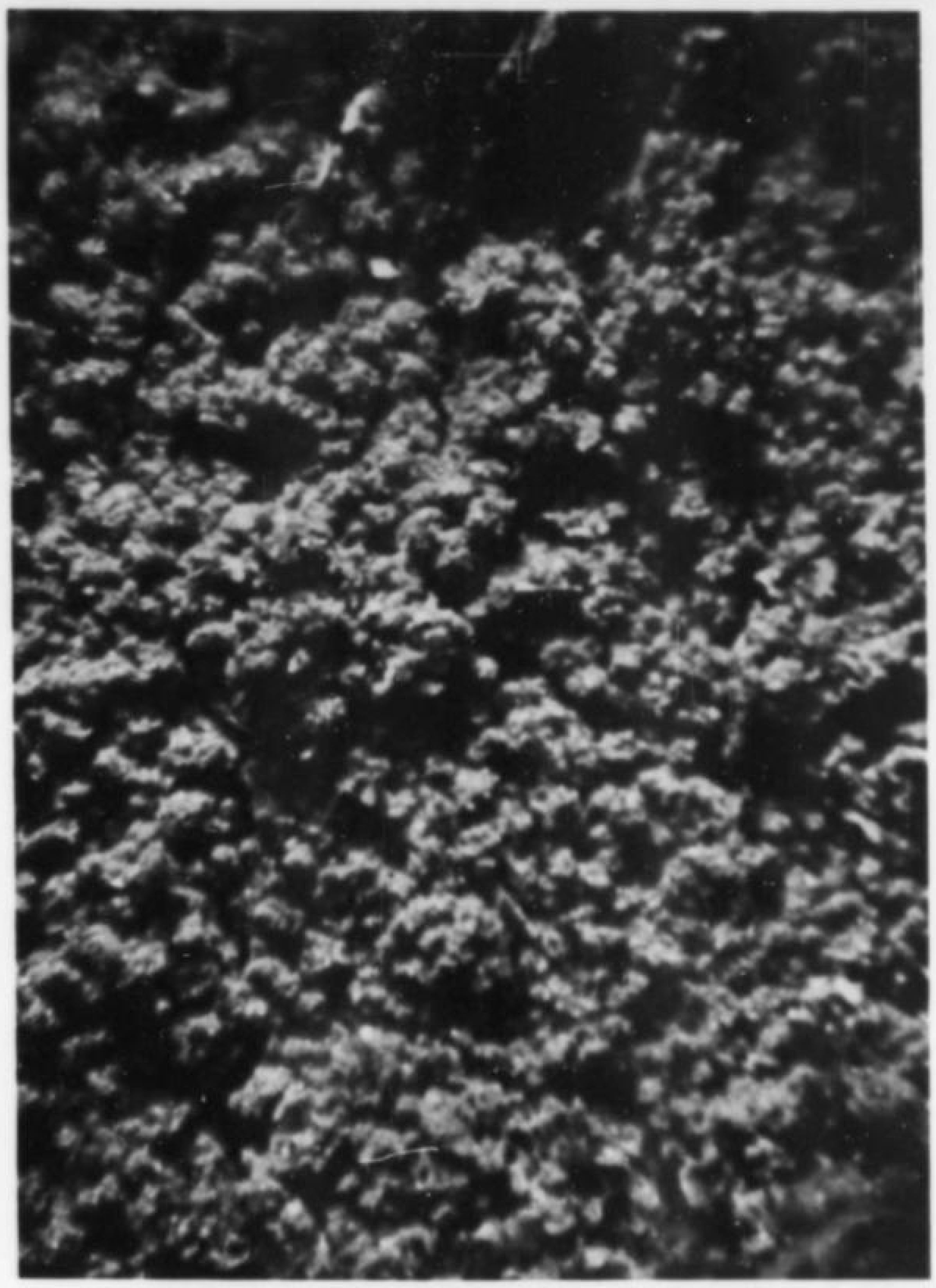

***Figure 11.* Spheroidal aggregates of metavoltine on gray shale. Width of picture is 5 cm. Photo by G. Brizzi.**

***Figure 12.* Metavoltine (lemon yellow, granular) with sideronatrite (pale yellow, soft). Width of picture: 5 cm. Photo by G. Brizzi.**

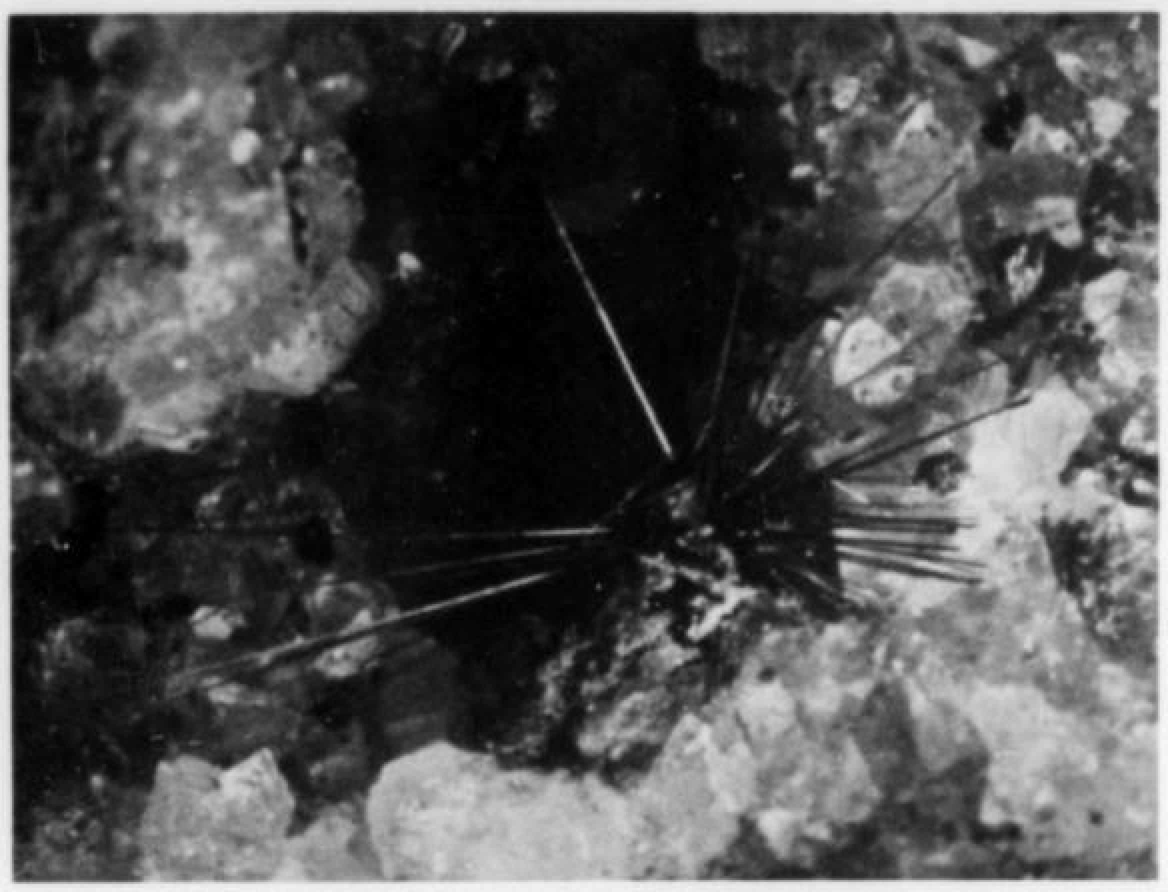

Figure 13. **Brass-yellow radiating needles (up to 10 mm) of millerite on calcite. Photo by G. Brizzi.**

usual habit, as sparse tufts of brass-colored radiating needles, sometimes as isolated needles; it stands out against the white of the massive calcite matrix. Most frequently the matrix is argillaceous.

Pyrrhotite, rather uncommon at Cetine, consists of bronze-yellow, tabular, hexagonal crystals (up to 3 mm across), sometimes with a slight iridescent tarnish. It occurs individually or as radiating clusters of crystals.

On the same calcitic gangue one can observe rare coatings of minute rhombohedral crystals of siderite, usually yellowish brown in color.

Mirabilite $Na_2SO_4\cdot 10H_2O$

This species occurs as matted aggregates of white fibrous crystals up to several centimeters in length. It can be mistaken for epsomite, but it never has a silky appearance and it is rarer than epsomite. Once removed from the mine, mirabilite rapidly dehydrates to the corresponding anhydrous sulfate thenardite; in fact, an X-ray powder pattern obtained some hours later shows a marked presence of the anhydrous salt.

Potassium Alum $KAl(SO_4)_2\cdot 12H_2O$

This alum is relatively uncommon and occurs as a white coating on a gray argillaceous matrix. It is massive with a coarse-grained structure and is associated mainly with gypsum, alunogen, epsomite and halotrichite.

Roemerite $Fe^{+2}Fe_2^{+3}(SO_4)_4\cdot 14H_2O$

At the Cetine mine roemerite is a relatively rare mineral. It is found as amber-brown aggregates of transparent, rough crystals mixed with white masses of microcrystalline gypsum.

Rozenite $Fe^{+2}SO_4\cdot 4H_2O$

Rozenite occurs as white powdery patches replacing the greenish encrustations of melanterite; it has the appearance of a mineral resulting from dehydration. It is rarely observable in the mine, depending on the relative humidity.

Sideronatrite $Na_2Fe^{+3}(SO_4)_2(OH)\cdot 3H_2O$

Sideronatrite, as pale yellow granular aggregates is commonly intimately associated with metavoltine (smaller yellow nodules). Judging from color alone, it is difficult to distinguish these two minerals from each other and from copiapite. Sideronatrite ranges in color from pale yellow to orange yellow. It is not as abundant as metavoltine and sometimes can be found in well-defined minute acicular crystals. A preliminary search of the literature indicates that this mineral has not previously been observed in Italy, therefore the present find is the first Italian occurrence.

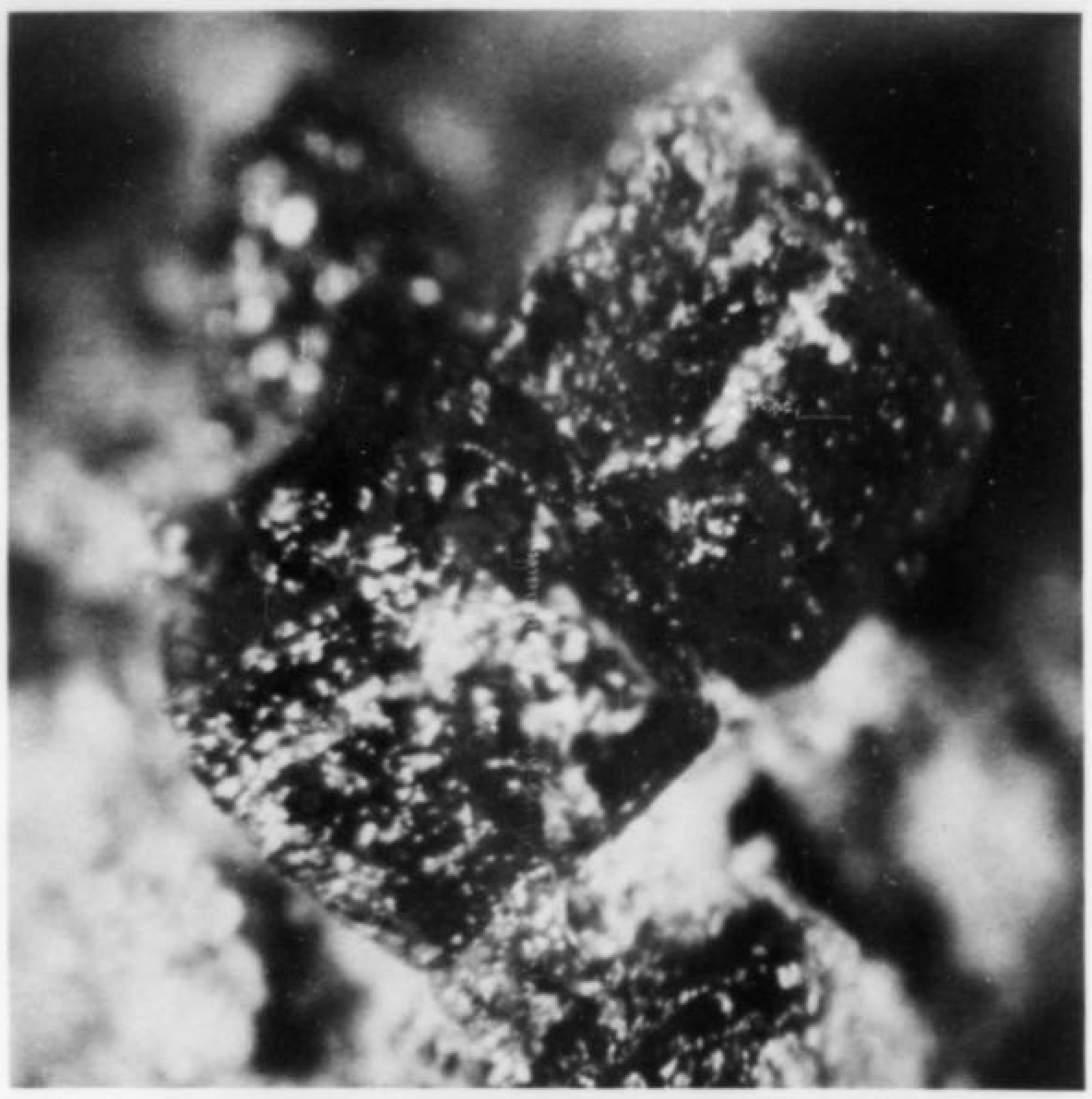

Figure 14. **Equant, rough crystals of roemerite up to 1 mm. Photo by G. Brizzi.**

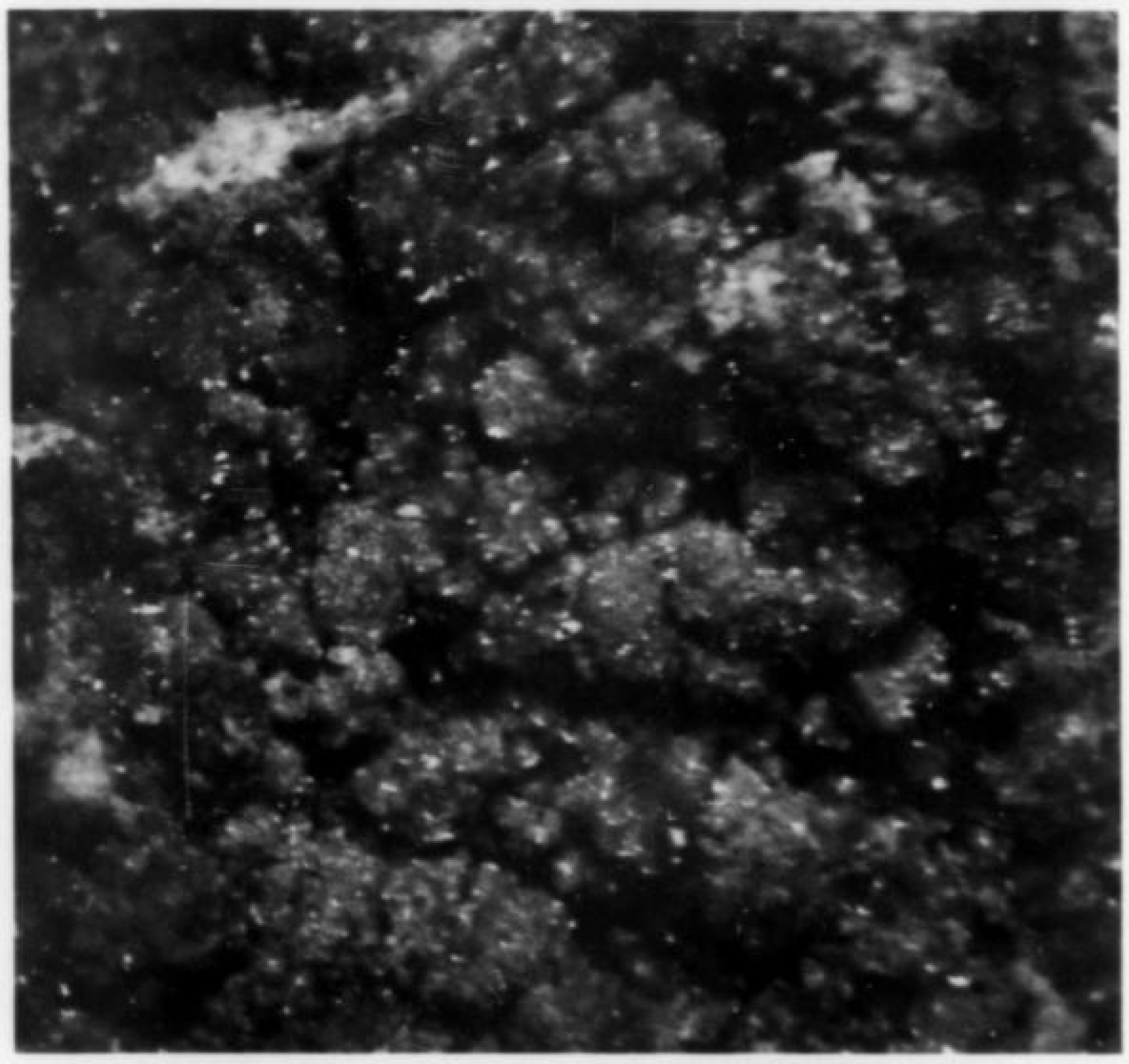

Figure 15. **Granular aggregates of sideronatrite. On the surface of the nodules minute acicular or platy crystals are visible. Width of picture: 3.5 cm. Photo by A. Santucci.**

Tamarugite $NaAl(SO_4)_2\cdot 6H_2O$

Only a few specimens of this mineral have been found. It occurs as whitish spheroidal aggregates of very fine, pearly platelets, typically in intimate association with metavoltine and halotrichite. Tamarugite has been described from only a few localities in the world, generally from arid environments. In Italy only one occurrence has been noted (Zambonini, 1907): a sulfur cave at Miseno, near Naples. The occurrence at the Cetine mine, where the relative humidity is rather high, requires further investigation.

MINERALS OF THE EASTERN SIDE OF THE MINE

In this part of the deposit the Calcare Cavernoso formation predominates. The silicification of this limestone has been very inten-

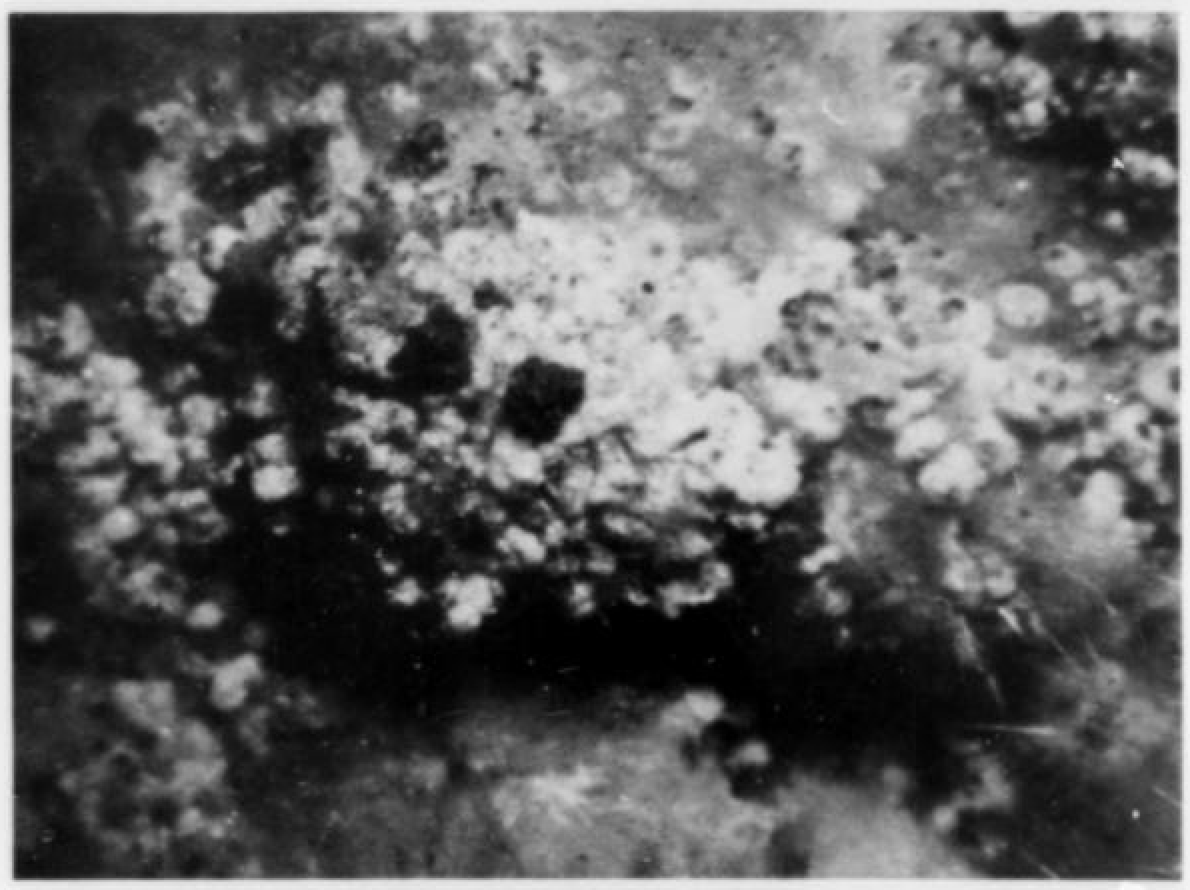

Figure 16. **White pearly aggregates (about 0.4 mm across) of tamarugite crystals, in association with halotrichite and metavoltine. Photo by A. Santucci.**

sive; pure chalcedony is encountered frequently. Stibnite needles are embedded in this hard rock, and stibnite alteration products occur in the rare vugs. They are almost always in association with quartz, sulfur and gypsum crystals.

Celestite $SrSO_4$

Although celestite is abundant at Spannocchia, a few kilometers away, at the Cetine mine it is a rare species. It occurs in small cavities of the hard, black limestone, mainly as colorless, thick, tabular crystals. Sometimes well-formed, equant crystals can be found.

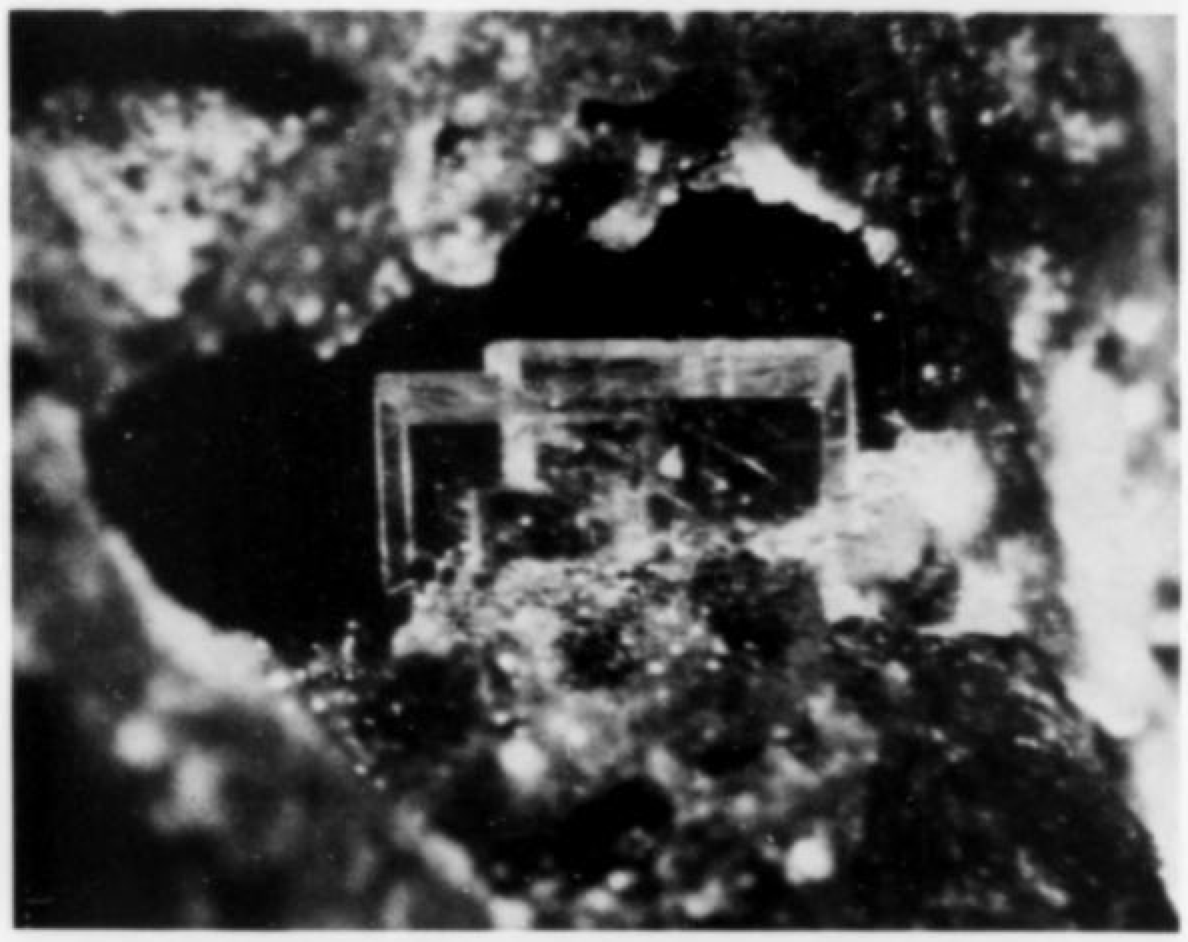

Figure 17. **Colorless, well-formed, tabular crystals (about 2 mm) of celestite on hard limestone. Photo by A. Santucci.**

Klebelsbergite $Sb_4^{+3}O_4(OH)_2SO_4$

The first occurrence of klebelsbergite was reported by Zsivny (1929) from Felsöbànya (Baia Sprie) Romania, and a complete description on the Romanian material was published by Nakai and Appleman (1980). Cipriani *et al.* (1980) reported a new occurrence from Pereta (Tuscany, Italy), where the mineral is found as colorless or yellow tufts of acicular crystals. The Cetine mine occurrence represents the third find of klebelsbergite in the world, and we have also positively identified samples from Micciano. Therefore it is likely that klebelsbergite is not a rare mineral at many antimony deposits.

Figure 18. **Pale pink tufts of 1.5-mm crystals of klebelsbergite on stibnite. In the middle of the picture a yellowish rounded mass of peretaite can be seen. Photo by G. Brizzi.**

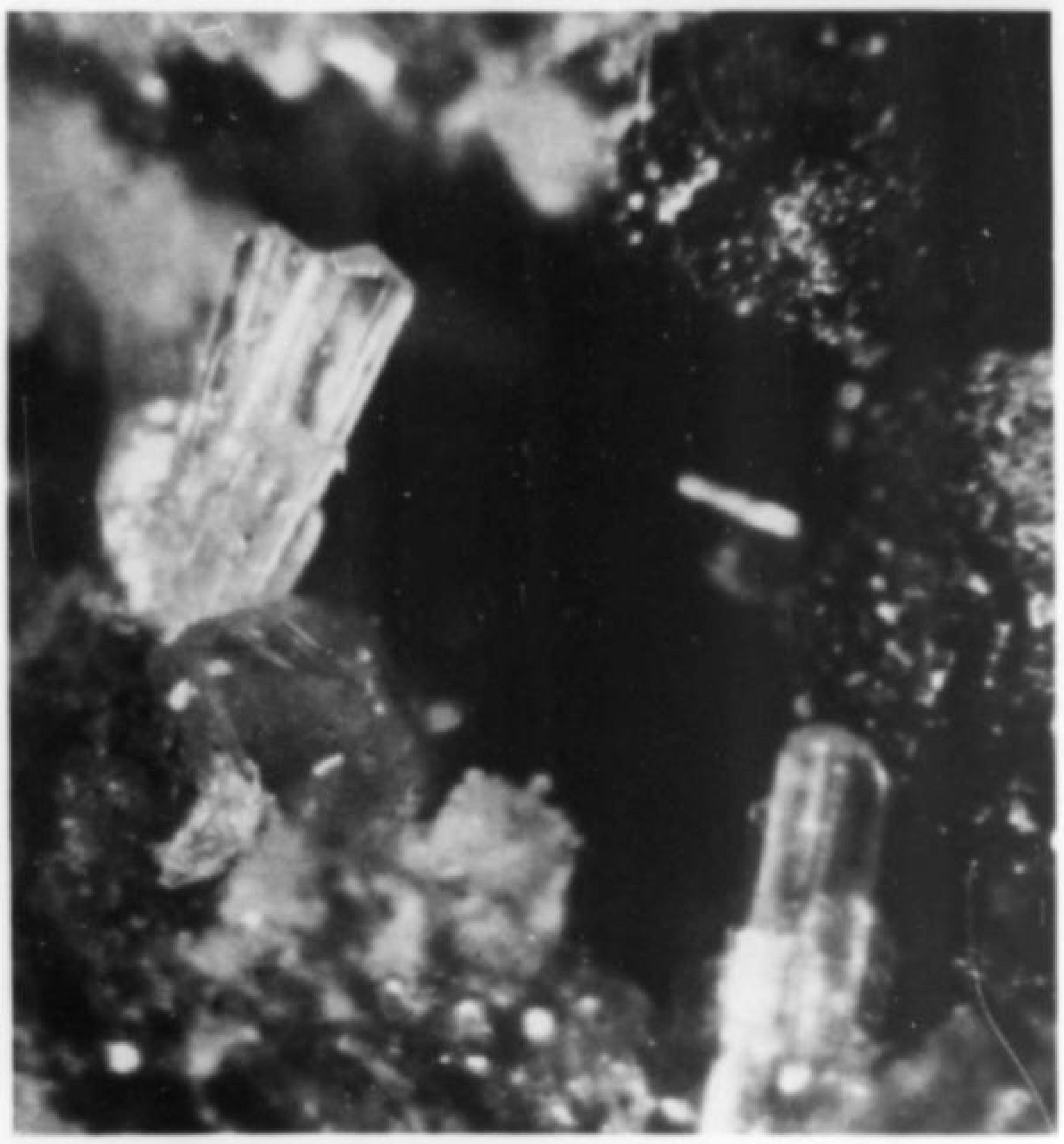

Figure 19. **Well-terminated transparent crystals of klebelsbergite (0.6 mm) with sulfur, in a cavity in silicified limestone. Photo by G. Brizzi.**

The occurrence at the Cetine mine closely resembles the material described from Pereta, but is less concentrated. Klebelsbergite can be found in the interstices of the hardy vuggy limestone, in tufts of acicular crystals with yellowish to light pink color. It is frequently associated with massive peretaite and sometimes with onoratoite, indicating a possible co-crystallization of these three stibnite alteration minerals. Very rarely klebelsbergite can be found in well-formed and transparent crystals having the usual prismatic habit.

Onoratoite $Sb_8O_{11}Cl_2$ (or $Sb_8O_{10}(OH)_2Cl_2$)

One of the most important minerals among the oxidation products of stibnite is the antimony oxycloride, onoratoite, which was identified by Fornaseri (1947), and later named and better defined by Belluomini *et al.* (1968). Of all the minerals found at the Cetine mine onoratoite is undoubtedly the most famous. It has been intensively searched for by amateur mineralogists during the past ten years because it has not, as yet, been found at any other locality. Unfortunately the onoratoite occurrence has now been essentially exhausted.

The mineral occurs as very thin, white, radiating needles grown directly on or very close to stibnite crystals. If altered, the silky and flexible crystals become rather brittle and yellowish in color. Onoratoite also occurs as thin elongated platelets. A single-crystal X-ray analysis of this material shows these crystals to be composite and made up of many individuals with their [010] axes parallel.

Regarding the crystal structure of onoratoite, there are two hypotheses in the literature: Edstrand (1955) assigned the mineral to the monoclinic system and gave the formula $Sb_8O_{10}(OH)_2Cl_2$; Sgarlata (1970) regarded the crystals as triclinic with the formula $Sb_8O_{11}Cl_2$. The crystal structure determination on natural crystals is now in progress in this laboratory, in order to clarify both the symmetry and the chemical formula. The latest indications seem to favor Edstrand's hypothesis and the anhydrous formula, but with 12 oxygen sites, some of which exhibit partial occupancy.

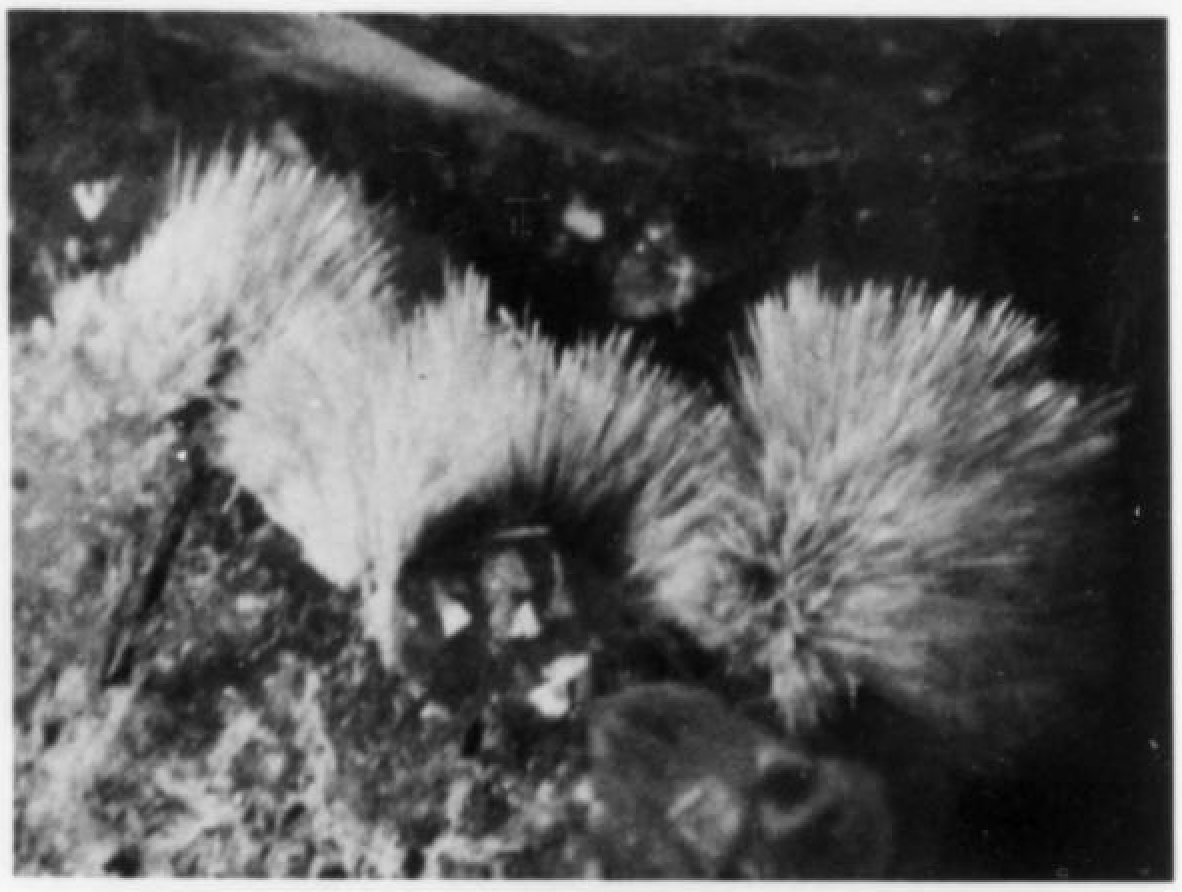

Figure 20. **Tufts of acicular crystals (about 0.5 mm) of onoratoite on quartz. Photo by G. Brizzi.**

Peretaite $CaSb_4^{+3}O_4(OH)_2(SO_4)_2 \cdot 2H_2O$

For this mineral three modes of occurrence have been found at the Cetine mine:

1. Peretaite occurs mainly in massive form, in roughly botryoidal growths on stibnite, quartz and sulfur crystals, lining the rare cavities of the compact Calcare Cavernoso limestone. The color is usually various shades of pale pink, probably due more or less to diffused reddish alteration in the deposit. Klebelsbergite and onoratoite have been observed in association. Sometimes these masses exhibit the shape of large and irregularly terminated crystals, fairly transparent, which, on the basis of several fragments tested by the Weissenberg method, are definitely single crystals.

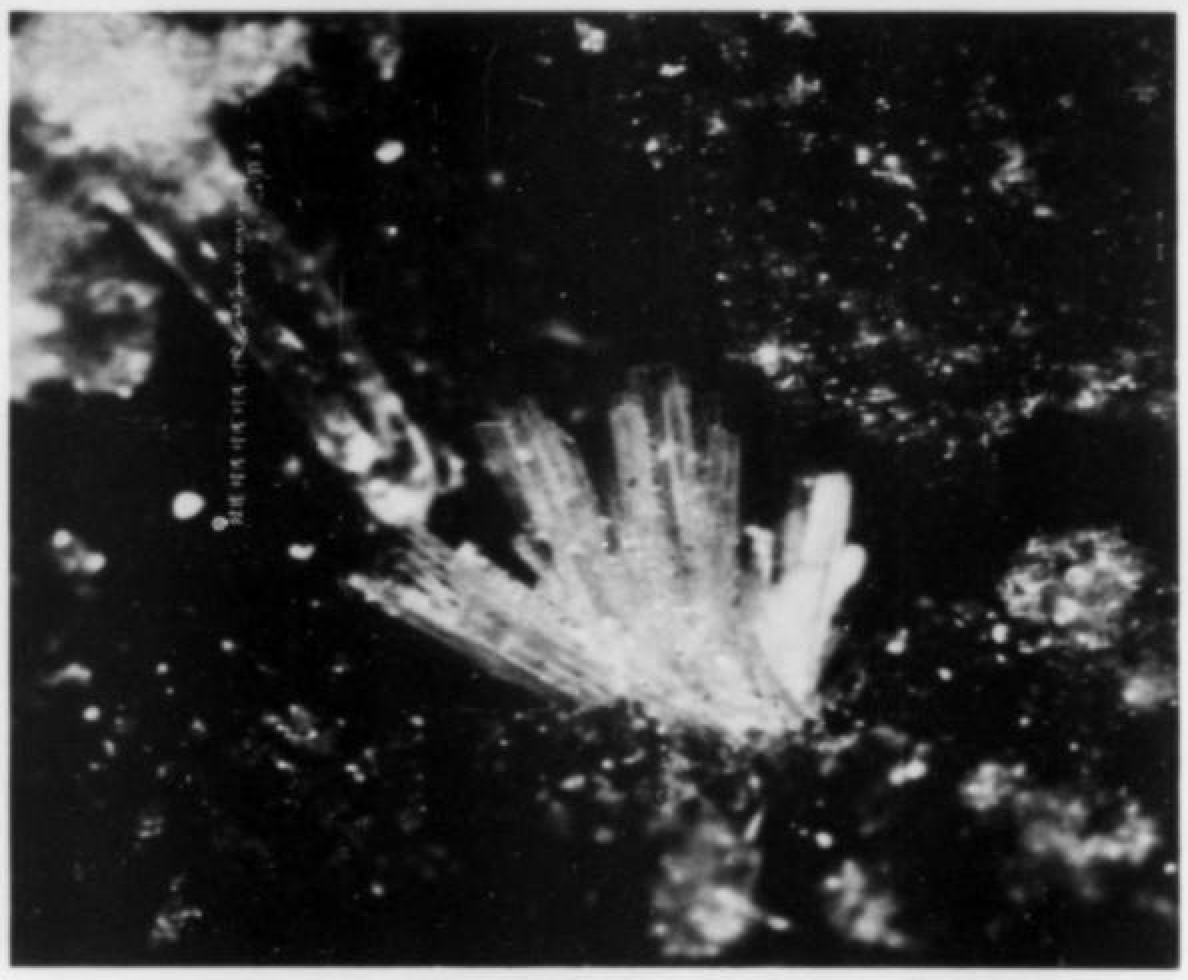

Figure 21. **Lamellar, transparent, 1.5-mm crystals of onoratoite with quartz. Photo by A. Santucci.**

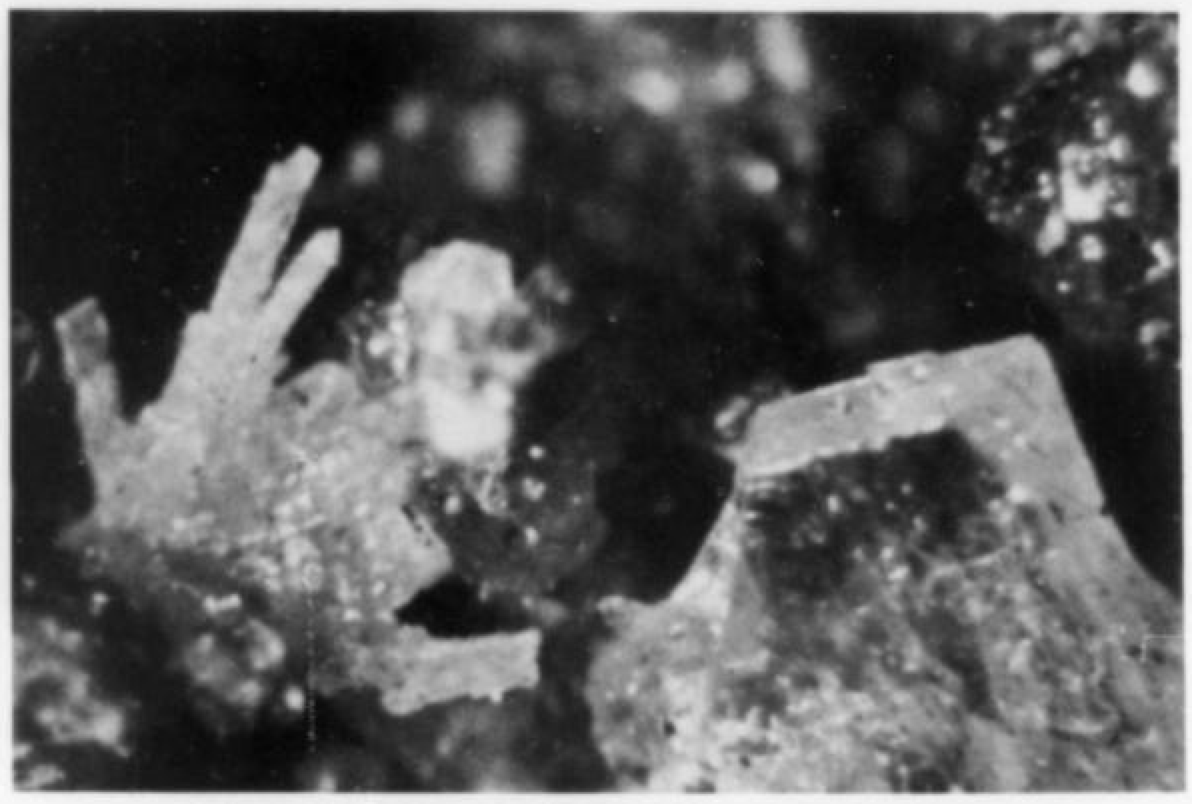

Figure 22. **Peretaite in lath-like crystals, opaque and pale pink in color (on the left) and as a large (2 mm) transparent crystal (on the right). Photo by G. Brizzi.**

2. Peretaite can occur also as divergent groups of lath-like crystals, opaque and pale pink in color. Though not terminated, even these crystals, as in the previous case, are single crystals, but their elongation axis does not coincide with any of the crystallographic axes. It is difficult to explain what causes this strange growth habit. Should this peretaite be interpreted as a pseudomorph after stibnite?

3. Most rarely peretaite occurs as perfectly colorless and transparent individuals, well crystallized in euhedral forms. This crystal habit, sketched in Fig. 23b, is the one most frequently encountered at Pereta (Cipriani *et al.*, 1980).

By comparative examination of Weissenberg photographs of type-3 crystals with fragments of the other two types, another curiosity catches one's eye: the euhedral crystals are always twinned, as described by Menchetti and Sabelli (1980) in the crystal structure determination on the Pereta material; efforts to find an untwinned crystal proved fruitless. On the other hand, all anhedral fragments checked by X-ray analysis proved to be untwinned. Why is this? Why are there twinned and untwinned crystals on the same

Figure 23. **A transparent, euhedral crystal of peretaite (0.3 mm) associated with klebelsbergite crystals (foreground). Photo by G. Brizzi.** ***(Inset:)*** **Typical crystal habit of peretaite (from Cipriani *et al.*, 1980).**

specimen, completely different in their morphology? It seems likely that there was more than one mineralizing event producing different generations, but without any significant temperature/time interval, because no evident paragenetic sequence was observed.

Senarmontite Sb_2O_3

This antimony oxide is extremely rare at the Cetine mine. It occurs in the vugs of the silicified limestone as small groups of crystals or as single isolated individuals, bright, colorless and transparent, in the usual octahedral habit. Generally the crystals are implanted on stibnite, sometimes on stibiconite; a crystal was observed on celestite. Associated minerals are sulfur, gypsum, quartz and onoratoite.

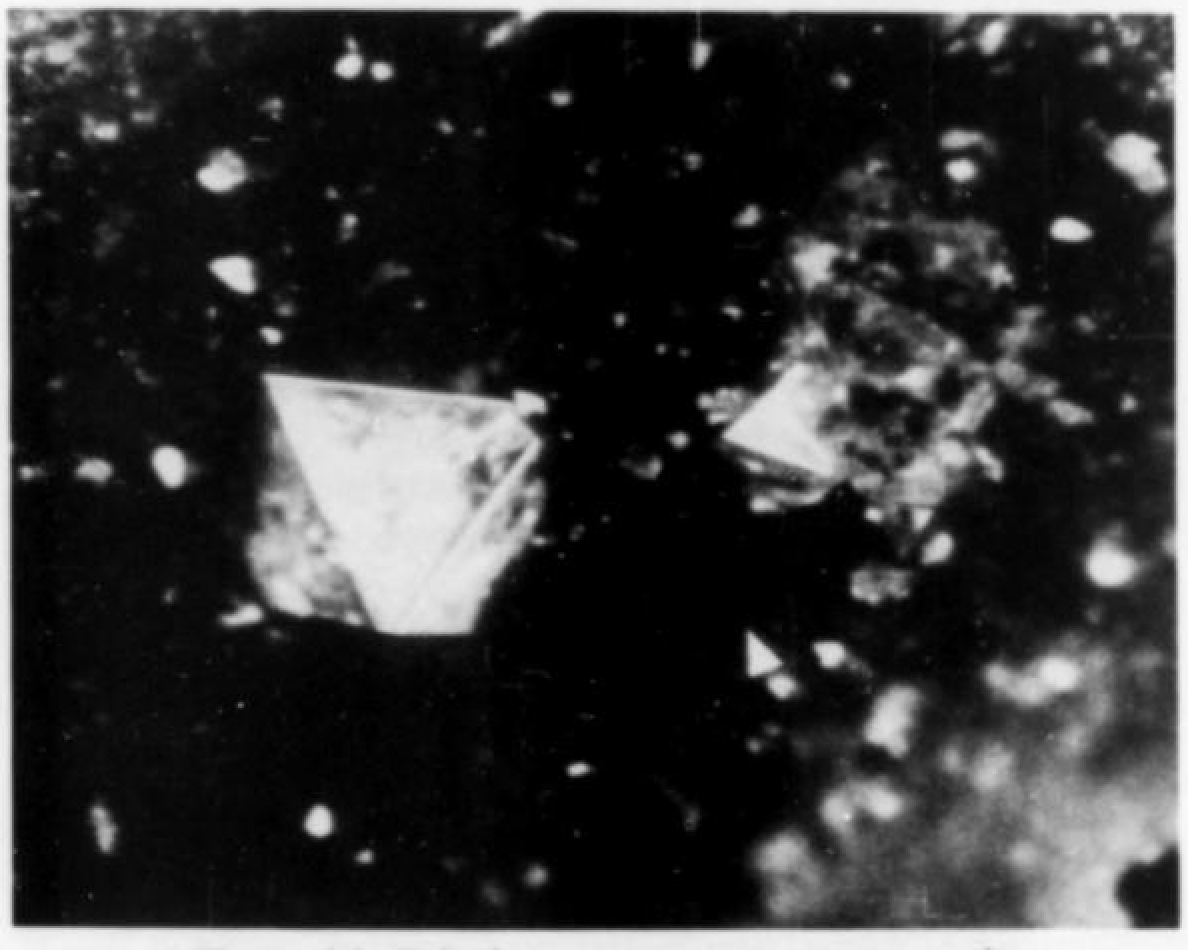

Figure 24. **Colorless, transparent senarmontite crystals, in octahedral habit (edge 0.4 mm). Photo by A. Santucci.**

Valentinite Sb_2O_3

Valentinite occurs in the same manner as its dimorph, senarmontite, in small cavities in the hard limestone. It is almost as rare as senarmontite. Valentinite, in sparse aggregates of cream or light beige colored crystals, exhibits both the common prismatic [100] habit and also a thin, tabular habit, with [001] the axis of elongation.

Figure 25. **A tuft of light cream, acicular crystals of valentinite, among quartz crystals. A well-formed, transparent, crystal 2.5 mm in length and elongated on [100] can be seen. Photo by A. Santucci.**

CONCLUSIONS

The Cetine area is among the most interesting in Tuscany; it is very rich in sulfate minerals and it presents an interesting suite of rare stibnite alteration minerals. The present investigation is just a preliminary account of this area. Additional studies need to be made on the deposit in order to establish the conditions of formation of the secondary minerals, their paragenetic association and their sequence relationships. A systematic and exhaustive sampling of the mine is therefore necessary. Unfortunately this entails some difficulties, since in recent years the deposit has become increasingly unsafe.

Table 1 lists all minerals found at the Cetine mine. It is subdivided into two sections: the first deals with the species previously known, and the second lists the 18 minerals recognized during the course of this study. Of the first section only cinnabar and kermesite are to be considered doubtful species. These names are likely to be assigned to the red coatings or encrustations frequently encountered in the mine. But X-ray diffraction studies indicate no cinnabar or kermesite is present on specimens collected during the present investigation. Furthermore, the X-ray lines of these red materials are very weak, indicating poor crystallinity; considering this, the mineral in question is most likely metastibnite.

Table 1. **Minerals of the Cetine mine.**

Previously reported	
Calcite	$CaCO_3$
Cervantite	Sb_2O_4
Cinnabar (?)	HgS
Fibroferrite	$Fe^{+3}(SO_4)(OH)\cdot 5H_2O$
Gypsum	$CaSO_4\cdot 2H_2O$
Hexahydrite	$MgSO_4\cdot 6H_2O$

Kermesite (?)	Sb_2S_2O
Marcasite	FeS_2
Melanterite	$Fe^{+2}SO_4 \cdot 7H_2O$
Metavoltine	$K_2Na_6Fe^{+2}Fe_6{}^{+3}(SO_4)_{12}(OH)_4 \cdot 18H_2O$
Millerite	NiS
Onoratoite	$Sb_8O_{11}Cl_2$ (or $SB_8O_{10}(OH)_2Cl_2$)
Pyrite	FeS_2
Quartz	SiO_2
Roemerite	$Fe^{+2}Fe_2^{+3}(SO_4)_4 \cdot 14H_2O$
Siderite	$FeCO_3$
Stibiconite	$Sb^{+3}Sb_2^{+5}O_6(OH)$
Stibnite	Sb_2S_3
Sulfur	S
Valentinite	Sb_2O_3
New for the locality	
Alunogen	$Al_2(SO_4)_3 \cdot 17H_2O$
Celestite	$SrSO_4$
Copiapite	$Fe^{+2}Fe_4^{+3}(SO_4)_6(OH)_2 \cdot 20H_2O$
Epsomite	$MgSO_4 \cdot 7H_2O$
Ferrinatrite	$Na_3Fe^{+3}(SO_4)_3 \cdot 3H_2O$
Fluorite	CaF_2
Goethite (limonite)	$HFeO_2$
Halotrichite-Pickeringite	$(Fe,Mg)Al_2(SO_4)_4 \cdot 22H_2O$
Jarosite	$KFe_3^{+3}(SO_4)_2(OH)_6$
Klebelsbergite	$Sb_4^{+3}O_4(OH)_2SO_4$
Mirabilite	$Na_2SO_4 \cdot 10H_2O$
Peretaite	$CaSb_4^{+3}O_4(OH)_2(SO_4)_2 \cdot 2H_2O$
Potassium Alum	$KAl(SO_4)_2 \cdot 12H_2O$
Pyrrhotite	FeS
Rozenite	$Fe^{+2}SO_4 \cdot 4H_2O$
Senarmontite	Sb_2O_3
Sideronatrite	$Na_2Fe^{+3}(SO_4)_2(OH) \cdot 3H_2O$
Tamarugite	$NaAl(SO_4)_2 \cdot 6H_2O$

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tr

Siegenite
from the Buick Mine Bixby, Missouri

by **Mark Le Font**
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INTRODUCTION

Siegenite, a rare cobalt-nickel sulfide of the polydymite-linnaeite series, occurs as sharp, euhedral crystals associated with calcite, galena, chalcopyrite, pyrite, and sphalerite in a brecciated Cambrian calcarenite in the Buick mine near Bixby, Missouri. The mine is one of many in the Viburnum Trend Lead Belt of Southeastern Missouri, the largest lead and zinc deposit in the world. Fifteen percent of the world's total lead and zinc come from this region (Wharton, 1975). Many other mines in the area have produced fine mineral specimens, notably the Sweetwater mine, which has also produced some siegenite (Dunn, 1978). The La Motte, Indian Creek, Fletcher and Brushy Creek mines have also produced some fine specimens, but no siegenite crystals. Siegenite does occur as disseminated grains at the La Mott mine (Kidwell, 1946).

HISTORY

Lead deposits have been known to exist in southeastern Missouri since 1700. Emphasis shifted around the region as new mining techniques were developed and progressively less accessible orebodies became available for mining. The famous Tri-State lead district supplemented the output of the southeastern Missouri Lead Belt until 1957, when Tri-State became worked out. In 1955 St. Joe Lead Company discovered lead deposits near Viburnum through prospect drilling and soon many other companies, excited by the possibility of a major find, had come into the area. They include Ozark Lead Company, COMINCO American, AMAX-Homestake (owner/operator of the Buick mine), Bunker Hill Company and others. It seems that new production records in this area are constantly being set, making it the largest lead district in the world. It not only accounts for about 85 percent of the total lead output in the United States, but for over 15 percent of the world's total lead production (Wharton *et al.,* 1975).

Collecting in this area is, unfortunately, forbidden. The entire district is composed of very active mines; access to and removal of specimens is discouraged by the mining companies, even among their miners. Nevertheless, some specimens do find their way out of the mines, mostly via the "lunchbox express." This is fortunate, because the specimens from this locality certainly rival or excell those from similar districts (including minerals from the Tri-state area, with which they are often confused), and they are certainly worthy of preservation.

GEOGRAPHY

The Viburnum Trend is located in southeastern Missouri and runs north-south with one end in the common corner of Crawford and Washington Counties, through Iron and Reynolds Counties, ending up in Shannon County (Fig. 1). It is in the midst of many other famous mining districts, including the Franklin County district, the Indian Creek district and the La Mott district. The Buick mine is located about a mile northeast of the town of Bixby, Missouri, population approximately 200. Larger population centers include Rolla, Missouri, 41 miles northwest, and St. Louis, 84 miles northeast. Topographically, the mine is in the Ozarks, with mile upon mile of rolling hills covered by forests and streams.

The Buick mine consists of a mill, power plant, office buildings, several headframes and lifts, and extensive ore-handling equipment (Fig. 2). The main workings consist of one level of room-and-pillar stopes about 3500 feet long. Siegenite comes from the most richly mineralized part of the mine (Fig. 3).

GEOLOGY

The Buick mine intersects a calcarenite which is a member of the middle Bonnterre formation, Upper Cambrian in age. The orebodies in the Viburnum Trend occur as north-south trending "lenses" of solution-induced collapse breccias in three elongate "fingers" paralleling each other. These are designated as the *east, central,* and *west* ore zones. In the Buick mine the west ore zone is highly mineralized owing to an additional solution-induced collapse fault on its eastern flank. It is in this highly mineralized area that siegenite crystals are found in vugs in highly porous calcarenite. Apparently these fingers of ore are ancient, refilled, brecciated, lagoonal scour channels where permeable sand was replaced and mineralized. Siegenite occurs in a "brittle style" brecciation zone in the upper part of the breccia piles with vein-like boundary fractures and white efflorescences and fillings of evaporite magnesium minerals. Collapse breccia formed due to solution of calcite by ground water along faults, which may have a displacement of as

Figure 1. **Siegenite crystals to ¼ inch on matrix from the Buick mine.**

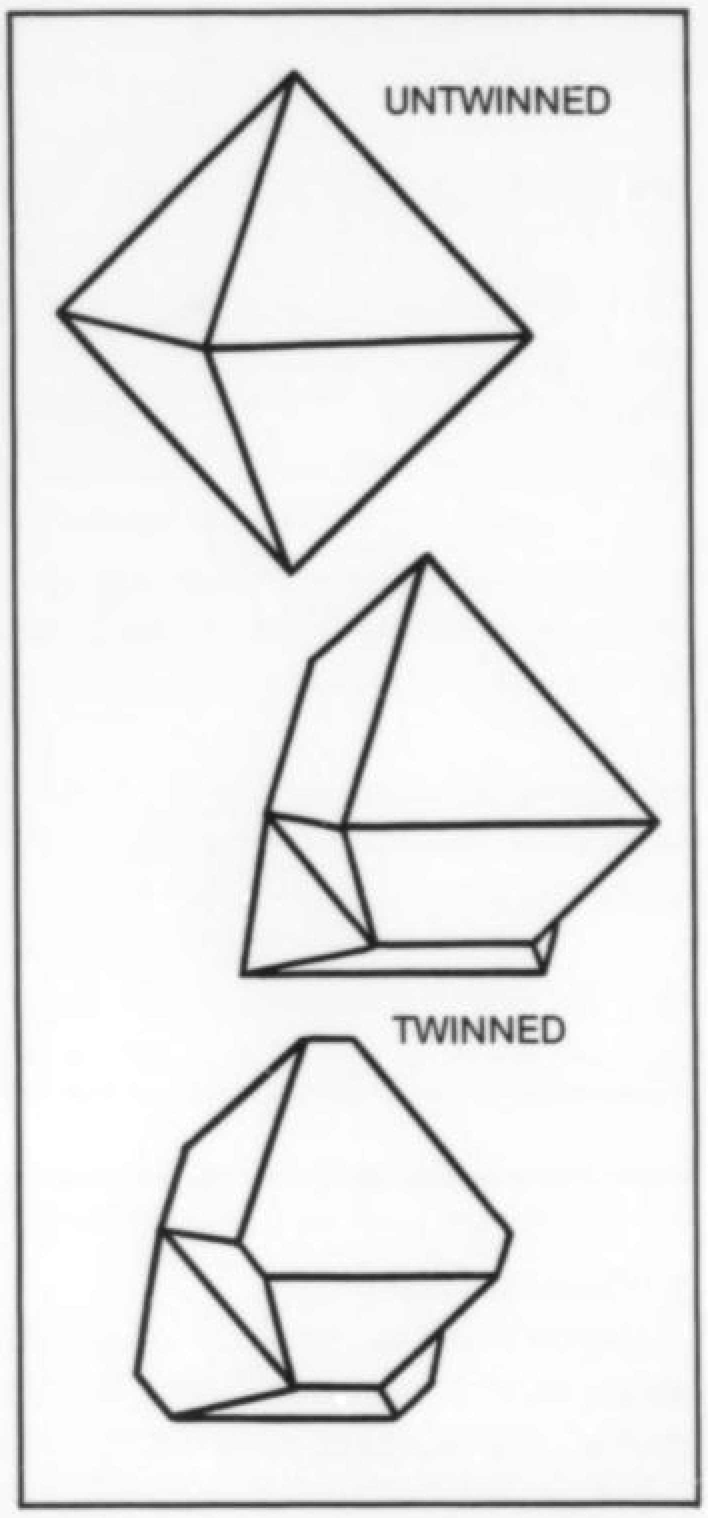

Figure 2. **Crystal habits of siegenite.**

much as 30 feet. A shale bed of Upper Cambrian age caps the ore zone, but is earlier than the collapse faulting.

MINERALS

Siegenite $(Co,Ni)_3S_4$

Siegenite occurs as sharp, equant, silvery, octahedral crystals up to ¼ inch or so. The faces are covered with triangular polysynthetic twinning lamellae (Fig. 4). These may be related to the exsolution lamellae of millerite found on the {100} and {111} faces of siegenite crystals from Brestovskog, Sweden (Jurkovic, 1954). The crystals are commonly twinned according to the spinel law on (111), siegenite being an inverse thiospinel (Ribbe, 1974). Crystals of siegenite from other localities also exhibit such twinning (Dunn, 1978). In some cases the crystals are elongated. Almost all of the cobalt and nickel in the deposit is present as siegenite.

Siegenite also occurs in the following localities worldwide: as an opaque accessory mineral in the eclogites of the Munchsberg massif, Bavaria, Germany (Knauer and Matthes, 1970); in minute amounts with traces of germanium, silver and lead from Lower Silesia (Nahn, 1970); in the Raipas district near Finnmark, Norway (Vokes, 1957, 1967); in the Kalgoorlie district, Western Australia, as disseminated grains (Ostwald, 1978); in Alp-Taspegn, Switzerland, from a uranium enriched augen-gneiss with rare associated stannite and other minerals (Sommerauer, 1972); in Brestovskog, Sweden, from a barite vein in an actinolite-epidote schist (Jurkovic, 1954); in the Shinkolobwe district, Zaire, where it occurs as a selenian variety (Vaes, 1947); in minor amounts from the Messina copper mines in South Africa (Söhnge, 1946); in the

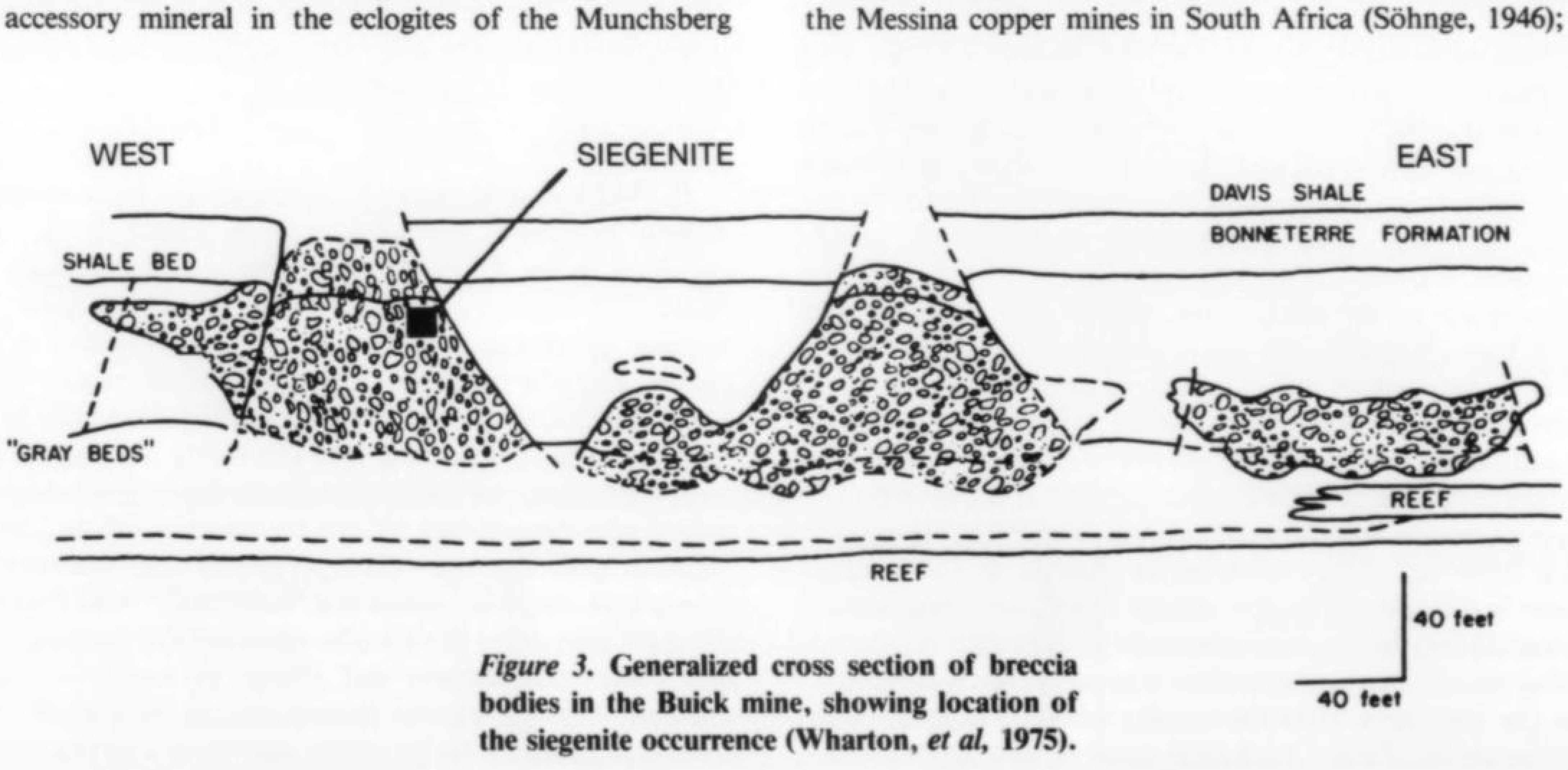

Figure 3. **Generalized cross section of breccia bodies in the Buick mine, showing location of the siegenite occurrence (Wharton, *et al,* 1975).**

Langis mine, Cobalt-Gowganda, Ontario, Canada, where it occurs as a cobalt-rich variety (Petruk, 1968); and in Szechuan, China, where it occurs with pyrite in biogenic ooliths (Wang and Ye, 1963). It should be pointed out that at most of these occurrences the mineral is present only in very small, anhedral, disseminated forms and not as large, euhedral crystals. Siegenite from a nearby district, Frederickstown, Missouri, has been found to be of a nickel-rich variety of the general formula $CoNi_2S_4$ (Minceva-Stefanova and Kostov, 1976). This is confirmed by the analysis of Short and Shannon (1930).

Calcite $CaCO_3$

Calcite occurs as small (under 0.04 inch), white, sharp, rhombohedral crystals in druses covering rock and filling veins. It is post-brecciation (having been dissolved and redeposited) and post siegenite/chalcopyrite/galena in sequence, indicating that solution-induced collapse probably occurred previous to hydrothermal mineralization and was followed by secondary redeposition of calcite.

Chalcopyrite $CuFeS_2$

Chalcopyrite occurs as small (to about 0.15 inch) tetrahedral crystals near siegenite. It is coincidental in sequence to the siegenite, being the copper/iron sulfide phase, and contains nearly all of the copper in the deposit.

Galena PbS

Galena occurs as cubic to cuboctahedral crystals, up to several inches, which seem to be coincidental in sequence with siegenite/chalcopyrite. This mineral is the primary lead mineral present and is the original reason for lead mining in this district. Galena accounts for 7 percent by weight of the ore from the mines in this area.

Pyrite FeS_2

Pyrite occurs as a gangue mineral, not in euhedral crystals, in association with siegenite; but larger, better-formed crystals occur elsewhere in the mine.

Sphalerite ZnS

Sphalerite does not occur in euhedral crystals; it forms in association with siegenite. Druses of microcrystals have also been observed.

Quartz SiO_2

Quartz occurs as gangue and as druses of microcrystals; elsewhere in the mine it forms larger crystals associated with pyrite and chalcopyrite.

DISCUSSION

The paragenetic sequence of the portion of the Buick mine in which the siegenite occurs seems to be fairly simple: specimens indicate a stage of pyrite/sphalerite deposition followed by almost coincidental deposition of siegenite/chalcopyrite/galena followed by slow solution-redeposition of calcite. This can be compared with the more complex paragenetic sequence of the Raipas formation in Norway: siegenite → bornite → chalcopyrite → tennantite (?) → digenite → chalcocite → covellite → secondary chalcopyrite → unknown sulfide (Vokes, 1957).

Siegenite in rare and large, euhedral crystals occurs only in a few localities in the world. The combination of rarity and esthetics in specimens from this locality makes them valuable additions to reference and display collections alike. The relatively large crystals with sharp twinning and lamellar features may very well make these the best examples of this mineral in the world.

ACKNOWLEDGMENTS

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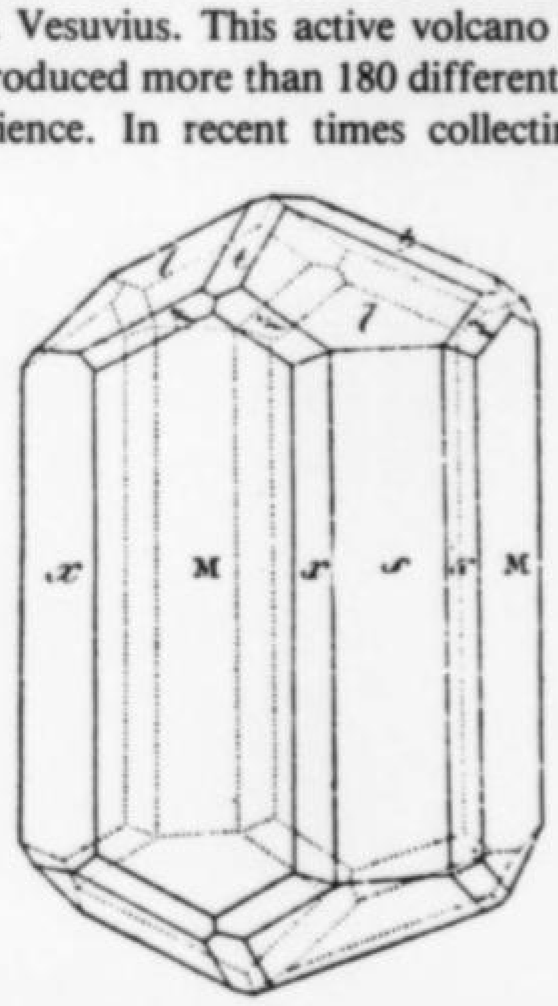
Notes from Italy

by **Gianni Porcellini**

Collectors in Europe know quite a bit about American minerals, but it is perhaps not as easy for Americans to keep informed about what is happening overseas. In this new column I plan to cover recent mineral discoveries in Europe, as well as some older localities which are still producing and which might be visited, especially here in Italy.

Italy is rich in minerals, from the Sicilian sulfur deposits in the South to the Alpine clefts in the North. Over 700 species have been identified from Italy, and new ones continue to be added to the list each year. The country supports an enthusiastic multitude of mineral collectors who are active field collectors and traders. And there is a fine publication available which deals with Italian minerals: *Rivista Mineralogica Italiana* (advertised in the *Mineralogical Record).* For $15 per year readers receive color photography and interesting locality articles.

The first locality I want to mention is one known by name to everyone: Mount Vesuvius. This active volcano near Napoli has, over the years, produced more than 180 different species including some new to science. In recent times collecting has not been especially fruitful. One must venture up the small canyons on the slopes of the volcano following heavy rains, or visit one of the few operating quarries. On my last visit I found some attractive crystals of meionite to about 5 mm, colorless, water-clear and well-terminated. More common are the beautiful crystals of ferroan spinel (*pleonast*), lustrous and deep green, in octahedral crystals sometimes modified by the dodecahedron. Associated with the spinel are very nice, transparent, yellow, well-terminated crystals of pyroxene.



Meionite from Vesuvius (after Goldschmidt).

Among the most important recent discoveries in Italy are the exceptional museum-quality specimens of brookite from Monte Bregaceto, near Genova in Liguria. The platy orange crystals reach an astounding 2 cm in length and 1 cm in width. They occur esthetically perched on matrix associated with yellow anatase crystals to a few mm. These specimens are very expensive.

Much less expensive (only a few dollars each) are the hundreds of anatase crystals turned up in a roadcut for a road being driven near Baceno in Valle Antigorio, in the Piemonte Alps. The crystals are pale blue to a bicolored pale blue/pale yellow, have a truncated bipyramidal habit, and reach about 3 mm in size.

Last summer I visited the white marble district near Carrara in Toscana. This is in the Alpi Apuane region, where the wonderful mountain landscapes seem to be covered with snow; actually they are covered with immense dumps of white marble from the many quarries. The climate is mild, being only a few kilometers from the Mediterranean Sea. Dozens of dumps are accessible, though many are unstable and prone to landslides. Here can be found pyrite crystals to a few mm which are very similar to those found at Lengenbach, Switzerland, but better. Other minerals include white calcite crystals and Italy's finest specimens of *adularia* (orthoclase), in colorless to white crystals up to 1 cm long. However, in order to obtain the best and rarest specimens which Alpi Apuane has to offer, one must visit the quarrymen door to door. With a little luck, the rare, dark yellow, tetrahedral crystals of colusite ($Cu_3(As,Sn,V,Fe)S_4$) to 3 mm can be purchased for $20 to $40 each. Superb crystals of yellow-brown wurtzite on sphalerite can be found for $30 to $50. Among the most rare are specimens of sulvanite (Cu_3VS_4) in dark, lustrous, cubic crystals on white marble . . . one specimen I saw, with four 2-mm crystals on a 3 x 4-cm matrix, was priced at $700.

The Italian Alps are not as famous among mineral collectors as the Alps of Switzerland and Austria, but the mineralogy is more or less identical. Among the most interesting of the Alpine cleft localities is the area in the Aosta region surrounding Monte Bianco, the highest mountain in Europe. Some of the best collecting is to be found in glacial debris of the immense moraine of the Miage Glacier. This moraine is literally a "river of rocks" many kilometers long and hundreds of meters wide. Just about all of the Alpine cleft minerals can be found among these millions of stones. The most rare and interesting is xenotime, found here for the first time two years ago. The crystals are pale yellow to colorless and transparent with a square prismatic habit terminated by low-angle bipyramids. Crystal size reaches only a millimeter or two. Associated minerals include platy, colorless, hexagonal crystals of apatite, dark acicular rutile (var. *sagenite*), colorless quartz, white albite, green chlorite and limonite pseudomorphs after pyrite. Last July I was on the moraine for a week, and returned with only three specimens of xenotime; but one is a matrix piece measuring 3 x 4 cm, with 15 crystals of xenotime!

That's all for the present. Write to me if you need information on Italian minerals, and I'll be glad to help.

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47037 Rimini, Italy

What's New in Minerals?

DENVER SHOW 1983

You can't ignore what everyone says, and everyone says that Denver is an up-and-coming show. That certainly proved to be true at their 16th annual show this past September. In fact, the show has even spawned a satellite show in a nearby motel . . . a sure sign that interest is increasing. Fifty-four dealers at the main show and perhaps a dozen at the satellite show were quite sufficient to draw plenty of collectors, and indeed the attendance at the main show topped 4000. (As for the *Mineralogical Record,* our table at the main show did more business than at any show other than Tucson; our thanks to the Denver Council of Gem & Mineral Societies for graciously donating booth space for us.)

An important new discovery of bournonite has been made near La Oroya, Lima, Peru. Some crystals are a lustrous metallic gray, though many lesser specimens are heavily pitted. But the crystal form is very good, with sharp edges on the multiply intergrown crystals. Size of the largest crystals is over 1½ inches though most measure around ½ inch; thumbnails to cabinets are available. There is very little associated material, just a little micro quartz and no real matrix. But the specimens are esthetic and reasonably priced; average miniatures were priced under $40, and very attractive cabinet pieces could be had for $100 to $300. Apparently most of the specimens were brought into the U.S. by Don Knowles (*Golden Minerals*), who obtained about 30 flats. Don wholesaled a significant amount to several other dealers including Mitch Abel (*Abel Minerals*) at the satellite show.

Figure 1. **Bournonite crystals on massive bournonite from La Oroya, Lima, Peru. The central group is about 1 inch tall. Don Knowles specimen.**

Jewel Tunnel Imports offered a new batch of chalcopyrite crystals ranging from ½ to over 1 inch, many twinned, on a matrix of quartz, sphalerite and pyrite crystals. About 30 flats of these were removed recently from the Bandora mine at Ouray, Colorado.

Cal Graeber and Mark Rogers shared a booth at the show, and Cal had Polaroids of a major batch of the ettringite-like mineral from South Africa which he acquired too late to prepare them for the show. The specimens are large and fine, with an interesting variety of crystal habits.

Over at the satellite show Dave Shannon had some interesting wulfenite from a new locality in Arizona: the Padre Kino mine, about 1 mile north of the famous Red Cloud mine. The crystals are steep bipyramids, red-orange in color, to almost ¼ inch. Some are associated with willemite. They were priced very low, with many miniatures under $10. Dave also had specimens with plancheite balls (X-rayed) to about ⅛ inch on matrix with brochantite, chlorargyrite, anglesite and cerussite from the Nugget Fraction mine about 15 miles south of Casa Grande, Arizona.

Resource Enterprises carried a number of large and fine golden barite crystals from the septarian concretions at Elk Creek, South Dakota. These have not been seen for several years in any size, and not for a long long time in crystals reaching 4 and 5 inches!

Next year's show dates have already been set: September 7, 8, and 9, 1984, at the Denver Merchandise Mart.

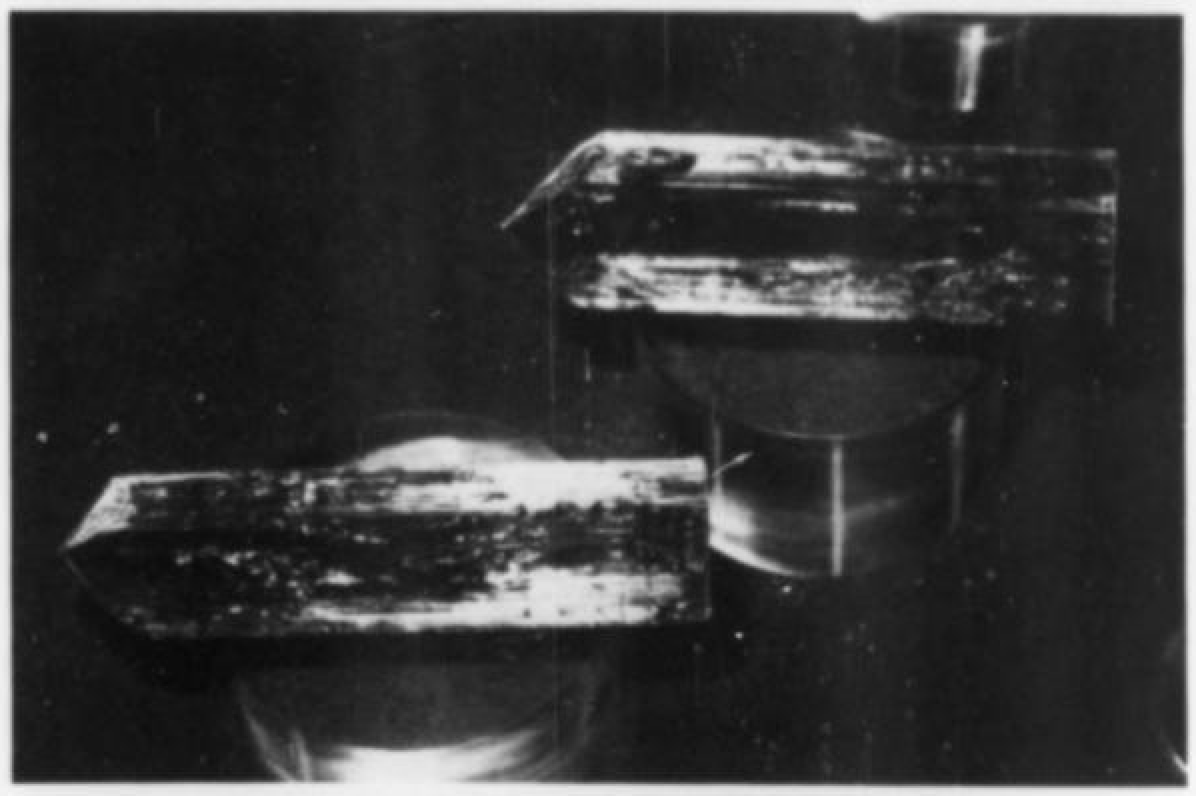

Figure 2. **Crystals of golden orange "imperial" topaz from near Ouro Preto, Minas Gerais, Brazil; about 4 inches long. Perkins and Ann Sams collection.**

DETROIT SHOW 1983

The annual Detroit Show maintained its reputation as one of the nation's top mineral events again this year, with its usual triple-play: top-quality dealers, fine displays, and good lectures held together by a friendly and enthusiastic staff of volunteers. The paid attendance of 3500 was down a bit from last year, but this was due to some promotional difficulties and not to the quality of the show itself.

A mineral show can't call itself "major" unless it can muster a good selection of displays, and the displays at Detroit this year were very satisfying. To the delight of mineral collectors, the centerpiece case (which greets visitors first as they enter the show hall) contained crystal specimens instead of the fossils or lapidary material of recent years. And what specimens! Curator Ron Bentley brought a small selection from the Perkins and Ann Sams collection: four magnificent gold specimens, three superb emeralds, two crystals of orange ("imperial") topaz measuring about 4 inches each, and a truly remarkable diamond crystal (a penetration twin) over 1¼ inches across.

Other fine displays included two by the Royal Ontario Museum on Chivor emeralds and beryls in general (the ROM collection is

***Figure 3.* A 1¼-inch penetration twin of gray diamond from South Africa. Perkins and Ann Sams collection.**

***Figure 5.* Tabular, butter-yellow wulfenite crystals on white barite from the Zelidja mine, shaft #11, Toussit, Morocco. The crystals measure about ½ inch on an edge. Brad Van Scriver specimen.**

presently in storage awaiting the rebuilding of its public display facilities), Harvard's case of Russian specimens, two top-quality displays of specimens from the Wayne State University collection, not to mention cases from the Cranbrook Institute, Michigan Technological University, the Cleveland Museum of Natural History, the Funk Museum and others.

Private displays were very good this year as well, and included some noteworthy competitive thumbnail collections. Minerals from Russia and from Långban filled three cases from the Pinch Mineralogical Museum, and many other dealers and private collectors too numerous to mention mounted excellent exhibits.

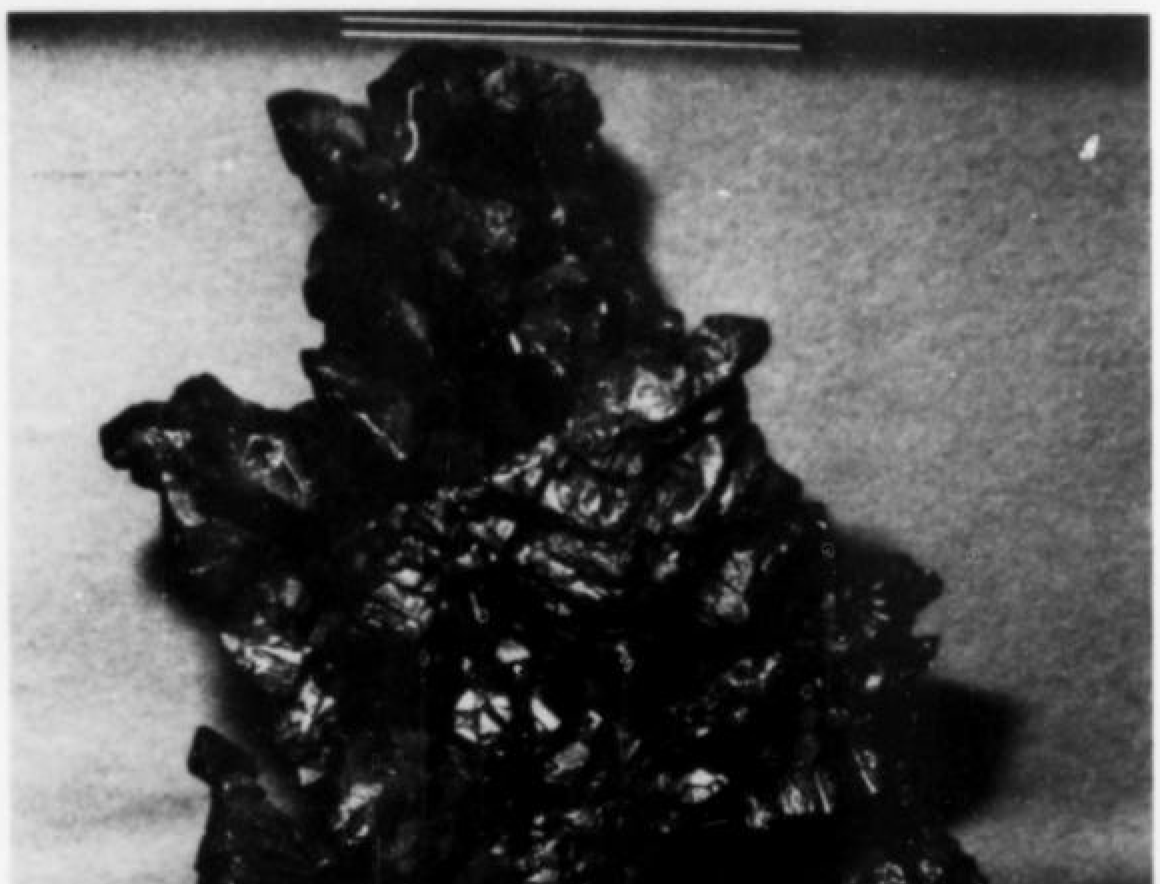

***Figure 4.* A large group of copper crystals about 10 inches tall, from Upper Michigan. Wayne State University collection.**

Wayne and Dona Leicht (*Kristalle*) offered a number of new/old items including some very attractive, newly mined gold specimens from Michigan Bluff, California (see vol. 13, p. 384–385). The thumbnails and miniatures were reasonably priced (for gold). They also had newly mined kämmererite from Turkey, also reasonably priced (see vol. 9, p. 277–287) and a fine collection of native copper from Upper Michigan which they had obtained from Cal Tech.

Chris Wright (*Wright's Rock Shop*) had a large lot of newly mined tourmaline (over 250 crystals) from the Himalaya mine in California (see vol. 8, p. 461–475). Most crystals were without matrix though a few carried lepidolite or quartz and a very few showed stilbite crystals in association. The crystals are almost all bicolored red and green. Unusual (at least I've never seen any before) are the partially resorbed crystals in which only the pink portion of bicolored crystals has been dissolved, leaving the green termination and a ragged, columnar skeletal remnant beneath it. These tend to be rather small, though the complete crystals range from 1 to 7 inches.

Also at Wrights booth were several of the new bournonite crystal groups from Peru which are achieving fairly wide distribution among the dealers after their introduction at the preceding Denver show. Victor Yount (in the motel show) had some fine examples as did a number of other people.

Wright and Leicht each had a number of very nice sapphire crystals from Sri Lanka. These, which reportedly came from a lot numbering nearly 1000 crystals, range in size from 1 to 3 inches and in color from blue to yellow, brown and colorless. They are the typical steep bipyramid habit, sometimes in small groups but without matrix and showing some evidence of being stream-worn as one might expect.

A new locality has been discovered for vanadinite in Arizona by Gary Novack and Neal Pfaff (*What on Earth*). It is called the J. C. Holmes claim and is situated somewhere in Santa Cruz county. The best specimens have orange crystals to nearly ½ inch, though most crystals are in the ⅛ to ¼-inch range. What makes them unusual is that there is little if any pinacoid to the habit, which consists basically of the hexagonal prism and bipyramid. Several dozen specimens were available. Although the color is not the blood-red of the better known Arizona localities (Apache mine and Old Yuma mine), the specimens do stand well on their own as an important occurrence.

Morocco remains productive and several dealers were carrying the material in Detroit. Two distinct habits of wulfenite are coming out. The Zelidja mine, shaft #11, at Toussit is yielding sharp, well-formed tablets of a butter-yellow color, and the older occurrence near Oujda is still producing bright orange crystals of irregular shape on barite. Victor Yount (at the Holiday Inn-Troy satellite show) and Claude Ben David from Casablanca (at the Holiday Inn-Hazel Part satellite show) are primary sources although many other dealers are obtaining the material by one route or another. Brad Van Scriver had a particularly fine cabinet specimen of the Zelidja type, the best I've seen. Ben David also had some exquisite gemmy yellow anglesite in miniatures, thumbnails and cabinet specimens. The largest has partially gemmy crystals to about 5 inches, but even the small ones, with crystals ½ to 1 inch, are stunning. A smattering of vanadinite and cerussite are still available too, though some is probably from earlier finds held back.

Ken and Betty Roberts (*Roberts Minerals*) obtained some very interesting Brazilian calcite crystals to 4 or 5 inches, in groups. What makes these attractive is the pine-green color from included chlorite. Some of the new ettringite-like mineral from South Africa was available as well (see vol. 14, p. 387), in excellent thumbnails and miniatures. Roberts and also Bill Pinch had specimens of dark red almandine crystals in groups from the famous N'Chwaning mine in South Africa, a species not reported previously (see vol. 9, p. 137–153) from that mine.

Figure 6. **A magnificent spray, 3 inches across, of pale sky-blue aquamarine on quartz and feldspar from the Gilgit-Skardu area, Kashmir, Pakistan. Herb Obodda and Dave Wilber specimen.**

Dave Wilber and Herb Obodda were sharing ownership at the show of a superb, one might almost say fantastic, specimen of aquamarine from Haramosh in the Gilgit-Skardu area, Kashmir, Pakistan. It consists of a 3-inch-wide *spray* of large aquamarine crystals on quartz and feldspar. Single crystals have long been known from that area (see vol. 11, p. 383), but I'm hard pressed to think of any similar aquamarine from *any* locality which consists of a diverging spray of perhaps two dozen crystals. Herb and Dave also had large and attractive tourmalines and a variety of other species.

Tony Jones (*California Rock and Mineral Supply*), down in the wholesale section, had a large lot of vivianite crystals from the Santa Fe mine, Morococala, Oruro, Bolivia. The first I had seen of this batch (collected perhaps a year ago) is pictured in the previous issue (vol. 14, p. 388–389), but many more were available in Detroit. The Jones-Nagin lot consisted of about 220 pieces including perhaps 20 cabinet-size crystals generally without matrix and very well formed. The largest crystals are 4 to 5 inches long, relatively transparent, with multiple growths in a semi-parallel arrangement. Crystal form is excellent and a few in all sizes are on matrix. (The correct spelling, incidentally, is Morococala . . . the second c was omitted in the previous report.)

During the last year or so some major discoveries of barite have been made at the old Elk Creek locality, South Dakota, and a number of dealers now have specimens. The most good specimens I've seen in one place were at the booth of the Black Hills Institute of Geological Research in the wholesale section. Crystals to 4 or 5 inches are not uncommon, and there are many excellent pieces to choose from.

The latest collecting season up on Rapid Creek in the Yukon Territory, Canada, has again yielded a quantity of the well known Yukon phosphates, of which Rock Currier (*Jewel Tunnel Imports*, wholesale section) seemed to have by far the most. Very nice crystals of lazulite, wardite, whiteite, augelite, siderite and apatite were available for extremely reasonable prices. The lot consisted of about 35 flats, and among these two specimens of childrenite and one of brazilianite were also found. Currier also had several dozen specimens of lustrous black wolframite in large crystals on quartz from Mundo Nuevo, Peru. The crystals are rather simple in habit and range from 1 to 2 inches in size.

Gilbert Gauthier over in the Holiday Inn-Troy show had his usual fascinating selection of Zaire minerals including some new cornetite from the Star of the Congo mine, Lubumbashi, Shaba province. The crystals form thin, round rosettes to about ¾ inch across, of typical cornetite-blue color. Also available from Gauthier were non-pseudomorphous malachite crystals to about ¼ inch in solid layers from the famous Musonoi mine. A few rare crystals reach ½ inch, and some are associated with *katangite* (a variety of chrysocolla).

Forrest Cureton (*Cureton Mineral Company*) at the Holiday Inn-Troy brought many flats of rare minerals and display pieces including a remarkable miniature of native lead *crystals* from Vermland, Sweden. The whole piece measures 2 inches tall, and the top crystal, though somewhat rounded and partially coated with pyrochroite, measures 1½ inches across. Lead is not generally found crystallized . . . does anyone know of a better crystal than this? (See photo.)

Also in Cureton's stock was what *must* be the world's finest crystal of plumbomicrolite (previously known to Forrest, at least, only as powder). It is a grayish yellow-green and measures 1⅛ inch on an edge and 2½ inches overall. Like its analog microlite, the habit is simple octahedral. Associations include biotite and microcline; the locality given is West Keivy, Kola Peninsula, Soviet Union.

Figure 7. **Native lead crystals (side and top view) from Vermland, Sweden. The group is 2 inches tall and is sprinkled with lustrous black pyrochroite crystals. Cureton Mineral Company specimen.**

Figure 8. **A gray-green, octahedral crystal of plumbomicrolite, $(Pb,Ca,U)_2Ta_2O_6(OH)$, measuring 1⅛ inch on edge and 2½ inches overall, from Keivy, Kola Peninsula, Soviet Union. Cureton Mineral Company specimen.**

Figure 9. **Stannite crystal aggregates 2 inches across from the San Jose mine, Oruro, Bolivia (mentioned here in the previous column). Jack Lowell specimen and photo.**

All in all it was a good weekend for the careful shopper. Several famous finds of previous years were again available at significiantly lower prices, and there were many discoveries old and new to choose from. Minerals aside, I still contend that Detroit is a very interesting place to visit despite all the bad press it has received for inner city problems and auto industry unemployment. The Detroit Institute of Art is the fourth largest art museum in the United States. The Detroit Library houses over a million volumes, and the Detroit Museum of History is certainly worth a visit. Then there is the famous Cranbrook Institute and the Henry Ford Museum, plus a perfectly adequate selection of good restaurants and shopping areas. Collectors who have never visited the show or the city should give it serious thought for next year. The show dates are October 12, 13 and 14, 1984.

Book Reviews

***American Geological Literature, 1669 to 1850,* by Robert M. Hazen and Margaret H. Hazen. Published (1980) by Dowden, Hutchinson and Ross, Stroudsburg, Pennsylvania. Hardcover, 6⅞ x 10 inches, 430 pages; order from Van Nostrand Reinhold Company, Order Processing, 7625 Empire Dr., Florence, Kentucky 41042. Price: $36.50; no postage or handling charge on prepaid orders.**

Bibliographies are incredibly useful guides for students and scholars who must enter a subject in depth. Preparation of any detailed bibliography requires an astonishing amount of dedication and patience, as well as the *simple know-how* . . . where to *find* the material. The specialized bibliography also calls for an intimate knowledge of the specialty being surveyed.

Before *any* scholarly bibliography I halt in tribute. Before *American Geological Literature, 1669 to 1850,* I am consumed in envy. Probably the authors, Robert and Margaret Hazen, did not read every entry, but they at least had the privilege of tracking them down and making some judgment in assembling them. They are, in my opinion, far ahead of even veteran mineralogists and collectors of the literature, most of whom, like myself, while aware of the existence of the literature, would never know where to look for most of it. I am further impressed that the two bibliographers, limiting themselves to the period 1669 to 1850, managed to fill 391 pages exclusive of the indices. 1669? Indeed, that year in Cambridge, only 49 years after Plymouth Rock, saw the publication of the first work pertaining to geology printed in America – curiously it dealt with an eruption of Mt. Aetna.

You will probably not read this work completely from front to back, but I can say that it has been a pleasing experience to do so and not at all forbidding. Earthquakes, fossils, medicine, mining, magnetism and even religion touched the expanding science of geology, and the Hazens have not neglected them nor the dozens of other corollary subjects. As geology became more popular the numbers of publications (journals as well as books) increased in variety. A great many reference treasures are included here and they make for illuminating reading. Fortunately the Hazens have underlined the most important entries, a welcome help.

Mineral collectors will find the hundreds of entries regarding species a priceless key to many old and forgotten mineral localities. Mineralogy and geology literature collectors will wonder how they ever managed before the existence of "Hazen & Hazen." I am delighted to have a copy at hand for my personal use.

My only complaint is that the type, while readable, is woefully small. I suppose there was no other way to compress 11,033 entries into this handsome volume.

Lawrence H. Conklin

***The Minerals of the Maldon Goldfield,* by J. C. Haupt. Published (1982) as Special Publication no. 1 of the Mineralogical Society of Victoria, P.O. Box 146, Collins Street, Melbourne, Victoria 3000, Australia. Softcover, saddle-stitched (like the *Mineralogical Record*), 7¼ x 9¾ inches, 36 pages plus one 3-color map; U.S. $9.50 per copy airmail postpaid.**

Dana collectors will welcome this thorough and concise review of the famous Maldon goldfield in Victoria. A dozen major mines in the area are discussed, including Nuggetty Reef, type locality for maldonite (Au_2Bi). History and geology are nicely capsulized, followed by a descriptive list of approximately 100 minerals, mineral groups and questionable species. Photos of several mineral species and historic scenes are included, all in black and white except for a color cover photo of gold.

The only drawback is the price, however it does include airmail postage. Furthermore, short-run specialized publications such as this enjoy no economies of scale and are bound to be more expensive. Society publications treating important localities in depth are all too rare and should be encouraged. Consequently, this little monograph is heartily recommended to everyone interested in the mineralogy of Australia.

W.E.W.

***Minerals of California* by H. Earl Pemberton. Published (1983) by Van Nostrand Reinhold; send mail orders to their warehouse address: 7625 Empire Dr., Florence, KY 41042. Hardcover, vii + 591 pages, $29.95 postpaid when payment accompanies order.**

California is one of our most richly mineralized states and because of this has had many "catalogues" of its mineral species published by various state agencies. The first such appeared in 1866 with 76 species recorded. This newest lists 736 terrestrial species and 5 species discovered in meteorites that landed in California and not yet discovered on earth.

The minerals are grouped into chemical classes according to Kostov's 1968 geochemical classification. Fleischer's *Glossary of Mineral Species* (1980) was used for species validity. The chemical composition is given for each species; crystal system and relationship to other species are sometimes included. The minerals are usually listed individually, but some are grouped either by association, e.g., smithsonite and hydrozincite, or by classification, e.g., rutile, anatase, and brookite. At times this grouping of occurrences can be a little tedious when looking for a specific mineral. For example, magnetite and magnesioferrite are listed together. Out of the 46 occurrences recorded for the two minerals, only one is of magnesioferrite. Elsewhere, copiapite, magnesiocopiapite, cuprocopiapite, and ferricopiapite and grouped together, but magnesiocopiapite is not listed as a separate species in the occurrences given. The alphabetical index in the back is useful.

The occurrences are listed alphabetically by county with the localities described in great detail, often including map coordinates. Over 100 locality maps, ranging from one-locality maps to those showing a dozen or more localities are given, as well as over 100 photographs. Many of the photographs are of museum specimens and many are SEM photographs, and all add a great deal to the volume. Unfortunately, some of the photographs show specimens from localities not given in the locality listings. The photographs and crystal drawings should also be cross-indexed in the locality listings as an additional aid. The bibliography, over 60 pages and over 1800 references, is excellent and covers the literature from 1849 through 1981. The Glossary is almost totally useless, and I would not recommend that section. The rest of the volume, even with the imperfections given here, is one of the best local or regional mineralogies yet seen. Anyone who works with mineral occurrences in California, whether amateur or professional, should acquire and use a copy of this volume.

James A. Ferraiolo

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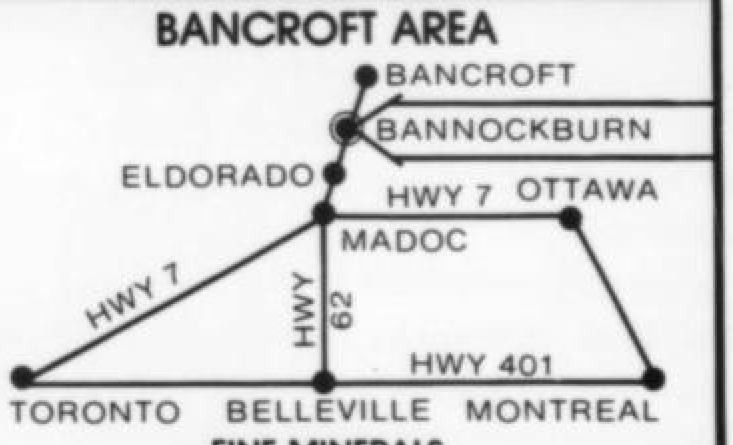

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Letters

PATIENCE STRAINED

Dear sir,

About 14 years ago, I and my wife discovered an unknown mineral and took it to the Smithsonian for identification. I was told that it was a new species. They asked me to leave it with them, and I did so on the condition that they inform me of its name and composition as soon as they were determined. The mineral was turned over to a mineralogist with the U.S.G.S.; I called her several times over the next two years, and was eventually informed that the composition had been determined, but that I could not have the formula until publication. She gave me no estimate of when publication might take place. When I said that I would therefore consider giving the specimen to a different mineralogist to work on, she asserted that this would be unethical.

Several more years went by. I wrote to the Smithsonian and was given no assurances that any progress toward publication had been made.

More years go by. I bumped into a well known member of the mineral fraternity who told me that the U.S.G.S. mineralogist who had been given my specimen was notorious for delays and procrastination. Upset by this, I arranged a conference with a Smithsonian official, and was finally given the composition (no name) and the request that I not reveal it to anyone.

More time passes. The U.S.G.S. mineralogist *retires* without ever having published a description of the new species. Late last year I began to sizzle again, and arranged a conference with an Undersecretary of the Smithsonian, through whom I was finally given a mineral name (and asked not to reveal it to anyone). The name was distinctly Russian; it turns out that the Russians discovered the mineral independently, promptly characterized it and obtained approval of their name from the I.M.A. Publication is now imminent, by the Russians.

I am of the firm opinion that, if a mineralogist does not identify and publish a new species within a reasonable time, the collector who supplied the material to him should have no restrictions about taking the mineral elsewhere for more prompt characterization. Furthermore, the collector should be entitled to early notification of the name and composition.

Philip Marcus
Wheaton, Maryland

Early notification after I.M.A. approval (but before publication) is the mineralogist's option, and it does seem like a reasonable courtesy. As to unreasonable delays, it is not unethical to take one's discovery elsewhere for more prompt attention, despite what you were told. The collector should check with the mineralogist every three months or so; presuming no unusually difficult technical problems are involved, a year or two for characterization should be ample. Fourteen years is ridiculous. (For more discussion on what to do with a potential new species, see Pete Dunn's guest editorial, "So you think you have found a new mineral?": vol. 6, no. 5, pp. 220–221.)

Ed.

CHIBOUGAMAU CUBANITE

Dear sir,

I think an important addenda to the article by Lévesque on cubanite from Chibougamau, Québec (May–June, page 151) would be the mention of the cubanite occurrence in the Portage mine, which is immediately adjacent to the Henderson II mine. The Portage mine is one of two producing mines in the Chibougamau area which are owned by Northgate Explorations Limited of Toronto. Campbell Resources Inc. of Toronto has three operating gold/copper mines near Chibougamau.

Cubanite was found in the Portage mine in October of 1982, in a stope about 40 feet above the 2550 level. All of the cubanite was found in pockets formed as tension gashes in the anorthosite country rock. Portage mine cubanite is of the same habit as cubanite from the Henderson II mine, but the crystals are generally less than half the size. At least 20 specimens have thus far been recovered, the largest crystal measuring 1 cm. Other pocket minerals include gray, cleavable ankerite, massive pyrite and stringers of chalcopyrite. Some specimens consist of cubanite crystals on massive pyrite with water-clear, euhedral calcite crystals to 8 mm. Other specimens consist of cubanite crystals perched on small, gray, cloudy calcite crystals.

The shut-down of the Henderson II mine mentioned in the Lévesque article was in effect for only two months; the mine was reopened in November, 1982.

Regarding the map on page 152, the location identified as the Henderson II mine is actually the Henderson I mine. The symbol 8 mm to the northeast is the Henderson II mine, although it should appear *in* the lake because both mines are collared on man-made peninsulas. The Portage mine should be shown about 1 cm farther to the northeast of the Henderson II mine, directly on the shoreline.

Irwin Kennedy
Chibougamau, Québec

COLLECTING AT WHEATLEY

Dear sir,

Your solicitation for collecting stories reminded me of the following. The Philadelphia Mineralogical Society scheduled a field trip to the Wheatley mine some time in the early twenties. Several members decided to go out in advance and turn the dump over with a few charges of blasting powder. I don't know how many were involved, but Harry Trudell (who told me this story) did mention Bill Knabe and Morris Biernbaum. The blasting party met early one morning at the P&R railroad station in Philadelphia with their bicycles, lunch, powder, fuse and a 6-foot bar. After checking their gear into the baggage car they rode to Phoenixville, where they secured their gear on the bicycles and pedaled the 6 miles or so to the mine. On arrival they searched the dump for any worthwhile material that might be in view, and found several pyromorphites and one anglesite specimen.

After eating lunch they went to work poking holes in the dump with the bar, pouring powder and setting fuses. They tamped the holes and moved their belongings back to a safe place. Then came the big moment; they lit the fuses and waited to see the dump rise up, turn over and fall back. Harry's description: "It was the best fireworks display I had ever seen. Fire squirted from under nearly every rock on the dump but, to the best of my knowledge, not a rock larger than the palm of your hand moved. So much for good intentions." The society's field trip was subsequently held as scheduled, and the members had to dig for their specimens as usual.

If you have a Wheatley specimen with a black sooty deposit on one side you may have an artifact from this fiasco.

Bill Hunt
Sun City, AZ

EXCHANGES

I am a Brazilian geologist and mineral collector interested in beautiful specimens of both rare and common species. As there are very few mineral collectors in Brazil, I would like to exchange specimens with other readers of the *Mineralogical Record.*

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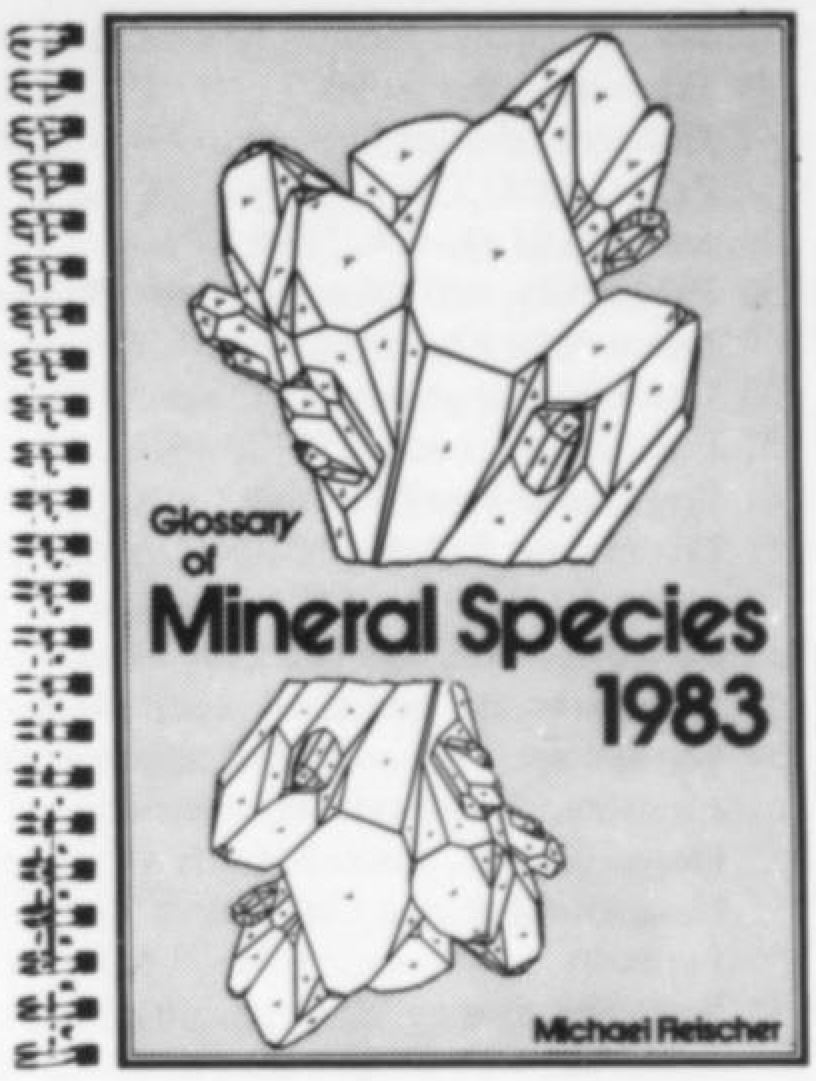
Additions & Corrections to the Glossary of Mineral Species 1983



by **Michael Fleischer**
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In the eleven months from October 15, 1982, to September 15, 1983, the torrent of new data on minerals has not abated. This appended list of additions and corrections to the 1983 Glossary contains nearly 300 entries, 73 of which describe new minerals.

I am indebted to many friends for suggestions, and especially to Robert Cobban, Lakewood, Colorado; Jim Ferraiolo, Smithsonian Institution, Washington, D.C.; Andrew Palmer, Mayfield, New York; and George Shokal, San Carlos, California, for thoughtful and incisive comments that have led to improvements in the Glossary.

Page

2 **Aeschynite-(Nd),** $(Nd,Ce,Ca)(Ti,Nb)_2(O,OH)_6$, orth.
2 **Agardite,** add **Mixite** group
2 Ainalite = tantalian **Cassiterite**
5 Alurgite change to "magnesian ferrian manganian **Muscovite**"
6 **Anduoite** in the reference, change 806 to 808
7 **Aphthitalite** change hex. to trig.
8 **Ardaite,** $Pb_{19}Sb_{13}S_{35}Cl_7$, mon., **68,** 642 (1983)
8 **Argutite,** GeO_2, tet., **Rutile** group
8 **Arhbarite,** $Cu_2(AsO_4)(OH)\cdot 6H_2O$, blue
9 **Arsendescloizite,** add **68,** 280 (1983)
10 **Atelestite,** change formula to $Bi_8(AsO_4)_3O_5(OH)_5$
12 **Balangeroite,** $(Mg,Fe^{+2},Fe^{+3},Mn^{+2})_{42}Si_{15}O_{54}(OH)_{36}$, orth., brown, fib., compare **Gageite, 68,** 214–219 (1983)
12 **Bannermanite,** formula $(Na,K)_xV_x^{+4}V_{6-x}^{+5}O_{15}$, add **68,** 634–642 (1983)
13 **Baricite,** add "compare **Vivianite.**"
14 **Bassanite,** change trig. to hex.
14 **Becquereiite,** formula $Ca(UO_2)_6O_4(OH)_6\cdot 8H_2O$
15 **Benavidesite,** add **68,** 280 (1983)
16 **Berdesinskiite,** add **67,** 1074 (1982)
17 **Billietite,** formula $Ba(UO_2)_6O_4(OH)_6\cdot 8H_2O$
18 **Bismite,** delete "dimorph. with **Sillenite**"
18 **Bismutostibiconite,** $Bi(Sb^{+5},Fe^{+3})_2O_7$, cub., **Stibiconite** group
19 **Boleite,** change formula to $Pb_{26}Ag_{10}Cu_{24}Cl_{62}(OH)_{48}\cdot 3H_2O$
19 **Bonshtedtite,** $Na_3Fe^{+2}(PO_4)(CO_3)$, mon., ps. orth., compare **Bradleyite, Sidorenkite**
20 **Bradleyite,** add "compare **Bonshtedtite**"
23 **Burangaite,** add "compare **Natrodufrenite**"
24 **Cabriite,** Pd_2SnCu, orth., Can Mineral. **21,** 481–487 (1983)
24 **Calciobetafite,** $(Ca,Na,Ce,U,Th)_2Zr_2(Ti,Nb,Fe)_4O_{14}$, cub., **Pyrochlore** group, dimorph. with **Zirkelite, 68,** 262–276 (1983)
24 **Calciotantite,** add **68,** 471 (1983)
26 **Carboirite,** $Fe^{+2}Al_2GeO_5(OH)_2$, tric., green, forms a series with **Chloritoid**
26 **Carnotite,** add "compare **Margaritasite**"
27 **Cassidyite,** change formula to $Ca_2(Ni,Mg)(PO_4)_2\cdot 2H_2O$
27 Cathophorite, move to precede Catoptrite
28 **Cechite,** add **67,** 1074 (1982)
29 **Cesstibtantite,** change formula to $(Cs,Na)SbTa_4O_{12}$, add "compare **Natrobistantite**"
29 **Chalcostibite,** change formula to $CuSbS_2$
30 **Chameanite,** add **67,** 1074–1075 (1982)
30 **Chessexite,** $Na_4Ca_2(Mg,Zn)_3Al_8(SiO_4)_2(SO_4)_{10}(OH)_{10}\cdot 40H_2O$, orth.
31 **Chiavennite,** $CaMnBe_2Si_5O_{13}(OH)_2\cdot 2H_2O$, orth., orange, **68,** 623–633 (1983)
31 **Chloritoid,** add "forms a series with **Carboirite**"
31 **Chlormagaluminite,** add **68,** 849 (1983)
31 **Chlorophoenicite,** add "compare **Jarosewichite**"
32 **Chloroxiphite,** should precede **Choloalite**
32 **Chromdravite,** $NaMg_3(Cr,Fe^{+3})_6(BO_3)_3Si_6O_{18}(OH)_4$, trig., dark green, **Tourmaline** group
33 **Claraite,** add **68,** 471 (1983)
35 **Collinsite,** change formula to Ca_2
35 **Colusite,** change formula to $Cu_{26}V_2(As,Sn,Sb)_6S_{32}$
36 **Compreignacite,** formula is $K_2(UO_2)_6O_4(OH)_6\cdot 8H_2O$
37 **Coyoteite,** $NaFe_3S_5\cdot 2H_2O$, tric., **68,** 245–254 (1983)
38 **Cronstedtite,** formula $Fe_2^{+2}Fe^{+3}(SiFe^{+3})O_5(OH)_4$
39 **Cuztiçite,** add **68,** 471 (1983)
39 **Cyanophiliite** misspelled
40 **Daomanite,** add **65,** 408 (1980)
42 **Dervillite,** Ag_2AsS_2, mon.
44 **Dufrenite,** add "compare **Natrodufrenite**"
45 **Dwornikite,** $(Ni,Fe^{+2})SO_4\cdot H_2O$, mon., **Kieserite** group, 68, 642 (1983)

48 **Ericaite,** change formula to $(Fe^{+2},Mg,Mn)_3B_7O_{13}Cl$

48 **Ericssonite,** misspelled

49 **Eudialyte,** change formula to $Na_4(Ca,Ce)_2(Fe^{+2},Mn)ZrSi_8O_{22}(OH,Cl)_2$

49 **Eztlite,** add **68,** 471 (1983)

50 **Fairbankite,** add "dimorph. with **Plumbotellurite**"

50 **Falkmanite,** $Pb_5Sb_4S_{11}$, mon.

50 **Fedorite,** change mon., ps. hex. to tric.

51 Fengluanite, change 1981 to 1980

51 **Fergusonite-beta-(Nd),** $(Nd,Ce)NbO_4$, mon.

51 **Ferri-annite,** $K(Fe^{+2},Mg)_3(Fe^{+3},Al)Si_3O_{10}(OH)_2$, mon., **Mica** group, **67,** 1179–1194 (1982)

53 **Ferrocolumbite,** add "compare **Magnocolumbite**"

53 **Ferrokaersutite,** add $(OH)_2$ to the formula

54 **Ferropumpellyite,** add "Pumpellyite group"

55 **Fichtelite,** change orth. to mon.

55 **Florencite-(La),** misspelled

55 **Fluocerite-(La),** $(La,Ce)F_3$, hex.

56 **Fornacite,** add "compare **Molybdofornacite**"

56 **Forsterite,** change "dimorph. with **Ringwoodite**" to "trimorph. with **Ringwoodite** and **Wadsleyite**"

57 **Friedelite,** change trig. to "mon., ps. trig."

57 **Fülöppite,** reference should be **15,** 201•202 (1930)

57 **Furutobeite,** add **67,** 1075 (1982)

58 **Gageite,** change formula to $(Mn,Mg,Zn)_{42}Si_{15}(O,OH)_{90}$, add "compare **Balangeroite**"

59 **Gebhardite,** change formula to $Pb_8(As_2^{+3}O_5)_2OCl_6$

59 **Geffroyite,** add **67,** 1074–1075 (1982)

60 **Georgiadesite,** formula is $Pb_{16}(AsO_4)_4Cl_{14}O_2(OH)_2$, or $Pb_{16}(AsO_4)_4Cl_{14}(OH)_6$. Change orth. to mon.

61 **Giraudite,** add **67,** 1074–1075 (1982)

62 **Gobbinsite,** $Na_4(Ca,Mg,K_2)Al_6Si_{10}O_{32} \cdot 12H_2O$, tet., **Zeolite** group, **68,** 642–643 (1983)

62 **Gordonite,** add "**Paravauxite** group"

62 **Gortdrumite,** $(Cu,Fe)_6Hg_2S_5$, orth., Mineralog. Mag. **47,** 35–36 (1983)

63 **Goudeyite,** add "**Mixite** group"

63 **Grayite,** add "compare **Ningyoite, Rhabdophane**"

64 **Grossular,** change "forms two series" to "forms three series"

65 **Gustavite,** add "forms a series with Lillianite"

67 **Hausmannite,** delete "compare **Iwakiite**"

69 **Hetaerolite,** delete "compare **Iwakiite**"

69 **Hewettite,** change orth. to mon.

70 **Hingganite-(Y),** $(Y,Yb,Er)BeSiO_4(OH)$, mon., compare **Datolite**

70 **Hingganite-(Yb),** $(Yb,Y)BeSiO_4(OH)$, mon., compare **Datolite**

71 Hokutolite = plumboan **Barite,** $(Ba,Pb)SO_4$

71 **Honessite,** change **Pyroaurite** group to **Hydrotalcite** group

73 **Hyalotekite,** $(Ba,Pb,Ca,K)_6(B,Si,Al)_2(Si,Be)_{10}O_{28}(F,Cl)$, tric., ps. mon., **67,** 1012–1020 (1982)

73 **Hydrobiotite,** 1:1 regular interstratification of **Biotite** and **Vermiculite** layers, mon., **Mica** group, **68,** 420–425 (1983)

73 **Hydrombobomkulite,** correct misspelling and move to p. 74

77 **Imogolite,** add **54,** 50–71 (1969)

78 **Iraqite,** change hex. to tet.

78 **Isomertieite,** add **68,** 851 (1983)

79 **Jarosewichite,** $Mn^{+2}Mn^{+3}(AsO_4)(OH)_6$, orth., dark red, compare **Chlorophoenicite** and **Magnesium-chlorophoenicite, 67,** 1043–1047 (1982)

79 **Jeanbandyite,** add **68,** 471–472 (1983)

80 **Johannite,** add **68,** 851 (1983)

80 **Johillerite,** add **67,** 1075 (1982)

81 **Julgoldite,** add "**Pumpellyite** group"

84 **Keckite,** add "compare **Whiteite**"

84 **Kegelite,** formula should be $Pb_{12}(Zn,Fe^{+2})_2Al_4(SO_4)_4Si_{11}O_{38}$

84 **Kermesite,** change mon. to tric., ps. mon.

85 **Khademite,** add "compare **Rostite**"

87 **Kolfanite,** add **68,** 280 (1983)

87 **Konyaite,** $Na_2Mg(SO_4)_2 \cdot 5H_2O$, mon., **67,** 1035–1038 (1982?

87 **Korshunovskite,** misspelled, add **68,** 643 (1983)

88 **Krinovite,** add "Aenigmatite group"

89 Kurgantaite = strontian **Tyretskite**

90 Laffittite, add "compare **Marrite**"

90 **Langite,** change "trimorph. with **Posnjakite** and **Wroewolfeite**" to "dimorph. with **Wroewolfeite**"

90 **Lannonite,** $HCa_4Mg_2Al_4(SO_4)_8F_9 \cdot 3H_2O$, tet., Mineralog. Mag. **47,** 37–40 (1983)

91 **Laueite,** add "**Paravauxite** group"

91 **Lawsonbauerite,** change formula to $(Mn,Mg)_9Zn_4(SO_4)_2(OH)_{22} \cdot 8H_2O$, add **67,** 1029–1034 (1982)

93 **Lermontovite,** change formula to $U^{+4}(PO_4)(OH) \cdot H_2O$ (?), add "orth., fib., gray-green"

93 **Levyne,** correct spelling of Levynite

94 **Liebigite,** change formula to $Ca_2(UO_2)(CO_3)_3 \cdot 11H_2O$

94 **Lillianite,** add "forms a series with **Gustavite**"

94 **Lindsleyite,** $(Ba,Sr)(Ti,Cr,Fe,Mg,Zr)_{21}O_{38}$, trig., black, **Crichtonite** group, **68,** 494–505 (1983)

94 **Lithiotantite,** $Li(Ta,Nb)_3O_8$, mon.

94 **Lithosite,** $K_6Al_4Si_8O_{25} \cdot 2H_2O$, mon., ps. orth.

95 **Lotharmeyerite,** $CaZnMn^{+3}(AsO_4)_2 \cdot 2H_2O$, reddish-orange, Mineralog. Record **14,** 35–36 (1983), **68,** 849 (1983)

95 **Loudounite,** $NaCa_5Zr_4Si_{16}O_{40}(OH)_{11} \cdot 8H_2O$, Can. Mineral. **21,** 37–40 (1983)

96 **Luddenite,** $Pb_2Cu_2Si_5O_{14} \cdot 14H_2O$, mon., green, **68,** 643 (1983)

96 **Lun'okite,** $(Mn,Ca)(Mg,Fe^{+2},Mn)Al(PO_4)_2(OH) \cdot 4H_2O$, orth., **Overite** group

97 **Machatschkiite,** change formula to $(Ca,Na)_6(As^{+5}O_4)(As^{+5}O_3OH)_3(PO_4,SO_4) \cdot 15H_2O$. Add **68,** 851–852 (1983)

100 **Makatite,** change orth. to mon., add **68,** 852 (1983)

101 **Mansfieldite,** correct spelling of **Scorodite**

102 **Marcasite,** add "orth."

102 **Margaritasite,** $(Cs,K,H_3O)(UO_2)_2(VO_4)_2 \cdot H_2O$, mon., yellow, compare **Carnotite, Tyuyamunite, 67,** 1273–1289 (1982)

102 **Marrite,** add "compare **Laffittite**"

102 **Mathiasite,** $(K,Ca,Sr)(Ti,Cr,Fe,Mg)_{21}O_{38}$, trig., black, **Crichtonite** group, **68,** 494–505 (1983)

103 **McGillite,** change trig. to "mon., ps. trig."

104 **Meixnerite,** formula should be $Mg_6Al_2(OH)_{18} \cdot 4H_2O$

104 **Melanothallite,** Cu_2OCl_2, orth., black, **68,** 852 (1983)

105 **Mertieite-II,** change 1975 to 1976

106 **Metahewettite,** $CaV_6O_{16} \cdot 3H_2O$, mon., deep red

106 **Metakoettigite,** $(Zn,Fe^{+3},Fe^{+2})_3(AsO_4)_2 \cdot 8(H_2O, OH)$, tric., bluish-gray, compare **Metavivianite, Symplesite**

107 **Metastudtite,** $UO_4 \cdot 2H_2O$, orth., pale yellow, **68,** 456–458 (1983)

107 **Metavanmeersscheite,** add **67,** 1077 (1982)

107 **Metavivianite,** add "compare **Metakoettigite**"

107 **Mgriite,** add **68,** 280–281 (1983)

108 **Miharaite,** formula should be $PbCu_4FeBiS_6$

108 **Minrecordite,** add **68,** 281 (1983)

109 **Mixite,** add "Mixite group"

109 **Mohite,** add **68,** 281 (1983)

109 **Mohsite,** add **68,** 474 (1983)

109 **Molybdofornacite,** $Pb_2Cu[(As,P)O_4][(Mo,Cr)O_4](OH)$, mon., light green, compare **Fornacite, Vauquelinite**

110 **Molybdophyllite,** change hex. to trig.

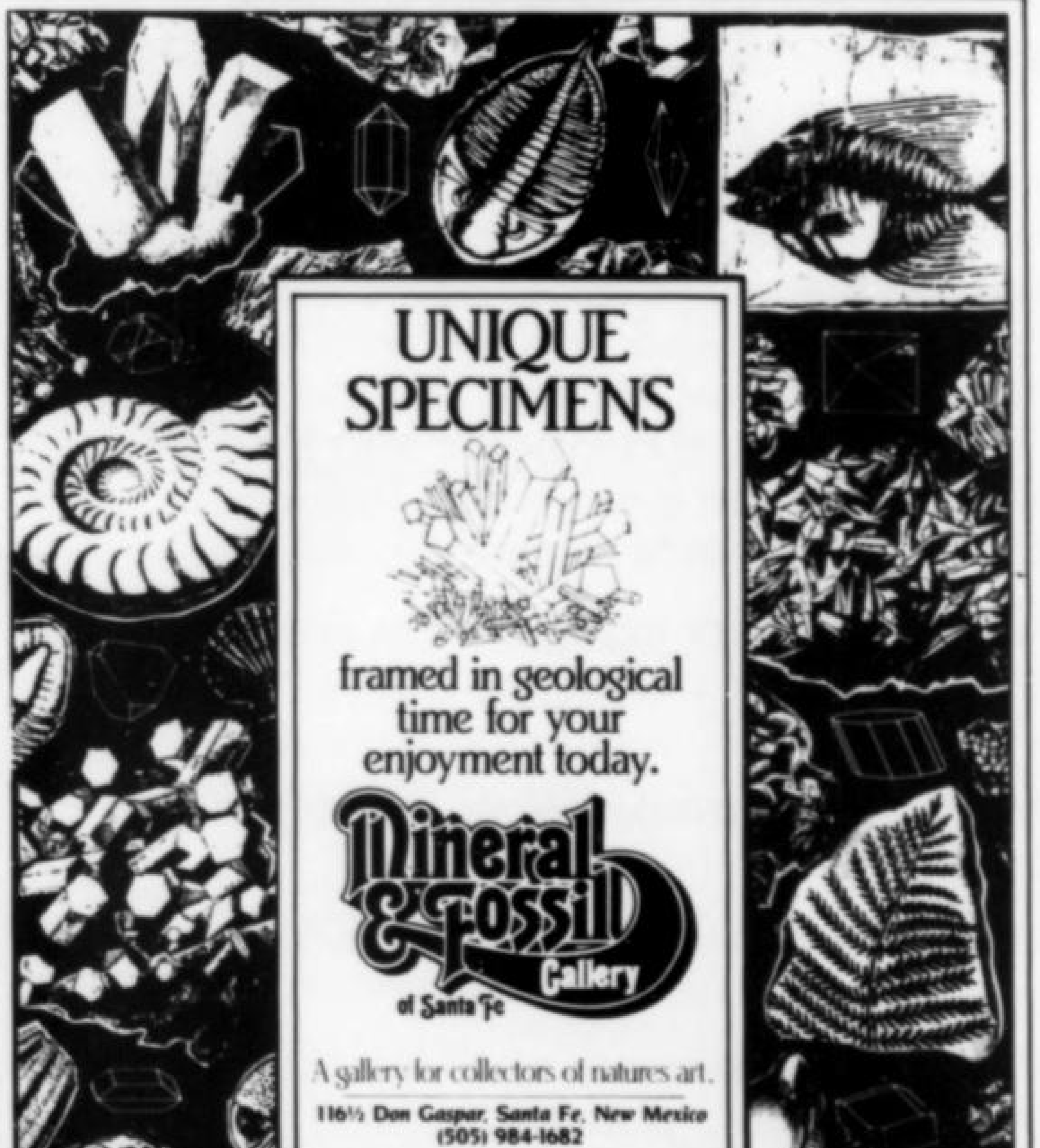
110 **Monazite-(Nd),** $(Nd,La,Ce)PO_4$, mon., **68,** 849 (1983)

110 **Moncheite,** change hex. to trig.

111 **Mooreite,** formula $(Mg,Zn,Mn)_{15}(SO_4)_2(OH)_{26} \cdot 8H_2O$, add **68,** 474 (1983)

112 **Mountkeithite,** formula $(Mg,Ni)_{11}(Fe^{+3},Cr,Al)_3(OH)_{24}(SO_4,CO_3)_{3.5} \cdot 11H_2O$
112 **Mundrabillaite,** $(NH_4)_2Ca(HPO_4)_2 \cdot H_2O$, mon., Mineral. Mag. **47,** 80–81 (1983)
112 **Musgravite,** $(Mg,Fe^{+2},Zn)_2Al_6BeO_{12}$, trig., green, compare **Pehrmanite**
113 **Nabaphite,** $NaBaPO_4$, cub., compare **Nastrophite, 68,** 643–644 (1983)
113 **Namuwite,** add **68,** 281 (1983)
114 **Nastrophite,** add "compare **Nabaphite**"
114 **Natanite,** add **67,** 1077 (1982)
114 **Natrite,** add **68,** 281–282 (1983)
114 **Natrobistantite,** $(Na,Cs)Bi(Ta,Nb,Sb)_4O_{12}$, cub., bluish- to yellowish-green, **Pyrochlore** group, compare **Cesstibtantite**
114 **Natrodufrenite,** $Na(Fe^{+3},Fe^{+2})(Fe^{+3},Al)_5(PO_4)_4(OH)_6 \cdot 2H_2O$, mon., bronze-green, compare **Dufrenite, Burangaite**
115 **Neltnerite,** add **68,** 282 (1983)
115 **Niahite,** $(NH_4)(Mn^{+2},Mg,Ca)PO_4 \cdot H_2O$, orth., pale orange, Mineralog. Mag. **47,** 79–88 (1983)
116 **Niggliite,** add "**Nickeline** group"
117 Niobozirconolite, change 1965 to 1961
117 **Niocalite,** $Ca_{14}Nb_2(Si_2O_7)_4O_6F_2$, mon.
117 **Nolanite,** change formula to $(V^{+3},Fe^{+2},Fe^{+3},Ti)_{10}O_{14}(OH)_2$, add **68,** 833–839 (1983)
119 **Ohmilite,** $Sr_3(Ti,Fe^{+3})(Si_2O_6)_2(O,OH) \cdot 2\text{–}3H_2O$, mon., pink, **68,** 811–817 (1983)
119 The order should be **Ojuelaite, Okanoganite, Okenite, Oldhamite**
119 **Okenite,** change formula to $Ca_{10}Si_{18}O_{46} \cdot 18H_2O$, add **68,** 614–622 (1983)
120 **Orickite,** near $2CuFeS_2 \cdot H_2O$, hex., brass-yellow, **68,** 245–254 (1983)
122 **Oursinite,** $(Co,Mg)(UO_2)_2Si_2O_7 \cdot 6H_2O$, orth., pale yellow
122 **Overite,** add "**Overite** group"
123 **Parachrysotile,** add "polymorph. with **Orthochrysotile**"
125 **Paravauxite,** add "**Paravauxite** group"
125 **Parisite,** change hex. to trig.
126 **Pehrmanite,** change formula to $(Fe^{+2},Zn,Mg)_2Al_6BeO_{12}$, add "compare **Musgravite**"
126 **Peisleyite,** $Na_3Al_{16}(SO_4)_2(PO_4)_{10}(OH)_{17} \cdot 20H_2O$, mon., **68,** 849–850 (1983)
127 **Petersite,** $(Y,Ce,Nd,Ca)Cu_6(PO_4)_3(OH)_6 \cdot 3H_2O$, hex., yellow-green, **Mixite** group, **67,** 1039–1042 (1982)
128 **Phaunouxite,** $Ca_3(AsO_4)_2 \cdot 11H_2O$, tric., **68,** 850 (1983)
129 **Pilsenite,** Bi_4Te_3, trig.
131 **Plumbotellurite,** add "dimorph. with **Fairbankite**"
131 **Posnjakite,** delete "trimorph. with **Langite** and **Wroewolfeite**"
132 **Preisingerite,** add "compare **Schumacherite**"
133 **Pumpellyite,** add "**Pumpellyite** group"
133 **Pumpellyite-(Mn),** add "**Pumpellyite** group"
135 **Raite,** change formula to $Na_4Mn_4Si_8(O,OH)_{24} \cdot 8\text{–}10H_2O$ (?)
135 **Ramdohrite,** change formula to $Pb_6Ag_3Sb_{11}S_{24}$, change orth. to mon., twinned
136 **Rayite,** $(Ag,Tl)_2Pb_8Sb_8S_{21}$, mon., compare **Semseyite**
136 **Rebulite,** $Tl_5Sb_5As_8S_{22}$, mon., **68,** 644 (1983)
136 **Reinhardbraunsite,** $Ca_5(SiO_4)_2(OH,F)_2$, mon.
137 **Revdite,** add **67,** 1076 (1982)
137 **Rhodplumsite,** $Pb_2Rh_3S_2$, trig., compare **Shandite**
138 **Richelsdorfite,** $Ca_2Cu_5Sb(AsO_4)_4Cl(OH)_6 \cdot 6H_2O$, mon., blue
138 **Ringwoodite,** change "dimorph. with **Forsterite**" to "trimorph. with **Forsterite** and **Wadsleyite**"
139 **Roggianite,** change formula to $Ca_8Al_8Si_{16}O_{44}(OH)_{16} \cdot 13H_2O$, add **68,** 852 (1983)
139 **Rokühnite,** $Fe^{+2}Cl_2 \cdot 2H_2O$, mon., **66,** 219 (1981)
139 **Romanechite,** change orth. to mon.
140 **Rostite,** compare **Khademite**
144 **Sayrite,** $Pb(UO_2)_5O_6(OH)_2 \cdot 4H_2O$, mon., yellowish- to reddish-orange
146 **Scholzite,** change mon., ps. orth. to orth.
146 **Schumacherite,** $Bi_3[(V,As,P)O_4]_2O(OH)$, tric., yellow, compare **Preisingerite**
147 **Searlesite,** change reference to **61,** 123–129 (1976)
147 **Segelerite,** add "**Overite** group"
147 **Semseyite,** add "compare **Rayite**"
148 **Shafranovskite,** $(Na,K)_6(Mn^{+2},Fe^{+2})_3Si_9O_{24} \cdot 6H_2O$, trig., olive-green to yellow-green, **68,** 644 (1983)
148 change **Shahovite** to **Shakhovite,** mon., change formula to $Hg_4Sb(OH)_3O_3$
148 **Shandite,** add "compare **Rhodplumsite**"
149 **Shuiskite,** add " **Pumpellyite** group"
149 **Sidorenkite,** add "compare **Bonshtedtite**"
149 **Sigloite,** add "**Paravauxite** group"
149 **Sillenite,** change formula to $Bi_{12}SiO_{20}$ and delete "dimorph. with **Bismite**"
150 **Simonite,** $TlHgAs_3S_6$, mon., red
152 **Sopcheite,** add **68,** 472 (1983)
152 **Sosedkoite,** $(K,Na)_5Al_2(Ta,Nb)_{22}O_{60}$, orth., **68,** 644 (1983)
153 **Spertiniite** should follow **Sperrylite**
153 **Srilankite,** $(Ti,Zr)O_2$, orth., blackish-brown
153 **Stanleyite,** $VOSO_4 \cdot 6H_2O$, orth., deep blue, **68,** 644–645 (1983)
154 **Staurolite,** change orth. to mon., ps. orth.
154 **Steacyite,** add **68,** 472 (1983)
157 **Sulfoborite,** change formula to $Mg_3B_2(SO_4)(OH)_8(OH,F)_2$, add **68,** 255–261 (1983)
157 **Sulphotsumoite** should follow **Sulphohalite**
157 **Surinamite,** add **68,** 804–810 (1983)
158 **Suzukiite,** correct spelling of **Haradaite,** add **68,** 282 (1983)
158 **Sveite,** add **67,** 1076 (1982)
158 Svetlozarite = twinned **Dachiardite,** Mineralog. Mag. **46,** 157–161 (1982)
158 **Symplesite,** add "compare **Metakoettigite**"
158 **Synadelphite,** change orth. to tric., ps. orth.
158 **Synchysite,** change hex. to ps. hex.
159 **Synchysite-(Nd),** change hex. to ps. hex.
160 Taaffeite-9R = **Musgravite**
161 **Tantite,** Ta_2O_5, tric. (?)
161 Taprobanite = **Taaffeite, 67,** 1076 (1982)
161 **Taramellite,** change formula to $Ba_4(Fe^{+3},Ti,Fe^{+2},Mg,V^{+3})_4Si_8B_2O_{29}Cl$
162 **Tengerite,** change tet.(?) to orth.
162 **Terskite,** $Na_4ZrSi_6O_{15}(OH)_2 \cdot H_2O$, orth., ps. tet., colorless to pale lilac
163 Texasite, change 159 to 169
163 **Theisite,** add **68,** 282 (1983)
165 **Tobelite,** $(NH_4,K)Al_2(Si_3Al)O_{10}(OH)_2$, mon., **Mica** group, **68,** 850 (1983)
166 **Toernebohmite,** $(Ce,La)_2Al(SiO_4)_2(OH)$, mon., **67,** 1021–1028 (1982)
166 **Tolovkite,** add **67,** 1076–1077 (1982)
166 **Tombarthite,** change 1960 to 1969
166 **Torreyite,** $(Mg,Mn)_9Zn_4(SO_4)_2(OH)_{22} \cdot 8H_2O$, mon., compare **Lawsonbauerite, 34,** 589–595 (1949), **67,** 1033 (1982)
167 **Triangulite,** $Al_3(UO_2)_4(PO_4)_4(OH)_5 \cdot 5H_2O$, tric., yellow
169 **Tyuyamunite,** add "compare **Margaritasite**"
171 **Uranosilite,** $U^{+6}Si_7O_{17}$, orth., yellowish
171 **Urvantsevite,** misspelled
171 **Ushkovite,** $MgFe_2^{+3}(PO_4)?_2(OH)_2 \cdot 8H_2O$, tric., yellowish to orange, **Paravauxite** group
173 **Vanmeersscheite,** add **67,** 1077 (1982)
174 **Vauquelinite,** add "compare **Molybdofornacite**"

175 **Vishnevite,** formula should be $(Na,Ca,K)_6(Si,Al)_{12}O_{24}[(SO_4),(CO_3),Cl_2]_{2\text{-}4}\cdot nH_2O$
175 **Vismirnovite,** add **67,** 1079 (1982)
176 **Vozhminite,** $(Ni,Co)_4(As,Sb)S_2$, hex., **68,** 645 (1983)
176 **Vuorelainenite,** add **68,** 472–473 (1983)
177 **Wadsleyite,** beta-$(Mg,Fe^{+2})_2SiO_4$, orth., trimorph. with **Forsterite** and **Ringwoodite,** Can. Mineral. **21,** 29–35 (1983)
177 **Walpurgite,** add **68,** 852 (1983)
178 Wehrlite = mixt. of **Pilsenite** plus **Hessite**
179 **Wicksite,** add **67,** 1077–1078 (1982)
179 **Wilcoxite,** $MgAl(SO_4)_2F\cdot 18H_2O$, tric., Mineralog. Mag. **47,** 37–40 (1983)
179 **Wilhelmvierlingite,** $CaMn^{+2}Fe^{+3}(PO_4)_2(OH)\cdot 2H_2O$, orth., **Overite** group
182 **Yafsoanite,** add **68,** 282–283 (1983)
184 **Zakharovite,** $Na_4Mn_5^{+2}Si_{10}O_{24}(OH)_6\cdot 6H_2O$, trig.
184 **Zhonghuacerite, add 67,** 1078 (1982)
187 **Aenigmatite Group,** add Cr^{+3} to B elements, add **Krinovite**
191 **Cobaltite Group,** Hollingworthite misspelled
191 **Crandallite Group,** add **Florencite-(La),** add La to A elements
191 **Crichtonite Group,** add **Lindsleyite, Mathiasite,** add to A elements Ba, K; add to B elements Zr, Fe^{+2}, V
194 **Hydrotalcite Group,** add $\cdot 4H_2O$ to formula given
194 **Kieserite Group,** add **Dwornikite,** add Ni to M elements
195 **Manasseite Group,** add $\cdot 4H_2O$ to the formula given
196 **Mica Group,** add **Ferri-annite** and **Tobelite**
196 **Mixite Group,** Hexagonal arsenates and phosphates of general formula $ACu_6(XO_4)_3(OH)_6\cdot 3H_2O$, A = Al, Bi, Ca, Nd, Y; X = As, P. Agardite, Goudeyite, Mixite, Petersite
196 **Monazite Group,** add **Monazite-(Nd)**
197 **Nickeline Group,** add **Niggliite.** Add Sn to B elements
197 **Olivine Group,** general formula should be $A^{+2}SiO_4$
197 **Overite Group,** Phosphates of general formula $ABC(PO_4)_2\cdot(2\text{–}4)H_2O$; A = Ca,Mn,Zn; B = Mg, Fe^{+2}, Mn^{+2}; C = Fe^{+3}, Al. Orth. Lun'okite, Overite, Segelerite, Wilhelmvierlingite
197 **Paravauxite Group,** Triclinic phosphates of general formula $AB_2(PO_4)_2(OH)_2\cdot 8H_2O$, A = Mg, Fe^{+2}, Mn^{+2}; B = Al, Fe^{+3}, Cr^{+3}. Gordonite, Laueite, Paravauxite, Sigloite, Ushkovite
198 **Pumpellyite Group,** Monoclinic silicates of general formula $Ca_2AB_2(SiO_4)(Si_2O_7)(OH)_2\cdot H_2O$; A = Mg, Mn^{+2}, Fe^{+2}; B = Al, Fe^{+3}, Cr^{+3}. Ferropumpellyite, Julgoldite, Pumpellyite, Pumpellyite-(Mn), Shuiskite
198 **Pyrite Group,** Villamaninite is misspelled
198 **Pyrochlore Group,** add **Calciobetafite, Natrobistantite**
198 **Rosasite Group, Glaukosphaerite** – change (Co,Ni) to (Cu,Ni)
199 **Rutile Group,** add **Argutite;** add Ge to M elements
199 **Smectite Group,** add **Aliettite**
199 **Sphalerite Group,** add Fe to A elements
200 **Stibiconite Group,** add **Bismutostibiconite,** add Bi and Fe^{+3} to A elements
200 **Tourmaline Group,** add **Chromdravite**
201 **Zeolite Group,** add **Gobbinsite,** delete Svetlozarite



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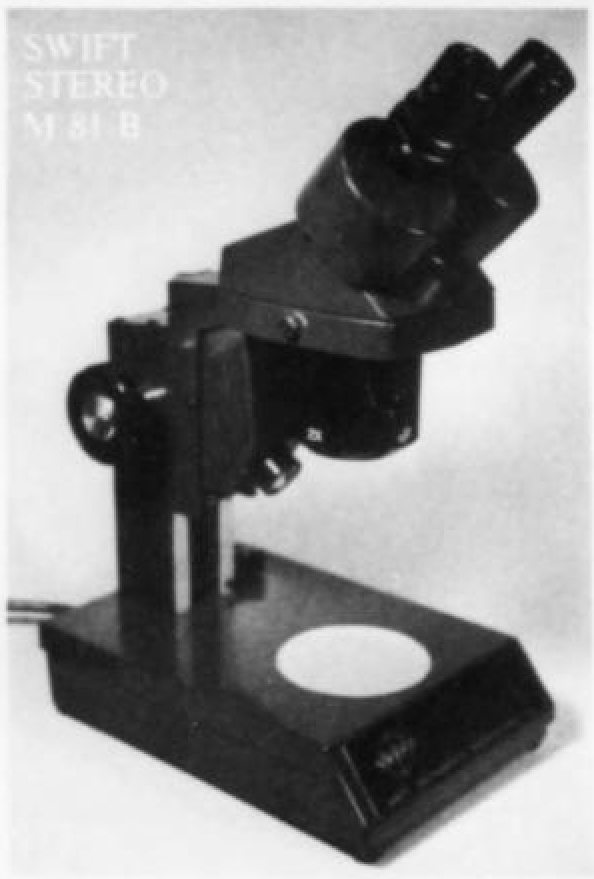

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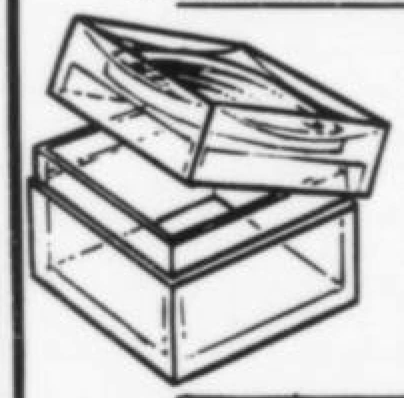

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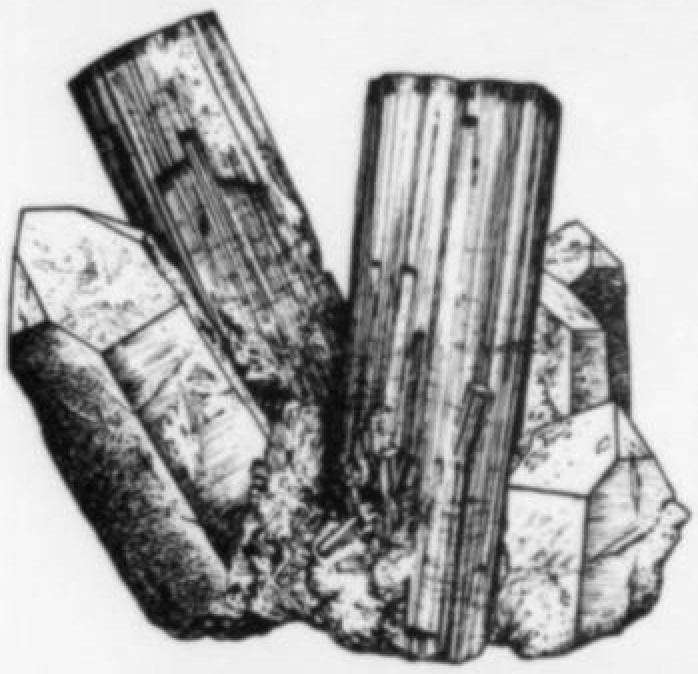

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