Mexico

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Mexico

Special Issue IV

The Mineralogical Record

❖

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Front Cover
AMETHYST cluster, 12.2 cm (4.8 inches), one of the finest ever found in the Amatitlan area of Guerrero State, Mexico. See the article in this issue. Wayne Thompson specimen, collected in 1998; Jeff Scovil photo.

Frontispiece (page 4)
The Candelaria mine, San Pedro Corralitos district, Chihuahua, Mexico, ca. 1907. Photo courtesy of Peter Megaw.

MINERS' BANK, CHIHUAHUA CITY 1914

Mexico-IV

Here we are again with another Mexico Issue in our series—a reminder that, despite the wealth of mineral specimens surging forth today from places like China, Pakistan and the former Soviet Union, Mexico is still fertile ground for the mineral collector. The three famous localities covered in this issue—the **San Francisco mine**, the **San Pedro Corralitos mines**, and the **Guerrero amethyst mines**—are all either currently producing specimens or are still easily capable of doing so for the skilled collecting professional.

The mineral localities of northern Sonora and Chihuahua resemble those in the contiguous desert region of Arizona. Secondary lead deposits, weathering to significant depths in an arid environment, produce beautiful minerals like wulfenite, cerussite and mimetite in abundance. The San Francisco mine may well be the world's single most prolific locality for fine wulfenite specimens, and San Pedro Corralitos has certainly produced the world's most voluminous run of botryoidal mimetite, all of it from a single pocket! Further exploration at each of these localities may well yield new bonanzas in the future, inasmuch as the productive zones have by no means been exhausted. Farther south, in the lush green hills of Guerrero state, a large tract of mountainous land riddled with amethyst veins has yielded many fine specimens since 1930 (including the cover specimen, found in 1998). In fact, specimens from all three of the famous localities described in this issue have been found in such abundance that they are still readily available today on the mineral market. Although the mineralogy is uncomplicated, we hope these articles will help collectors appreciate their specimens even more, through a deeper knowledge of the geological and historical context.

Each of these articles contains never-before-published first-hand information, often in the words of the people who actually made the big discoveries. Manuel Ontiveros, at 82 years old, is "living history," and it has been great to work with him on the Guerrero amethyst article. The same may be said of the much younger Wayne Thompson. It happens that I taped an interview with Wayne back in 1976 in which he described in detail his adventures at the San Francisco mine when they were still fresh in his mind (fortunately I was still able to *find* the tape, which had been gathering dust for nearly 30 years!).

We are continuing our tradition of making 300 **hardbound copies** in bonded leather available, at the low price of $50 plus postage. These hardbound volumes are ultimately going to make a truly wonderful set for the collector, so I strongly recommend that interested readers obtain all four of them published so far while we still have a few of each in stock. Once they have sold out and are obtainable only on the secondary market their prices will no doubt escalate. So start your set now, and sign up to have us reserve for you a copy of each future hardbound edition. And you can also sign up to have us mail you one or more extra copies of the softcover editions as each is published.

Right now we have at least two more Mexico Issues well along in preparation, and several more have been blocked out with proposed tables of contents. (I won't spoil the suspense by telling what they will contain!) These issues often require much research by the editorial staff, because potential outside authors on such esoteric localities are difficult to find. But being in Tucson we have some significant resources to draw on, including our close proximity to Mexico itself, the incredible Miguel Romero mineral collection at the University of Arizona, the unique files of Tucsonan Peter Megaw and his extensive knowledge of Mexican localities, the photo library of Jeff Scovil just two hours away in Phoenix, and a great many kind people who are willing to share their experiences and memories with us. And a few of these people are actually writing articles too! I remain very excited about this series, and I look forward myself to each new entry. My sincere thanks to Peter, Jeff, our color-work donor Philip Rust, and everyone who has helped us out thus far.

So it's that time again, as you hold the latest Mexico Issue in your hands. Make your way to that big leather easy-chair (the one with the steer horns mounted on the back). Stoke the stone fireplace with a few more mesquite logs to keep it burning brightly. Pour yourself a small crystal glass of sipping-tequila. Then warn the other *mineros* and *barreteros* (miners and drillers) not to bother you for a while, as you settle back to enjoy another vicarious journey to some of Mexico's most famous and most productive mineral localities.

Wendell E. Wilson

Candelaria mine, San Pedro Corralitos, ca. 1907

Famous mineral localities:

San Pedro Corralitos

Chihuahua, Mexico

Wendell E. Wilson
The Mineralogical Record
4631 Paseo Tubutama
Tucson, Arizona 85750

Yellow mimetite crystals from Namibia and China are considered to be the finest examples of the species, but attractive botryoidal specimens are so different in appearance that they tend to be judged separately. The best examples of bright yellow botryoidal mimetite from the 1968 San Pedro Corralitos find are treasured for their own unique beauty, and are considered to be the best of their type.

LOCATION

The San Pedro Corralitos district is located in the Nuevo Casas Grandes municipio in northern Chihuahua, Mexico. In the old days it was reached by the Rio Grande, Sierra Madre & Pacific Railroad to San Pedro Station, 118 miles from Juarez, Mexico, across the Rio Grande from El Paso, Texas. Today the mines are easily reached by a well-maintained dirt road. Altitude in the mine area is about 5200 feet, and the climate is dry and semi-arid. The mines lie in a clump of low hills, the highest of which is San Pedro Peak, rising about 1000 feet above the surrounding plain.

MINE WORKINGS

Of most interest to the mineral collector are the Congreso-León workings, wherein the fabulous mimetite pocket of 1968 was discovered. These workings are extensive and include several impressively large stopes measuring up to 100 x 150 feet, some of which are open to the surface. The orebodies contained oxidized lead ore. Most of the known ore chimneys in the area are located in the Congreso-León mine, confined to an area of about 400 x 800 feet. The workings consist of 14 levels 40 feet apart and extending to a depth of about 420 meters (1365 feet). These are accessed by two main vertical shafts (the Congreso shaft to the 5th level, and the Laird shaft to below the 8th level) and an inclined shaft. Level 12 and below are flooded (as of Alvarez, 1970).

The León Group of mines includes the León, Congreso and San Celestino mines (not yet interconnected in 1907) in the southern part of the property. Orebodies are irregularly shaped and carry gold, silver and lead in the gouge (which varies from almost pure quartz to half quartz and half iron oxides). These orebodies occur in contact zones between limestone and porphyritic felsic intrusive rocks, although there is little contact metamorphism present; the zone appears to have afforded channels for ore-bearing solutions. Ores are oxidized to a depth of 335 feet below the present water table. The best and largest orebodies have been found where dikes intersect with more massive intrusive bodies. Orebodies in the Congreso mine occur over a 1000-foot extent as measured along the contact zones. The main orebodies occur in one particular bed of fossiliferous limestone along several intrusive contacts

Shortly after the turn of the 19th century, two 16-inch drill holes were sunk for the purpose of pumping water in order to lower the water table in the mines. On the average, a pumping rate of 1000 gallons per minute lowered the water table by 3 feet per month. Rogers (1907) wrote: " At a level where extensive cavities exist the water level will lower slowly, whereas where there are few cavities

Figure 1. **Location map showing the railway route and the current highway route from Juarez/El Paso to the San Pedro Corralitos area.**

Figure 2. **Mines in the San Pedro Corralitos district, situated around Candelaria Peak (Cerro Candelaria).**

the water level will be lowered rapidly. The large cavities, of course, are indicative of large bodies of [oxide] ore, so that there is likely to be compensation for slow progress."

The Porvenir mine opens on some iron oxide outcrops about 1500 feet north of the Congreso mine. A few small bodies of high-grade oxidized and sulfide lead and copper ore were found in these outcrops.

The Candelaria Group of mines includes the San Pedro, Durita, Candelaria and San Librado mines (along with a number of other small workings). They are situated in low hills to the north of San Pedro Peak, about 4 miles from San Pedro Station. The country rock is impure limestones and shales interspersed with extrusive trachyte bodies and trap dikes, accompanied by mineralized fissure veins generally less than 18 inches thick. The San Librado vein is apparently an extension of the San Pedro vein, thrown southward by a fault.

The San Pedro vein was mined extensively from the surface on down, over a 700-foot distance along the outcrop. The first level adit (782 feet long) intersects the vein at about 45°. Drifting north and south on this level for over 700 feet encountered ore. Near the point where the adit meets the orebody a shaft from the surface extends to a depth of 242 feet, from which level an inclined shaft connects to the surface.

The San Nicholas Group includes the San Nicholas, the Cobriza and the '99 mine, all situated west of San Pedro Peak, probably on the same vein. The geology is similar to that of the other veins; in places the "pay streak" of the vein was 1 to 2 feet thick.

The San Benigno Group includes the San Benigno, La Cortada, Los Luises and La Llanura mines, all situated a short distance north of the San Nicholas mine. Only the San Benigno produced much ore before 1907, consisting of sulfides with a little gold.

HISTORY

Mining History

The first "modern" ore production at the Congreso mine took place in 1885 when the mine was acquired by E. D. Morgan and Associates of New York, who formed the Candelaria Mining Company, although there were certainly earlier, more primitive operations on the site. The Candelaria end of the property was worked first, and it was not until after 1895 that serious attention was paid to the Congreso-León end, except for the "Old León" workings which date to the earliest days of the camp. In 1907 the Candelaria Mining Company controlled a total of 266 claims of 1 hectare each, surrounded by a blanket location covering a total area of 1157 hectares (2858 acres) within the San Pedro Mining District.

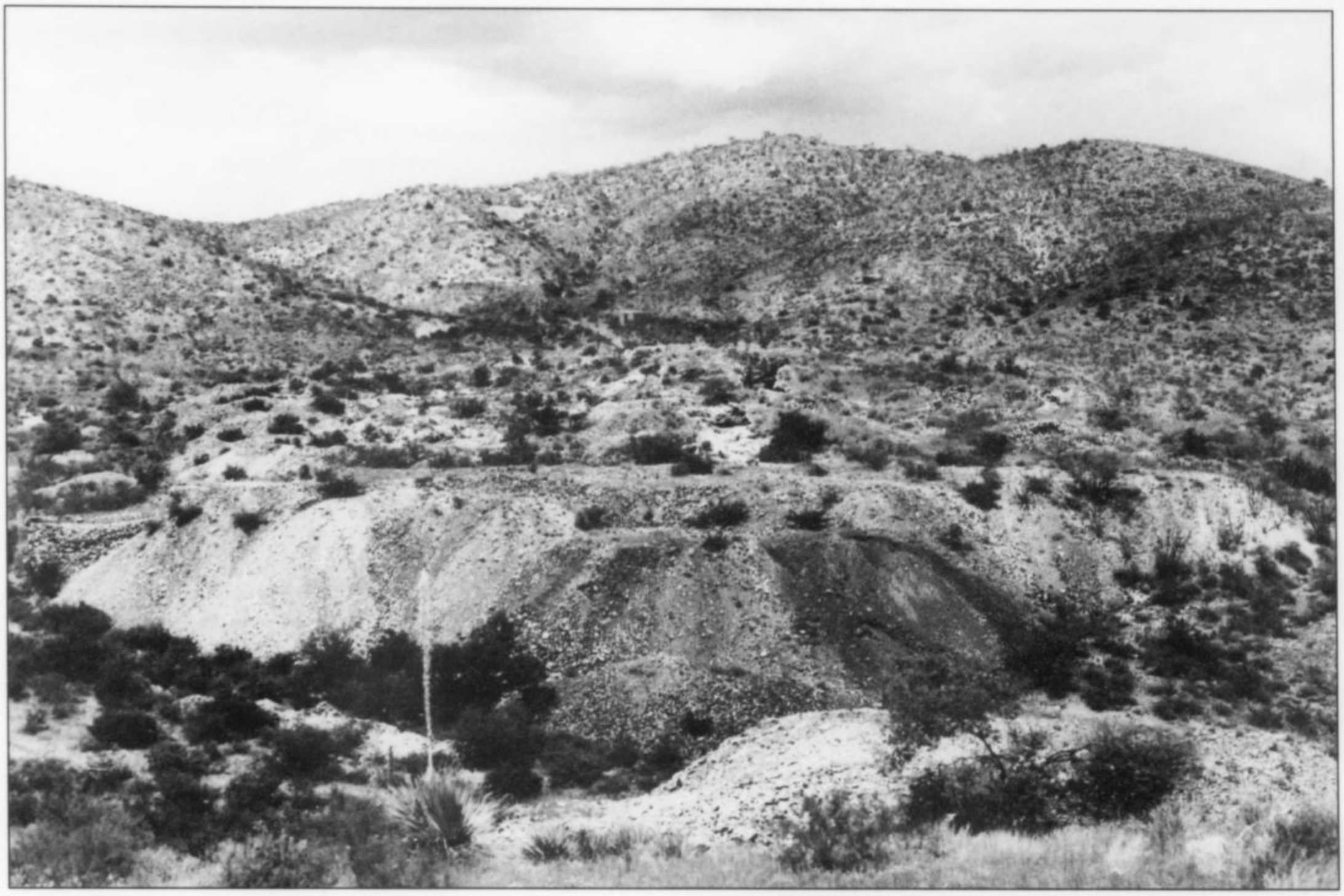


Figure 3. **Entrance to the Old León workings, August 1991 (Peter Megaw photo).**

After 1900 work was carried out at the Congreso mine and also at the Old León mine. As the ore zone was followed south, the New Congreso (or Laird) shaft was sunk and became the principal working shaft. By 1909 the Candelaria Mining Company was shipping 90 carloads a month of carbonate ore from the Congreso mine (mainly from the Bonanza and 49 chimneys). By 1910 seven orebodies had been discovered, all of them ore-bearing down to the water table, and giving evidence of continuing ore mineralization farther downward. These included the Bonanza, Morgan, Dwight, Reeves, Pilota, Avalos, Espinoza, Garcia and Garcia Extension bodies, some of which joined at depth to form one chimney.

Work in the area generally ceased by 1913, except for very minor surface work by small lessees and the occasional prospecting work by various mining companies. Because of the inflow of ground water, mining was never able to proceed below the 400-foot level, despite various pumping operations aimed at ameliorating the water problem. At the time of the shut-down two large steam pumps were about to be installed, but they were instead abandoned on the site and never used.

In 1926 a lease contract was negotiated with the Peñoles Mining Company, under which there would be a 50-50 division of profits. Mining operations resumed in 1927 under the supervision of Peñoles. A small orebody was opened first but the grade proved too low to profitably ship. Another orebody (the Dwight) was discovered, extending from the 4th to the 6th level, and it proved to be of higher grade. Exploratory drilling revealed other orebodies (named the Bonanza, Espinoza, and Morgan orebodies). Nevertheless, the company was unable to develop a profitable orebody before the option deadline, and all mining was again shut down in April 1928.

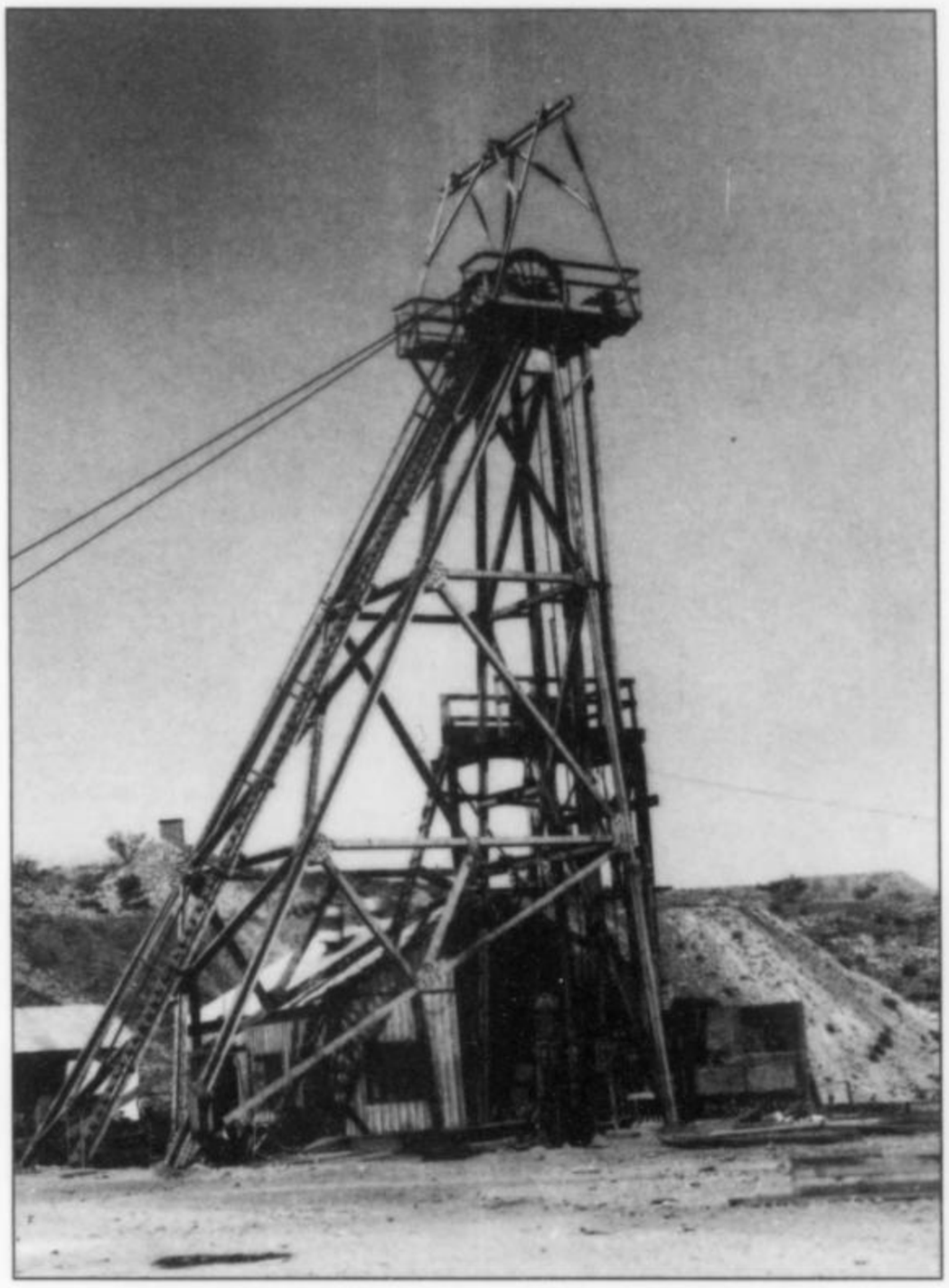


Figure 4. **Headframe over the Laird shaft of the Congreso-León mine in the 1940's. Photo courtesy of Peter Megaw.**

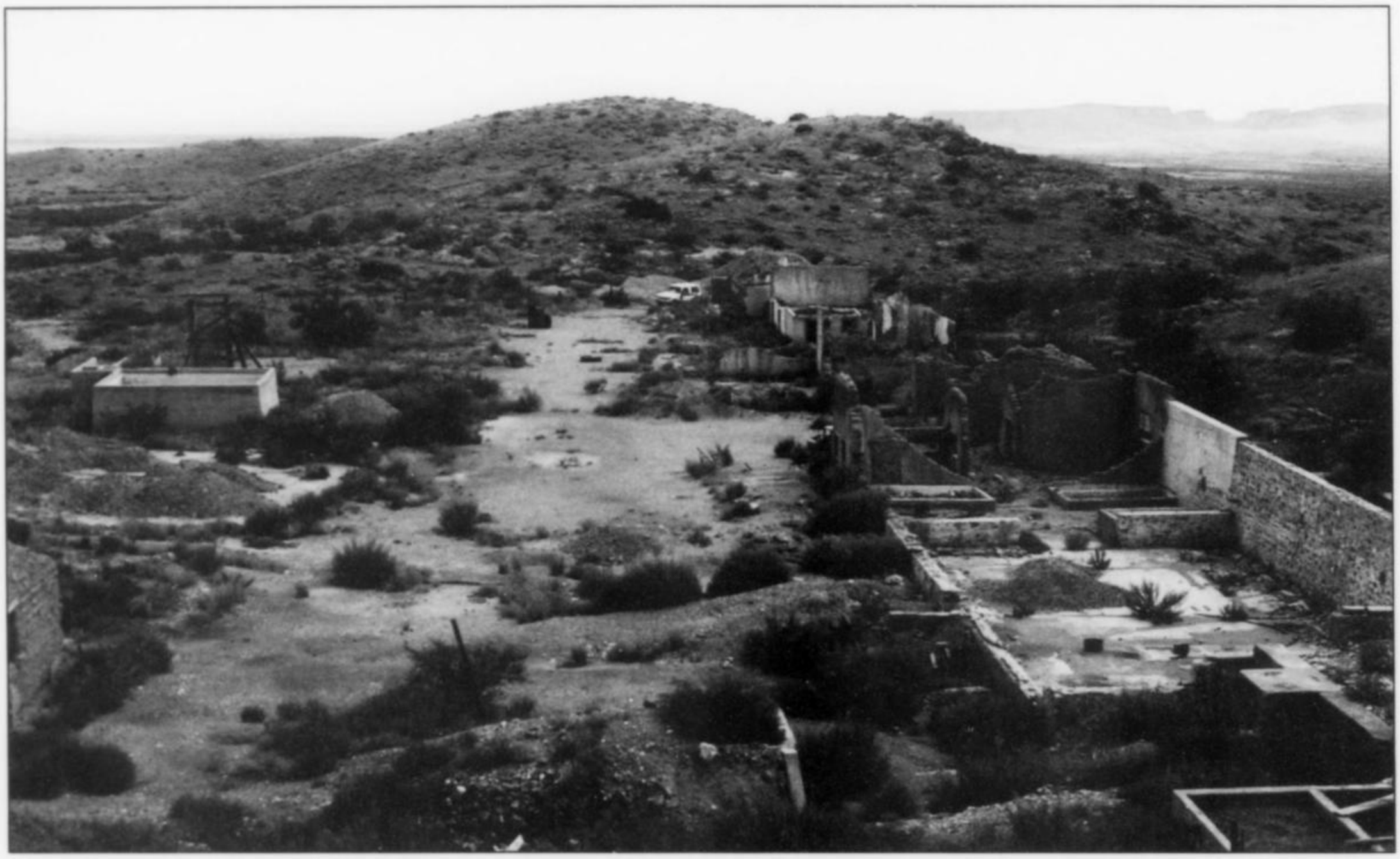


Figure 5. **Ruins of the surface workings of the Congreso-León mine, August 1991. Remnants of a small wooden headframe over the Laird shaft are visible at left. Peter Megaw photo.**

Figure 6. **Ruins of a small smelter building at the Corgreso-León mine, August 1991. Peter Megaw photo.**

Figure 7. **Abandoned church near the Candelaria mine, August 1991. Peter Megaw photo.**

Figure 8. **Another opening to the Old León workings, August 1991. Peter Megaw photo.**

Figure 9. **The Old León (background) and Congreso (foreground) dumps in the 1940's. Photo courtesy of Peter Megaw.**

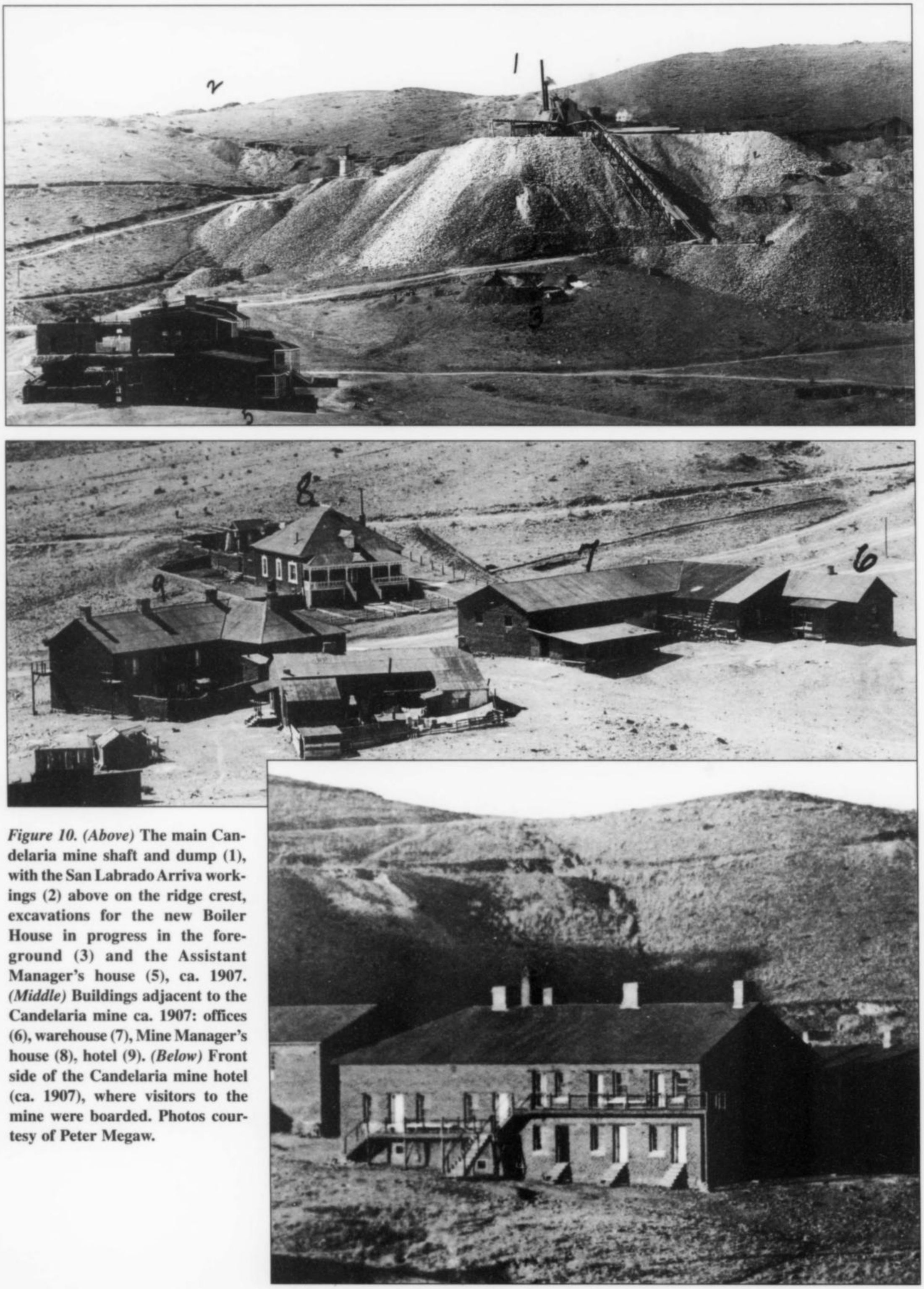


Figure 10. (Above) **The main Candelaria mine shaft and dump (1), with the San Labrado Arriva workings (2) above on the ridge crest, excavations for the new Boiler House in progress in the foreground (3) and the Assistant Manager's house (5), ca. 1907.** *(Middle)* **Buildings adjacent to the Candelaria mine ca. 1907: offices (6), warehouse (7), Mine Manager's house (8), hotel (9).** *(Below)* **Front side of the Candelaria mine hotel (ca. 1907), where visitors to the mine were boarded. Photos courtesy of Peter Megaw.**

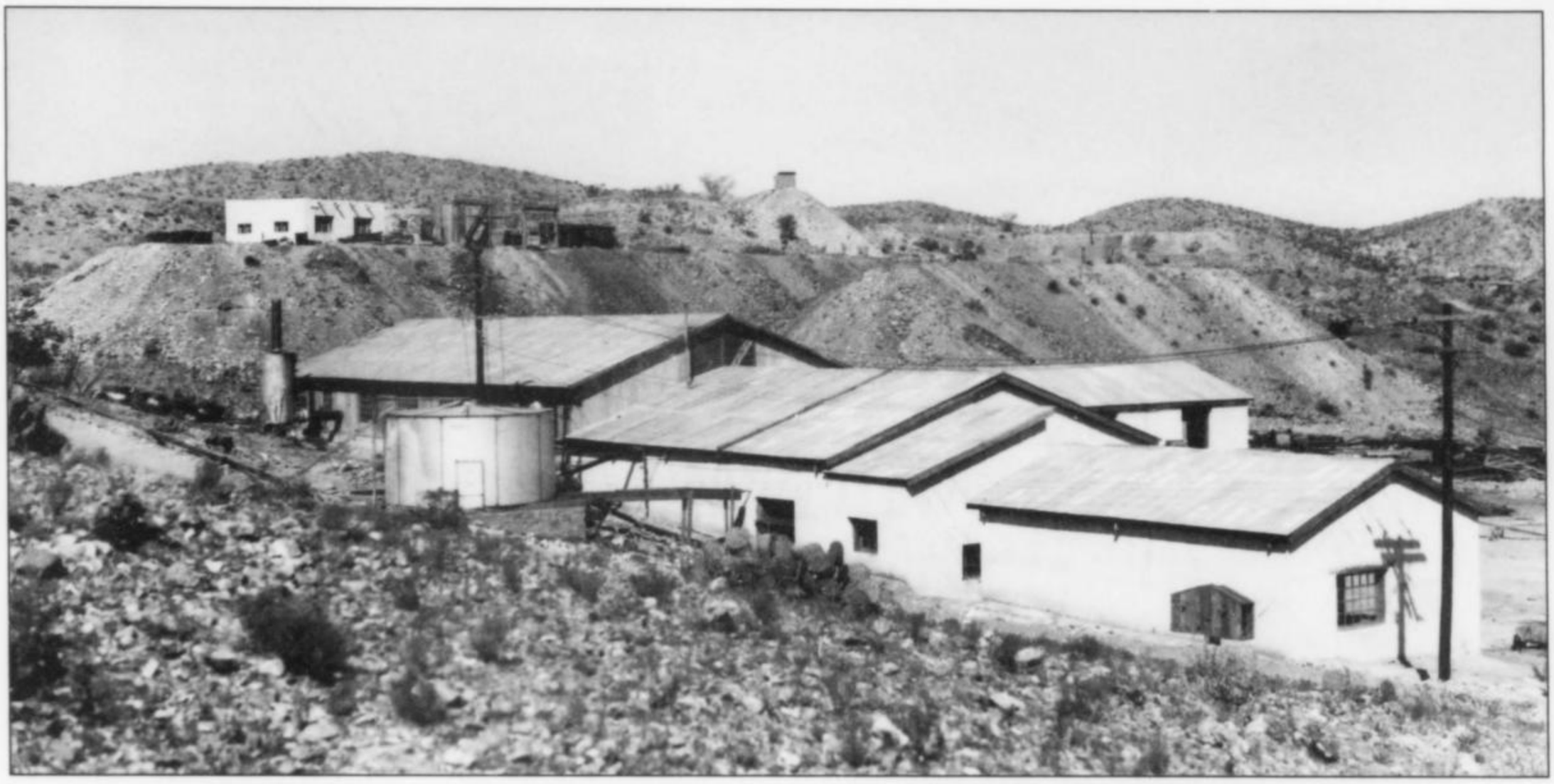


Figure 11. **Mine building associated with the Congreso-León mine in the 1940's. Photo courtesy of Peter Megaw.**

Minor amounts of ore were shipped in 1936–1944 by the Hemly and Blackwell mining companies.

Further exploration was evaluated by Wisser (1946) for the Eagle Pitcher Mining Company, headquartered in Joplin, Missouri. The Bonanza chimney was thought to persist to at least 30 meters below the 8th level. Eleven other chimneys discovered by that date had already been mined to or near the water table, but were never explored at depth, and another 10 chimneys had produced appreciable ore. Geologic mapping indicated that the chances were good for the extension of the ore chimneys for several hundred meters below the lowest workings. Apparently explorations continued through 1949, drilling from lower levels that had been dewatered with great difficulty and heavy pumping.

Eagle Pitcher tried to operate the mine in the early 1950's but had great difficulty with water control, and the irregularity of the orebodies rendered exploratory drilling inherently inconclusive (Alvarez, 1970). McCarthy (1953) reported that at that time the lowest working level was the 850-foot level, and that a shaft had been sunk from that level to 1050 feet. Exploratory drilling had cut the Bonanza orebody at a depth of 1400 feet below the collar and, remarkably, the ore was still found to be oxidized at that great depth. The mine had shown a profit of 349,000 pesos for 1952, but was reduced to break-even and was predicted to soon show a loss. Operations were suspended in 1953 (Villaseñor, 1963).

In 1961 the Candelaria Mining Company merged with the San Luis Mining Company under the name of Minas San Luis S.A., which became Luismin in 1962. In 1991 the property was still held by Minas Luismin S.A. de C.V., which had become Mexico's third-largest mining company. Nine claims covered the old productive part of the district, but most were under option to Minas Luismin (Megaw, 1991). Wheaton River Minerals, Ltd. acquired Minas Luismin in 2002.

During its productive years the San Pedro Corralitos district yielded a total of about 1 million tons of oxide ore grading 7% lead, 7% zinc, 1.5% copper, 219 grams of silver per ton, and from 1 to 6 grams of gold per ton.

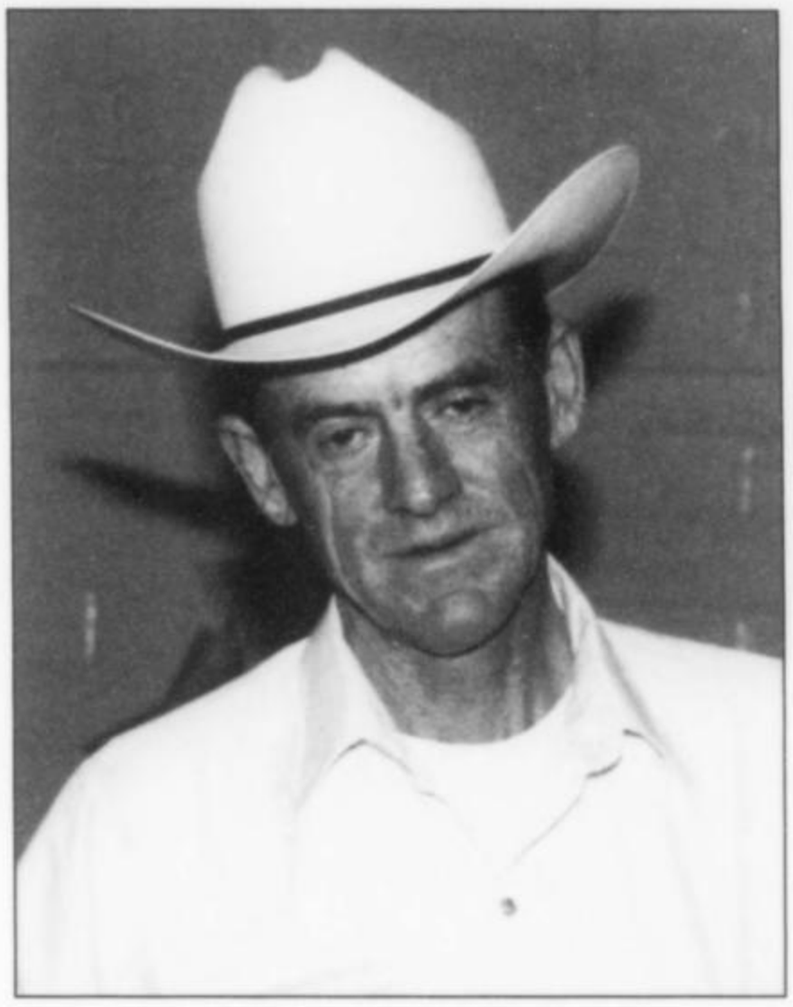


Figure 12. **Mineral dealer Benny Fenn, who explored part of the abandoned Congreso-León mine in 1968 and made the famous mimetite discovery there. Kent England photo.**

The 1968 Mimetite Discovery

In 1968 mineral dealer Benny Fenn decided to do some exploratory work in the deep underground workings of the Congreso-León mine, workings that had lain abandoned and had been slowly deteriorating since the 1950's or earlier. The deepest workings there reach 1,400 feet but the lower 200 feet of the mine were flooded at the time. Furthermore the timbering in the main inclined shaft had been burned out at some time in the distant past, a hindrance that would have stopped most people.

Benny, however, lowered himself 900 feet down the incline on ropes. He noticed much evidence of mimetite mineralization showing all along the incline between the 8th and 9th levels. Leaving the incline on the 9th level, he ultimately found a showing of some mediocre mimetite in a wall of the old San Pedro mine

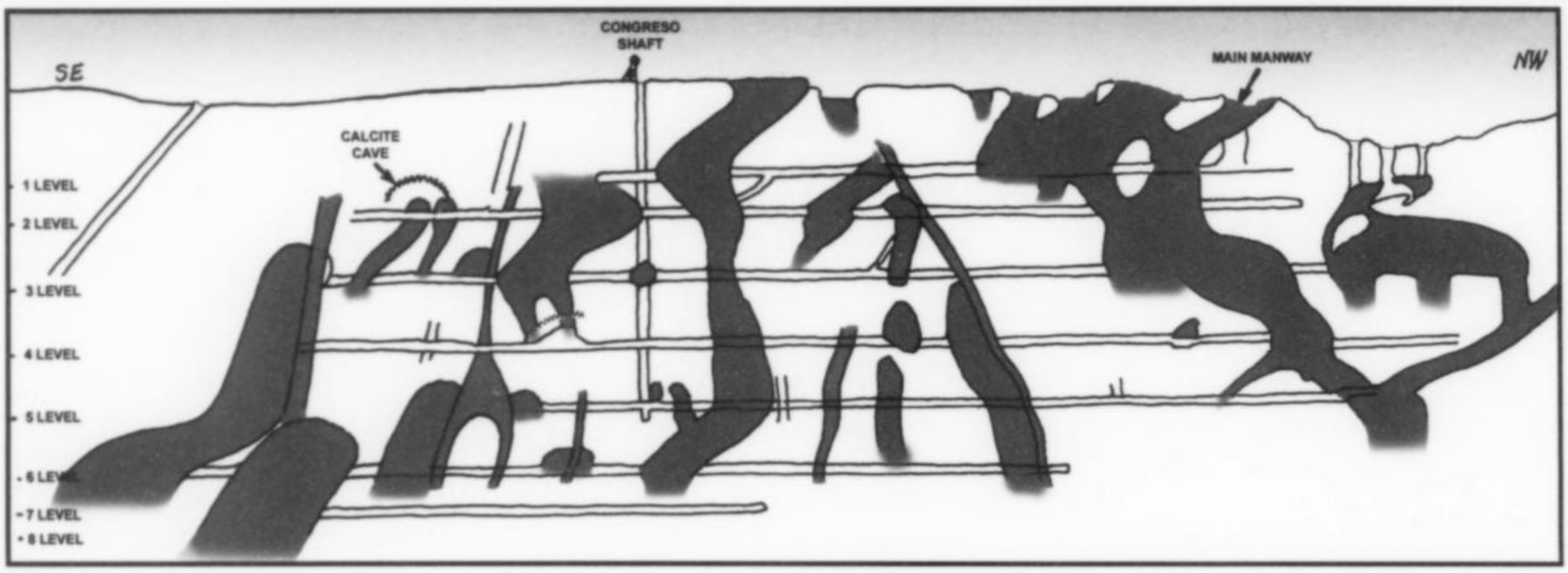
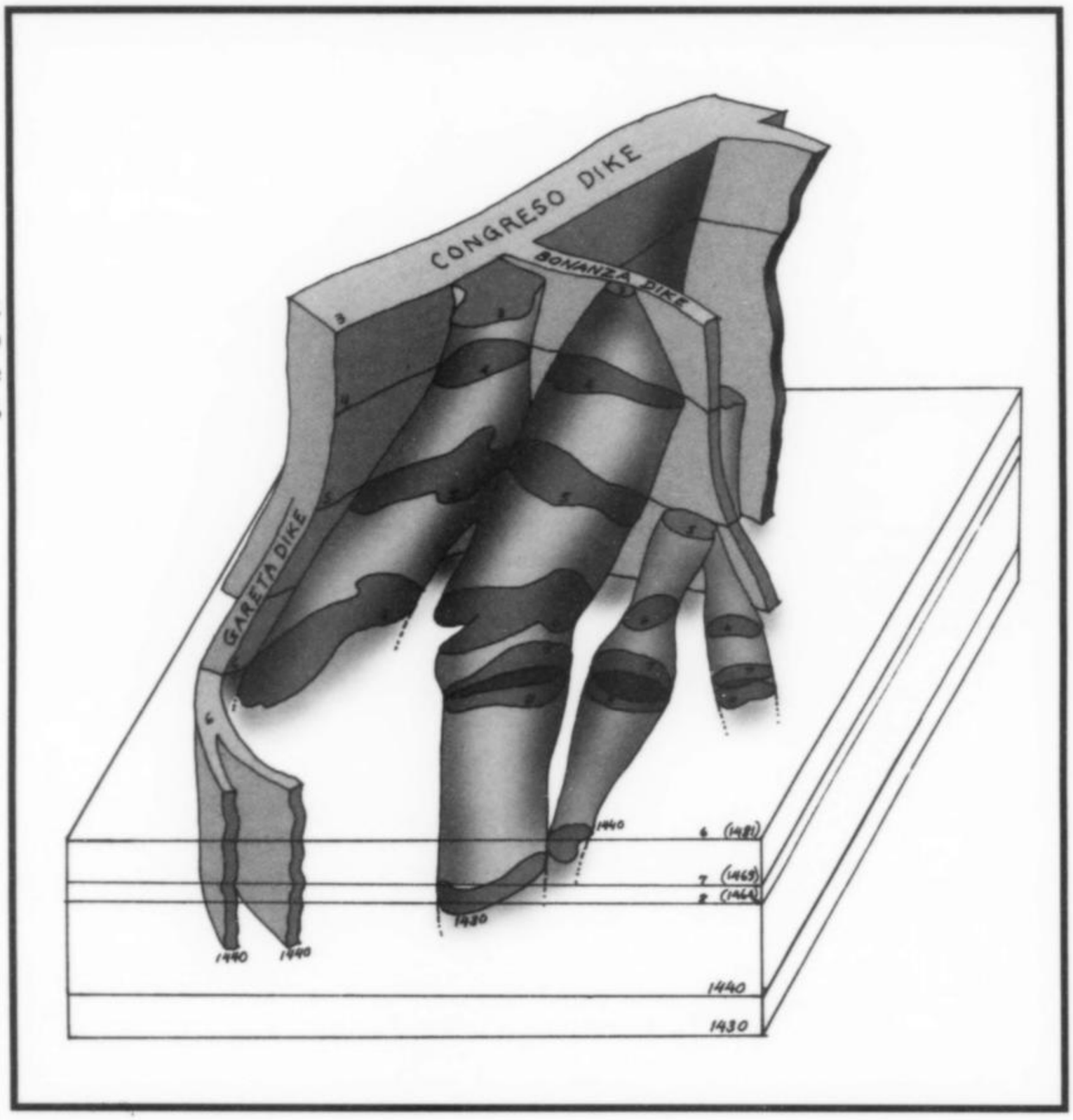


Figure 13. **Cross-section through the pipe-like orebodies (red) of the Congreso-León mine. Note the "calcite cavern" indicated between the 1st and 2nd levels (after Wisser, 1944).**

Figure 14. **Three-dimensional block diagram showing the relationship between dikes and ore pipes in the Congreso-León mine (after Wisser, 1944).**



section (originally an independent mine which was later connected with and absorbed into the larger Congreso-León mine). He began digging into the wall, following a narrow vein; the mimetite got better and better until the vein suddenly opened up into a huge room about 40 feet long, 20 feet wide and 30 feet tall between the 8th and 9th levels, completely lined with the most beautiful botryoidal yellow mimetite anyone had ever seen!

Being a skilled professional at mineral collecting, Benny was able to extract over two tons of fine specimens with very little or no damage. He began wrapping and packing them carefully, then had to find a way to get them back up to the surface. Ultimately he had a hoist built over a nearby vertical shaft (probably the Laird shaft) to raise specimens so that he could continue to carefully clean out the room for the next three months until he had completely stripped the walls and had collected all that was to be found.

Naturally the mineral world was excited to see such a large number of exquisite specimens of beautiful mimetite, and the prices were such that even collectors of limited means could obtain at least a small example. It was several years before mineral dealers and rock shops across the country had sold most of the find, and during that time window (1969 to ca. 1975) it was possible to obtain superb specimens in any size at very reasonable prices. The quantity was such that even today fine specimens occasionally appear on the market; at the 2004 Denver Show several dealers

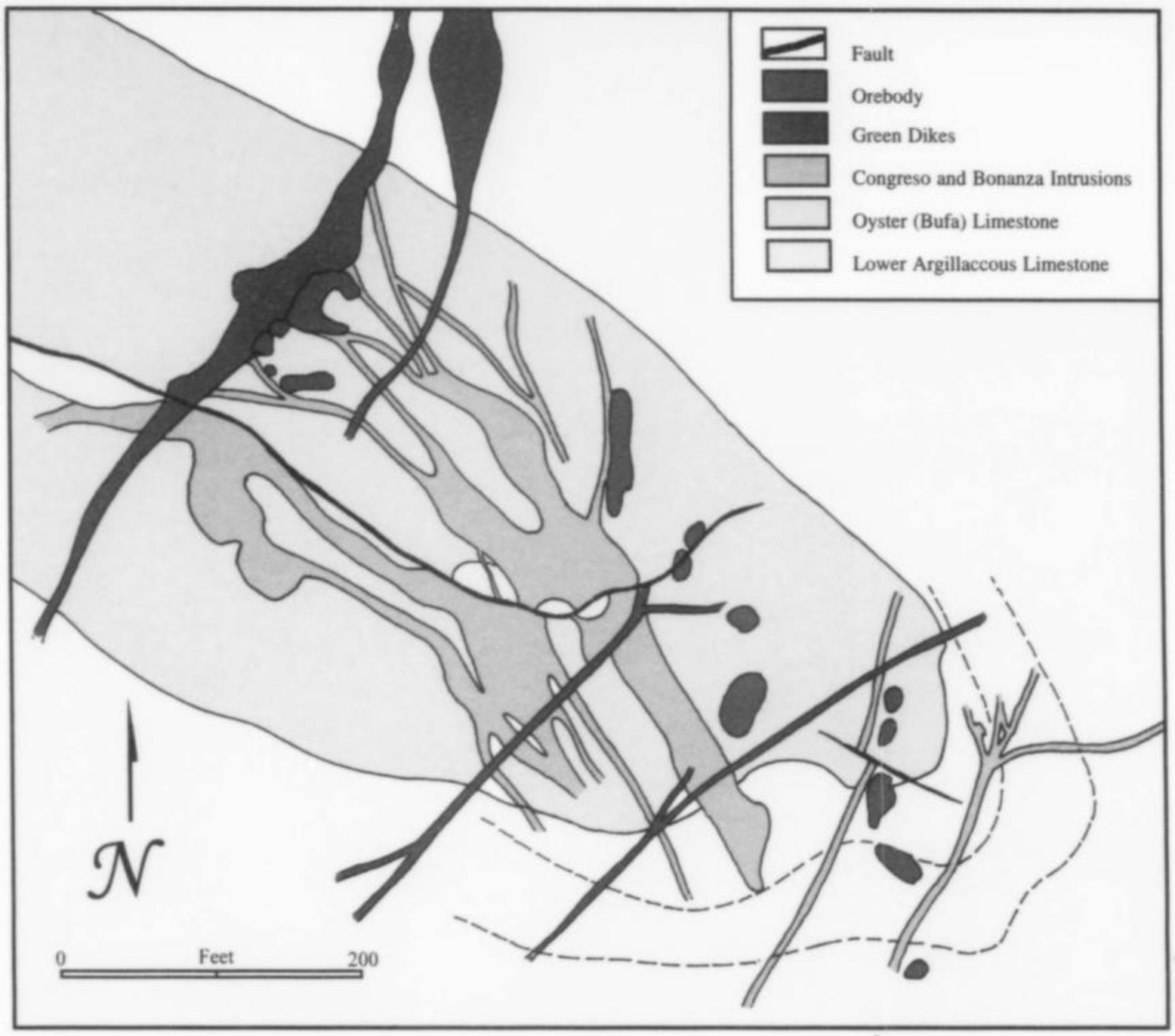


Figure 15. (above) **Geology of the Congreso-León mine area. The anticlinal structure dominating the area plunges to the southeast, and is cross-cut by dikes (green) and parallel intrusions (tan). The westernmost cross-cutting dike is called the Barrier dike because of its significance in ore control. The main body of the parallel intrusions (tan) is called the Congreso dike, and the fault shown is the Don Abraham fault. (After a hand-drawn unpublished map by Wisser, 1944.)**

(including The Arkenstone and Kristalle) had a total of perhaps three flats of fine old specimens available.

GEOLOGY

The country rock in the district consists of Cretaceous thin-bedded limestones and shales that have been injected with felsic eruptive rocks, the largest mass of which is the granodiorite laccolith forming San Pedro Peak near the center of the property. Later more mafic diorites and hornblende andesite porphyries intersect the sedimentary rocks and the earlier eruptive rocks. These intrusions were probably contemporaneous with fissuring which facilitated the emplacement of ore veins north and west of San Pedro Peak. The contact zones between eruptive rocks and limestones in the southern part of the district include some important carbonate-replacement lead-copper-zinc-gold-silver orebodies, especially those of the León Group.

Mineralization occurs in two general zones: one at San Pedro Corralitos proper on the southeast side of San Pedro Peak (principally the Congreso-León mine), and the other to the northwest of the peak at Candelaria.

Large vertical chimneys containing oxidized sulfide ores occur along the hangingwall contacts of major northwest-trending dikes, and feed horizontal mantos. The mines lie along the axis of a

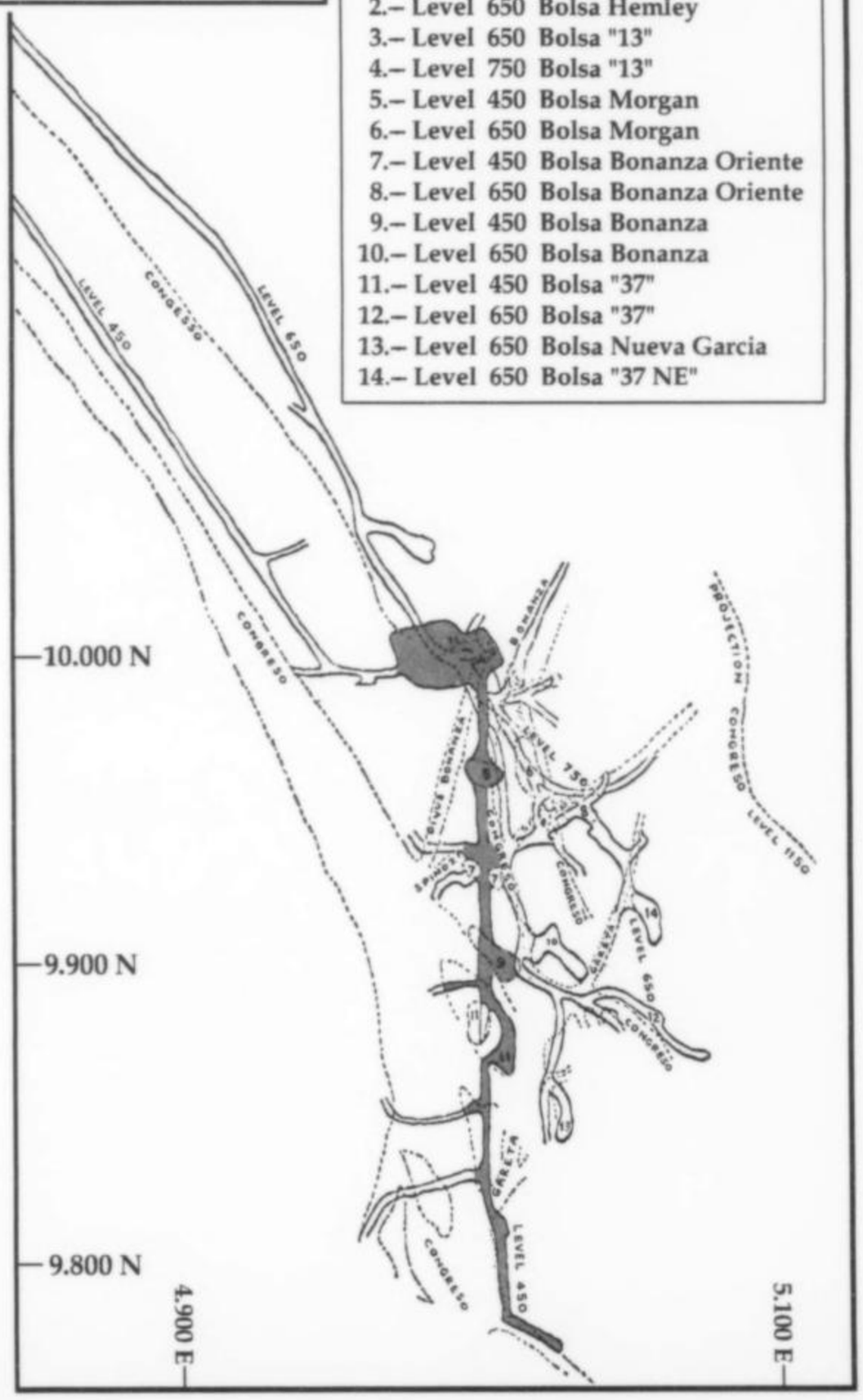


Figure 16. (below) **Some of the workings in the Congreso-León mine; the main inclined shaft is shaded (from Wisser, 1944).**

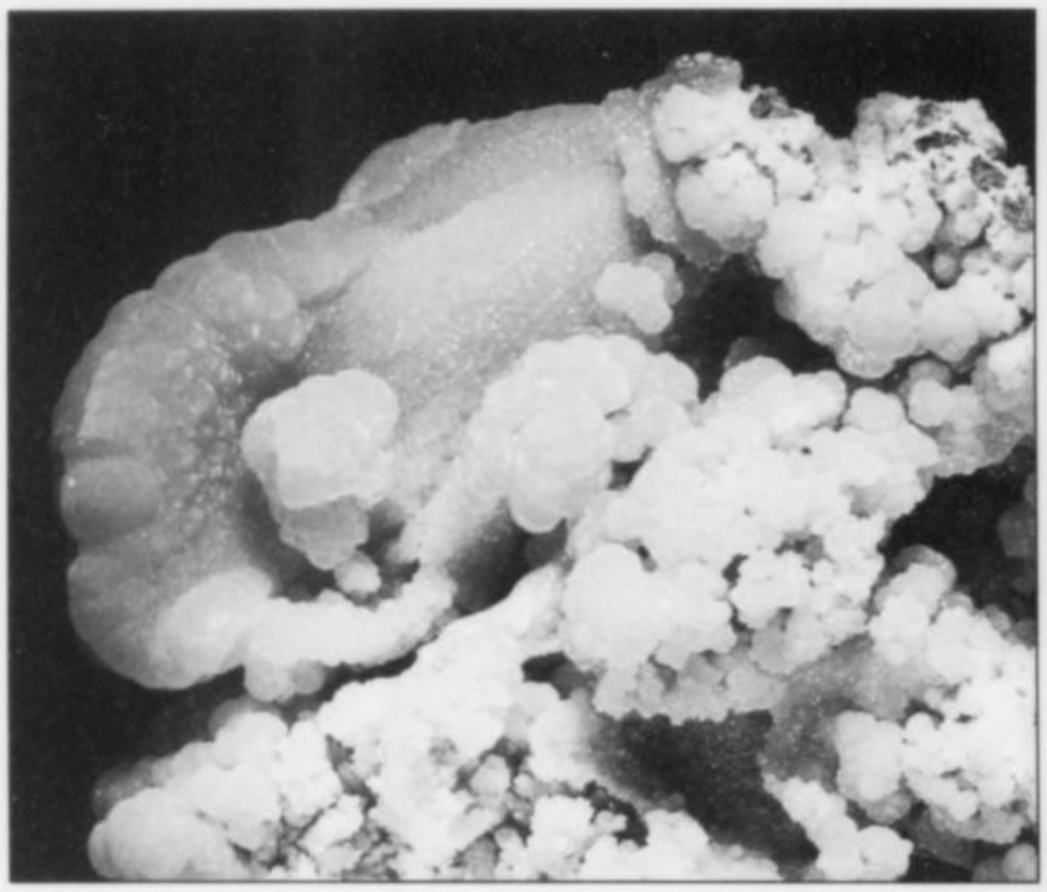


Figure 17. **Mimetite, 3.9 inches wide, from San Pedro Corralitos. Philippe Henrissat collection; Jeff Scovil photo.**

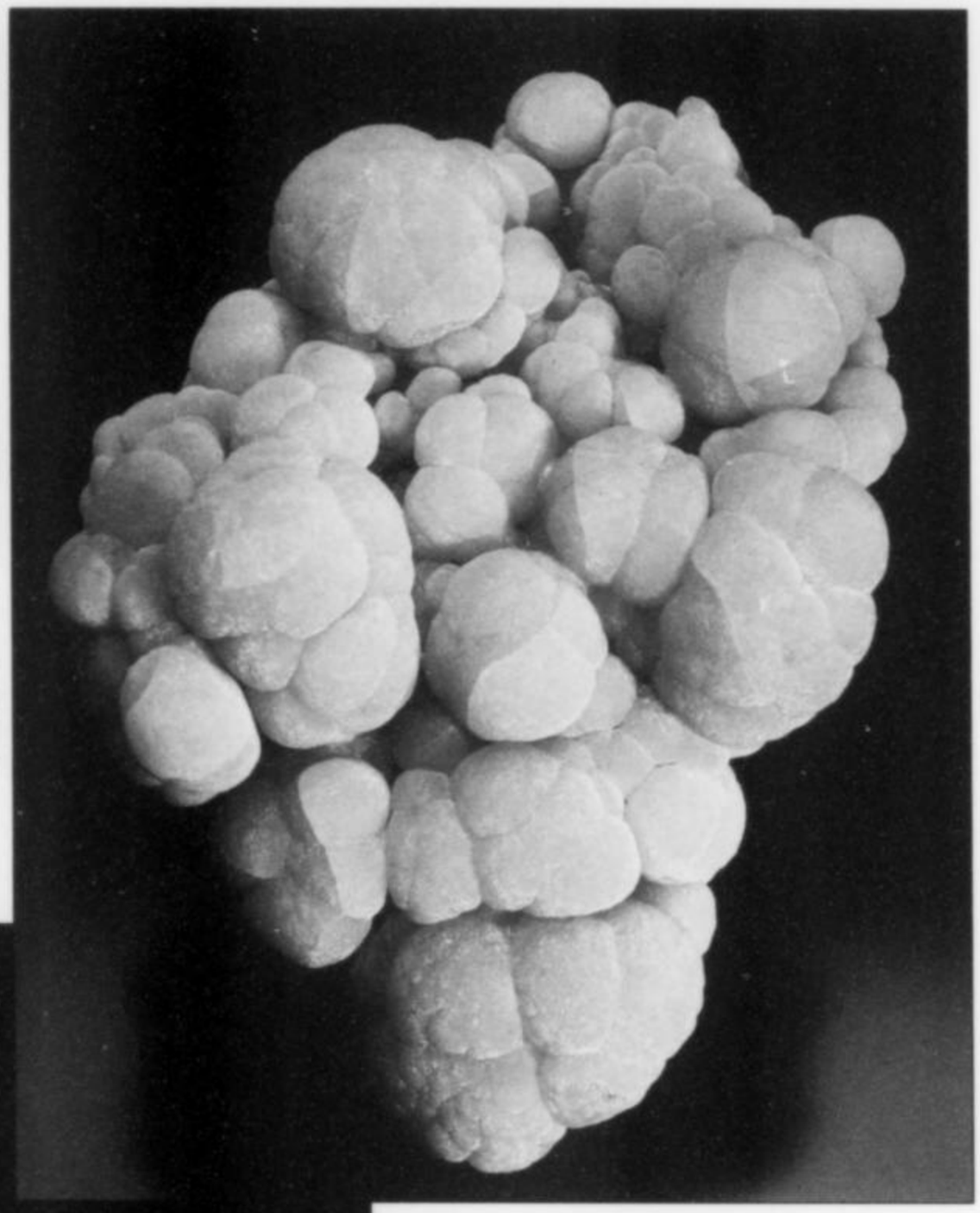


Figure 18. **Mimetite, 4.6 inches, from San Pedro Corralitos. Houston Museum of Natural Science collection; Jeff Scovil photo.**

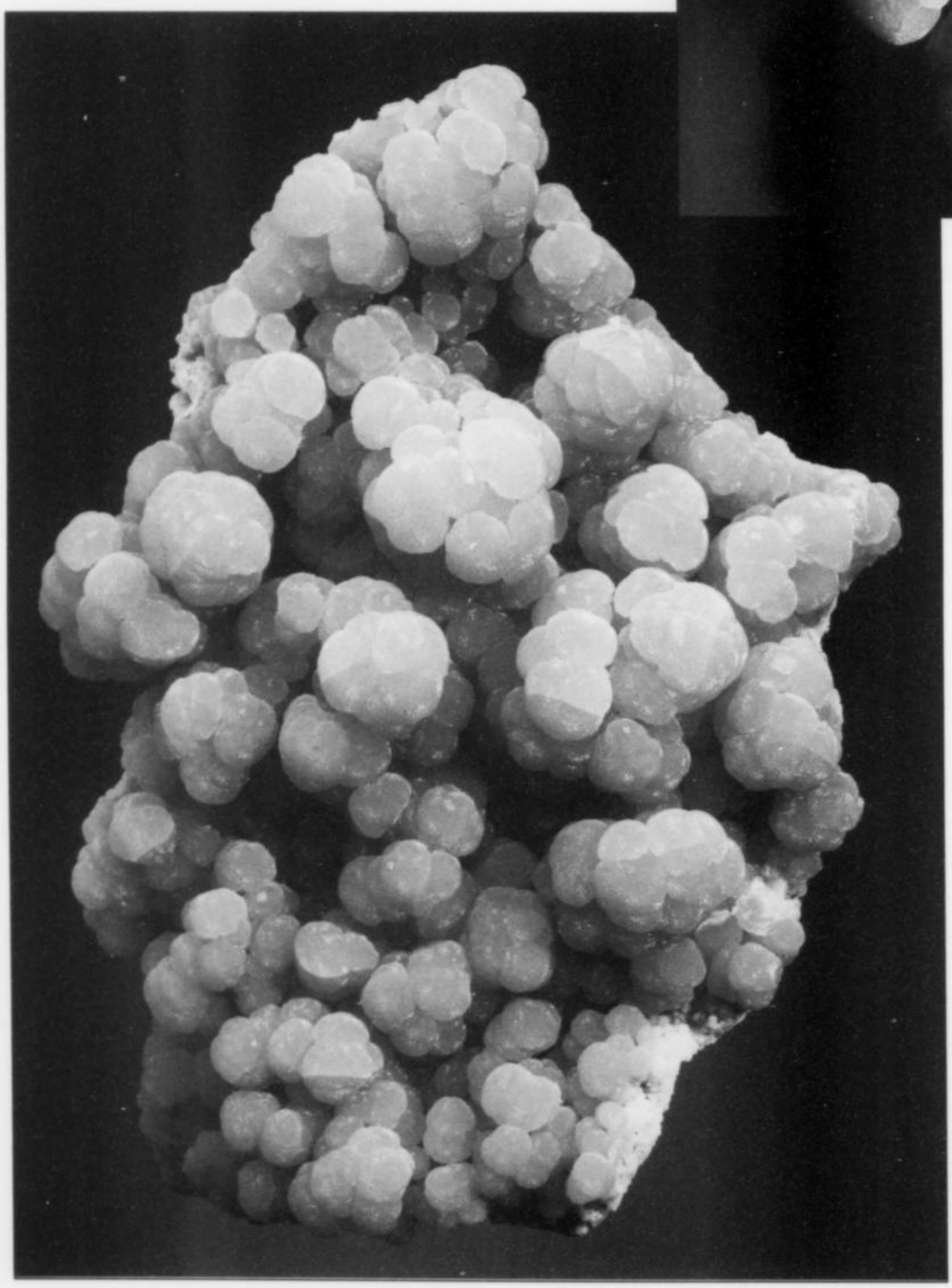


Figure 19. **Mimetite, 4.6 inches, from San Pedro Corralitos. Sandor Fuss collection; Jeff Scovil photo.**

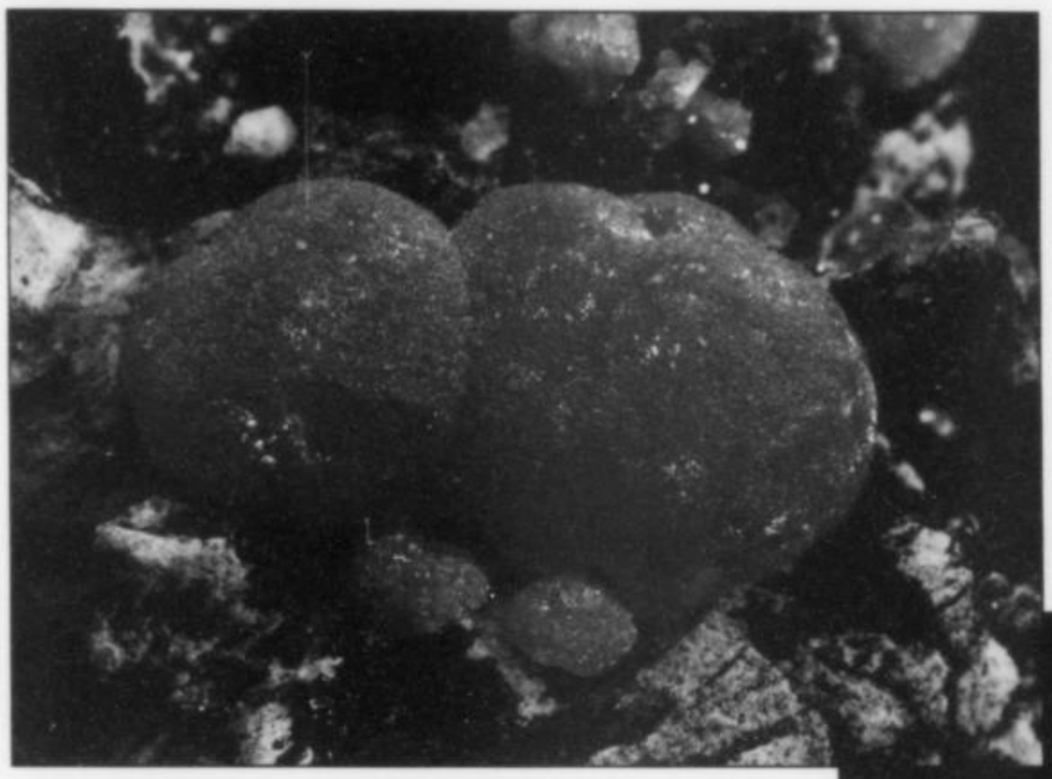
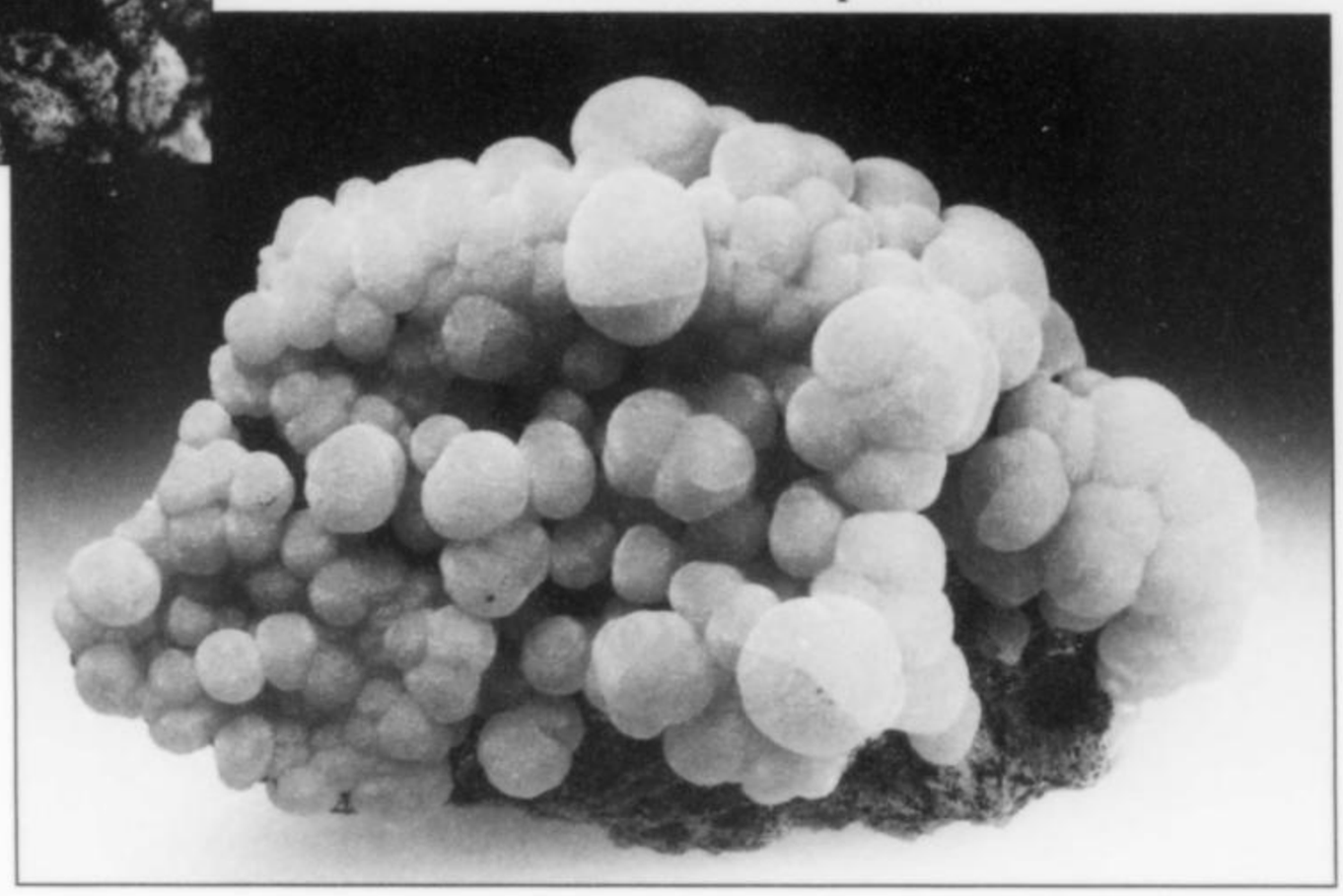


Figure 20. **Mimetite botryoids (rare red-orange color), 0.6 inches, from San Pedro Corralitos. Martin Zinn collection; Jeff Scovil photo.**

Figure 21. **Mimetite, 3.5 inches, from San Pedro Corralitos. Miguel Romero collection, now in the collection of the University of Arizona; Wendell Wilson photo.**



plunging southeast-trending anticline. Andesite porphyry bodies intruded along southeast-trending vertical fractures oriented parallel to the vertical axis of this anticline. Cross-fractures also developed and were intruded by andesite porphyries and later lamprophyres. Mineralization took place along the hanging wall of dikes located within flexures. Extensive recrystallization and marbleization took place around the orebodies, and dikes near orebodies have undergone chalky sericitic alteration. Fluorite dikes occur in southwest-trending fissures but their relationship to ore mineralization is not clear.

Mineralization is zoned concentrically about the San Pedro Peak laccolith. The mineralized zone is high in copper near the intrusion and becomes more lead-zinc rich with increasing distance from the peak (Megaw, 1991). Skarns about the intrusion consist of fine-grained garnet and diopside with pyrite, chalcopyrite and arsenopyrite. Dikes found within 30 feet of a mineralized orebody are highly fractured and sometimes coated by iron oxide.

A small, unnamed prospect about 2 miles north of the Congreso-León mine produced a pocket of superb, gemmy-yellow wulfenite crystals in the early 1970's; it is sometimes labeled as the San Pedro mine, though this is probably incorrect.

MINERALS

The Congreso-León mine and others in the district were mined out at a time when there was little awareness of the value of mineral specimens. Considering the large empty stopes, the number of orebodies, the depth of oxidation of the Pb-Zn-Cu-Ag sulfides, and the normal mineralogical results of weathering such ore veins in an arid climate, we may well suspect that a vast treasure trove of collectible secondary minerals was crushed and smelted during the years of operation. What is left to us now is the result of the explorations of one man, Benny Fenn, without whom almost nothing of the exciting specimen mineralogy of this remarkable occurrence would be known. Appreciative as we are, we must understand that what has been salvaged is no doubt only a negligibly tiny fraction of what originally existed there. Consequently the descriptions of the collectible species given below are rather brief.

Mimetite $Pb_5(AsO_4)_3Cl$

Mimetite from the 1968 Congreso-León find (8th-9th level) is generally a bright lemon-yellow in the best specimens, grading only slightly to a duller, grayer yellow in some specimens and a greenish yellow in others. A few rare examples are a bright red-orange, but never in large coverage on the matrix. The habit is almost universally botryoidal, in attractive specimens up to about 10 inches. The luster, at its best, is a bright, almost sparkling sheen reminiscent of the appearance of the well-known Kelly-mine smithsonite. Inferior specimens have a flatter, less lustrous appearance and a grayer yellow color. The high luster (composed of microscopic crystal points covering the botryoidal surface) is highly prone to showing bruises, nicks, scratches and rubs, so much so that truly pristine examples are especially highly prized.

Elsewhere in the mine, where mimetite occurs with wulfenite, it forms crusts of gemmy, pale yellow microcrystals and botryoidal blebs of orange to red-orange color.

Wulfenite $PbMoO_4$

Wulfenite is comparatively rare at the mine, and has been collected mainly from the 5th level. Crystals are generally small, usually under a quarter inch, but Benny Fenn recovered a very thin crystal measuring almost 1.6 inches, on matrix (illustrated in Panczner's *Minerals of Mexico* but since broken). Smaller crystals

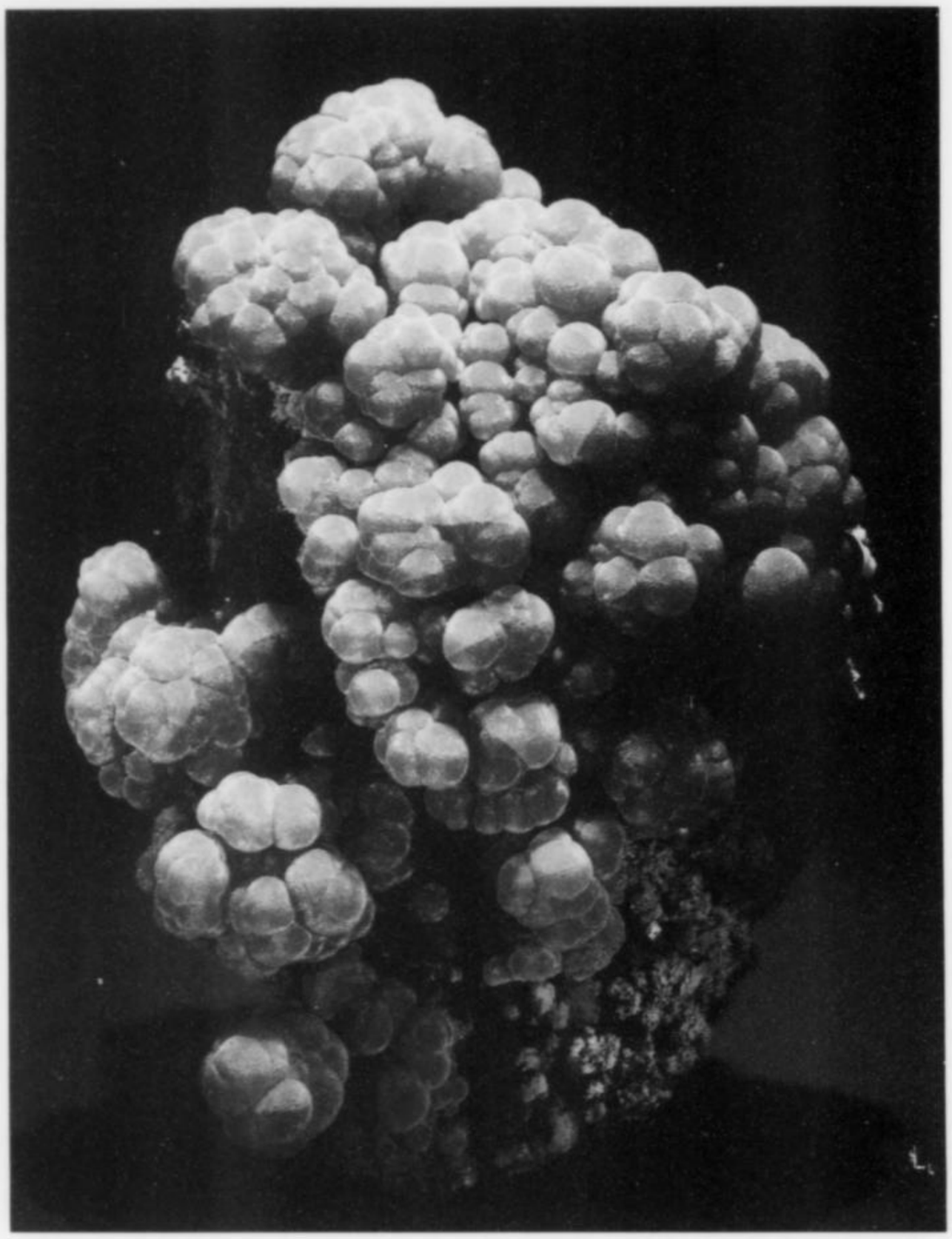
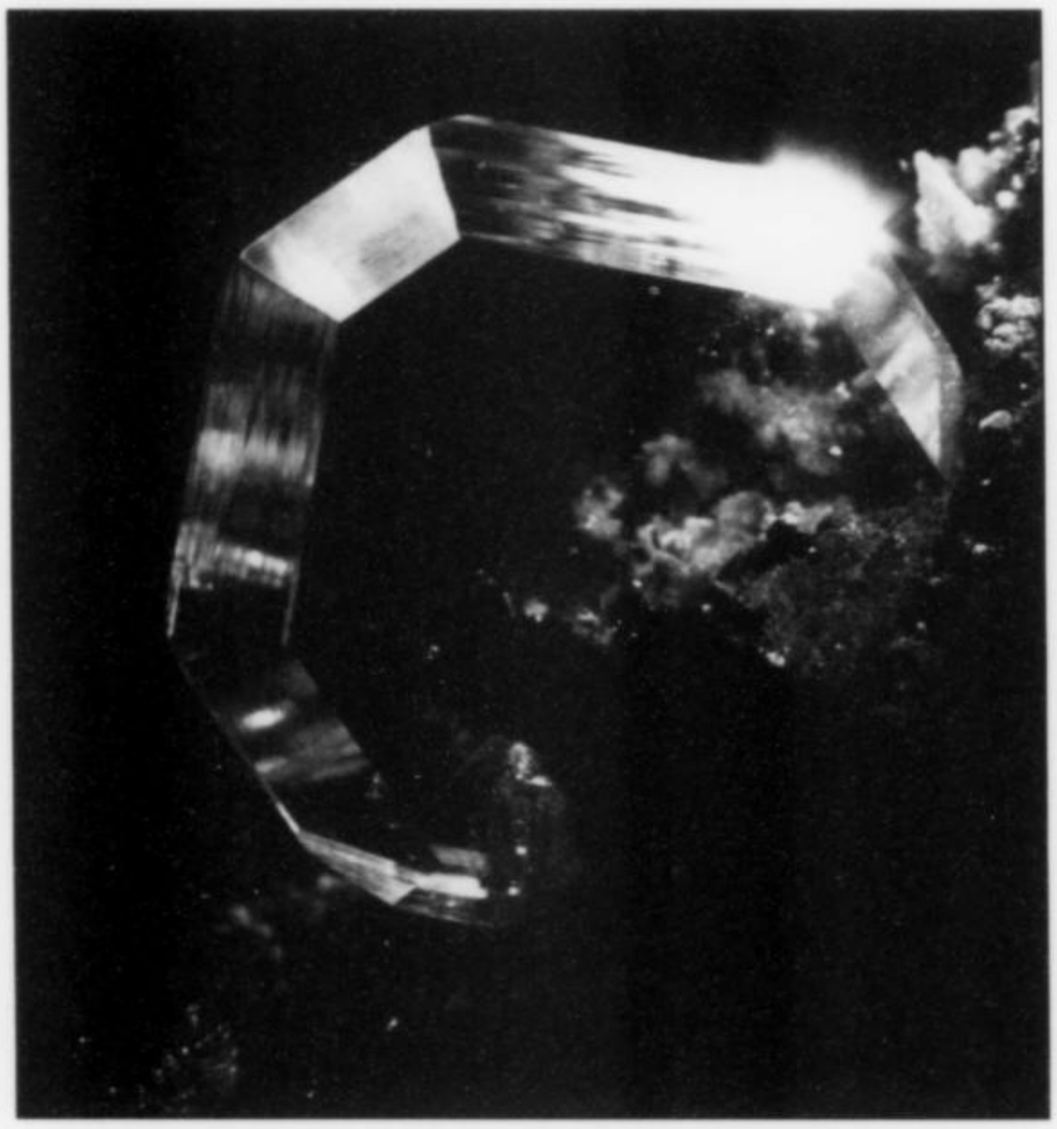


Figure 22. **Mimetite, 7.9 inches, from San Pedro Corralitos. U.S. National Museum of Natural History (Smithsonian Institution) collection; Chip Clark photo.**

Figure 23. **Wulfenite crystal, 0.6 inches, from San Pedro Corralitos. U.S. National Museum of Natural History (Smithsonian Institution) collection; Wendell Wilson photo.**



may be thicker and highly lustrous and transparent. The color is pale to bright lemon-yellow (commonly) to yellow-orange (rarely), and the habit thin tabular. All crystals show edges beveled by the tetragonal pyramid, and some also show second-order pyramid faces which, when approaching equal dominance, result in octagonal tabular plates. Crystals that are more than paper thin are extremely rare and highly valued.

Other Minerals

Benny Fenn reports finding attractive blue barite in transparent crystals to 1 inch on the 4th level, and also blue botryoidal smithsonite and arborescent cave growths of calcite and aragonite elsewhere in the mine. A diagram of the mine workings prepared by Wisser (1944) shows a large cavernous area on the second level, atop two ore pipes, which is labeled "calcite cave" and outlined by a spiky delineation suggesting that the cavern is lined with calcite crystals. Unfortunately no photos or further descriptions survive, but the cavern is probably still there, undisturbed, after all these years, and is well above the water table.

CONCLUSIONS

The San Pedro Corralitos mines probably hold great potential for specimen production in the future, inasmuch as they are entirely in the oxide zone and have, for the most part, not been explored extensively by mineral collectors. The orebodies above the water table have been mostly stripped out, along with most of their treasures in crystallized minerals, and yet Benny Fenn, in one visit, was able to locate a substantial side-cavern that lacked what the miners would have called ore but was nevertheless rich in specimens. A vast area of underground workings above the water table remains to be explored and prospected for mineral specimens.

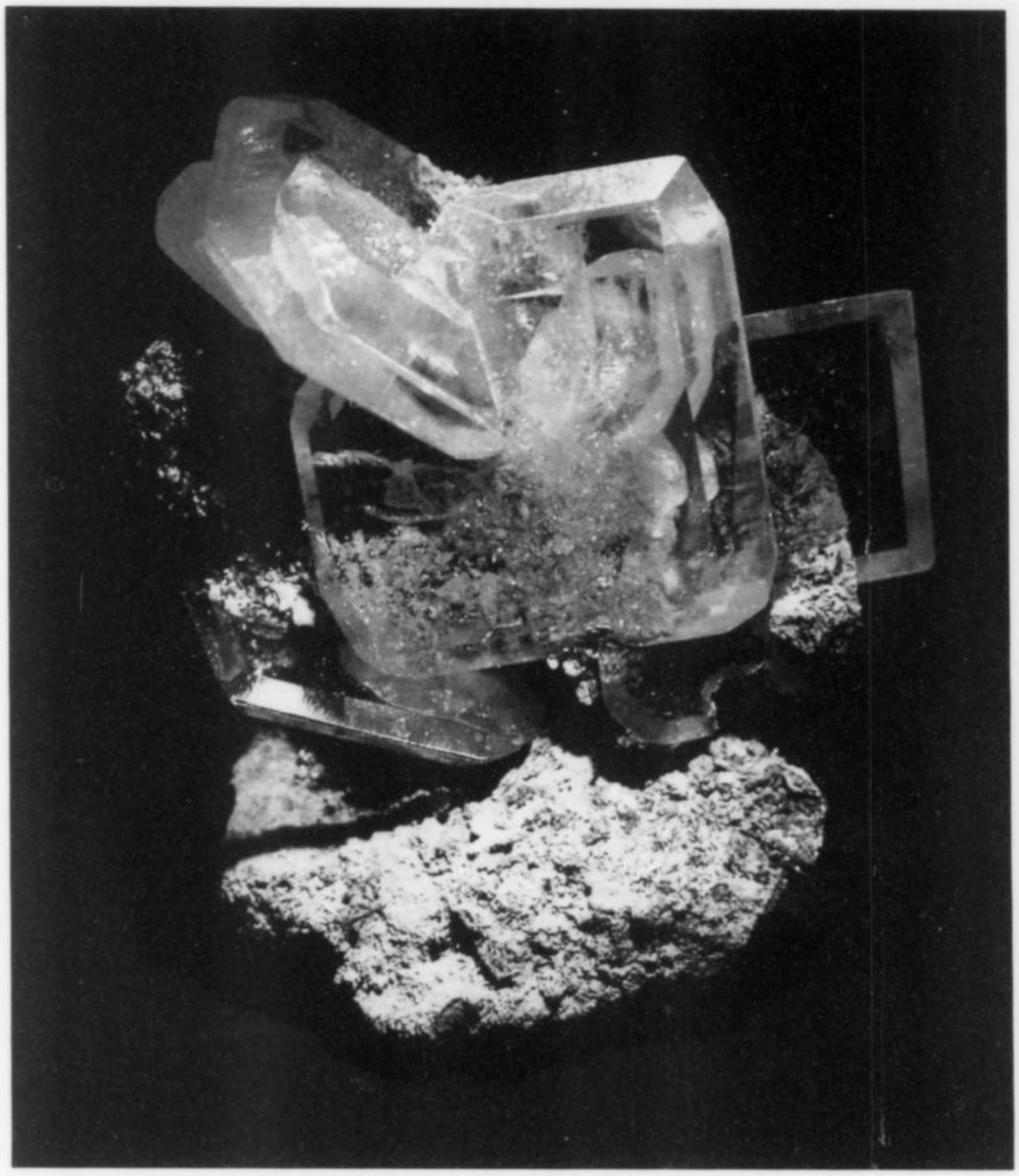


Figure 24. **Wulfenite, 1.9-cm crystal, from San Pedro Corralitos. U.S. National Museum of Natural History (Smithsonian Institution) collection; Wendell Wilson photo.**

In addition, many of the known orebodies extend for hundreds of feet below the water table, where they are still intact and unmined; exploratory drilling indicates that the oxide zone (i.e. the zone containing well-crystallized secondary minerals) also continues for hundreds of feet below the water table, throughout the unmined portions of the orebodies. This represents an enormous potential reserve of specimens that perhaps someday may be mined, if and when technological advances sufficiently lower the cost of water pumping. The same may be said for many famous oxide mines in the Desert Southwest and adjacent Mexico, from the Rowley mine in Arizona to the Los Lamentos mine in Chihuahua.

***Table 1.* Vein minerals found on the dumps of the Congreso-León and Gachupin mines.**

Vein Minerals	
Adamite	Goethite
Arsenopyrite	Gold
Austinite	Hemimorphite
Barite	Malachite
Beudantite	Mimetite
Calcite	Smithsonite
Cerussite	Sphalerite
Chalcopyrite	Plumbojarosite
Chlorargyrite	Pyrite
Chrysocolla	Rosasite
Conichalcite	Tetrahedrite
Fluorite	Willemite
Galena	Wulfenite

ACKNOWLEDGMENTS

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(continued on p. 65)

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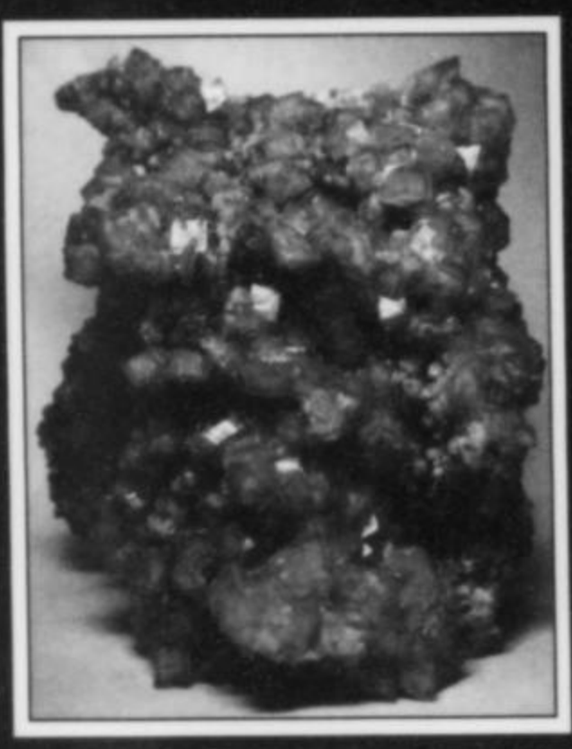

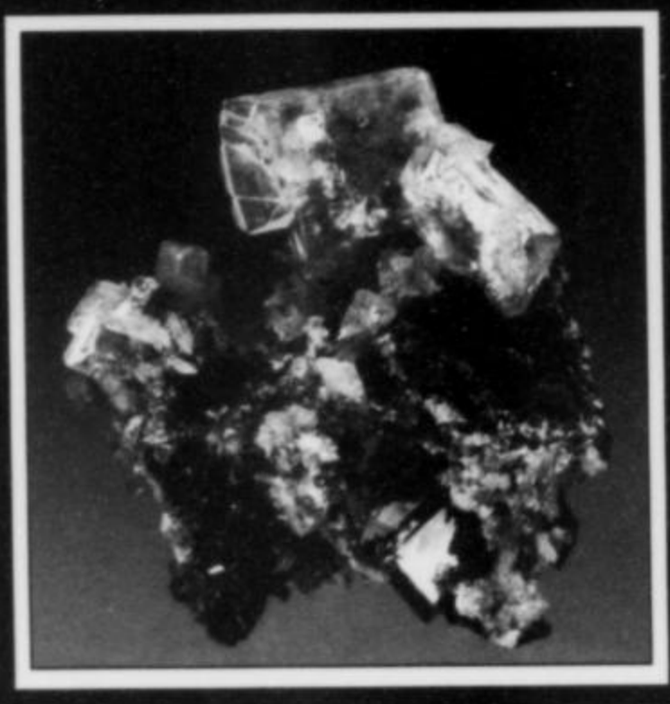

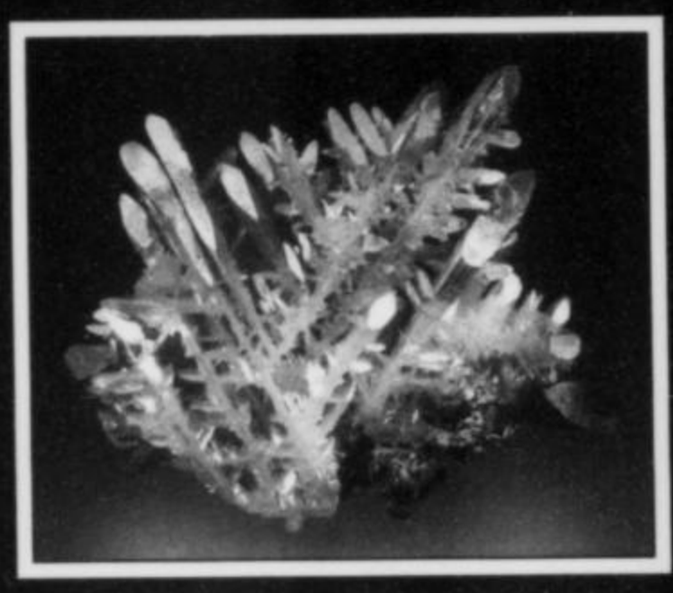

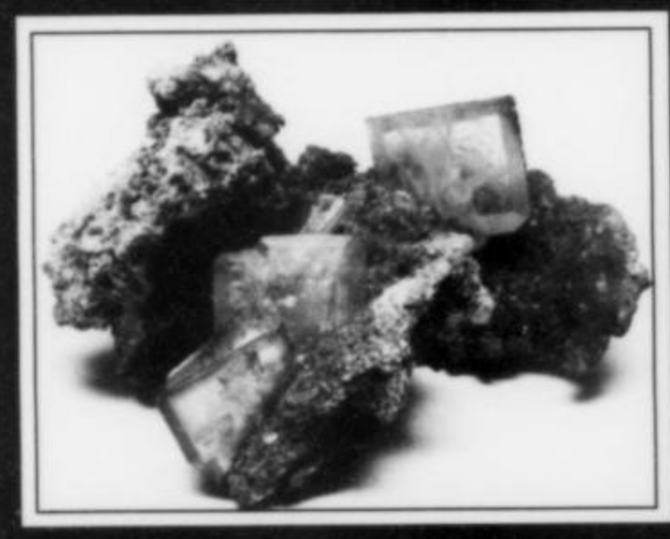

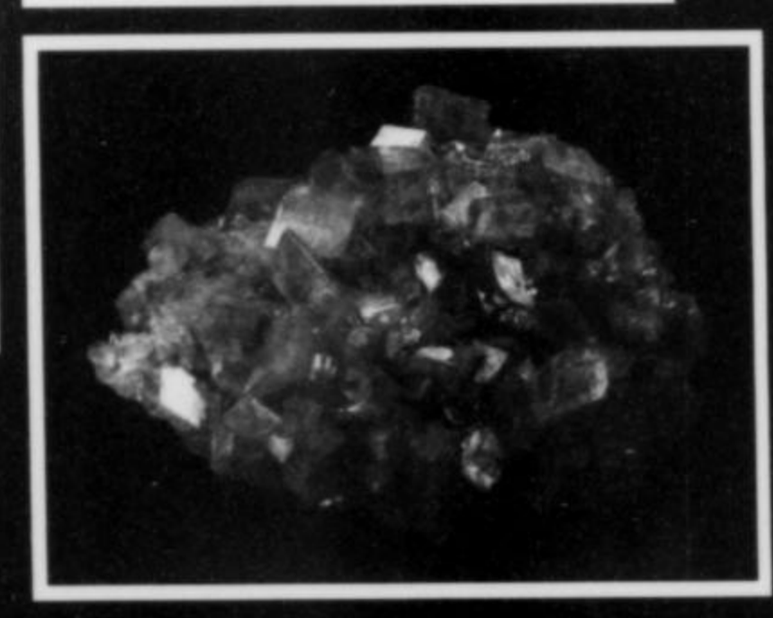

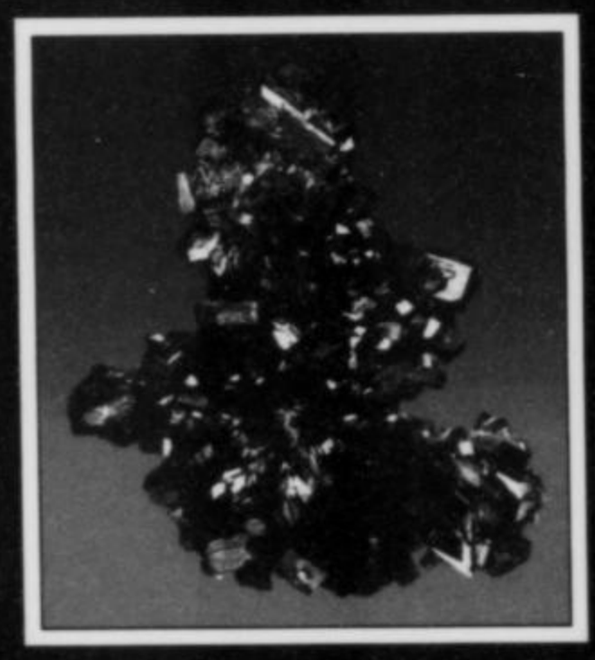

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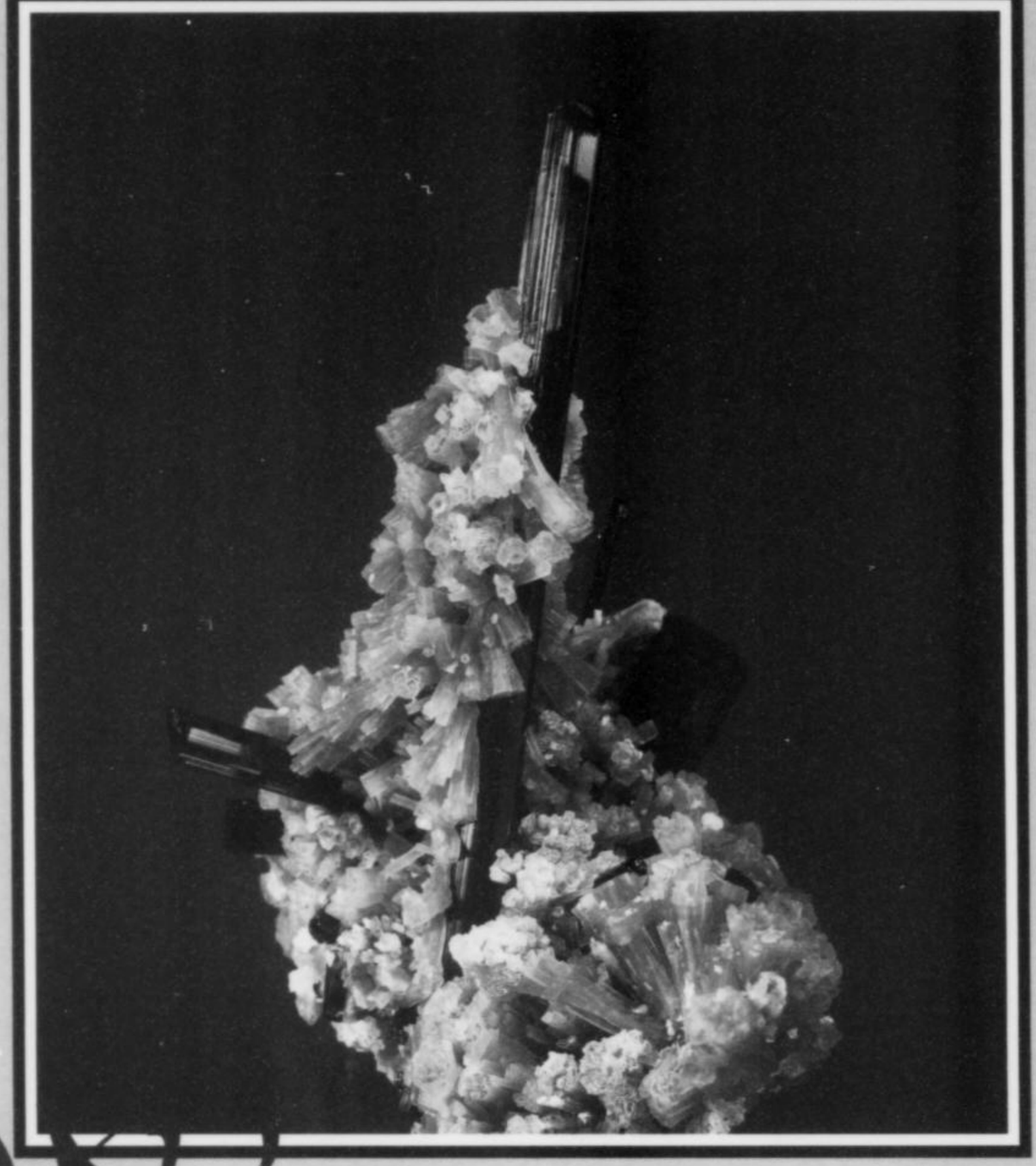

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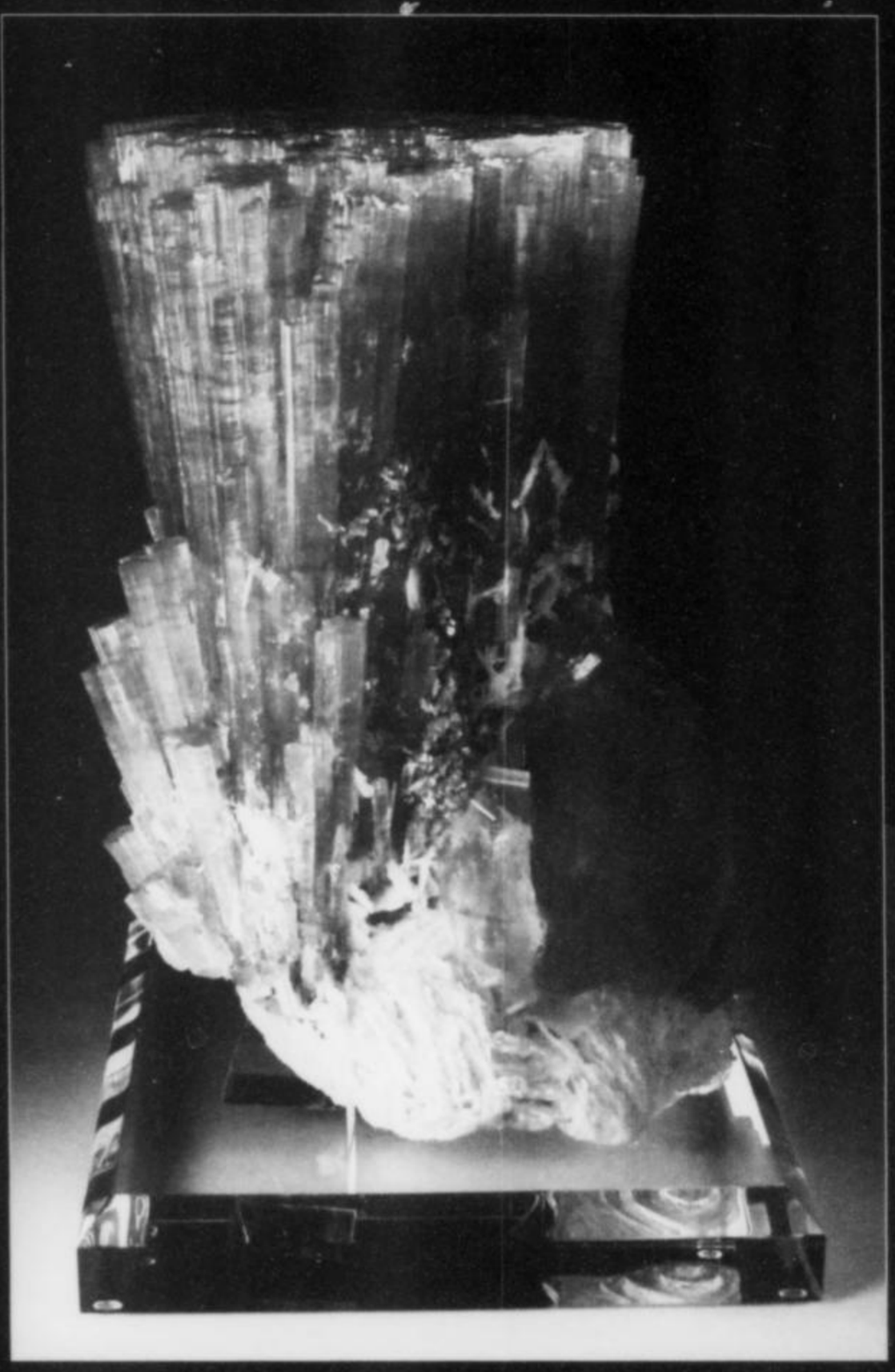

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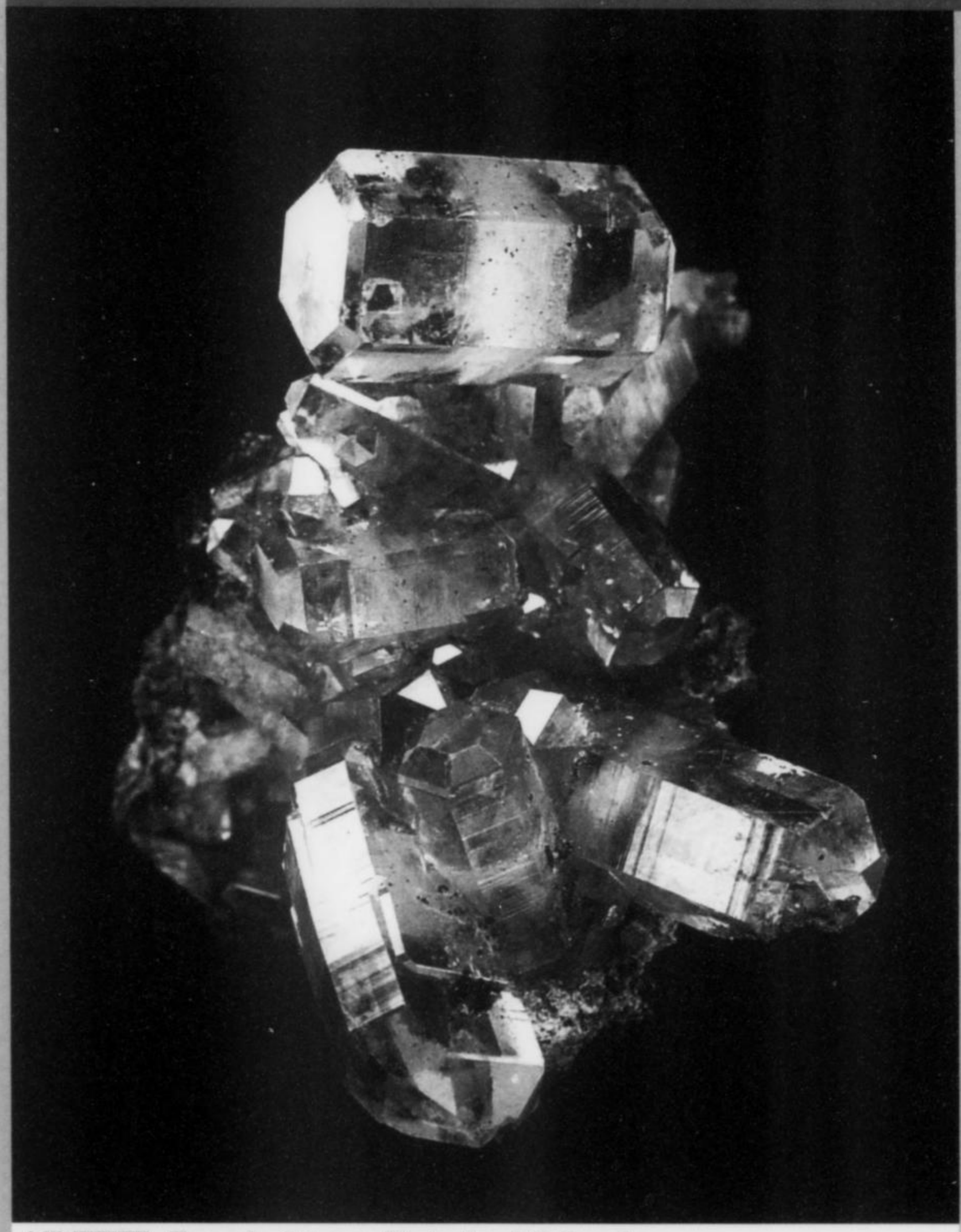

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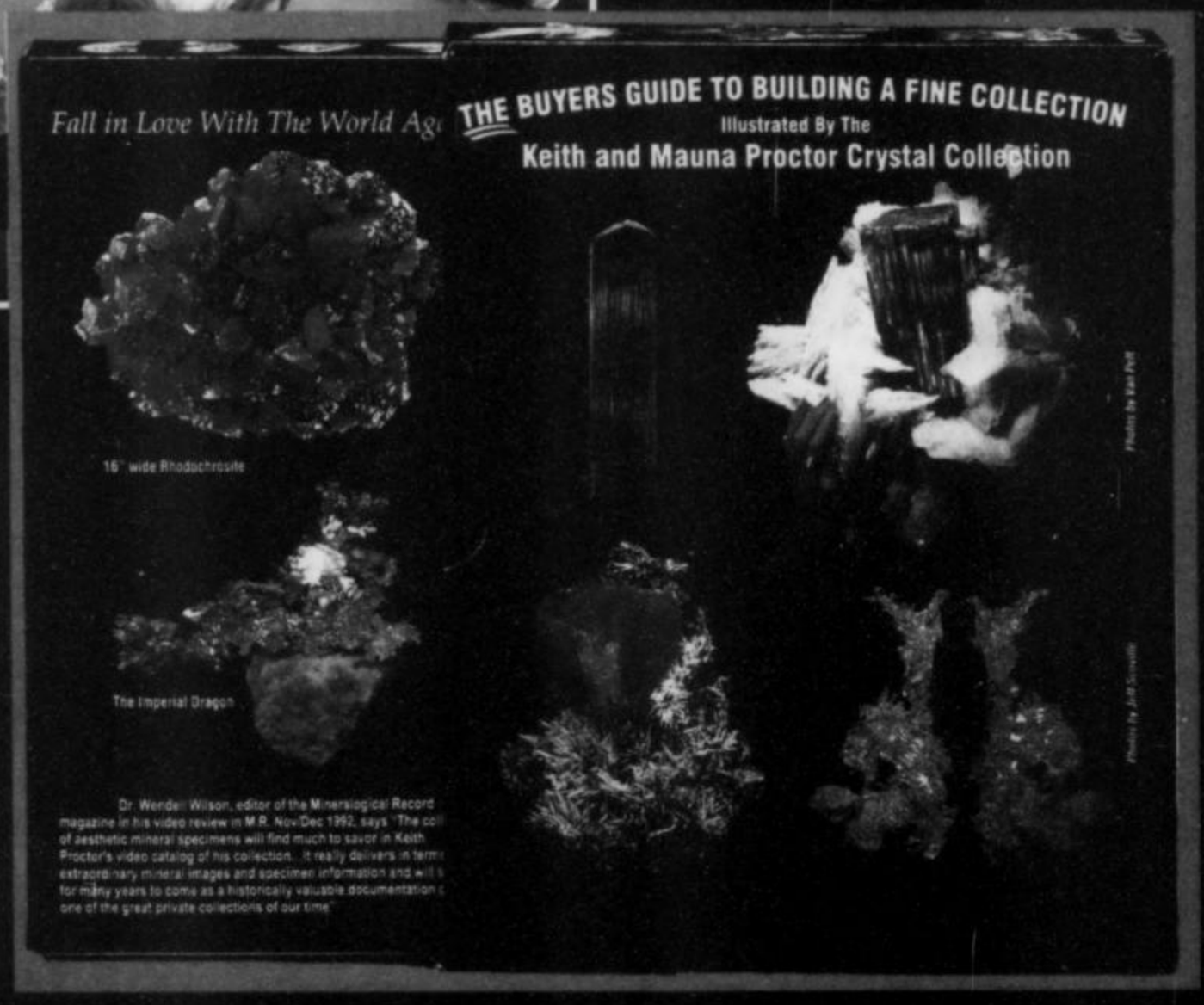

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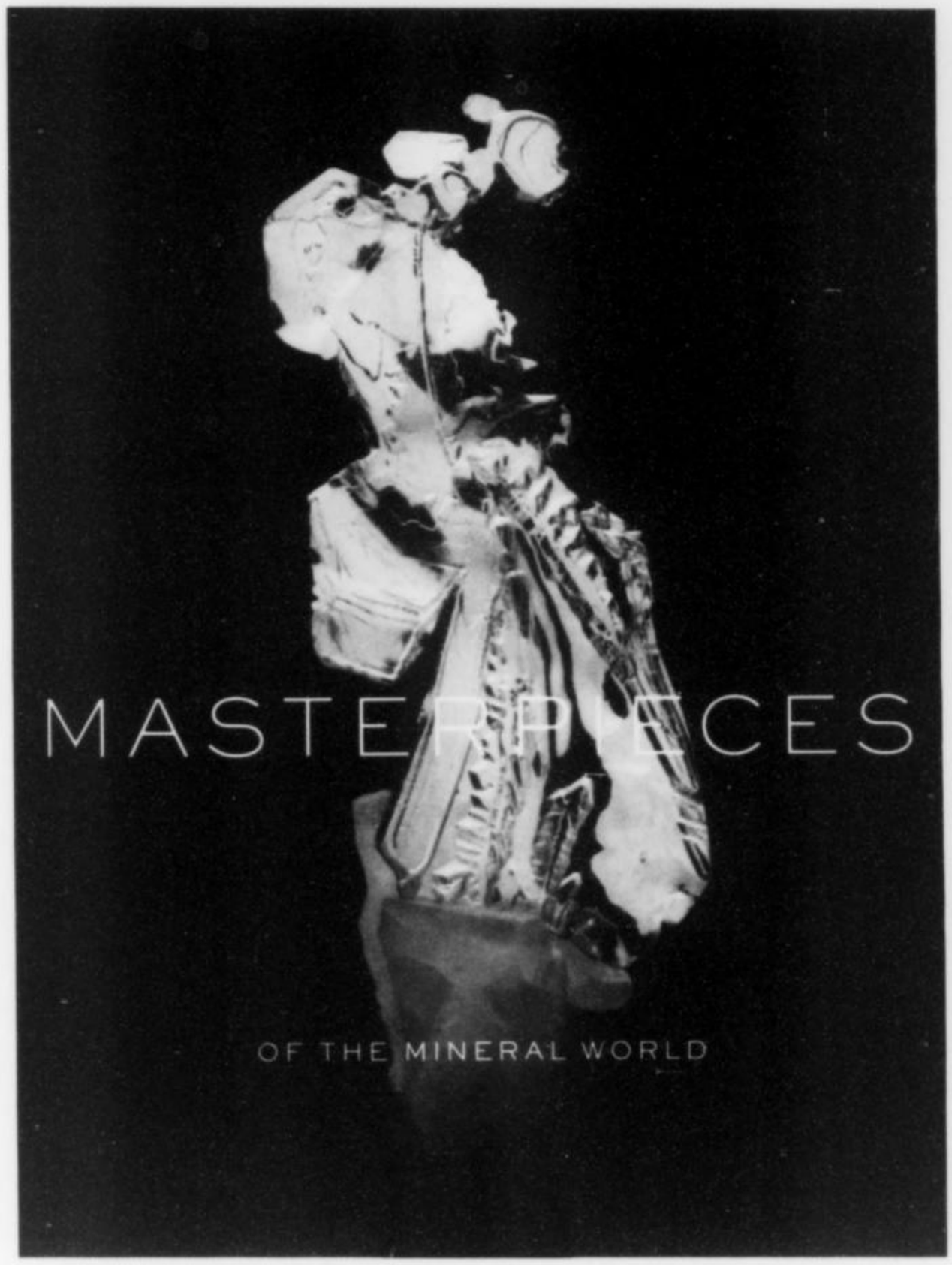

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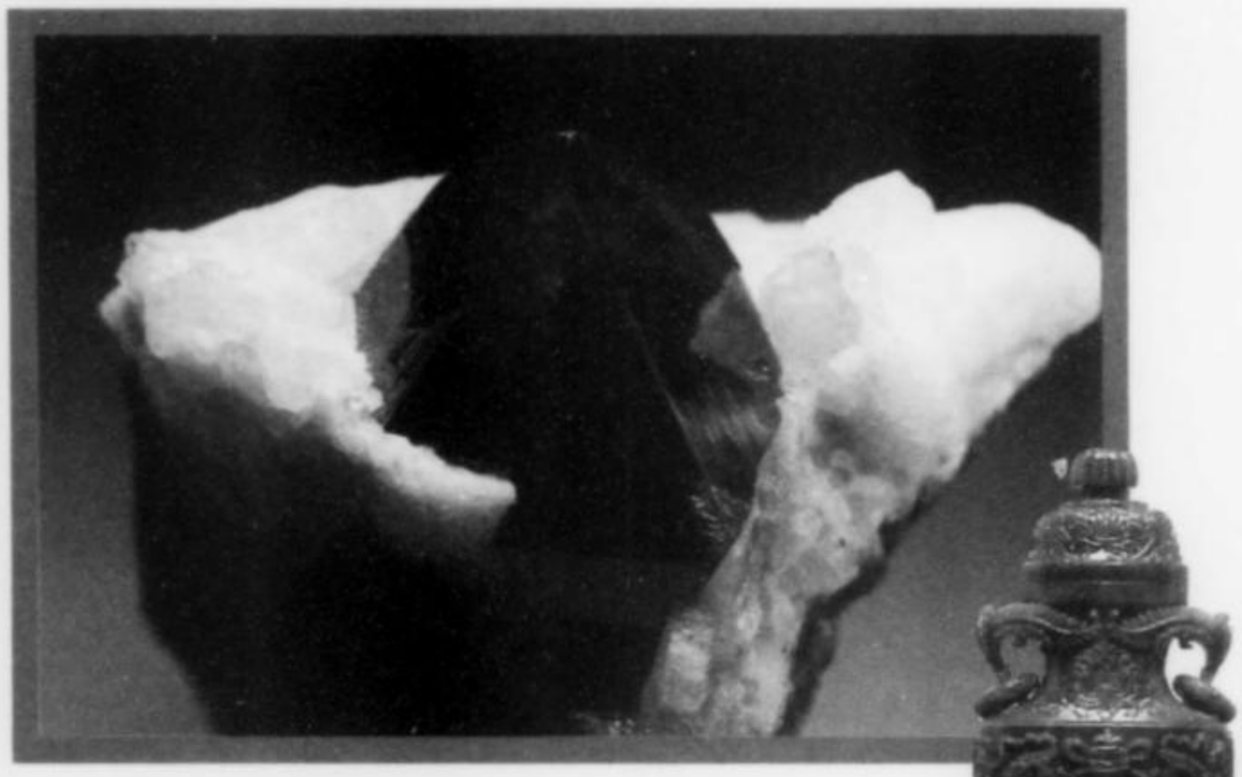

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The Guerrero Amethyst Deposits

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Some of the finest amethyst specimens in the world have come from the remote mountains of the Sierra Madre del Sur of north-central Guerrero State in Mexico. Few outsiders have ever visited this dangerous area, known as much for opium production as for amethysts, but fine specimens and high-quality gem rough continue to emerge periodically from many small but similar deposits worked by the local people.

INTRODUCTION

The Guerrero amethyst mines are famous among mineral collectors worldwide as one of Mexico's two great sources of fine amethyst specimens—the other being the Las Vigas mines in Veracruz (see the article by Lieber and Frenzel in the *Mexico-III* special issue, November-December 2003). Guerrero amethyst is easily recognized, and distinguished from Veracruz amethyst, by the crystal shape and coloration. At Guerrero the elongated amethyst crystals tend to be a bit fat around the lower and middle area, and taper to typical quartz terminations (Las Vigas crystals are rarely tapered).

The amethystine color—a deep reddish purple comparable to the best Siberian amethyst—is generally very dark and rich in the core of the central and lower area but fades to colorless/white at the outermost zones and the termination (most Las Vigas crystals become darker toward the termination, and are nowhere as dark as the Guerrero crystals). Sharply contrasting phantoms are common. Rarer crystals are concentrically zoned, with nondescript milky outer zones concealing rich purple interiors. Color patterns vary greatly between occurrences and even within individual pockets; many finds are sufficiently characteristic in habit or coloration to be immediately distinguished from specimens from other pockets.

Crystal sizes in the 5 to 10-cm range are not uncommon, and rare individuals over 60 cm and 45 kg have been found (Wayne

Figure 1. **Map showing the approximate locations of several of the historically most important amethyst claims near Amatitlan. The Sorpresa mine is in the same area, overlooking the Balsas River.**

Thompson, personal communication). Clusters tend to be somewhat divergent and highly attractive. The crystals are often found coated by manganese oxide.

The rich color of Guerrero amethysts brings good prices on the gem rough market. Sinkankas (1997) reported that fine faceted gems to 200 carats have been cut, and that one pocket of crystals may have yielded as much as $500,000 in gem rough!

The locality, first worked extensively in 1930–1933, is often cited as the small town of Amatitlan (or sometimes the neighboring town of Iguala, or as the Rio Balsas district), but in fact the amethyst has come from many veins scattered throughout the mountains northeast of Amatitlan. These are mined by trenching and tunneling to a depth of 8 or 10 meters; the workings are then abandoned in favor of searching out new veins. Some of the more prolific sites retain their claim names (Margarita, Valenciana, Palo Verde, Santa Rita, mina Amatitlan, Altamirano, Rayas, Sorpresa) whereas the names of many other diggings are now lost.

Mina La Sorpresa was mined for amethyst in 1997–1998 by employees of Mike New, Wayne Thompson and Ruben Avila. The Sorpresa property consists of a half-mile-long exposure of veins running across a hillside overlooking a tributary to the Rio Balsas (Wayne Thompson, personal communication). After extensive digging into the refuse-filled veins they found that the major pockets had already been removed and filled in at some time in the past . . . perhaps when the mine went by another name. Nevertheless, they recovered some extremely fine specimens, including the example shown on the cover of this issue.

Guerrero amethyst occurs in veins and pods related to Gold-Iron Skarn deposits that comprise what has come to be known as the "Guerrero Gold Belt." These contact metasomatic skarns occur in Lower Cretaceous dolomitic limestones and calcareous shales of the Morelos and Mezcala Formations, where they are intruded by lower Tertiary granodiorite stocks. The skarns are dominated by andradite-grossular garnet and diopsidic and johanssenitic pyroxene. The skarns also contain significant amounts of specular hematite and magnetite, with large pods of massive magnetite occurring along the contacts between skarn and surrounding host rocks. Most of the recent skarn discoveries in the region have been made through airborne magnetic surveys which easily detect the massive magnetite bodies through younger rock or vegetation cover.

For many years, exploration of the region was impeded because the majority of the ground (aside from a few small privately-held claims) covering the known gold and amethyst deposits was incorporated into the "Morelos Mining Reserve," established by the Mexican Government in the late 1970's. Mining Reserves give exclusive exploration and production rights to the government and, although Mexican government exploration groups developed successful exploration strategies for the region, they only followed through in limited areas because nationwide policy turned against public sector exploration funding. The Morelos Reserve was split

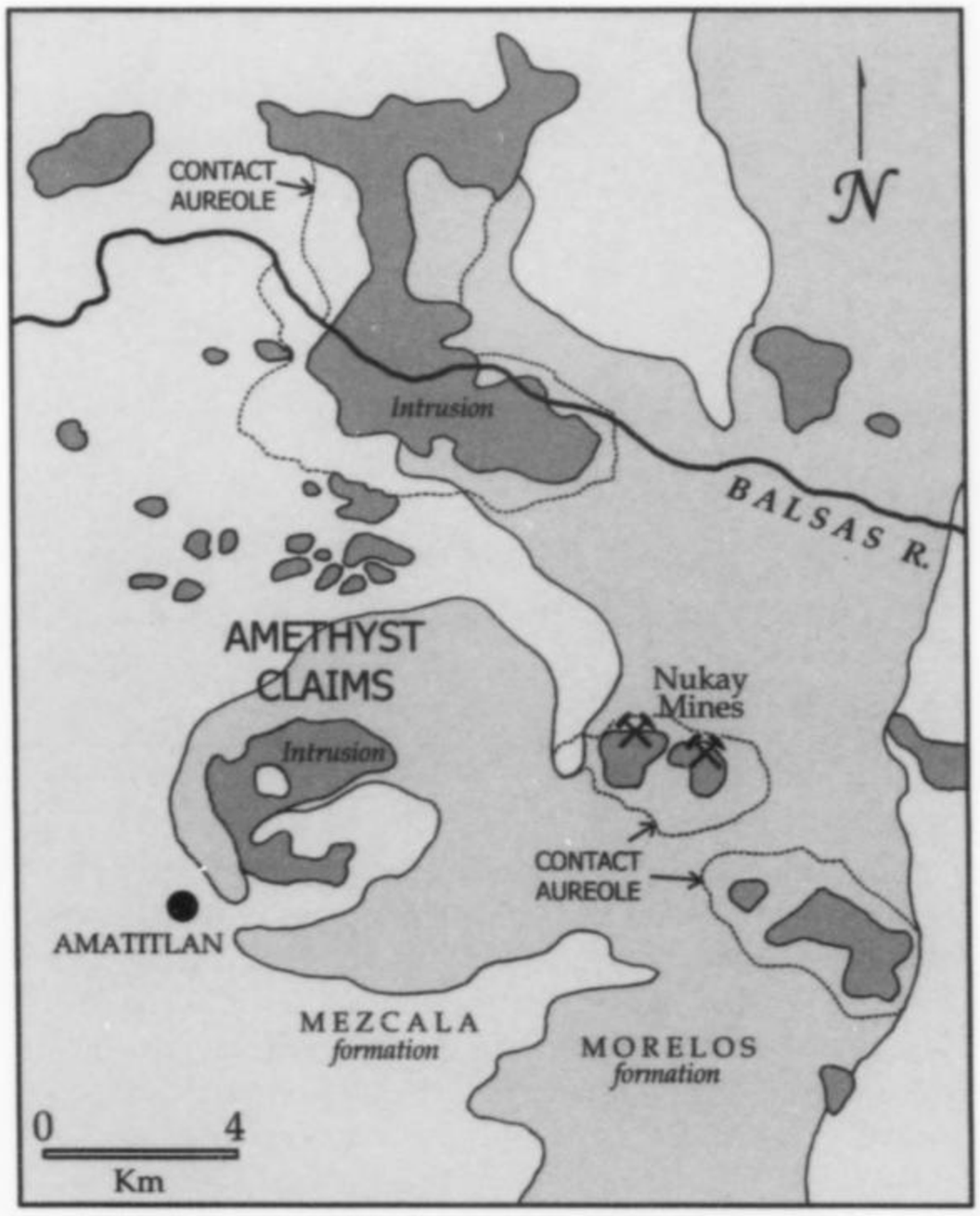


Figure 2. **General geology of the Amatitlan area. The Nukay copper mines have yielded azurite crystals.**

Figure 3. **Other mines and deposits in the Amatitlan area, shown in relation to the Massive Sulfide Belt and the Guerrero Gold Belt.**

Figure 4. **Author Ontiveros (today 82 years old) as a young man, at about the time that he was involved in the early-1930's amethyst explorations described here.**

into two pieces (North and South) in 1998 and sold to Grupo Mexico (the successor to ASARCO Mexicana) and Teck-Cominco (the world's largest zinc producing company). These companies (and certain competitors who obtained private ground within the Reserve . . . including several amethyst claims!) paid handsomely for the mining rights because they recognized the importance of these deposits as bulk-mineable gold deposits.

Exploration efforts have burgeoned since the region was privatized, and over 8 million ounces of gold have been blocked out in 4 major deposits (Xochipala, Bermejal/Mezcala, Nukay/Los Filos, and El Limon/Todos Santos) over the last few years. All are either in production or will become major new gold mines in the near future. Most of these deposits (and many more known skarns which have yet to be adequately explored) have potential for amethyst discoveries around their margins. Only the existing amethyst claims are likely to be formally operated for specimens in the foreseeable future unless someone can make a deal with one of the major mining companies . . . or unless they abandon ground outside of their principal areas of interest so that others can file claims on amethyst occurrences. Nevertheless, greatly improved access throughout the region may result in increased specimen production by highgraders who are unconcerned about claim ownership.

One of us (MO) was involved in the original discovery of the Guerrero amethyst deposits. His story is as follows, with supplementary data added in square brackets by the other authors:

DISCOVERY of the DEPOSITS

Amatitlan

I don't remember the exact date, but it was around 1930. Señor Donato Retana, who lived in the small village of Amatitlan, Guerrero, was a peasant farmer who raised corn in the mountain highlands near Tenantla, a small town near Amatitlan. While tilling the soil in order to sow the fields he began to find white and purple crystals of quartz. Hoping to profit from the find, he took the crystals to Iguala, Guerrero, where his nephew Margarito Retana lived. Because Don Donato didn't know how to write, he asked for

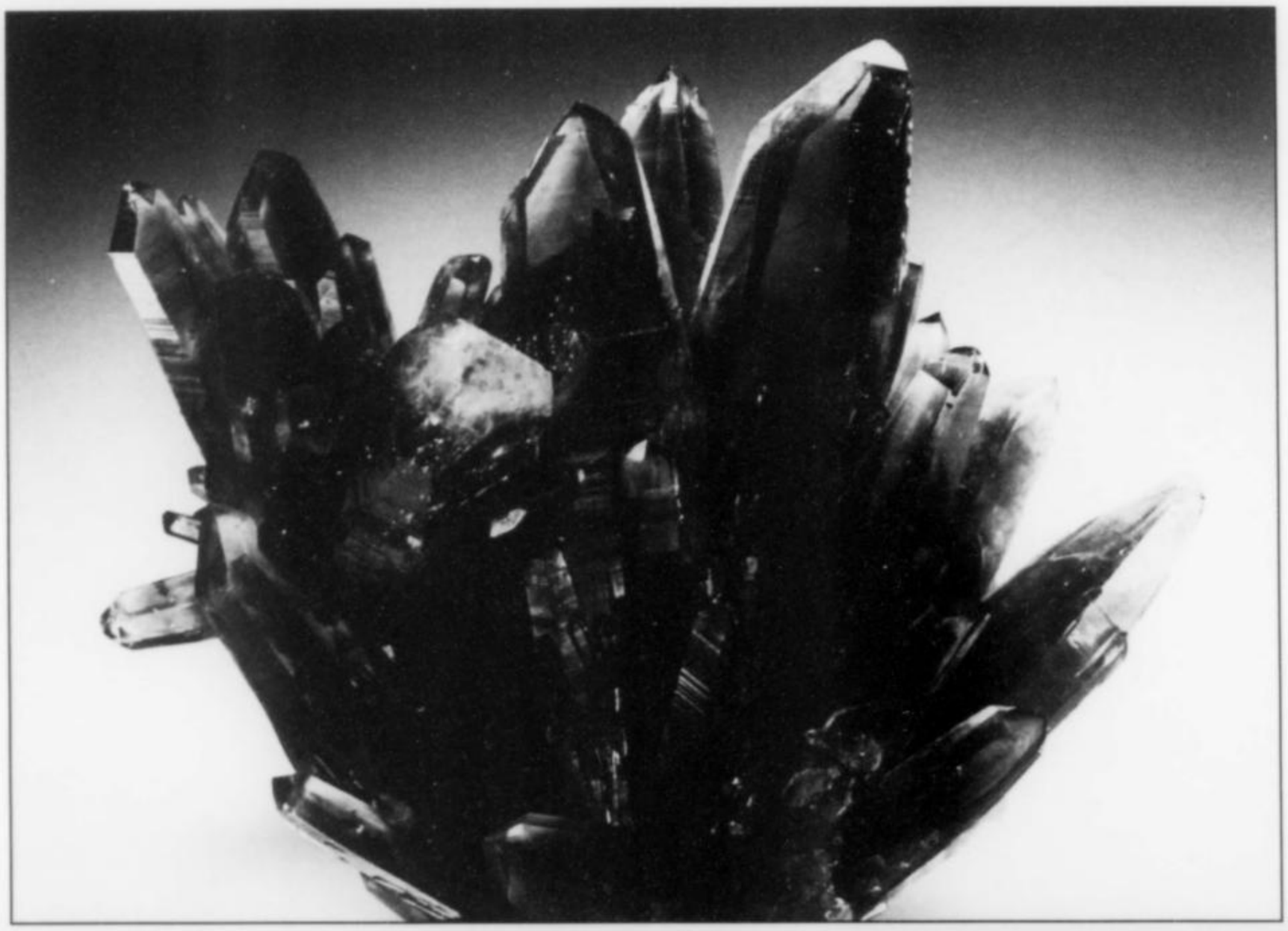
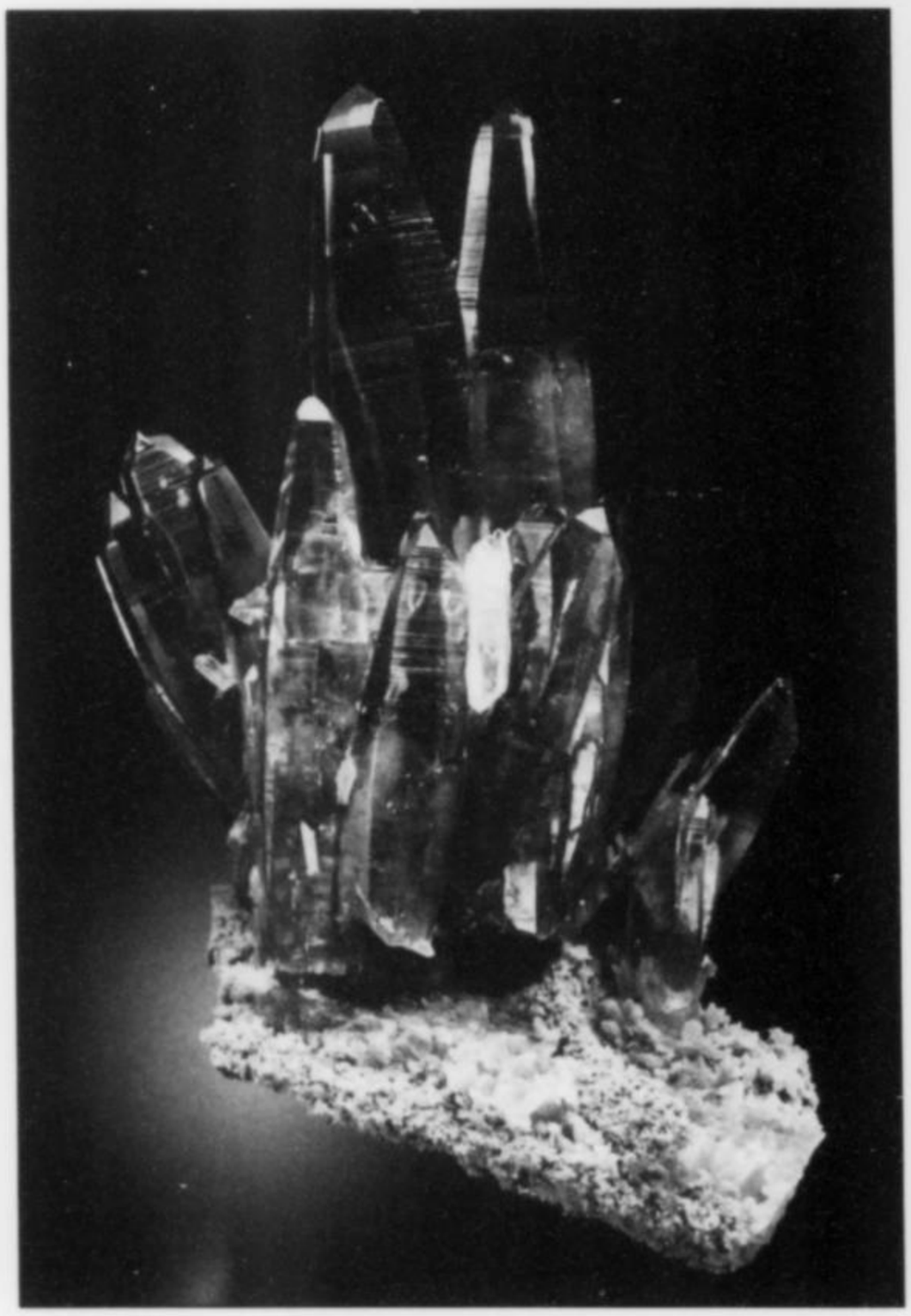


Figure 5. **Cluster of Amatitlan amethyst crystals, 17.5 cm. Cal and Kerith Graeber collection; Wendell Wilson photo.**

Figure 6. **Large amethyst crystal cluster, 24 cm, from the Margarita mine near Amatitlan. Natural History Museum of Los Angeles County collection; Van Pelt photo.**



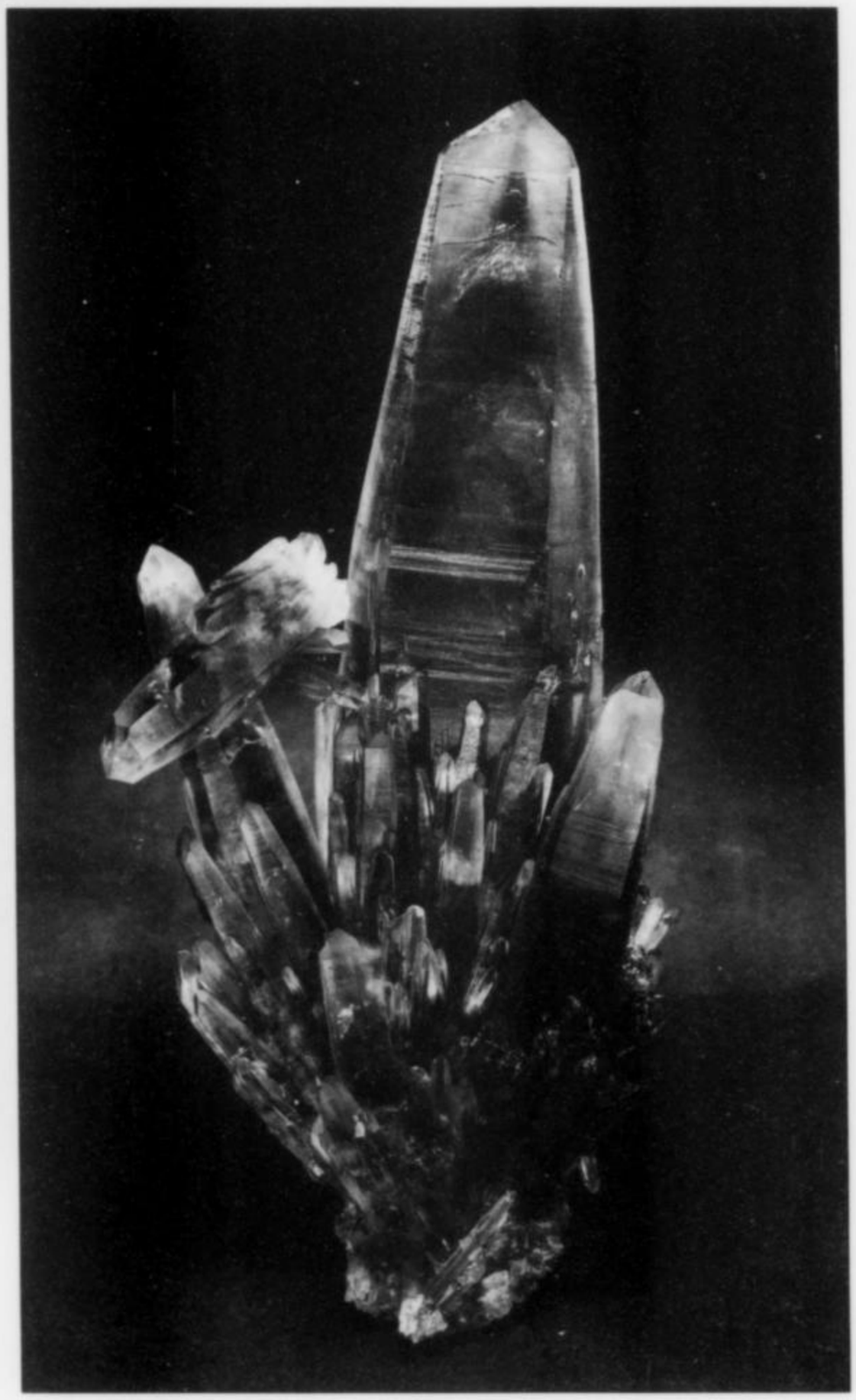


Figure 7. **Exceptionally transparent amethyst cluster on matrix, 7.5 cm, from near Amatitlan. De Natura specimen; Jeff Scovil photo.**

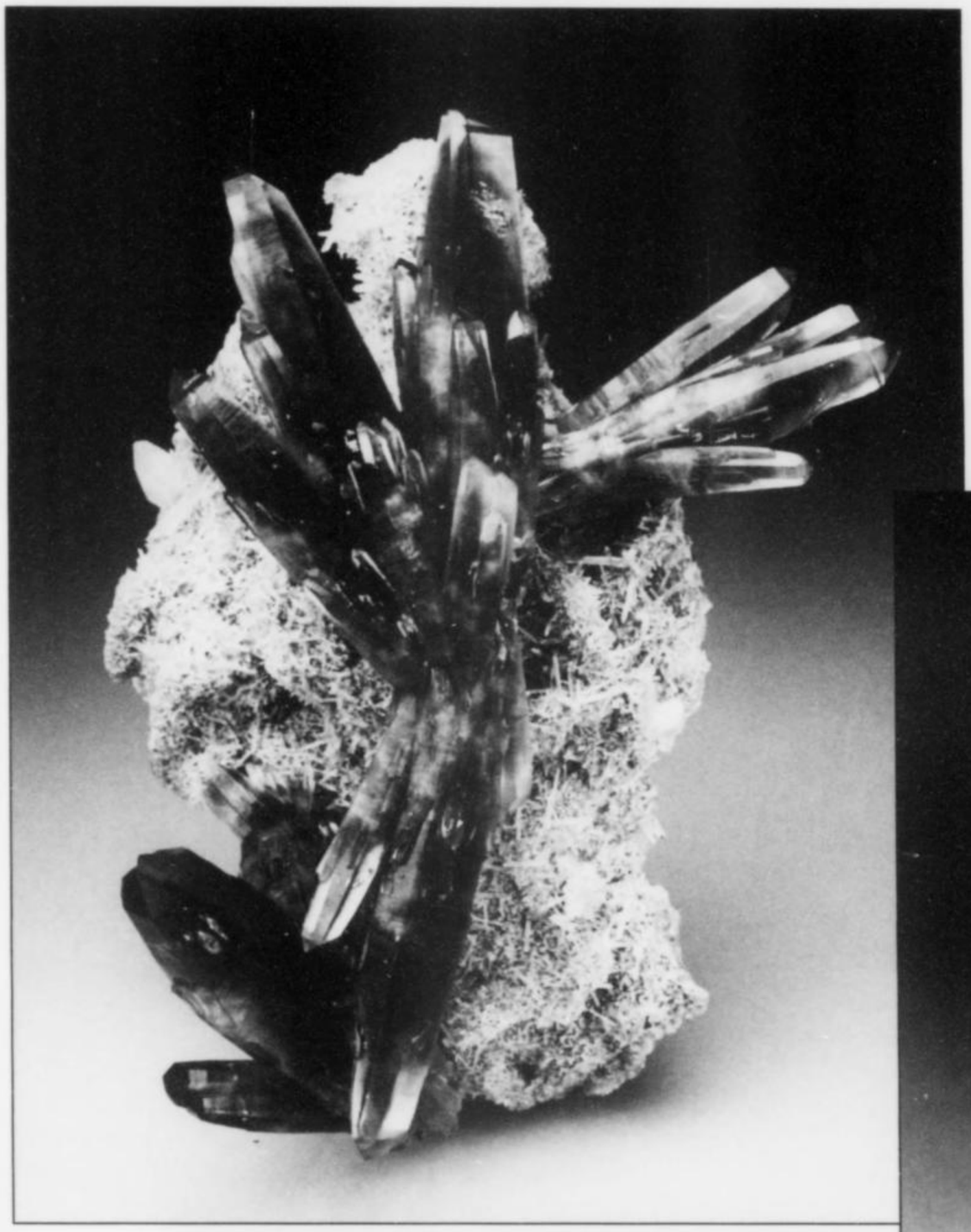
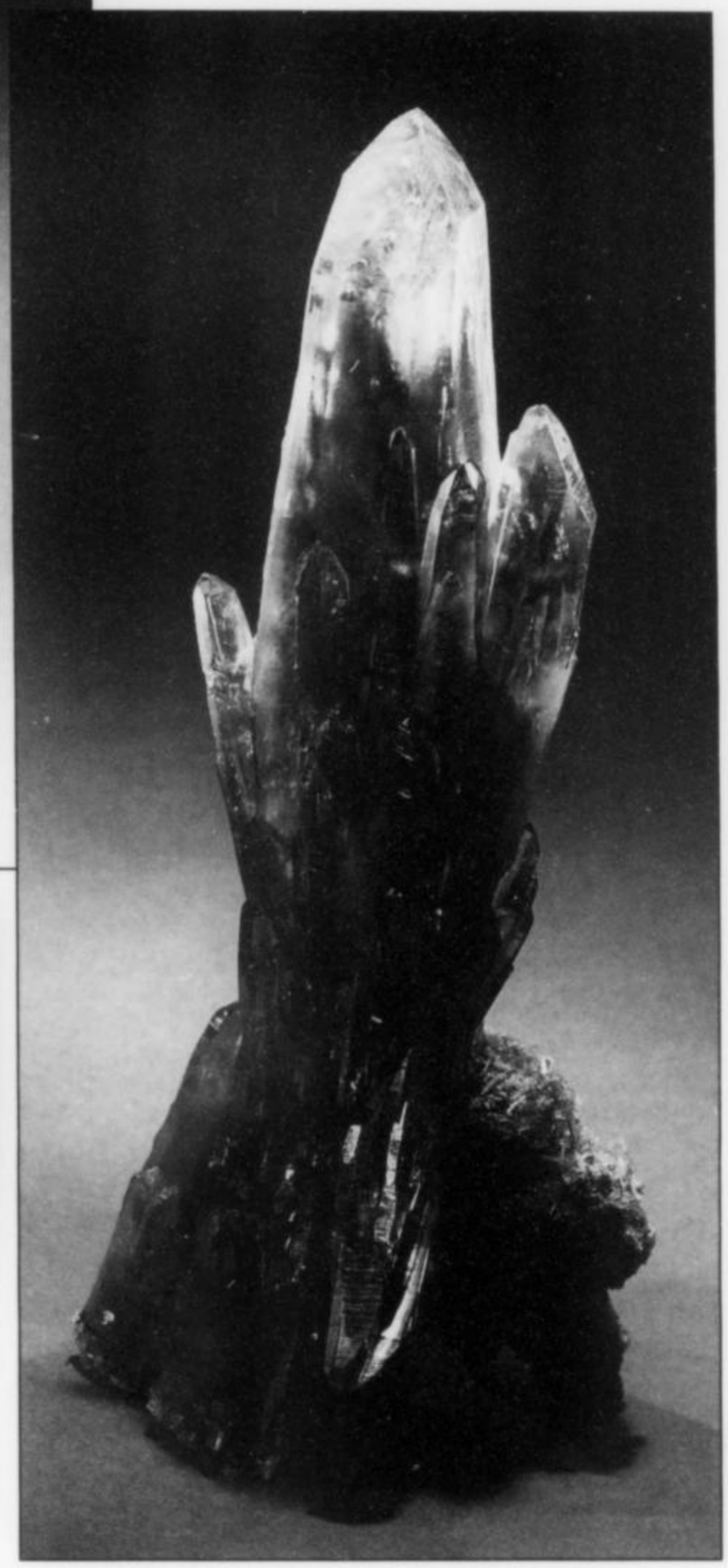


Figure 8. **Amethyst clusters on matrix, 20 cm, from near Amatitlan. Ed David collection; Jeff Scovil photo.**

Figure 9. **Amethyst cluster, 15 cm, from near Amatitlan. Norm and Roz Pellman collection and photo.**



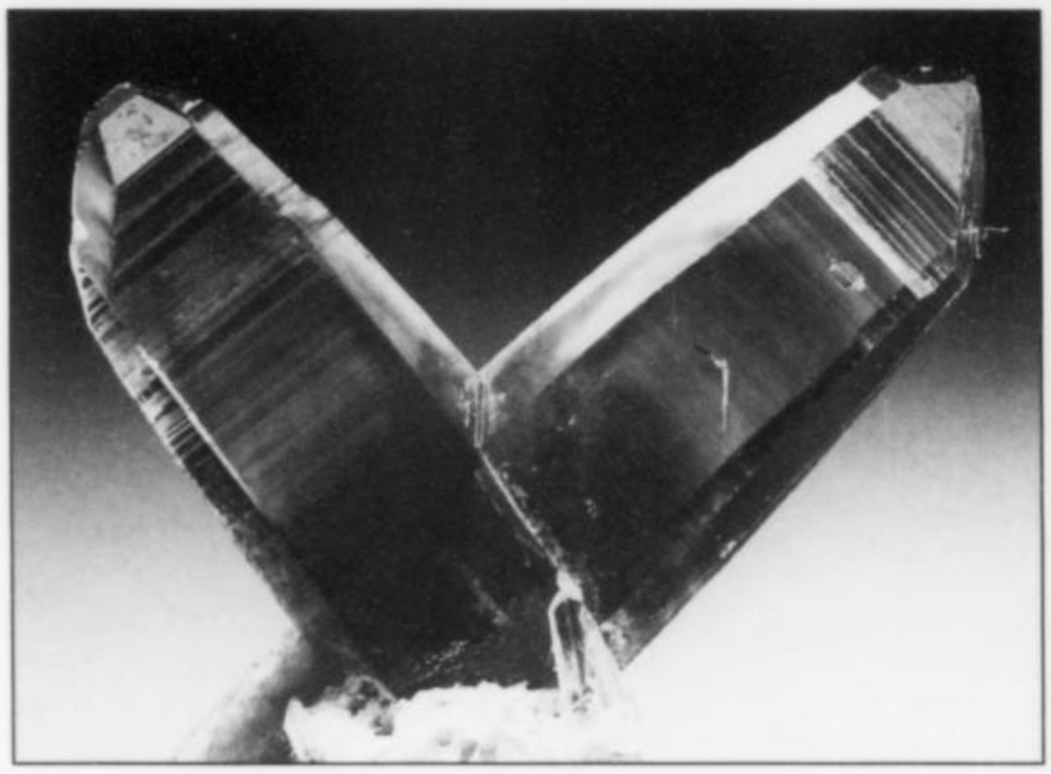


Figure 10. **Exceptionally rare Japan-law twinned amethyst from near Amatitlan. Steve Green collection; Wendell Wilson photo.**

help from his nephew in filing a mining claim. The nephew took advantage of the ignorance of his uncle by making the claim in his own name, depriving his uncle of all rights. This caused a family feud—very common in that part of the Sierras. Shortly they were killing each other, one after the other, not just the men but also the women and children, nearly exterminating the two families.

As Queretaro was famous for its lapidary industry, Señor Donato traveled there to enquire about possible interest in the newly discovered quartz specimens. Because my family in Queretaro needed amethyst for our own lapidary work, we made some trips to visit Señor Donato. There were two routes which led to Amatitlan: one via the Balsas Train Station, thence by mule and on foot to a

Figure 11. **Extremely large cluster of amethyst crystals, about 60 cm tall, collected by the Ontiveros family from their claims near Amatitlan, shown here as it is today in its exhibit case at the Smithsonian Institution. In the 1960's this specimen was considered by Smithsonian curator Paul Desautels to be the finest amethyst specimen in the world. It is pictured from a different angle in Desautel's famous book, *The Mineral Kingdom* (1968, p. 237). Photo by Ken Larsen.**

mountain called Aguacatillo. When we traveled by that route the climb took us about five hours. The other approach started at the Iztla Bridge, which crosses the Balsas River, and from there it was a six-hour climb up to Amatitlan. The trail passes an old copper mine, where we stopped to admire some beautiful azurite crystals occurring as float in the soil, but we knew nothing about the value of collector specimens in those days and were searching only for gem material, so we continued on. [This was probably the site of the present-day Nukay mine, some specimens from which did eventually reach the market.]

Some time later my father, Señor Joaquin Ontiveros, staked a claim of his own at Amatitlan which he named the "La Cuña." It was a lode claim situated not far from the mountain peak, and heavily covered by vegetation. My father asked me to work the claim (since he himself had other projects to attend to), and so, with the help of some of his best workers, we began to prospect for amethyst crystals. The claim began to produce very good crystals for us, a fact which we tried to keep secret to avoid trouble from envious people. Our work at the mine produced some very large crystals, some as large as a Coke bottle, others even larger, and almost all having a deep amethystine color. Not knowing much about specimen crystals, we broke them apart to extract clean pieces of gem rough for facetting.

Later my father staked another claim in the high part of the mountains. At this place, hidden by the undergrowth, there was a system of crystal pockets in the rock. My father instructed me to hire an engineer to survey the site preparatory to filing of the official claim with the government. I named the claim the "Margarita" in honor of my older sister [it is sometimes incorrectly called the "Santa Margarita" claim]. During the course of his surveying work the engineer called my attention to a chalky zone with embedded crystals. I decided to dig at this site, and at a depth of around 3 meters we found a sand-filled pocket containing a large number of amethyst crystals. The Margarita mine proved to be near one end of a long geological fault which has produced most of the Amatitlan amethyst specimens.

Of course we didn't stop working at La Cuña. However, within two months we began to have problems with envious people with poor reputations. A friend of ours warned us in confidence that these people were planning to attack us on the coming Sunday, and that they were not known to make idle threats. We worked day and night to conceal all signs of our work at La Cuña, scattering rubble and vegetation about to hide our activity. That night it rained in torrents, which aided us in hiding the site. We left, and the site has never been rediscovered. I am the last man who still knows where it is.

Fearing that our enemies would be waiting for us along one of the paths, we decided to make our way directly over the trackless mountains, exploring as we went, and aim for the coast. We did find an interesting occurrence in the mountains, at some distance from the city of Chilpancingo. There were quite a few floater crystals of amethyst scattered about, some of them having good color, but we didn't like them very much so we continued onward.

We passed by a small village called Campo Morado, where we obtained some food. The villagers were familiar with the local roots and forest plants, which were a great help to us. [Campo

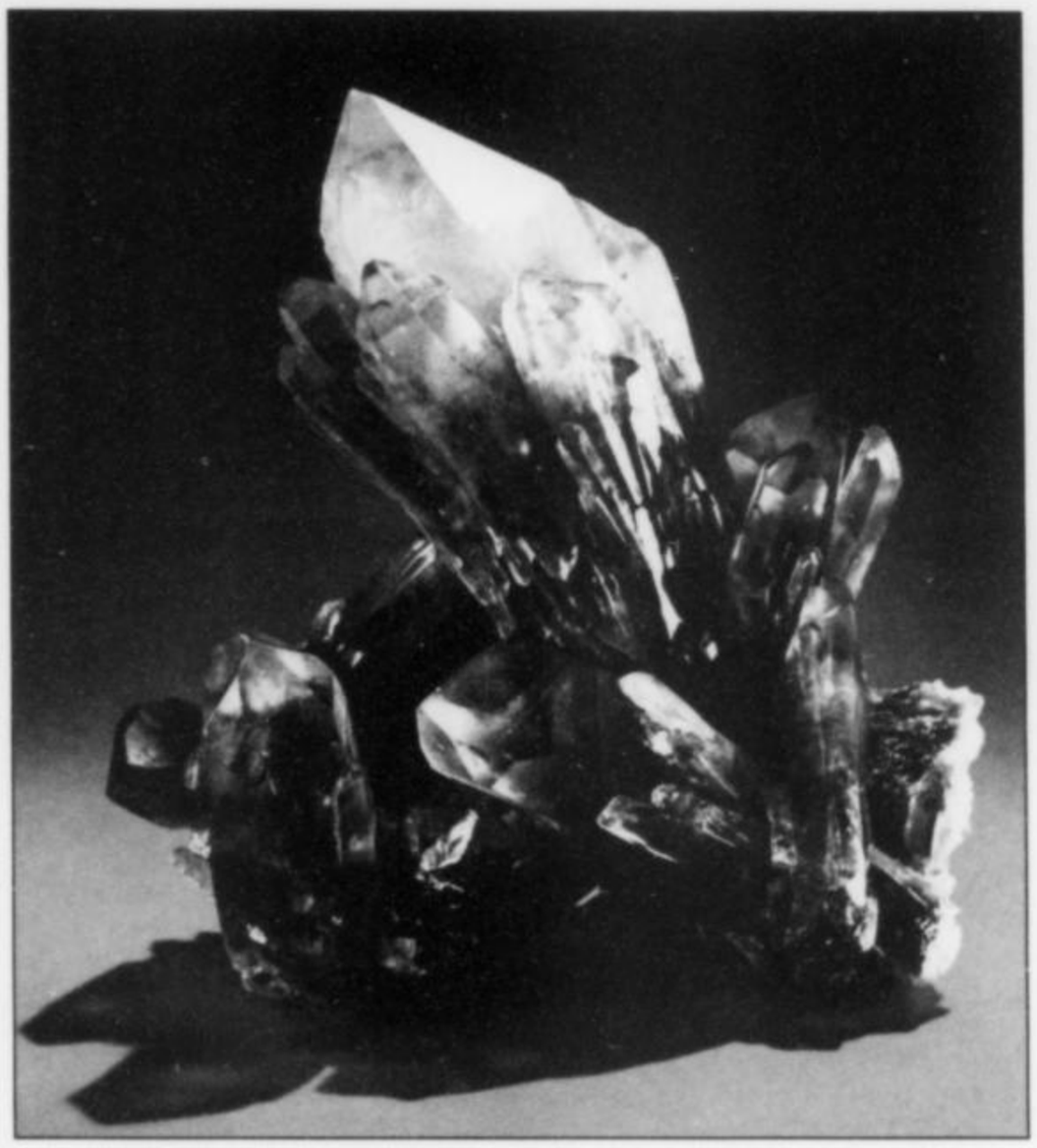


Figure 12. **Another cluster of Guerrero amethyst crystals illustrated in Paul Desautel's book, *The Mineral Kingdom* (1968, p. 82). Smithsonian Institution collection; Lee Boltin photo.**

Morado is known today as a major volcanogenic massive sulfide district which has produced chalcanthite stalactites up to 15 cm in diameter and over 1.5 meters long!] From there we continued onward to a cluster of houses called Corral de Piedra, where we found an interesting chalky formation containing amethyst crystals of very good color. The soil was soft, and we were able to dig out about 15 kg, which we divided into three loads; we could carry no more because of the difficulty of traveling through the mountains.

Our trip on foot through the very beautiful, uninhabited mountains took about a month. At one point, dying of hunger, we came across a fairly large stream wherein a small dam had created a pool full of fish. I joked to our guide that it was too bad we didn't have any fish hooks. He said not to worry, and that we would eat soon. Then he went off into the woods while I took a much-needed bath. He returned with an armload of branches from some plant I didn't recognize, and carried them down to the pool. He then crushed the branches with a rock and let the sap fall into the water. After a short time the fish began to float to the surface, and we hurriedly collected as many of them as we could. The guide told me that the sap from the branches had a paralyzing effect on the fish for about 15 minutes. We prepared and ate the fish as quickly as we could.

We continued hiking, and came to a heavily wooded area where we had to cut our way through with machetes; the leaves of huge ferns were densely interwoven with the tree branches. I still don't know how our guides managed to find their way; they said that the sun and stars guided them. I believe that God was leading us down the right paths. It took many more days to finally reach the town of Atoyac on the coast. I then traveled on to Mexico City where I sold the amethysts, reserving some for ourselves for facetting; my companions and I realized a nice profit which we divided equally. I was only 17 years old at the time, and this was an adventure that I would never forget; despite the hunger and hardship, I wouldn't exchange the experience for all the gold in the world.

In time the claims passed to my brother-in-law, Javier Hernandez of Queretaro, who worked them in partnership with a resident of Amatitlan, taking out large quantities of amethyst. My family had come to recognize the value of crystal specimens, and a great many specimens were sold on the collector market. I was by then already established as a mineral dealer in El Paso, Texas, and bought crystal specimens from Javier. A particularly large one measuring about 2 feet tall is now in the Smithsonian Institution collection—it was considered by curator Paul Desautels (1968) and also by Frederick Pough (1968) to be the world's finest example of amethyst known at that time. Another fine one (measuring about 12 inches) I sold to Señor Smith of the Adamas Rock Shop in Youngstown, Ohio.

There were only two big bonanzas of amethyst among those early claims, other than Señor Donato's original claim: La Cuña and Palo Verde (where a very large pocket 20 meters deep was found as a pod in decomposing granite, not in veins). What I found at La Cuña was somewhat similar to the Palo Verde amethyst. In general, however, the good specimen groups all came from the Margarita claim; I never saw any groups come from the other claims, only cutting-grade material.

Other Guerrero Occurrences

We used to go to Taxco to purchase lapidary-grade amethyst for our work [amethyst from Taxco was known long before the Amatitlan deposits were discovered]. One day while we were eating at a restaurant in the Taxco market and examining our

Figure 13. **Unusually transparent amethyst crystal cluster, 7.6 cm, from the Amatitlan area. De Natura specimen; Jeff Scovil photo.**

Figure 14. **A V-shaped cluster of amethyst crystals, 7.2 cm, from the Amatitlan area. Jim Walker collection; Jeff Scovil photo.**

Figure 15. **Amethyst crystals to 11 cm from the Amatitlan area. Western Minerals specimen; Wendell Wilson photo.**

purchases, a man told us he knew where there were many such crystals. He asked us to meet him in Huitzuco, which we did, and from there he took us to the Barranca [=valley] del Ocote area. He led us up one of the barrancas some 5 km east of the town of Huitzuco. There we dug out about 5 tons of massive amethyst suitable for cabbing, and shipped it to our family headquarters in Queretaro, but the potential of this locality had barely been scratched. [Huitzuco is a famous old mercury camp. It was the first place the Spanish found significant quantities of cinnabar in Mexico, and they produced it clandestinely to circumvent the Crown's monopoly on quicksilver. Huitzuco is the type locality for livingstonite.]

He told us that he had found also some good crystals farther up the Barranca del Ocote which were similar to some we had shown him from Amatitlan. He took us to some hills on the right side of the valley, almost at its end, and we followed a dry arroyo until we began to find purple and white crystals cropping out. Two sites which we found had amethyst crystals of good size and color, looking exactly like those from Amatitlan. We worked this occurrence for about six months and found a large quantity of crystals which we sold as Amatitlans. We never filed a claim with the government; we just worked the pocket zone until we reached the harder, unaltered bedrock which was too much for our simple hand tools. We divided the proceeds with our friends from Huitzuco, who made out very well on the deal.

Before leaving to go north, I joined with my brother Alfonso (who now rests in peace) to go on a trip, as someone had told us that there were amethyst crystals visible on Pico de Oro near Caballos in the state of Guerrero. After exploring the mountains from bottom to top for a month, we finally had success: we found an amethyst deposit on one of the peaks of an impressive mountain range known as Filo Mayor.

Instead of horses we acquired two burros to carry our food and mining equipment, and each weekend we brought in necessary provisions. I remember that one Sunday we were planning some new explorations to find a better deposit to work. We had just settled on a plan which seemed interesting when two armed men suddenly arrived and accused us of being spies. They took us deep into the countryside to their leader, a foreigner (I don't know what his nationality was). Along the way we saw many people working amid fields of poppy flowers, and in truth we did not know what this was all about. The foreigners were thinking of killing us, but someone we didn't recognize approached them and told them that we were miners, and that he had worked with us before. We were then permitted to leave, although with an escort of guards. We

gathered up our crystals and loaded them onto the burros. The guards took us through the mountains until we came to a road which could accommodate haulage trucks; there they left us, after warning us that if we returned to the area we would never come out again.

We had explored many places throughout Guerrero, and during all of that time the local inhabitants always helped us with food and by giving us places to sleep. It was very rare to have a mishap like the one we had with the foreigners. The mountains had been free of evil before that time, and one could travel everywhere without danger. This was the last of our expeditions for amethyst in the state of Guerrero.

ACKNOWLEDGMENTS

Our thanks to Si and Ann Frazier, Wayne Thompson and Mike New for background information.

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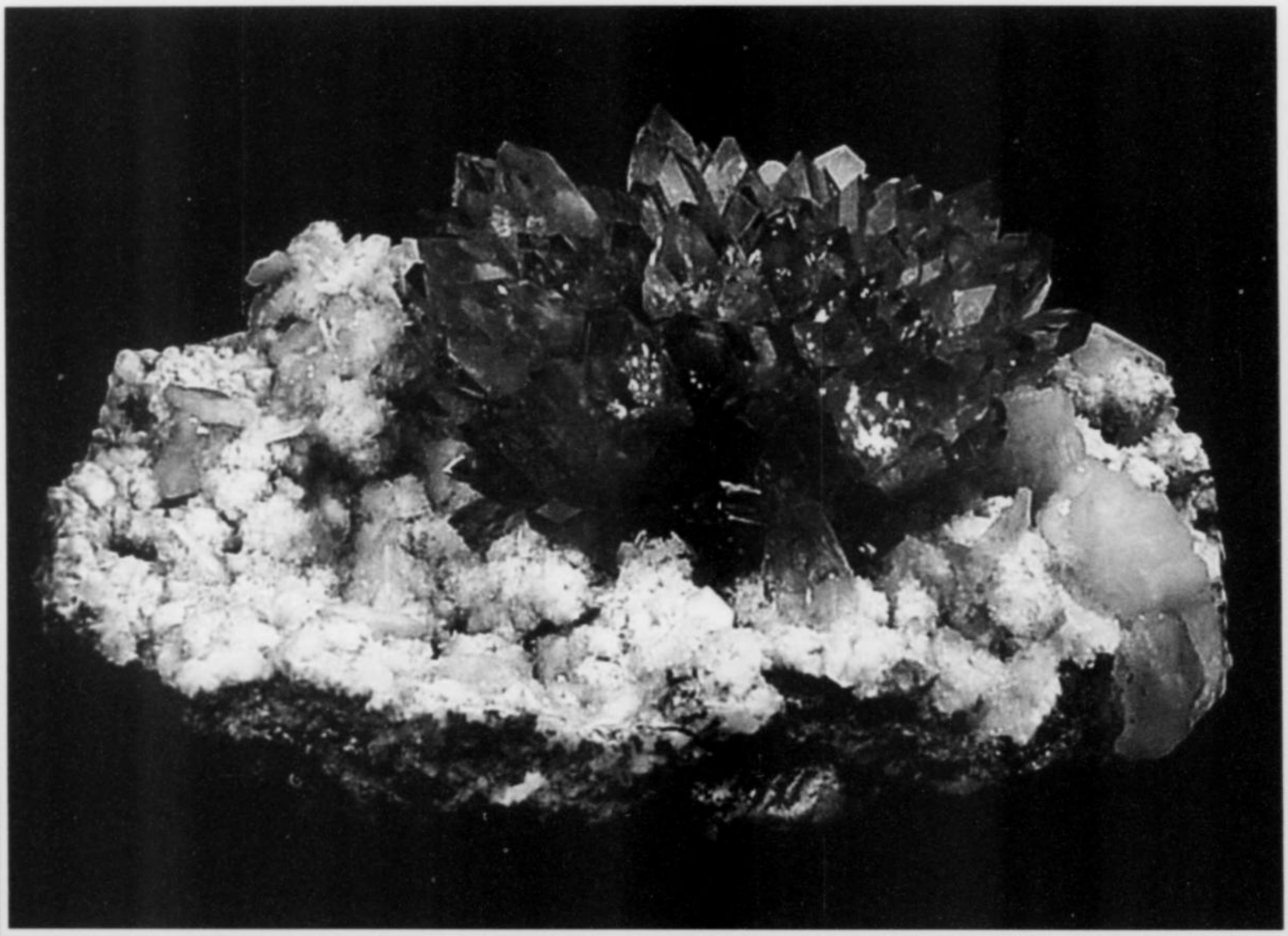

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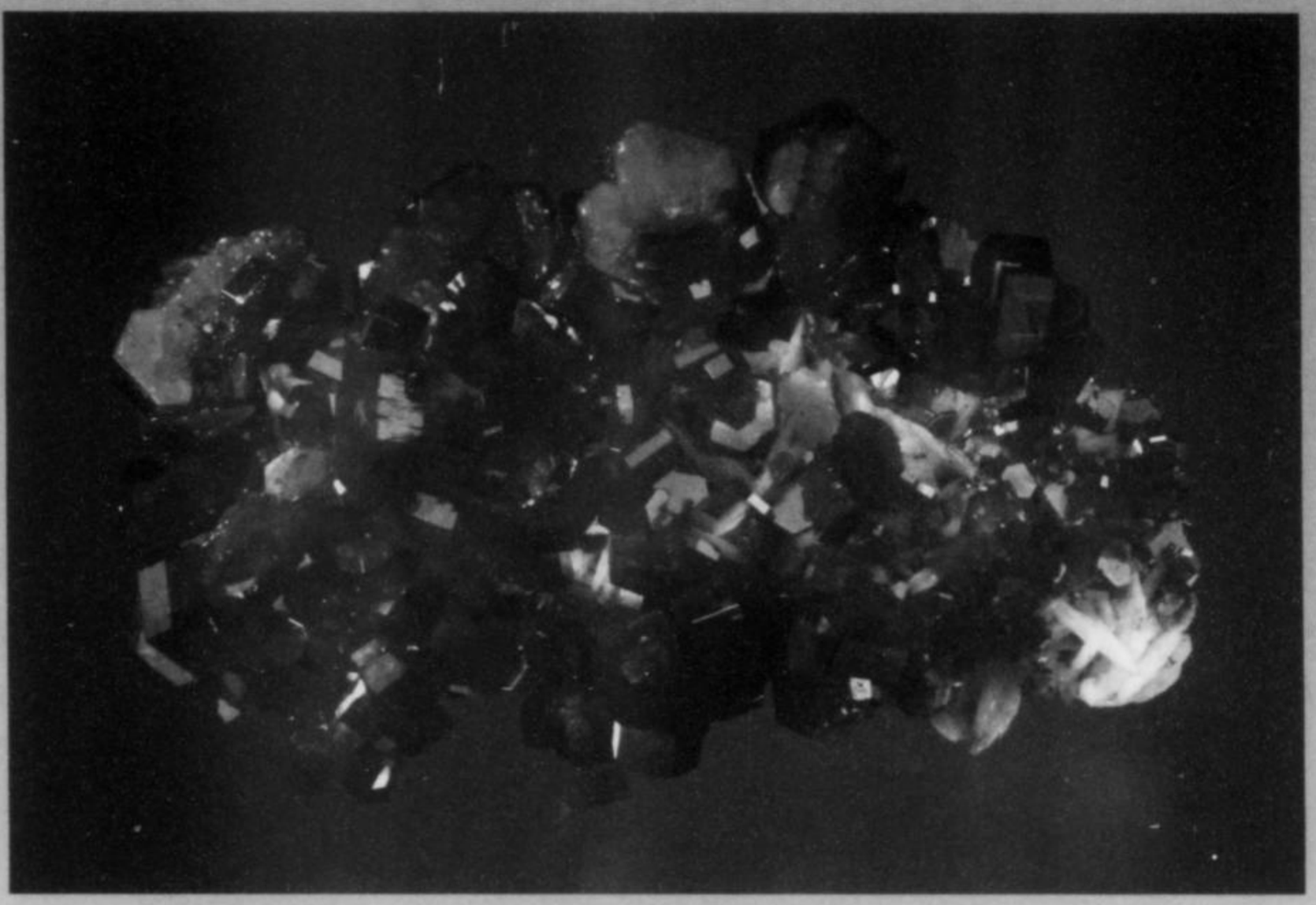

VANADINITE, 10 cm, from Mibladen, Morocco. Jeff Scovil photo.

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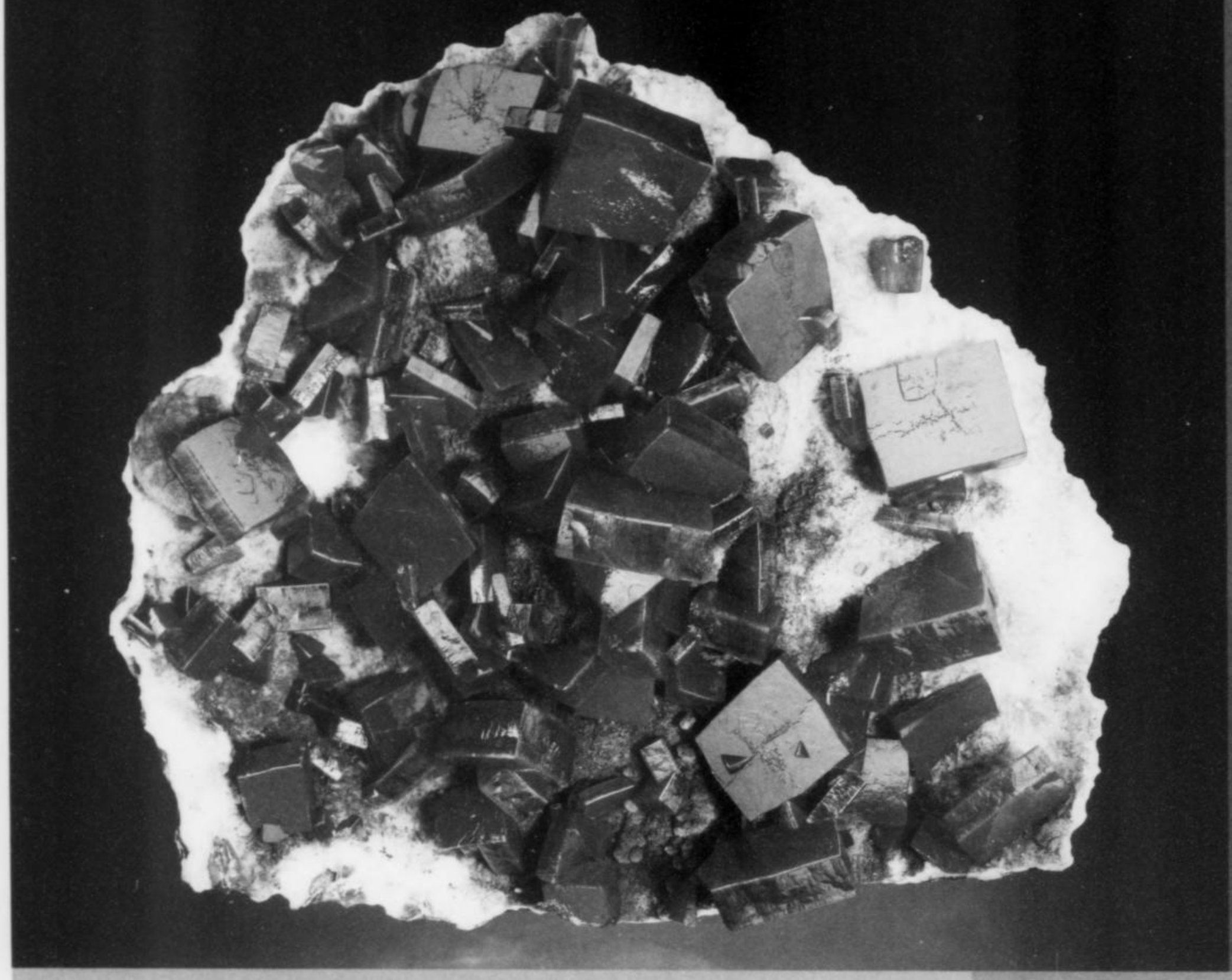


Wulfenite, 12.7 cm, from Los Lamentos, Chihuahua, Mexico.

Jeff Scovil photo.

Famous mineral localities:

The San Francisco Mine

Sonora, Mexico

Thomas Moore
5755 E. River Rd. #1317
Tucson, Arizona 85750

The San Francisco mine in Sonora is among the world's most important and prolific wulfenite localities, having yielded well over 100,000 specimens since the early 1970's. Beautiful examples of large, thin, transparent crystals and clusters may be found in collections and museums around the world.

INTRODUCTION

The San Francisco mine lies 12 kilometers by dirt road from the village of Cucurpe, which in turn is about 50 kilometers southeast of the town of Magdalena, Sonora, Mexico, and 110 km from the international border at Nogales, Arizona/Mexico. The city of Hermosillo, about 140 km to the south, is easily reachable from Cucurpe along paved Mexico Highway 15.

Two old mining claims cover the immediate area: the San Francisco claim and the San Felix claim. The wulfenite occurrence takes its name from the former. The San Francisco claim, covering about 10 hectares, is underlain by the mine workings; the much larger San Felix claim, extending over 211 hectares, completely encloses the San Francisco claim. Both are presently held by Rosa Whitmire of Yuma, Arizona, widow of mineral prospector and dealer John Whitmire; John was one of several prominent southwestern American mineral prospectors and dealers to have worked in the San Francisco mine during the past four decades. Rosa Whitmire may be reached through her associate Ing. Ruben Rodrigeuz, to whom she has given power of attorney (Megaw, 1995).

When the fabulous wulfenite and mimetite specimens from this locality first emerged on the specimen market in the early 1970's, the source was most often cited as "Cerro Prieto" (White, 1972; Bideaux, 1972), or "Sierra Prieto," after the Cerro Prieto ridge of dark limestone which rises more than 300 meters above the mine's portal, or perhaps after Rancho Cerro Prieto, owned and operated by Don Pedro Trelles—the facilities of the mining camp lie on this ranch. Although "Cerro Prieto" may still occasionally be seen on older labels, "San Francisco mine" had already begun to replace it by the mid-1970's, during the earlier of two exciting episodes of wulfenite pocket discoveries. By this time the San Francisco mine had already won fame as the source of some of Mexico's finest wulfenite specimens, in crystals that are transparent, paper-thin yellow to orange "windows" spotted with yellow to fiery red spherules of mimetite. By the time of renewed, extensive work in the early 1990's, the mineral world was well primed to appreciate San Francisco mine wulfenite (Moore, 1994; Robinson *et al.*, 1995), and today the material is firmly established as "classic"—particularly since no new specimens have been recovered since 1994. No collection specializing in major wulfenite occurrences around the world is complete without a glowing yellow-orange wulfenite/mimetite crystal group from the San Francisco mine.

LOCATION

To reach the mine, one leaves Magdalena on the paved road southeastward to Cucurpe, then turns northward onto a dirt road after about 40 km. Most of the dirt road lies along the bottom of a

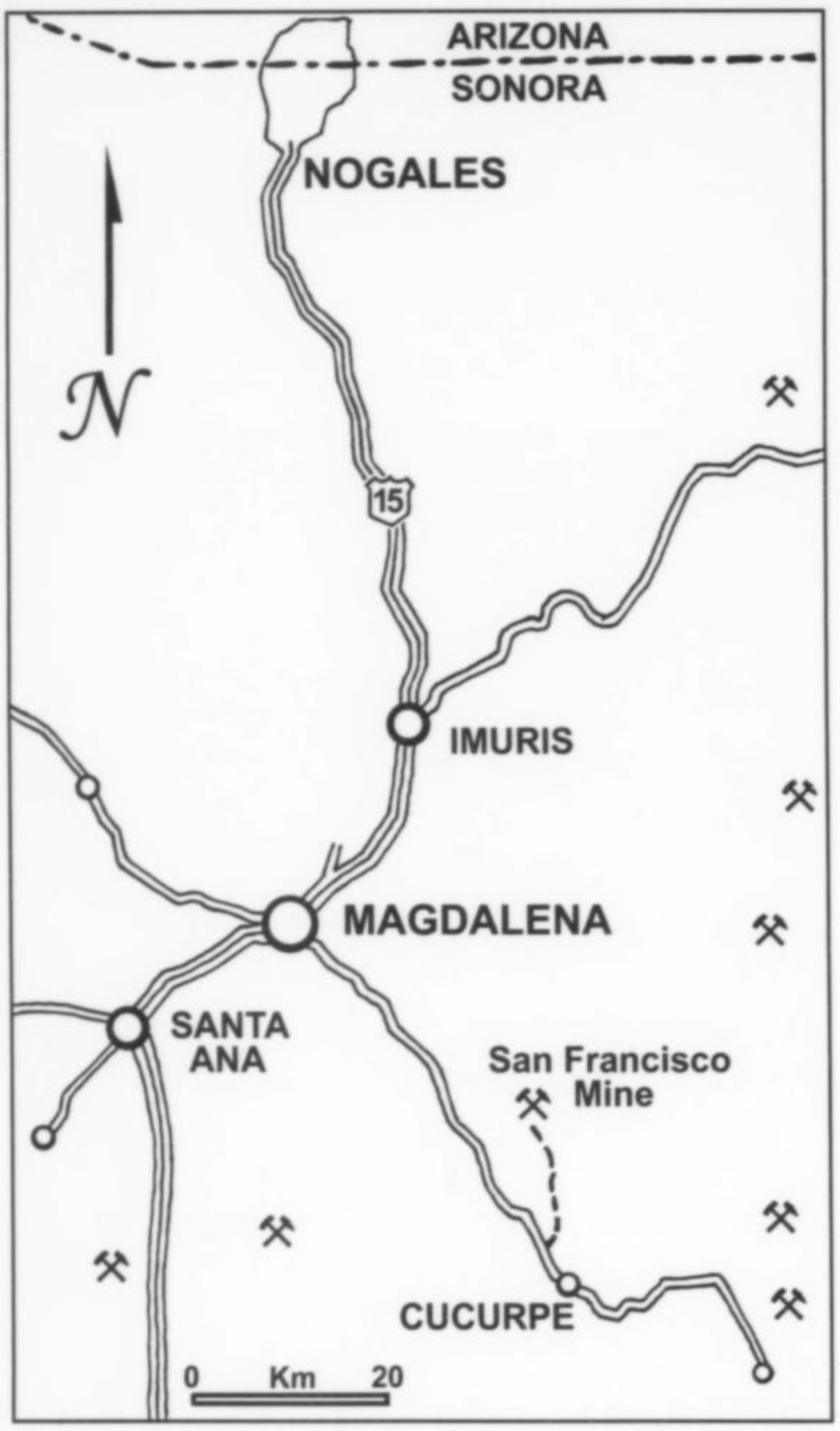


Figure 1. **Location map. The dirt road to the mine branches off to the north about 4–5 miles before Cucurpe and travels up a (usually) dry wash to the mine. Cerro Prieto (the hill in which the mine workings are located) is visible from a distance and looks rather like a volcano because of its conical shape and the excavations at the peak.**

major drainage and must be repaired after each flood; failing such reconstruction, only very tough vehicles can be expected to negotiate the final 12 km to the mine. The workings lie within the boundaries of Rancho Cerro Prieto, the proprietors of which (the members of the Trelles family) are hospitable to visitors (Megaw, 1995).

The climate, typically for the Sonoran Desert, is arid, with very high temperatures in the summer, although the elevation of about 1400 meters above sea level somewhat tempers the heat. Rainfall comes chiefly in the form of midsummer monsoon storms, sometimes intense enough to flash-erode adobe structures. In the early 1990's miners often had to spend many hours, following monsoon storms, refilling and reinforcing the erosion channels which had formed literally overnight on the outside walls of their bunkhouses and, once in awhile, on the inside walls as well.

This Sonoran terrain offers a bright, prickly beauty to those who can get past the sense of its eerie asceticism and its utter indifference to man. Giant saguaro cacti, agave, ocotillo, and mesquite and ironwood trees dominate the swells of the land. Fairly near Cucurpe and up a semi-camouflaged canyon of beige cliffs, there is a cave with Native American petroglyphs and paintings of stick-figure hunters stalking ocherous beasts. The more conspicuous fauna in and about the mining camp include gila monsters, scorpions, millipedes, giant toads, various species of mice and of the snakes who eat them, and a particularly repulsive species of black, inch-long, blood-sucking insect (Swoboda, 1994). During the hot months, legions of these latter creatures appear, creeping along bunkhouse walls after nightfall to feed silently on sleeping people (Ed Swoboda would sometimes lie awake to enjoy the satisfaction of ambushing them, switching the light on suddenly and sweeping the bugs alive into a glass trophy-jar).

In the old upper mine levels, where gold ore was mined around the turn of the 20th century, many hundreds of thousands of bats make their home. Swoboda (1994) writes that "the warm exhaust of ammoniated bat dung" rises powerfully from old tunnel openings on the hillside, and that there have been "cases in past years of miners and visitors contracting histoplasmosis after having spent time underground." To this day the deadly disease, caused by a fungus which thrives in bat guano, remains a threat to anyone who might venture into the mine (Peter Megaw, personal communication, 2004).

On the positive side, Swoboda (1994) used to enjoy watching the militant forays of bats during the summer months, when, at sundown, sinuous black columns would stream out of the tunnels near the ridgecrest, and ravens, buzzards and hawks would hover about the old glory hole in anticipation of bat-catch feasts. Each great hawk, talons extended, would plunge into the stream of bats and disappear in it, while the noise of thousands of beating bat wings would unfurl over the mining camp. On the following dawn the black stream would return, the bats converging in tight formation, with intricate coordinated braking maneuvers and vertical dives, and pour back into the mine tunnels.

HISTORY

Before 1970

At some time in the late 19th century, outcrops of the ore veins on and around the summit of Cerro Prieto were found to be rich enough in gold to constitute valuable ore, and by the turn of the 20th century the deposit was being worked by the Chenowith brothers of Nogales, Arizona. During this earliest mining operation the ore was taken from an open pit at the summit (today the rusty orange pit is starkly visible against the dark rock around it), and several adits were dug straight in from the upper parts of the hill's south slope. Around 1900 a 20-stamp amalgamation mill at the site was recovering gold and silver in the ranges of 15 grams/ton and 30–60 grams/ton respectively (AGS Report, 1991).

According to one source (AGS Report, 1991), the mine was purchased around 1904 by a Mr. Frank Cox, who, with engineer P. N. Moore, formed the Black Mountain Mining Company, which operated the mine until the Mexican Revolution of 1912 forced closure. Another source (Dominquez, 1980) has it that in 1906 the mine was purchased by the Cierro Prieto Gold Company (this organization perhaps is identical with the Black Mountain Mining Company: "Cerro Prieto," "Dark Hill," "Black Mountain"), which operated it until 1909 or 1910. Whatever the administrative facts may be, it seems clear that during the first decade of the 20th century the scale of mining expanded rapidly, and much ore was produced. By 1909 the "Sierra Prieta mine" was supplying a 100-stamp mill at the mining camp with substantial tonnages of ore per day (Panczner, 1987).

One report by an independent examining engineer on behalf of a

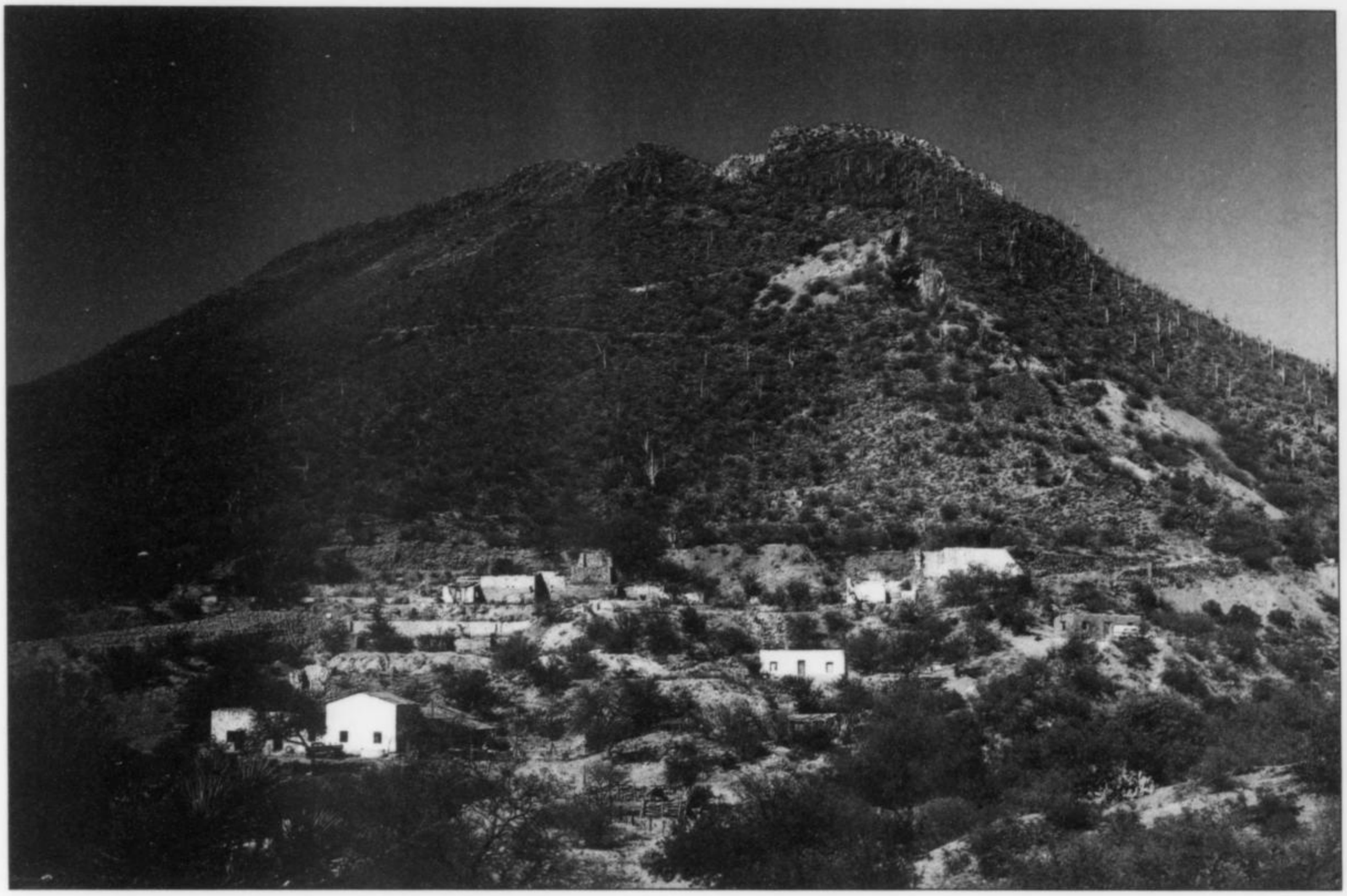


Figure 2. **Cerro Prieto, in which is located the San Francisco mine. Evidence of excavations is visible at the peak and down the mountainside, following the near-vertical trend of the vein. The ruins of mine buildings are visible in the foreground. Tony Potucek photo (1976).**

financial group from New York, dated May 31, 1909, affirms that by that year the mine workings had been "fully developed." By 1912, when the Mexican Revolution intervened, at least 80% of all accessible ore above the 800-foot-level adit had already been extracted (AGS Report, 1991). Just before closure, i.e. during the period 1910–1912, some prospecting work, including diamond drilling, by the Anaconda Company found that the gold content of the ore decreased rapidly below the 800-foot level, but that silver and molybdenum increased.

Anaconda returned to the property (albeit in only a tentative way) about two decades later, but during the First World War and the 1920's nothing whatever happened at Cerro Prieto—unless imagination sports with a rumor that "during the First World War some Englishmen attempted to make a commercial vanadium concentrate from the 1909 tailings" (Manning, 1969).

In 1934, at which time the mine was held by a concern called the Magdalena Gold Mining Company (AGS Report, 1991), two engineers from the Anaconda Company, V. D. Perry and R. B. Mulchay, surveyed the deposit and workings. Noting the decrease in the gold content of the ore with depth, they concluded that there was minimal potential for additional gold reserves, but that significant quantities of primary sulfide ores might lie at depth. At some time during the late 1930's or 1940's, Anaconda leased the mine and did some development work on the 1050-foot level, driving crosscuts into the hanging wall of the ore vein and diamond-drilling from the extremities of the cuts (Manning, 1969; Panczner, 1987). In 1948, Anaconda drilled three inclined holes from an underground station in search of the deep-seated primary sulfides, but failed to find them: the ore, it turned out, was oxidized to at least a depth of 520 meters (1700 feet). There was to be no resumption of serious ore mining by Anaconda, which in due course relinquished its lease on the mine (Panczner, 1987).

During the 1950's and 1960's the Cerro Prieto orebody was intermittently worked by small, local mining groups. When a Canadian company, Ramada Resources Ltd., sent consulting engineer L. J. Manning to examine the mine in the late 1960's, a work crew of six to eight men and a 22-ton cyanide mill were operating under the direction of Señor Pedro Trelles (Manning, 1969)—it will be remembered that the Trelles family today owns and operates the Rancho Cerro Prieto, which includes the surface over the mine. At least three more investigations for ore potential were conducted at the San Francisco mine since that by Manning for the Canadian company in 1969: reports were written by Willard B. Pye for the Devex Corporation in 1972 (Pye, 1972); by Evaristo Dominquez for the contemplated partnership of the Dravo and Peñoles corporations in 1980 (Dominquez, 1980); and by Peter Megaw of Imdex, Inc. for Minera Cascabel in 1994 (Megaw, 1995). Despite some notes of optimism in all of these reports, the fact remains that no ore mining on any significant scale at the San Francisco mine has taken place since 1912. Mining for wulfenite specimens, however, is quite another story. . . .

The 1970's

To peruse the company reports listed above is to note (with irony and with relief) how the presence of dramatic wulfenite crystal pockets passed below the radars of seekers after industrial ore—except, of course, for mineral collector/dealer Peter Megaw in

Figure 3. **A view of the surrounding scenery from the peak of Cerro Prieto (the scarp at left is part of the mine workings). Tony Potucek photo (1994).**

1994. Pye's 16-page report of 1972, for example, offers only two offhand sentences about crystal pockets, the more verbose of which is "There is a verbal report that a shaft a mile or more away has some underground workings and wulfenite crystals have come from them"—this at a time when Wayne Thompson and others were energetically taking out gorgeous, world-class wulfenite crystal groups by the thousands.

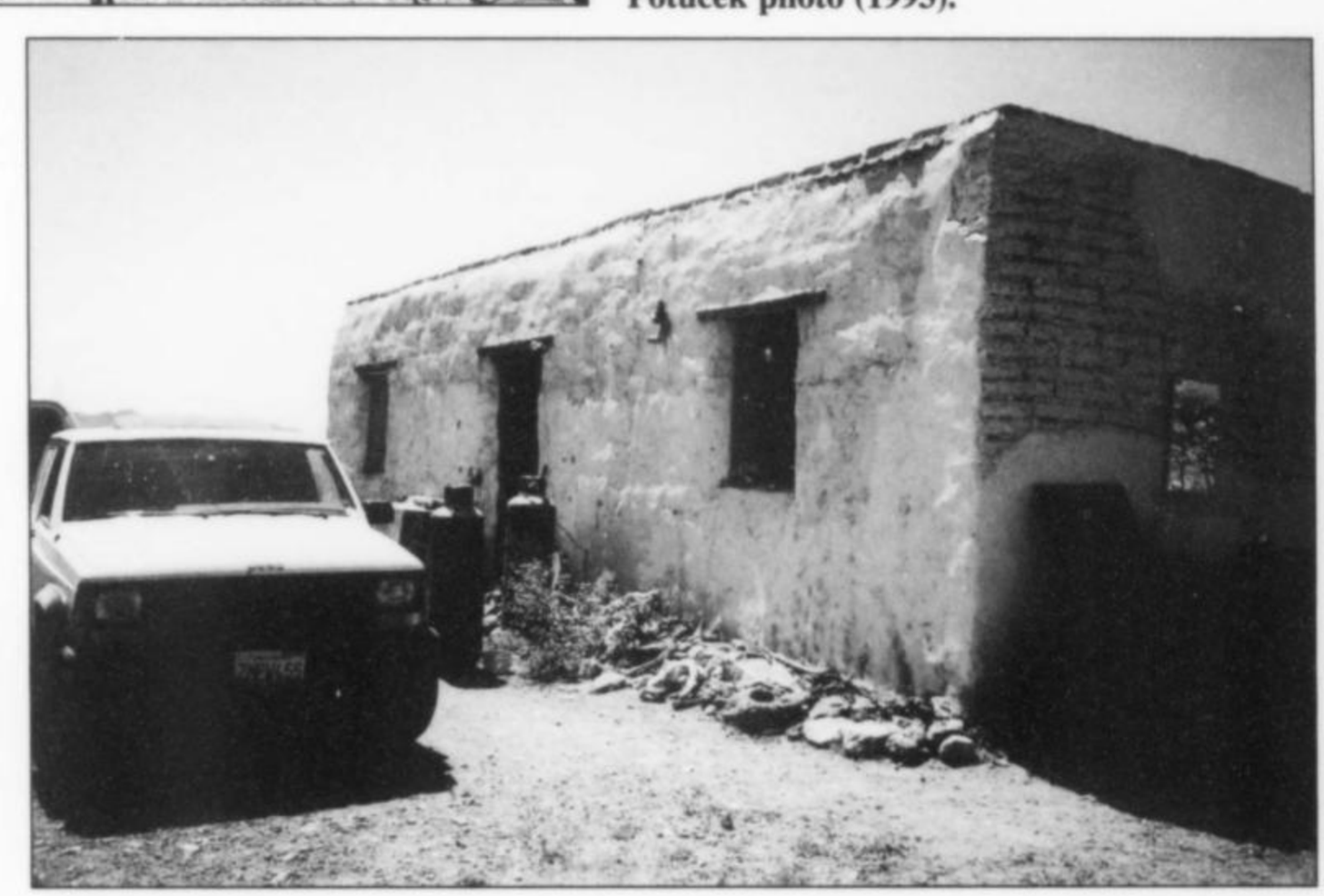
According to Manning (1969), the "earliest authoritative report" on the San Francisco mine, the one made for the New York investors' group in 1909, mentioned that "a coating of wulfenite on some of the minerals" had been noted during the sinking of the interior shaft (winze) from the 800-foot-level adit. Panczner (1987) writes that the occurrence of wulfenite had been recorded during the Anaconda effort of 1912, and that "large pockets of wulfenite in the mine's lower levels" were found by Anaconda workers during the 1930's. Panczner (1987) further notes that dark yellow tabular wulfenite crystals to 5 cm were found (he does not say when) in a few of the old gold stopes above the 800-foot level, and Swoboda (1994) refers to rumors of "fine pockets of wulfenite crystals [found] eighty or ninety years ago" in the mine's "lower areas." However, chasing these rumors, Swoboda (1994) found no real records of such specimens, either in old reports or in the memories of the few remaining old-timers around the mine. The occurrence, therefore, was exciting and entirely new to the mineral-collecting world when major specimens began to emerge in abundance in 1971 and 1972 (White, 1972; Bideaux, 1972, 1990).

The story of the bonanzas of wulfenite discovered during this period begins in the late 1960's, when Alfonso Miranda, a local second-generation miner whose father had worked underground at Cerro Prieto during the old gold-mining days, decided to visit the San Francisco mine and explore its underground workings (Swoboda, 1994). He walked down the 800-foot-level adit, came to the winze, climbed down its ladder to the 1000-foot level, and walked about 7 meters to a small drift that ended at the outer edge of the ore vein. Here the colorful altered rock, which contained much powdery black manganese oxide and much bright yellow massive wulfenite, piqued his curiosity. After a bit of inexpert digging in the yellow seam, Miranda came on a small pocket of brilliant wulfenite crystals, which he removed—and this was the first known "mining" of wulfenite crystals in the San Francisco mine (Swoboda, 1994). When Miranda later visited the nearby town of Santa Ana, he left one of the wulfenite specimens with a local ore buyer, Don Marco Serrato, to add to the little mineral collection that Serrato displayed in his office.

Soon Serrato had another visitor: an American expatriate named Joseph Korvirge, *aka*. José Cobre or "Copper Joe," who noticed the wulfenite specimen and asked where it had come from. Serrato obligingly told Copper Joe where Alfonso Miranda could be found, and within a short time Copper Joe, with his partner Bob James, were signing a six-month contract wherein the partners agreed to pay Miranda $1,000 per month for the privilege of mining for wulfenite. Copper Joe renewed the contract at each opportunity for the next several years, and thus he and his crew of eight to ten hired miners came to enjoy much wulfenite-digging in the San Francisco

Figure 4. **Entrance to the Swoboda-Thompson decline East Vein workings, 900 level of the San Francisco mine. Tony Potucek photo (1993).**

Figure 5. **Adobe building that still serves as the headquarters for collectors and miners working at the San Francisco mine. Tony Potucek photo (1993).**



mine. For those who care about the preservation of fine mineral specimens, however, the results of this contract could fairly be called calamitous.

Early on, Copper Joe and Bob James carried 20 to 30 flats (24-can beer boxes) of crystallized wulfenite to Tucson each week. But Joe had no knowledge of, and cared nothing about, the proper techniques for removing specimens damage-free, wanting only a guaranteed set price per flat of "ore," regardless of the contents' condition. The great majority of the wulfenite specimens delivered during this time suffered grossly from the kind of damage which comes from careless collecting and packing. Wayne Thompson (1976) harbors painful memories of having watched Copper Joe simply slam the lids down on flats in which wulfenite crystals projected above the surface, all but the smallest pieces being instantly ruined, with sickening crunches, while Copper Joe to all appearances remained indifferent. Moreover, as the collecting contract ran on, wulfenite pockets appeared less frequently, and the miners increasingly stole specimens to sell on their own.

Enter, early in 1971, Wayne Thompson—known today as one of the mineral world's premier dealers and prospectors, but at that time merely a senior geology major at Arizona State University. Thompson (1999) wrote:

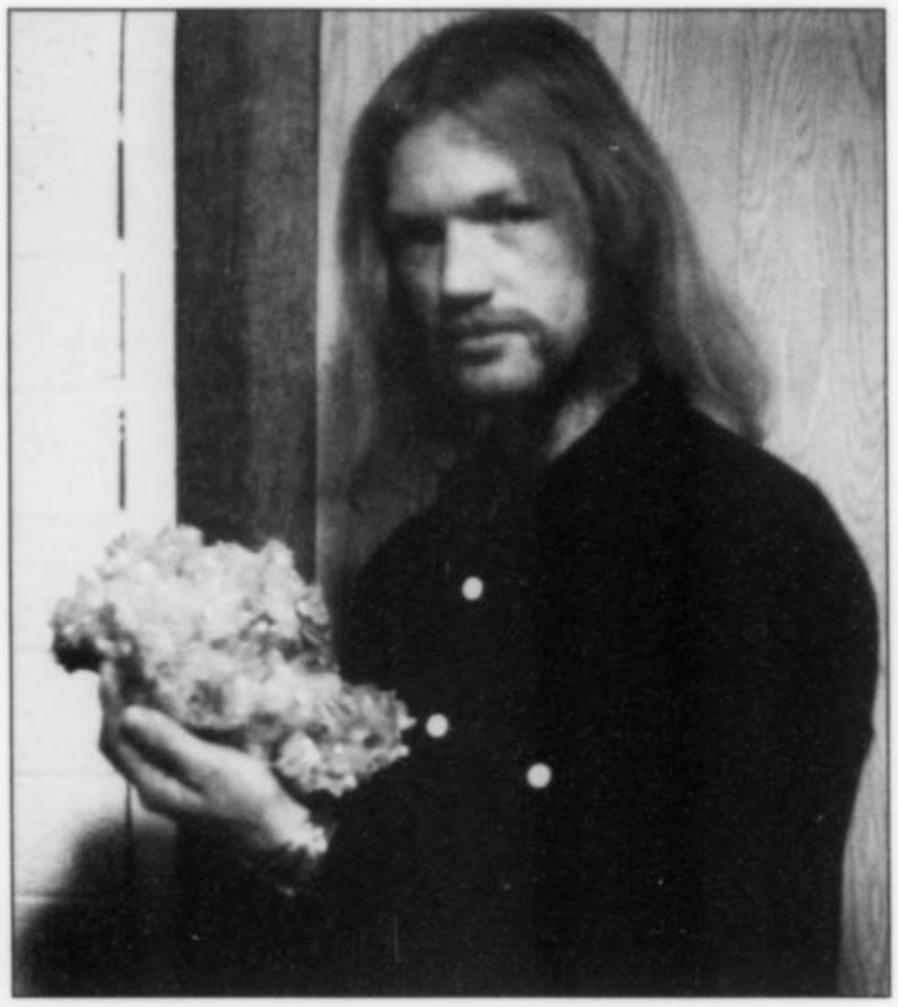


Figure 6. **Wayne Thompson in 1972 with one of the wulfenite specimens he had recently recovered at the San Francisco mine. Wendell Wilson photo.**

Figure 7. **Wayne Thompson at the 800-level portal to the San Francisco mine. Tony Potucek photo (1993).**

> Near the end of 1971 a couple of truck drivers, Bob James and José Cobre, showed up at some local Arizona shows with really crummy looking wulfenite from the San Francisco mine. At the Globe [Arizona] Show in early 1972, they had some much better material. Just before the 1972 Tucson Show they brought up an even better batch with nice yellow wulfenite crystals to a half inch on edge, with pale orange mimetite balls. I bought the entire lot and promised to buy whatever they mined. After the show, the material kept getting better and better.

In late March and again in early April of 1972, Thompson went to the mine to do some digging and collecting himself. During the March trip he explored the 1000-foot level and down to the pumping station on the 1050-foot level, where a 2-meter tank was installed in a small gallery cut from one side of the winze. In a narrow manway leading upward from the roof of the pumping station for about 15 meters he found his first, small wulfenite pockets. Shortly thereafter, out of a 60 cm-deep hole in the floor of the pumping station, he extracted several flats of specimens showing long, greenish, matted crystals of mimetite, with small wulfenite crystals. Encouraged, Thompson probed next at a point about 70 meters south of the shaft on the 1000-foot level, where a crosscut led to a vuggy area; here, from two spherical voids about 2 meters above the tunnel's roof, he collected lemon-yellow wulfenite crystals up to 5 cm across and displaying an unusual flattened-pyramidal habit.

But it was during his trip in the next month—April 1972—that Thompson broke into a pocket which would secure this locality's reputation as among the world's premier sources of high-quality wulfenite specimens. It would also change Wayne Thompson's life, as the experience of working in this great pocket made him resolve suddenly not to go back to school (he was two months shy of graduation), but instead to make mineral-specimen prospecting and dealing his career (Thompson, 1999):

> The source of the wulfenite was a rat hole overhead in the stope that climbed at about a 45-degree angle. Late one afternoon they set off a round [of dynamite]. Usually after that everybody would leave and come back in the morning. I didn't want to wait until the next day for the powder fumes to clear, so I got one or two of the miners to stay with me. The opening was really narrow, so I took off my hard hat, put my lamp in my mouth, and climbed the ladder, mucking things out as I went up. I was on the end rung of the ladder, poking around because everything was really loose, and this piece fell out into my hand. I couldn't look at it until I got to the foot of the ladder: then I saw that it was a specimen about 4 x 4 inches, covered with 2-inch transparent lemon-yellow wulfenite blades, with pale orange mimetite balls. At the time I thought it was the best wulfenite I had ever seen—certainly the best yellow wulfenite.
>
> After I got over the shock, I thought, "Well, maybe there's more up there," so I climbed the ladder and reached in again. By now I had made a small opening into what seemed to be a pocket. As I was pushing on my toes, to reach as far in as I could, this big piece fell in my hand, and then the top rung of the ladder that I was standing on snapped. I slid all the way down the ladder and ruined the wulfenite.
>
> I flipped the ladder upside down, so as to have a rung at the top, and climbed back up again. I shined my lamp into the

hole and saw a cavity 6 or 7 feet long, 3 feet wide, and about 5 or 6 feet high. It was completely lined with lemon-yellow crystals and pale orange balls, and there were a few crystals up to 3.5 inches on edge. This was the first big pocket.

I stayed down there and, together with my cousin David Netherlin and some miners, dug out the pocket. In the next three or four days we took out about one hundred flats that were super, which I then sold to Walt Lidstrom and Bill Larson, among others. The material was scattered all over the country within a few months.

This was a spot on the 1000-foot level—a "rathole" stope in a continuation of the same large wulfenite seam that Thompson had already worked farther down.

The rest of the story of Thompson's first phase of major involvement at Cerro Prieto is less upbeat. He had already concluded an agreement to buy out Bob James' share in the collecting partnership with Copper Joe, and part of this agreement was that he would drive James around northern Mexico in search of other minerals (especially turquoise) to mine. Although the extent of the wulfenite pocket zone just broken into had not yet been fully revealed by mid-April 1972, Thompson at that time took James off on one of these scouting trips, as per agreement. They were gone four days, while Copper Joe and his miners were left in charge of exploring for further wulfenite pockets. As Thompson told the story to Wendell Wilson (1976):

> I thought I could be gone four days and be right here again when the pocket really opened up. Well, while I was off with Bob looking for turquoise, I remember it was a Thursday night, I got this incredibly heavy feeling that said "get back to the mine!" Bob squawked, but we drove all the way from the Rio Sonora, an eight-hour drive.
>
> [When we arrived] Joe denied at first that they'd found anything at all, but when I got back into the mine they were just cleaning out the last of the pocket. This narrow seam had gone in about two feet and just "balled out" to an opening three feet wide. The thing had been blasted and worked so fast that its floor was covered with three or four inches of broken crystals that crunched like broken glass. I pulled out a handful of the broken stuff that I kept a few years. It was total destruction, man. One piece they had taken out was a magnificent group with two big broken areas, palm prints, on the sides, where they'd broken off crystals so they could pull the thing off the wall.

Thompson secured for himself the last two or three flats of remains then being packed up, and salvaged nine further flats of fairly good specimens. From these and from the look of the carpet of crystal corpses, he inferred that the original pocket had been completely lined with gemmy orange wulfenite crystals to 7 or 8 cm on edge, their surfaces decorated with bright red mimetite crystals.

Still worse followed: when Thompson returned from a routine supply run to Tucson, he found that Copper Joe had renegotiated the collecting contract and had managed to deal Thompson out of the partnership altogether. The wulfenite pockets, as it turned out, were to be left to Copper Joe's miners for about another four years. Wayne Thompson's involvement with the San Francisco mine was not over, but the greatest of all known pockets from this mine was yet—soon—to come, and he would not be there to deliver it carefully and professionally to the light.

Discoveries on and around the mine's 1050-foot level continued through the rest of 1972 and into 1973. One pocket produced attractive cauliflower-like masses of yellow-orange mimetite upon which are scattered golden yellow wulfenite crystals to about 1.2 cm (Swoboda, 1994); this is probably the pocket which produced the specimen pictured (in black and white) in John White's "What's New in Minerals" column that same year (White, 1972). In May 1973, another good pocket produced large plates of wulfenite crystals, with some individuals reaching 15 cm, and with red mimetite crystals attached. Most of the specimens from this pocket display slight to very severe etching, and their luster is relatively dull; this lot of specimens was purchased by Suzie Davis, a Tucson mineral dealer of the time (Thompson, 1976; Bideaux, 1990). The contents of still another significant pocket were purchased by Tucson dealer Gene Schlepp: the wulfenite crystals are pale orange and reach 3 mm thick (Swoboda, 1994). There was also a "black wulfenite" pocket, a walk-in one about 2 meters long whose walls were lined with wulfenite crystals blackened by inclusions of manganese oxides (Thompson, 1976).

What is probably the finest wulfenite pocket ever found in the mine was discovered in May 1973, in a crosscut on the 1000 level, 75 meters south of the interior shaft (actually its precise location is uncertain, but this is the best guess of both Wayne Thompson, 1976, and Ed Swoboda, 1994). Thompson, as already noted, had worked this part of the wulfenite vein several months earlier, but had found his pockets by digging upwards from the roof of the tunnel; this time, Copper Joe's mining crew was digging a 6-meter hole in the floor, and in that way they broke into a narrow pocket measuring about 30 cm wide by 1 x 2 meters and containing some of the best wulfenite specimens known from anywhere in the world. Traditionally it is called the "Red Pocket," from the fiery red color of its exceptional crystals and spherules of mimetite, the latter reaching 2 cm in diameter. The wulfenite crystals themselves reach 9 cm and are yellow-orange to amber, lustrous, and transparent. Only Copper Joe and his miners ever collected from the Red Pocket, which fact, for reasons made clear by now, is unfortunate. Speaking to Wendell Wilson of the Red Pocket, Thompson (1976) said:

> Nobody was there except Joe and his miners, and they butchered it. I'd say about 25 pieces came out of that pocket mostly undamaged, and they were heavy-duty, but at least ten times that many were ruined. I got one of the really good ones. There were two others that really were the best, and the Arizona-Sonora Desert Museum got one of them, but the other one that was even better was one of the butchered specimens. It would have been a $25,000 specimen [this in 1976 prices—Ed.]; it had deep amber-orange three-and-a-half-inch crystals, probably 30 of them, and deep red six-sided mimetite barrels hanging on everywhere. What a specimen it would have been if they'd only taken it out carefully, but only three or so of the 30 wulfenite crystals didn't have any damage; the rest were beat to hell.

During the glory times of the early 1970's, a number of prominent American mineral people paid visits to the San Francisco mine. Ed Swoboda, who 20 years later would succeed Wayne Thompson as chief San Francisco wulfenite miner, briefly considered a mining venture in 1971. The peerless Arizona specimen-prospector Dick Jones once told Thompson "I wouldn't touch that mine; you want it, you've got it . . . ," but two months later complained that Thompson had shut him out of the action (Thompson, 1976). Gene Schlepp, Richard Bideaux, Tony Potucek and others collected in the mine, and Potucek did some important mapping of the mine workings. But when, in 1976, Copper Joe at last relinquished his collecting contract, it was the mineral-dealing Van Scriver family (then headquartered in Phoenix) who took over wulfenite mining for a brief time. The late Curt Van Scriver signed

a one-year lease on the mine, and soon, needing capital, took in John Whitmire as a partner.

Sometime in 1976, Curt Van Scriver's mining crew entered a very large pocket in the mine and saw to it that, this time, essentially all the contents came out in largely undamaged condition—Van Scriver having wisely insisted that only he, and not the miners, actually remove specimens from the pocket. Brilliant, delicate crystal clusters of all sizes displaying fine yellow wulfenite "windows" to 5 cm on edge (many also with the familiar orange mimetite spherules) were offered at the 1976 Detroit Show (Wilson, 1977). This pocket occurred about 45 meters south of the shaft on the 1050 level (Swoboda, 1994).

In mid-1977, problems concerning the legal claims to the mine were discovered; Curt Van Scriver and John Whitmire had a falling-out, and Van Scriver left. Whitmire and his wife Rosa took on Ruben Rodriguez, a competent Mexican mine owner, as a partner, and the legal problems were resolved.

The last significant specimen-mining effort to take place during the 1970's was short-lived but modestly successful. A new lease was granted to a new partnership: Fred Libby (one of the participants in the Van Scriver project), mineral dealer John Seibel and Bill Panczner (author of *Minerals of Mexico*). With the help of a Mexican mining crew fluctuating between 7 and 10 men, these partners began serious mining in November 1976, and over the next five months they recovered thousands of wulfenite specimens ranging in size from miniature to large cabinet and in quality from average to superb. The team worked almost all the way down to the water table, securing about 700 flats of wulfenite. In the Desert Inn during in Tucson Show in 1977 John Seibel marketed the pick of the lot. Because of various problems the project ended in March 1977 (John Seibel, personal communication, 2004)—but not before proving that there were many more crystal pockets waiting to be discovered around the base of the winze and between the 1000 and 1100 levels.

And yet the 1980's were to prove a fallow period. In 1981, Wayne Thompson, Mike New and Richard Bideaux leased the property from the Whitmire/Gonzales partnership, but had to agree to the condition that no ore carrying values in silver could be removed from the mine. In truth the wulfenite vein is enriched in silver, and the underground workings already were so crammed with the wastes from the 1970's mining that there was not enough space to allow major new mining to be conducted *unless* large quantities of rock were taken out of the mine. The collecting group's lease therefore was abandoned. When, in 1993, the Swoboda mining team drove their new adit back into the area of the Van Scriver workings of 1976–1977, they found that a considerable amount of further cross-cutting and digging for pockets had been done there by someone—but there seems to be no record of the identities of these (no doubt unauthorized) diggers. Despite the apparent highgrading that took place, it is likely that between 1977 and 1991 nothing stirred at the San Francisco mine except, of course, winging and skittering fauna.

The 1990's

Late in 1990, Wayne Thompson, James Horner and Ed Swoboda signed a five-year mining contract with the partnership of Rosa Whitmire (John Whitmire had died in 1989) and Ruben Rodriguez. The mining camp was to be set up, and mining operations directed, by Ed Swoboda, with the help of his son Bryan, while Thompson would furnish coordination from the U.S. (and would eventually, it was hoped, market the wulfenite specimens to be found); operating capital was supplied by all three partners. Ed and Bryan Swoboda, with a Mexican mining crew that consisted alternately of two or three men, and with much help and cooperation from various hands at Rancho Cerro Prieto, had set up a camp by midsummer 1991 and, after many mechanical and bureaucratic setbacks, had brought down essential mining and support equipment. The crucial question was how, exactly, to reach the wulfenite-producing area.

Clearly the target area was the vuggy part of the ore vein where it was intersected by earlier mine workings near the base of the winze, on and around the 1050 level. All known major wulfenite pockets of past years had been found in this area—and who knew what waited in unopened parts of the vuggy ore vein where it dipped into the 1050 level and then continued to dip, below that level and to the north, as far as the water table? Before his death, John Whitmire had thought of reaching this target area simply by moving equipment in through the existing haulage adit on the 800-foot level and clearing out the mine wastes which were clogging the winze and blocking access to the 1050 and 1100-foot levels. However, Swoboda's team soon found that rubble from rockslides and an extraordinary tonnage of mine waste were blocking large stretches of the 800-level adit also, and that, more ominously, the bat colony had taken over the adit, introducing the threat of histoplasmosis.

Reconnoitering outside the mine, Bryan Swoboda came upon the portal of another old adit which emerged on the south hillside about 30 meters below the 800-foot-level portal; this "ninth level" opening had been dug by someone, sometime, for only about 30 meters into the mountain (and human refuse at its opening testified that someone once had lived in it). Ed Swoboda, projecting a line between this portal and the wulfenite target zone at the bottom of the winze, found himself contemplating the trace of a brand-new decline which would run for about 460 meters, at an incline of about 10°, from hillside opening to target area. Constructing this new working, he reasoned, would eliminate the need to clear out the old workings, would avoid the bat colony, and, most tantalizingly, would let the crew come at the wulfenite area from a new angle—probably from underneath—and thus enhance their chances of finding fresh pocket zones.

Ed Swoboda has written an extensive, previously unpublished account of the mining project, from which I will quote liberally from now on. The excerpt below, concerning the early days of driving the new tunnel, will perhaps catch the mood during the opening phase of the work:

> The first 30 meters in from the portal was the most time-consuming period. I had mistakenly assumed that we would derive more of an advantage from the existing tunnel, but a combination of poorly performing equipment and poorly placed drill holes made by local miners we had hired who didn't really know their job, forced us to repeat over and over again the same labor until we finally got it right.
>
> The front loader was still so listless (after a recent major repair) that even when working properly it could only shovel up loose waste from the tunnel floor. It not only wasn't working properly, but the miners were not creating loose waste by their method of blasting. Time and again the bucket would hang up on a rocky projection and all meaningful work would cease until somebody leveled the floor so the loader could continue. The machine operator was unfamiliar with this model of front loader, and he hadn't acquired the knack of maintaining our tunnel at a ten percent decline. It was our learning period, and every time we turned around, something else went wrong. . . .
>
> I had given a lot of thought to the vertical range within which we may encounter wulfenite crystals and to where within this range the better pockets will be found. A major impact on this study could be, as I am hoping, a factor that is brought out on an old cross-section map of the lower levels. It

Figure 8. **The late Curt Van Scriver (left), who operated the mine for specimens with John Whitmire in 1976–1977, with Marcie Greenberg and Brad Van Scriver. The ruins of some of the abandoned mine equipment at the surface are remarkably intact. Tony Potucek photo (1976).**

Figure 9. **The remains of a five-stamp mill near the San Francisco mine. Tony Potucek photo (1993).**

shows a 350-foot high-grade zone encompassing the wulfenite vein, a mineral-rich oreshoot that courses downward to the south at an angle to include . . . the locations of all the major wulfenite finds of the last twenty years. To my knowledge, little heed has been paid to the geological features of the underground by the wulfenite miners. After all, the existing tunnels that led to the digging areas were squirrel holes dug some 30 or 40 feet this way or that. . . . Our venture is quite different. We may end up digging 1,500 or 2,000 feet of tunnel or more just following out our mining program, a very time-consuming and costly endeavor. We would like to think that most of that digging will be in a meaningful direction.

By mid-May 1991, a rudimentary production schedule had been established, many logistical puzzles and technical hurdles had been put behind them, and more of the working time each day could go into advancing the tunnel. About 60 meters in, they constructed their first loading ramp, where waste could be transferred from the front loader to a diesel scoot which would take it out of the mine; a decision was made to build these ramps at 61-meter (200-foot) intervals from then on. At about 75 meters, what was showing at the tunnel face was a banded mixture of soft gray mud, vuggy quartzite, varicolored clays, black manganese oxide, and fractured, mineralized rock in shades of bright ocher with mimetite and wulfenite smears, and "one little vug contained a 6-mm golden yellow wulfenite that made my heart start to pump a little stronger."

By November 1991 the tunnel had reached the 140-meter mark. Swoboda drove home to Los Angeles to spend Thanksgiving with his family, but more equipment broke down in his absence, and he was back at the mine at the beginning of December. Just past the 150-meter mark the work entered a wide part of the vein too soft and crumbly to sustain the tunnel, so they veered to the west, still drifting northward.

Figure 10. **Underground entrance to the area mined by Curt Van Scriver and John Whitmire. Tony Potucek photo (1993).**

Figure 11. **Wulfenite and mimetite lining the walls of one of the major wulfenite pockets (1075 level). The crystals measure up to about 1 inch, and the mimetite has a salmon color characteristic of this pocket. Tony Potucek photo (1994).**

The near-vertical vein on its northward-bearing strike, which we are paralleling with our tunnel, most likely forms a juncture with the other steeply dipping vein that can be seen in the old upper workings, and the convergence is probably somewhere in our vicinity. A sharp, well-defined slickenside clearly separates the vein from the country rock, forming the smooth east wall of our tunnel. Somewhere up ahead the single vein we are now following should divide into the two veins that occupy the old workings, the east vein of gold and silver fame and the west vein that presently consumes our interest because of its wulfenite potential.

In March 1992, Wayne Thompson visited with two geologist friends, Les Presmyk and Tony Potucek (John Lucking was along as well), and the little team spent two days mapping underground workings. They concluded that the inclined tunnel, now 165 meters in from the portal, should contact the southernmost end of the workings on the 1000 level in another 140 meters.

By mid-June they had reached the 237-meter mark, and Swoboda calculated that:

> If our projected twelve-percent decline in the tunnel is maintained, we should be only five or ten feet at most above the old tenth-level tunnel on up ahead where the fine wulfenite crystal pockets were dug out both from above and below the tenth level.

Then, after just one more round of shots, they encountered their first real pocket of mineral specimens. These unfortunately did not include wulfenite, but bright yellow spherules of mimetite coated the walls of the little vug in an even layer about two millimeters thick; nearby, in the zone of jumbled rock fragments, other pieces of rock also showed coatings of mimetite spherules. "They are bright yellow, to their credit, and to my eyes, hungering for the sight of crystal specimens, they look awfully good."

By the end of July 1992, with the tunnel approaching the 277-meter mark, they were again encountering the loose, friable material of the mineralized vein. For the first time, large amounts of amethyst were encountered in the vein: violet, tightly folded veinlets up to 5 cm thick growing from translucent granular quartz infused sparingly with thin yellow bands of mimetite. The stalk-like amethyst prisms were crammed tightly together, and few crystal terminations were visible. A vein of reddish mud dipping in from the west made for hard going, since when mixed with lubricant water the mud created a glutinous substance that encased the steel bit, clogged the hole and jammed the drill. But:

> The mimetite pocket that we passed under . . . makes me want to believe, as does the large amount of amethyst we are passing through, that this vein we are accompanying will turn out to be the wulfenite vein. The old Van Scriver workings up ahead, where a major amount of wulfenite was encountered, was preceded by the uncovering of large amounts of amethyst. . . .

As the old workings were approached, Ed Swoboda and his miner, Miguel, devised a system whereby the "aim" of the tunnel could be adjusted. Miguel would walk down the 800-level adit, climb the old ladder down the interior shaft, and hammer on some solid part of the southern end of the 1000-level tunnel, Swoboda meanwhile hammering in answer from the working face of the new tunnel. Repeated signaling of this kind showed them that the new tunnel was farther to the west than they had been calculating, but that they were somewhere between 15 and 25 meters from breaking through to the old workings, although they were still not sure how close they were to the richest wulfenite-bearing zone. Swoboda decided to keep digging the new tunnel on a decline rather than to try to go upwards to meet and use the old 1000-foot level; perhaps being beneath the old workings would allow them to find major pockets of crystals which had not been reached before.

Around Thanksgiving 1992, some side-digging for the construction of yet another loading ramp unexpectedly broke through to an old working ahead and above. The 1000-foot level was now accessible from the tunnel face. The collecting areas where Wayne Thompson and Curt Van Scriver had worked in the 1970's turned out to be an extensive maze enlarged by someone else's more recent workings:

> Curt's locale seems to be the most worked over. It is now a labyrinth of twisted passageways starting mostly from a common center, a twenty by thirty-foot room connected to the [1000-level] tunnel by a fifty-foot cross tunnel. A hand-operated winch in this room services descending workings on the vein to at least thirty feet below the floor level. Side tunnels lead out from the room as on a hub, penetrating the vertical vein at all angles above and below the room level for distances of forty, fifty and sixty feet, forming a network of distorted spokes exploring the vein.

On December 1, 1992, at a distance of 336 meters from the portal, they hit their first real wulfenite pocket. It was about 20 meters back from the end of the tunnel, where the miners had been excavating for a loading ramp. When they broke through a layer of soft dirt and altered vein matter to come up into the pocket floor, they thought at first that they had made another breakthrough into an old working. But shattered wulfenite crystals, along with other dislodged vein material, littered the floor, and further solution flow had given birth to little rosettes of second-generation wulfenite crystals, bright lemon-yellow to brown, perched on and growing out of the remnants of first-generation crystals; other rosettes occurred as floaters in the same rubble.

> Careful hand-sifting . . . in the floor of the pocket produced hundreds of the little lemon-yellow wulfenite rosette floaters averaging a half-inch in size and rarely exceeding an inch in diameter. Occasionally, an attachment of one of these little complex crystals upon a mound of dark orange mimetite-coated rock was uncovered, forming an attractive thumbnail-sized matrix specimen. . . . The total yield of this pocket filled only a handful of flats of mostly low-value specimens of wulfenite and mimetite. . . .

The pace of the hunt can now be felt, in Swoboda's journal, as quickening: they were in pocket country. Swoboda made sure that the welded iron entryway gate would be kept securely shut at all times—both when the mine was working and when it was not—and went home to join his family for Christmas, 1992.

While he was still in California, a phone call from Alfonso Miranda (now one of the miners employed by the project) informed him that while the tunnel was being curved to the west to meet up with the wulfenite-rich area now visible in the adjacent old workings, a watercourse had been intercepted, and it was full of crystal pockets. Back at the mine in the first week of January, 1993, Swoboda mounted a ladder to gaze into a 7-meter-high cavern above his head, where tiny wulfenite crystals by the thousands were scintillating in the light from his lamp. But the larger crystals were an unattractive, muddy yellowish brown, and severely corroded; the only real specimen value here came in the form of more of the little yellow rosettes. Alfonso remembered having found similar rosettes years before, in a section of mediocre pockets above the tenth level. The Mexican miners, he said, had called them "orejas de raton"—rat ears.

The tunnel excavation was now being made to meander about, to keep within the major wulfenite vein.

> Our tunnel . . . will make a full 180-degree curve . . . and then head back to the north. By making this zigzag, [the tunnel] stands to gain twenty-five precious feet of vertical distance directly below our incoming tunnel above us. A costly but necessary procedure for the depth we seek.

By this strategy, they repeatedly intersected the vein, repeatedly coming on small wulfenite pockets—but still, for months yet, no jackpot pockets appeared. At one point near the western edge of the wulfenite vein's footwall they came upon a 10-cm veinlet of opaque, massive cream-colored cerussite with galena remnants in its central portions.

Late in July, 1993, Wayne Thompson came down with Bob Johnson (who, years later, would open a great pocket at the Red Cloud mine), and they found that Swoboda had saved a few promising-looking, small wulfenite pockets for them to dig out. From the same crosscut, at about this time, other pockets produced about five flats of specimens with lemon-yellow wulfenite crystals associated with black manganese oxides. At the end of July there appeared:

> . . . another half flat of matrix specimens from a soft hole of powdery black manganese in the roof at the end of our tunnel. The wulfenites [measure] $^1/_2$ of an inch on an edge and are very thin and transparent. They are delicately arranged on a thin base of orange mimetite and are the nicest specimens we have found so far.

For the rest of 1993, as the tunnel continued to zigzag, and small side adits explored the mineralized area, many wulfenite pockets of middling significance came to light. On September 7 they broke into a huge watercourse pocket completely lined with subhedral barite crystals for a distance of 3 meters above the roof of the main tunnel and at least 5 meters below its floor. In the manganese-oxide-rich veins between massive blocks of limestone in this area, wulfenite "teaser" vugs were plentiful:

> Peering into these brilliant little vugs, some up to ten and twelve inches in length, is a special joy. One gaping mouth-shaped vug, full of scintillating crystals, even had two evenly spaced rectangular incisors growing downward from the roof, with whistle space between them.

Each vug was carefully hand-collected, and each seemed to point the way to more. The tunnel was meanwhile proceeding on its irregular course, looping from side to side and still inclining downward, from a level almost directly below the major wulfenite workings of 20 years past. The wulfenite/manganese veins threading through the limestone produced specimens of several varieties: some of the wulfenite crystals were bright yellow, some orange, some drab olive-colored from included matter, and orange mimetite spherules and white, scraggly barite crystals were everywhere. One pocket was found to be lined with tangerine-colored mimetite

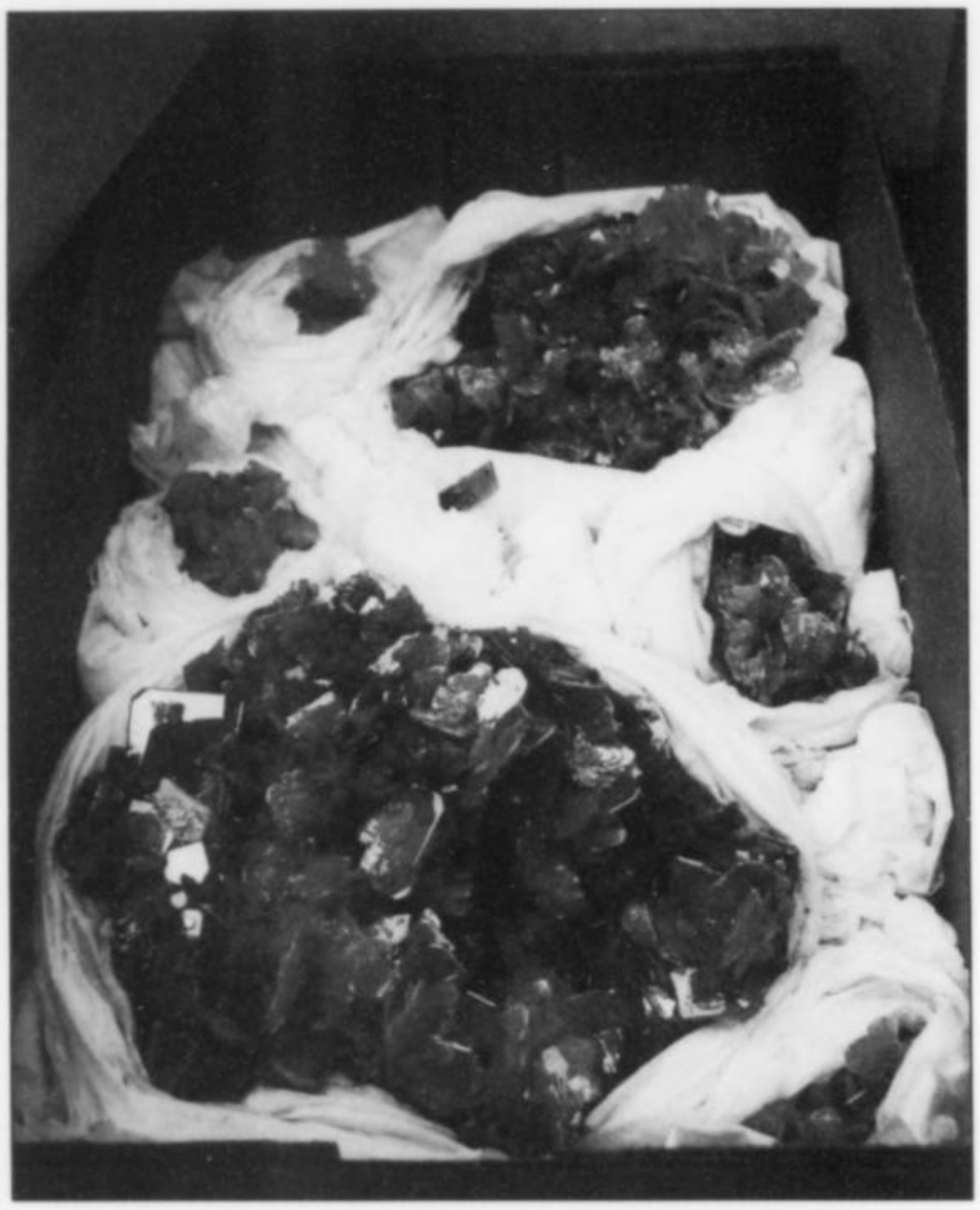


Figure 12. **A beautiful sight: a flat packet full of fine, just-collected wulfenite specimens in 1994. Tony Potucek photo.**

showing hexagonal cast-like forms, this material comprising matrix for 2-cm, transparent wulfenite crystals of a very attractive dark orange color.

By late January 1994, the main tunnel's face was 572 meters from the portal and 17 vertical meters lower—well below the deepest of the old workings. The tunnel having been turned again to the south, its end had reached a point 12+ meters below the famous "Red Pocket." Swoboda decided to turn again to the north, and soon they were entering a region of yellow wulfenite veinlets coursing through the powdery black manganese oxide and fractured siliceous rock. Cautiously, the miners dug by hand into the soft material. After 60 cm or so, a 25-cm pocket of bright yellow wulfenite crystals was uncovered at shoulder height. The vuggy vein seemed to be enlarging downward, so a pit was dug in the floor of the tunnel, just on the edge of the downward trend of the vein. Swoboda got down into the little pit and struck his pick into the crumbly vein rock a few centimeters below the exposed pocket:

> By chance the first blow pried away a four-inch piece of rock with wulfenite crystals attached on the inner side that exposed a window opening into another pocket of wulfenite that extended for twelve or fifteen inches. The cavity was completely lined with crystals, some over an inch and a half on an edge, and their overall color was remarkable . . . generous sprinklings of mounds of deep reddish orange mimetite coated one side of most of the luscious transparent golden window-like crystals. With great care I removed some of the altered gangue rock that covered the pocket, and was soon carrying on a spirited conversation with myself and the elements as specimen after specimen of beautifully crystallized dark orange wulfenite surrendered to my finely honed pocket-digging tools. . . .

Aware that each colorful piece that I removed was contributing its share to the dissolution of the many aggravations of this mining project, I began to associate each specimen as it came out with [an] equivalent portion of the more than three years spent at this property. With each specimen I handed upward to my daughter for careful wrapping and storage, I would call out "two weeks," "two months," or in the case of a very few, "a year" or "a year and a half." Time just flew by unnoticed, and emerging at a later hour from the underground, we discovered to our surprise, Sumiya and I, that we had been completely absorbed in the dismantling of a pocket of major importance during a space of more than eight hours.

This wondrous vuggy vein descended steeply, and small intersecting veins yielded more fine specimens over the next few weeks of work. On the 3-meter-long floor of the descending trench, four separate channels were revealed, all coursing downward, each showing crystals. Three distinct specimen types were collected: transparent golden "windows" which had grown separately on beautiful bright orange mounds of mimetite; solid masses of transparent wulfenite crystals without mimetite; and golden 2.5-cm "window" crystals closely packed in parallel, like playing cards, with mimetite spherules to 6 mm between them.

A system was devised for following the descending vein. Swoboda directed his miners to cut a meter-wide groove in the nearly vertical wall of the pit, then position a sturdy ladder which would descend at a 45-degree angle over and past the descending streams of crystals. Meanwhile, the main tunnel was redirected to pass to one side of this pocket-digging shaft, continuing its progress north; by March 12, 1994, the tunnel had advanced another 20 meters, and the downward-plunging crystal "pit" had been lowered another meter.

Climbing down the ladder to the bottom of the pit, Swoboda began digging in its side wall, and almost immediately his pick broke through into a pocket:

> Cleaning away the loose and occasional rock provided an opening that I shone the miner's lamp into. My what a sight! One-half and three-quarter-inch clear wulfenite windows perched on salmon-pink mounds of mimetite covered the whole interior of a maze of passageways, ample enough to gingerly insert my total forearm into, where fingers transmitted the sensation of multiple hidden crystals packing the walls. Further probing revealed that the crystal-covered passageways continued downward, which signaled greater things to come.

Swoboda decided to take a short break before collecting out the new pocket zone, in order to secure a video camera with which to capture the image of the crystals in place. On March 16, Swoboda and his daughter were back at the site with plenty of knockdown boxes and wrapping paper, and their preliminary reconnaissance underground turned into five hours of collecting. They enlarged the opening to the pocket in the side wall of the descending vein, and then could not stop themselves from taking out about seven flats of specimens of golden wulfenite "windows" on coral-pink mimetite. At some time in the past, they noticed, parts of the walls and roof of the pocket had fallen in, so that shattered, 2.5-cm-wide wulfenite crystals now littered the floor, and an alluvial fan of soft black material had coursed downward from other pockets above. And not more than 60 cm below, the water table was lying in wait for them in the form of a still little pool: they were just 5 meters above the flooded 1100 level of the old workings.

Then there was the job of cleaning out the side pocket:

It will take at least four more days to systematically deplete the pocket contents. . . . After the miners had removed the waste from my Thursday's digging activity on the approach to the pocket, Sumiya and I went back underground with newly charged miners' lamps and a tempting array of foodstuffs, selected and prepared by Sumiya. Six hours of intensive specimen removal and packing netted us some exceptional wulfenites. I was now able to insert half my body within the pocket, and by lying on a thick slab of foam rubber, could face up, down or sideways in order to methodically remove segment after segment of the crystal-covered walls. Sumiya was cloistered in a very uncomfortable space directly over the pocket in a thin little ledge that formed the roof . . . close enough above me to receive each delicate piece from my outstretched arm.

Simultaneously and only a few meters away, Wayne Thompson and Gene Meieran were opening a meter-long vug which yielded a few dozen superb specimens of golden yellow wulfenite crystals on orange mimetite. And a few days later, now working 5 meters below the level of the main tunnel, the miners encountered a cavern measuring 1.2 x 2 x 4 meters, its walls and roof covered with glistening snow-white, skeletal barite crystals. Many of the barite individuals reach or exceed 4 cm, and some are perched on lustrous golden wulfenite crystals. The lower third of the space of this little cave was submerged in a tranquil pond of clear water, marking the water table. Shining the mining lamps down into the water revealed open veins with bright, golden wulfenite crystals, still descending. ("We may have to resort to scuba gear!")

Swoboda, Thompson, Graham Sutton and Stan Esbenshade collected their way through the cavern, taking wulfenite/barite specimens from the roof and walls where they could be reached, until, by May 18, Swoboda found himself lying prone on planks laid over the still pool, reaching down into the water as far as he could to try to pluck out sunken treasure . . . .

> . . . stirring up sediment as my fingers explored for crystal specimens. Two hours of shoulder-deep probing . . . produced three flats of wulfenite specimens, all with the snow-white rosettes of crystallized barite, three of which displayed some spectacular wulfenite crystals of an elegant deep reddish orange.

Meanwhile the main tunnel, above, was turned to head south at an incline, directly toward the new crystal cave. About 10 meters from that goal, the tunnel's course was leveled off to keep it just centimeters above the water table. Soon enough it broke through to the cave's far end, providing for the easy removal of waste. Thompson, Sutton, Esbenshade and Swoboda removed hundreds of specimens from the cave, taking the last of them from a very porous vein structure near the point where the main tunnel had broken through.

Recounting his final days in the workings, Swoboda described lying prone in a pit which kept being filled by water which gushed from below. His arm fully extended under the water, he could feel the tepid flow coming up from deeper parts of the pocket system—and his fingertips still felt the edges of wulfenite crystals. "Underground pumping will now become one of our major priorities. If all works out, we intend to pursue the underwater vein structure to the maximum depth that some soon-to-be-installed more efficient pumps will allow us to descend."

At this point, Ed Swoboda left the mine. But Graham Sutton was soon employed in installing pumps and pipes to remove the upwelling water. Wulfenite-digging then proceeded for about another 10 meters. By now, however, the ground was tightening, the pockets were getting sparser, and the water-soaked region which was now above them seemed worrisomely unstable. Wayne Thompson reports (personal communication, 2004) that by the time the decision was made finally to shut down operations, the workings had reached a level about 3 meters lower than the projected extension of the 1100 level. This, at last, was the terminal point of the collecting effort.

WORKINGS

The San Francisco ore deposit is small and simple, as are the workings that have exploited it. A fault-related shear zone, shot through by totally oxidized polymetallic ores, strikes roughly north-south, cropping out on the Cerro Prieto ridgetop, with outlying veins also showing at points along the hillside. The early mining for gold took place on the topmost levels, creating the present glory hole. The mineralized veins dip very steeply (between 80° and 90°) to the east, and are intersected inside the mountain by eight parallel mine adits, now all long disused (some are caved). The portals to these adits are spaced at intervals of 30.7 meters (100 feet) up the slope of the mountain.

Much of the gold ore was mined by block-caving and channeled down to an 825 meter-long access and haulage tunnel at the 800-foot level; this major adit runs horizontally into the mine from its portal on the mountain's south slope. A 210-meter-long tunnel 60 meters below the 800-foot-level adit and parallel to it, on the 1000-foot level, is not accessed by any surface portal: the 1000-foot level is reached only via a winze which descends from a point about 370 meters inward on the 800-level haulage adit. The winze has three compartments, and penetrates below the 1000-foot level—to the 1050-foot level, just above the water table, where many wulfenite pockets were found, and even to the 1100-foot level, now below the water table.

When the mine was active, a pumping station existed at the winze's bottom, providing access to crosscuts on the 1100-foot level; in later decades, however, water filled the shaft to just below the 1050-foot level (Pye, 1972; Panczner, 1987). Between the 800 and 1050 levels and around the winze, a system of crosscuts and drifts was dug during the early period, and a few more during the 1930's and 1940's, to follow the ore. Later, many more honeycombed workings were dug in the area, chiefly during the 1970's and early 1990's, to search for wulfenite pockets.

The lowermost adit enters almost at the base of the hillside, its portal marked by a 5000-ton waste dump: this is the decline dug between 1991 and 1994 by Ed Swoboda's wulfenite-mining team. It does not run parallel to the earlier workings but inclines downward at about 10°, following the hanging wall of the vein system and taking corkscrew turns near its end, at last reaching below the 1050-foot level near the base of the old interior shaft.

Shortly after the wulfenite miners left in 1994, a portion of the old 800-foot-level adit collapsed near its portal (Megaw, 1995). The mine is only very questionably of any further industrial value, but mining for wulfenite specimens may at some time again be feasible, especially if strong pumps are utilized.

GEOLOGY

Mineralization at Cerro Prieto occurs irregularly in a shear zone, 20 to 30 meters wide, which runs along the western flank of the mountain. The shear zone is a product of a major, complex fault that cuts lightly metamorphosed shales, arkoses and limestones of the Lower Cretaceous-age Bisbee Group and overlying Lower Tertiary andesite and basalt flows and rhyolite-dacite ash-flow tuffs. The stratified sediments and volcanic rocks have a general strike of N60–70°E, and dip 30–40° NW, whereas the shear zone

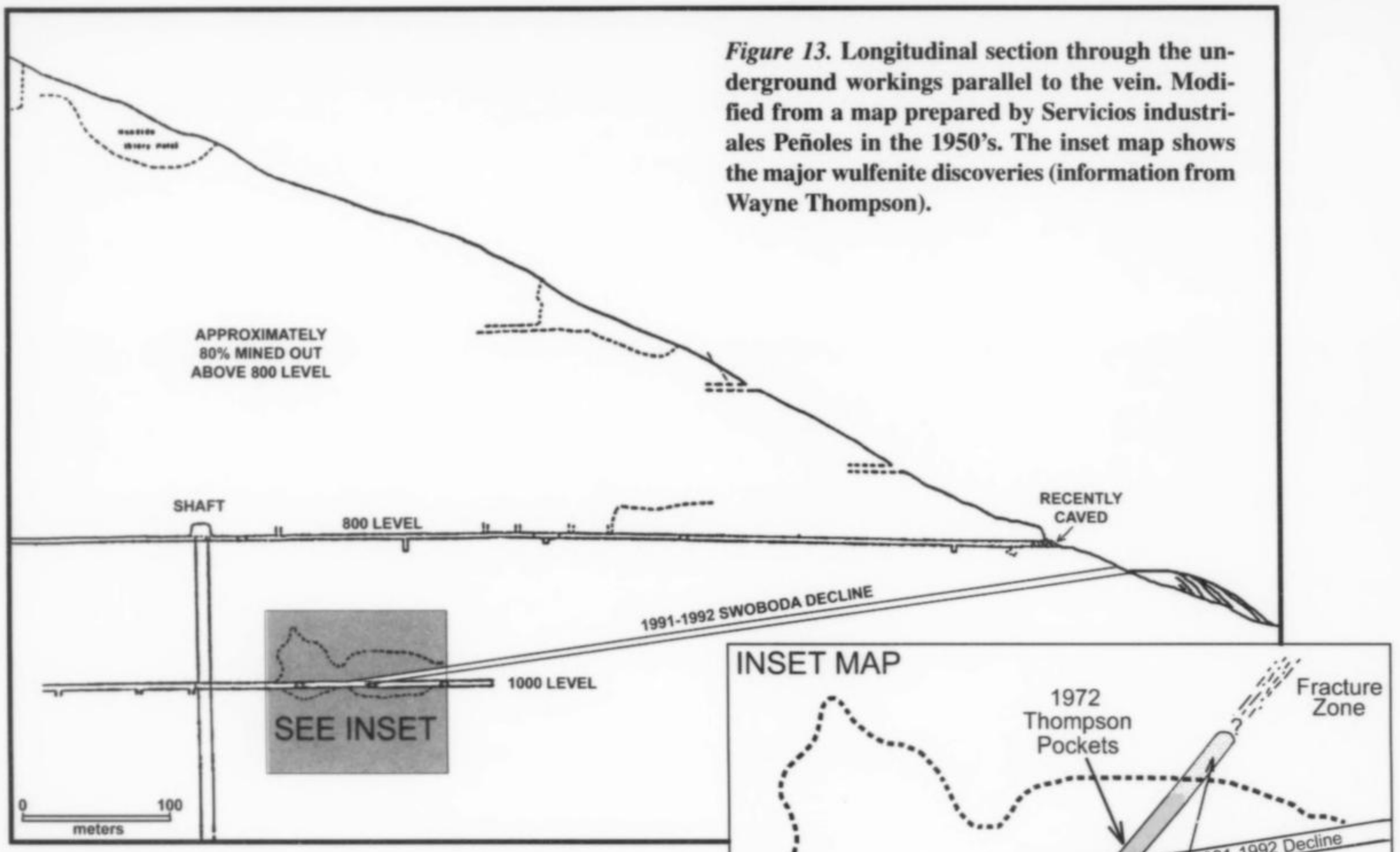


Figure 13. **Longitudinal section through the underground workings parallel to the vein. Modified from a map prepared by Servicios industriales Peñoles in the 1950's. The inset map shows the major wulfenite discoveries (information from Wayne Thompson).**

has an almost perpendicular overall strike of N27°W, and dips 80–90° to the east. Intermediate igneous dikes occur along the margins of the shear zone at a few places near the mine, and exploration drilling below the lowermost mine workings by the Anaconda Company in 1948 encountered a granite body of unknown dimensions. This granite is inferred to be the source of the Mo, Au, Ag, Pb, Zn and As-bearing hydrothermal fluids that deposited the primary orebodies.

Within the shear zone are numerous individual fault strands which vary considerably in strike and dip. Wherever an individual fault strand twisted or steepened, a highly porous and permeable breccia zone formed. Averaging 3 to 4 meters wide but of limited longitudinal continuity, these breccia zones were excellent sites for mineralization, so that gradually, with the entry of hydrothermal fluids, a series of irregularly distributed, lenticular orebodies developed, overlapping each other or being arrayed *en echelon*. The orebodies are composed of angular wall rock fragments partly cemented by fine-grained quartz (amethystine in some cases), specular hematite, calcite, dolomite and barite. Pods, stringers and irregular patches of galena, sphalerite and pyrite occur sporadically in the veins; at one place the tunneling project of the 1990's encountered a massive vein of cerussite.

The metallic sulfides once present have oxidized to a variety of secondary minerals with finely dispersed native gold. It was this oxidation that made what was originally an erratic, relatively poorly mineralized system economically attractive (Peter Megaw, personal communication, 2004). Native gold liberated by oxidation of the sulfides was concentrated in the upper parts of the shear zone, to become the focus of early mining activity near the peak of Cerro Prieto. Later, mining attention shifted to the auriferous and argentiferous oxidized lead ores. Gold and silver grades drop quickly below the 800 level, while Pb, Zn and Mo increase. The low precious-metal grades and the irregularity of the base-metal mineralization make future mining of the deposit unlikely.

MINERALS

The San Francisco mine is in effect a one-mineral-species locality: even the small, brilliant mimetite crystals and spherules and the white barite crystals are notable only for playing effective supporting roles in wulfenite crystal specimens. The totally oxidized ore of the veins is mineralogically uninteresting except where wulfenite pockets occur in brecciated zones enriched in manganese oxides. Occasional veins of quartz harbor only crude amethyst "points" which struggle for expression in too-narrow openings. Thus the very short list, below, of species of collector interest.

Barite $BaSO_4$

Bladed barite crystals in sheaf-shaped aggregates to 4 cm occur in watercourse veins; they are colorless to milky white, not highly lustrous, and are stained, in many cases, by non-removable coatings of black manganese oxides. Almost all specimen-quality barite crystals were found below the water table: these are the snow-white, lustrous crystals found with the wulfenite of the "cave" in the lowermost level. These barite crystals are compound and somewhat feathery, but create a beautiful color contrast with the yellow/orange wulfenite crystals on which they have grown. The barite, having formed later than the wulfenite, completely covers it in some specimens, but the two species also compose beautiful "combination" pieces to more than 35 cm.

Figure 14. **Wulfenite crystals covering an 18.5-cm matrix, from the San Francisco mine. Wayne Thompson specimen, now in the Francis Benjamin collection; Jeff Scovil photo.**

Cerussite $PbCO_3$

Massive cerussite and "sand cerussite" are common in oxidized lead deposits and often constitute a portion of the ore, though these forms have no collector value. In 1977 John Seibel and Bill Panczner worked the mine extensively for several months and encountered so much ore-grade cerussite that they considered mining it commercially to help defray costs. They also found small crystal specimens periodically (John Seibel, personal communication). Ed Swoboda collected a number of small cerussite V-twins, reticulated twins and sharp sixlings to 1 cm on "rotten" galena from small voids within the veins. The cerussite crystals range from colorless and gemmy to milky white. The best specimens are small thumbnails, while the majority consists of very fine large micromounts.

Gold Au

John Seibel (personal communication) reports that nice amethyst specimens were recovered in 1977, some of them containing visible wires and flecks of native gold. These were mostly highgraded by the miners. Wulfenite was also found containing flecks of native gold in and on the crystals.

Mimetite $Pb_5(AsO_4)_3Cl$

Sharp, well individualized, slightly convex barrel-shaped crystals of mimetite to 1 cm, fiery orange-red and highly lustrous, were found with the wulfenite of the "Red Pocket" of 1973, but otherwise mimetite occurs in the San Francisco mine as spherules from 1 mm to 1 cm in diameter. The spherules range in color from mustard-yellow through yellow-orange, coral-pink, red-orange, and red, and in most cases they show a satiny sheen on the surface. In 1976–1977 the Libby/Seibel/Panczner team found beautiful red-orange botryoidal mimetite specimens which lack wulfenite and

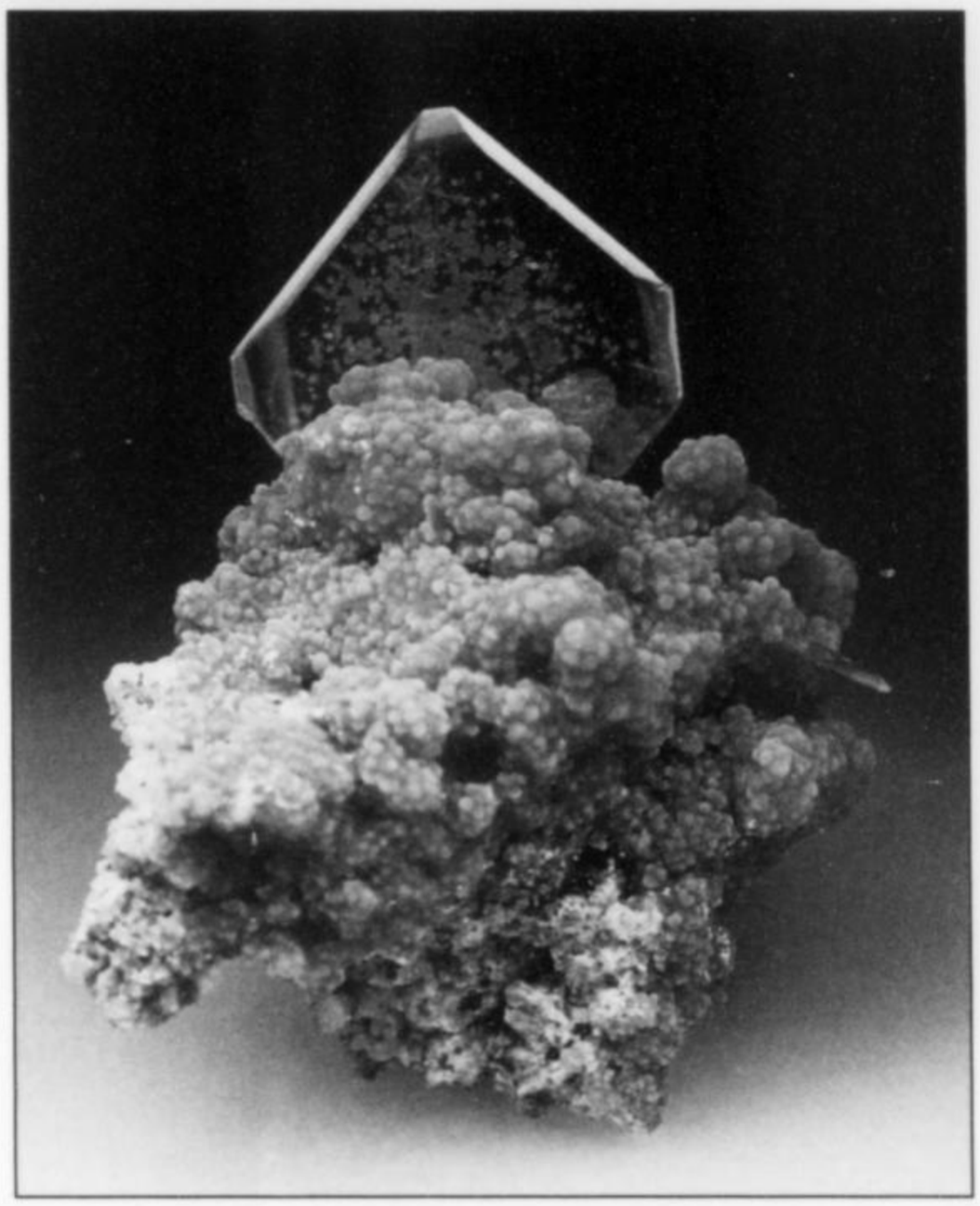


Figure 15. **Wulfenite crystal on mimetite-coated matrix, 5.1 cm, from the San Francisco mine. Wayne Thompson specimen; Jeff Scovil photo.**

which (except for the color) strongly resemble the famous mimetite from San Pedro de Corralitos, Chihuahua (about which see the article in this issue). Continuous intergrowths of mimetite spherules can form botryoidal coatings on rock matrix or on wulfenite

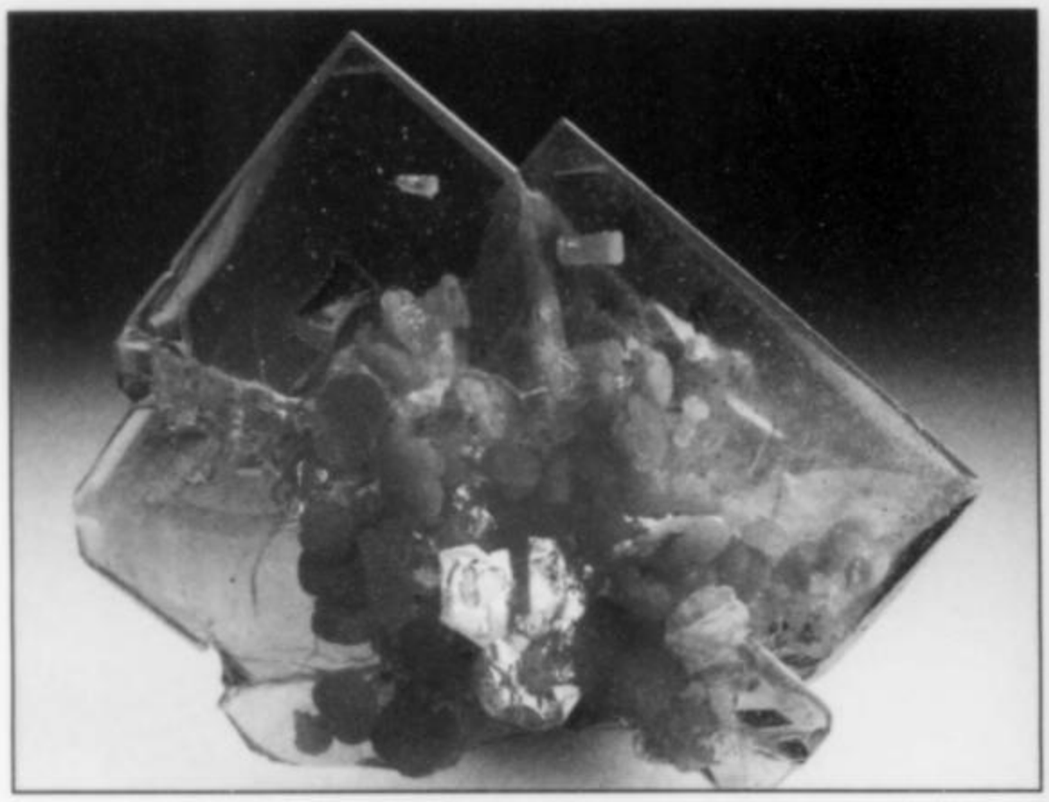


Figure 16. **Wulfenite crystal with orange mimetite, 6.8 cm, from the San Francisco mine. Kristalle specimen; Wendell Wilson photo.**

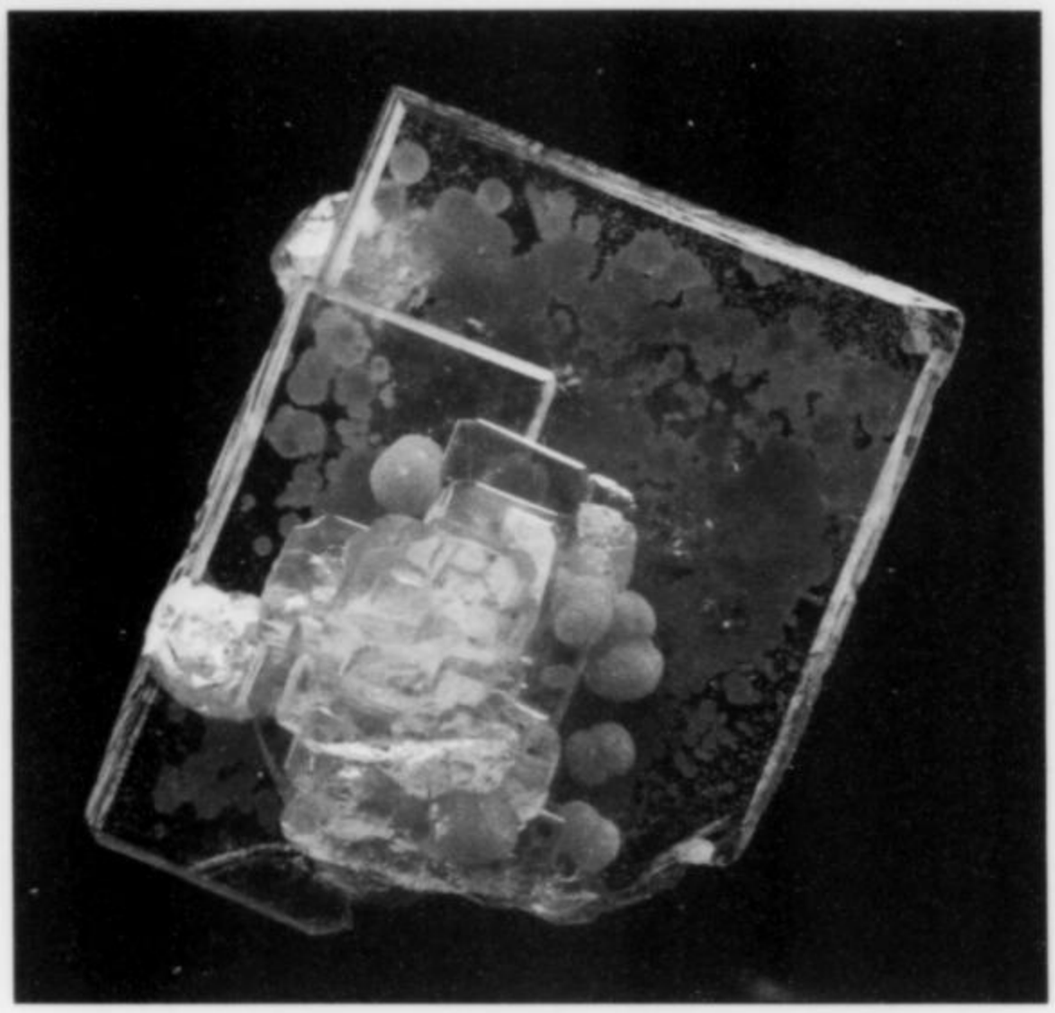


Figure 17. **Wulfenite crystal with orange mimetite, 3.2 cm, from the San Francisco mine. Shirley Fiske collection; Jeff Scovil photo.**

Figure 18. **Wulfenite crystals to 2 cm on mimetite, from the San Francisco mine. Wayne Thompson specimen; photographed by Wendell Wilson in 1972.**

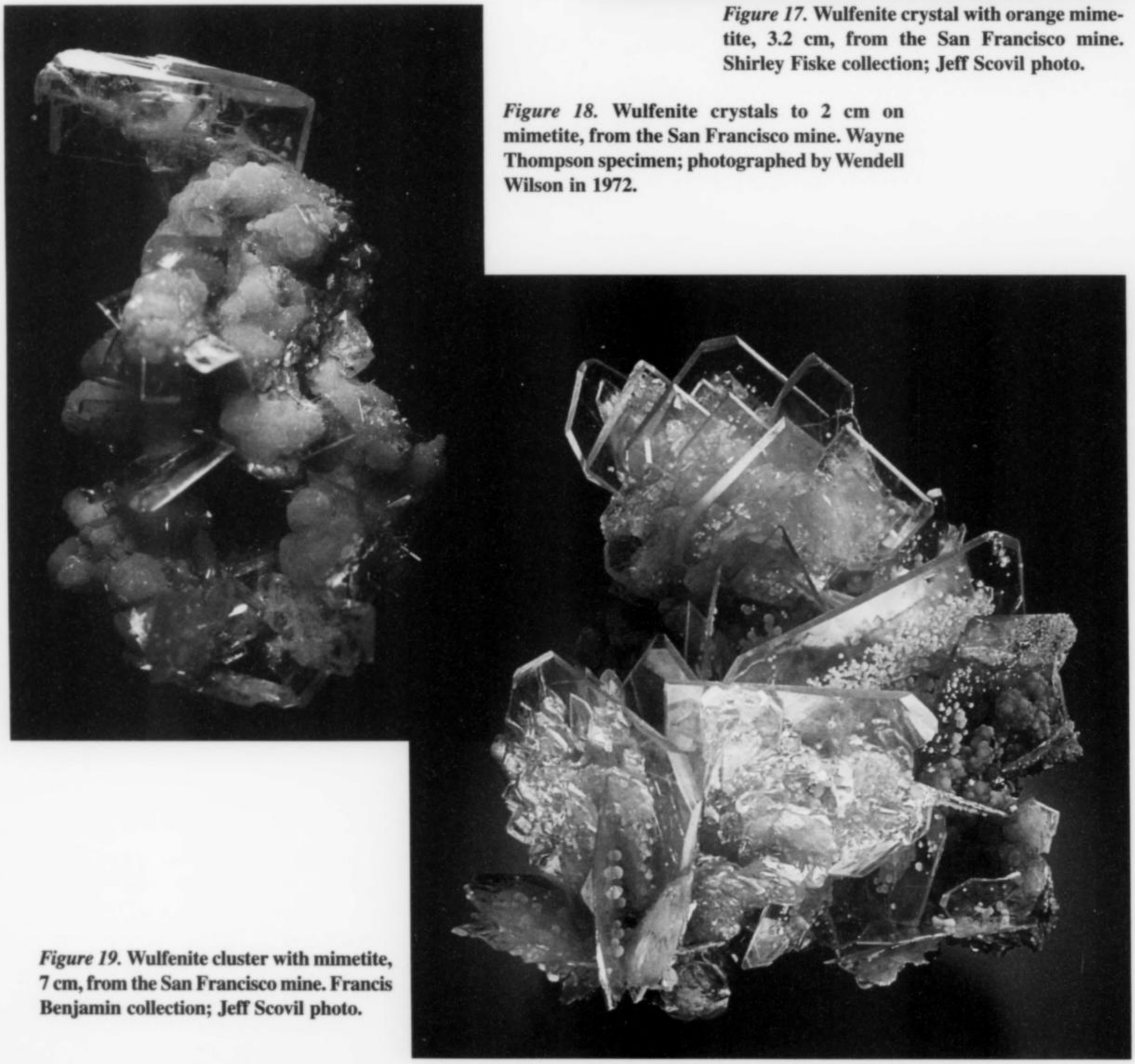


Figure 19. **Wulfenite cluster with mimetite, 7 cm, from the San Francisco mine. Francis Benjamin collection; Jeff Scovil photo.**

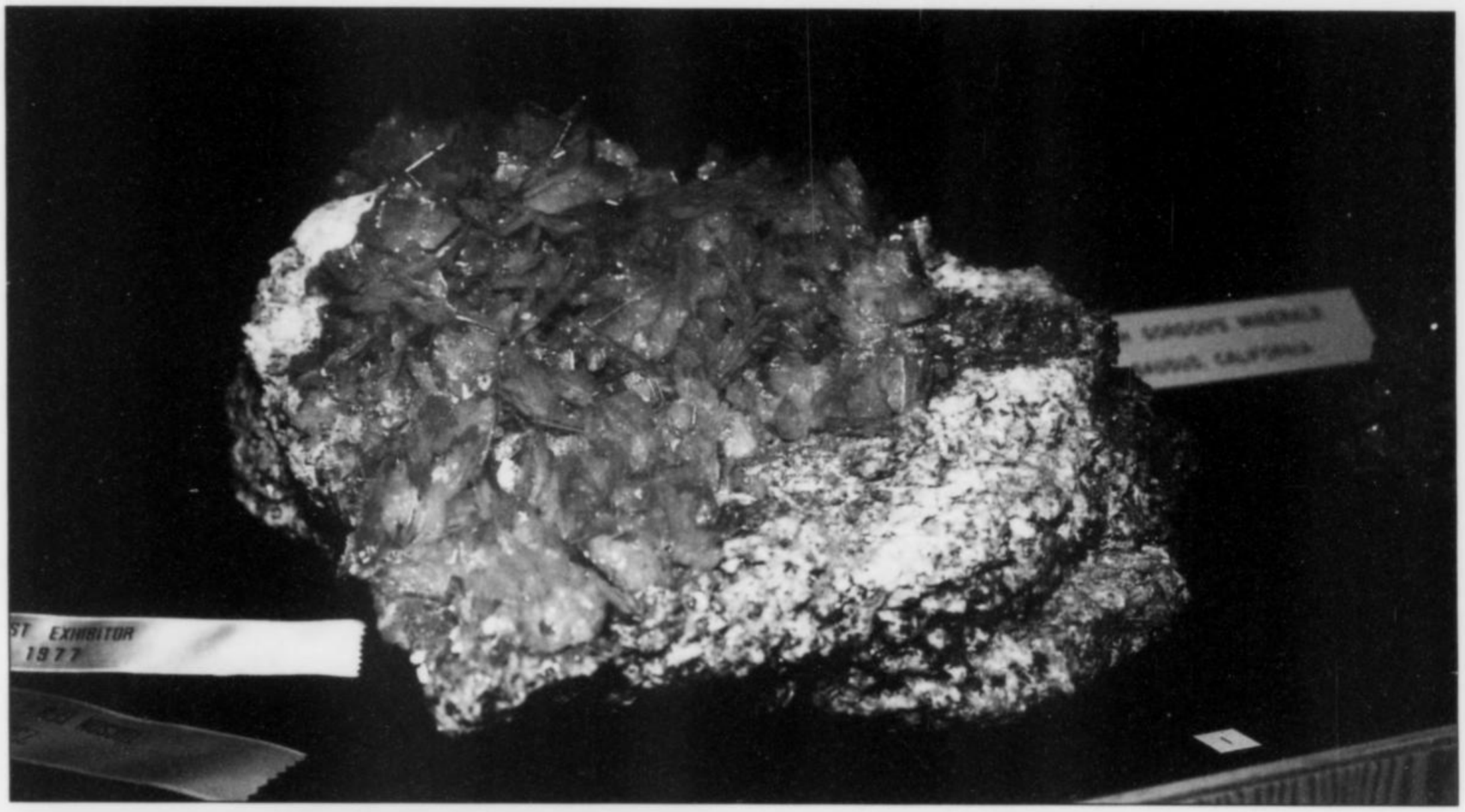


Figure 20. **Large cluster of wulfenite crystals on matrix over 30 cm across, mined by Curt Van Scriver and exhibited in the case of his grandmother, mineral dealer Beth Gordon, at the 1977 Detroit Gem and Mineral Show. Wendell Wilson photo.**

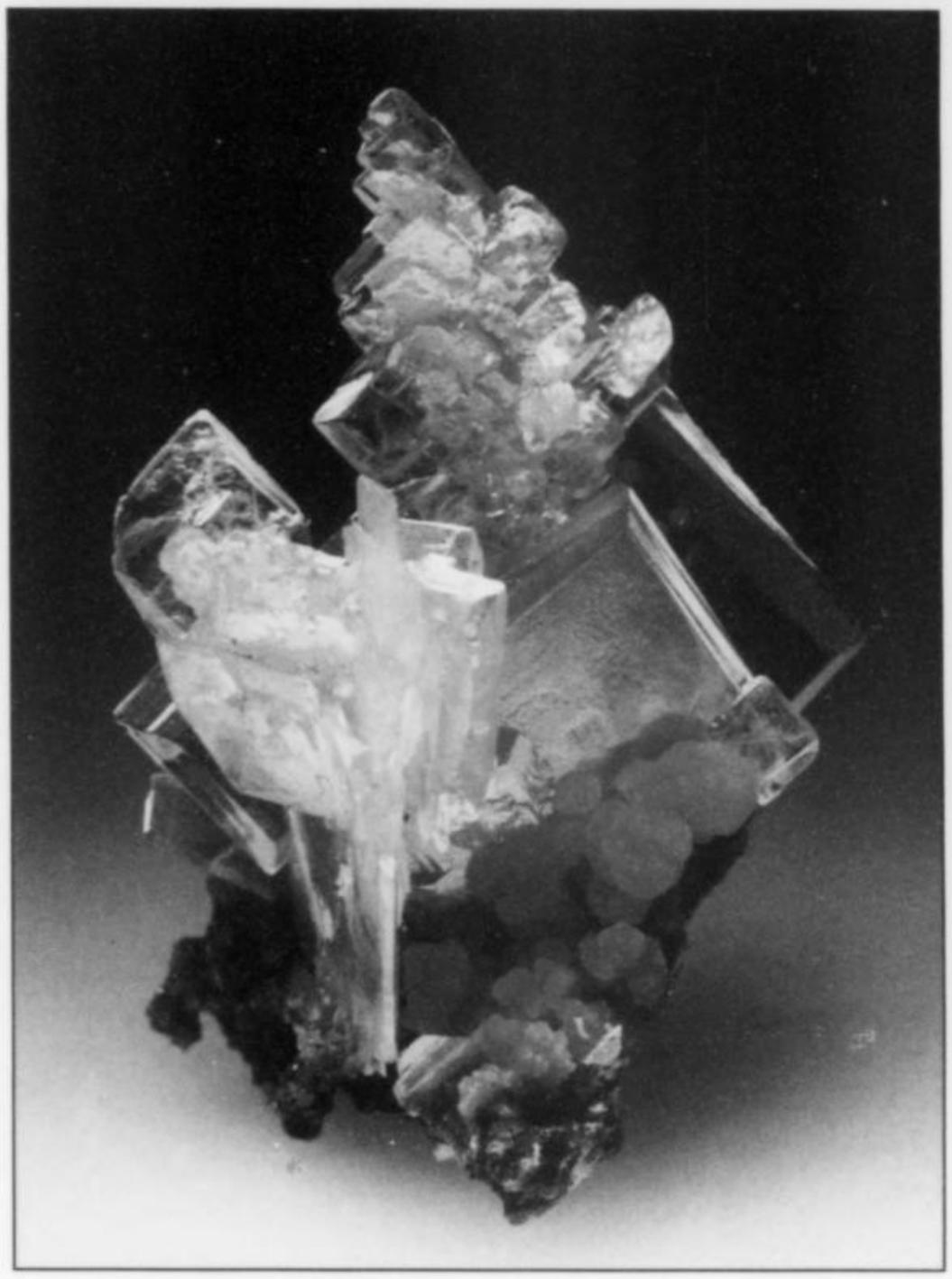


Figure 21. **Wullfenite crystals on orange mimetite, 5.4 cm, from the San Francisco mine. Western Minerals specimen; Wendell Wilson photo (1983).**

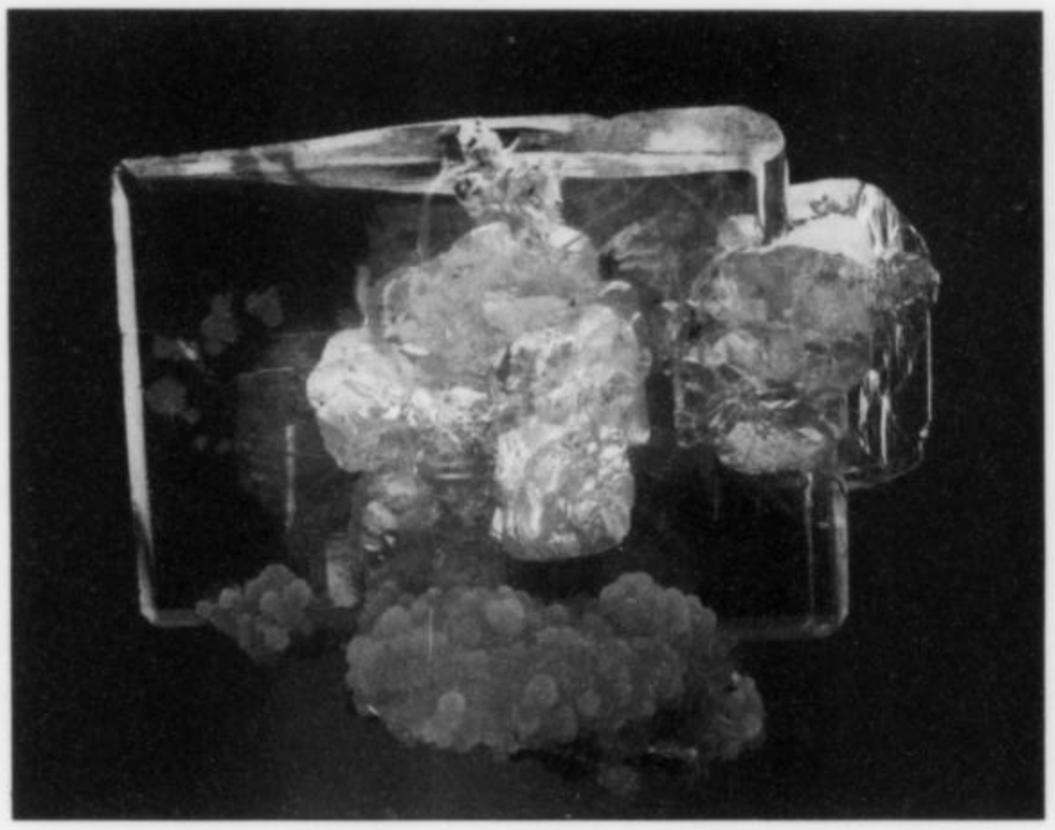


Figure 22. **Wulfenite crystal with mimetite, 3.7 cm, from the San Francisco mine. Francis Benjamin collection; Jeff Scovil photo.**

crystals, and Panczner (1987) notes mimetite "replacements" of wulfenite. However, the most coveted specimens are those in which brilliantly colored (the redder the more highly coveted) spherules rest individually or as grapelike clusters on wulfenite crystal "windows" or between them, populating the wulfenite crystal groups, thickly or thinly, with splotches of cousinly color.

Pyromorphite $Pb_5(PO_4)_3Cl$

Panczner (1987) mentions pyromorphite crystals to 1 cm associated with wulfenite on the San Francisco mine's "11th level." However, obvious (i.e. green) pyromorphite was not seen in the mine

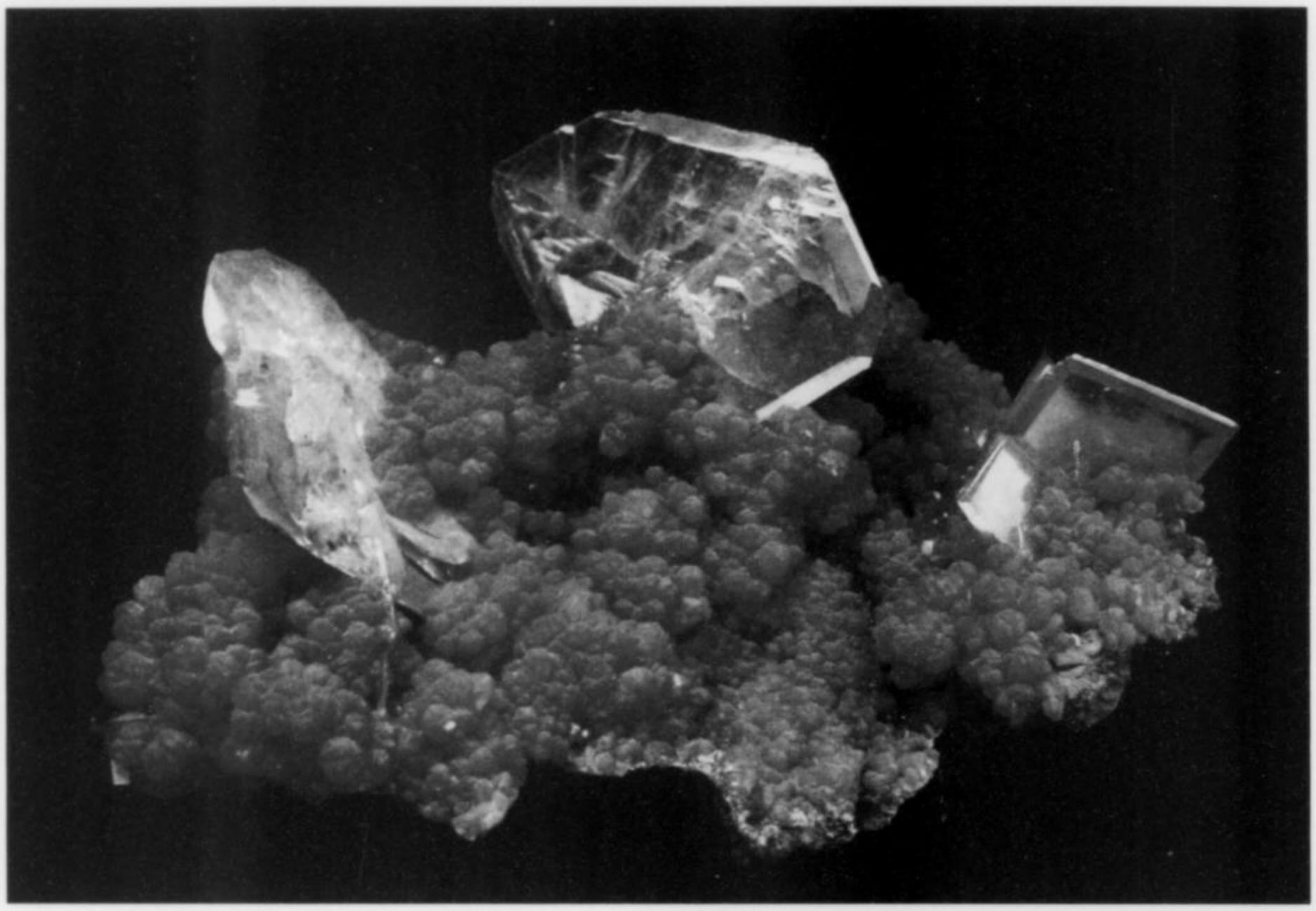


Figure 23. **Wulfenite crystals on mimetite, 6.4 cm, from the San Francisco mine. Jack Halpern collection; Jeff Scovil photo.**

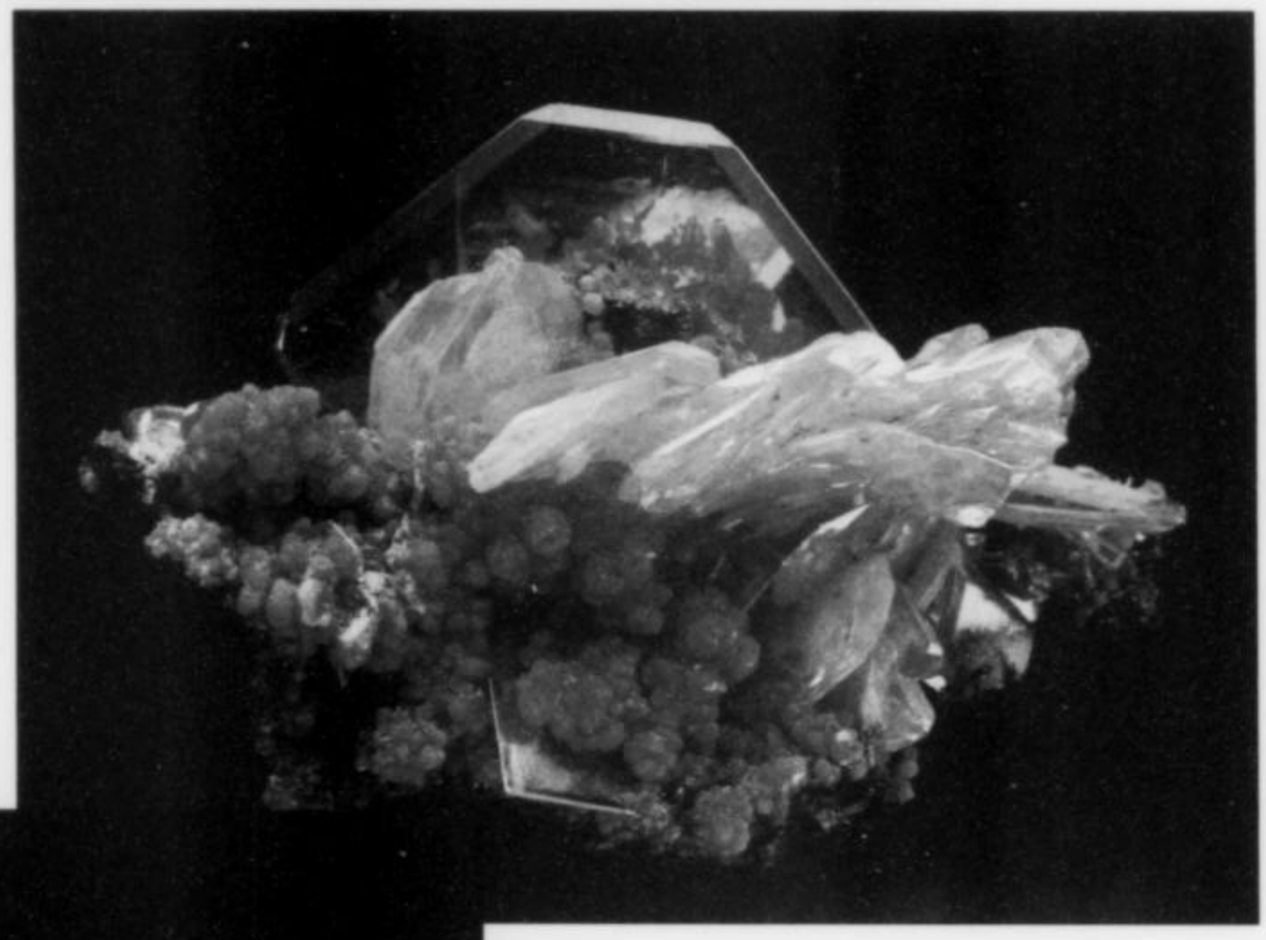
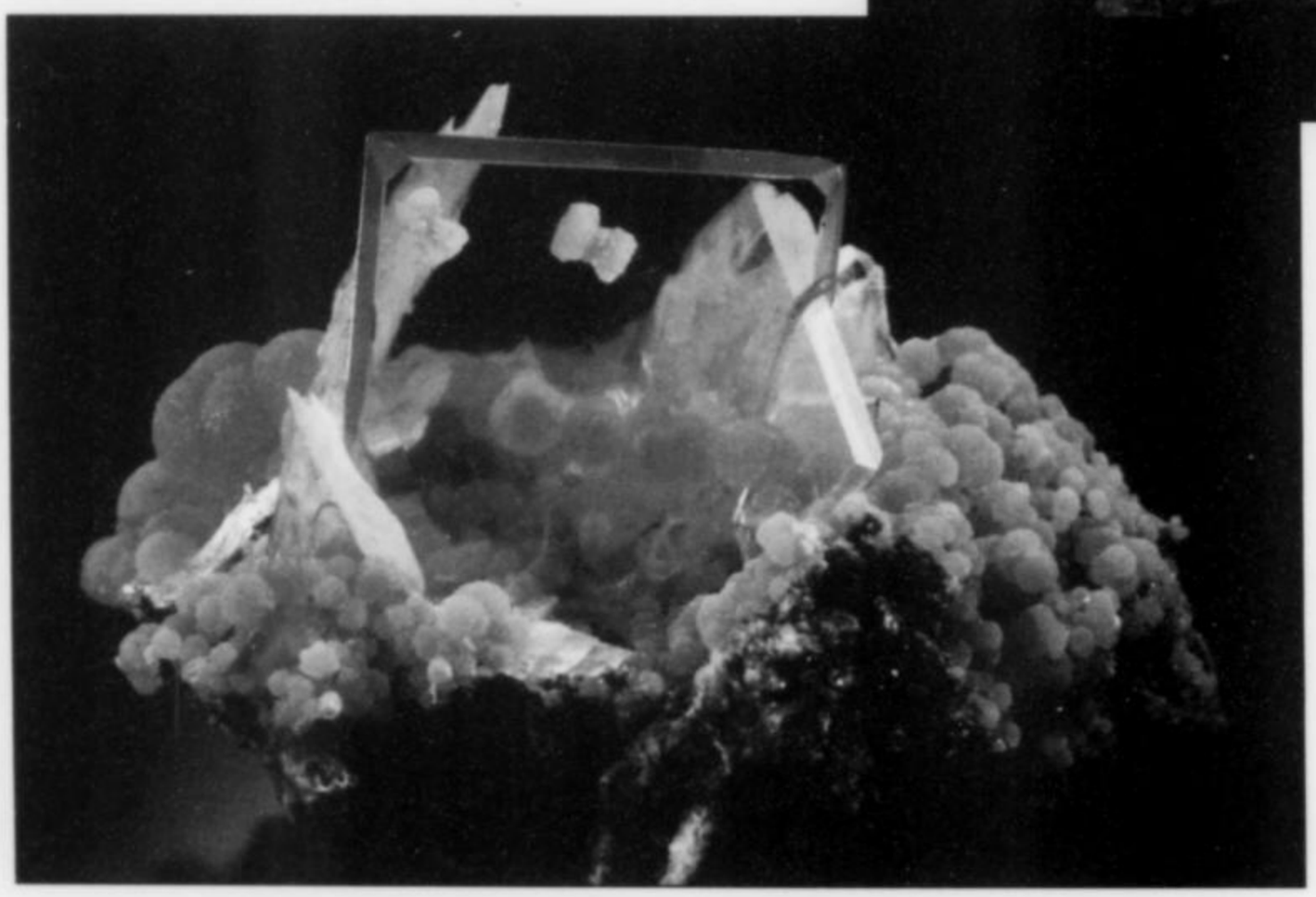


Figure 24. **Wulfenite crystals on mimetite, 5 cm, from the San Francisco mine. Steve Neely collection; Jeff Scovil photo.**

Figure 25. **Wulfenite crystals on mimetite, 5.5 cm, from the San Francisco mine. Francis Benjamin collection; Jeff Scovil photo.**



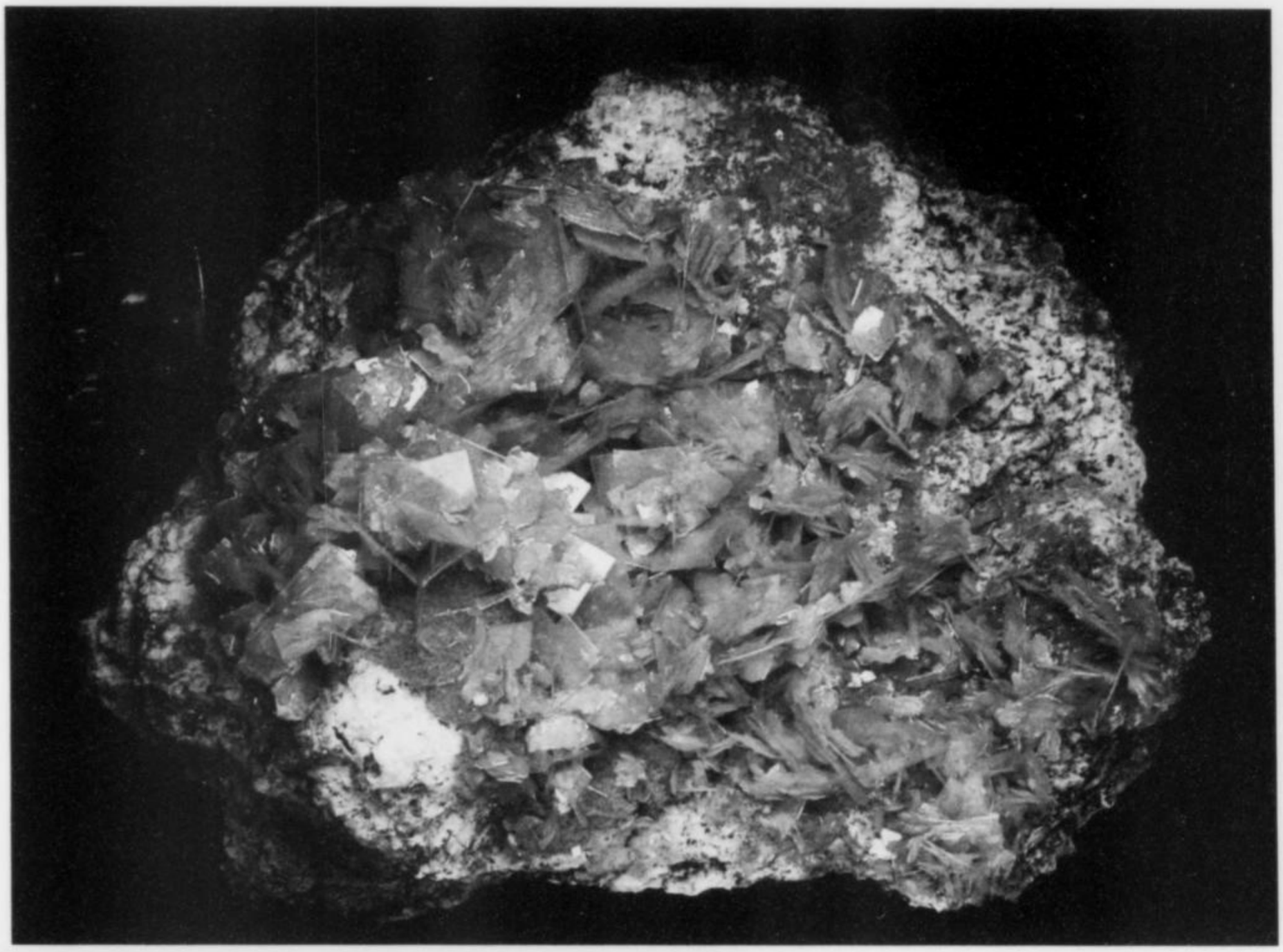


Figure 26. **Large block of matrix, 40 cm, covered with wulfenite crystals, from the San Francisco mine. Lance Hampel collection; Jeff Scovil photo.**

Figure 27. **Wulfenite with barite, 9.9 cm, from the San Francisco mine. Wayne Thompson specimen (1994); Jeff Scovil photo.**

by Wayne Thompson during the 1970's, and Ed Swoboda's journal from the 1990's does not mention his mining crews' encountering it. While collecting near the bottom of the interior shaft in the mid-1980's, Cal Graeber and John Whitmire found a few small crystal groups—none larger than 5 cm across—of what they assumed to be pyromorphite, although the material was never tested (Cal Graeber, personal communication, 2004). At the 2003 Tucson Show, the present author purchased a thumbnail specimen labeled as San Francisco mine pyromorphite—and it is fairly attractive. The hexagonal-prismatic crystals, ranging from 2 to 4 mm, cluster densely on earthy brownish black matrix, standing up at all angles from it; they are slightly hoppered at the terminations, lustrous, and yellowish green, with discernible color-zoning—olive-green in the lower halves of the prisms and more yellow than green in the upper halves.

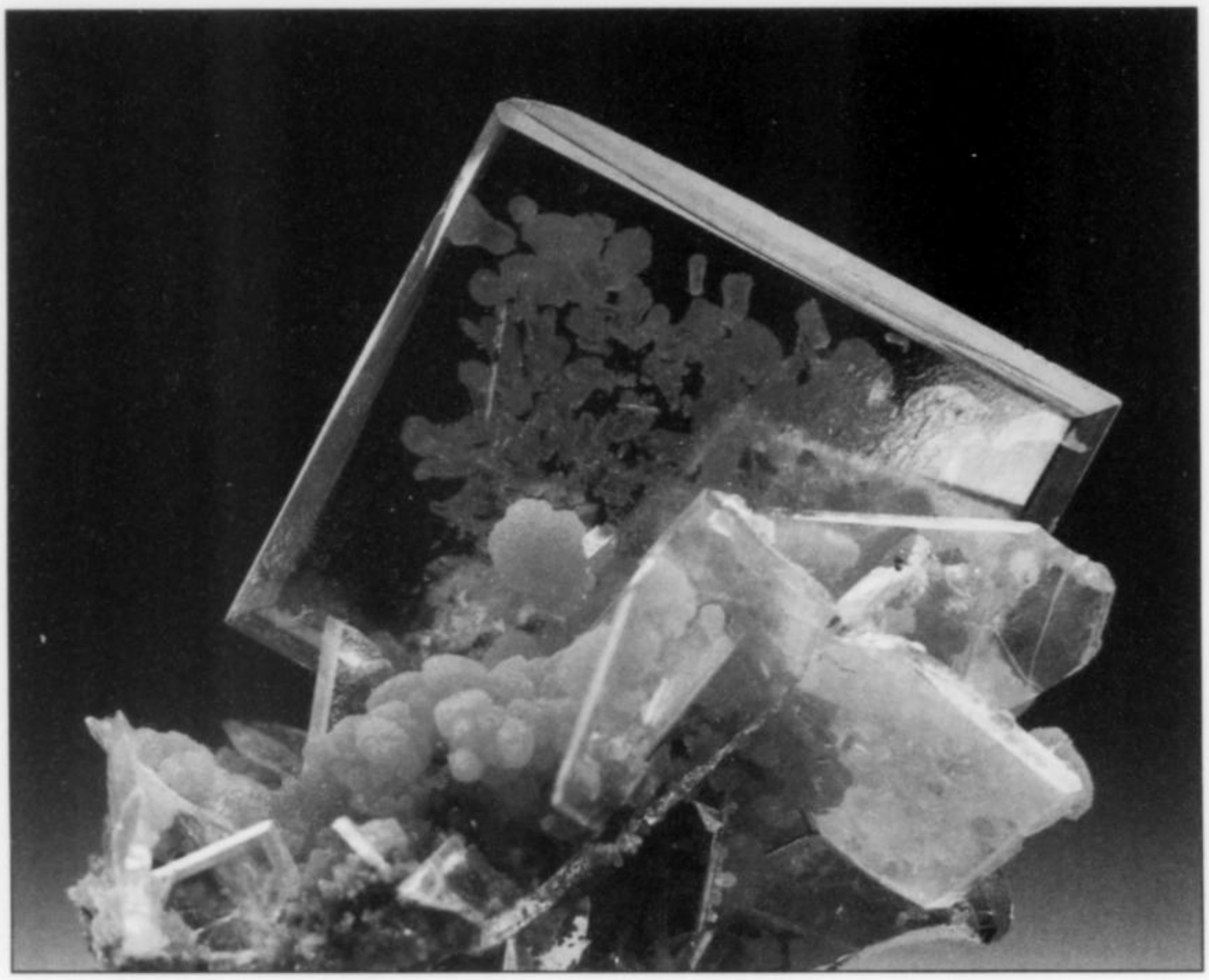


Figure 28. **Wulfenite crystals with mimetite, 4.3 cm, from the San Francisco mine. Cal and Kerith Graeber collection; Jeff Scovil photo (1993).**

Quartz SiO_2

As mentioned, the amethystine quartz veins intersected by the Swoboda incline of the early 1990's were too tight to allow crystals to grow, but about two flats of very good amethyst specimens were collected during the Libby/Seibel/Panczner effort of 1976–1977. The sharply terminated amethyst crystals reached 5 cm, and some have tiny wulfenite crystals perching on them (John Seibel, personal communication, 2004).

Wulfenite $PbMoO_4$

Wulfenite specimens mined in the early 1970's reached the specimen market quickly: even as more fresh pockets were being opened, John White (1972) reported in print on wulfenite crystals, mustard-yellow and all about 1.25 cm, on "wart-like crusts" of mimetite of the same color. In the very next issue of the *Mineralogical Record*, Richard Bideaux (1972) wrote of how the wulfenite of this locality can mimic that of older localities—"rosetted yellow crystals, like Tombstone; transparent yellow-orange crystals with yellow tufted mimetite, like Tiger; orange crystals with orange mimetite balls, like the Rowley mine; and yellow masses of crystals like early Glove specimens." But by the time the specimens collected by Curt Van Scriver in the mid-1970's hit the market (Wilson, 1977), the first of the two important collecting periods at the mine had already ended. The products of the second period, passing from Ed Swoboda's mining team to Wayne Thompson and thence onto the market, also debuted quickly but remained available only briefly, the really important lots of specimens being offered for only about two years in the mid-1990's (Moore, 1994; Robinson *et al.*, 1995). Some very good pieces, having been held back for awhile, showed up about five years later (Moore, 2001), and some appeared in Europe (Larson, 2003). But the locality has produced no fresh material for ten years as of this writing.

Most commonly, San Francisco mine wulfenite crystals are "windows," i.e. wide, square tablets with extremely short prism faces, the edges of many crystals beveled lightly by pyramidal forms. Some crystals show second-order prisms and thus are octagonal. Thicker wulfenite crystals are rare, the largest observed thickness-to-width ratio being about 1:4; some of the famous amber-orange, totally transparent crystals from the "Red Pocket" of May 1973 approach this ratio.

Individual wulfenite crystals to 13 cm on edge have been reported from the mine (Panczner, 1987). As narrated above, many specimens were extracted as loose, single crystals or rosette-shaped aggregates, some with mimetite spherules or dark manganese oxide-infused matrix. The most spectacular specimens are, of course, the great, flaring, excruciatingly delicate clusters of "windows" which, only loosely attached to each other or loosely joined by mimetite, burst up and out at the viewer like playing cards escaping from a clumsy hand. Specimens of this description to more than 20 cm across were found not too uncommonly during both major working periods. One crystal cluster extracted in 1972 (and bought, after a few intermediate stops, by the pianist Roger Williams) measures 45 cm across.

CONCLUSION

More than 100,000 wulfenite specimens are said to have come from the early 1970's pockets alone (Souza *et al.*, 1990), of which perhaps 10,000 are very fine (Wayne Thompson, personal communication, 2004). Add about another 50,000 from the work in the early 1990's (Wayne Thompson, personal communication, 2004) and a few thousand more from the Van Scriver discoveries of the mid-1970's, and consider unrecorded discoveries, and it is clear that the San Francisco mine has been an extraordinarily prolific locality for wulfenite—but where are all those specimens now? For the most plausible (and depressing) general answer to this question, see Wilson and Currier's essay "Mineral Specimen Mortality" (2001).

The number of truly "major" wulfenite pockets discovered in the San Francisco mine is probably between 12 and 15. In the 1970's, Wayne Thompson worked three of these and Copper Joe worked five to seven; in the mid-1970's, Curt Van Scriver worked one; in the 1990's, the Swoboda/Thompson/Horner partnership worked three. Whether more will ever be found no one can say. In the

meantime, these wonderful wulfenite specimens will be cherished, and must be carefully guarded against the demons of entropy, by all collectors lucky enough to possess them.

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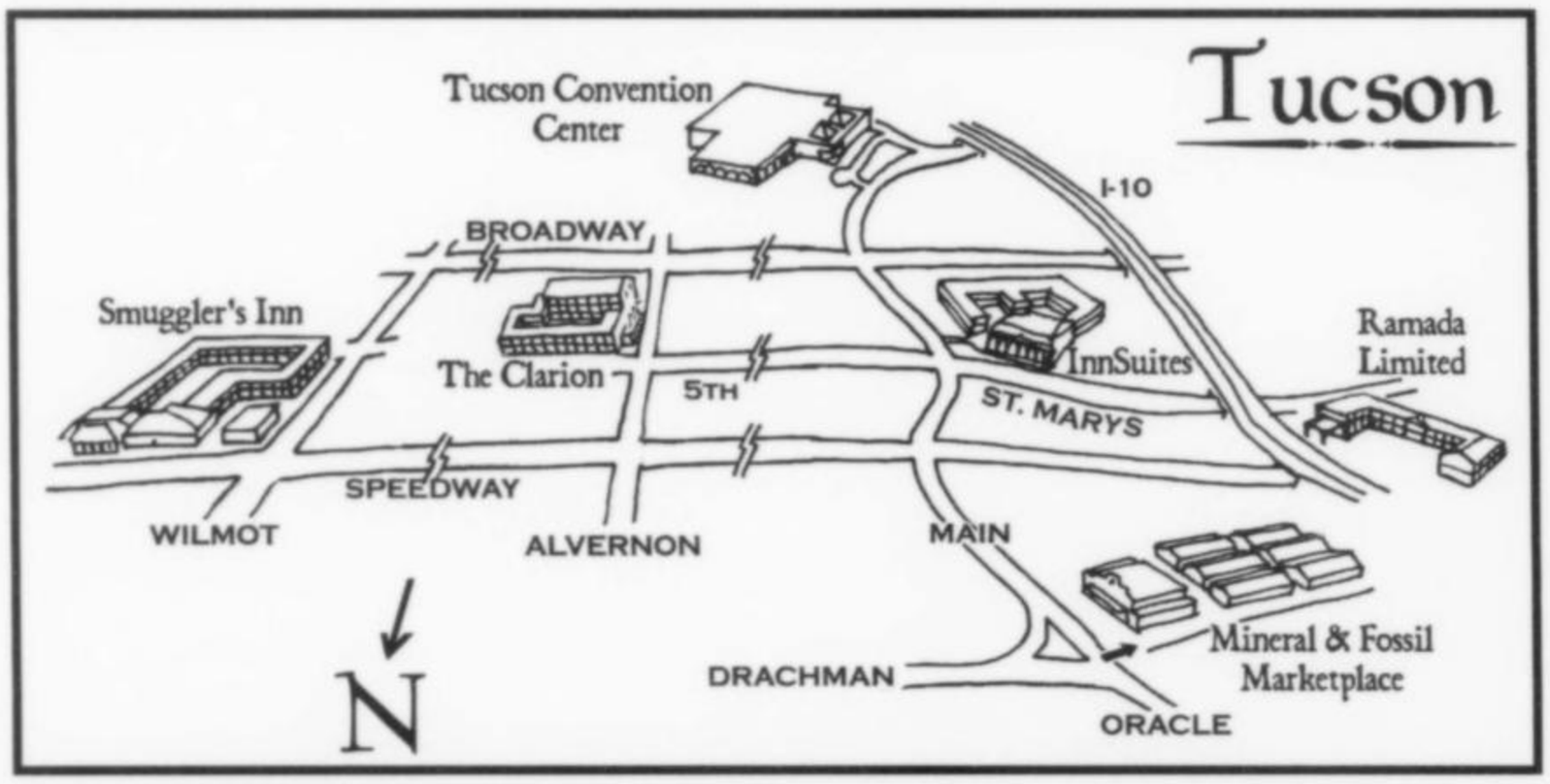

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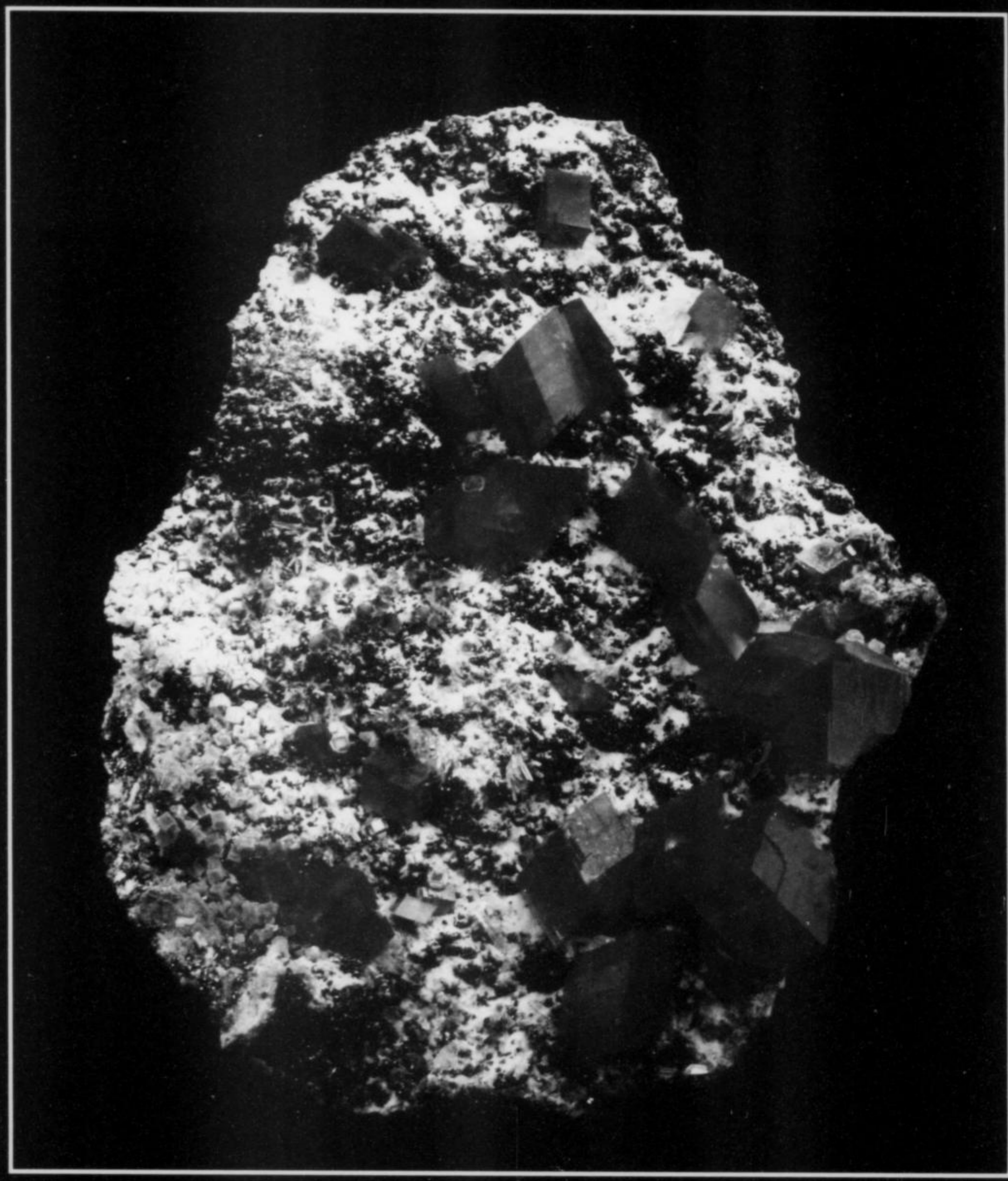

Rhodochrosite, Fluorite, Native Silver
Sweet Home Mine, Alma, Colorado, 25 cm specimen
Jeff Scovil photo

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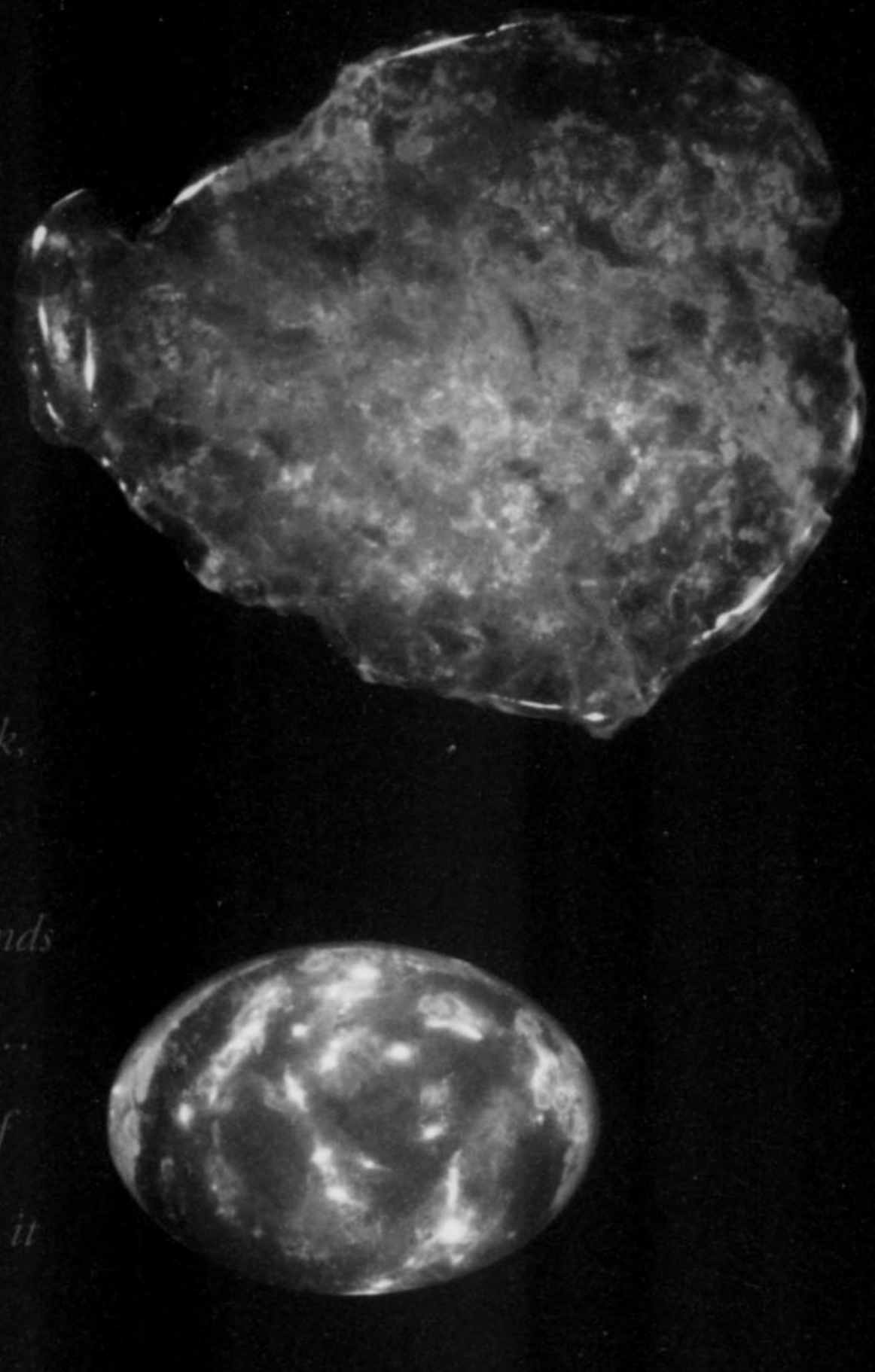

As we looked up the height of rock, there, peering and winking at us like myriads of curious eyes, shone thousands upon thousands of these bright opals... At the mine I went over the boards of opals, each one a miniature sunset as it lies in your palm, like a shower of fireworks as they pour from your fingers.

– G.F. Kunz in Mexico

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Mexican Opal

Photo: Harold & Erica Van Pelt