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Editor & Publisher
Wendell E. Wilson

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Circulation Manager
Mary Lynn Michela
(Subscriptions, back issues, reprints)
P.O. Box 35565
Tucson, Arizona 85740
602-297-6709

Editing, advertising
Wendell E. Wilson
4631 Paseo Tubutama
Tucson, AZ 85715
602-299-5274

Promotions Manager
Sue Jones
1601 Fairview Dr., Suite C
Carson City, NV 89701
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*Continued on p. 95

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January–February 1989
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NEW MEXICO

COVER: FLUORITE from the Pine Canyon deposit, Grant County, New Mexico. (See the article on page 47.) The specimen is 2.9 cm tall. Collection of R. S. DeMark; photo by Wendell E. Wilson.

notes from the EDITOR

NEW MEXICO!

Every mineral collector, save those who have sequestered their interest into strictly local environs, knows about New Mexico. Much of this widespread familiarity is based on a single mineral from a single locality: smithsonite from the Kelly mine. Probably ever since the 1860's, when "Old Hutch" Hutchason discovered the Kelly, pieces of beautiful, sky-blue, botryoidal smithsonite with a strangely appealing silken luster have circulated among collectors. Surprisingly, the *Mineralogical Record* has never had an article on the Kelly, but for this special issue on New Mexico, Ron Gibbs was kind enough to prepare one for us; it covers not just the Kelly mine but the Magdalena district as a whole.

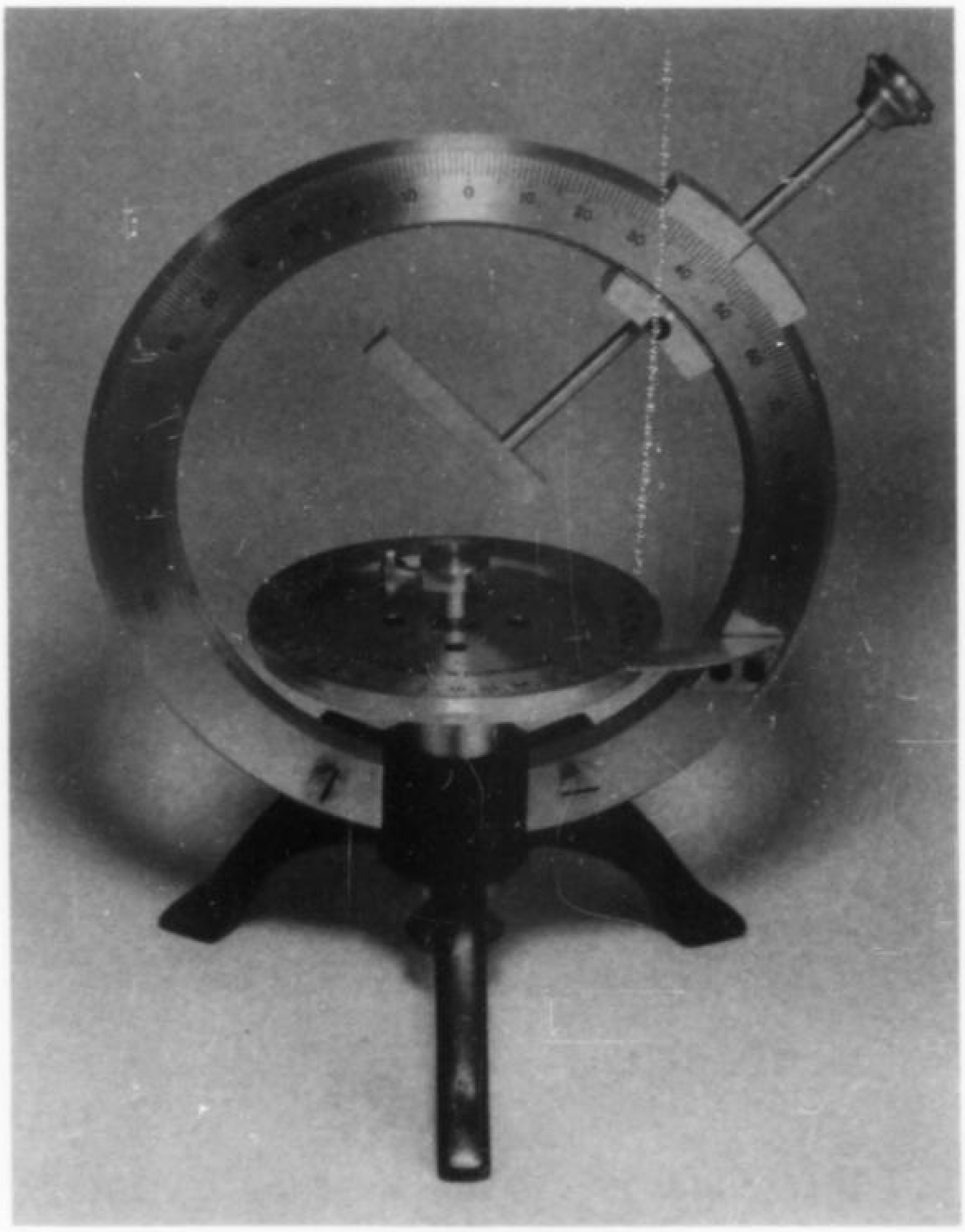
This is not to say, of course, that New Mexico is a one-locality state; far from it! Many other occurrences have developed some fame, and others equally interesting remain obscure or known only to local collectors. Some idea of the abundance of productive mineral localities can be gained by reading Ray DeMark's article on micromounting in New Mexico; many of the localities he mentions yield macro specimens as well.

Past issues of the *Mineralogical Record* have carried several articles on New Mexico localities. The first was Janet Hammond's article on the Stevenson-Bennett mine (**4**, 31–32), which is New Mexico's principal famous wulfenite occurrence. An article by Taggart and Grigsby described multiple Japan-law quartz twins from the San Pedro mine (**7**, 34–35). There was also a thorough review by Jahns and Ewing regarding the Harding pegmatite (**8**, 115–126), a locality which has been preserved under the auspices of the University of New Mexico. Ray DeMark contributed two articles, one on the Red Cloud mines (**11**, 69–72) (not to be confused with Arizona's more famous Red Cloud mine), and another on the Point-of-Rocks quarry (**15**, 149–156), an occurrence remarkably similar in mineralogy to the quarries at Mont St-Hilaire, Quebec. Finally, Bill Henderson discussed some New Mexico occurrences in his review of Western volcanic microminerals (**16**, 137–145).

New Mexico is extraordinarily well endowed with mineralization, and with natural beauty of the landscape. But it is still relatively underpopulated, containing little more than a million people in an area roughly as large as New England, New York and New Jersey combined. There is plenty of elbow-room for collectors in New Mexico, plenty of known localities to go around, and Dana-only-knows how many great undiscovered occurrences. This issue demonstrates that New Mexico is a great mineral state; and there is much more discovering and collecting yet to be done there.

GONIOMETERS

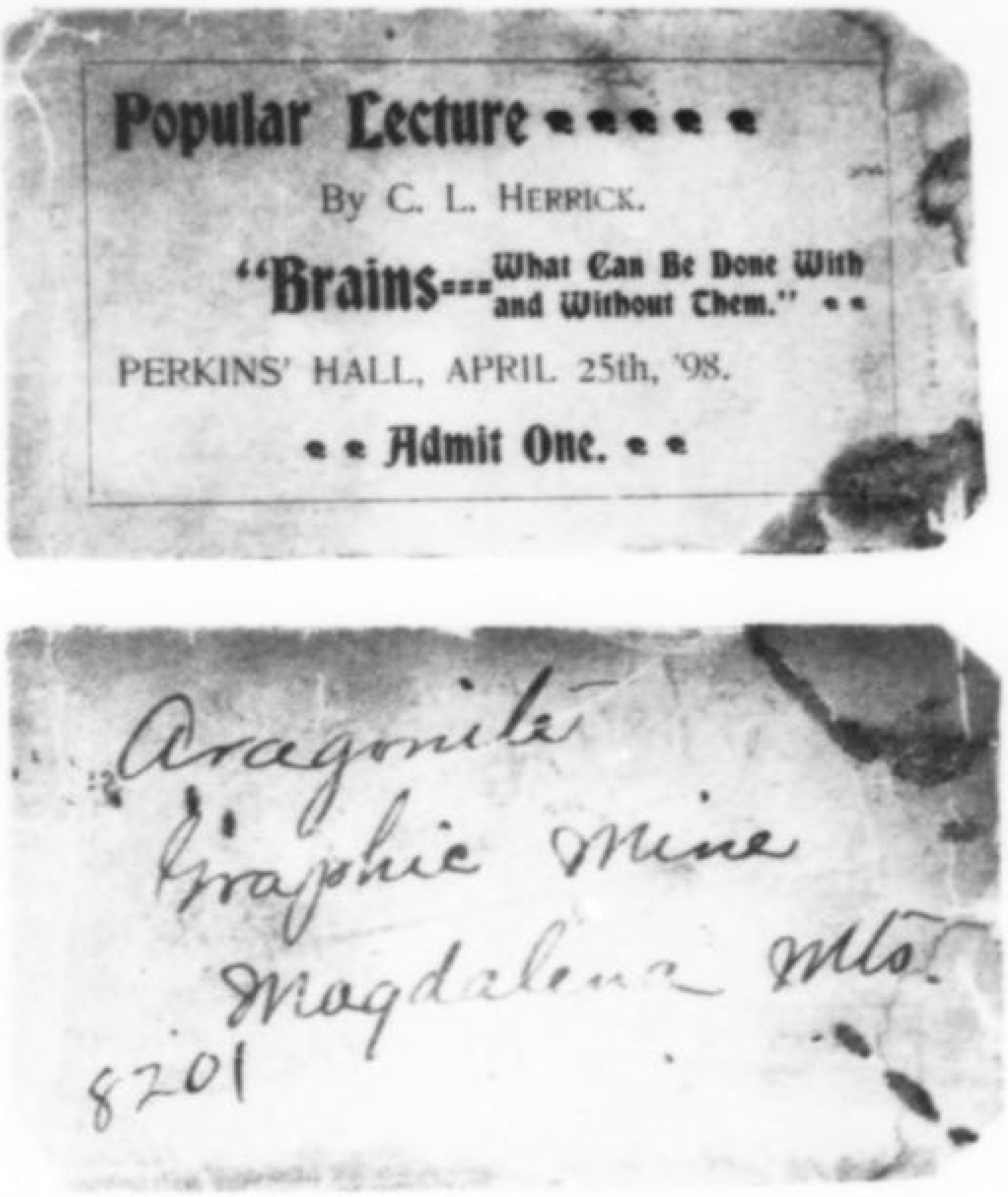
I have often wondered if many of our readers know what the odd-looking silhouetted logo is on our title page. It is, of course, a goniometer: a device for measuring the angles between faces on thumbnail to miniature-size crystals. The general idea of contact-goniometry was originated by Arnold Carangeot in the late 1700's; our example was made by P. Stoe in Heidelberg, probably around 1900–1920. It has been our corporate emblem since the magazine was founded, and I've always liked its symbolism . . . taking the measure of the mineralogical world, so to speak. Goniometers such as this are prime collectibles today, and have recently been selling for more than $5000 on the antique scientific instruments markets. So it is unlikely that many collectors will be able to find or afford one as an embellishment for their bookshelf, showcase or coffee table. At least they are unlikely to find an *old* one; Uli Burchard (coauthor of *Mineral Museums of Western Europe* and an expert on antique goniometers) has recently commissioned the German instrument makers Böhm and Wiedemann to prepare 50 individually numbered examples after the original design, all in brass with a black-painted cast iron base. These are available, while they last, at $750 postpaid, and I know that a number of them sold at the Denver Show. They are beautifully crafted, and are every bit as functional and expertly made as the old examples. I hesitate to call these "reproductions," because they are made by an old company which did indeed make goniometers around the turn of the century. In any case, the opportunity to acquire something like this may well not come again. Interested parties should contact Uli (Schlosstr. 6, D-8040 Haindlfing-Freising, West Germany), or Minieralien & Fossilien Galerie (Fahrgasse 88, D-6000 Frankfurt).



Burchard goniometer

EDITOR'S FILE

Editors tend to save all sorts of miscellaneous items: clippings, notes, photos, cards, copies and so on, which might by some extreme stretch of the imagination be useful someday. In rummaging through my New Mexico trivia file preparatory to assembling this issue I came across a hand-written mineral label salvaged from a drawer in an old university study collection. It had long since become dissociated from its specimen, but it referred to an aragonite from the Graphic mine, Magdalena, New Mexico (see the article on the Magdalena district in this issue). What caused me to save it was the fact that it had been



Popular Lecture ◆ ◆ ◆ ◆ ◆

By C. L. Herrick.

"**Brains**---What Can Be Done With and Without Them." ◆ ◆

PERKINS' HALL, APRIL 25th, '98.

◆ ◆ **Admit One.** ◆ ◆

Aragonite
Graphic Mine
Magdalena Mts.
8201

Old New Mexico specimen label written on lecture ticket

written on the back of an 1898 lecture ticket. The lecture topic: "Brains—What can be done with and without them." Not a bad title, even today. (C. L. Herrick was a prominent early-day New Mexico geologist.)

NEW MEXICO WALL MAP

A large and attractive wall map of New Mexico, 40 x 64½ inches and colored according to elevation, is available from Raven Maps, c/o New Mexico Magazine, 1100 St. Francis Drive, Santa Fe, NM 87503. It can be ordered in plain paper ($24) or vinyl laminated ($48). Add $4 shipping per tube (limit of 10 maps per tube). This is a highly detailed map, at 10 miles to the inch, and would make a very useful wall hanging for anyone with an interest in New Mexico.

COLLECTING THE EASY WAY

Good specimens don't just fall in your lap, y'know. Sometimes they land ten feet away. The June 1988 issue of *Meteoritics* reported the following incident involving the Salem, Oregon, L6 chondrite:

"The Salem meteorite hit the house of Deputy Sheriff James P. Price at 1:05 a.m. on May 13, 1981. Price was in front of the house talking with a colleague when both men heard a fluttering sound overhead, followed by the sounds of the meteorite hitting the house and of debris falling nearby. A piece still warm to the touch (22.2 grams) was found within a few minutes on the driveway within 3 meters of the officers. Because of scientific training, Price surmised it was meteoritic. More pieces were recovered the next day, for a total of 61.4 grams. Neither a fireball nor sonic phenomena were reported."

NEW PUBLICATION

A new quarterly publication entitled the *Mining Artifact Collector* has recently been issued. Subject areas are planned to include carbide lamps, miners' candlesticks, oil lamps, safety lamps, blasting items, assay equipment, and paper collectibles. The cost is $12 per year (U.S.) and $16 per year (foreign). Send orders to Ted Bobrink, 12851 Kendall Way, Redlands, CA 92373.

NOTICE

Died, Richard Scott Mitchell, 59, on July 31, 1988. Mitchell joined the Department of Geology of the University of Virginia in 1953 as an assistant professor, and subsequently completed his PhD program at the University of Michigan three years later. In 1964 he was appointed acting chairman of the department and served in that capacity until 1969. In that year he became Professor of Environmental Sciences, upon the establishment of that department. He taught petrology and mineralogy for 35 years, and was highly admired and appreciated by his many students. Early in his career he became involved in curating the extensive Brooks Museum collection (24,000 specimens of rocks, minerals and fossils), which he continued to supervise for 25 years.

In 1975, Professor Mitchell was appointed an executive editor of *Rocks & Minerals*. He contributed a popular bimonthly column of biographies of people for whom minerals have been named, and wrote a book on the subject: *Mineral Names: What do they Mean?* (1979), followed by a book on rock names in 1985. His personal bibliography includes over 100 publications. He was an abstractor for *Mineralogical Abstracts*, a Fellow of the Mineralogical Society of America and the Geological Society of America, and was an active member of several other professional societies.

Professor Mitchell bequeathed a generous sum of money to the James Madison University Mineral Museum, for the purpose of developing a premier collection and display facility devoted to Virginia minerals. His friends and colleagues have arranged for this collection to be formally known as the Richard Scott Mitchell Memorial Virginia Mineral Collection. The displays will be open to the public, and will stand as a lasting tribute to an outstanding mineralogist.

Richard S. Mitchell, 1929–1988

A trust fund has been established by the James Madison University Foundation to receive additional donations from the public. The interest from this fund will assure a continuing income for the support and growth of the collection. The museum is also seeking gifts of Virginia mineral specimens suitable for display. All gifts are tax deductible. Monetary donations should be mailed to the R. S. Mitchell Memorial Fund, James Madison University Foundation, James Madison University, Harrisonburg, Virginia 22807. Specimen donations can be sent directly to the Mineral Museum c/o Dr. Lance E. Kearns, Dept. of Geology and Geography.

W.E.W.

Mineralogical Record BACK ISSUES!

v.8/#6 California Issue Benitoite, Gold, L.A. County Museum, Himalaya mine $7

v.9/#3 Kalahari rhodochrosite, Paterson-NJ, Brumado district-Brazil, Bosch Coll. $7

v.9/#5 Turkish Kämmererite, Afghan pegmatites, Chuquicamata-Chile $7

v.10/#5 Thomas & Wah Wah Ranges-Utah (famous for Topaz, Red Beryl, etc.) $7

v.10/#6 Colorado-II Issue Locality Index, Amazonite, Mt. Antero, Sweet Home $7

v.12/#4 Mineral Fakes, Mineral Fraud, Leadhills-Wanlockhead England $7

v.16/#1 Nevada Issue Getchell, Comstock, White Caps, Steamboat, etc. $9

v.16/#3 Colorado-III Issue Leadville, Rico, Pikes Peak Cresson Vug, CSM Museum $9

v.16/#5 Tourmaline Issue History, Mineralogy, Calif., Elba, Nepal, Pakistan, ME $12

v.17/#3 Knappenwand, Laurium, Tucson Show, Senaite-Brazil, New Zealand, Italy $9

v.17/#4 Tip Top-Black Hills, Stoneham-Colorado Barite, Tuscany-Italy $9

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v.17/#6 Bleiberg-Austria, Oklahoma, Romania, Australia, Author's Guide $9

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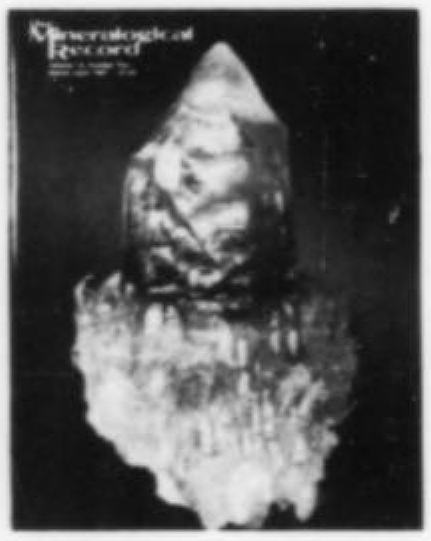

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A SHORT HISTORY OF

MINING IN NEW MEXICO

Wendell E. Wilson
4631 Paseo Tubutama
Tucson, Arizona 85715

[1]The first Spanish expedition to enter what is today New Mexico was probably the one led by Alvar Núñez Cabeza de Vaca in 1535. He was given some copper, "silver" (mica?) and "antimony" (galena?) by local Indians, who told him of a large copper deposit, possibly the one at Santa Rita. Four years later a second expedition penetrated north from Spanish Mexico, this one led by Fray Marcos de Niza. He encountered many Indians possessing abundant turquoise jewelry, but, like his predecessor, saw no minerals *in situ*.

In 1540, Captain-General Francisco Vázquez de Coronado's large military expedition reached Zuni, New Mexico (supposedly the fabled Cibola). He too saw a great deal of Indian turquoise, some garnets, "emeralds" (probably peridot olivine), "very good salt in crystals," and also some gold and silver. But still, no occurrences observed in place.

Finally, in 1581, a small force led by Captain Francisco Sánchez Chamuscado reached Cerrillos, New Mexico, and found mineral deposits. They also came upon the Estancia salt lakes, which they enthusiastically described as "the best salines ever discovered by Christians." Later, somewhere between Sierra Ladrones and the San Mateo Mountains, they found "very good veins, rich in contents," and remarked, "There are so many deposits that it is indeed marvelous . . . [some assaying] at twenty *marcos* [148 ounces troy] per hundred weight of ore."

The 1582 expedition of Don Antonio de Espejo reported finding deposits of "antimony" (probably galena), possibly in the Organ, Caballo and Manzano Mountains. Other expeditions and colonizing attempts followed, including those of de Sosa (1590) and Oñate (1598), who found azurite and malachite.

In 1610 Santa Fe was founded as the new capital, and explorations for silver and gold continued. Fray Geronimo de Zárate Salmerón, in his *Relaciones* (compiled in 1629) mentions many different ore deposits and reports having seen "silver, copper, lead, lodestone, copperas, alum, sulfur, and mines of turquoise," and also salt and garnets. He wrote:

> In all the ranges of the Hemex [Jemez] there is nothing but deposits, where I discovered many and filed [claims] on them for His Majesty. From the which I took out 18 arrobas [207 kg] of ore. Before all things, there are mineral deposits, and there is no corner which has them not.

Fray Alonso de Benavides, in his *Memorial* (1630), has a chapter entitled "Mineral Deposits of Socorro" in which he notes "very great treasures in mineral deposits, very rich and prosperous in silver and gold."

Little is really known about the true extent of Spanish mining in New Mexico during the 17th century. The Indian uprising of 1680 drove the Spanish out for a period of 12 years, and provided a convenient basis for later legends. The Spanish, tradition says, were revolted against because of their cruel enslavement of Indians, who were forced to work in mines operated by the Jesuits. Following the revolt, all of the known mines were filled up and camouflaged, and all the mining records were destroyed or carried back to Spain. Succeeding generations of returning Spaniards thus had no clue to the whereabouts of the supposedly once-prosperous mines. Most current authorities, however, believe that relatively little actual mining had taken place; prospecting and a little alluvial gold panning were probably the principle activities in most districts. Nevertheless, physical remains of early Spanish mining have been found at many sites.

During the 18th century the (presumably Spanish) population of New Mexico is said to have grown to more than 30,000.

In the year 1800, a friendly Apache chief revealed the location of the Santa Rita copper deposit to Lieutenant-Colonel José Manuel Carrasco, officer in charge of the Spanish military posts in New Mexico. Carrasco sold the claim to Don Manuel Francisco Elguea, of Chihuahua, and copper mining commenced; the yield is said to have been 20,000 mule loads annually (although recent scholars dispute this).

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[1] Summarized largely from Northrup, S. A. (1959) *Minerals of New Mexico*. University of New Mexico Press, 665 p., which see for references. Early engravings are from Gregg, A. K. (1968) *New Mexico in the Nineteenth Century, a Pictorial History*. Univ. of New Mexico Press, 196 p.

Valley of the Santa Rita mines, 1854.

New Mexico officially became a province of the newly independent country of Mexico in 1821, and a territory in 1824. Four years later, a major placer gold discovery was made by a sheepherder in the Oritz Mountains; this is generally regarded by historians as the first important discovery of gold west of the Mississippi River. The news took three months to reach the banks of the Missouri River, just 800 miles away, but it sparked the first frantic gold rush in the history of the West.

Mining concentrated primarily on gold during the 1830's and 1840's. Some placer operations were yielding $250,000 per year, including some large nuggets up to 7 pounds and one from the Old Placers said to contain $3400 in gold. The goldfields were in full boom; one mining town (Golden) is said to have had more than a hundred houses and 22 stores "transacting more business than was done in Santa Fe."

New Mexico east of the Rio Grande became a part of the United States in 1845, being included in the annexation of Texas. Most of the remainder was ceded to the United States in 1848, under the Treaty of Guadalupe Hidalgo, and the southern tip was purchased from Mexico in 1853. Originally, New Mexico Territory included what is now Arizona and southern Colorado.

The territorial period saw renewed exploration for mineral deposits. Wislizenus (1848) traveled through the new American holdings, and wrote:

> A . . . much neglected branch of industry in New Mexico is the *mines*. Great many now-deserted mining places in New Mexico prove that mining was pursued with greater zeal in the old Spanish times than at present, which may be accounted for in various ways, such as the present want of capital, and want of knowledge in mining, but especially the unsettled state of the country and the avarice of its arbitrary rulers. The mountainous parts of New Mexico are very rich in gold, copper, iron, and some silver.

More expeditions were to follow, particularly with regard to mapping out the most favorable railroad route to the Pacific. Explorer/geologists such as William P. Blake, Jules Marcou and Prof. J. S. Newberry took care to investigate local ore mineralogies at every opportunity.

In 1860, gold placers were discovered at Pinos Altos, and within a few months the lodes were found, attracting 1,500 miners to the area. More gold was found near Fort Stanton, and three copper mines and a silver mine were opened in Dona Ana County. The Hanover mine in Grant County began producing copper ore as well. The state's mining industry was on the upswing. But in 1861 Civil War broke out, the Confederates invaded New Mexico, and mining was more or less suspended. Military activity took men into the back country, and so it is not surprising that the state's first important silver discovery was made by a soldier (at Pueblo Springs, in 1863).

When the Civil War ended, gold was promptly discovered near Nogal (1865), lead-silver ores were found in the Magdalena district (1866), silver was discovered at Georgetown (1866) and placer gold in the Moreno Valley (1866). The latter placers inspired a rush which dramatically swelled the population of Elizabethtown. Thirty lodes of gold-bearing quartz were found at Pinos Altos (1866), and by that year over 50 silver mines were in operation in the Organ Mountains. More gold was found near Taos (1867), and silver at Socorro Peak (1867). Despite all this activity, mining and prospecting were still heavily constrained due to Indian hostilities.

In 1868 the Ladron and Water Canyon districts were located, and "the Big Ditch," a 41-mile-long canal, was completed in order to bring water for placer mining from Red River to Elizabethtown. Rich silver ores were found at Chloride Flat (1871) giving Silver City its name; over $3,000,000 in silver was won within a short time. A number of other districts were opened during the 1870's and exploration in established areas located more deposits.

The Organ Mountains and the Rio Grande, near Las Cruces (1876).

The Lake Valley district was discovered in 1878, and yielded 5,000,000 ounces of silver within a few years. One pocket in this district, called "the Bridal Chamber," contained one of the richest silver orebodies ever found anywhere in the world. Fifteen million dollars worth of silver was said to be "in sight" (an obvious exaggeration), with ore running up to $27,000 per ton. Governor Safford is said to have offered the mine owners $50,000 for all the ore he could extract unaided from the Bridal Chamber in ten hours. Some years later, Governor Otero claimed that a single lump of ore removed from the Bridal Chamber contained $80,000 in silver.

The Eureka district was also discovered in 1878, and was accompanied by some interesting archeological findings. Prehistoric turquoise workings at the site contained ancient Indian pottery fragments, crude stone hammers and other primitive mining implements.

The following year saw more discoveries: Modoc, Wilcox, Orogrande, and Chloride. A zinc-lead-silver boom was under way at Cerrillos, and the district shortly yielded $3,000,000 in gold from the deepest dry shaft in the nation.

In 1880 the population of New Mexico was reckoned to be about 120,000. The Cochiti, Jicarilla, Tecolote, Cooke's Peak, Kingston,

Pinos Altos Mountains near the Santa Rita copper mines were an Apache stronghold for many years (1886).

Ladron, Steeple Rock, New Placers, White Oaks, Placitas, Coyote Creek, Eureka and Fremont districts were discovered or expanded. Indian troubles still continued in some areas; the notorious Apache renegade Victorio led raiding parties and massacred miners in the Mogollon district, and Nana's band of Apaches harried camps in the Black Range.

A Territorial Fair was held in Albuquerque in 1881. Exhibited there were "cabinets of minerals from every mining district"; $100 prizes were established for the best collections of specimens from a single mine, a single district, and from the territory at large (the names of the winners were not recorded).

By 1882, construction had been completed on the Southern Pacific Railroad and on the Atchison, Topeka and Santa Fe Railroad (after which santafeite was later named). Track had been extended to Las Vegas (New Mexico, not Nevada), Santa Fe and Albuquerque. Prospectors and miners streamed into the territory. Soldiers detailed to guard railroad gangs and stage routes spent their spare time prospecting, and many new deposits were found. Although gold had been the dominant commodity mined up to 1879, silver took its place during the following decades.

The 1880's saw the gradual end of Indian raids, as the last of the Apaches were brought under control. Mining and prospecting expanded at a rapid rate and many important new districts were opened. Virgin ground still remained for prospectors. One man on Ute Creek, for instance, found 90 gold nuggets in one year. More than a hundred claims were staked in the Tres Hermanas district in one year, and more than 130 mines were in simultaneous operation in the Cerrillos district. The Mimbres Mining Company of Georgetown produced 170,000 ounces of silver in one year. The superintendent of the Lake Valley mines reported removing a single piece of chlorargyrite weighing 10,000 pounds and containing over $60,000 in silver. A 4-foot-thick vein of native copper was encountered in the St. Felicite district which, like similarly sized masses found in Upper Michigan, would not respond to explosives and had to be chiseled out by hand. The same district was also the source of fine, red vanadinite; *Mining World* (July 15, 1882) reported that "anyone in search of fine cabinet specimens will do well to secure some of this vanadinite." At Kingston, veins of solid acanthite assaying 16,530 ounces of silver to the ton were found. These are just a few entries from the decade's mining ledger.

The 20th century opened with roughly 300 organized mining districts and 2000 mining claims operating in the territory. By this time, copper, lead and zinc were being produced in large tonnages, but gold and silver production was still high. The Gold Standard mine, for example, was particularly rich in specimen-quality gold, or "jewelry gold" as it was called in California. According to one writer in 1901:

> The white quartz is beautifully shot through with great chunks of yellow metal. Miners at work in the claim say they often pick up nuggets from the floor worth $2 to $12. Many of these sell at the rate of $40 per ounce, because of their fantastic shapes and their association with pure white quartz crystals, which makes them popular for stickpins and other ornaments.

Panning gold in the mountains near Cerrillos (1859).

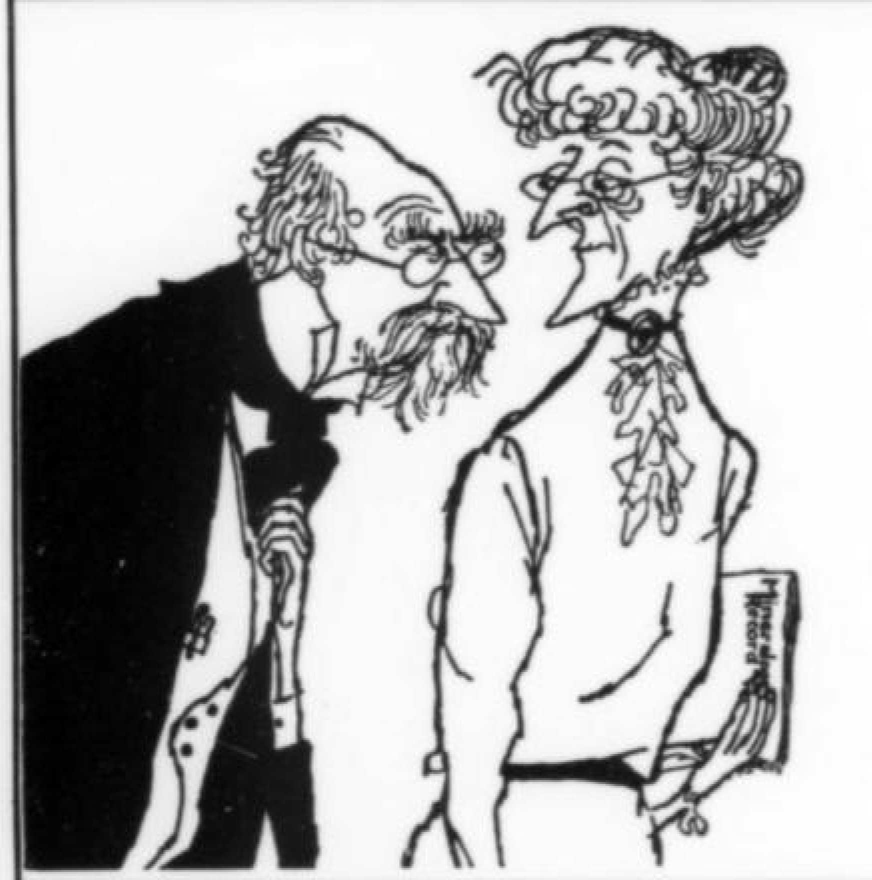
It is interesting to note that the boom at Sylvanite in 1908 was not based on the mineral sylvanite as first thought; it was later identified as a new mineral, tellurobismuthite. (It's unfortunate that the species was not established earlier; perhaps the town would have been named Tellurobismuthite!)

New Mexico was admitted to the Union as the 47th state in 1912. Low-grade copper production, as at Santa Rita, was in full swing, and silver production was still booming. With the advent of World War I, metal prices soared and the state's total production for 1917 topped $43 million ($28 million of this from copper). Production of molybdenum began at Red River in 1919.

When the Great Depression set in, copper prices fell from 18 cents a pound in 1929 to less than 5 cents in 1932. The mining industry suffered accordingly, and most mines were closed. But by 1937 the economy had more or less recovered, and annual production was up to $65 million. The following year, gold production peaked (at $1.5 million).

In 1953 the state's metal production had risen to nearly $330 million, including a considerable portion from uranium mining in the Colorado Plateau, as in the Grants and Laguna districts. By the following year a total of 68 uranium-mining companies were in operation, producing ore from 75 properties. The Jackpile mine was considered to be the largest uranium deposit in the world. The uranium boom was on! More than 1000 uranium claims were filed around Carlsbad and Truth or Consequences. And more than 500 geologists were employed by government and industry to search for uranium and manage the working mines. Even helicopters were brought into service for prospecting. During the first half of 1955, 7,500 uranium claims were filed in McKinley County alone, including roughly 1,000 filed on a single day. The Atomic Energy Commission announced the following year that New Mexico had two-thirds of the known uranium ore reserves in the United States, including $400 million worth in the Jackpile and Haystack districts.

Since that time mining has continued apace particularly at the large, low-grade copper deposits such as Tyrone and Chino. Uranium is certainly not the strategic commodity that it used to be, but many other minerals are still sought, and the mines of New Mexico promise much more to come.



MINERALS FIRST DESCRIBED FROM NEW MEXICO

Jean F. DeMouthe
Geology Department
California Academy of Sciences
San Francisco, California 94118

The rich and diverse geology of New Mexico is reflected in the variety of the mineral species found there, including many that were new to science at the time they were described. Of the 23 mineral species described from New Mexico, 13 are still valid. Of the valid species, there are two oxides, two tellurides, three sulfates, three vanadates and three silicates.

INTRODUCTION

The term "type locality" has not been defined in light of modern type specimen classifications (Embrey and Hey, 1970, and Dunn and Mandarino, 1988). And type localities are generally of more interest to collectors than to mineralogists. Only those localities that produced specimens used to obtain necessary, quantitative descriptive data for a new species will be herein referred to as type localities.

Some authors of new species mentioned specimens from New Mexico in their original descriptions, but did not use those materials in obtaining quantitative data. In those instances, New Mexico is merely a recorded occurrence, rather than a type locality. These species include cryptomelane (Richmond and Fleischer, 1942), doloresite (Stern *et al.*, 1957), sherwoodite (Thompson *et al.*, 1958), and zellerite (Coleman *et al.*, 1966).

Mineral species that were described wholly, or in part, based on specimens from New Mexico are listed chronologically in Table 1. Some of these species have been discredited, but are included here as part of the historical record of mineralogy in New Mexico. The localities mentioned in this paper are shown on the index map on page 11.

Until recently, it was not traditional for authors to state, in their original descriptions, where they were depositing type specimens, if they did at all. In most cases, the information presented here regarding type specimens in the U.S. National Museum of Natural History is taken from Roe and White (1976).

The following are brief descriptions of the 13 valid species whose initial descriptions were based, at least in part, on New Mexico specimens. The species are presented alphabetically. This section is followed by a brief discussion of some of the historical, discredited mineral names that have been associated with New Mexico minerals.

Georgechaoite $NaKZrSi_3O_9 \cdot 2H_2O$

Georgechaoite was described by Boggs and Ghose (1985) as a new mineral from Wind Mountain, Otero County, New Mexico. It occurs as colorless to white crystals up to 1 mm long, in small cavities in an analcime nepheline syenite, in the Wind Mountain laccolith. Associated minerals include microcline, nepheline, analcime, aegirine, chlorite, catapleiite and monazite. Georgechaoite is isostructural with gaidonnayite.

Type material was deposited by the original authors in the U.S. National Museum of Natural History, Smithsonian Institution, Washington, D.C., which is hereinafter referred to as the NMNH.

The name honors Professor George Y. Chao of Carleton University, Ottawa, Canada, for his work with zirconium silicates.

Goldmanite $Ca_3(V,Al,Fe^{+3})_2Si_3O_{12}$

Goldmanite was described as a new vanadium member of the garnet group by Moench and Meyrowitz (1964). They obtained their descriptive data from specimens from a metamorphosed uranium-vanadium deposit in the Laguna uranium district, Valencia County, about 72 km west of Albuquerque, New Mexico. The specific location is an unnamed prospect pit in the Sandy or South Laguna mine area, about 6.4 km southeast of Laguna. The location of that pit is shown on a map published with the original description.

Goldmanite occurs as dark green to brownish green crystals which rarely exceed 0.1 mm in size. Crystals were found imbedded in a vanadium-rich clay and also as inclusions in calcite.

Type specimens were deposited at the NMNH.

The name honors Marcus I. Goldman, a sedimentary petrologist with the U.S. Geological Survey.

Grantsite $Na_4Ca_xV^{+4}_{2x}V^{+5}_{12-2x}O_{32}\cdot 8H_2O$

Grantsite was first described by Weeks *et al*. (1964), based primarily on specimens collected in 1952 and 1957 at the F-33 mine (section 33, T12N, R9W), about 10 km northeast of Grants, Valencia County, New Mexico. The mineral occurs as dark olive-green to green-black aggregates of fibrous or bladed microcrystals. It sometimes forms pseudomorphs after haggite and paramontrosite. Associations include uranophane, tyuyamunite, hewettite and barnesite.

Type specimens are held at the NMNH.

The name is for the town of Grants.

Hendersonite $Ca_2V^{+4}V_8^{+5}O_{24}\cdot 8H_2O$

Hendersonite was described by Lindberg *et al.* (1962) as a new vanadium mineral from one of the Eastside mines in San Juan County, New Mexico, about halfway between the towns of Baclabito and Red Rock. A second locality, 192 km to the north in Colorado, is located in the same geologic unit, the Salt Wash Sandstone member of the Morrison Formation.

Hendersonite is greenish black to black, and forms bladed to fibrous microcrystals in thin seams and veins bordering unoxidized ore.

Type specimens are held by the NMNH.

Hendersonite is named in honor of Edward P. Henderson of the U.S. National Museum, in recognition of his mineralogical studies of the vanadium-uranium deposits of the Colorado Plateau.

Johannsenite $CaMnSi_2O_6$

Johannsenite is a pyroxene originally described by Schaller at a meeting of the Mineralogical Society of America in 1932, and published by him in 1938. Ten localities were listed in the original paper, only half of which appear to have provided specimens for the quantitative description. This includes the Empire Zinc Company mine near Hanover, Grant County, New Mexico. Other reported localities are in Oregon, New Jersey, Algeria, Hungary, Italy and Mexico.

The location of New Mexico type specimens is unknown.

The name honors Professor Albert Johannsen of the University of Chicago.

Lannonite $HCa_4Mg_2Al_4(SO_4)_8F_9\cdot 3H_2O$

Lannonite was described as chalky white nodules at the Lone Pine mine, Catron County, New Mexico (Williams and Cesbron, 1983). It is a post-mining product, associated with gypsum, khademite and wilcoxite.

Type material was deposited by the original authors at the University of Arizona at Tucson and at the British Museum of Natural History.

The name is for Dan Lannon, who staked important claims in this district in the late 1800's.

Plumbojarosite $PbFe_6^{+3}(SO_4)_4(OH)_{12}$

Plumbojarosite was first described by Hillebrand and Penfield (1902), based on material collected in the Cooks Peak district, Luna County, New Mexico. They described it as a "glistening, crystalline powder and as loosely cohering masses" of dark-brown to golden brown crystals measuring up to 0.28 mm in size.

Type specimens are held by the NMNH.

The name refers to its chemical relationship to jarosite (Pb replacing K).

Table 1. **Minerals first described from New Mexico.**

Date	*Name*	*County*	*Status*
1885	Endlichite	Sierra	= vanadinite
1892	Ricolite	Grant	= serpentine (antigorite?)
1902	**Plumbojarosite**	Luna	valid
1909	Bonamite	Socorro	= smithsonite
1920	Kithilite	Grant	= bassetite
1931	**Tellurobismuthite**	Hidalgo	valid
1938	**Johannsenite**	Grant	valid
1943	**Ramsdellite**	Sierra	valid
1946	Dunhamite	Dona Ana	= lead telluride
1947	Microdunhamite	Dona Ana	= lead telluride
1950	Iron Uralite	Grant	= bassetite
1953	Chinoite	Grant	= libethenite
	Ferrojahnnsenite	Grant	= johannsen-nite
1958	**Santafeite**	McKinley	valid
1961	**Grantsite**	Valencia	valid
1962	**Hendersonite**	San Juan	valid
1964	**Goldmanite**	Valencia	valid
1964	Blanchardite	Socorro	= brochantite
1979	**Rajite**	Catron	valid
1983	**Lannonite**	Catron	valid
1983	**Wilcoxite**	Catron	valid
1985	**Georgechaoite**	Otero	valid
1988	**Scrutinyite**	Socorro	valid

Rajite $CuTe_2^{+4}O_5$

Rajite was described by Williams (1979) as a natural cupric pyrotellurite from Lone Pine, Catron County, New Mexico. It occurs as small green crystals (to 1.5 mm), with mackayite in rhyolite. It may be pseudomorphous after teineite.

The name is in honor of Robert Allen Jenkins (RAJ-ite), a mineralogist who was the first to recognize this new species.

Ramsdellite MnO_2

Ramsdell (1932) described a new manganese oxide, based on a single sample from an unknown locality, but he did not name it. Subsequently, specimens of the same mineral were collected by S. C. Creasey at Lake Valley, Sierra County, New Mexico, in 1941. Fleischer and Richmond (1943) briefly mentioned the new species and named it after Ramsdell, based on an examination of what they called his "type" specimen and on the more abundant material from Lake Valley. Fleischer *et al*. (1962) eventually published the complete data on which the new species was based.

It occurs as iron-gray to black, thick, tabular crystals or platy masses. It is commonly found intermixed with pyrolusite.

The name honors Professor Lewis S. Ramsdell of the University of Michigan, who reportedly first described the mineral.

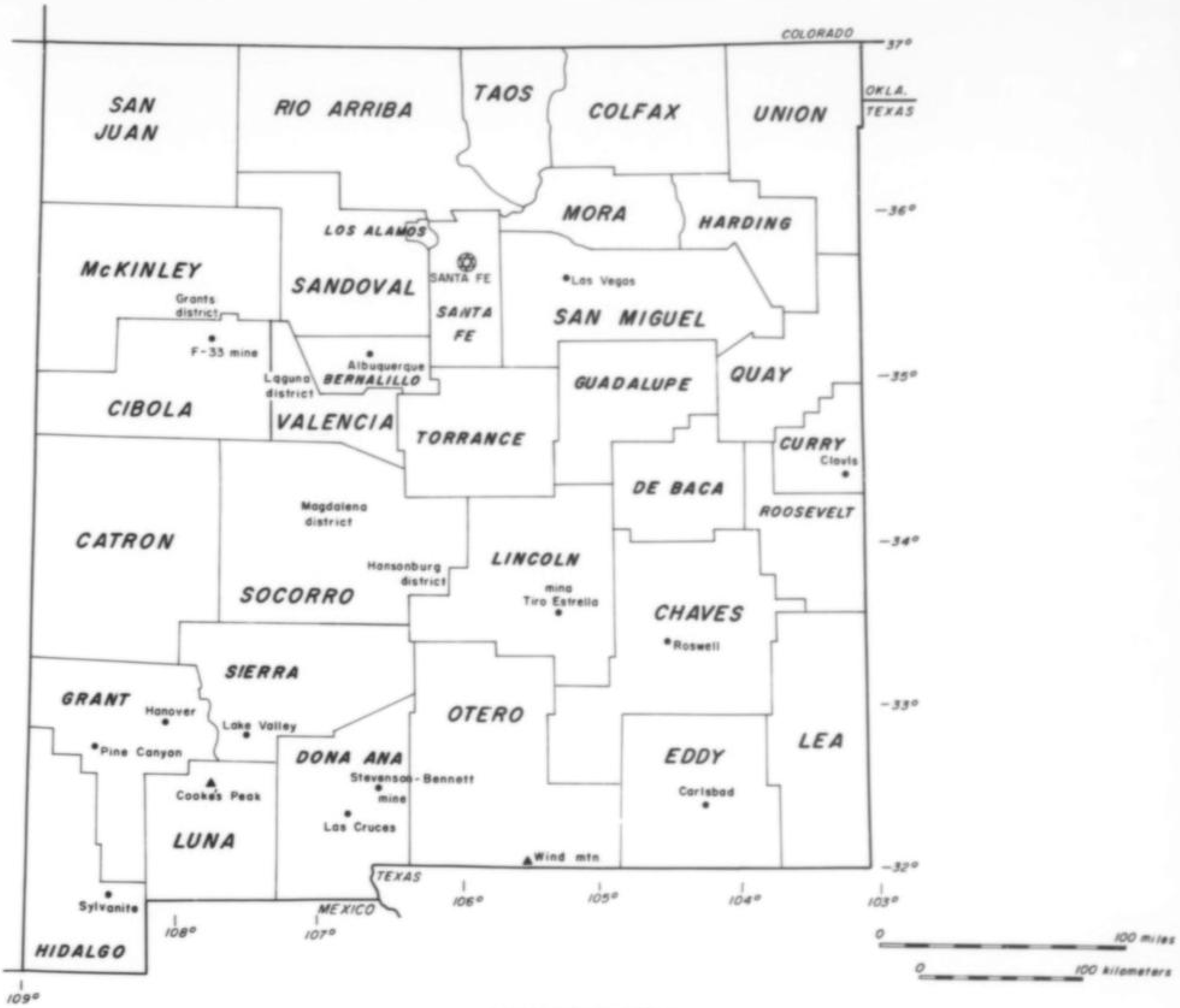
Santafeite $(Na,Ca,Sr)_3(Mn^{+2}, Fe^{+3})_2Mn_2^{+4}(VO_4)_4(OH,O)_5\cdot 2H_2O$

Santafeite was described by Sun and Weber (1958), based on specimens found in a cliff-face outcrop of the Todilto limestone in an unnamed uranium mine in section 25, T13N, R10W, about 19 km north of Grants, New Mexico, and 1.6 km north of the McKinley-Valencia county line.

It occurs as a crust of small brown rosettes of acicular crystals, sometimes in association with cuprosklodowskite.

Type specimens are held by the USNM.

Santafeite is named for the Atchison, Topeka and Santa Fe Railroad Company, because of its contribution to the exploration and development of the New Mexico uranium deposits.



Scrutinyite αPbO_2

Scrutinyite was recently described as a new species by Taggart *et al.* (1988), based on specimens from the Sunshine #1 mine, Hansonburg district, Socorro County, New Mexico.

This mineral forms extremely small, transparent, reddish brown crystals, always associated with plattnerite.

The name alludes to the close scrutiny that is necessary to distinguish the mineral from its dimorph, plattnerite.

The holotype specimen has been deposited in the NMNH.

Tellurobismuthite Bi_2Te_3

Tellurobismuthite, previously considered a variety of tetradymite, was elevated to species status by Frondel (1940), based, in part, on material from the Little Mildred mine, Sylvanite district, Hidalgo County, New Mexico. Other specimens used in the quantitative description were from Whitehorn, Fremont County, Colorado; and Mt. Sierra Blanca, San Luis County, Colorado. The mineral was also reported from Montana, Georgia, Virginia, Sweden and Japan.

Tellurobismuthite occurs as pale gray, metallic, foliated masses and irregular plates associated with gold and other tellurium minerals. At the Little Mildred mine, it was found with tourmaline, hessite and gold in quartz.

Wilcoxite $MgAl(SO_4)_2F \cdot 18H_2O$

Wilcoxite was described by Williams and Cesbron (1983) as a new fluosulfate from the Lone Pine mine, Catron County, New Mexico. It is a post-mine product that occurs as crusts and effluorescences in the adit and walls of the mine. It is found in association with gypsum, khademite and lannonite.

Type material was reportedly deposited at the University of Arizona at Tucson and at the British Museum of Natural History.

Wilcoxite is named for William Wilcox, who discovered this mining district in 1879.

OTHER NAMES

Many species, over the course of time, have become discredited or suspect as a result of later studies. Some names found in the older literature are actually rock or trade names that were never formally proposed as actual species names. Fleischer (1987) has been used here as the principal authority on questions of validity and composition.

Blanchardite is mentioned as a new mineral from the Blanchard claims by Strong (1964), who states that Dr. Frondel of Harvard University was describing an unknown that might be given that name. Both Abraham Rosenzweig, University of New Mexico, and Peter Embrey, British Museum of Natural History, identified blanchardite as brochantite (White, 1972).

Bonamite and ricolite are trade names for certain specimens of smithsonite and serpentine, respectively. Apple-green smithsonite from the Kelly mine, Socorro County, was called bonamite by lapidaries who marketed it in New York. Ricolite was an unusual banded serpentine that was commercially produced from an area north of Lordsburg, Grant County (Northrop, 1959).

Chinoite was originally described by Beck and Givens (1953) from the Chino pit, Kennecott Copper Company, Santa Rita District, Grant County. An error was made in the initial determination of the specific gravity of chinoite, on which the new species was largely based, and it was later found to be identical with libethenite (Guillemin, 1953).

Dunhamite and microdunhamite are names applied to an insufficiently described lead telluride mineral from the Hilltop mine, Dona Ana County (Fairbanks, 1946, 1947).

Endlichite was described by Genth and vom Rath (1885) as an intermediate species between vanadinite and mimetite, from the Lake Valley district, Sierra County. It is now regarded as arsenatian vanadinite (Fleischer, 1987).

Ferrojohannsenite or ferroan johannsenite were names proposed for iron-rich johannsenite from the Star mine, Grant County (Allen and Fahey, 1953). There is insufficient evidence to warrant the designation of a new species; this material is considered to be identical with johannsenite.

Kithilite and iron-uralite were names applied by two different authors (anonymous, 1920, and George, 1950) to the same material from the Merry Widow mine, near Silver City, Grant County. Frondel (1954) identified it as bassetite.

Nickel-skutterudite was proposed as a name for isometric $NiAs_3$, the nickel member of the skutterudite isomorphous series, by Holmes (1942). His description, and basis for the name, was based on synthetic material. Hillebrand (1889) made a preliminary description of specimens from the Rose mine, Black Hawk district, Grant County, including an analysis that yielded a composition between RAs_2 and RAs_3 (R = Ni, plus some Co, Ag and Fe). Waller and Moses (1892) also described a mineral from the Bullard's Peak district, Grant County that was probably identical with nickel-skutterudite. None of these early authors assigned a name to their described nickel arsenides. In 1942, Holmes attempted to reorganize the skutterudite series, based primarily on synthetic material. He proposed the names nickel-skutterudite and iron-skutterudite, which were challenged by Fleischer (1943). Northrop (1959) refers to the New Mexico occurrences as type localities, but this is technically incorrect.

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FAMOUS MINERAL LOCALITIES:

THE MAGDALENA DISTRICT KELLY, NEW MEXICO

Ronald B. Gibbs
P.O. Box 448
Tyrone, New Mexico 88065

The Magdalena district is famous for beautiful specimens of botryoidal blue-green smithsonite from the Kelly mine. Notable specimens of barite, azurite and aurichalcite have also been recovered from the Kelly mine and other neighboring mines in the district.

INTRODUCTION

The deserted town of Kelly lies at the foot of the Magdalena range, about 4.8 km (3 miles) southeast of Magdalena, Socorro County, New Mexico. Kelly was the principal town for the many mines that were active in the district in the late 1800's and early 1900's. At an elevation of 2160 meters, the climate ranges from semi-arid to sub-alpine. The largest mines, the Kelly, Graphic, and Juanita, operated on lead ores until the early 1900's when production turned to zinc. Today, the mines are all closed; most are posted against trespass and many have deteriorated to the point where the underground workings are very dangerous.

One of the best known dealers of Kelly minerals is Tony Otero, who has operated Tony's Rock Shop in Magdalena for many years. He has collected some of the finest Kelly mine smithsonites, as well as other local minerals, and still sells them from his shop. Tony has a wealth of information about the Kelly mine and other mines in the district; a visit to the area should include a stop at his shop.

HISTORY

The history of the Magdalena mining district begins with the arrival of Colonel J. S. Hutchason, a prospector known as "Old Hutch." Hutchason had been prospecting nearby without luck, but in the spring of 1866 he discovered rich lead outcroppings that became the Juanita claim, the first in the district. Hutchason also located the Kelly and the Graphic. The mines were worked in a small way for their lead value. Ore was smelted at the mine in small adobe furnaces and the lead bullion shipped to St. Louis. After a few years, metal prices fell and mining was suspended.

By 1872 many other claims had been located. Various smelting schemes were tried but with little success. Hutchason had given the Kelly claim to his friend, Andy Kelly. Kelly worked the claim for a while but Hutchason eventually restaked it after Kelly failed to perform the necessary annual assessment work. Hutchason did some additional work and then sold it to Patrick Dorsey and his associates of Socorro for $6,000 (Eveleth, 1983). He sold his other claims as well and left the district. Dorsey lost no time in continuing development work in the Kelly and eventually blocked out an impressive body of lead carbonate ore.

The Juanita and Graphic mines were also being worked at this time. Colonel E. W. Eaton operated the Juanita and smelted the ores in a small adobe furnace. He later bought another furnace, converted it to a water-jacketed blast furnace, and continued processing lead ores for several years.

The district was emerging as a major lead producer with small values in silver. It attracted the attention of Gustav Billing, a master smelterman in Leadville, Colorado. Billing arrived in 1882 and promptly bought the Kelly for $40,000 (Eveleth, 1983). The Graphic was also sold about this time, and many new claims were located in the district.

The Kelly was developed with a new Billing shaft and some smelting was done with development ore, but Billing had planned to build a large smelter for custom ores as well as Kelly ore. The Billing smelter was located at Park City, near Socorro, and was blown in in September of 1883. Billing was able to convince the Atchison, Topeka and Santa Fe Railroad to extend their line to Magdalena in 1885.

The Kelly, the Billing smelter and the new railroad line were thriving as the town of Kelly, and the whole district, enjoyed a lead-silver boom. The Billing smelter was able to make a profit with the low-silver Kelly ores by blending them with siliceous Mexican ores high in silver. Mexican ores could be imported duty-free if their gold or silver value exceeded their lead value. The other mines continued to

***Figure 1*. The Kelly mine, surface facilities, ca. 1940. Photo by G. F. Loughlin, courtesy of the U.S. Geological Survey.**

produce secondary lead-silver ores, small amounts of rich copper ore, and some lead and zinc sulfides.

The lead-silver boom lasted until about 1888, when lead and silver prices began to fall. The duty-free status of the Mexican ores ended in 1890 and, along with lower metal prices and higher costs, resulted in the Silver Crash of 1893 which forced many American mines to close overnight. The Billing smelter held on until July of 1894 when it was permanently closed. The Graphic smelter, erected in 1896 to treat lead carbonate ores at the rate of 100 tons per day, was able to operate until 1902 when the ores were exhausted. The boom was over, the Kelly mine had closed and production from the district fell drastically.

Although the district was fairly quiet, lessees operated many of the mines. While operating the Graphic mine, C. T. Brown and J. B. Fitch became interested in the zinc carbonates that had been avoided during lead mining, and purchased the mine. Samples sent to eastern zinc smelters and pigment plants generated enthusiastic orders for ore shipments and a zinc boom began.

A wide assortment of geologists and engineers soon paid the district a visit as the mines reawakened for zinc production. Articles appearing in the trade magazines described the great zinc camp that was soon to be. Brown and Fitch sold the Graphic mine to the Sherwin Williams Paint Company for $150,000, who then organized the Graphic Lead and Zinc Mining Company to operate it. Later the name was changed to the Ozark Smelting and Mining Company. The Kelly mine was sold to the Tri-Bullion Smelting and Development Company by Mrs. Billing for $220,000. Production began from dumps and orebodies that were virtually blocked out by the previous mining for lead. The mining of sulfide ores became important as well. Tri-Bullion sank the Traylor shaft in 1907, to gain access to deeper sulfide orebodies, and installed a new processing plant in 1909. The Waldo tunnel was driven 570 meters to intersect the "silver pipe" bed and help develop the Graphic mine.

Large sulfide orebodies were developed by the managing companies, who also built and experimented with concentrators. The majority of the carbonate ores produced were mined by lessees working in the upper levels. C. T. Brown, who worked the upper levels of the Kelly mine until 1911, shipped sizeable quantities of zinc carbonate ore, 15,000 tons in 1910 alone. Tri-Bullion left the district in 1913 when it sold the Kelly mine to the Empire Zinc Company for $87,500 (Loughlin and Koschmann, 1942). Empire Zinc improved the mill and operated on sulfide ores until their exhaustion in 1917. Carbonate ores continued to be mined until 1921 when the mine was idled.

Production for the district peaked in 1916, and by the early 1920's had declined. Various lessees have operated many of the mines intermittently since the decline, and although there were occasional small revivals of mining, the district never again achieved the production levels of its lead and zinc boom days. Finally, in 1970, the last active mine in the district closed. The Empire Zinc Company was acquired by Gulf and Western Corporation, which has been seeking a buyer for its holdings in the district. The Waldo-Graphic mine has been leased by the New Mexico Institute of Mining and Technology and is used for research and teaching.

During its productive history the Magdalena district yielded more than 162,500 tons of zinc, 73,000 tons of lead, 5,500 tons of copper, 4 million ounces of silver, 10,000 ounces of gold, and countless fine mineral specimens.

At the Kelly mine, the Traylor shaft headframe and Tri-Bullion's roasting ovens stand amid the ruins of other structures, silently awaiting renewed mining. Many of the collectors who used to visit the district no longer return because of the deteriorated condition of the workings. The town of Kelly, which sprang to life officially in 1883, survived the silver crash and grew during the zinc boom, declined and was deserted by the 1950's. The only building that has remained in the town that once boasted 3,000 residents is the new Catholic church. It was built in 1948 with lumber from a dismantled saloon and dancehall which had served as the earlier church.

GEOLOGY

Several discussions of the geology are available and Titley (1959) gives a concise summary. The Magdalena district lies on the west side of the north-south trending Magdalena mountains. These block-faulted

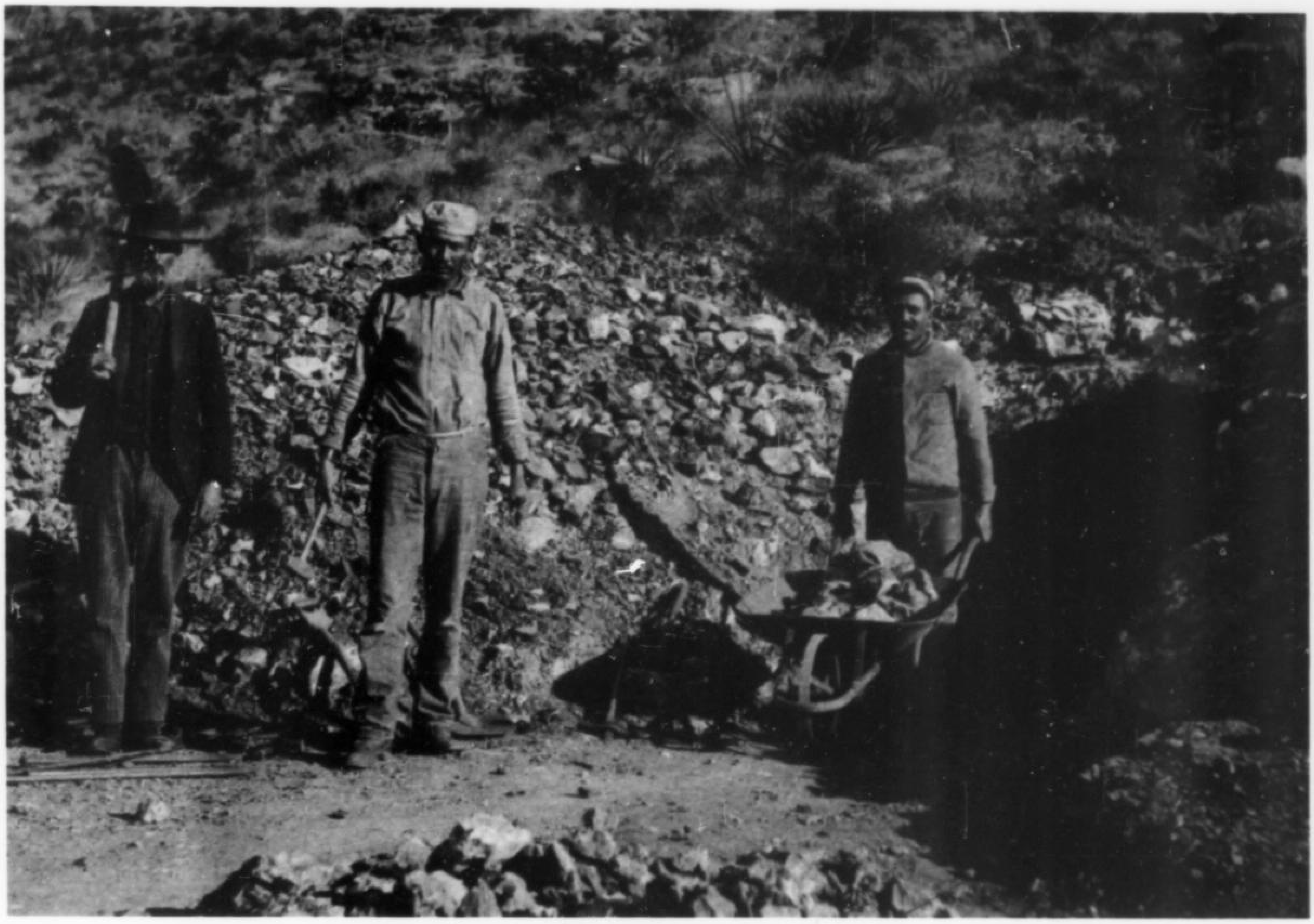


Figure 2. **Mexican miners at Kelly (1887). Photo by Joseph E. Smith, courtesy of David R. Phillips, Chicago.**

mountains contain a Precambrian core of argillites accompanied by intrusions of granites, diabase, gabbro and felsite. Younger Paleozoic sediments are found as down-dropped fault blocks which have been dropped as much as 460 meters by major north-south and smaller traverse faults. The oldest of the sediments is the Mississippian Kelly Limestone which unconformably overlies the Precambrian. It has been divided into four units; a basal sandy unit up to 2 meters thick, the lower crystalline limestone, 15 meters thick, a 1–4 meter thick dolomitic and shaly limestone known as the "silver pipe," and an upper crystalline limestone, 15–18 meters thick. The Kelly Limestone is the most economically important unit in the district, hosting nearly all the major deposits. The Kelly is overlain by sediments of the Pennsylvanian Magdalena Group and the Permian Abo Formation.

Tertiary "Laramide"-age intrusion of granitic and monzonitic stocks provided the mineralizing fluids for ore formation. Most of the ore deposits of the Magdalena district are formed as replacement bodies in the Kelly Limestone. Faults, locally intense fracturing, and the "silver pipe" bed localized ore deposition. Many meters of drifting was done along the "silver pipe" in search of additional ore.

Orebodies have been classified by Loughlin and Koschmann (1942) according to temperature of formation. Hypothermal assemblages were deposited nearest the intrusions and are characterized by masses of magnetite and specular hematite. Mesothermal deposits are found farther from the intrusions, mainly in the Kelly Limestone, as pyrite-galena-sphalerite bodies or more economically important sphalerite-galena bodies. Leptothermal deposits formed farthest from the intrusions and consist of minor assemblages of sulfides-barite-fluorite. Most orebodies contain all three types and grade laterally away from the intrusions, from hypothermal to leptothermal. Attendant rock alteration included the formation of contact metamorphic silicates, such as wollastonite, diopside, garnet, epidote and jasperoid.

Subsequent erosion and oxidation have produced secondary orebodies of carbonates, oxides and mixed sulfides-carbonates. As carbonate and oxide ores were being formed above the water table, a zone enriched in hematite was formed at the water table (Loughlin and Koschmann, 1942). Lead carbonate orebodies formed essentially in place after the copper and zinc were leached out. Zinc carbonate ores formed below and downdip from the lead carbonates, and secondary copper ores were formed near the bottom of the oxide zone.

Loughlin and Koschmann described the formation of the secondary ores in detail. Percolating groundwater placed zinc in solution and then deposited it by replacing limestone with smithsonite, at or below the water table. As zinc was exhausted, pyrite and chalcopyrite oxidized to form iron oxides and acids which dissolved the previously formed smithsonite. This remobilized zinc was redeposited as smithsonite by replacing massive limestone or by lining cavities. Where copper was present, the smithsonite took on a pleasing blue-green color and aurichalcite formed, often interlayered with smithsonite. Where copper was deposited from solution in the absence of limestone, azurite, malachite, native copper and other oxides formed.

Galena was the last sulfide to oxidize and formed bodies of cerussite virtually in place. Where compact and dense, the ore was called "hard carbonate"; where it formed a mass of loosely attached crystals, it was known as "sand carbonate." C. T. Brown encountered sand carbonate that freely flowed out of the stope and had only to be shoveled into ore cars. Such ore needed no blasting and some lessees simply

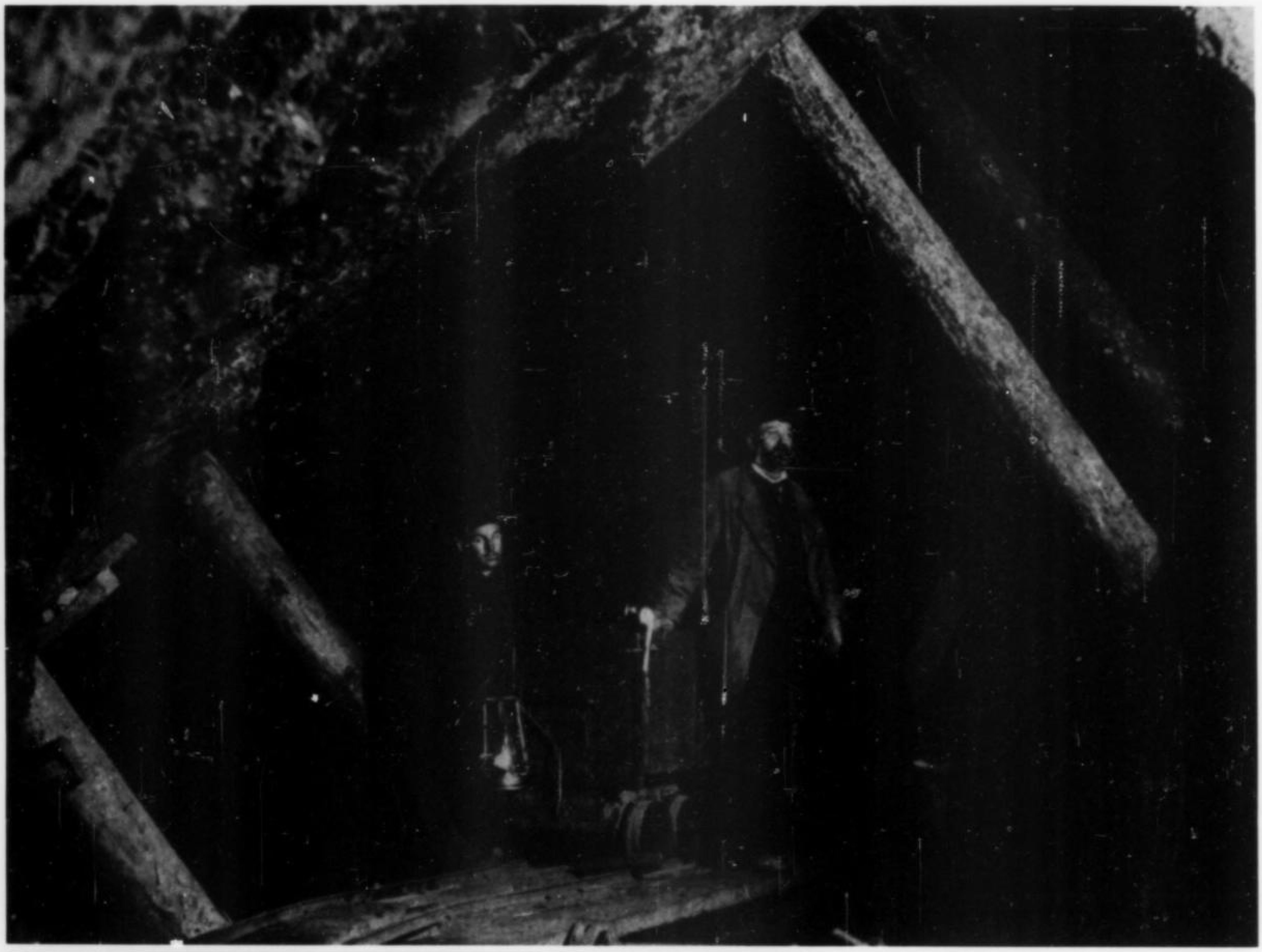


Figure 3. Underground at the Kelly mine (1887). Photo by Joseph E. Smith, courtesy of David R. Phillips, Chicago.

Figure 4. Miners working a vuggy vein in the Kelly mine (1887). Photo by Joseph E. Smith, courtesy of David R. Phillips, Chicago.

shot into the stopes with rifles to get more ore flowing (T. Otero, personal communication). Some of this ore carried as much as 20 ounces of silver per ton, which is very good for the district.

The final step in the oxidation sequence was the formation of iron and manganese oxides. Smithsonite was again deposited on these recently formed oxides. With carbon dioxide nearly exhausted, the basic carbonates hydrozincite and aurichalcite formed on and alternately with smithsonite. Hemimorphite was the last zinc mineral to form when carbon dioxide was finally depleted.

MINERALS

The Magdalena district has produced a rich variety of minerals and has been visited by countless collectors for many years. Unfortunately, literature references and specimen labels often refer to the locality simply as Kelly or Magdalena and do not identify a specific mine. The Graphic, Kelly and Juanita mines adjoin each other, are interconnected at depth, and have similar mineralogy. Most of the following mineral descriptions are based on the observations of Herman Wuestner (1930), who visited the district in 1927, and Loughlin and Koschmann (1942), who studied the geology and ore deposits in detail for the United States Geological Survey.

Acanthite Ag_2S

A mineral resembling acanthite was found by Loughlin and Koschmann intergrown with chalcocite in high-grade silver ore from the Iron Mask mine.

Actinolite $Ca_2(Mg,Fe^{+2})_5Si_8O_{22}(OH)_2$

Wuestner reported actinolite occurring as bluish green fibers with pyroxene and epidote. No actinolite was observed by Loughlin and Koschmann during their study of the district.

Allophane (amorphous hydrous aluminum silicate)

The outcrop of the Kelly orebody contains conspicuous allophane as pale bluish to greenish translucent masses that become chalky white on exposure. The color is due to the presence of small amounts of chrysocolla. This and other clay minerals are common in the oxidized ores.

Andalusite Al_2SiO_5

Andalusite has been noted from the Hardscrabble mine as a few grains with sericite and chlorite in hornfels.

Andradite $Ca_3Fe_2^{+3}(SiO_4)_3$

Andradite has been found as yellowish brown granular aggregates replacing part of the Kelly Limestone at the Linchberg Tunnel, in association with hedenbergite, quartz, calcite, hematite, magnetite and sulfides.

Anglesite $PbSO_4$

Anglesite was common in the oxidized zone as thin-banded gray to white crusts on remnants of galena, usually altering to cerussite.

Antigorite $(Mg,Fe^{+2})_3Si_2O_5(OH)_4$

Antigorite has been found as soft, pale brown, highly cleavable masses partially replacing diopside in contact metamorphic zones and as massive replacements of limestone. Pseudomorphs after an unknown elongate mineral were found on level 2 of the Nitt mine.

Antlerite $Cu_3(SO_4)(OH)_4$

A specimen of cuprite furnished to Loughlin and Koschmann by Herman Wuestner contained very small quantities of antlerite with azurite and spangolite. The mine from which the specimen was taken was not reported.

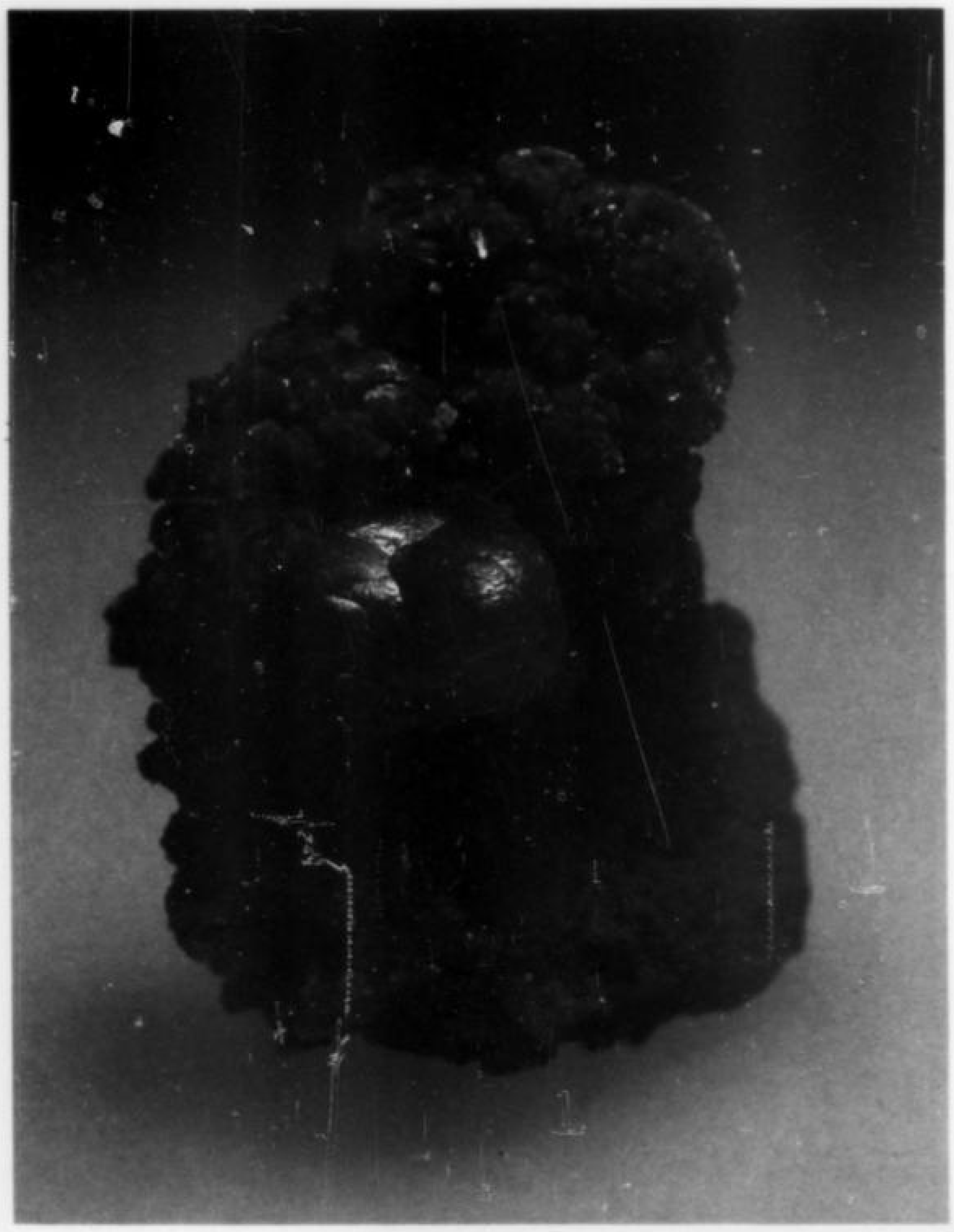
Aragonite $CaCO_3$

Wuestner reported aragonite occurring as delicate fibers, botryoidal or massive, crystalline, and as clusters of pseudohexagonal crystals partly replaced by smithsonite.

***Figure 5.* Mines in the Magdalena district (after U.S.G.S. Magdalena District map of 1932).**

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

Aurichalcite has been found throughout the district, as acicular



crystals and fine-bladed aggregates, often with a silky appearance. It is often found as layers between botryoidal and crustiform smithsonite, as drusy cavity linings and as small tufts on smithsonite and other minerals. A unique occurrence in the old Graphic workings (Keys, 1905) consisted of aurichalcite-lined cavities covered with clear crystalline calcite which appeared to be colored green.

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

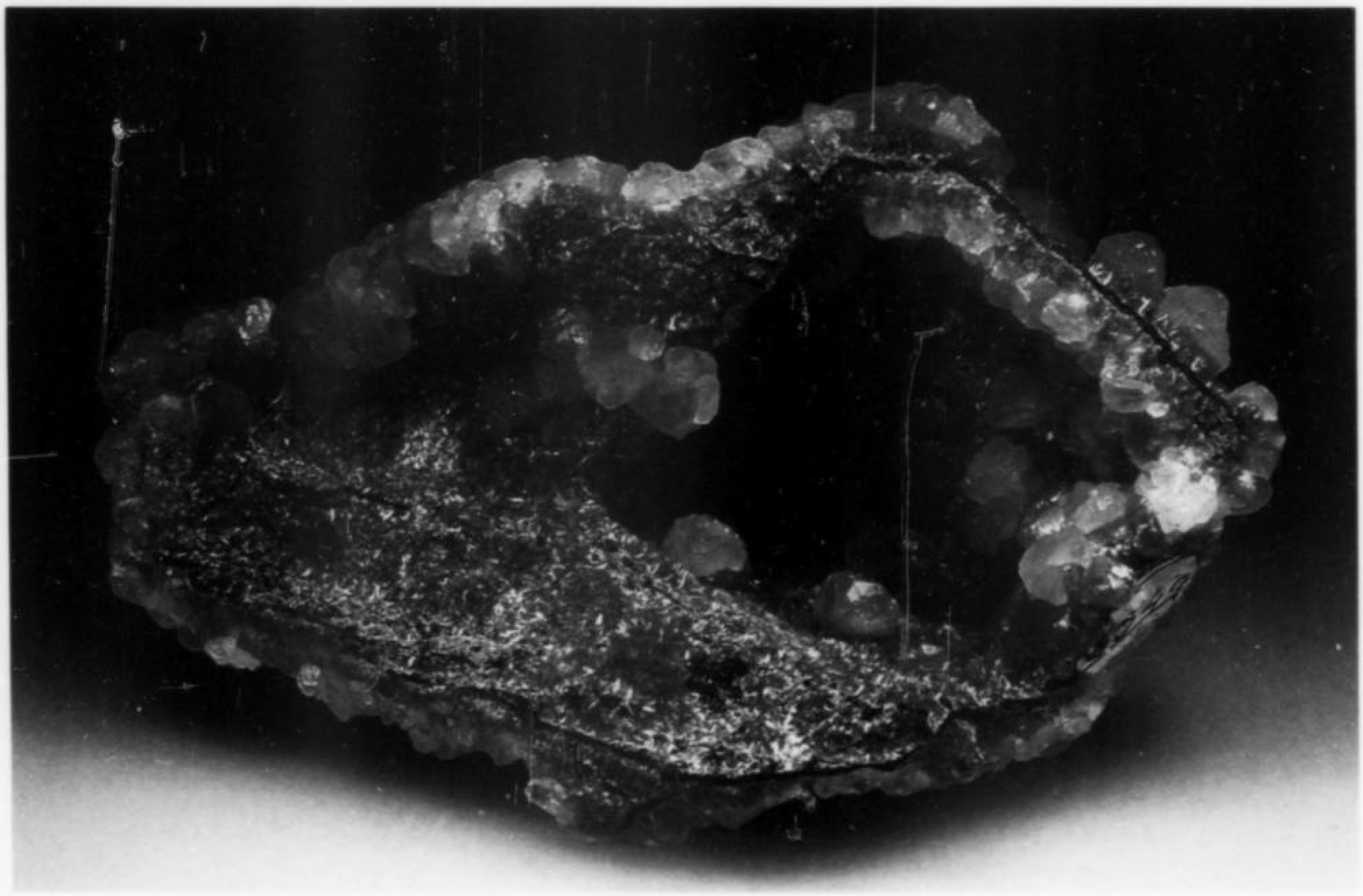
Azurite is a common member of the oxide suite, associated with smithsonite, malachite, aurichalcite, hydrozincite, allophane and iron and manganese oxides. It is commonly found as coatings and crystalline aggregates in the form of spheres and knobs. Fine, lustrous, single crystals up to 1 cm long were found in the Kelly mine by C. T. Brown in the 1920's (?) and are now part of the New Mexico Bureau of Mines and Mineral Resources collection. "Floater" crystals have been screened from the dumps of the Juanita mine (Holmes and Kennedy, 1983).

Barite $BaSO_4$

Barite has been found in many of the mines where the ore deposits formed at lower temperatures. Euhedral crystals are white to pale pink or tan, up to 10 cm long, and form radial and interlocking groups with quartz and fluorite. Many fine specimens of tan barite crystals on quartz have been found in the Juanita mine and similar ones occur in the Kelly mine.

Figure 6. **Aurichalcite with smithsonite, 3.2 cm tall, from the Kelly mine. Tony Otero collection; photo by Ron Gibbs.**

Figure 7. **Calcite with aurichalcite lining a vug, 15 cm across, from the Kelly mine. Harvard collection.**



Bornite Cu_5FeS_4

Bornite has been reported as sparingly present by Wuestner but not observed by Loughlin and Koschmann.

Calcite $CaCO_3$

Calcite is common in the district; Loughlin and Koschmann have identified three types of occurrences related to ore formation. Platy white to pale gray crystals in radial aggregates up to 1.2 cm in length are found in the sulfide ores of the Graphic-Waldo and Kelly mines. They are accompanied by specular hematite, sulfides and quartz, and are thought to have been formed at relatively high temperatures before the main sulfide ores were deposited. Scalenohedral crystals are found

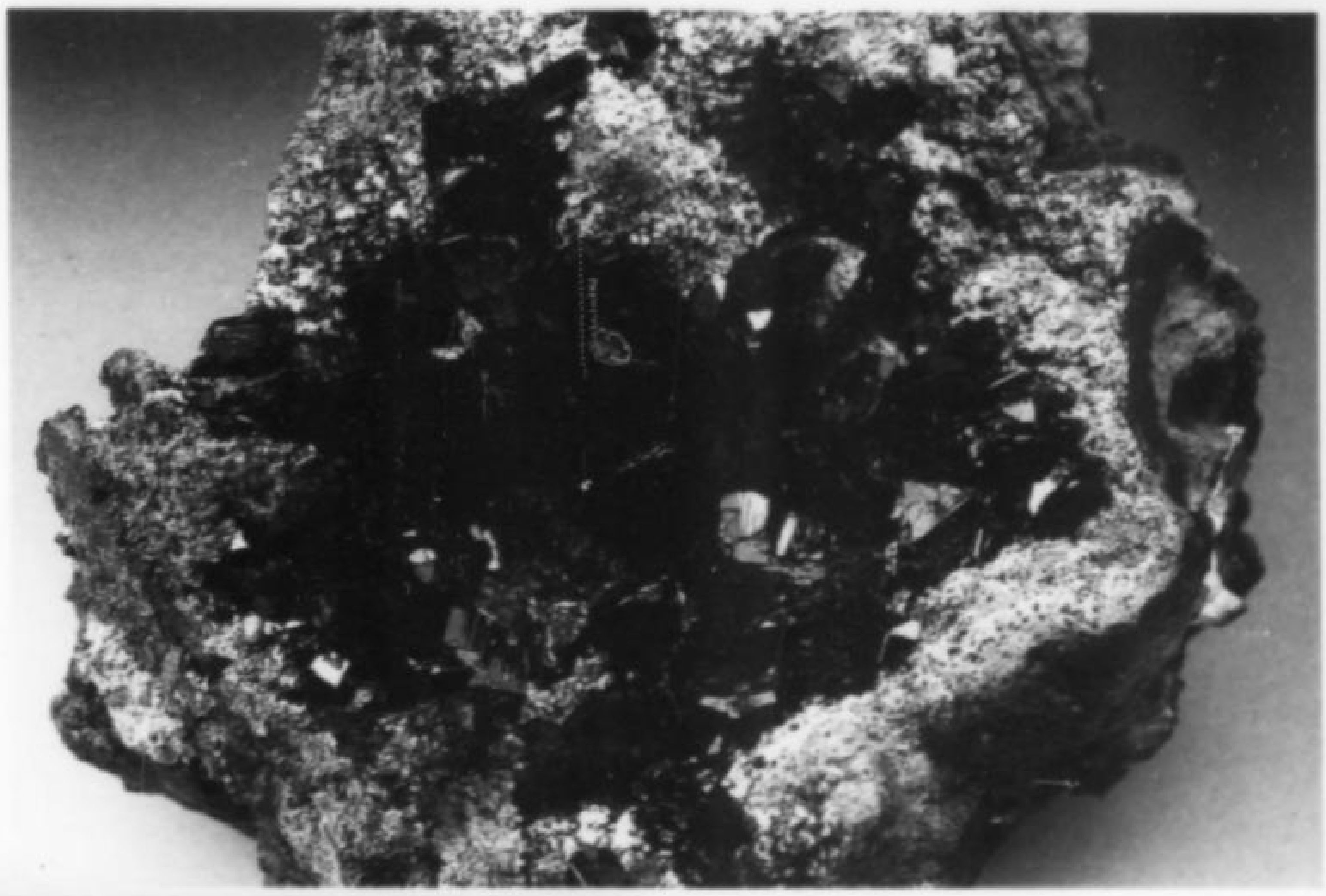


Figure 8. **Azurite crystal pocket, 6.6 cm, from the Kelly mine. New Mexico Bureau of Mines collection.**

Figure 9. **Azurite crystals on limonite, 10.5 cm, from the Kelly mine. Harvard collection.**

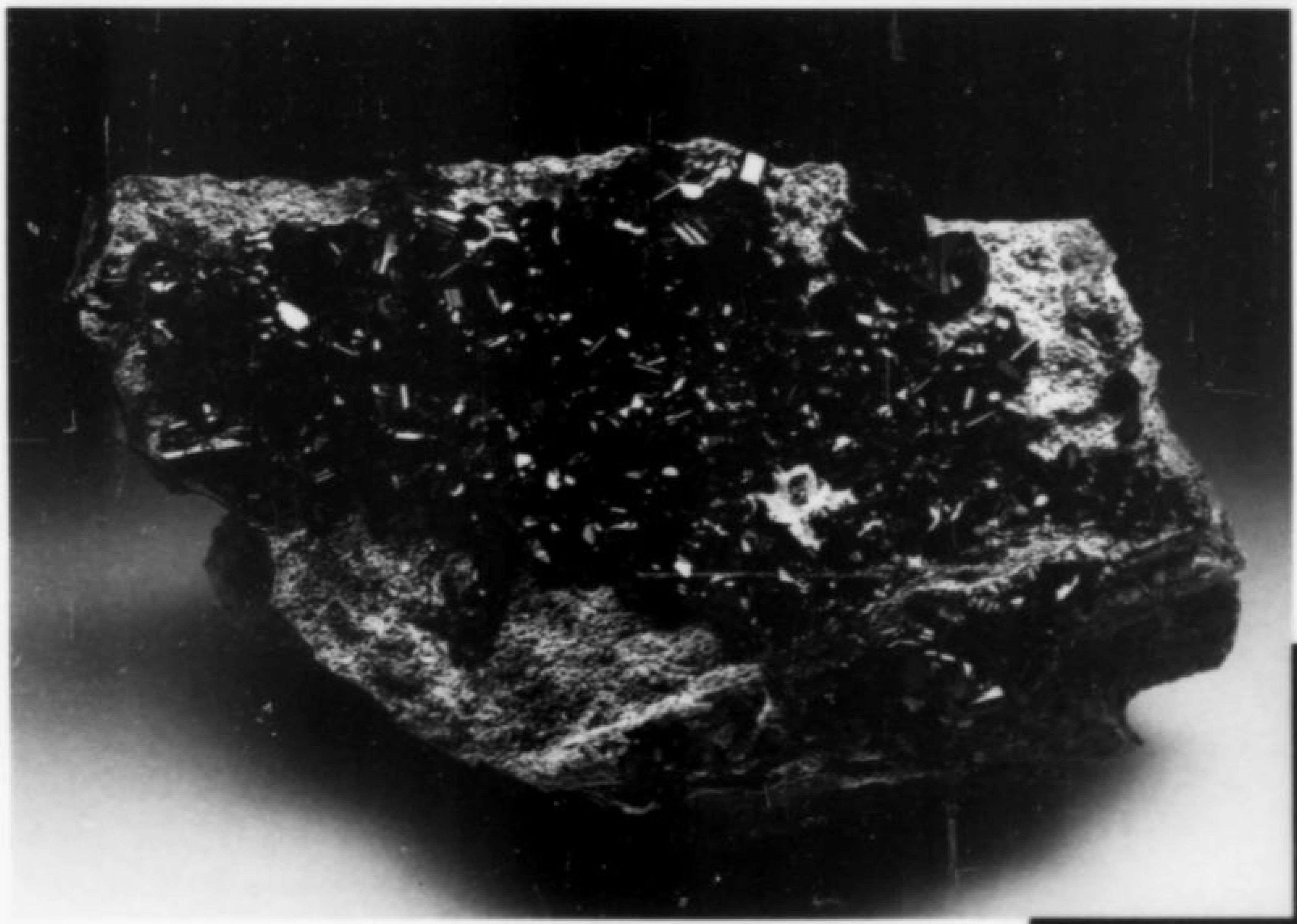
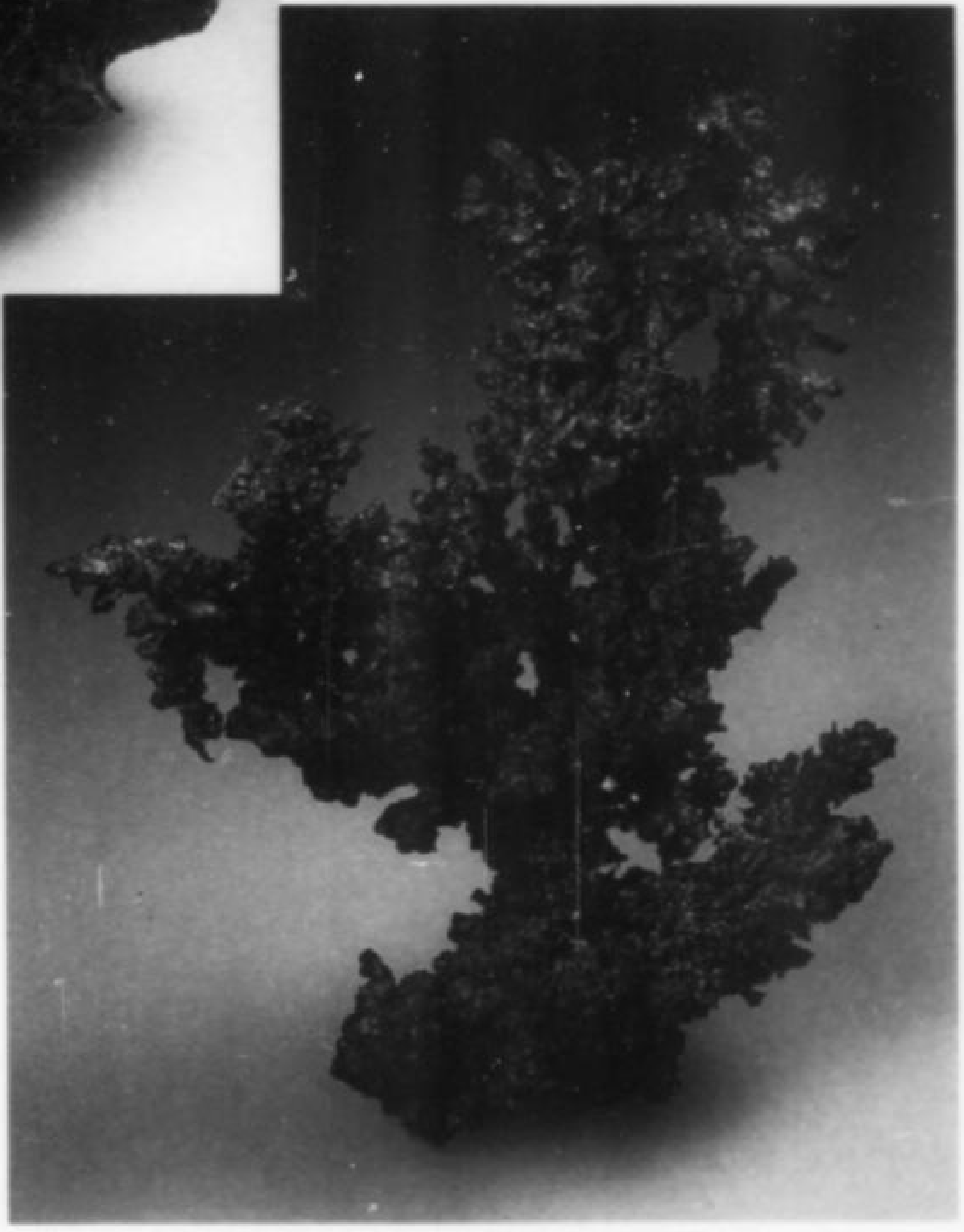


Figure 10. **Arborescent copper, 9.7 cm, from the Kelly mine. New Mexico Bureau of Mines collection.**



lining or filling vugs and fractures around and near the orebodies, and are thought to have been deposited by weak ascending hypogene solutions. Supergene calcite is common in the oxidized zone as disk-like or "nailhead" crystals up to 1.2 cm in diameter.

Cerussite $PbCO_3$

Found throughout the district, cerussite was occasionally the most important ore mineral. Banded or glassy masses, and aggregates of prismatic or bladed crystals up to 1.2 cm long, are often stained reddish brown or yellow by iron oxides. Cerussite usually formed in place but has also been found as veinlets and small crystal clusters in fractures in unmineralized rock. Large masses of loosely attached crystals formed "sand carbonate" orebodies up to 20 meters wide that were particularly easy to mine.

Chalcanthite $CuSO_4 \cdot 5H_2O$

Chalcanthite has been found rarely as crusts in old mine workings and open fissures.

Chalcocite Cu_2S

Sooty black chalcocite coats and fills small cavities and cracks in pyrite and chalcopyrite. Not abundant anywhere in the district, it is usually found with orebodies encased in silicified rocks where copper carbonates were less likely to form. Massive and crystalline chalcocite has been found in the Stonewall mine and at the Iron Mask mine.

Chalcophanite $(Zn,Fe^{+2}, Mn^{+2})Mn_3^{+4}O_7 \cdot 3H_2O$

Chalcophanite has been found sparingly throughout the district as steel-blue aggregates and crusts on smithsonite (Brinsmade, 1906).

Chalcopyrite $CuFeS_2$

The only primary copper mineral in the district noted by Loughlin and Koschmann is chalcopyrite, found in two forms: as visible, small, irregular grains up to 2.5 cm in diameter, and as microscopic blebs enclosed in sphalerite.

Chlorargyrite $AgCl$

All the oxidized lead and zinc ores of the district contained silver, and Loughlin and Koschmann surmised that it occurred as cerargyrite or "horn silver." It has been found in the Juanita mine as small, subhedral to euhedral, greenish brown to tan crystals (Bill Hunt, personal communication, 1987).

Chlorite group

Widespread in the district, fine-grained, dark green, micaceous chlorite occurs with sericite as replacements of dark rock-forming silicates in altered igneous and sedimentary rocks. It has also been found in the orebodies; in the Graphic-Waldo it is a prominent gangue mineral in pyritic lenses.

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

Chrysocolla, although common in the andesite to the west and northwest of the main part of the district, is rarely found in the limestone areas.

Copper Cu

Native copper is commonly found in the oxidized portions of the ore deposits as masses, thin leaves and arborescent growths. Wuestner reports arborescent copper embedded in cuprite. According to C. T. Brown, the southern part of the Graphic-Waldo mine contained "lumps of native copper too big for two men to lift."

Covellite CuS

About as abundant as chalcocite, covellite is found as minute grains associated with chalcopyrite, galena and chalcocite. It is found along with anglesite, replacing chalcopyrite and galena in the copper shoot of the Graphic-Waldo mine, and also replacing chalcocite at the Iron Mask mine where it is being replaced by copper, cuprite and copper carbonates.

Cuprite Cu_2O

Cuprite occurs as masses and as fine euhedral crystals in cavities in massive cuprite. Crystals are highly modified cubes and dodecahedrons. Octahedrons of malachite, and rarely azurite, as pseudomorphs after cuprite, have also been found, notably in the Graphic-Waldo workings. Massive cuprite occasionally contains native copper.

Cyanotrichite $Cu_4Al_2(SO_4)(OH)_{12} \cdot 2H_2O$

A small cuprite specimen collected in the Kelly mine between 1900 and 1905 by Herman Wuestner contained deep blue, compact masses of radiating fibers that Loughlin and Koschmann report are probably cyanotrichite.

Delafossite $Cu^{+1}Fe^{+3}O_2$

Small black spherical crystal aggregates of delafossite have been found at the Kelly mine by Bill Hunt (personal communication).

Diopside $CaMgSi_2O_6$

Diopside is common in contact metamorphosed limestone with garnet, wollastonite and calcite. In the Nitt mine, diopside, as crystal aggregates with calcite, has been observed slightly altered to serpentine.

Dolomite $CaMg(CO_3)_2$

One sample of dolomite collected by Philip Argall (1908) contained pink rhombs on quartz in a quartz-specularite vein. Dolomite was not observed by Loughlin and Koschmann.

Dundasite $PbAl_2(CO_3)_2(OH)_4 \cdot H_2O$

Dundasite has been found in the Juanita mine and on its dumps, and also at the Kelly and Tip Top mines (Bill Hunt, personal communication, 1987). It occurs as white to pale blue, very small, spherical aggregates of acicular crystals no more than 2 mm in diameter, in cellular limonite associated with allophane and azurite.

Epidote $Ca_2(Al,Fe^{+3})_3(SiO_4)_3(OH)$

Epidote is found sparingly in the ores of the district but is more widespread in the altered rocks where it imparts a green color. It usually occurs as dense, yellow-green to green veins and patches in altered rocks but is occasionally found as coarse granular aggregates or bladed columnar crystals.

Fluorite CaF_2

Fluorite occurs in the outlying areas in low-temperature veins as colorless to green cubic crystals and masses with barite and quartz.

Galena PbS

Galena is present in most of the ores of the district, becoming increasingly prominent farther away from the monzonite contact. It is usually the least abundant sulfide and occurs as fine grained crystalline masses with sphalerite and chalcopyrite. Farther from the contact it is coarse grained and becomes the dominant sulfide. Galena is occasionally found in the oxidized ores as remnant lumps surrounded by anglesite and cerussite and locally associated with plumbojarosite.

Gold Au

Little gold has been produced from the district, but native gold was found in the Stonewall mine with cerussite and willemite in silicified limestone. Wires of gold were also reported in galena from this mine.

Goslarite $ZnSO_4 \cdot 7H_2O$

Goslarite is a post-mining mineral found as coatings on the walls of mine workings. It forms white, fibrous tufts with silky luster, occasionally as long as 10 cm, but so delicate that good specimens cannot be recovered intact.

Greenockite CdS

Greenockite has been found as a very thin, orange-yellow coating on smithsonite. Schaller and Fairchild (1938) determined that some cadmium sulfide is present in specimens of white, yellow and brownish amethystine Kelly mine smithsonite.

Grossular $Ca_3Al_2(SiO_4)_3$

Grossular is found throughout the district in contact metamorphosed limestones, and is locally prominent as brown or green massive granular aggregates.

Gypsum $CaSO_4 \cdot 2H_2O$

"Ram's horn" gypsum occurs in the "Big Room" of the Juanita mine (Bill Hunt, personal communication, 1987).

Halloysite $Al_2Si_2O_5(OH)_4$

Massive halloysite has been found as a replacement of allophane in the Juanita mine, and mixed with kaolinite in the Kelly mine.

Hedenbergite $CaFe^{+2}Si_2O_6$

Hedenbergite occurs in the contact metamorphic zone as fine grained masses, rosettes to 1 cm in diameter, and as sheaves of crystals up to 5 cm long with garnet, hematite, magnetite, quartz, calcite and sulfides. Greenish black when fresh, it alters to a dull green-brown.

Hematite Fe_2O_3

Hematite formed at high temperature as aggregates of bladed crystals in radiating sheaves. It is associated with magnetite, pyrite and ferroan sphalerite in lead-zinc sulfide orebodies.

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

Hemimorphite occurs in drusy aggregates of bladed, elongated crystals seldom more than 3 mm long, in cavities with smithsonite or "limonite." Occasionally it is found coated with colorless rhombs of calcite.

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

Hydrozincite occurs as thin, white, chalky to earthy interlayers with botryoidal smithsonite. Occasionally it is colored very pale green, possibly by the presence of minute amounts of malachite or aurichalcite.

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

Jarosite is found throughout the district in the upper portions of the oxide zone. It is conspicuous at the Hardscrabble mine, the Tabaschi tunnel of the Graphic-Waldo and in the outcrop of the Black Cloud orebody, as soft and earthy material ranging in color from ocherous yellow to yellow-brown. It is associated with plumbojarosite at the Hardscrabble mine.

Kaolinite $Al_2Si_2O_5(OH)_4$

Kaolinite has been found mixed with halloysite in the Kelly mine. Material that resembles kaolinite makes up much of the impurities in the silver pipe bed (Loughlin and Koschmann, 1942).

Limonite (hydrous iron oxides)

The term "limonite" has traditionally been used to describe yellow-brown to reddish earthy iron oxides containing water. It is often mixed with manganese oxides, and forms pseudomorphs after pyrite in some white rhyolite dikes.

Magnetite $Fe^{+2}Fe_2^{+3}O_4$

Magnetite forms irregular grains and masses associated with hematite, minute grains within hematite, and rarely as crystals to 0.5 mm in size.

Malachite $Cu_2(CO_3)(OH)_2$

Malachite is found throughout the district as a minor constituent of oxidized ores. It occurs as films, crusts and crystalline aggregates. Wuestner reports that it replaces azurite and cuprite and even crinoid stems. Fine pseudomorphs of malachite after cuprite crystals to 6 mm in size have been found in the Graphic-Waldo mine. Spheres of radiating acicular malachite up to 1 cm in diameter have been found in the Kelly mine, associated with smithsonite, barite, psilomelane and iron oxides.

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

Melanterite occurs locally as encrustations on the walls of mine workings, associated with goslarite and chalcanthite.

Muscovite $KAl_2(Si_3Al)O_{10}(OH,F)_2$

The variety sericite is abundant in argillite and altered igneous rocks as replacements of feldspar and other minerals. Muscovite was reported in metamorphosed limestone from Oak Spring.

Plumbojarosite $PbFe_6^{+3}(SO_4)_4(OH)_{12}$

Plumbojarosite has been noted prominently in the outcrop of the Hardscrabble mine where it occurs as minute crystalline flakes resembling jarosite.

Psilomelane (massive manganese oxides)

Found throughout the district, "psilomelane" usually occurs as mixtures of earthy, undetermined manganese oxides with pyrolusite, wad and iron oxides. Loughlin and Koschmann (1942) mention the manganese oxides psilomelane, pyrolusite and wad, but remarked that they were usually indistinguishable. These oxide mixtures are prominent along the margins of zinc and lead carbonate orebodies.

Pyrite FeS_2

Pyrite is common in sulfide ores throughout the district, as one of the earliest minerals to form. It is generally found as coarsely crystalline masses replacing Kelly limestone and as lenses and layers in hematite-magnetite masses. It is associated with hematite, magnetite, sphalerite and chalcopyrite. Well formed crystals up to 2 cm have been found, exhibiting a combination of the cube and pyritohedron.

Pyrolusite (see psilomelane)

Pyrrhotite $Fe_{1-x}S$

Pyrrhotite was reported by Argall in the ores of the Graphic-Waldo mine but was not observed by Loughlin and Koschmann.

Quartz SiO_2

Quartz is found throughout the district as massive, milky to gray veins connecting the orebodies, sometimes associated with other minerals. It is also widespread, but much more abundant, as massive to cellular "jasperoid" that has replaced the Kelly Limestone. Openings in the cellular jasperoid sometimes contain unreplaced limestone or are lined with small euhedral quartz crystals.

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

Rosasite occurs as small, blue-green, compact spheres of radiating acicular crystals at the Kelly and Juanita mines (Bill Hunt, personal communication, 1987).

Sanidine (K-Na feldspar)

Sanidine was reported as rare in samples from a dump near Oak Spring, associated with tremolite, wollastonite, garnet, diopside, muscovite and titanite (Loughlin and Koschmann, 1942).

Siderite $Fe^{+2}CO_3$

Siderite has been found in the Kelly and Germany mines associated with galena, sphalerite, quartz and barite. The crystals are small and occur as pale brown to white rhombs coating vugs in the vein and in the silicified limestone, and also perched on botryoidal sphalerite. A massive, granular carbonate found in the Graphic-Waldo mine resembles the manganoan siderite of the Leadville district and may explain the prominence of iron and manganese oxides in the oxidized zones (Loughlin and Koschmann, 1942).

Silver Ag

Silver in native form is not common in the district. It has been found as wires at the Anchor mine, in seams in galena and other sulfides, and at the Black Cloud mine as specks with pyrite in replacement quartz. Tony Otero has found small amounts of silver in the Kelly mine, and Bill Hunt observed small wires of silver associated with chlorargyrite in the Juanita mine.

Smithsonite $ZnCO_3$

Most smithsonite in the Magdalena district occurs as massive replacements of the Kelly Limestone. The massive material ranges in color from white to gray and brown, and has a uniform crystalline texture that resembles the original limestone. This type of replacement is often so perfect that fossils have been faithfully preserved (Keyes, 1905). Recognition is difficult except for its greater specific gravity. Some smithsonite ore occurred in the form of boxwork structures and brown to reddish porous replacements of Kelly limestone.

Botryoidal and mammillary crusts were also common, and formed in open spaces, sometimes as typical "turkey fat" ore. This type of smithsonite occurs in a variety of colors including white, yellow, gray, brown and amethyst, but the most prized are the various shades of blue-green. Yellow smithsonite from the Kelly mine was analyzed by Schaller and Fairchild (1938). Their specimen contained bands of brown, white and yellow, all of which contained cadmium. Little sulfide was present and the authors concluded that the color was due to the presence of cadmium carbonate.

Individual crystals are rare, but small bowties, globules and rice-

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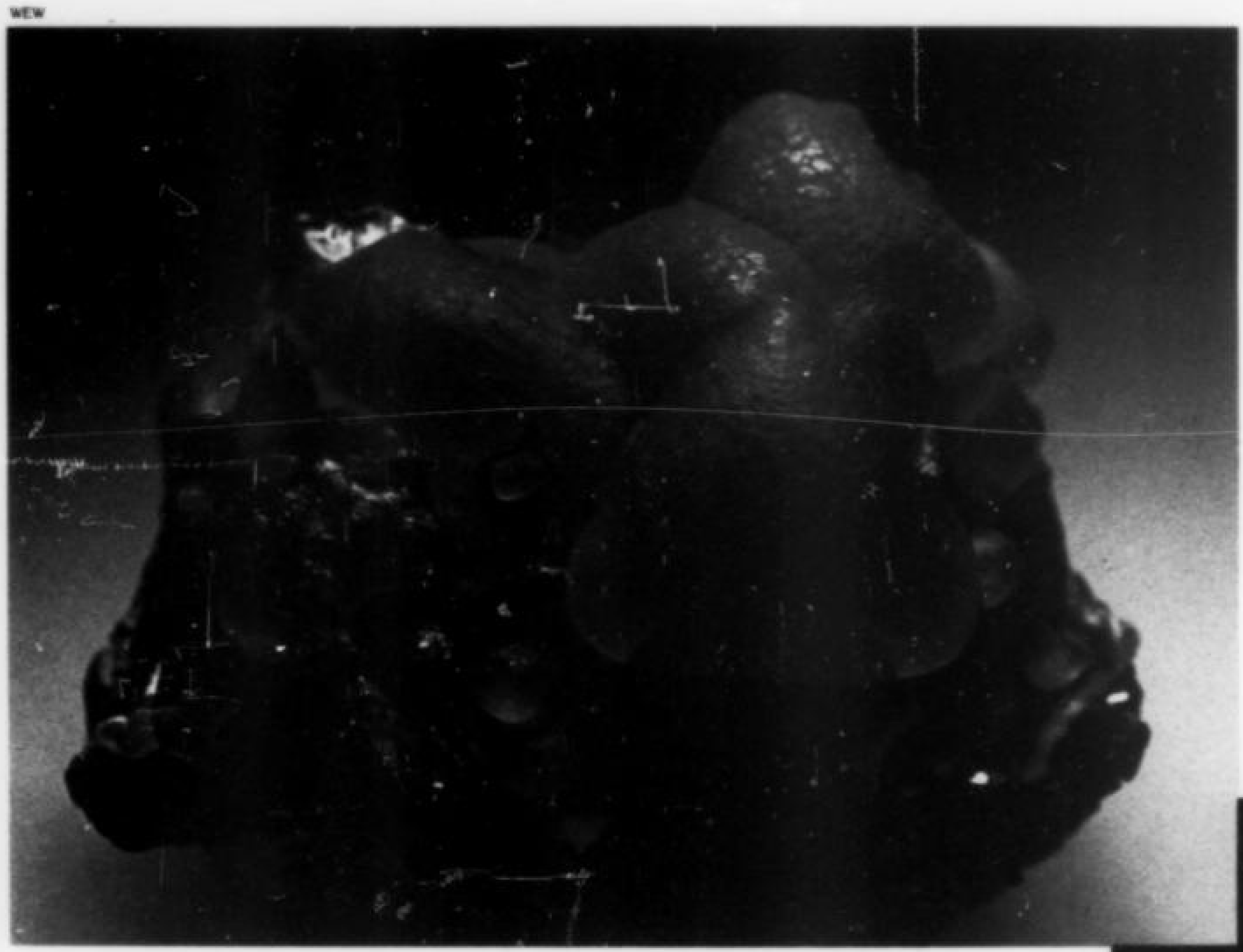
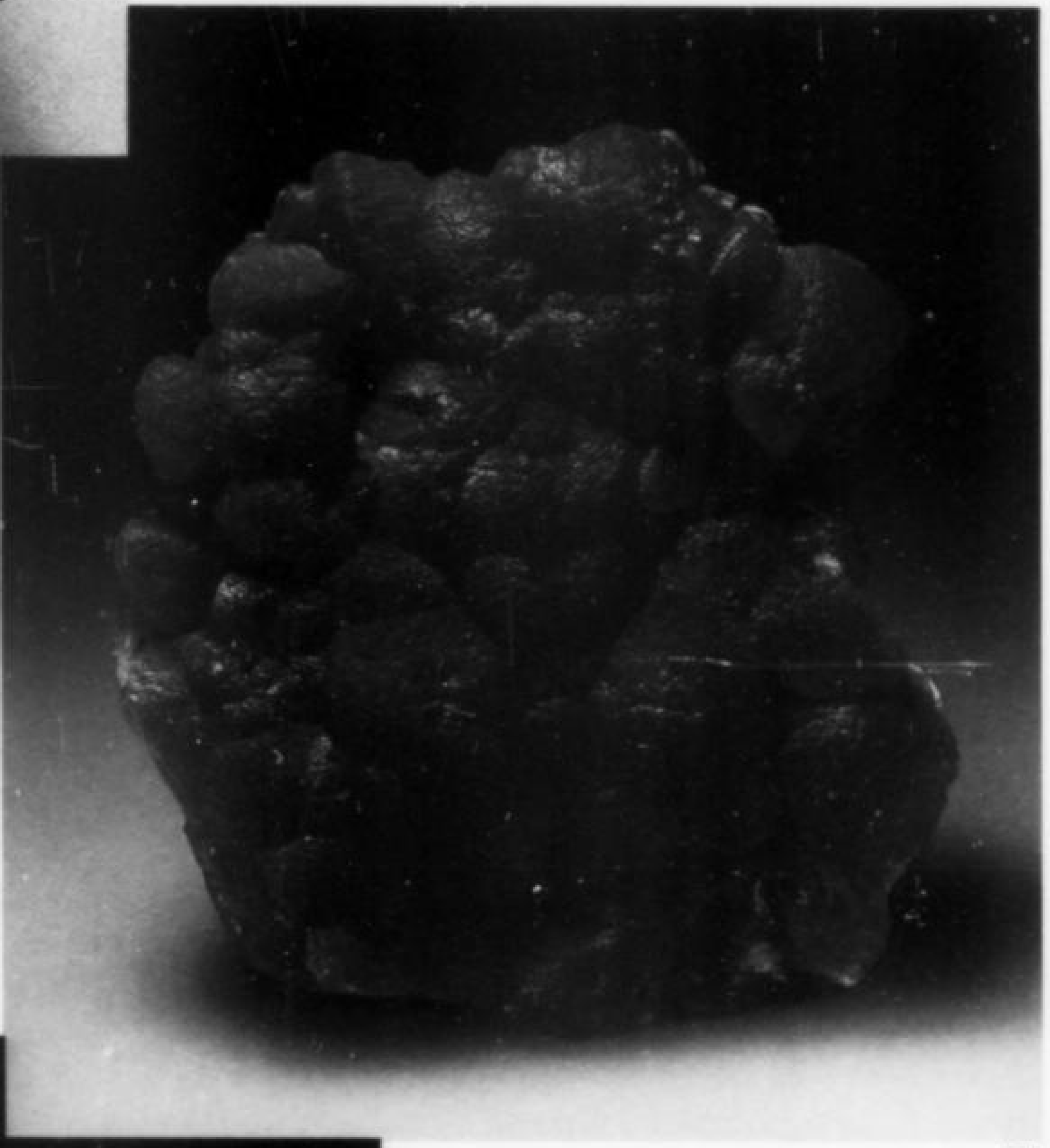


Figure 11. **Rounded trigonal aggregate of smithsonite, 1.4 cm, on matrix, from the Kelly mine. Wayne and Dona Leicht collection.**

Figure 12. **Plate of sheaf-like to botryoidal smithsonite, 8.8 cm, Wayne and Dona Leicht collection.**



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grain or spike-like crystal aggregates are common. Stalactitic growths are sometimes found attached to the walls of pockets. More rarely, it occurred as small globular encrustations and replacements (?) of intergrown branching stalactites of calcite (?). The Kelly mine was the most famous and prolific producer of fine specimens. They are most often botryoidal crusts, as much as 13 cm thick and 45 cm across with color ranging from light apple-green through blue-green to brilliant sky-blue. Botryoidal masses of great size were sometimes found (Sterrett, 1907); and one smithsonite-lined cavity is reported to have measured nearly 8 meters long.

Smithsonite also occurs as scattered clusters of globular or simple crystal aggregates on crusts of acicular blue-green aurichalcite. Aurichalcite is commonly interlayered with botryoidal crusts of smithsonite.

Translucent, gemmy, blue-green smithsonite has been sold as a semi-precious gemstone for cabachon cutting since the time it was first discovered. Attractive cut stones resemble chrysophrase in color. Unfortunately, the softness of the stones precludes frequent wearing.

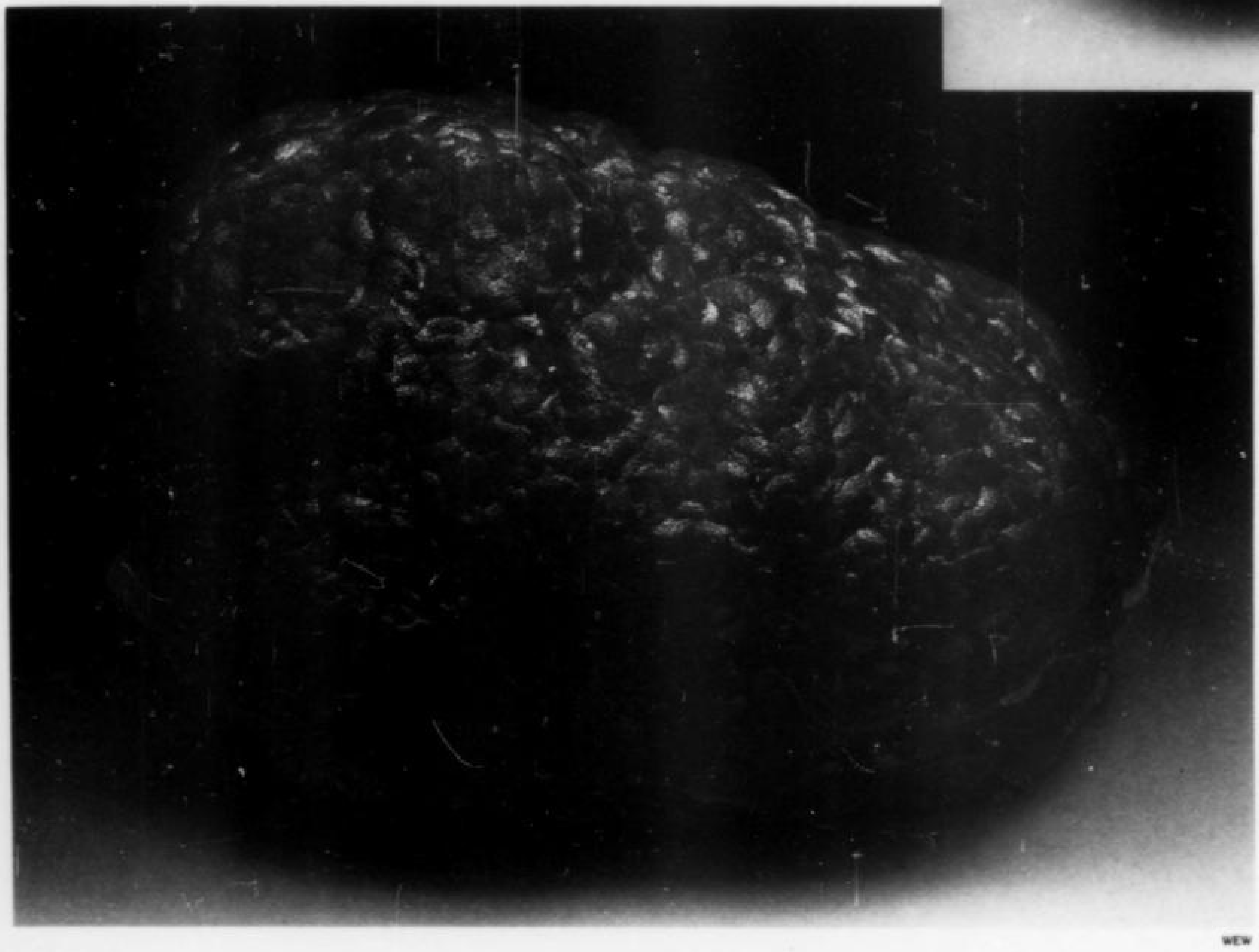

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Figure 13. **Large mamillary crust of smithsonite, 13 cm, from the Kelly mine. Harvard collection.**

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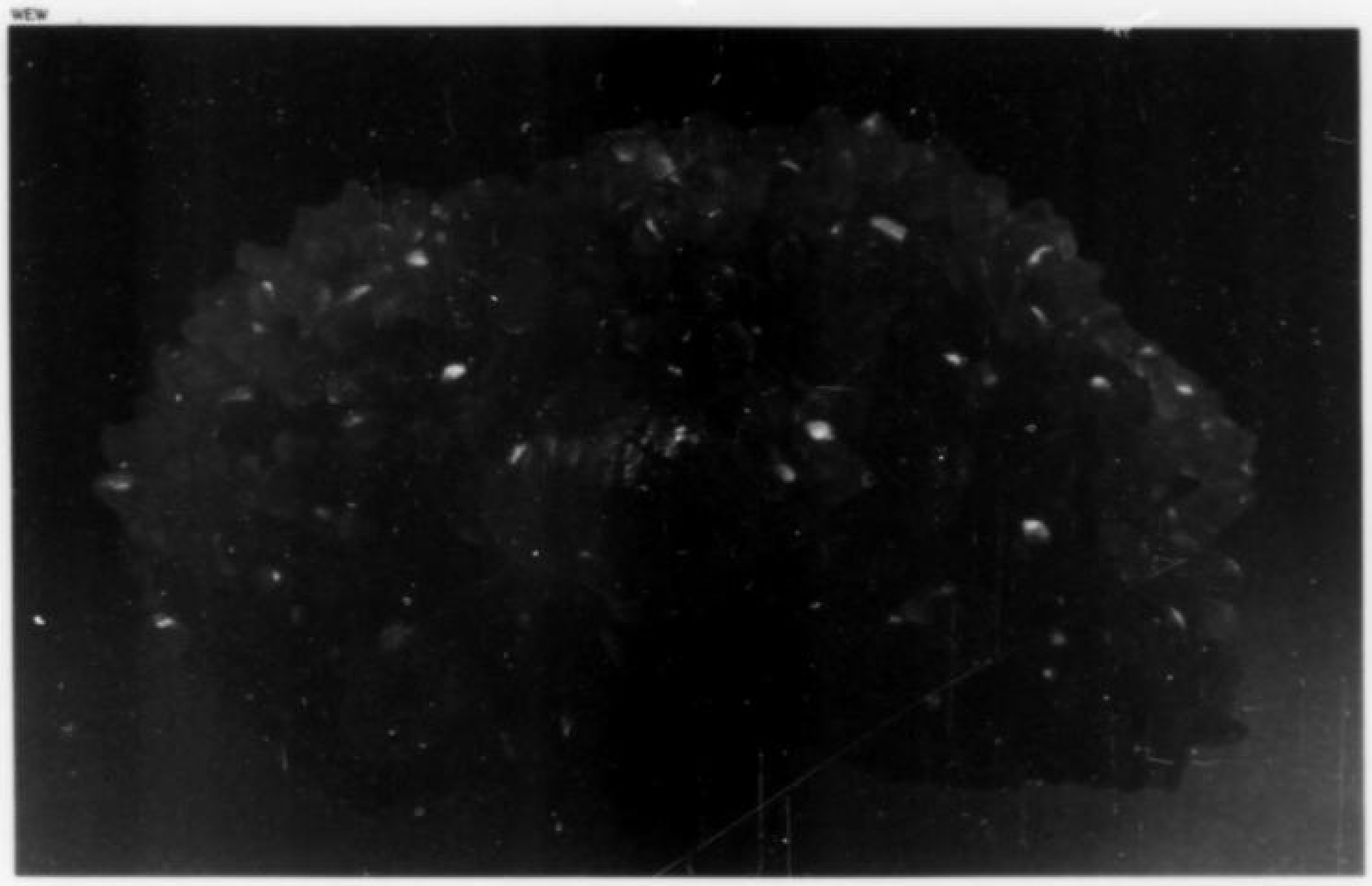
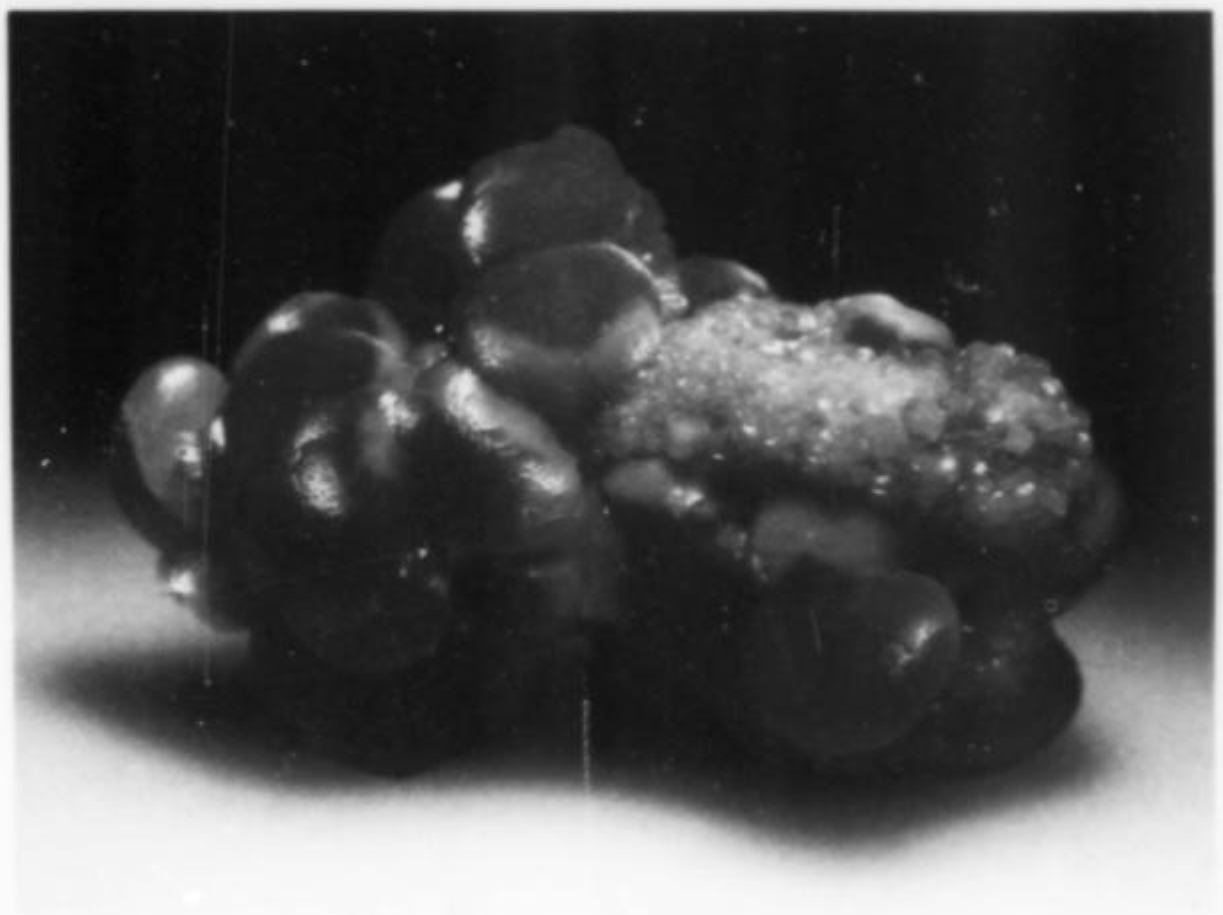


Figure 14. "Rice-grain" crystal group of smithsonite, 3.5 cm, from the Kelly mine. Douglas Miller collection.

Figure 15. Grape-like cluster of smithsonite spheres, 9 cm, from the Kelly mine. Tony Otero collection; photo by Ron Gibbs.



Rough gem smithsonite was selling for $2–5 per pound in Magdalena in 1907 (Sterrett, 1907).

Spangolite $Cu_6Al(SO_4)(OH)_{12}Cl\cdot 3H_2O$

The same specimen described under antlerite contained larger quantities of bluish green, massive spangolite.

Sphalerite (Zn,Fe)S

Sphalerite is the most abundant sulfide mineral in the ores of the district (with the possible exception of pyrite). It occurs as dark brown to black irregular grains and massive aggregates associated with pyrite, specular hematite-magnetite and galena. Botryoidal crusts of sphalerite have been found in the Germany mine. Some of the ores occurred as such fine grained mixtures that zinc concentrates could not be made and the ore was only suitable for making paint pigments.

Tenorite CuO

Tenorite has been found as thin black scales in cavities in native copper.

Thaumasite $Ca_3Si(CO_3)(SO_4)(OH)_6\cdot 12H_2O$

Thaumasite occurs as felted crusts of silky white fibers in metamorphosed limestone northeast of Oak Spring.

Figure 16. Peculiar stalactitic or helictitic growths of smithsonite, 13 cm, from the Kelly mine. Harvard collection.

WEW

Titanite $CaTiSiO_5$

Titanite has been found in samples from a dump near Oak Spring (see sanidine).

Tourmaline group

Tourmaline has been found in late-stage pegmatite and aplite dikes and on fracture surfaces in argillite and felsite.

Tremolite $Ca_2(Mg,Fe^{+2})_5Si_8O_{22}(OH)_2$

Tremolite has been found in metamorphosed limestone near Oak Spring and in ore samples from the district.

Willemite Zn_2SiO_4

In the Magdalena district, willemite has been found only at the Stonewall mine as small rosettes of prismatic crystals associated with calcite, barite, cerussite and gold.

Wollastonite $CaSiO_3$

Wollastonite occurs as pale gray to white, fine grained, sugary masses and as coarse aggregates of elongated crystals in contact metamorphic replacements of the Kelly limestone, occasionally resembling marble except for its higher specific gravity.

Table 1. **Important mines of the Magdalena district.**

Ambrosia
Anchor
Black Cloud
Cavern
Connelly Tunnel
Germany
Grand Ledge
Grand Tower
Graphic-Waldo
Hardscrabble
Iron Mask
Juanita
Kelly
Key
Little Loella
Lynchberg Tunnel
Nitt
Sampson
Sleeper
South Juanite
Stonewall Tunnels
Tip Top
Victor Tunnel
Vindicator
Young America
West Virginia Tunnel
Woodland

Table 2. **Minerals reported from the Magdalena district.**

actinolite
allophane
anglesite
andradite
andalusite
antigorite
antlerite
aragonite
aurichalcite
azurite
barite
bornite
calcite
cerussite
chalchanthite
chalcocite
chalcophanite
chalcopyrite
chlorargyrite
chlorite
chrysocolla
copper
covellite
cuprite
cyanotrichite
delafossite
diopside
dolomite
dundasite
epidote
fluorite
galena
gold
goslarite
greenockite
grossular
gypsum
halloysite
hedenbergite
hematite
hemimorphite
hydrozincite
harosite
kaolinite
limonite
magnetite
malachite
melanterite
muscovite
"psilomelane"
pyrite
pyrolusite
pyrrhotite
quartz
rosasite
sanidine
siderite
silver
smithsonite
spangolite
sphalerite
tenorite
thaumasite
titanite
tourmaline
tremolite
willemite
wollastonite

COLLECTING

The Kelly mine was recently purchased by mineral dealer Tony Otero and partners. Production of mineral specimens is expected to begin soon, and the dumps are being opened for collecting on a fee basis. The dumps of the Graphic mine are also open to collectors, for a fee, through Bob's Rock Shop in Magdalena. Road-trip logs to the district, with directions to collecting areas, are available from the New Mexico Bureau of Mines in Socorro.

ACKNOWLEDGMENT

The author is indebted to Robert North and Robert Eveleth of the New Mexico Bureau of Mines, and Bill Hunt, Tony Otero and other collectors for sharing their knowledge of the mines, minerals and history of the district.

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THE STEPHENSON-BENNETT MINE

Janet Hammond*
Department of Physical Sciences
Pasadena City College
Pasadena, California 91106

The Stephenson-Bennett mine has produced superb pseudocubic and tabular wulfenite resembling material from Los Lamentos, Mexico; hemimorphite similar to specimens from Mapimi, Mexico; and large cerussite twins that could pass for Tsumeb specimens.

INTRODUCTION

The Stephenson-Bennett mine is located in the Organ district, on the west flank of the Organ Mountains, Dona Ana County, New Mexico, about 13 miles northeast of Las Cruces and 1.5 miles south of the town of Organ. The mine is easily seen from U.S. Highway 70 where, a mile west of Organ, a dirt road leaves the highway and proceeds south for 0.6 miles to a cattle gate; here a lesser dirt road leads east to the mine workings. The mine is shown on some topographic maps as the Empire zinc mine. The current owner of the property is John Stow of Las Cruces; the mine is closed to collecting, at least temporarily, while blasting for production of construction aggregate is underway.

HISTORY

The property known as the Stephenson-Bennett mine exploited three related orebodies. The Stephenson lode was discovered in 1847 by Jose Perez, Alejo Carrasco and Jose Blas Duran. A local resident, Hugh Stephenson, joined the three in a partnership and, within a few years, became the sole owner of the mine.

Raids on the small mining camp by Apache Indians were so numerous that strong adobe fortifications were built on the mountainside overlooking the mine.

In 1858 Stephenson sold his mine to an Army officer named Bennett, who was stationed at nearby Fort Fillmore, for $12,500. Up to that time the mine had yielded about $90,000 in lead and silver, and it continued to be a good producer under the new owner. Ore was carried out on the backs of laborers, then packed out on burros to an adobe smelter at Fort Fillmore (Jones, 1905).

The Civil War caused difficulties when Confederate soldiers captured Fort Fillmore in 1861 and confiscated newly arrived mining machinery. Following the war, the mine was relocated by a rival group, and litigation eventually resulted in shared ownership (Dunham, 1935).

The Bennett orebody was discovered in 1887 by a lessee named Carrera. Although lower in silver than the Stephenson lode, it was considerably larger in size. A smaller deposit, called the Page orebody, was also found. Carrara and his partner sold their lease to George and C. C. FitzGerald, who immediately discovered a major body of carbonate ore. The Stephenson and Bennett properties were consolidated in 1889 as the Stephenson-Bennett Consolidated Mining Company, and a mill was constructed on the site.

In 1916 Phelps Dodge Copper Company leased this and other mines in the area, but after some unsuccessful development work they relinquished the lease to American Smelting and Refining Company in 1917. A considerable quantity of ore was removed, but the mine was dismantled in 1920 and there has been little activity in the district since that time. Total production has been estimated at $1.2 million (Dunham, 1935). For a detailed history of the mine see Eveleth (1983).

GEOLOGY

Mines in the Organ district show a distinct zonal distribution of metals. The Torpedo mine contains primary copper; the Memphis and Excelsior mines are in the zinc zone; the Stephenson-Bennett and Homestake mines are in the silver-lead zone; and the fluorite-barite zone is about 5 km to the south (Dunham, 1935).

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*This article is an expanded version of one published in this journal by the same author in 1973.

Figure 1. **An early view of the Stephenson-Bennett mine, on the western flank of the Organ Mountains. Photo courtesy of the Museum of New Mexico, Santa Fe (neg. 5241).**

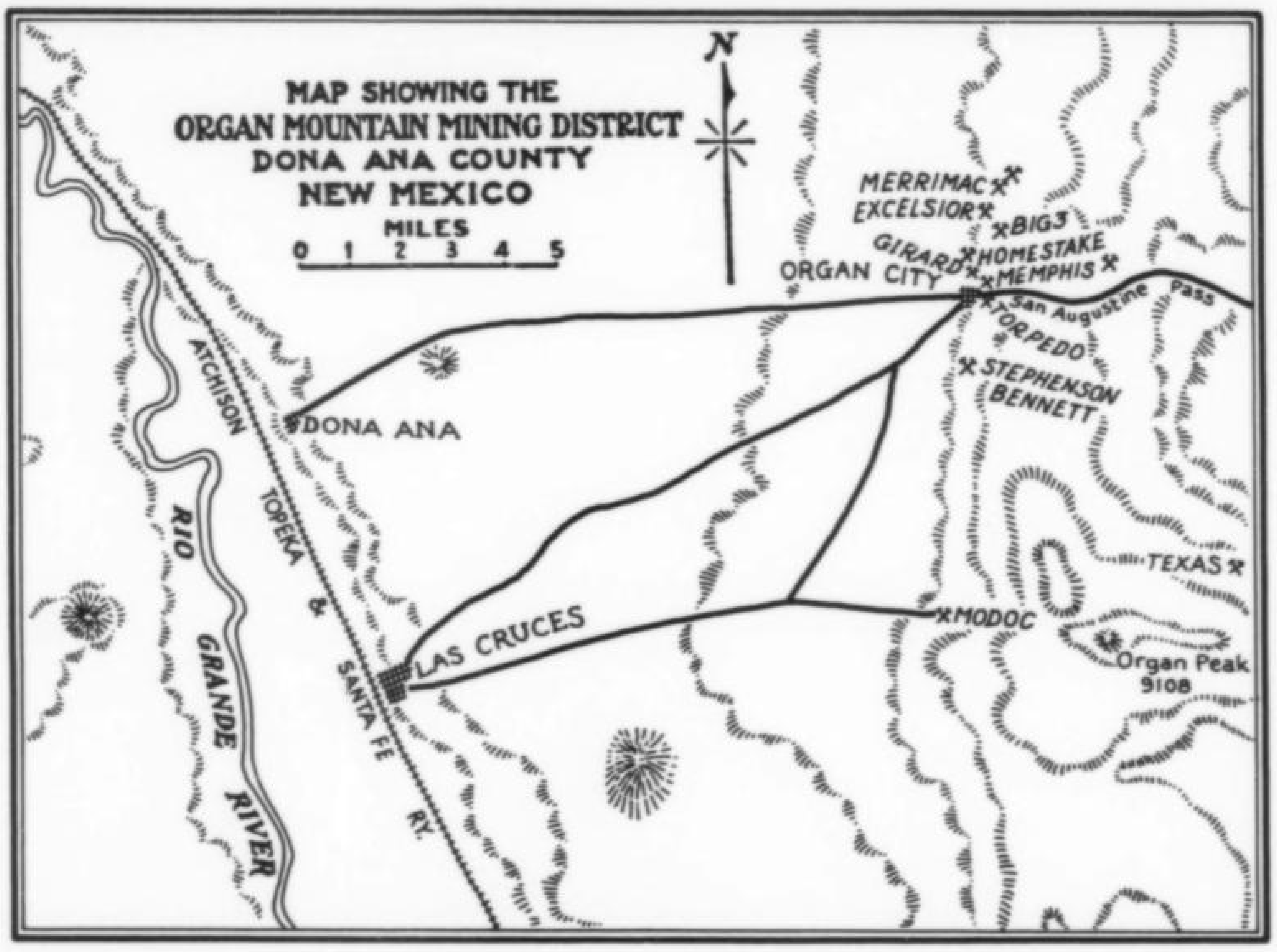


Figure 2. **Location map published in 1914 by Welsh, in *Engineering and Mining Journal.* Interstate Highway 25 now follows the route of the railroad, and Highway 70 runs from Las Cruces to Organ.**

The Stephenson, Bennett and Page orebodies are in altered sedimentary beds which flank the Organ Mountains batholith. The geology of the Organ district has been mapped and described in detail by Dunham (1935), from which the following has been summarized.

The most important structure relative to the orebodies is a north-south-trending zone of parallel faults several kilometers long. The orebodies lie within a narrow, 1.6-km fault block in this zone, bounded on the north and south by post-mineralization faults. A northwest-dipping intrusive sheet of quartz monzonite porphyry cuts the local sedimentary beds.

The fault zone was formed following intrusion of the porphyry, and provided channels for the circulation of mineralizing fluids. The fluids silicified brecciated limestone in the fault zone.

The orebodies are controlled by faults, fissures, and the contacts between dolomite and porphyry. They are tabular, irregular replacement bodies. The Stephenson orebody follows one of the eastern faults downward from the surface, and at depth follows the lower contact with the porphyry sheet. The most common minerals there were quartz, green fluorite, smithsonite, cerussite, and a few residual masses of argentiferous galena.

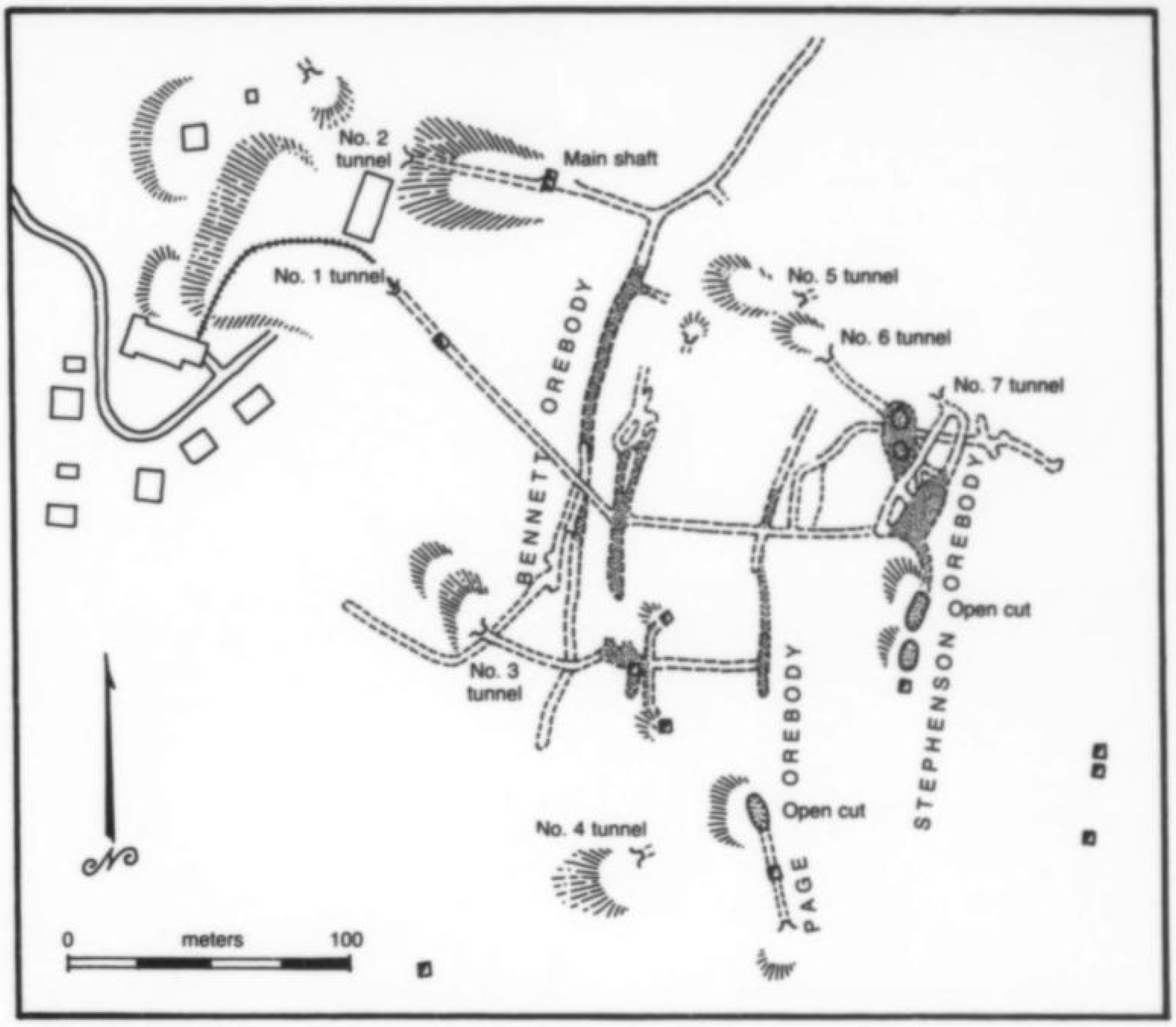
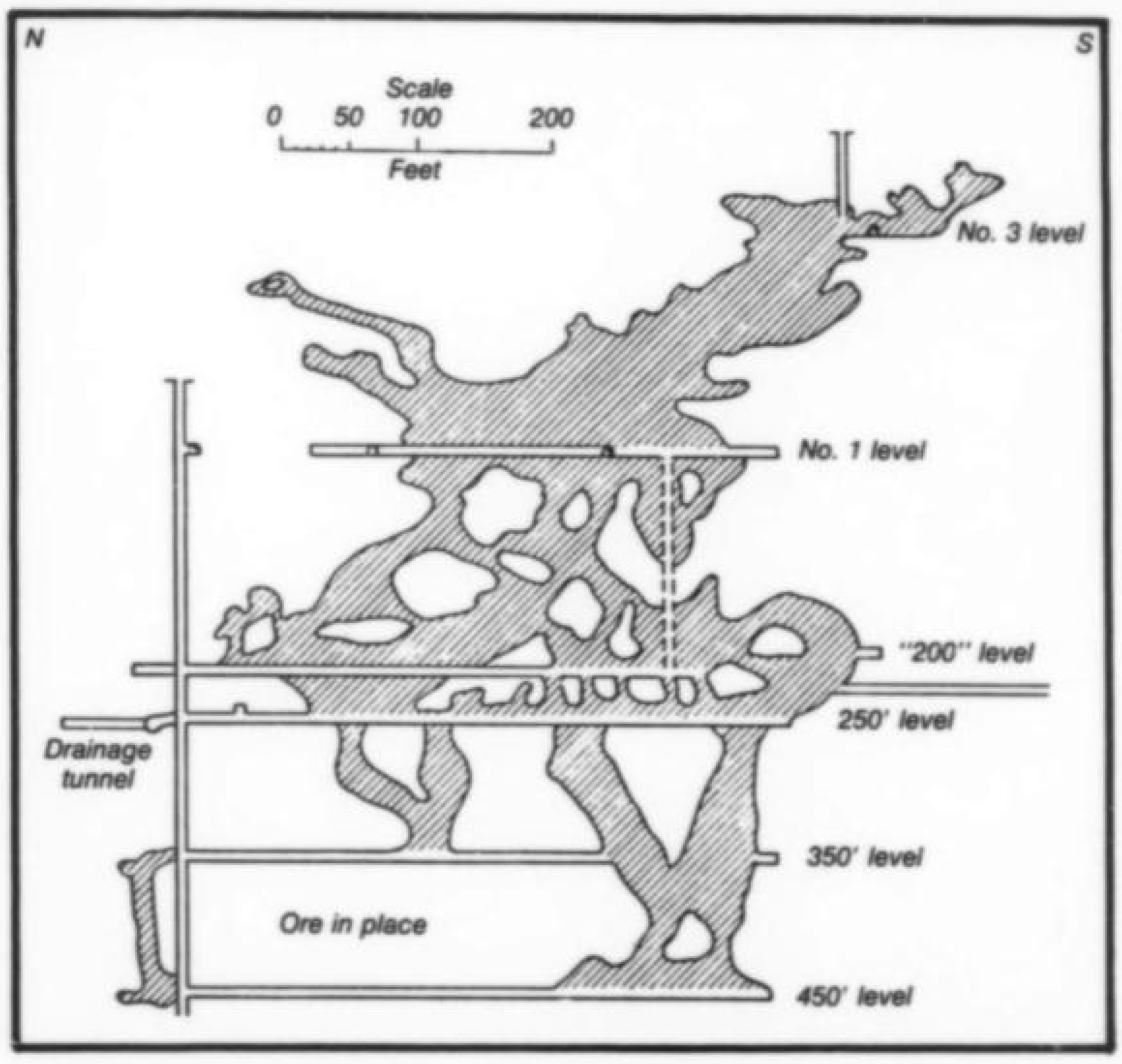


Figure 3. **Principal workings of the Stephenson-Bennett mine (adapted from Dunham, 1935). Stipled areas show where the veins have been stoped.**

Figure 4. **Vertical projection parallel to the Bennett orebody (Dunham, 1935). The upper portions of this orebody yielded large quantities of fine wulfenite specimens.**



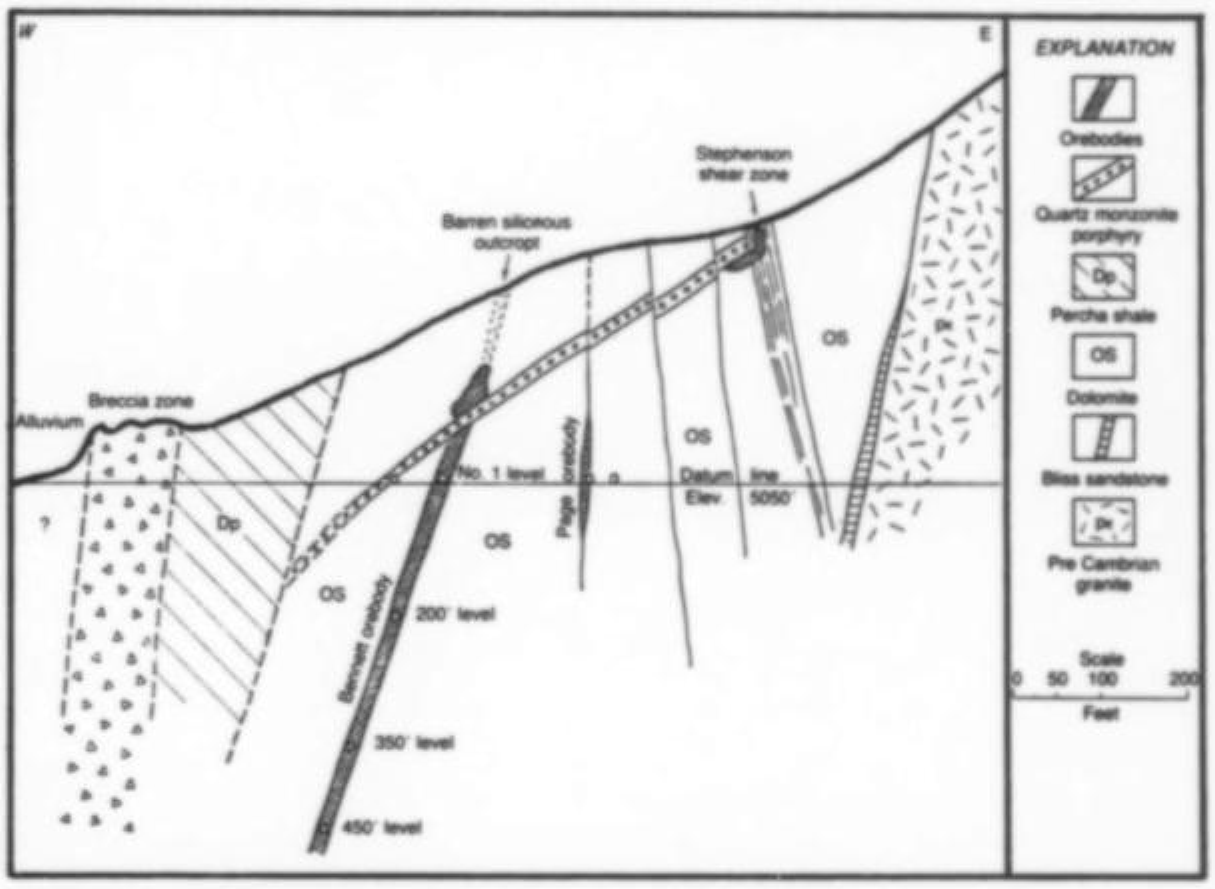


Figure 5. **Cross section of the ore zones (Dunham, 1935).**

The larger Bennett orebody, lying just to the west, is a fracture-controlled, tabular mass averaging about 3 meters in thickness and dipping steeply to the west. It has a known vertical extent of about 200 meters, and a maximum length nearly as great. The controlling fracture passes upward through the porphyry sheet, and the orebody resumes on the other side but does not extend all the way to the surface. Common minerals found in the upper oxidized zone of the Bennett orebody include cerussite and locally abundant wulfenite with minor anglesite, smithsonite and pale blue aragonite. This zone had natural caverns containing much "limonite" and cerussite. The lower, unoxidized portion of the orebody contains pyrite, galena, sphalerite and quartz; much of this apparently remains unmined.

A small north-south fracture between the Stephenson and Bennett lodes contains the Page orebody. Minerals found there include hemimorphite, cerussite and smithsonite in the upper portion and pyrite and galena below. Dunham (1935) states that thallium is known to be present in the Page orebody.

MINERALOGY

Anglesite $PbSO_4$

Northrup (1959) reports that "museum specimens" of anglesite were collected from the Organ district. It was probably most commonly found as an alteration rind surrounding remnant cores of galena.

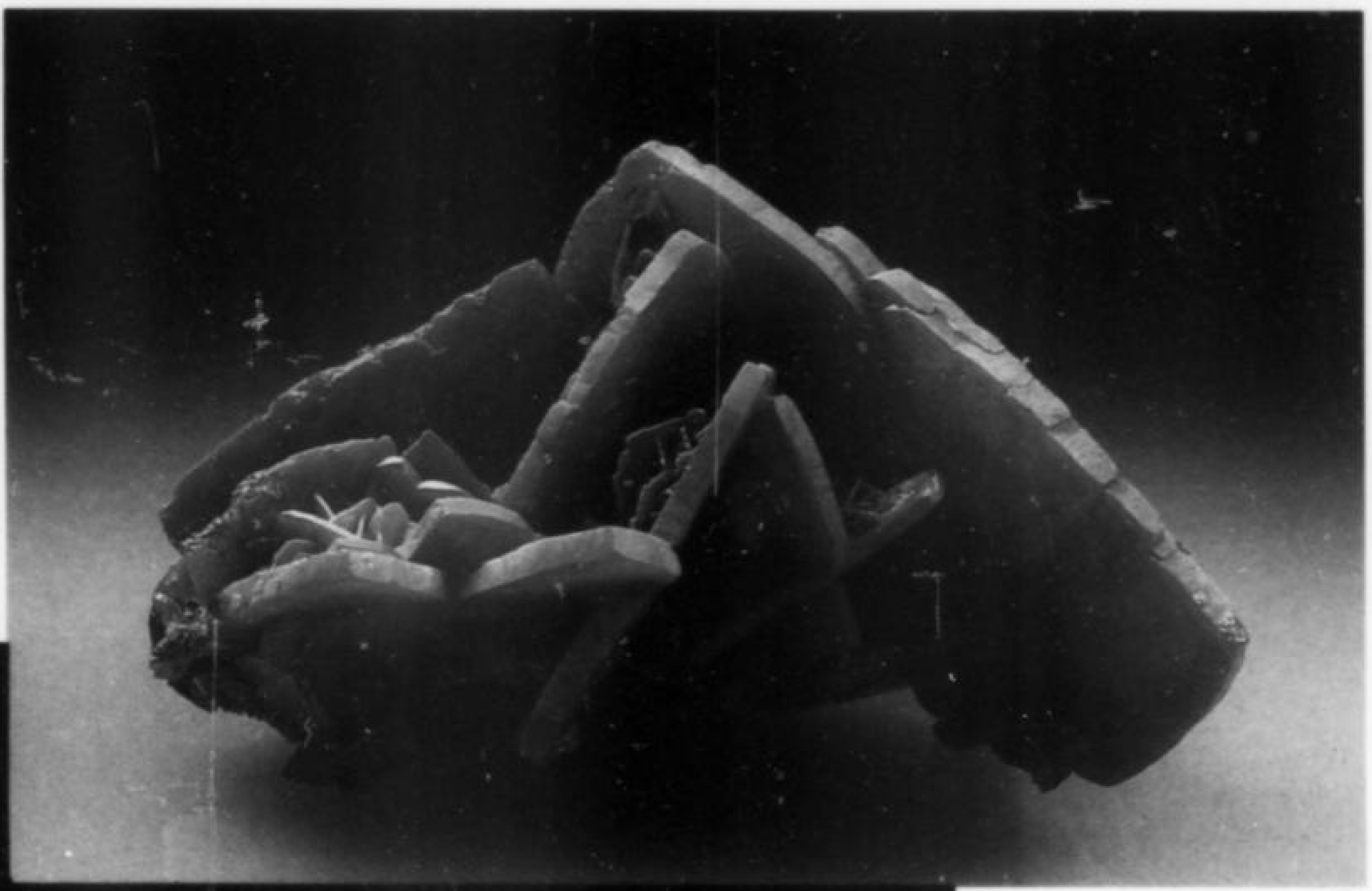
Aragonite $CaCO_3$

Aragonite is usually found at the Stephenson-Bennett mine as white, botryoidal masses, but some specimens show bands of pale green. Some typical pseudohexagonal twins have also been found, and Northrup (1959) reports pale blue crystals.

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

Farrington (1900) reported finding a single specimen of caledonite on the dump of the Stephenson-Bennett mine in 1896. This was, at

Figure 6. **Tabular wulfenite crystals to 1.2 cm. Jim Walker collection.**



WEW

Figure 7. **Wulfenite crystals to 1.3 cm, on matrix. Jim Walker collection.**

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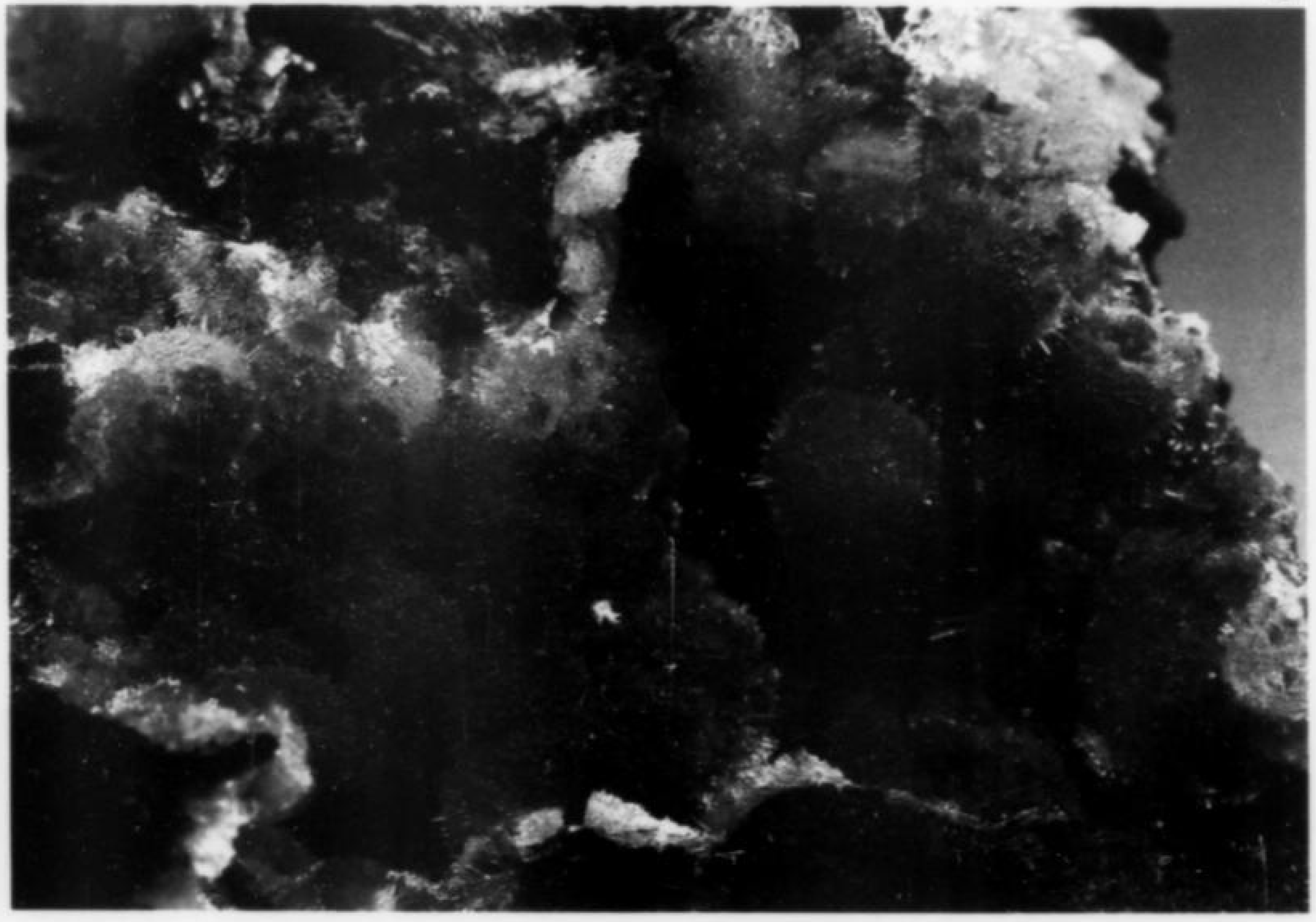

Figure 8. **Rosasite on hemimorphite, 1.5 cm across. Jim Walker collection.**

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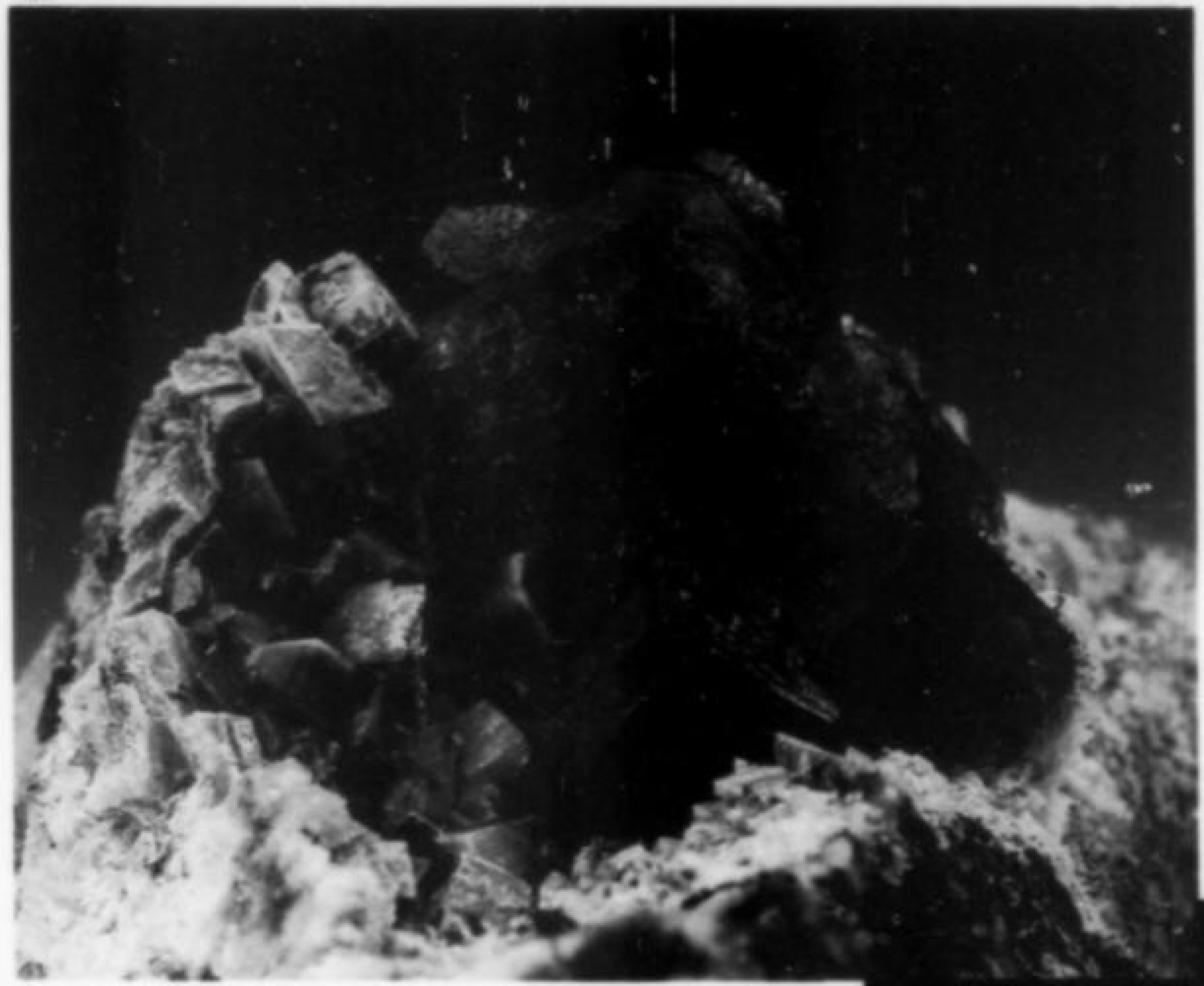


Figure 9. **Fluorite crystals (cube + dodecahedron) on manganoan calcite. Jim Walker collection.**

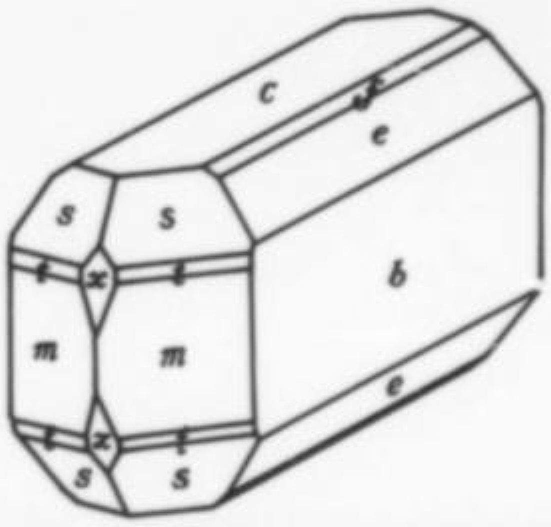


Figure 10. **Caledonite crystal drawing, Stephenson-Bennett mine (Farrington, 1900).**

the time, only the third reported occurrence of caledonite in North America. The specimen contained several good crystals up to 3 by 5 mm, and from one of these Farrington was able to definitely establish caledonite as orthorhombic.

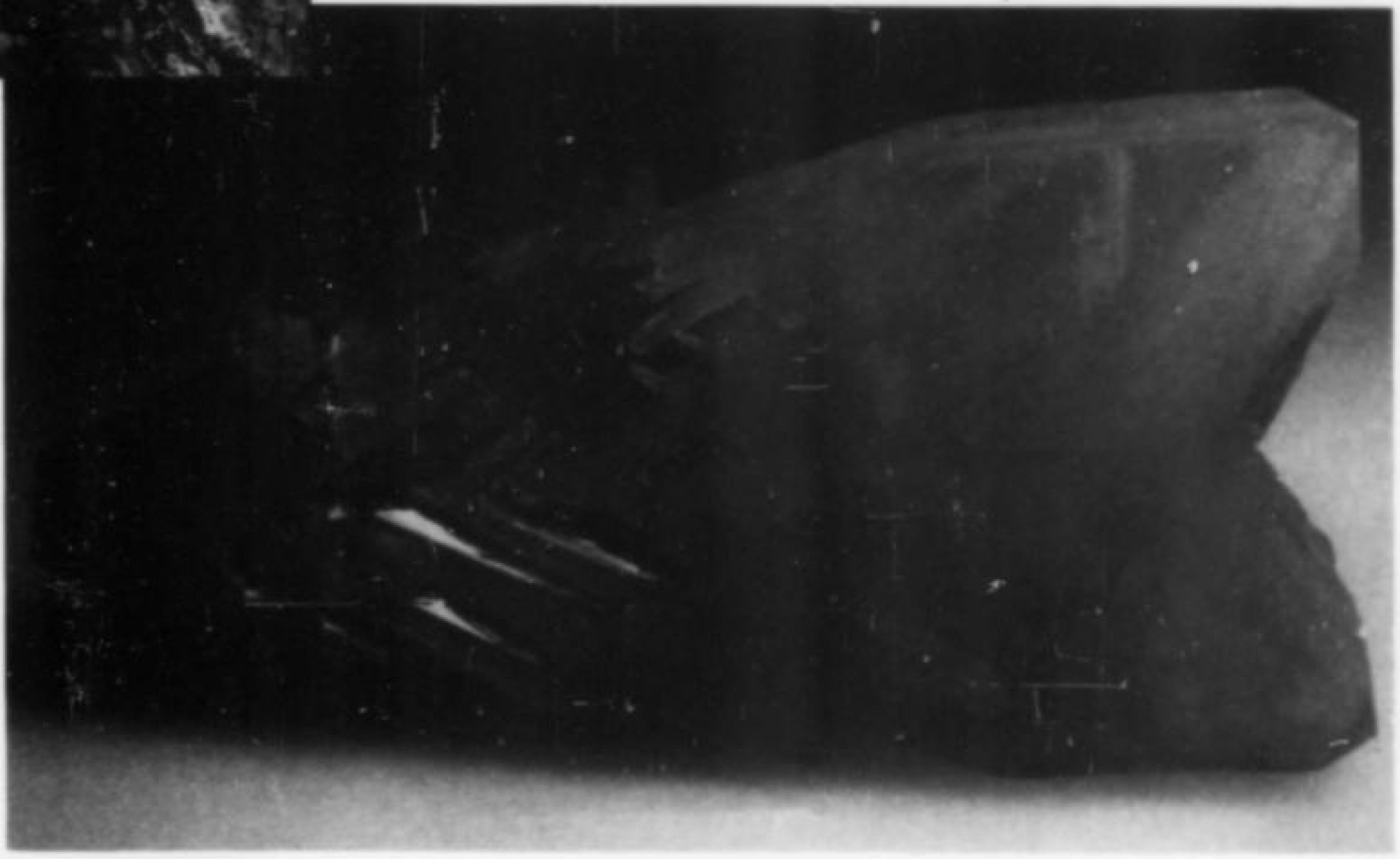
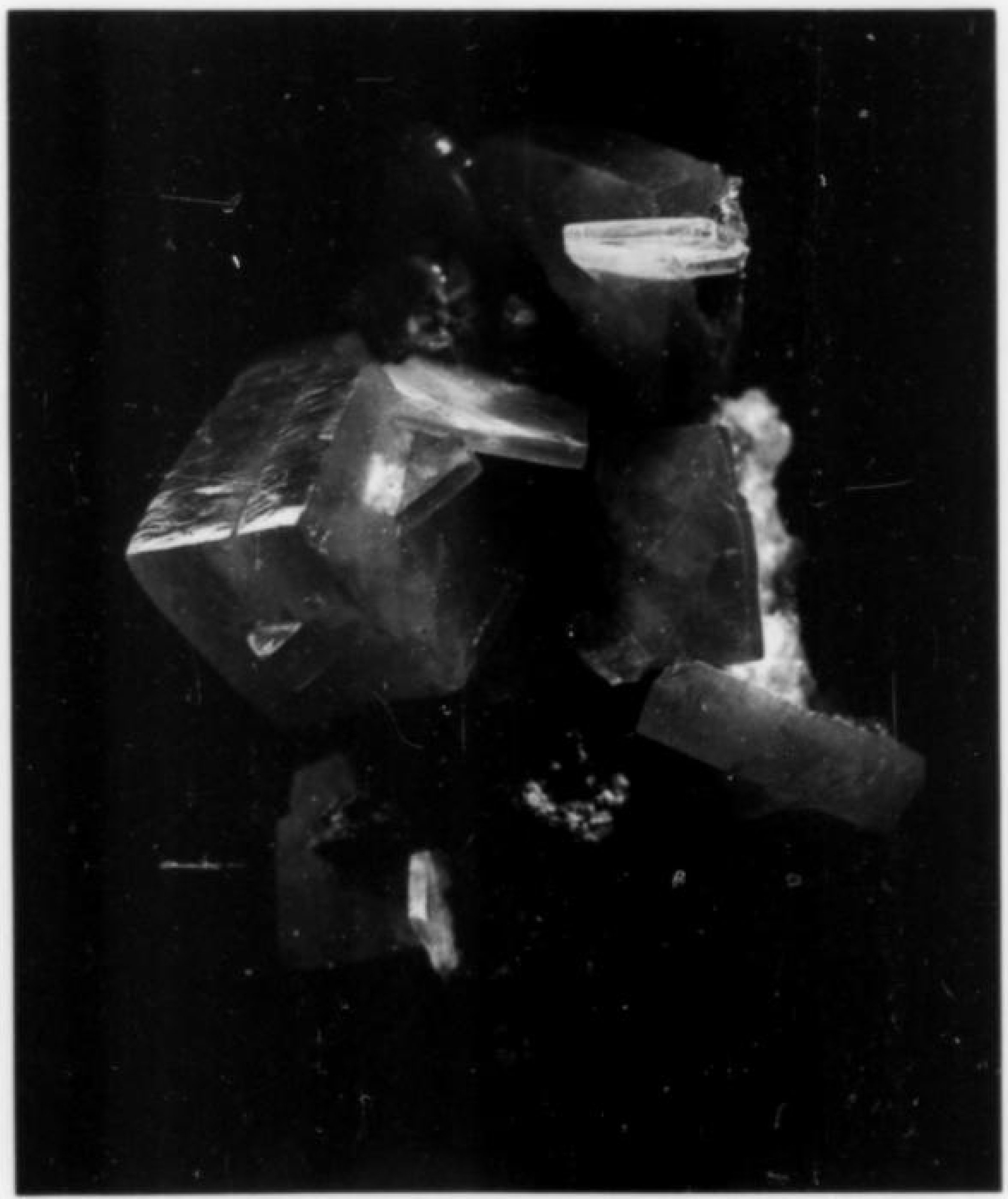


Figure 11. **Pseudocubic wulfenite crystals to 1.2 cm. Smithsonian collection.**

WEW

Figure 12. **Cerussite twin 18 cm long, the largest such specimen known from the Stephenson-Bennett mine. Harvard collection.**



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Cerussite $PbCO_3$

Large, superb, arrowhead-shaped twins of cerussite from the Stephenson-Bennett are represented in numerous collections including those of the Smithsonian and Harvard. The twins are rather thick and flat-faced, dull to lustrous, and may or may not have a re-entrant in the wide end.

Fluorite CaF_2

Fluorite is abundant in the district. It is found on the upper dumps of the Stephenson-Bennett mine as cleavage fragments and partial crystals to more than 1 cm. Color ranges from translucent green to colorless and, more rarely, purple.

Galena PbS

Galena is occasionally found as well formed single crystals to 1 cm and corroded crystal clusters having an alteration coating of anglesite.

Hemimorphite $Zn_4Si_2O_7(OH)_2{\cdot}H_2O$

Well formed, colorless, lustrous crystals to 3 cm, closely resembling the better known specimens from Mapimi, Mexico, have been found at the Stephenson-Bennett mine. Ford and Ward (1909) described crystals from the district which most likely came from the Stephenson-Bennett mine. Hemimorphite is readily found on the dumps, as nice microcrystals up to 5 mm in size.

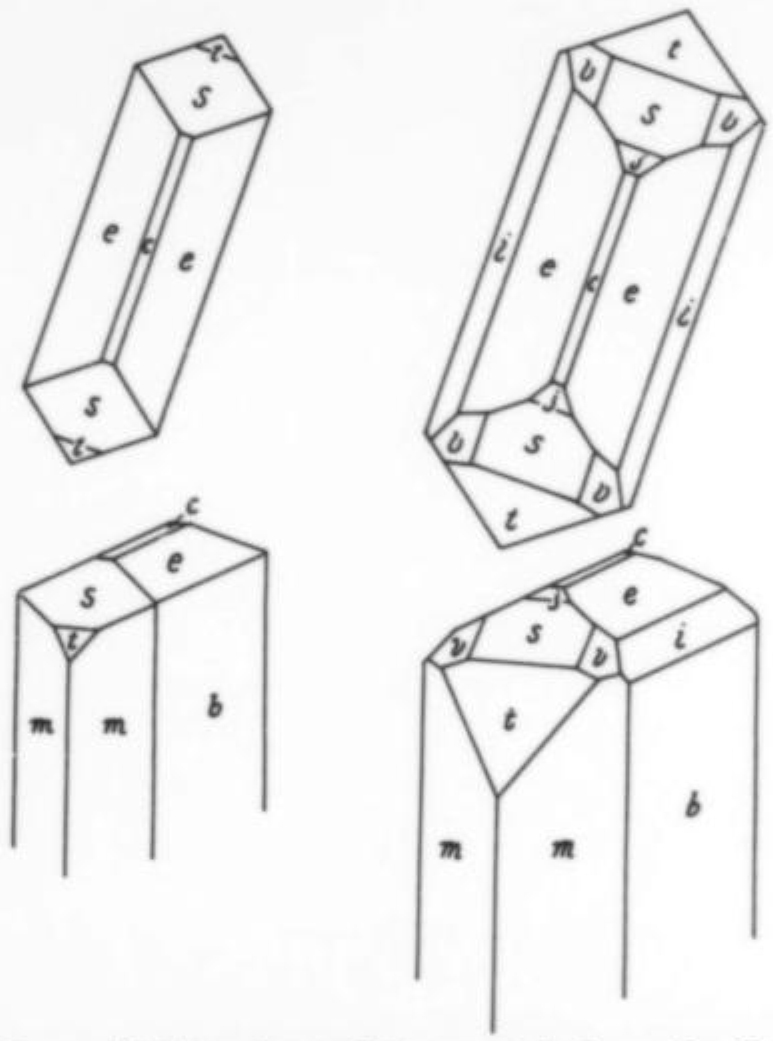

Figure 13. **Hemimorphite crystals from the Organ district, probably from the Stephenson-Bennett mine (Ford and Ward, 1909).**

Linarite $PbCu(SO_4)(OH)_2$

Farrington (1900) noted a small quantity of linarite found at the Stephenson-Bennett mine.

Phosgenite $Pb_2(CO_3)Cl_2$

Northrup (1959) reports that several fine crystals up to 3.7 cm and perhaps larger were found at the Stephenson-Bennett mine by a local collector named L. B. Bentley in 1936. The crystals were sold for as much as $125 each, which was quite expensive at that time. Their current disposition is unknown.

Pyrite FeS_2

Pyrite is common at the Stephenson-Bennett mine, especially on the lower dumps, as pea-sized, tarnished pyritohedrons.

Pyromorphite

A pyromorphite specimen consisting of several elongated, olive-green crystals to 2 mm, was found on the dump in the early 1970's.

Quartz SiO_2

Quartz is abundant as small, clear crystals, some containing phantoms delineated by hematite inclusions.

Smithsonite $ZnCO_3$

Alfredo (1952) reported finding a large (48 cm) plate of white, botryoidal smithsonite on the dump along with smaller specimens.

Wulfenite $PbMoO_4$

Welsh (1914) described wulfenite from the Bennett orebody as being "remarkable for the form and color of the individual crystals," and stated that such specimens were "frequently encountered." Dunham (1935) reported that the Bennett orebody yielded locally abundant wulfenite in quantites large enough to constitute ore.

Hess (1924) illustrated "tabular yellow crystals of wulfenite varying considerably in thickness," including some "yellow crystals approaching cubical dimensions," from the Organ Mountains. Koning (1948) measured 23 individual crystals, thin and tabular, some of them transparent, and yellow to yellowish brown in color. Some of the crystals show a hemimorphic habit which is rare in wulfenite. These are listed only as "Dona Ana County" but are most probably from the Stephenson-Bennett mine. Samples in the Smithsonian Institution collection range in habit from pseudocubic to tabular with an odd distortion resulting in diamond-shaped *c*-faces (two opposing acute angles and two obtuse instead of all at 90°).

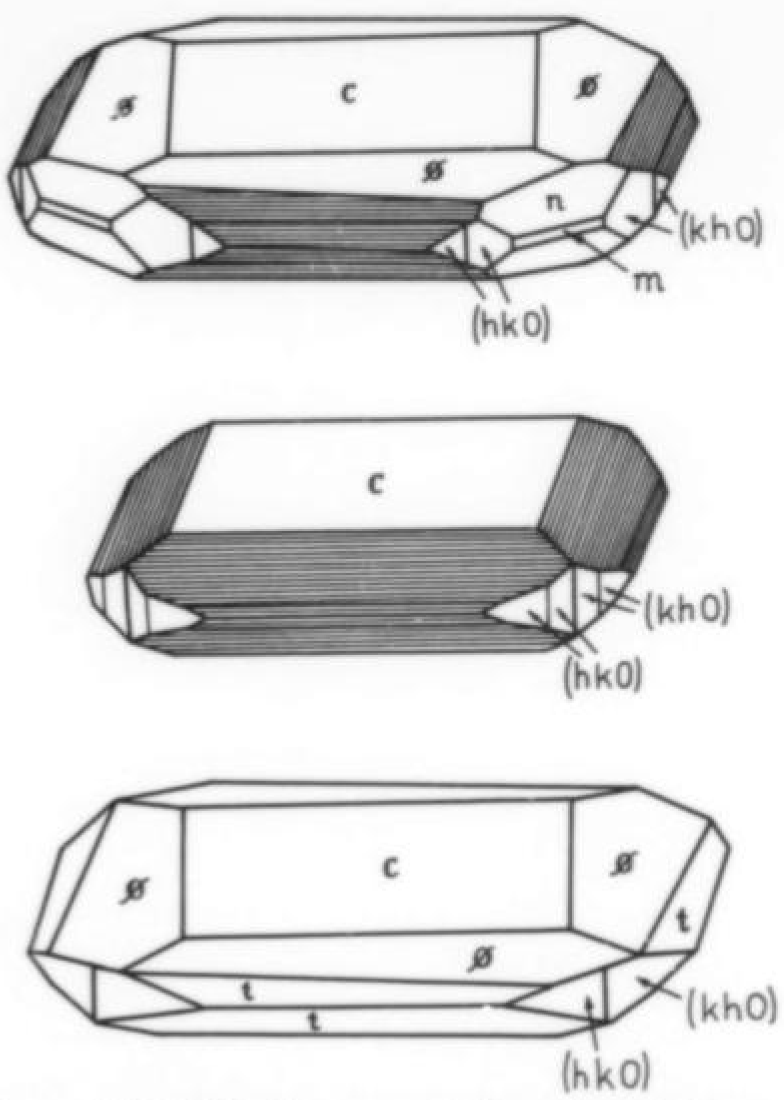

Figure 14. **Wulfenite crystal drawings, "Dona Ana County, New Mexico" (Koning, 1948), which are most likely from the Stephenson-Bennett mine.**

Wulfenite is common on the dumps, generally as opaque to transparent, bright yellow to orange-brown microcrystals up to 5 mm in size. Collectors have been known to venture underground (in some cases employing inflatable rafts), and are said to have found some fine specimens. Generally speaking, however, the best specimens came out when the mine was in operation. The underground workings are very dangerous and should be avoided.

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FAMOUS MINERAL LOCALITIES:

THE HANSONBURG DISTRICT

BINGHAM, NEW MEXICO

Joseph E. Taggart, Jr.[1]
U.S. Geological Survey
Denver Federal Center, MS 973
Denver, Colorado 80225

Abraham Rosenzweig[2]
Rosenzweig Associates
P.O. Box 16187
Tampa, Florida 33687

Eugene E. Foord
U.S. Geological Survey
Denver Federal Center, MS 905
Denver, Colorado 80225

The Hansonburg district has been intermittently active as a mining area for over 100 years. Production of copper and lead ores has not been of particularly great economic significance, but during the past 30 years there has been a continuing interest in the mineralogy and geology of the area.

INTRODUCTION

The Hansonburg district may be more familiar by the name Bingham, New Mexico; Blanchard claims; Mex-Tex or other mine names. Fluorite, galena and barite, the "economic minerals" of the district have received most of the attention in the past, while the interesting, minutely crystallized oxidation-zone minerals have been largely overlooked. Two of us (JET and AR) have had contact with the area during a total of nearly 40 years of active, though intermittent, investigations.

In 1980 some world-class linarite specimens were discovered in the Sunshine #1 tunnel, leading to renewed interest in mineral specimens. Some late-night mineral collectors were arrested at gunpoint, gates were locked, and mine openings were either bulldozed shut or closed with steel doors that were padlocked shut. Availability of specimens was limited to previously collected samples and a few very high quality, but very high priced, specimens from the mine owners. A few samples were still collected at great risk by late night "high-graders," frequently with sketchy information about where they were from and how they were acquired.

In 1987, however, things changed significantly when the annual assessment work was not performed and the claims were restaked by private individuals interested in the recovery of mineral specimens (DeMark, 1987). The claims are now open to collectors on a daily fee basis. They must check in with Sam Jones at Bingham, receive a briefing on the hazards in the area, and sign a liability waiver. Collecting is limited to above-ground workings and dumps.

The district is at the north end of the Sierra Oscura, about 5 miles south of Bingham, Socorro County, New Mexico. The several mines and claims are reached by driving south from Bingham on a graded dirt road. The district is within 12 miles of Trinity Site, the location of the first atomic bomb detonation. Because of its proximity to the White Sands Proving Grounds, the area and principal access road (Route 380) may be evacuated during testing. A telephone call to (505) 678-1178 will reach a recorded message providing roadblock information.

The highest point in the district is about 2000 meters (6500 feet) above sea level. Precipitation averages about 28 cm per year, and the mean annual temperature is about 56°F. Summer temperatures may

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[1] Formerly with New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico.
[2] Formerly with the Department of Geology, University of South Florida, Tampa.

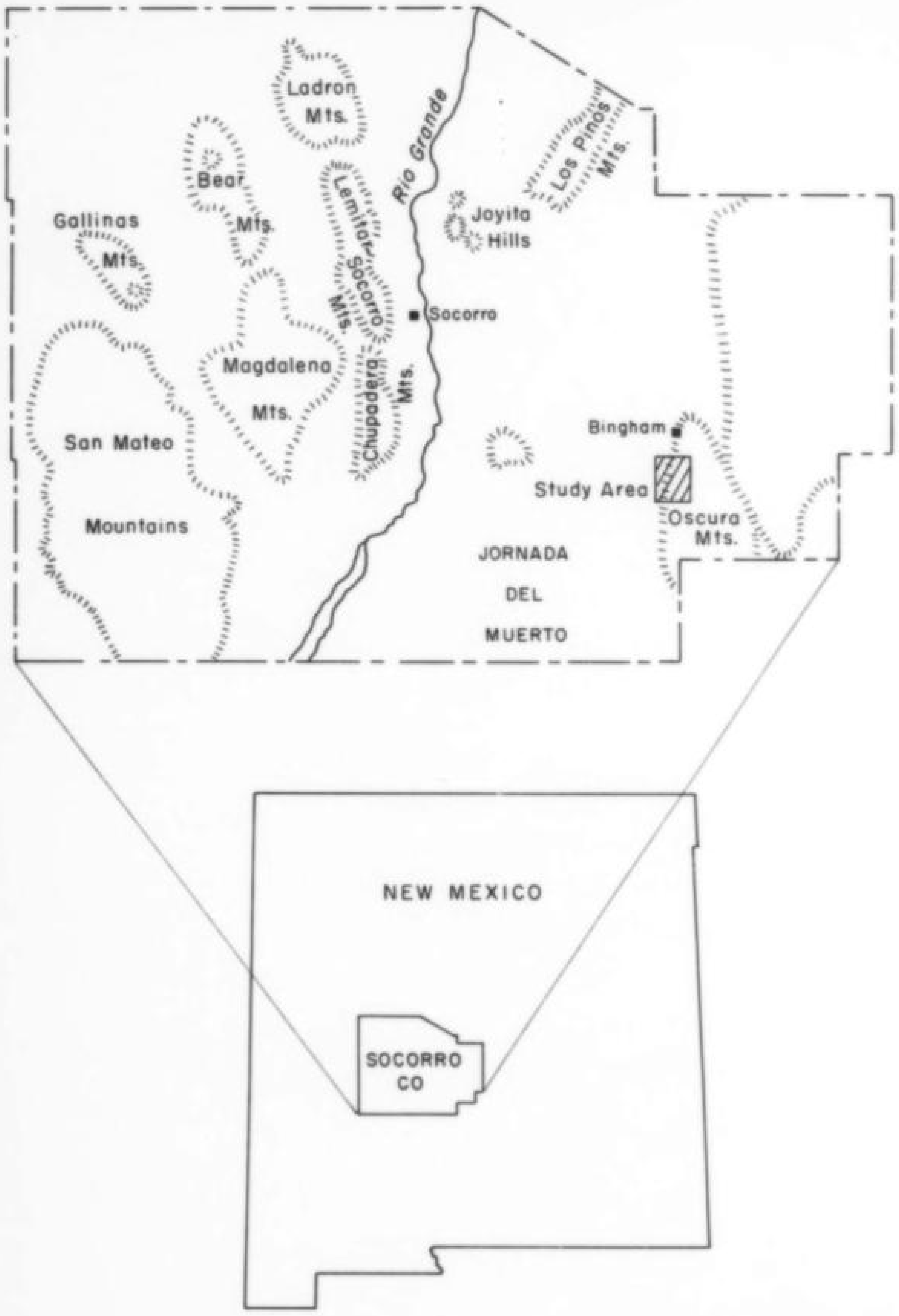

Figure 1. **Location map of Hansonburg mining district, Bingham, New Mexico.**

exceed 100°F, and winters may be bitterly cold, particularly along the exposed upper workings where winds are often strong. Julian Arroyo is susceptible to flash flooding and should be avoided during heavy rain in late summer. The nearest drinking water is at Bingham; motel and camping facilities are available in Socorro.

HISTORY

Early records (Anonymous, 1881a, 1881b; Kernal, 1881; W.T.M., 1881) give Col. A. H. Hanson the credit for discovering the "Chloride district," while Hansonburg is described as "the new town situated at the mouth of Silver Glance Cañon . . . named in honor of Col. A. H. Hanson." Apparently the mines were known by the Indians and early Spanish, as it was reported they were worked probably centuries ago and that Messrs. O'Neill, Hanson and Proto purchased all claims of the Pueblo Indians to the old mines of the district. The manto-type ore deposits in the silicified limestone were just being rediscovered at the time. They are mentioned as "The New Discovery mines . . . about five miles from Hansonburg in the main range of the Oscura mountains," where Lewis Proto and Samuel Dupont were cleaning out an old Spanish tunnel further up on the main mountain ". . . in a vein six feet thick of quartz and spar" (Anonymous, 1881a).

The lead-fluorite-barite mineralization of the limestones was later worked by various companies, and has a colorful history. The following companies have been involved in the district: Western Mineral Products, 1916; Louis & Halstead, 1938; Globe Mining Company, 1939; F. L. Blanchard, 1943; Portales Mining Company, 1948; Scott Mineral Company, 1949; Mex-Tex Mining Company, 1949; Atomic Mineral Corporation, 1960; Galbar, Inc., 1961; Sunshine Mining Company, 1961; Basic Earth Science Systems, Inc., 1972; New Mexico Spar Company, 1976; Hansonburg Mines, Inc., 1979; Western

Figure 2. **Photo of the Sierra Oscura, looking to the southeast from the graded dirt road from Bingham. The Royal Flush properties are too low and far off to the left (east) to be seen in this view, but the Mex-Tex (on the hill just above the road at left) and Blanchard properties (center-right) can be easily located.**

Royal Flush Group

1 North Pit - Royal Flush (C76)*
2 South Pit - Royal Flush (C76)
3 Downey Stope - (C76) (K)
   † AKA Mountain Canyon Mine (BQ) (K)
   AKA Ace High (K)
   AKA Desert Rose Mine (GSC)

Lower Mex-Tech Group

4 Unnamed bulldozer cut, 150 by 135 feet (C76)
5 Ora Mine (BQ)
6 Caliche (BQ)
7 Hickey No. 1 Mine (BQ)

Upper Mex-Tex Group

8 Snake Pit (C76)
9 Byrd Tunnel and Pit (C76)
   Upper Mex-Tex Mine (C76)
   AKA Julian Malicite [SIC] Mine (BQ)

Blanchard Claims

11 Moreno Drift (RS)
12 Upper and Lower Blanchard Glory Holes (RS)
13 Sunshine #5 (RS)(De)
14 Sunshine #1 (RS)(De)
15 Sunshine #'s 2, 3, and 4 from north to south (RS)(De)
16 Sunshine #6 (RS)(De)
   AKA Ora Blanchard Mine
   AKA Portales Mine (RS)
   AKA "The Big Room"
17 Clarence Barrett Workings (De)
   AKA Sam Jones Workings

* (C76) Williams et al. (1964)
(BQ) U.S. Geological Survey Bingham, New Mexico Quadrangle Map--1948
(K) Kopicki (1962)
(RS) Personal Communication, Rene Steensma, company records--1978
(GSC) U.S. Geological Survey Garden Springs Canyon, New Mexico Quadrangle Map--1982
(De) DeMark (1987)
† AKA--Also known as

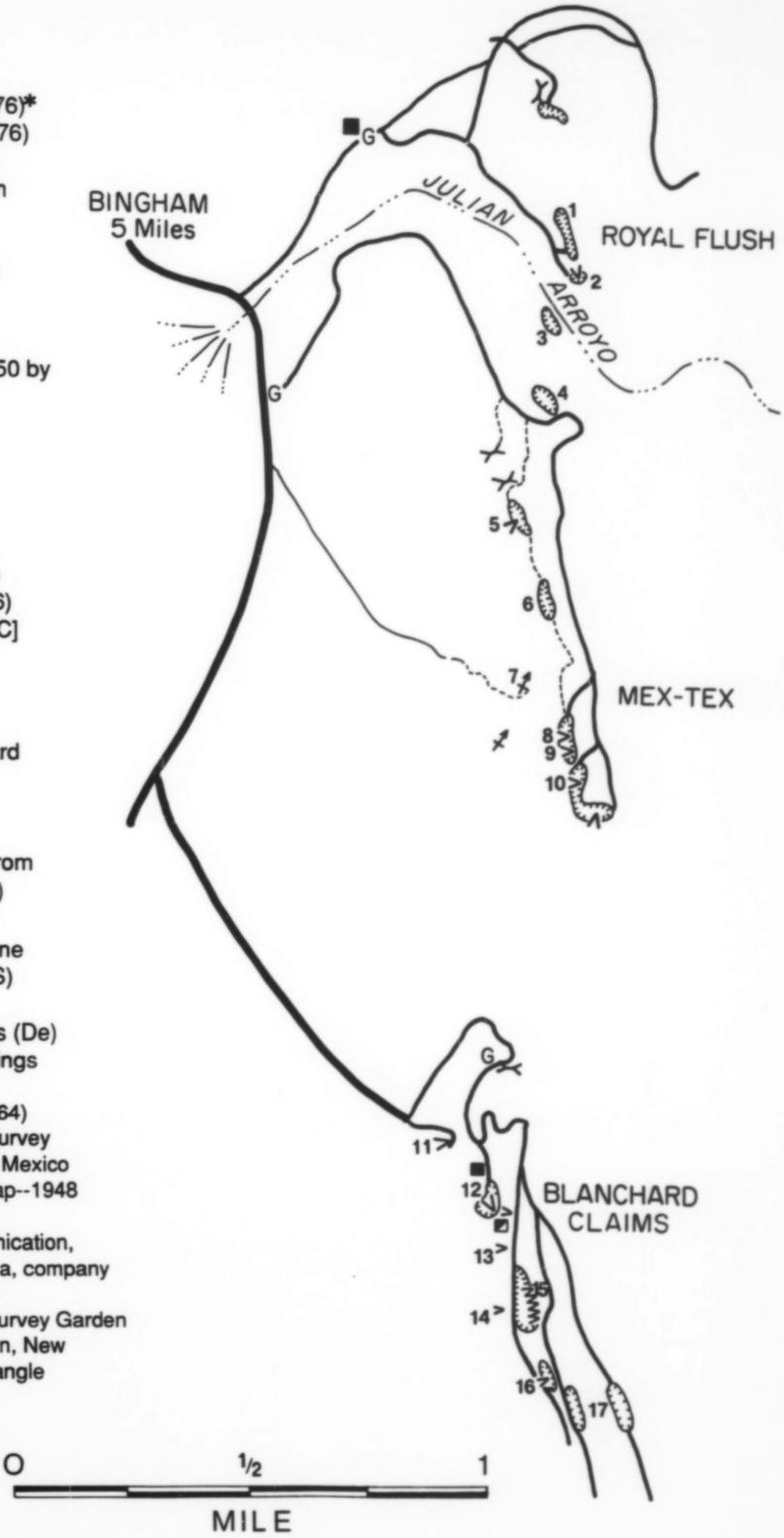

Figure 3. **Mine names, Hansonburg mining district, Bingham, Socorro Co., New Mexico.**

Figure 4. **Mrs. Ora Wallace Blanchard (1896–1968) outside the Portales mine (Dean Wise photograph taken in 1961). She had a great love for the minerals to be found on her family claims, and would assist visitors in finding their way to the more popular collecting sites.**

General Resources, Inc., 1983; Ozark-Mahoning Co., 1984 (DeMark, 1987); and in 1987, properties were claimed by private individuals interested in the recovery of mineral specimens (DeMark, personal communication). Figure 2 shows the location of mines and subdistricts. As the history outlined above shows, the district has had a complex record of ownerships. This has resulted in many mines undergoing frequent name changes. In addition, mineral collectors have coined their own names for favorite collecting sites.

During the 1950's and early 60's, visitors to the area almost certainly encountered Mrs. Ora Wallace Blanchard (1896–1968), whose family name has been associated with the district since the beginning; Judge Charles Blanchard was part-owner of the Williams mine in 1881 (Kernal, 1881); F. L. Blanchard was active in the mid-1900's. Mrs. Blanchard lived the life of a recluse in a small house below the Blanchard claims. As with so many of the colorful personalities associated with mining areas, her response to visitors was unpredictable, being alternately friendly or suspicious. She had a great love for the minerals to be found, and offered much guidance to one of the authors (AR). In her last years she was unable to make the trek up the hill on foot, and relied for transport on visiting collectors, many of whom also brought her food and supplies.

GEOLOGY

The Sierra Oscura is a series of north-south trending fault blocks tilted to the east, separated by near-vertical faults from the Jornado Del Muerto syncline to the west, and separated by a transverse shear zone from the San Andres Mountains to the south. This shear zone marks the intersection of the Rio Grande Rift with the Santa Rita lineament (Chapin, 1978). The mineral deposits in the northern portion of the range are of two types: red beds of the Permian Abo Formation occur upsection on the eastern upthrown block and on the western downthrown block and contain local concentrations of copper as malachite, azurite, chalcocite and small amounts of bornite and chalcopyrite; the minerals are found as replacements after organic debris and the calcite cement of the sandstones. The second type of mineralization, which is the topic of this article, is a series of manto-like, bedded, open-space fillings, with minor replacement extending laterally outward from north-south trending faults into favorable limestone beds in the Pennsylvanian Council Spring Limestone and the Burrego Formation (Thompson, 1942; Kottlowski, 1953).

MINERALOGY

The mineralogy of the Hansonburg District has been studied by many people. Lists of mineral occurrences of varying degrees of reliability are quite common for the area. Table 1 presents the minerals observed by the authors either in the field or from collections. Only the hypogene minerals present in large crystals were identified by sight; all other species were identified on the basis of X-ray diffraction, optical properties and qualitative microchemical tests. A few species were quantitatively analyzed using electron microprobe, scanning electron microscope, atomic absorption, induction coupled plasma (ICP) spectroscopy, ion chromatograph, or wet chemical techniques. Unlike other studies, this investigation includes only those minerals found within the silicified shell of the manto-like deposits and does not include minerals from the surrounding sedimentary host rock, ore deposits outside the district, soil samples, fluid inclusions, or minerals produced by animals, man, or as a result of mining operations. Those species previously described by others, but not verified by the authors, are discussed in the text[3] and listed in Table 2. Early stages of min-

Table 1. **Minerals of the Hansonburg Mining District**

Anglesite $PbSO_4$
Antlerite $Cu_3(SO_4)(OH)_4$
Atacamite $Cu_2Cl(OH)_3$
Aurichalcite $(Zn,Cu)_5(CO_3)_2(OH)_6$
Azurite $Cu_3(CO_3)_2(OH)_2$
Barite $BaSO_4$
Brochantite $Cu_4(SO_4)(OH)_6$
Calcite $CaCO_3$
Carbonate-fluorapatite $Ca_5(PO_4,CO_3)_3(F,OH)$
Cerussite $PbCO_3$
Chalcopyrite $CuFeS_2$
Chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4\cdot nH_2O$
Cinnabar HgS
Corkite $PbFe_3^{+3}(PO_4)(SO_4)(OH)_6$
Covellite CuS
Creedite $Ca_3Al_2(SO_4)(F,OH)_{10}\cdot 2H_2O$
Dickite $Al_2Si_2O_5(OH)_4$
Fluorite CaF_2
Fraipontite $(Zn,Al)_3(Si,Al)_2O_5(OH)_4$
Galena PbS
Goethite $\alpha FeO(OH)$
Gypsum $CaSO_4\cdot 2H_2O$
Hematite αFe_2O_3
Hemimorphite $Zn_4Si_2O_7(OH)_2\cdot H_2O$
Hydrozincite $Zn_5(CO_3)_2(OH)_6$
Jarosite $KFe_3^{+3}(SO_4)_2(OH)_6$
Lepidocrocite $\gamma FeO(OH)$
Libethenite $Cu_2(PO_4)(OH)$
Linarite $PbCu(SO_4)(OH)_2$
Malachite $Cu_2(CO_3)(OH)_2$
Mottramite $PbCu(VO_4)(OH)$
Murdochite $Cu_6PbO_{8-x}(Cl,Br)_{2x}$
Opal variety Hyalite $SiO_2\cdot nH_2O$
Plattnerite βPbO_2
Plumbogummite $PbAl_3(PO_4)_2(OH)_5\cdot H_2O$
Psilomelane (unidentified hard Mn oxides)
Pyrite FeS_2
Pyromorphite $Pb_5(PO_4)_3Cl$
Quartz SiO_2
Rosasite $(Cu,Zn)_2(CO_3)(OH)_2$
Scrutinyite αPbO_2
Smithsonite $ZnCO_3$
Spangolite $Cu_6Al(SO_4)(OH)_{12}Cl\cdot 3H_2O$
Sphalerite $(Zn,Fe)S$
Tsumebite $Pb_2Cu(PO_4)(SO_4)(OH)$
Wulfenite $PbMoO_4$

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[3] Where possible, mineral formulas are from Fleischer (1987).

Table 2. **Minerals reported by others but not observed in this study**

Alabandite	Reported by Kopicki (1962).
Argentite	Tentative identification by Kopicki (1962).
Beaverite	Reported by many collectors, see discussion under jarosite.
"Bisbeeite"	Northrup (1959) credits Albright; bisbeeite is not a valid species, or otherwise accepted term; similar material identified as chrysocolla this study.
"Blanchardite"	First mentioned in an article by Strong (1964), numerous specimens so labeled have been found by optical and X-ray tests to be brochantite. (J. S. White, Jr. 1972, 1973).
Bornite	Reported by Kopicki (1962).
Caledonite	Sun (1957) "previously reported" but he did not observe. DeMark (personal communication, April, 1988) reports a sample from the Sunshine #4 tunnel with 3 brilliant euhedral crystals of 1 mm size. No damaged material was available for tests. This specimen is very likely a legitimate occurrence but could not be verified.
Celestite	Reported by Kopicki (1962), and Sun (1957).
Chalcanthite	Reported by Kopicki (1962).
Chalcocite	Reported by Kopicki (1962).
Cuprodescloizite	Reported by Kopicki (1962); equivalent to mottramite.
Dolomite	Reported in the country rock by Sun (1957).
Enargite	Reported by Lasky (1932); identified as bornite (Kopicki, 1962).
Langite	G. Young, J. Purson, personal communication; specimen provided by Purson identified as aurichalcite this study.
"Limonite"	Reported by Sun (1957); limonite is a generic term, identified as goethite and jarosite this study.
Marcasite	Tentative identification by Kopicki (1962).
Massicot	D. Wise, J. Purson personal communication; identified as mottramite this study.
Molybdenite	DeMark (personal communication, April, 1988) reports sample that appears to be molybdenite currently under study with Hlava.
Rhodochrosite	Tentative identification by Kopicki (1962).
Serpierite	Northrop (1959) credits Albright; specimen from D. Wise collection identified as tsumebite.
Siderite	Reported by Kopicki (1962); identified as mixture of goethite and calcite this study.
Stromeyerite	Tentative identification by Kopicki.
Tennantite	Reported by Lasky (1932); invalidated by Kopicki (1962).

eralization will be described as hypogene, and late stages as oxidation products.

Hypogene Minerals

Barite BaSO$_4$

Barite is very abundant throughout the district. It is usually pale buff, rarely colorless, and often lightly coated with limonitic material. It commonly forms large masses of subhedral, subparallel laths up to 25 cm in length. Celestite has been described by Kopicki (1962) and Sun (1957), but all specimens of possible celestite that the authors analyzed showed a preponderance of barium.

Chalcopyrite CuFeS$_2$

Like sphalerite, chalcopyrite is rare because it has been almost completely oxidized. It has been found enclosed in hypogene barite, galena and fluorite, where it was isolated, and thus protected from later oxidizing solutions. Cleavages of fluorite or barite with chalcopyrite inclusions may be polished to reveal interesting chalcopyrite crystals, some of which are extremely elongated. Masses of chalcopyrite oxidized to goethite are common and may occasionally show remnant chalcopyrite. Chalcopyrite was the main source of copper and a contributing source of iron for the late-stage oxidation minerals. All the galena, sphalerite, chalcopyrite and pyrite from this area are hypogene.

Fluorite CaF$_2$

Fluorite is an abundant mineral throughout the district and presents a great variety of colors and crystal habits, from microscopic crystals to ones in excess of 7 cm in diameter. Roedder *et al.* (1968) describe five stages of hypogene fluorite crystallization. Stage I fluorite forms large, pale green crystals of a rounded habit, resulting from step growths of the cube, dodecahedron and more complex forms. Stage II is characterized by sharp green crystals of cubic habit; stage III crystals are colorless to very pale green; stave IV crystals are dark purple, violet, and blue-green, often color-zoned and predominantly cubic in habit.

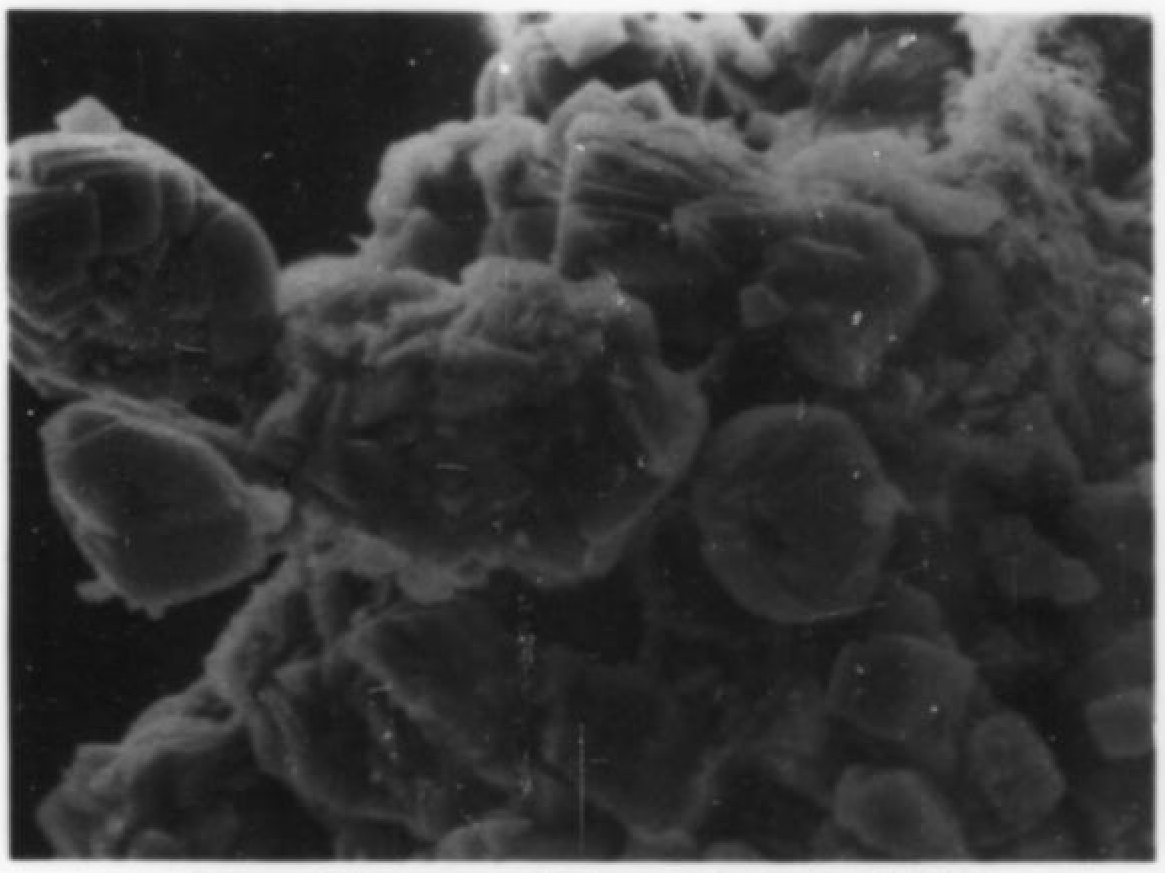

Figure 5. **Scanning electron microscope (SEM) photo of complex stage-VI fluorite. Crystal size of largest crystal 1 mm, Portales mine, Blanchard claims, specimen JET, photo EEF.**

The fluorites of stage V are usually cubic in habit; the color is purple, violet or, more commonly, a light blue. These stage V fluorites often form attractive groups of 1–3 cm cubes on a contrasting white or pale buff matrix of quartz and/or barite. Secondary minerals often cover these crystals. In a few rare cases stage V fluorite is found enclosing some of the secondary minerals. In some instances the stage V crystals have been deeply etched and corroded. Cubes with frosted surfaces are common. Although cubic crystals predominate in all stages except stage I, the smaller crystals in many stages display octahedral, dodecahedral, trisoctahedral, tetrahexahedral, and hexoctahedral faces, often resulting in nearly spherical forms.

In addition to the five hypogene stages of fluorite, the authors have found a sixth stage that crystallized after the hypogene stage was complete; although this sixth stage is insignificant in terms of the total volume of fluorite, it is, nevertheless, informative in terms of mineralization environments. Stage V and VI fluorites are described further with the oxidation stage minerals.

Galena PbS

Galena is present as large cubes (up to 10 cm) commonly modified by octahedral faces. In all cases the open-space filling crystals have been oxidized and have a coating of cerussite, anglesite or, less abundantly, brochantite, linarite or plattnerite and wulfenite. Complete replacement of galena to form pseudomorphs composed of cerussite and anglesite in concentric bands is commonly encountered. The galena was the principal source of lead for the late-stage oxidation products.

Pyrite FeS_2

Pyrite is not abundant, because most has been oxidized. Those specimens that have been found are coatings of interlocking cubes on brecciated silicified limestone fragments, cemented in a gypsum matrix, associated with sphalerite and covellite in the Sunshine #4. The pyrite was a principal source of iron for the late-stage oxidation products.

Quartz SiO_2

Quartz is abundant in the area and ranges from jasperoid wallrock alteration to 5-cm crystals. Most commonly the quartz is a translucent off-white, but smoky and amethystine varieties do occur. Crystals that appear to be black are in fact the result of a surface coating of goethite. The greatest portion of the quartz is hypogene, although small (less than 3 cm), late-stage, transparent crystals occur on some of the oxidation products, often as floaters of exceptional clarity.

Sphalerite (Zn,Fe)S

Sphalerite is rare in the Hansonburg district, most of it having been oxidized to secondary minerals. It occurs most abundantly at the Sunshine #4 tunnel where it can be found as loose, etched, anhedral crystals thinly coated with covellite, and encased within a shell of pyrite, which is in turn enclosed in gypsum. When the sphalerite is removed from the pyrite shell, it can be seen that the inner surface of the pyrite is a perfect cast of what was once a euhedral sphalerite crystal. Apparently, the sphalerite crystallized, was coated with pyrite, was partially resorbed, and was then coated with covellite before cementation in selenite. Fluid inclusion studies of this gypsum revealed no visible bubbles. Sphalerite was the principal source of zinc for the late-stage oxidation minerals. The hypogene sulfides described previously may have been the source of sulfur for the oxidation minerals, or the sulfate radical may also have been brought in by hydrothermal fluids that had turned oxidizing.

Oxidation-Stage Minerals

Although the hypogene galena and fluorite of these deposits are interesting and occasionally afford quite spectacular specimens, the authors' interest in this locality can be attributed to the occurrence of an unusual group of oxidation minerals formed largely, if not exclusively, at the expense of the hypogene sulfide minerals. Crystals of these oxidation products rarely exceed 5 mm in maximum dimension, but exceptional crystals have been found. Not only have a large number of species been found, but some individual species display a wide range of interesting crystal habits.

Antlerite $Cu_3(SO_4)(OH)_4$

Antlerite is uncommon in the Hansonburg district. Crystals do not exceed 3 mm, but antlerite can be found as coatings on specimens up to 10 cm across. Most crystals show resorption, although some brilliant, transparent, emerald-green sprays up to 5 mm occur. One of the authors (JET) found the mineral in only one pocket at the Blanchard claims, where it is associated with corkite, cyanotrichite, chrysocolla pseudomorphs after cyanotrichite, and minutely crystallized coatings of spangolite. Antlerite was distinguished from brochantite by its X-ray diffraction pattern.

Atacamite $Cu_2Cl(OH)_3$

Although atacamite has been reported by a number of collectors, the only specimens observed by one of the authors (AR) were several collected by Tony Otero of Magdalena, New Mexico. The specimens consist of brilliant, transparent, dark green laths with chisel-like terminations. The crystals are up to 3 mm in length, lining small cavities in a bluish green, fine-grained, unidentified matrix. The material came from a pocket at the Portales mine and was associated with some exceptional spangolite crystals. Identification was verified by X-ray diffraction.

Aurichalcite $(Zn,Cu)_5(CO_3)_2(OH)_6$, and
Hydrozincite $Zn_5(CO_3)_2(OH)_6$

Excellent crystals of aurichalcite may be found, especially at the Blanchard claims. Crystal morphology is like that of material from Mapimi, Mexico, but the specimens may be distinguished by the lighter colored matrix. Groups of crystal sprays covering areas larger than 4 cm across are uncommon.

Hydrozincite can be found as white minute botryoids, quite commonly covering large specimens. Good pieces are attractive fluorescent specimens. Hydrozincite must be considered rare, but it was easily found with the aid of a portable ultraviolet light in the Sunshine #2 tunnel. Both species have been identified by X-ray diffraction and microchemical tests.

Brochantite $Cu_4(SO_4)(OH)_6$

Brochantite is very common throughout the district. It is found as acicular, short prismatic, and equant crystals up to 1 cm in maximum dimension. Acicular crystals often form clusters nearly 2 cm in diameter. It is occasionally found as "bow ties" or "cauliflower" shaped crystal masses. Excellent micromounts up through museum-size specimens can be found. Specimens are a brilliant emerald-green color, grading into a translucent Kelly-green. The terminations of some equant, dark green crystals grade into an aggregation of parallel needles of lighter color. Brochantite is occasionally found replacing galena. This species was verified by X-ray diffraction on numerous occasions in the early stages of research on the identification of green minerals from the district.

Calcite $CaCO_3$

Calcite occurs in five forms in the district. The earliest calcite is the fragmented unsilicified limestone, which comes from the host rock and pre-dates the mineralization. Scalenohedrons of brownish black calcite are common and appear to be hypogene. Boxwork structure (impressions of calcite scalenohedrons in goethite, where the calcite was later dissolved) is very common in the area and seems to indicate that the earlier hypogene calcite may have been attacked and combined with the late-stage sulfate-rich solutions to produce gypsum. The dark brown calcite has frequently been misidentified as siderite but is, instead, a mixture of goethite and calcite, as determined by SEM and optical studies. Two types of late-stage calcite occur. These consist of rosettes of "papierspat" type, and of lustrous, water-clear, colorless, highly modified rhombohedrons up to 3 mm. The last calcite to form is travertine. Stalactites, stalagmites and helictites (a curved twiglike cave deposit that grows at the free end by deposition from water emerging there from a nearly microscopic central canal; Bates and Jackson, 1980) are still being formed in some places at the Blanchard claims. The habit of some of the crystallized material indicates that it probably was originally aragonite, but X-ray diffraction studies show that it now has a calcite structure. It is not unreasonable, however, to expect that some aragonite exists at the Blanchard claims. Natural active caves are found in the region and it is clear that a genetic relationship exists between the caves and the seeps in the mine workings.

Carbonate-fluorapatite $Ca_5(PO_4,CO_3)_3F$

Pale green to colorless, transparent, botryoidal clumps and aggregates of clumps of carbonate-fluorapatite occur in the Sunshine #4 mine. Individual spheres are generally in the range of 30–100 microns in diameter. The spheres show radial and banded concentric growth patterns which are characteristic of the variety of apatite known as *collophane*. The mineral gives an X-ray pattern of the apatite group. Partial electron microprobe analyses (average of multiple determinations) of the apatite gave: $P_2O_5 = 34$ wt %, $CaO = 51\%$, $ZnO = 3\%$, $CuO = 1\%$, $PbO = 1\%$, Fe as $FeO = 0.2\%$, $Na_2O = 0.55\%$ and $F = 4.5\%$. Very minor or negligible rare-earth elements were detected, and Mn, Cl, Mg, Si, Al and K were not detected above background. CO_2 and H_2O make up about 7% by difference. The apple-green color is probably due to the copper content. Optically, the apatite is somewhat unusual because of low refractive indices; $\omega = 1.604$ (2), and $\epsilon = 1.598$ (2); it may be intermediate between carbonate-fluorapatite and carbonate-hydroxylapatite. An analysis for H_2O and CO_2 would resolve the question but was not possible because of the paucity of sample material.

Cerussite $PbCO_3$, and **Anglesite** $PbSO_4$

These two minerals most commonly occur as alteration products of galena, encrusting and forming pseudomorphs after that mineral. Cerussite most commonly occurs as fine-grained, banded encrustations alternating with anglesite. The two are so closely related genetically, and are so commonly associated that they are discussed together here despite their difference in composition. The outer, coarsely crystallized surface of a galena pseudomorph is usually cerussite, sometimes tinted pale green or blue by the presence of minor amounts of secondary copper minerals. Both minerals vary in form from euhedral crystals to rounded grains, scattered on other minerals, particularly barite. Some cerussite has a non-uniform purplish red color, the cause of which the authors have not been able to ascertain. Most specimens of cerussite are small and show poor crystal development. A photograph of a twinned crystal of about 1 cm in the collection of Timothy Hanson was seen; Bob North (personal communication, 1984) said, "Pat Haynes gave me a crystal of cerussite about 1 cm across in a vug of silicified limestone." One micro-specimen of anglesite with ram's-horn habit has been observed by the authors. The best anglesite crystals observed by the authors are illustrated in Figure 7. Both species have been verified by X-ray diffraction and microchemical tests. Much cerussite has been misidentified as anglesite, which is by far the less common mineral. A simple microchemical test using 1:10 hydrochloric acid or 1:7 nitric acid will distinguish the carbonate. A fragment of the suspected cerussite will effervesce when put into a drop of the acid.

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

The importance of this species has been greatly overlooked. Being a very late oxidation-stage mineral, it has formed pseudomorphs after many of the earlier oxidation-stage minerals, notably: aurichalcite, brochantite, malachite, cyanotrichite, spangolite and hemimorphite. Replacement ranges from partial to complete, producing various shades of green through blue. Many of these partial replacements have been misidentified by previous investigators who identified species on the basis of color. The report of bisbeeite by Aldrich (in Northrop, 1959) is almost certainly a chrysocolla pseudomorph. Although the occurrence of langite, connellite and serpierite should not be ruled out, it is very possible that these minerals were identified on the basis of color and may actually have been chrysocolla pseudomorphs.

The occurrence of a partial replacement by chrysocolla is difficult to recognize. The mere presence of Cu and Si is not, of course, sufficient to identify chrysocolla. Because of the frequently poor crystallinity of the mineral, we have not found it possible to obtain an X-ray diffraction pattern from even a relatively pure sample. After looking at many collections, it became evident that chrysocolla commonly changed from light blue to an olive-green tint during storage. It was concluded that accelerating this color change could be used as an indication of the presence of chrysocolla, either as pure material or as a partial pseudomorph after another mineral. A microchemical test was devised in which a grain of the suspected chrysocolla is placed in a drop of concentrated hydrogen peroxide solution. Chrysocolla will start to turn dark olive-green almost immediately. Some specimens will ultimately turn black after long exposure to the oxidizing agent. If concentrated hydrogen peroxide is not available, drugstore-grade can be used, but the color change will be much slower. One author (JET) has tested dozens of specimens of chrysocolla from different worldwide localities; in all cases the test worked. An exhaustive test of all other secondary copper minerals has not been made, but fresh samples of those copper minerals found at the Hansonburg district did not change color. At this preliminary stage, it is suggested that the test be treated as an indication of the possible presence of chrysocolla or a partial chrysocolla pseudomorph. A color change in hydrogen peroxide should not be taken, however, as conclusive proof of the presence of chrysocolla.

Cinnabar HgS

Very recently Ramon DeMark discovered a very few samples with light dustings of a red mineral on gypsum. Energy dispersive X-ray on an SEM indicates the presence of mercury, and X-ray diffraction yields a cinnabar pattern.

Covellite CuS

Covellite is uncommon, occurring with sphalerite in the Sunshine #4 and also as an alteration product of chalcopyrite. Specimens are not attractive.

Creedite $Ca_3Al_2(SO_4)(F,OH)_{10} \cdot 2H_2O$

Specimens of creedite were brought to one of the author's (AR) attention by John Bynum of Albuquerque. His specimens consist of minute, white to colorless, prismatic crystals on rosettes of prismatic brochantite. The creedite has in part been replaced by fluorite in the form of a thin skeletal crust retaining the creedite morphology. These specimens were said to have been collected at the Mex-Tex property. An additional specimen of creedite was reported by Mike Kokinos (oral communication) and is allegedly from the Blanchard claims. Both samples have been verified by X-ray diffraction. Although creedite appears to be one of the rarest minerals in the district, it is not unlikely that specimens exist which have been misidentified as gypsum or quartz, or simply have been overlooked because of their small size and nondescript color.

Cuprite Cu_2O

Samples reportedly identified as cuprite have invariably turned out to be red goethite. Recently, however, Ramon DeMark gave one of us (JET) some samples from the Sunshine #4 tunnel that Paul Hlava said showed only copper lines on an SEM energy-dispersive scan. A sample of the suspected cuprite was X-rayed and found to give a cuprite diffraction pattern. The cuprite occurs as up to 0.5-mm inclusions in fragments of cerussite. The material is associated with the champagne-colored hemimorphite described later under that mineral. The samples consist of interlocking masses with radiating spherules of hemimorphite, glassy fragments of cerussite with inclusions of cuprite, and small sprays of euhedral green aurichalcite crystals partially altered to chrysocolla.

Cyanotrichite $Cu_4Al_2(SO_4)(OH)_{12} \cdot 2H_2O$

Cyanotrichite is rare, but it has been found at the Mex-Tex and Blanchard claims. It occurs as acicular sprays up to 3 cm in length, without the flattening seen in aurichalcite crystals. Material from the Sunshine #3 tunnel yielded a "normal" cyanotrichite X-ray diffraction pattern, while some from the Sunshine #4 tunnel appears to be largely replaced by chrysocolla and gave a pattern intermediate between cyanotrichite and carbonate-cyanotrichite. One specimen of material that

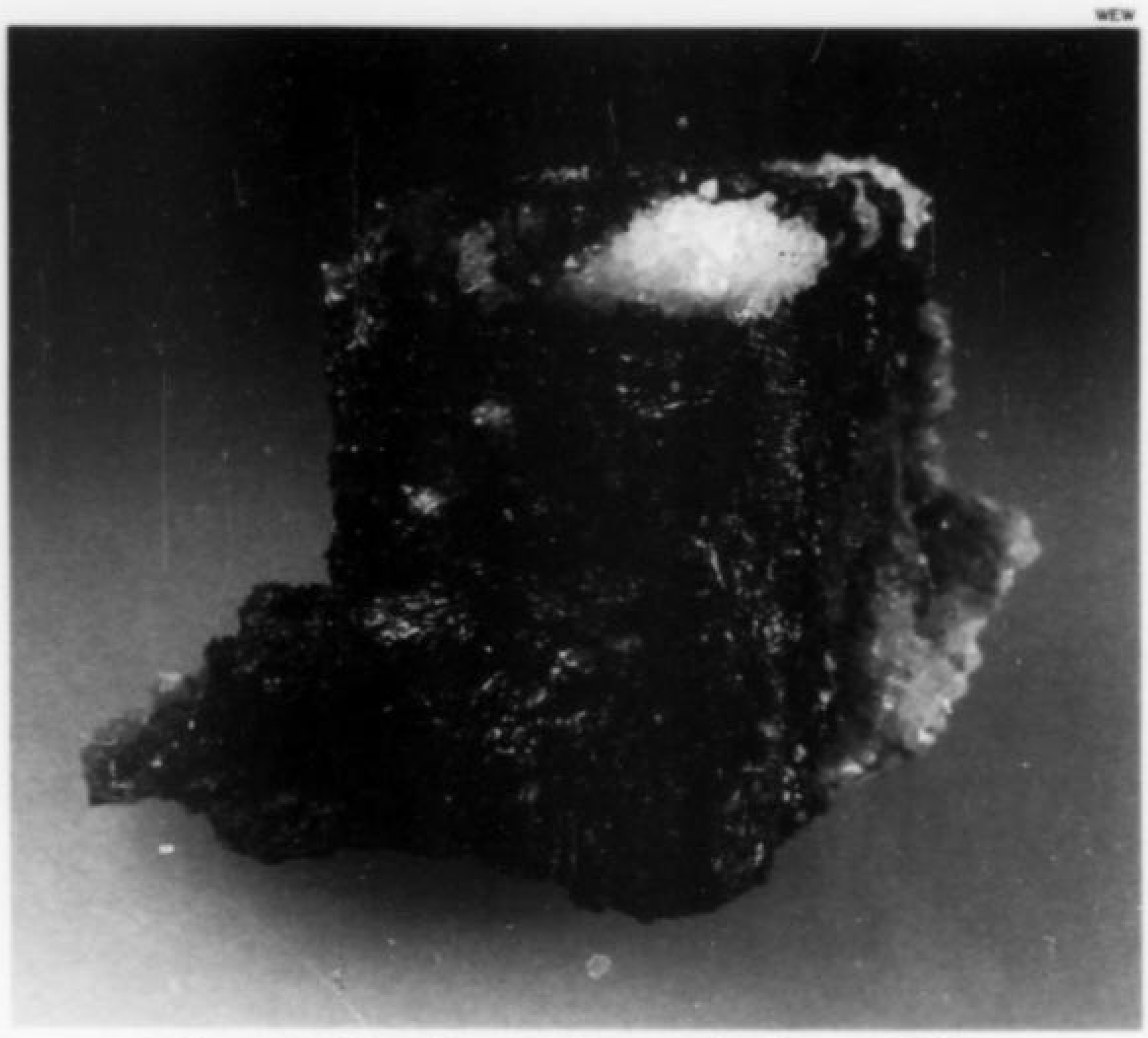

Figure 7. **Linarite pseudomorph after a cubic galena crystal, 3 cm, from the Sunshine #1 tunnel. R. S. DeMark collection.**

Figure 6. **Large fluorite group, 10 cm tall, from the Blanchard claims. J. Taggart collection.**

Figure 8. **Antlerite, size of spray 3 mm, Blanchard claims. Although antlerite is indistinguishable from brochantite by microchemical tests, its habit is significantly different and not easily confused. Specimen and photo JET.**

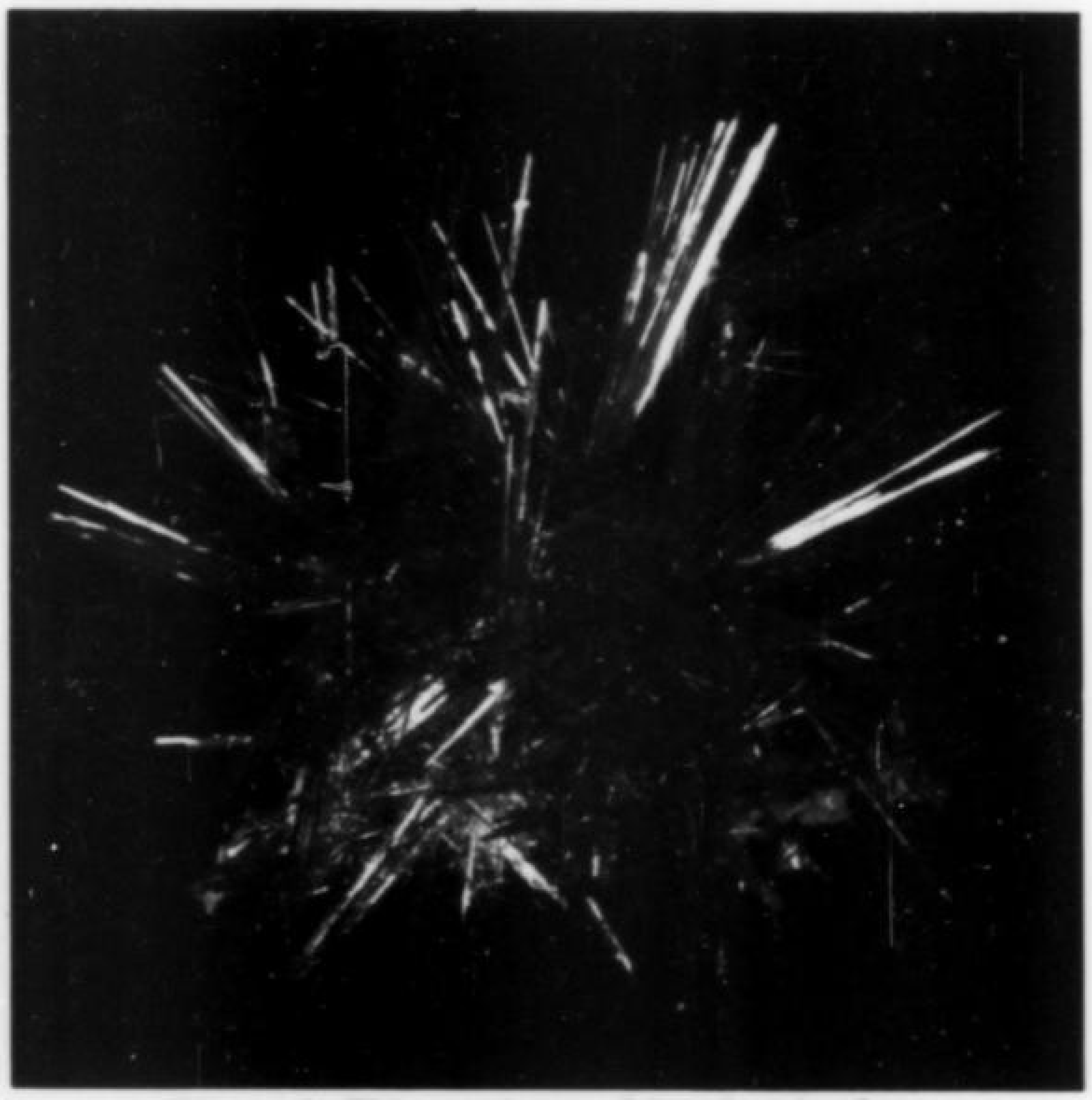

Figure 9. **This specimen of brochantite from the Blanchard claims is atypically brilliant. Euhedral, brilliant, needlelike crystals of this type are easily distinguished from the fuzzier looking malachite. Specimen and photo AR.**

has the acicular morphology of cyanotrichite gave a linarite pattern.

Cyanotrichite in the Hansonburg district is nearly always partially pseudomorphically replaced by chrysocolla in varying degrees. Numerous sky-blue specimens have been collected by two of the authors (JET and AR), only to turn an olive-green after a few months in storage. This replacement by chrysocolla has interfered greatly in the determination of the presence of carbonate-cyanotrichite. One specimen of cyanotrichite from the Upper Mex-Tex mine shows replace-

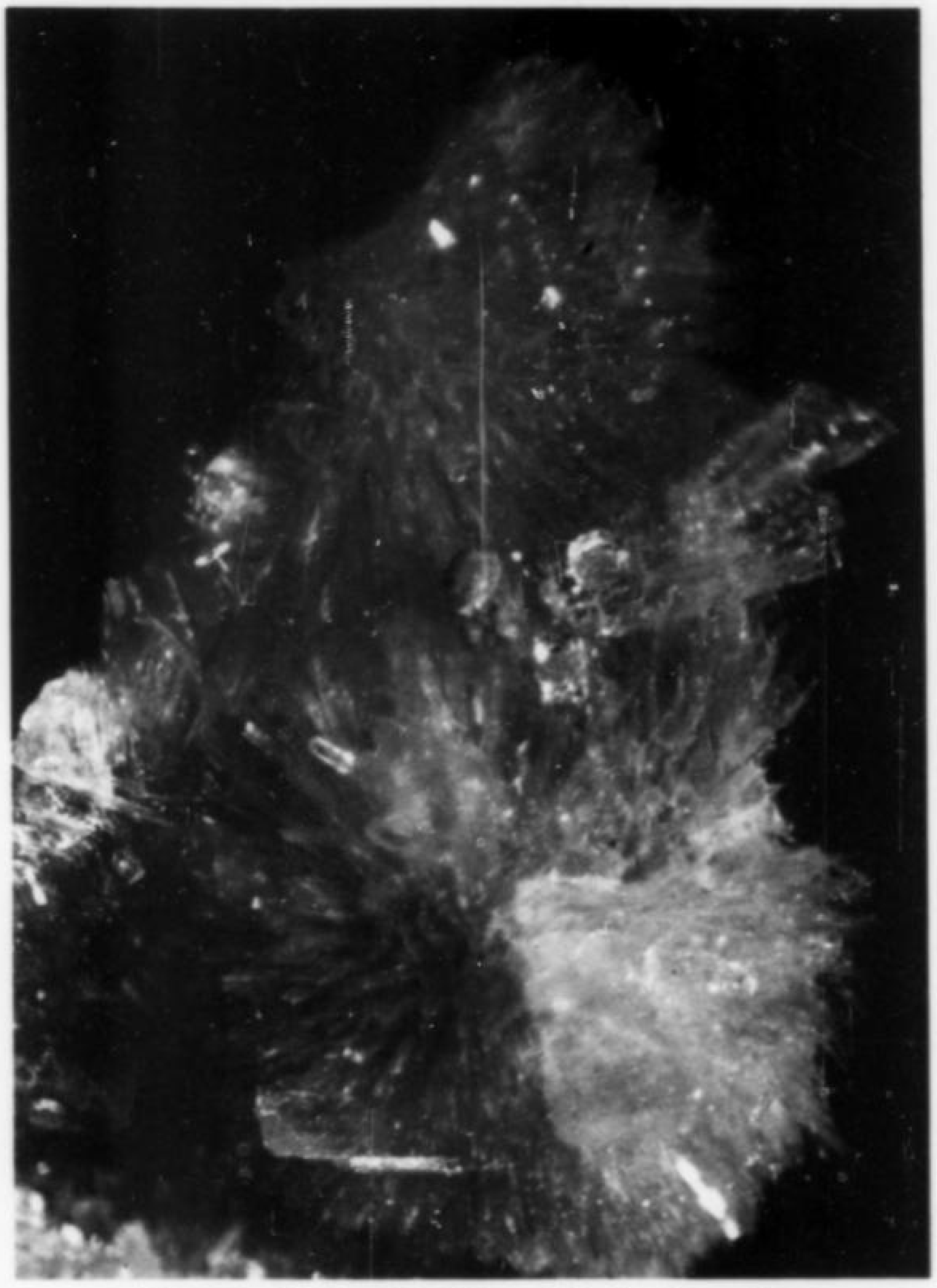

Figure 10. **Aurichalcite with hemimorphite from the Portales mine, Blanchard claims. Length of specimen 14 mm, located in the center of the specimen are two limpid cubes of stage VI-fluorite. Specimen and photo JET.**

ment of the acicular crystals by a light blue phase, while the center of the sprays, which are more tightly packed, remain a sky-blue. ICP spectroscopy analysis of a KOH fusion of the differently colored materials showed 11.5–15.8% SiO_2 in the dark blue portion, and about 25% SiO_2 in the light blue portion. The freshest cyanotrichite the authors were able to locate was from the Blanchard claims. One specimen yielded a fairly normal semiquantitative analysis for cyanotrichite, with about 5% silica, but another has 11% PbO and 3.8% CaO.

Specimens of cyanotrichite in a sugary gypsum matrix are the most abundant form and have been distributed by many dealers. This material is from the Portales mine, and many of the specimens seen by the authors are chrysocolla pseudomorphs. The mine is no longer accessible.

Fluorite CaF_2

Two stages of fluorite are included here under the description of oxidation stage minerals. A very few specimens of corroded, light purple fluorite enclosing lustrous, euhedral crystals of hemimorphite and wulfenite were found in the Portales mine. The appearance of the fluorite is similar to the stage V fluorite of Roedder *et al.* (1968). One specimen contained two crystals that were large enough to remove and polish for fluid inclusion studies. Determination of the filling temperatures (for temperature of formation, Roedder estimated a pressure correction must be added which corresponds to 10°–30°C) of a series of pseudo-secondary inclusions yielded a range of 136°–142°C (Taggart *et al.*, 1983), which is very close to the 142°–145°C range of filling temperatures determined by Roedder *et al.* (1968) for the last portion of stage V. This sample would appear to support an overlap in the two periods of mineralization, suggesting that there was a gradual change in conditions between what Roedder *et al.* (1968) and Allmendinger (1975) categorized as hypogene and supergene. Furthermore, this study recognizes the occurrence of a stage-VI fluorite which occurs as microscopic, waterclear, colorless, crystals, sometimes with opaque white cores. The habit varies from simple to highly modified cubes and octahedra. Fluorite of stage VI has been found on, or enclosing, such late-stage oxidation products as brochantite, aurichalcite, spangolite, hemimorphite and wulfenite. It has not, however, been possible to determine the fluid inclusion filling temperature because of the small size of the crystals and lack of inclusions.

Fraipontite $(Zn,Al)_3(Si,Al)_2O_5(OH)_4$ and
Dickite $Al_2Si_2O_5(OH)_4$

Dickite is common throughout the district. It occurs as small coatings and masses with the appearance of white to cream-colored popcorn. Under the SEM it can be seen that these masses consist of many small crystals (although these crystals are in fact large for the species). Masses of pure white dickite up to 2.5 cm across have been found. Identification of dickite is based on X-ray diffraction.

A mineral that is probably fraipontite or a closely related species has been found at the Blanchard claims, occurring as small, pale green to pale blue hexagonal plates less than 0.5 mm across. It yields an X-ray diffraction pattern which matches fraipontite. Quantitative microprobe analysis of some of the green crystals by Paul Hlava (New Mexico Institute of Meteoritics[4]) gave the following results: $SiO_2 = 24.6\%$, $Al_2O_3 = 18.0\%$, $CuO = 22.0\%$, $ZnO = 25.5\%$, $CaO = 0.4\%$, and $H_2O = 9.4\%$ (ignition loss at 500°C.) The light-blue crystals appear to contain more copper than zinc and are under further study. The material may be a mixture, or it may be the copper analog

Figure 11. **Hemimorphite group, 5 cm tall, colored red by cuprite inclusions (confirmed by microprobe analysis courtesy of R. S. DeMark), from the Sunshine #4 tunnel. R. S. DeMark collection.**

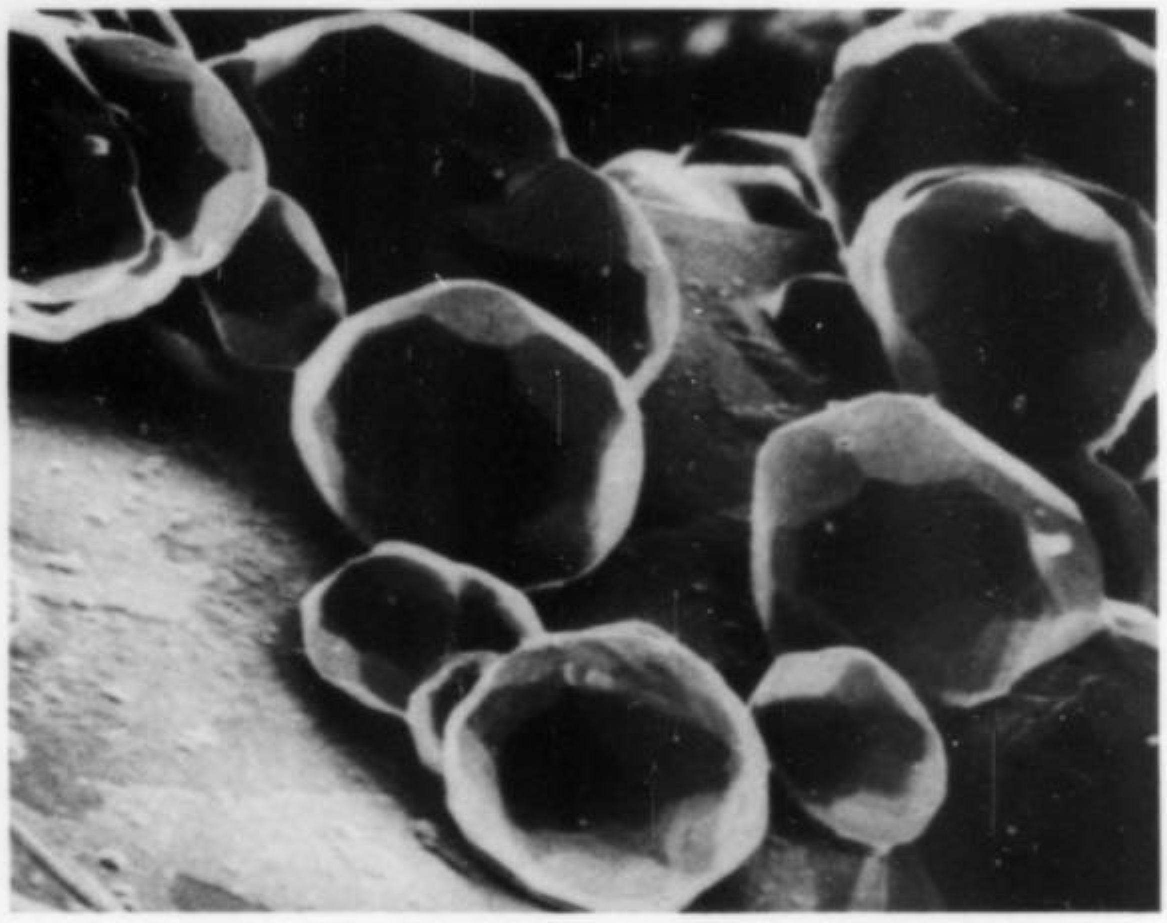

Figure 12. **SEM photo of fraipontite, Portales mine, Blanchard claims. Size of crystal $^1/_{10}$ mm, photo JET.**

of fraipontite. One of us (AR) is investigating the problem (and is indebted to W. W. Pinch for bringing this material to his attention).

Goethite $\alpha FeO(OH)$,
Lepidocrocite $\gamma FeO(OH)$, and
Hematite αFe_2O_3

All specimens of "limonite" X-rayed proved invariably to be goethite or members of the jarosite group. Color of the goethite varies from a light brown, to a dark black-brown, to a dark brick-red. The very dark material, which occurs as dendrites on the silicified limestone, is easily confused with what, at other localities, are commonly called psilomelane dendrites. Specimens of "black quartz crystals" are colored by a surface coating of black goethite. Goethite is commonly found as pseudomorphs after pyrite and chalcopyrite. It is easily confused with corkite, jarosite, mottramite and psilomelane, as described elsewhere in this article. The identifications of minium or cuprite by some investigators have in all cases but one (see under cuprite) been shown to be red goethite.

One specimen from the pocket that produced the corkite and pyromorphite (discussed under jarosite and pyromorphite) showed brownish earthy pseudomorphs of an unknown, previously existing phase. An X-ray diffraction pattern of this material showed it to be a mixture of hematite and lepidocrocite.

Gypsum $CaSO_4 \cdot 2H_2O$

A great deal of gypsum is present in the district, especially at the Blanchard claims. It usually occurs in two forms: as sugary masses of individual crystals up to 1 cm in length, and as interlocking masses of crystals, with individuals up to 30 cm long. Gypsum appears to have formed very late in the paragenesis. Crystals quite commonly show rounding because of later resorption. Of special interest are the oxidation stage minerals, included in the sugary masses and also in larger crystals of clear gypsum. Although some of the inclusions of secondary minerals are unaltered, many have been altered to chrysocolla. Close observation of the inclusions show some of them to be fragments that apparently fell on the gypsum as it was forming. They are thus not contemporaneous with the gypsum but formed earlier. In the spaces within the sugary gypsum, however, are crystals of secondary minerals formed after the gypsum. Fluid inclusion studies of both forms of gypsum show that the fluid inclusions do not contain gas bubbles and are, therefore, assumed to have formed at low temperatures, which implies that some of the secondary minerals also formed at very low temperatures.

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

Hemimorphite is relatively common and is found as sprays of crystals up to 3 mm, on specimens up to 20 cm across. Crystals ar colorless and transparent, similar to material from Mapimi, Mexico Occasionally, groups of hemimorphite of micro sizes have a sheaflik habit strongly reminiscent of stilbite. The hemimorphite crystals ar sometimes so clear that crystals of other minerals (such as aurichalcit and murdochite) attached to them appear to be suspended in air when viewed under the microscope. In April of 1988 Ray DeMark reported finding some champagne-colored spheres of hemimorphite in the Sunshine #4 tunnel.

Jarosite $KFe_3^{+3}(SO_4)_2(OH)_6$,
Mottramite $PbCu(VO_4)(OH)$,
Plumbogummite $PbAl_3(PO_4)_2(OH)_5 \cdot H_2O$, and
Corkite $PbFe_3^{+3}(PO_4)(SO_4)(OH)_6$

Minerals of this group display many similarities in the Hansonburg district and are therefore discussed together. Unfortunately, they require relatively sophisticated equipment to identify, and will therefore continue to be difficult to distinguish, especially where crystal size is small. All of the species commonly occur as thin fracture fillings and crystal coatings of tan to chartreuse-green. Because they form such thin coatings, a small amount of material appears to be more abundan than it actually is. Occasionally, these species do crystallize in open vugs.

Members of the alunite, beudantite and crandallite groups are difficult to distinguish from one another because of the similarities in their X-ray patterns and chemistry. For conclusive identification, the authors have relied on an X-ray diffraction pattern to establish the sample as a member of the group, followed by semiquantitative and quantitative analysis by a variety of methods. Jarosite is quite common in the area, especially at the Royal Flush mine, where fairly large specimens of pale tan, powdery, limonitic-appearing material can be found. An analysis of 6.86 mg of this material by ICP spectroscopy gave $K_2O = 5.82\%$, $Na_2O = 0.47\%$, $PbO = 3.37\%$, Fe_2O_3 (total iron expressed as Fe_2O_3) $= 44.7\%$, $Al_2O_3 = 0.52\%$, $CuO = 0.61\%$, $ZnO = 1.81\%$, and $P_2O_5 = 1.34\%$. At the Blanchard claims, a more coarsely crystalline specimen of brown hexagonal platelets was found in the Sunshine #3 tunnel. A qualitative energy-dispersive X-ray fluorescence analysis of this material showed major K, Fe and S with no Pb, Cu or Zn detected.

The question of the occurrence of beaverite has been brought up many times over the last 15 years. In all cases, it has involved the identification of a sample as a member of the alunite group from its X-ray pattern, and then a hasty identification as beaverite based on a qualitative determination of the presence of copper. Most recently, a pocket of well crystallized material was sold as beaverite at the 1982 Tucson Gem and Mineral Show. ICP spectroscopy analysis was conducted for Pb, Fe (total), Cu, Zn, As, K, P and Al, and ion chromatography for SO_4 on a 8.46 mg sample; analysis for H_2O (total) was made by a Mitsubishi[5] automatic Karl Fisher titrator on 9 mg; and analysis for FeO was made by titration on a 49.1 mg sample: these tests yielded the following results: $PbO = 32.4\%$, $K_2O = 0.45\%$, $Fe_2O_3 = 32.6\%$, $Al_2O_3 = 0.64\%$, $FeO = 0.26\%$, $CuO = 2.04\%$, $ZnO = 1.74\%$, $SO_3 = 10.1\%$, $P_2O_5 = 7.81\%$, $As_2O_5 = 0.06\%$ and H_2O (total) $= 10.2\%$. From this analysis it is obvious that there is not enough CuO for beaverite (even allowing the ZnO and FeO to substitute for the CuO the total does not come close to the 11–12% cations required to fill the appropriate site); furthermore, it is obvious from the phosphorous content that this mineral is not in the alunite group. The

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[4] Currently with Sandia Labs, Albuquerque, New Mexico.

[5] The use of trade names is for descriptive purposes only and does not constitute endorsement by the U.S. Geological Survey.

mineral is properly identified as corkite, a member of the beudantite group. Observation of the crystal morphology with an SEM also supports this, because the crystals are pseudocubic, instead of hexagonal platelets. This should not be taken to preclude the presence of beaverite in the Hansonburg district. It may exist, but the collector and mineralogist alike should avoid the pitfalls involved in the identification of members of these related species. Corkite has been found in various shades of olive-green to dark brown. It is most abundant in the southern portion of the district.

Mottramite has been recognized in the district for quite some time, although the name *cuprodescloizite* has been used in its description. The identification of cuprodescloizite by Kopicki (1962) is equivalent to mottramite. It is found as chartreuse to olive-drab coatings on fractures and in pockets. It appears to be more common in the North Pit of the Royal Flush mine than in any other part of the district. It was identified on the basis of its X-ray diffraction pattern, a qualitative energy-dispersive X-ray analysis, and a semiquantitative emission spectrographic analysis. Comparison of CuKα and ZnKα X-ray peak heights on samples from 3 separate pockets showed copper to be much more abundant than zinc. Cu:Zn peak ratios range from greater than 20:1 to 7:1. Descloizite was not found during this study. Mottramite, most commonly when it is found as a coating on oxidized galena cubes, has been frequently incorrectly identified as massicot by other investigators.

A single specimen of a light blue botryoidal mineral was obtained by one of the authors (AR) from Gary Young of Albuquerque. The material sparsely coats quartz and pale purple fluorite and is associated with brochantite which is partly altered to chrysocolla. The material is crystalline, brittle, and has a glassy luster on the fracture surface. The powder X-ray diffraction pattern is identical to that of plumbogummite from Dry Gill, Cumberland, Great Britain, which it physically resembles. Unfortunately, very little material was available for analysis. An ICP spectroscopy analysis on 0.36 mg yielded $PbO = 21\%$, $CuO = 2.2\%$, $CaO = 2.8\%$, $SrO = 4.4\%$, $ZnO = 0.6\%$, $Al_2O_3 = 22\%$, $Fe_2O_3 = 0.2\%$, $K_2O = 0.7\%$, $Na_2O = 0.4\%$, and an ion chromatograph analysis on 0.53 mg yielded $P_2O_5 = 20\%$ and $SO_3 = 2.3\%$. While clearly not pure "end member" plumbogummite, this is a member of the crandallite group, $AB_3(XO_4)_2OH_5 \cdot H_2O$, with phosphorus occupying both XO_4 anion sites, and with lead the most atomically abundant occupant of the A site; hence, plumbogummite is verified. The source of this material was traced to Timothy Hanson who had collected the specimen at the Mex-Tex mine. Another specimen collected from the same pocket is associated with apple-green crystals which had been identified as tsumebite. Further work showed the mineral to be libethenite.

Libethenite $Cu_2(PO_4)(OH)$

One specimen of libethenite was observed from the collection of Timothy Hanson. The specimen was collected at the Mex-Tex mine and was found associated with plumbogummite. The crystals are prismatic in habit, looking very much like a spray of brochantite crystals, but apple-green in color. An X-ray diffraction pattern matched libethenite, and energy dispersive X-ray fluorescence showed the presence of Cu and P. As, Pb, S and Zn were looked for, but not found.

Linarite $PbCu(SO_4)(OH)_2$

Linarite, although not quite as common as brochantite, occurs as spectacular crystals highly sought by museums. In 1980 some world-class crystals of linarite to 2.5 cm were found in the Sunshine #1 tunnel (Wilson, 1980). It is probably fair to say that the lure of these fine specimens has been the principal source of trouble between the mine owners, collectors and mine employees over the following five or six years.

The linarite crystals are a brilliant blue and are commonly found on a white matrix of barite or quartz. Brilliant euhedral crystals are rare, because most have been partially resorbed. Crystal sprays that appear to be very flat and parallel to the matrix surface are, in fact, almost completely resorbed, leaving only a thin reminder of the previous crystals. Sizes vary from micromounts up through cabinet specimens. Linarite has been found coating galena, giving the illusion of large (up to 5 cm) boleite crystals. Linarite is most common at the Blanchard claims and Mex-Tex mine. One specimen of acicular linarite was seen by one of the authors (JET). Identification of this species is based on X-ray diffraction.

Malachite $Cu_2(CO_3)(OH)_2$, and **Azurite** $Cu_3(CO_3)_2(OH)_2$

Early in the district's history, brochantite was misidentified as malachite, and all green minerals were identified as malachite. Later, when brochantite was identified, over-reaction then caused all green minerals to be identified as brochantite. In fact, both minerals are common throughout the district and can be distinguished most easily by a microchemical test, using dilute hydrochloric or nitric acid to check for the presence of carbonate. In general, the brochantite occurs as acicular to blocky crystals, while the malachite occurs as botryoidal to acicular masses.

Like brochantite, linarite has also been misidentified. Early reports do not mention linarite, but they do describe azurite as common. The authors have found that linarite is by far the more common mineral and have verified only one specimen of azurite by X-ray diffraction and microchemical tests.

Murdochite $Cu_6PbO_{8-x}(Cl,Br)_{2x}$ (formula of Dubler *et al.*, 1983)

Exceptionally lustrous cubes of murdochite, sometimes modified by octahedrons, can be found. The crystal size is less than 1 mm, but coatings of crystals covering surfaces up to a meter across may occasionally be collected. Murdochite is almost always found associated with some plattnerite, most commonly on a goethite-stained matrix. Those specimens with a brilliant surface luster, on a clean white matrix, are less common. The Hansonburg district produces some excellent, rich specimens of the species and, as a result, samples from the locality have played an interesting role in the interpretation of the mineral's composition and structure.

Murdochite was first described by Fahey (1955) on material from the Mammoth mine, Tiger, Pinal County, Arizona. His analysis of this material yielded the idealized formula Cu_6PbO_8. Microprobe analyses by Adib and Ottemann (1970), Burke and Masskant (1970) and Ottemann (1972) on material from the Hansonburg district and from the T.[6] Khuni mine in the Anarak area of Central Iran, however, showed significant zonation of the murdochite and appreciable chlorine and bromine: 3.0%–4.6%, and 1.5%, respectively. Burke and Masskant proposed that the chlorine and bromine substituted for oxygen and were responsible for the zoning. Ottemann (1972) pointed out that an appropriate amount of oxygen must then be omitted from the analysis in order to maintain a charge balance, and showed a microprobe traverse across a zoned specimen exhibiting a constant chlorine content with respect to zoning and an inverse relationship between copper and lead. Recognizing that a problem existed, the authors performed an analysis for chlorine and bromine by ion chromatography to verify their presence by a method independent of the X-ray spectra. The results on a 13.2 mg sample from the Portales mine show the presence of Cl^- and Br^- at 3.5% and 1.6%, respectively. Shortly after the authors performed this analysis, Dubler *et al.* (1983) described a new structure determination for murdochite, which yields the formula $Cu_6PbO_{8-x}(Cl,Br)_{2x}$ with $x \leqslant 0.5$. As halogens are added to their site, oxygen must be removed from its site, leaving vacancies in order to balance the number of ion sites in the formula. Thus, Ottemann appears to be correct, and the cations should not be expressed as oxides without a correction factor for the presence of the halogens. Dubler *et al.* (1983, p. 1144) further stated that "attempts to replace $^1/_{12}$ of the Cu^{+2} ions . . . by Pb^{+4} ions, instead of assuming oxygen vacancies to obtain

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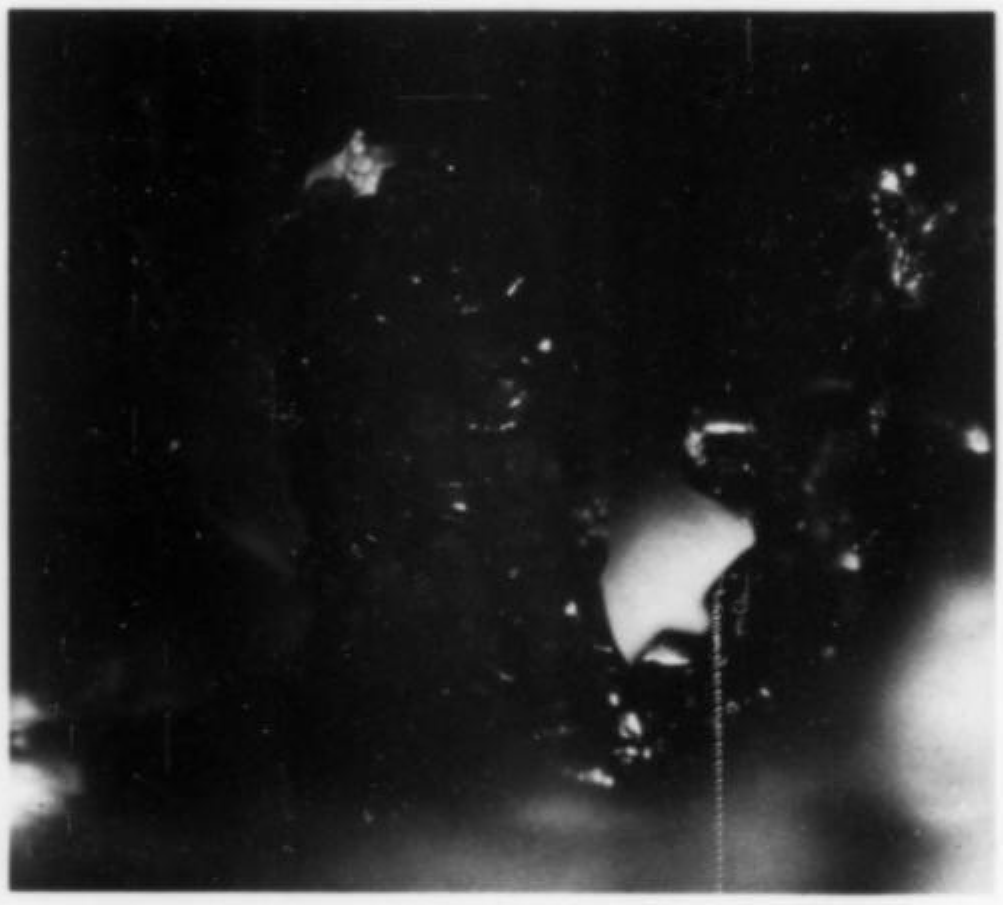
[6] T. = Tschah (Chah) = mine.

Figure 13. (right) **This crystal of linarite nucleated around a crystal of brochantite, which was then pseudomorphed to chrysocolla. Size of crystal 1 mm, Upper Mex-Tex mine, Mex-Tex group. Specimen and photo JET.**



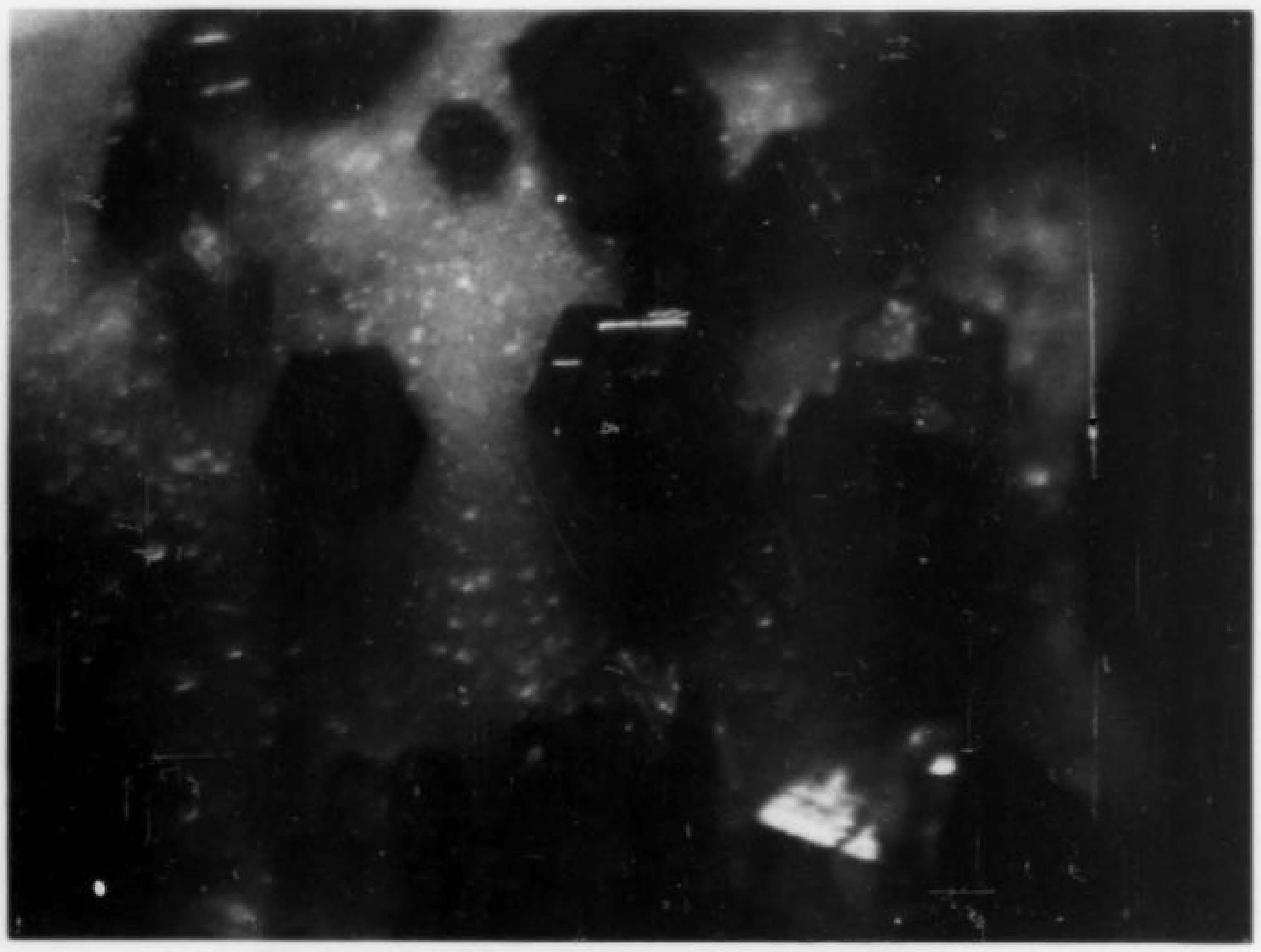


Figure 14. **Although uncommon, the Hansonburg district has produced some exceptional crystals of spangolite. The crystals in this photo are about $^1/_2$ mm in diameter and are from the Portales mine, Blanchard claims. Specimen and photo JET.**

Figure 15. (below) **Linarite thumbnail specimen with 1.5-cm crystal, found in 1980 at the Sunshine #1 mine. Jonathan Weiss collection.**

WEW

Figure 16. **Large linarite and quartz crystal group, 8.5 cm, found in 1980 at the Sunshine #1 mine. Artrox specimen.**

WEW


WEW

Figure 17. **Malachite pseudomorph after linarite, 2.3 cm, found recently in the Sunshine #4 tunnel. R. S. DeMark collection.**

electroneutrality of the compound, resulted in non-reasonable refinements of the structure . . . ." This is supported by Ottemann's (1972) microprobe traverse, which showed no correlation between chlorine content and the relationship between copper and lead.

Opal (variety hyalite) $SiO_2 \cdot nH_2O$

Hyalite is occasionally found coating some of the calcite; its green fluorescence is easily detected with a shortwave ultraviolet light. A natural cave just north of the Portales mine had abundant calcite coating the lower walls, with a coating of hyalite on the calcite. The calcite and hyalite were deposited in a pool that only partially filled the cave, judging from the high-water mark extending around the cave wall.

Plattnerite βPbO_2 and

Scrutinyite αPbO_2 (formula of Taggart *et al.*, 1988)

Plattnerite is moderately common at the Mex-Tex and Blanchard claims. Specimens are almost identical to Mapimi, Mexico, material but occur on a quartz matrix. Twins of plattnerite are relatively common. Brilliant crystals on a clean white matrix are, however, uncommon. At one location in the Portales mine, the entire hanging wall of a fault zone is covered with small plattnerite crystals and pseudomorphs of plattnerite after galena. The pseudomorphs are generally hollow and are lined with honey-colored dipyramidal wulfenite. These specimens are quite unusual and, unfortunately, no longer accessible.

A specimen of extremely small platy crystals, so thin as to appear reddish brown and transparent in transmitted light, was given to one of the authors (JET) by Tim Hanson. The material was found in the Sunshine #1 mine in the vicinity of the pocket that produced the spectacular linarite specimens in 1980, and was hoped to be a specimen of minium. Instead the material yielded a pattern that matched αPbO_2, and has been described as a new mineral: scrutinyite, alluding to the small size and close attention to detail that was required to describe the mineral (Taggart, *et al.*, 1984, Rosenzweig and Taggart, 1984, Taggart *et al.*, 1988). The scrutinyite has always been found in intimate association with plattnerite. It has, in fact, not been possible to get an X-ray pattern completely devoid of the most intense plattnerite lines. Work by the current mine owner to locate more samples has recovered only a few specimens. An additional occurrence was also discovered in Mexico, most likely at the Ojuela mine, Mapimi. The scrutinyite from Mapimi is associated with a larger quantity of plattnerite and it is difficult to get any more than the major lines of the scrutinyite X-ray pattern. Furthermore, because of the relationship between the crystal structures of the αPbO_2 and βPbO_2, plates of scrutinyite from the occurrence were found to be the nuclei for twins of plattnerite (Rosenzweig and Taggart, 1984) in a parataxial relationship. Because the material from the Hansonburg was the purest, all of the research on the new species was performed on the Hansonburg material and it has been defined as the type locality.

Psilomelane (hard, unidentified manganese oxides)

One specimen of psilomelane was observed, which consisted of black circular splotches associated with linarite on quartz. It gave a positive test for manganese, but yielded an X-ray diffraction pattern indicative of low crystallinity and could not be identified. "Psilomelane" can be easily confused with goethite, but a microchemical test for manganese (Feigl, 1958) will differentiate the two.

Pyromorphite $Pb_5(PO_4)_3Cl$

Pyromorphite is very uncommon in the Hansonburg district. When found, it is small, not abundant, and not in well-formed crystals. Two occurrences have been noted, both at the Blanchard claims. The first was a very few, small, hexagonal, straw-colored crystal sprays on a matrix of quartz crystals. These were brought to one of the authors' (AR) attention by J. G. Shinkle. Identification is based on an X-ray diffraction pattern which matched the apatite group, and a qualitative analysis by energy dispersive X-ray spectrometry on an SEM, showing the presence of Pb and Cl, and the absence of As. There is a line overlap of Pb on the P peak, so it was not possible to determine its presence. The second occurrence is of small, transparent, light yellow, individual hexagonal crystals associated with the corkite pocket sold at Tucson in 1982, as described elsewhere in this article. Although these crystals have the appearance of mimetite, a qualitative analysis by energy-dispersive X-ray spectroscopy showed only the presence of Pb and Cl; As was looked for, but not found. The X-ray diffraction pattern was indicative of the apatite group.

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

Rosasite is uncommon and always occurs in botryoidal masses sometimes up to 3 mm across. It has been found at the Mex-Tex claims and in the Sunshine #3 tunnel. Its botryoidal habit serves to distinguish it from aurichalcite. Samples of rosasite from the Blanchard claims and the Mex-Tex were tested for the relative atomic abundance of zinc and copper, using an energy-dispersive X-ray spectrometer, with the suspicion that zincrosasite, $(Zn,Cu)_2(CO_3)(OH)_2$, may be present. In all samples tested, however, copper predominated over zinc. An ICP spectroscopy analysis of 4.34 Mg from an atypically rich pocket at the Sunshine #3 tunnel gave 40.2% CuO and 31.6% ZnO, for an atomic ratio of 1.3:1 Cu:Zn. This does not, however, eliminate the possibility of the occurrence of zincrosasite. Typically, aurichalcite and rosasite are found associated with hemimorphite.

Smithsonite $ZnCO_3$

This species is very localized within the Hansonburg district. The authors know of one occurrence at the Portales mine which yielded a few specimens with translucent, white, rounded scalenohedrons up to 3 mm, having the so-called "grains of rice" habit. A genetically similar deposit, with an occurrence of smithsonite coatings and small crystals on a silicified limestone matrix, is reported to be located about 400 meters to the northeast from the Sunshine workings. The smithsonite is in very thin coatings, which are only slightly green.

Spangolite $Cu_6Al(SO_4)(OH)_{12}Cl \cdot 3H_2O$

The rare copper aluminum chloro-sulfate, spangolite, is one of the most noteworthy species found at this locality. It occurs as deep blue-green, transparent to translucent hexagonal crystals of pyramidal habit, sometimes terminated by a prominent basal pinacoid. Crystals are usually small, and rarely exceed 2 mm in diameter. With the exception of the very rare, large spangolite crystals from Bisbee, Arizona, the specimens from the Hansonburg district are the finest known. One of the most remarkable specimens seen by one of the authors (AR) was a crystal of spangolite approximately 4 mm in diameter suspended in a mass of cyanotrichite fibers up to 3 cm in length. This specimen was presented to the University of New Mexico Department of Geology in the mid 1950's by Mrs. Ora Blanchard, but the specimen subsequently suffered a "mysterious disappearance."

Because of the occurrence of Br and Cl in the murdochite from this district, it was felt that the possibility of the presence of Br substituting for Cl in spangolite should be investigated. An ion chromatography study indicated the presence of only 0.14% Br in a spangolite specimen from the Portales mine. The identification of spangolite was verified by X-ray diffraction.

Tsumebite $Pb_2Cu(PO_4)(SO_4)(OH)$

Tsumebite was found as a single specimen labeled serpierite in the collection of Dean Wise. An X-ray diffraction pattern of the material matches that for tsumebite from the type locality. Because of the small size of the crystals it was not possible to obtain a quantitative analysis. Comparison of the Pb:CuKα X-ray peak ratios between the tsumebite and some synthetic glass standards by energy-dispersive X-ray analysis on an Ortec Tefa showed a 2:1 Pb to Cu ratio. Optics were comparable to the Tsumeb, Namibia, material (Taggart and Foord, 1979). An energy-dispersive X-ray scan on an SEM did not indicate the presence of any arsenic in the Hansonburg district specimen, as is common in specimens from the type locality.

Wulfenite $PbMoO_4$

While not common, specimens of dipyramidal wulfenite ranging from caramel color to straw-yellow may be found. Many of the microcrystals are brilliant and very well formed. Some specimens, particularly those with a white matrix or associated with linarite, are quite spectacular.

DISCUSSION

The ore deposits at the Hansonburg district were formed by four episodes of mineralization. The first episode formed open spaces and silicic alteration of the host limestone; the second created the hypogene suite of minerals; the third created a suite of secondary minerals; and the fourth, an active cave environment, formed late-stage calcite, gypsum and silicic alterations of the existing minerals. Overlap of some of these episodes seems to support a genetic relationship for the mineralizing fluids, with changes in environmental conditions yielding the various suites of minerals. The authors propose that the mechanics of the basin brine convection cell model, which grades, through time, into a more oxygenated, near-surface, ground water model, can explain both the hypogene and oxidation stage mineralization in the Hansonburg district.

Within the favorable limestone beds of the Pennsylvanian Council Spring Limestone and Burrego Formation, solutions first moved along fractures and fault zones, creating cavities and silicification of the host limestone. Within the silicified cavities, solutions conducive to hypogene mineralization began to move and, over some unknown length of time, the hypogene minerals were deposited.

Hypogene Mineralization

The manto-like hypogene deposits of the Hansonburg district are similar to those in southern Illinois in that they contain galena with low silver contents and "J-type" lead (Slawson and Austin, 1960 and 1962 and Austin and Slawson, 1961). ["J-type" lead is anomalous lead that gives model ages younger than the age of the enclosing rock; in some cases even negative model ages (Bates and Jackson, 1980).] Like the deposits of southern Illinois, the Hansonburg district also contains an abundance of rhythmically banded "coontail" ore (Roedder *et al.*, 1968). At the same time, the manto-like deposits also show similarities to those mined for fluorite in Mexico—the classic Mexican manto. Mineralization similar to the Hansonburg occurs sporadically along the Rio Grande Rift (Ewing, 1978).

Allmendinger (1975) proposed that the hypogene minerals in the Hansonburg district were deposited by a hydrothermal convection cell, where deeply circulating ground water was heated by a high geothermal gradient. The hot brines altered feldspars in the sandy material that fills the basin and released the ore-forming elements into solution. Examination of solutions found trapped in small inclusions in the fluorites and barites are comparable to fluids found in modern basins. The ore minerals at the Hansonburg district were precipitated as the solutions circulated upward toward the surface. As they got closer to the surface the solutions experienced changes in pressure, temperature, oxygen content, acidity and salinity, causing precipitation. Hypogene mineralization in the Hansonburg district may have ended as the deposits in the limestone walls of the basin were uplifted above the deeper, higher-temperature basin fluids, to cooler, more saline and more oxidizing fluids. Allmendinger proposed that the earlier fluid would mix with the cooler fluids as demonstrated by a sudden decrease in temperature associated with barite precipitation, followed by a more gradual cooling trend associated with increasing salinity. Barite precipitation may therefore be the result of mixing of a "high"-barium fluid with a "high"-sulfate fluid.

Isotopic analyses of lead in galena from the Blanchard claims and the surrounding area by Austin and Slawson (1961) and Slawson and Austin (1960, 1962) show a linear isotopic relationship. Ewing (1978) interpreted this data as supporting Allmendinger's model, proposing that the Rio Grande Rift and continued magmatic activity developed many small-scale geothermal systems which leached the granitic sandy material that fills the rift and formed Hansonburg-type ore deposits. Roedder *et al.* (1968) proposed a mixing model of basin fluids and magmatic fluids based on their work with fluid inclusions. During a personal communication with Allen V. Heyl (1984), he pointed out that the mixing model is still valid with "a blending of basin brines and hypogene solutions straight up from the rift." Ewing, however, points out that Hansonburg-type ore deposits do not require a magmatic contribution to their lead. Beane's (1974) theory explains the observed lead isotopes by differential leaching of 1500 million-year-old rocks and sediments. Heyl (personal communication, 1984) points out that the composition of the brine found in fluid inclusions within the hypogene minerals found at the Hansonburg district is considerably more dilute than those in the Illinois-Kentucky deposits and at the same time has considerably higher salinity than those in most vein-type lead-zinc-silver-copper deposits of the Basin and Range Province; as at Creede, Colorado (Roedder, 1963), where they range from 5000 to 15,000 ppm total salts. Thus, the inclusions indicate that fluids present when the Hansonburg ores were deposited may have been of a transitional type. Fluid inclusion analyses by Putnam (1980) and Putnam *et al.* (1983) show a similarity of the chemistry of the Hansonburg brines to modern Gulf Coast formational waters. This, along with the hydrocarbons observed in both, strongly suggest that the Hansonburg ore fluids were similar to current-day basin brines, with the higher temperatures of the Hansonburg mineralizing solutions attributable to the elevated heat flow along the Rio Grande Rift. Putnam *et al.* (1983) postulated that the similarity between the deposits along the Rio Grande Rift is because of the presence of nearly homogeneous, Rio Grande Rift formational waters which came up along rift-activated faults and deposited mineralization in veins and cavity fillings with decreasing temperature and pressure. They conclude that the increasing relative oxidation state of the fluids with time could be due to loss of H_2S by precipitation of sulfides, or simply that later, cooler solutions had a lower capability of reduction. Their thermodynamic calculations, based upon the analyses, suggest that mineralization resulted from the simple cooling of saturated solutions. The increasing oxidation state of the hypogene solutions with time, recognized by these authors, is a trend that can be recognized to grade into an oxidation stage and finally into a present-day natural cave environment.

Oxidation-Stage Mineralization

Throughout this article the authors have carefully avoided, when possible, the use of the word "secondary" to describe the oxidation-stage mineralization. Although many, possibly all, of the oxidation-stage minerals in the Hansonburg district have formed at the expense of a previously existing phase, and are therefore secondary, the authors feel that the word implies a significant difference in genetic relationship, and/or two widely separated time periods in geologic history for the mineralization events. However, in the Hansonburg district, the authors believe the evidence clearly shows an overlap of the hypogene, oxidation, and cave stages of mineralization, both genetically and temporally. As tectonic activity and denudation continued during hypogene mineralization, the deposits approached the surface, solutions became cooler and more oxidizing, and mineralization graded from hypogene, into oxidation stage and ultimately into an active cave environment. This gradual change in the environment and in the oxidation potential of the fluids, would have caused the gradual change from fluorite deposition to oxidation stage mineralization. This gradual change allows the overlap of the hypogene stage IV fluorite—having fluid-inclusion filling-temperatures of 136° to 142°C—with the oxidation-stage mineralization.

The oxidation minerals of the Hansonburg district are principally sulfates, carbonates, silicates and oxides. Although not abundant, the vanadate anion has been known for some time to be present, and now the phosphate anion has been shown to exist in six species: tsumebite, corkite, fluorapatite, plumbogummite, libethenite and pyromorphite. Noticeably absent is the arsenate ion, which was virtually nonexistent in the pyromorphite and shows up only as a trace in the jarosite structure. Although, because of the small size of the crystals, the authors could not determine fluid-inclusion compositions on any of the late-stage oxidation minerals, chlorine was abundant enough to be structurally incorporated in five species. The source of the cations for the oxidation suite of minerals is most probably the earlier hypogene mineralization, although the lower-temperature fluids during the oxidation stage may still have contained ions leached from the arkosic sediments, and could have contributed to the oxidation-stage mineralization.

As uplift continued, the environment of the deposits moved into a highly oxidizing, active cave environment. The Sunshine #2 tunnel, for example, intersected a cavity where the cave environment was superimposed on the ore mineralogy. Throughout the district, this highly oxidizing environment was devastating to the hypogene and oxidation-stage minerals. Along some of the fault zones, which extend for tens of meters, openings are commonly 10 cm wide and are occasionally large enough for a person to crawl into. Exposed openings of this type served as water courses and rarely contain lustrous, euhedral crystals. Without exception, all species in these areas are attacked, leaving almost completely altered and expanded galena pseudomorphs, corroded fluorite, and etched quartz crystals. Under the most extreme conditions the delicate secondary minerals are virtually nonexistent. Everything is coated with a layer of iron stain, rock fragments and ore minerals.

One cave that did not have any ore mineralization associated with it is located less than 200 meters north of the Portales mine. Because of the lack of economic mineralization, the cave escaped the activities of mining and was relatively intact when one of the authors (JET) visited it on a couple of occasions during the 70's. Unfortunately, because it was considered an attractive nuisance, the opening was bulldozed over in 1978 and it is no longer accessible. Although the cave was dry, it still had seeps and a few small (up to 1 meter across) drip pools. The walls were covered with crystallized calcite, with a fairly sharp high-water mark extending around the room, above which there were bare limestone walls. Forming a thin, transparent coating on the calcite was a layer of hyalite opal. On the floor of the cave was a layer of sugary, crystallized (1-cm crystals) gypsum up to at least 20 cm thick, which gave the appearance of granular ice and snow. This gypsum covered a layer of crystallized calcite and thus formed later than the calcite. It was not noticed if the calcite below the gypsum had a hyalite opal coating, but a search with an ultraviolet light indicated there was no hyalite coating on the gypsum layer. This gypsum is identical in appearance to a layer of gypsum found in an open fault zone in the Portales mine and is very probably contemporaneous.

Below the gypsum layer in the Portales mine, the fault debris is cemented together with crystallized calcite. Of particular interest was an area in the fault debris where acicular malachite had crystallized, and some of the acicular needles acted as nucleation sites for individual scalenohedrons of calcite. Those crystals of malachite that were not encased by the calcite were then replaced by chrysocolla, while the encased crystals were protected and remained unaltered. From this sequence of crystallization it appears that the solutions that altered many of the secondary minerals to chrysocolla came after the cave calcite event, and may be contemporaneous with, and responsible for, the hyalite opal found in the cave. Specimens of the sugary gypsum from the Portales fault zone are found to contain inclusions of fragmented chrysocolla pseudomorphs of brochantite and malachite, as well as unaltered crystals of cyanotrichite and murdochite that formed on the gypsum. It is thought that the gypsum deposition came after the chrysocolla-hyalite opal event.

Fluid inclusions in the sugary gypsum from the Portales mine, and in the coarse gypsum associated with the sphalerite in the Sunshine #4 were found to have no visible bubbles. Roedder *et al.* (1968) also found no bubbles in the one specimen of gypsum they studied. This absence of bubbles would indicate a low-temperature environment; the period of secondary mineralization would extend from very late hypogene mineralization to the time of deposition of the low-temperature cave environment. The sugary texture of the gypsum and the rounded, resorbed edges of the gypsum crystals suggest that later solutions were not always saturated with respect to Ca^{+2} and SO_4^{-2}.

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The large part of the senior author's research collection of Hansonburg material, collected while employed by the New Mexico Bureau of Mines, is now the property of the Bureau's Mineral Museum, the better specimens being entered into the catalog and put on display.

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FLUORITE FROM THE

PINE CANYON DEPOSIT
GRANT COUNTY, NEW MEXICO

Robert M. North
New Mexico Bureau of Mines & Mineral Resources
Socorro, New Mexico 87801

Ramon S. DeMark
6509 Dodd Place, NE
Albuquerque, New Mexico 87110

Colorful octahedral fluorite from the Pine Canyon deposit in the Burro Mountains, Grant County, New Mexico, has been known at least since 1970. But specimens were for many years falsely labeled as coming from "Catron County" in order to keep the location a secret.

INTRODUCTION

Since the early 1970's, tens of thousands of purple octahedral fluorite specimens have appeared on the market, with the location given only as "Catron County, New Mexico." Most of this material was mined and sold wholesale by the late Dick Jones of Casa Grande, Arizona (see Bideaux, 1983). The precise location of this fluorite occurrence has always remained a mystery to mineral collectors familiar with New Mexico fluorite occurrences. Investigation of known Catron County fluorite locations identified in *Fluorspar Resources of New Mexico* (Rothrock *et al.*, 1946) did not resolve the mystery; the fluorite from the published locations was dissimilar to the specimens being marketed as from "Catron County." Northrop (1959) reported no other locations producing fluorite similar to the "Catron County" specimens.

During March of 1983, Robert H. Dickie and one of the authors (RSD) were investigating a fluorite location in the Burro Mountains near Silver City, Grant County, New Mexico. Crystal specimens collected at the site were immediately recognized as being essentially identical to the mysterious "Catron County" specimens.

The workings in the prospect area consist of a number of bulldozer-bladed areas and shallow trenches. The prospect was later determined to be the Pine Canyon fluorite deposit described by Gillerman (1952).

Fluorite similar in appearance was also found on the Spar Hill deposit, which is located about 1 km east of the Pine Canyon deposit. The workings in this area include an inclined shaft (caved), a large glory hole and numerous pits and trenches (Gillerman, 1952). No evidence of active or recent mineral collecting was observed in the Spar Hill area.

More specifically, the Pine Canyon area is in the SW 1/4, Sec. 27, T19S, R16W, New Mexico Principal Meridian (Fig. 1). The area is shown on the U.S.G.S. *Burro Peak* $7^{1}/_{2}$-minute quadrangle as a single prospect pit on the south side of Pine Canyon, about 800 meters southwest of the Spar Hill mine. The prospect is reached by taking New Mexico Highway 90 south from Silver City to graded Forest Road (FR 136). Take FR 136 approximately 10 miles to its intersection with FR 852. Continue southwest on FR 136 for another 0.6 miles. The collecting area is about 500 meters north-northeast. A rough, partially washed out, 4-wheel drive road leads to a windmill in Pine Canyon, near the collecting area. All but experienced drivers in good four-wheel-drive vehicles are advised to walk from here to the prospect.

HISTORY

The Spar Hill and Pine Canyon prospects were first located by Marshall N. Kuykendall of Lordsburg in the early 1940's (Gillerman, 1952). About 800 tons of fluorite were shipped from the Spar Hill deposit between February of 1942 and March, 1944. No shipments

***Figure 1.* Location of the Judith Lynn claim in Pine Canyon, Grant County, New Mexico.**

were made from the Pine Canyon deposit (Gillerman, 1952). Records from the Grant County Courthouse indicate this property was subsequently located in March of 1971 as the Old Snag mine by H. M. Jones and W. G. Fussner of Casa Grande, Arizona. In December of 1972, two claims, the Pine Canyon and Pine Canyon #1 were located over the same ground by Marshall Kuykendall. Kuykendall allowed the claims to lapse, and the area was relocated as the Golden Furnace claim by Richard L. and Helen Jones in March of 1979. The Joneses apparently failed to keep up the assessment work, and the area was again reclaimed in April of 1983, as the Judith Lynn claim, by one of the authors (RSD) and Robert H. Dickie. DeMark and Dickie have filed assessment work and currently hold the claim by rights of location. The claimants allow non-commercial collecting, provided that only hand tools are used, and that permission is obtained in advance.

GEOLOGY

Fluorite at the Pine Canyon deposit occurs as steeply dipping, northeast striking, 1 to 10-cm veinlets in a shattered area of the Spar Hill fault zone cutting weathered Precambrian Burro Mountain Granite. The fault zone strikes N60°E, and dips 70° NW (Richter and Lawrence, 1983). Small diabase dikes and plugs of probable Precambrian age intrude the granite in the area (Gillerman, 1952; Hedlund, 1978). The strike of the veinlets is irregular, bending every 5 meters or so. Northeast to east-striking Tertiary white rhyolite dikes crop out in Pine Canyon and may be genetically associated with mineralization. Similar dikes in the Burro Mountains have been dated at 44.7 million years old (Drewes *et al.*, 1985). Fluorite occurs in fractures cutting all rock types (Gillerman, 1952), but the best mineralization is found where the fractures cut the Precambrian granite.

The fractures in granite are filled by fluorite commonly having a coating of quartz and montmorillonite clay. These veinlets have been exposed by several bulldozer cuts and trenches. Some outcroppings of fluorite mineralization, however, have no significant workings on them, and represent excellent potential for additional specimen material.

The timing of fluorite mineralization in the Burro Mountains area is uncertain. It was probably not associated with the Tyrone porphyry copper system (56 m.y.), but is instead considerably younger, probably formed by a relatively small hydrothermal system associated with the emplacement of the rhyolite dikes at about 44 m.y. A third alternative is that the fluorite was formed by a hydrothermal system associated with mid-Tertiary (35 m.y.) volcanism in the area (Drewes, *et al.*, 1985).

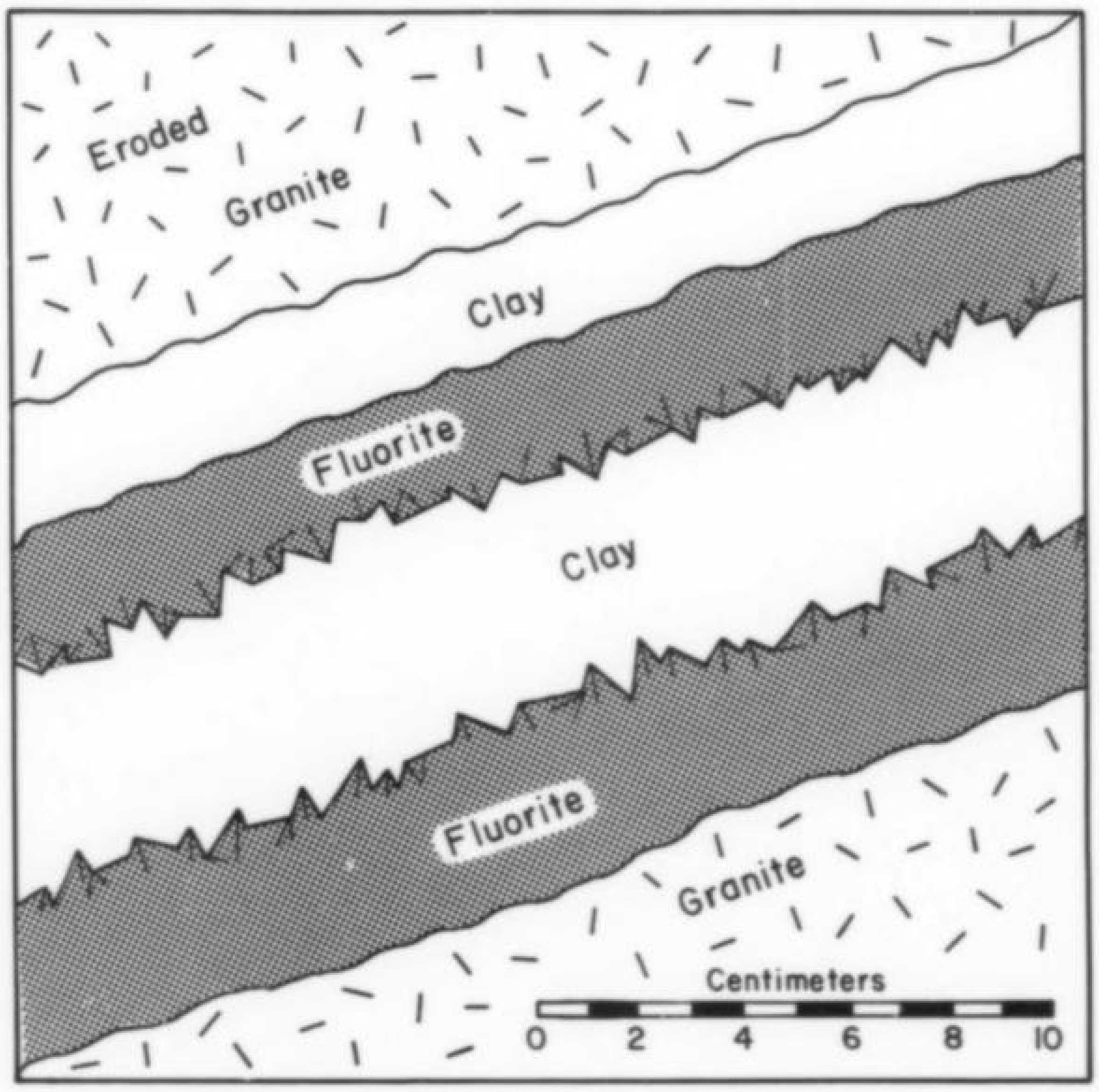

***Figure 2.* Sketch of the fluorite veinlets, Judith Lynn claim, Pine Canyon, Grant County, New Mexico.**

FLUORITE

Pine Canyon fluorite is always octahedral in habit with crystals ranging from 1 mm to 5 cm and occasionally larger. The predominant color is a dark purple, commonly with a green interior zone. The large purple crystals nearly always have a slightly convex or irregular surface, often with a "scallop shell" texture, and are generally very dark to almost opaque except on thin edges. Smaller crystals in the 1 to 4-cm range are sometimes more translucent, with frosty, slightly convex faces. Specimens with colorless fluorite surrounding purple cores and oscillatory zoning have also been found. Crystals are commonly zoned with lighter shades of purple. In some cases the octahedrons are a pink to lilac color and have a quartz matrix that appears to have been acid-etched.

Fluorite found on the dumps of the Burro Mountain prospect is invariably some shade of pink, and practically all of it is covered with a 1 to 2-mm drusy coating of quartz crystals. The quartz coating has usually been removed by dealers using hydrofluoric acid to expose the undamaged fluorite crystals. The finest fluorite specimens from the prospect have probably been etched out of quartz. The pink color of the fluorite on the dumps apparently results from exposure of purple fluorite to sunlight; no pink fluorite has been found *in situ*.

Recently, specimens labeled "T&G claim, Grant County, New

WEW

Figure 3. Fluorite, Pine Canyon, Grant County, New Mexico. Collected by the late Dick Jones in 1969, formerly in the collection of the late Tom McKee. The specimen is 9.5 cm across.

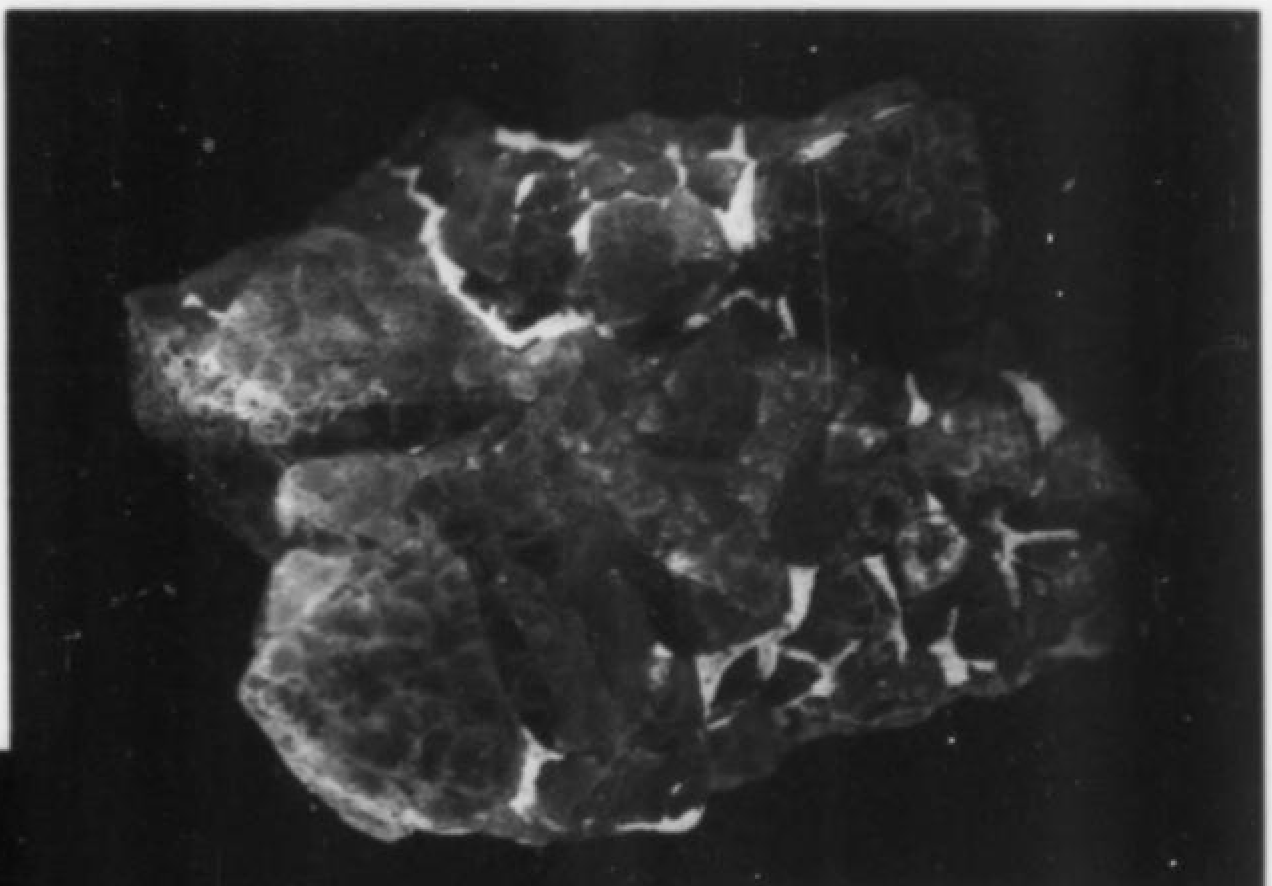

Figure 4. Fluorite, Pine Canyon, Grant County, New Mexico. Collected by R. W. Eveleth in 1970 from what is now the Judith Lynn claim. Largest crystal is 1.4 cm across; overall specimen length, 7.0 cm. New Mexico Bureau of Mines Mineral Museum specimen, catalog #9904. Photo by Angela Kirkman.

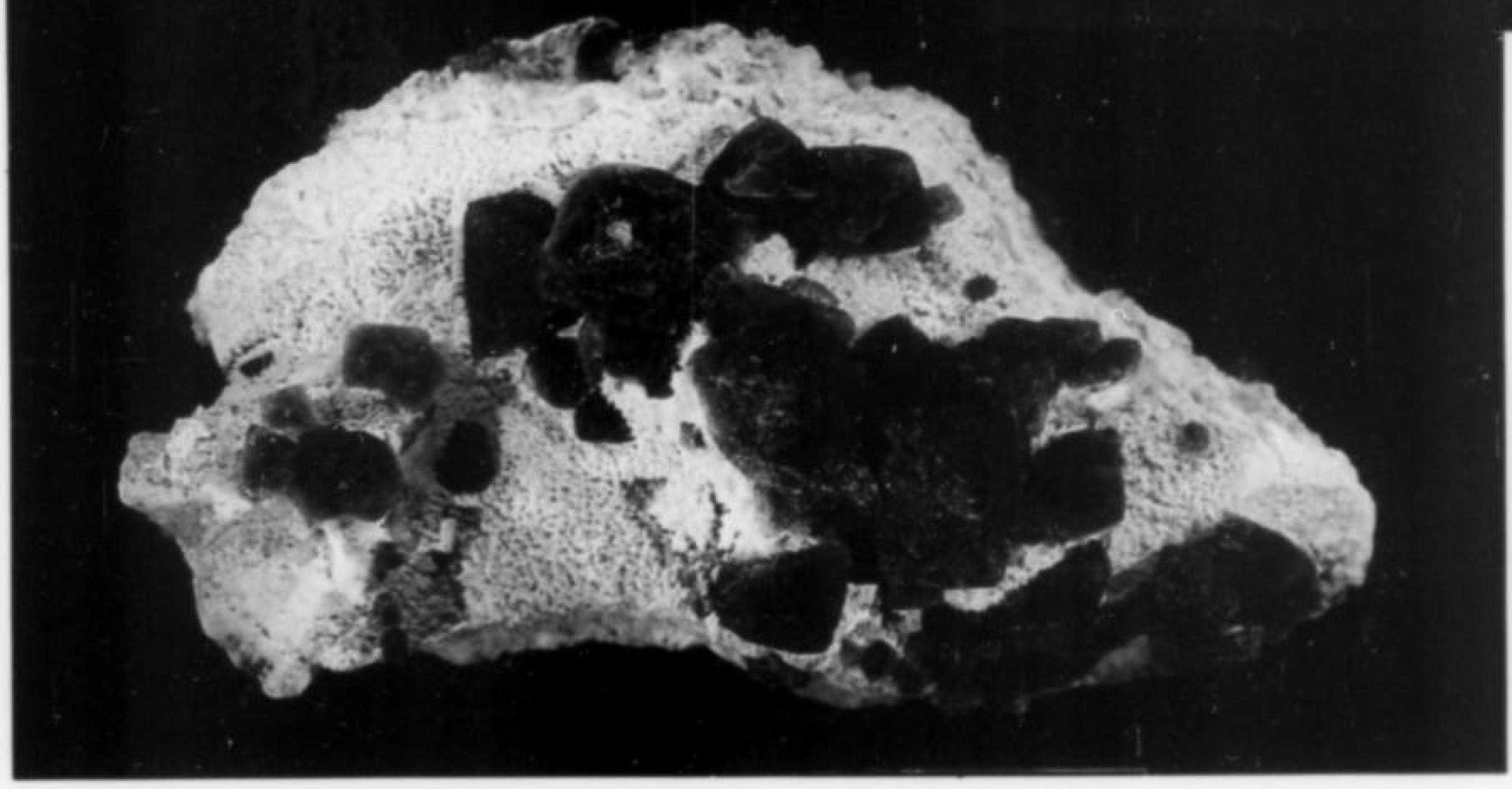

Figure 5. Fluorite, "Catron County," New Mexico. Note scalloped surface texture on crystals. New Mexico Bureau of Mines Mineral Museum specimen, catalog #10733. Largest crystal is 1 cm across. Photo by Angela Kirkman.

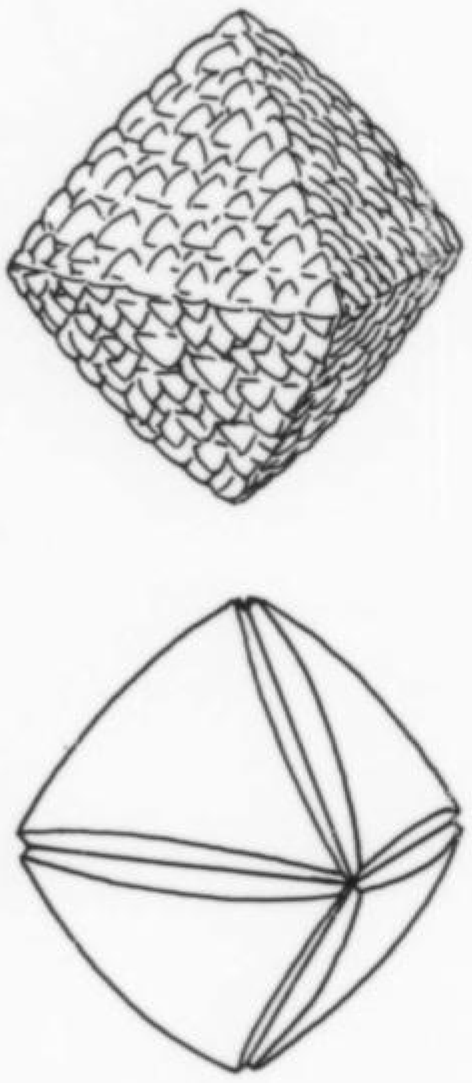

Figure 6. **Fluorite crystal sketches showing (*top*) "scallop shell" surface as on the specimen pictured at right, and (*bottom*) convex octahedral development as on the cover specimen for this issue.**

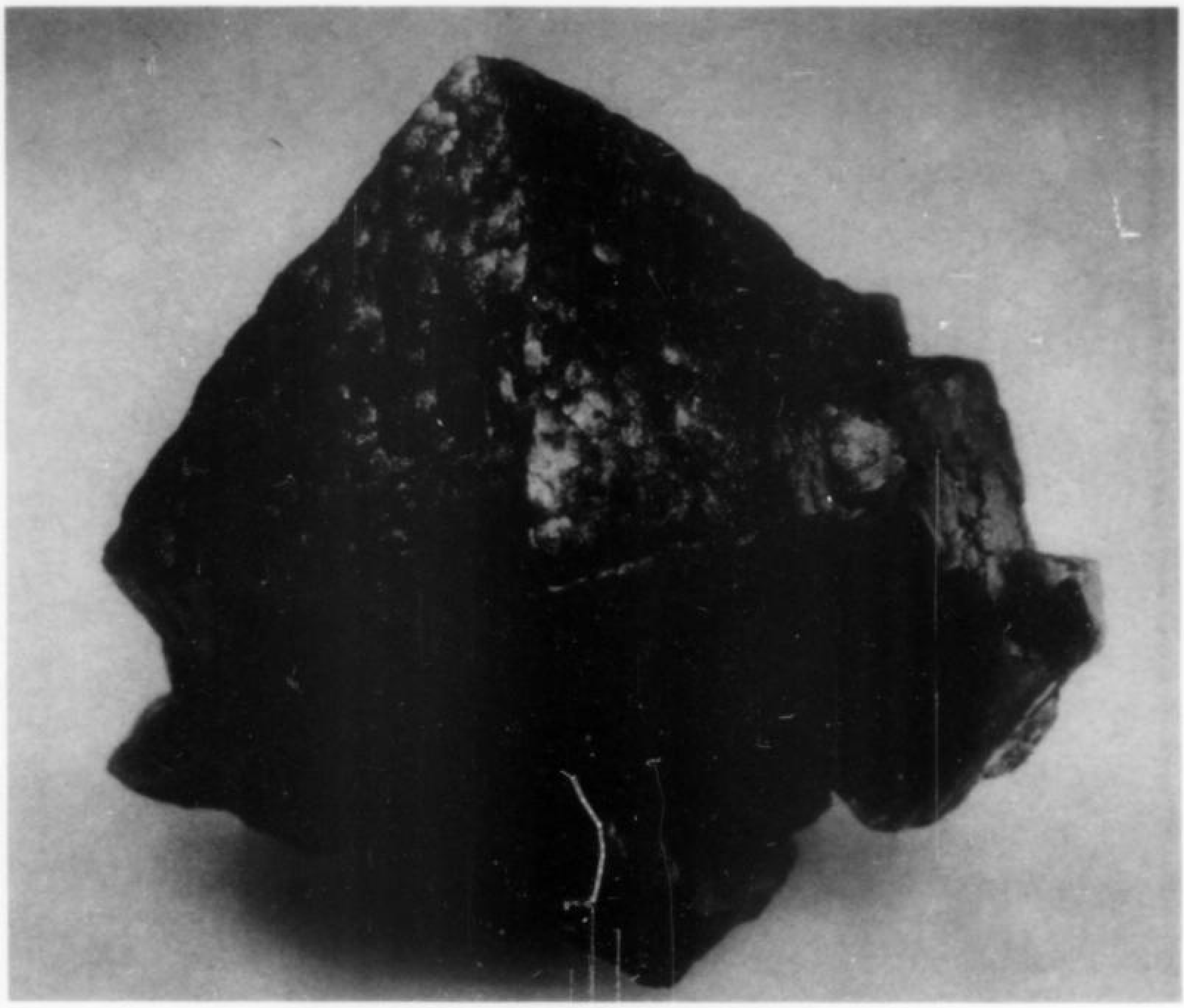

Figure 7. **Very dark purple octahedral crystal with "scallop shell" surface, 5.1 cm. Collection of R. S. DeMark.**

Mexico," have surfaced and these also appear identical to the fluorite from the Pine Canyon deposit.

Purple octahedral fluorite somewhat similar to Pine Canyon specimens occurs at a location on Cook's Peak in Luna County, New Mexico. These specimens are also zoned with a green interior but can easily be distinguished by their lack of scalloped surface features. The octahedral faces are flat rather than curved, and the crystals are much more transparent.

LABELING

Correct labeling presents a problem in cases such as this, where claim names have changed repeatedly (see Shannon, 1987). As mentioned above, the Pine Canyon deposit has been variously known as the Pine Canyon, Pine Canyon #1, Old Snag, Golden Furnace, "Catron County," T&G and Judith Lynn claims. For the sake of consistency, we recommend that all specimens be labeled "Pine Canyon deposit, Burro Mountains, Grant County, New Mexico." This is in accordance with the only recognized name for the deposit itself (as opposed to the claim), and is the only legitimate name to have previously appeared in the literature. Following the suggestion of Bentley *et al.* (1986), earlier labels with other names should be retained for historical purposes.

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MINA TIRO ESTRELLA

Tim Hanson
P.O. Box 1544
Socorro, New Mexico 87801

During the years 1979 and 1980, smoky Japan-law twinned quartz crystals were found at the "Mina Tiro Estrella" claim, Lincoln County, New Mexico. The best of these rank with the finest quartz specimens ever found in North America.

LOCATION

The Mina Tiro Estrella claim is located on the south side of the Capitan Mountains, Lincoln County, New Mexico. The claim is in the northeast corner of Section 35, T8S, R16E. An adjoining claim, the "Capitan" claim, crosses over into the southwest corner of Section 26, T8S, R16E. The discovery point on the vein is about 7360 feet (2240 meters) in elevation. The claims can be reached by traveling U.S. Highway 380 eastbound 8.5 miles (13.7 km) from Capitan, then taking a left at Double Crossing onto Salazar Canyon Road for 5.6 miles (9.0 km), which is 0.7 miles (1.1 km) past Baca Campground. At this point, take a left towards the northeast for 700 ft. (230 meters). Then take another left towards the north. Travel this road 1.2 miles (1.9 km) to a cattle tank, "Dean Tank." At this point "Pack Trail" begins. Take this trail 1.6 miles (2.6 km) north until you come upon "South Base Trail." Take a right going east onto South Base Trail for a half mile then go north, left off the trail, through the trees up slope for 500 feet (150 meters) to the claim (see Fig. 1).

HISTORY

During the uranium boom years of the 1950's the Capitan Mountains were extensively prospected for radioactive ore deposits. Numerous claims were located; however, not one prospect was rich enough to warrant production. Veins in the district were found to carry mostly quartz with allanite, epidote, purple fluorite, hematite, magnetite and tourmaline. Allanite was found to be carrying radioactive isotopes of thorium (the probable source for the radioactivity observed in the veins) (Griswold, 1959). After the boom years the district fell into obscurity.

Not until August of 1976 did the district come alive again, this time for a different reason: the collector value of the mineral specimens. As rumor has it, Richard "Dick" Jones met a hunter who had found some Japan-law twinned quartz. Dick got a general description of the area from the man and he and his wife Helen located a claim there, "Mina Tiro Estrella." Three years later, in April of 1979, they made a major find. Numerous smoky Japan-law twinned quartz specimens of exceptional quality were found. Four claims were filed: "Summit," "Capitan," "Mina Tiro Estrella," and "El Tigre." Two of the four, Summit and El Tigre, are suspected to be red herrings and are located miles from any known specimen material. The Mina Tiro Estrella and Capitan claims were recorded as being a half mile further north than they were actually found to be. This misinformation proved to be a good ploy, as it protected the secrecy of their claim until 1980. But in that year other collectors finally came upon the occurrence. One college student that I met in 1980 had three 5-gallon pails full of exquisite Japan-law twinned quartz and clay. Dick subsequently abandoned the claims. Since then, they have not produced much more in the way of substantial specimens.

GEOLOGY

Alaskite rock hosts the mineral deposit within a fault striking N48°E and dipping 52°SW. The fault is not easily traced, as it is covered along a hillside by colluvium and vegetation. However, for at least 275 meters a fairly good delineation can be made by observing float (quartz, magnetite and epidote) originating from the vein.

The vein has experienced postdepositional movement and as a result much of the vein material is brecciated. Much of the feldspar has been kaolinized. Towards the hanging wall of the 60-cm-wide vein, clay and quartz gouge are present. Most of the best specimens have originated from here.

MINERALOGY

Allanite-(Ce) $(Ce,Th,Ca,Y)_2(Al,Fe^{+3})_3(SiO_4)_3(OH)$

Allanite appears to be associated with the mafic minerals as coatings and granules, with the quartz mineralization as superb crystals on

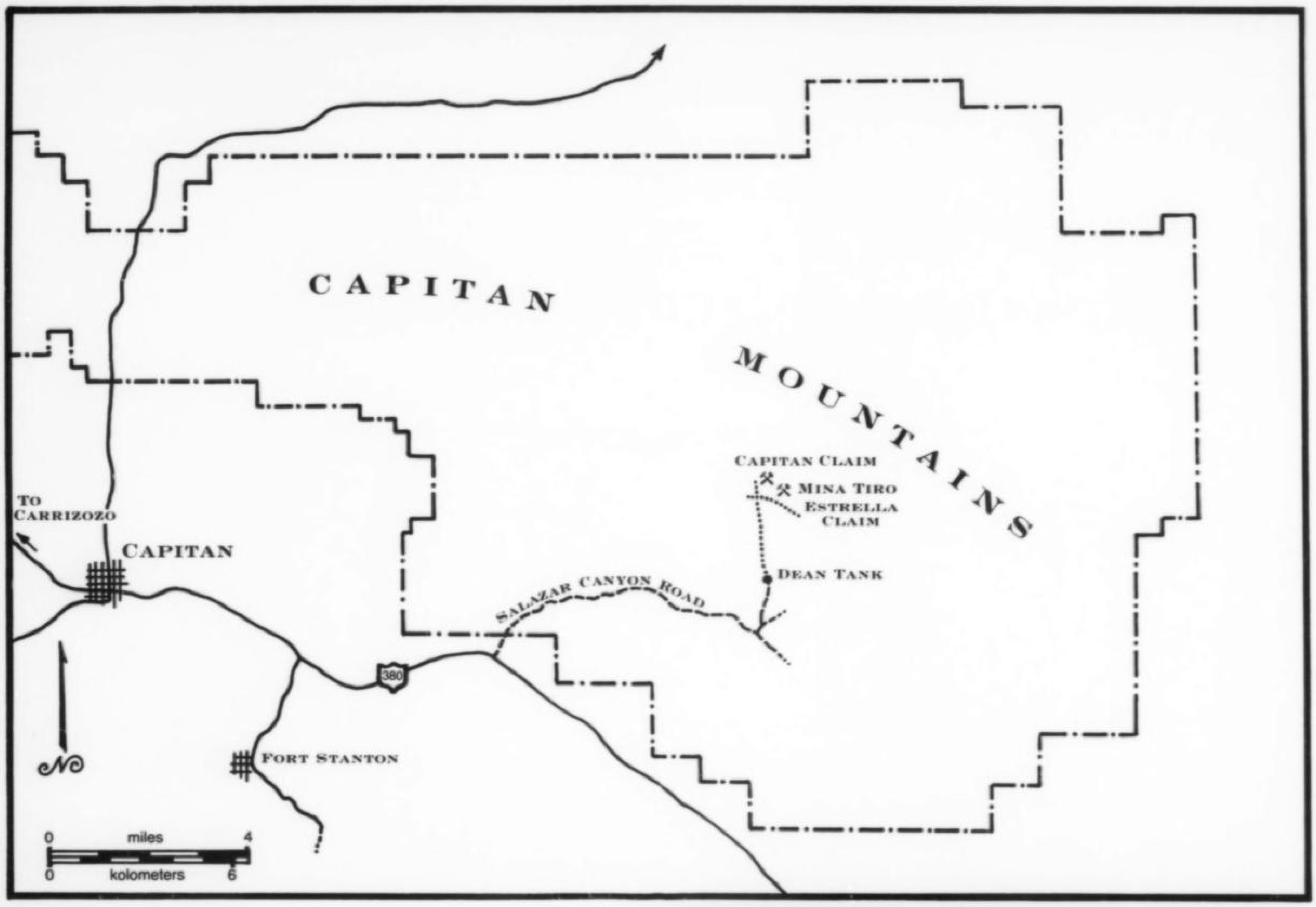

***Figure 1.* Location map.**

***Figure 2.* Excavations in the area where smoky quartz twins were first found. Photo taken in June, 1983.**

matrix, and free in clay. The crystals are pitch-black and can be quite lustrous. Some are as large as 3 cm but most are smaller.

Allanite from here carries an appreciable amount of thorium. Because of the radioactive thorium isotopes, some crystals appear to have become highly metamict. This makes some crystals crumbly. Another likely effect of the radiation is to have caused some quartz to turn smoky.

Feldspar

Feldspar (probably an alkali feldspar) is a common associate. It ranges from white to very pale pink and is most commonly associated with quartz, titanite and (much less so) with epidote. Crystals occur as individuals 1 cm or smaller and also as massive collections of intergrown crystals. They are not usually of collector quality.

Epidote $Ca_2(Al,Fe^{+3})_3(SiO_4)_3(OH)$

Epidote occurs as vug fillings and inclusions in quartz, as crystals to 0.5 mm in diameter and 1.2 cm in length. Most commonly it occurs as large masses, apparently as a metasomatic replacement of the footwall rock.

Quartz SiO_2

Quartz is easily the most collectible mineral from this locality. The crystals are lustrous and transparent and occasionally studded with titanite crystals. They form as singles and as Japan-law twins. The single crystals are usually no longer than 2.5 cm. However, "rabbit ear" twins have been found as long as 9 cm and heart-shaped twins are as large as 7.5 cm in diameter. Many specimens are smoky. The smoky color is probably the result of natural radioactivity from the thorium in nearby allanite crystals (the process is described by Nassau, 1988).

Titanite $CaTiSiO_5$

Titanite occurs as translucent, reddish brown, wedge-shaped crystals with an adamantine luster. The crystals measure as large as 6


WEW

Figure 4. **Smoky quartz Japan-law twin, 7 cm tall, collected by Dick Jones in 1976. From the collection of the late Tom McKee.**


WEW

Figure 3. **Smoky quartz Japan-law twin, 4 cm across, collected by Dick Jones in 1976.**

mm, but more typically around 1.5 mm, tending to occur sprinkled on quartz and feldspar in the middle of the vein. Other minerals present include actinolite, hematite, magnetite and microlite.

STATUS

In part, the Mina Tiro Estrella has been relocated as the "Estrellita" claim by Marlow Sharpe of Nogal, New Mexico, and Mark Deters of Socorro. The claim is currently closed to mineral collectors.

ACKNOWLEDGMENTS

I would like to thank Bob Thompson and Scott Fadrowski for their help in locating the claims in 1982, and Robert Eveleth, New Mexico Bureau of Mines and Mineral Resources, for his advice.

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ILMENITE EPITAXIAL ON BIXBYITE

FROM SIERRA COUNTY, NEW MEXICO

Wm. A. Henderson, Jr.
174 East Hunting Ridge Road
Stamford, Connecticut 06903

In 1978 or 1979, I received a single micro specimen of bixbyite with raised, parallel ridges of an unidentified mineral from Marvin Deshler, Phoenix, Arizona. In 1983, I received from William Hunt of Sun City, Arizona, four more specimens of the same material labeled as hematite on bixbyite. The remarkable regularity of the ridges on the bixbyite warranted a closer investigation, the results of which are reported here.

Hunt gave the location of the material as in Paramount Canyon, 12 miles east of Beaverhead, Sierra County, New Mexico. Deshler gave the location as Paramount Claims, Sierra County, New Mexico. Apparently, the location is the same as or very close to one described by Lufkin (1976) as being on the north rim of Paramount Canyon, 5.3 km west of Boiler Peak, in the Black Range, New Mexico.

The bixbyite occurs in highly localized areas of cavities and lithophysae in the Tertiary Taylor Creek rhyolite. Associated with it are a number of other oxide minerals: hematite, cassiterite, pseudobrookite and ilmenite. Other associates are quartz, sanidine, topaz, fluorite and silica polymorphs (Lufkin, 1976).

A few crystals of brilliant, gray-black bixbyite without any overgrowths are present on the specimens. These show major cube and trisoctahedron faces. Whereas the cube faces are smooth, the trisoctahedron faces are quite pitted. Two crystals of bixbyite are intermediate in character, showing ilmenite overgrowths at one corner of each crystal. Neither of these shows trisoctahedron faces.

Most of the crystals showing overgrowths are like those shown in Figures 1 and 2. Many show extensive intergrowth with quartz and/or feldspar, probably sanidine, as in Figure 1. In most cases, despite the heavy overgrowth of ilmenite, it is possible to discern cube plus octahedron or trisoctahedron faces (Fig. 2).

A few smaller crystals do not show the multiple ridges of ilmenite as in Figures 1 and 2. Instead, they show only a single set of ridges decorating the intersections of cube and octahedron faces (Figs. 3 and 4). These crystals are distinctly cavernous because the single set of ilmenite ridges is so pronounced.

The ilmenite was identified by semi-quantitative microprobe analysis. This showed only three metals to be present in the ratio Fe:Ti:Mn = 10:10:1. Considering the nature of the analysis, this fits ilmenite well, and rules out hematite. The crystals are essentially nonmagnetic.

Oriented (epitaxial) overgrowths of ilmenite (or hematite) on bixbyite have not previously been reported. However, epitaxial overgrowths of a closely related pair of minerals, magnetite and hematite, have been described by Mügge (1905). The relationship given is $\{111\}[110] = \{0001\}[10\bar{1}0]$. It is assumed that a similar relationship exists between the ilmenite and bixbyite described here, and the orientation of the overgrowths bears this out.

Figure 1. **Ilmenite, gray-black, in parallel ridges epitaxial on bixbyite, intergrown with quartz and feldspar. Size of crystal, 0.8 mm.**

Expitaxial (oriented) overgrowth of one mineral on another can occur when the arrangement and interatomic spacing of ions in the crystal lattice of one mineral closely match those of the second in certain directions. That such a relationship can exist for (isometric) bixbyite and (hexagonal-rhombohedral) ilmenite is shown in Figure 5. Bixbyite, although showing four-fold symmetry when viewed down a crystal axis, shows three-fold symmetry when viewed perpendicular to an octahedron face (upper right, Fig. 5). Ilmenite, when viewed down the *c*-axis, displays three-fold symmetry also (lower middle, Fig. 5). The arrangement of atoms in planes showing three-fold symmetry is then very similar for the two species, and it is known for the combination hematite-magnetite that the spacings are also very similar. The same must be true for the combination ilmenite-bixbyite, because epitaxial overgrowth does indeed occur. The overgrowths, as

***Figure 2.* SEM photograph of multiple ridges of ilmenite epitaxial on bixbyite. Viewed down a [100] axis, crude cube and octahedron faces of the bixbyite are discernible. Size of crystal, 0.6 mm.**

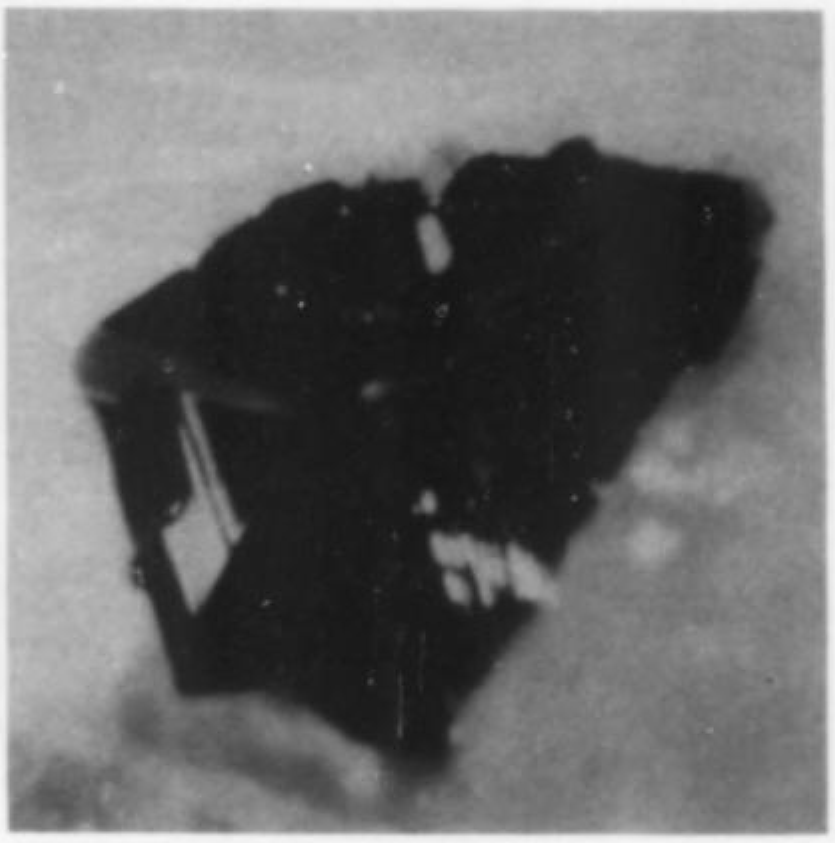

***Figure 3.* Pronounced ridges of ilmenite epitaxial on bixbyite, the ilmenite outlining or decorating octahedron edges and producing a cavernous appearance. Size of crystals, 0.3 mm.**

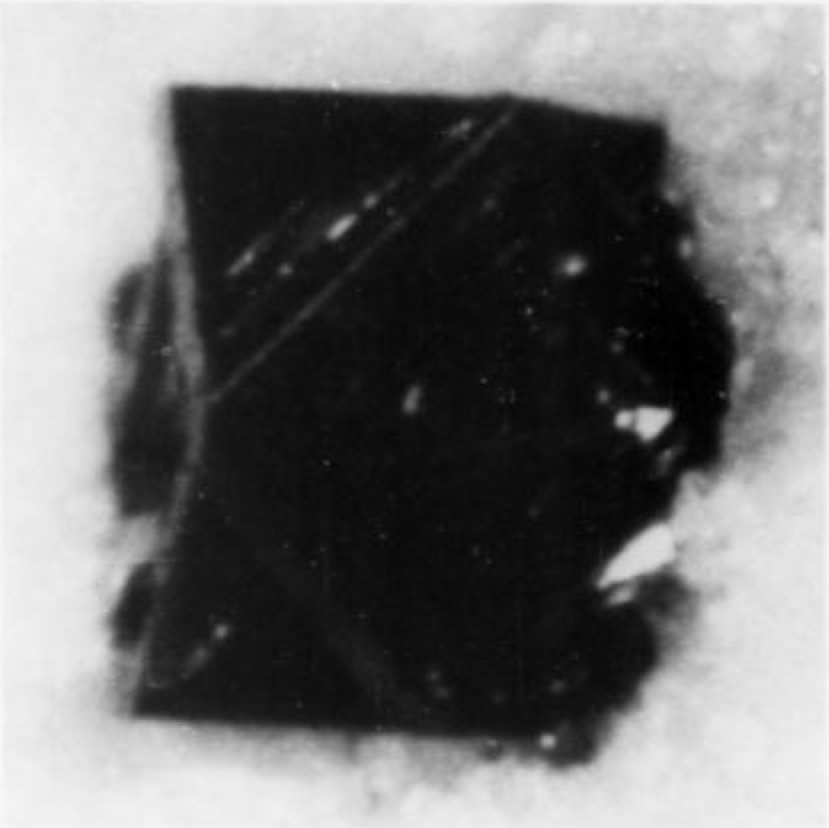

***Figure 4.* A cavernous crystal like that in Figure 3 but viewed down a [100] axis. Size of crystal, 0.2 mm.**

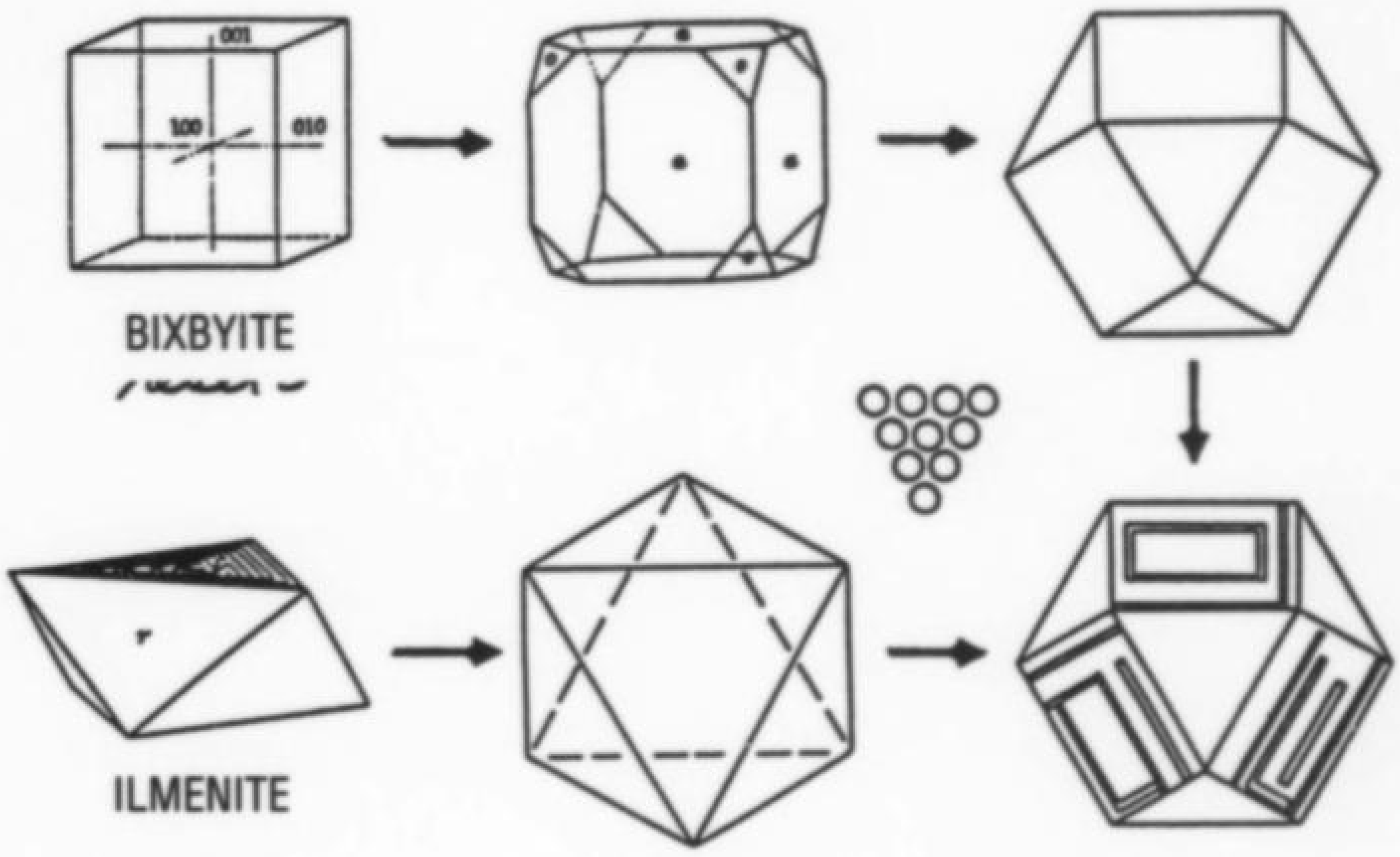

***Figure 5.* The relationship of isometric bixbyite and rhombohedral ilmenite such that oriented (epitaxial) overgrowths of the latter on the former can occur.**

shown in Figures 1 through 4, are not continuous, but are seen as parallel ridges of ilmenite. The faces observed on the ridges are doubtless the basal pinacoid and a rhombohedron. The faces are, of course, greatly elongated, rather than equant as they normally are in a single crystal of ilmenite. In the lower right portion of Figure 5, the ridges are shown only on the cube faces of the bixbyite for the sake of clarity.

The mathematical or Miller Index relationship of Mügge can then be restated in less technical terms as follows. The octahedron {111} plane of bixbyite is in contact with the basal {0001} plane of ilmenite. Thus, the layers of atoms with three-fold symmetry are also in contact. The [110] direction in bixbyite is parallel to the $[10\bar{1}0]$ direction in ilmenite. Thus, the infinite number of ways that the two minerals can have their {111} and {0001} planes lying one on the other is limited to the single orientation where the lines of atoms in their three-fold arrays are parallel. The mathematical shorthand notation of Mügge thus completely specifies the only spatial relationship between the two species which allows epitaxial growth.

ACKNOWLEDGMENT

The author thanks Carol Garland for the microprobe analysis of the ilmenite and for the SEM photograph in Figure 2.

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Photo by Earl Lewis, Hollywood

MICROMOUNTING IN NEW MEXICO

Ramon S. DeMark
6509 Dodd Place, N.E.
Albuquerque, New Mexico 87110

The mines and mountains of New Mexico offer the micromineral collector a variety and rarity of species difficult to match in other areas of the United States. To a large extent, much of New Mexico is untouched and unexplored from the micromounter's perspective. New discoveries await the diligent collector.

While it is unlikely that all of the sites mentioned here could be visited on a single trip, many could be encompassed during a visit of one week. To have some sort of plan for this hypothetical journey around New Mexico, we will start in the southwest corner of the state (a good place to visit in the winter) and then criss-cross the map, gradually working northward and culminating at the prolific Point of Rocks Mesa. Stop numbers are correlated with the numbers on Figure 1. Distances are given in miles, to correlate with American car odometers. Let us begin.

Stop 1: Lordsburg Mining District

Entering New Mexico from Arizona on Interstate 10 (I-10), the first major town is Lordsburg. The Lordsburg mining district is about 5 miles directly south of the town, and was operated primarily during the early 1900's for copper, gold, silver and lead (Lasky, 1938). The prominent mine in the area is the 85 mine; its dumps are quite productive of primary and secondary lead, copper and zinc minerals. Lustrous azurite crystals and sprays of hemimorphite are easily found along with crystals of smithsonite, malachite and barite.

Stop 2: Victorio Mining District

Proceeding east on I-10 for 40 miles we come to the Gage exit, from which the road south takes us to the Victorio mining district (Griswold, 1961). The Tungsten Hill area produces excellent honey-colored helvite tetrahedra and spessartine-grossular garnets in calcite. Scheelite is abundant on the dumps and has been found in crystals suitable for micromounting, after dissolving away some calcite matrix. About 200 meters west of Tungsten Hill is the Irish Rose vein. Tabular wulfenite crystals and balls and tufts of cream to yellow beyerite can be found here. Small (less than 0.5 mm), amber-colored crystals of stolzite also occur here. Cleavages of hübnerite and colorless to pale green beryl crystals up to 2 cm in length are available on the dump.

Stop 3: Mahoney Mining District

Next stop on the route is the Mahoney mining district, 23 miles south of Deming. This area can be reached by taking New Mexico Road 11 (NM 11) south for 13 miles and then continuing south for another 10 miles on a dirt road. The mines are ¼ mile east of this point in the Tres Hermanas Mountains ("Three Sisters" for us gringos). This is the location for one of only two reported U.S. occurrences (third world occurrence) of molybdofornacite (Medenbach *et al.*, 1983; Allen and Hunt, 1988) which occurs as grass-green, opaque to transparent crystals with a square outline. The crystals are usually less than 0.5 mm and may be grouped together in divergent clusters. Excellent crystals of willemite also occur here in delicate white, acicular sprays and as stout, colorless, hexagonal prisms. Mimetite, conichalcite, wulfenite and fluorite also occur as fine microcrystals.

Stop 4: Tyrone Pit

Tyrone is reached by backtracking north to Deming and continuing north on U.S. 180 to Silver City, then 5 miles south on NM 90. Access to this Phelps-Dodge open pit copper mine is normally not possible but the mine has in recent years produced some high quality microminerals, particularly phosphates. Torbernite occurs as emerald-green, transparent, square tablets and roses of exceptional quality. Ron Gibbs of Tyrone, an ardent micromounter, has recently discovered blue-green intergrown groups of chalcosiderite crystals which are topped with stunning sprays of wavellite. Wavellite can also be found as colorless balls up to 1 mm. Strengite is found as pale pink spheres

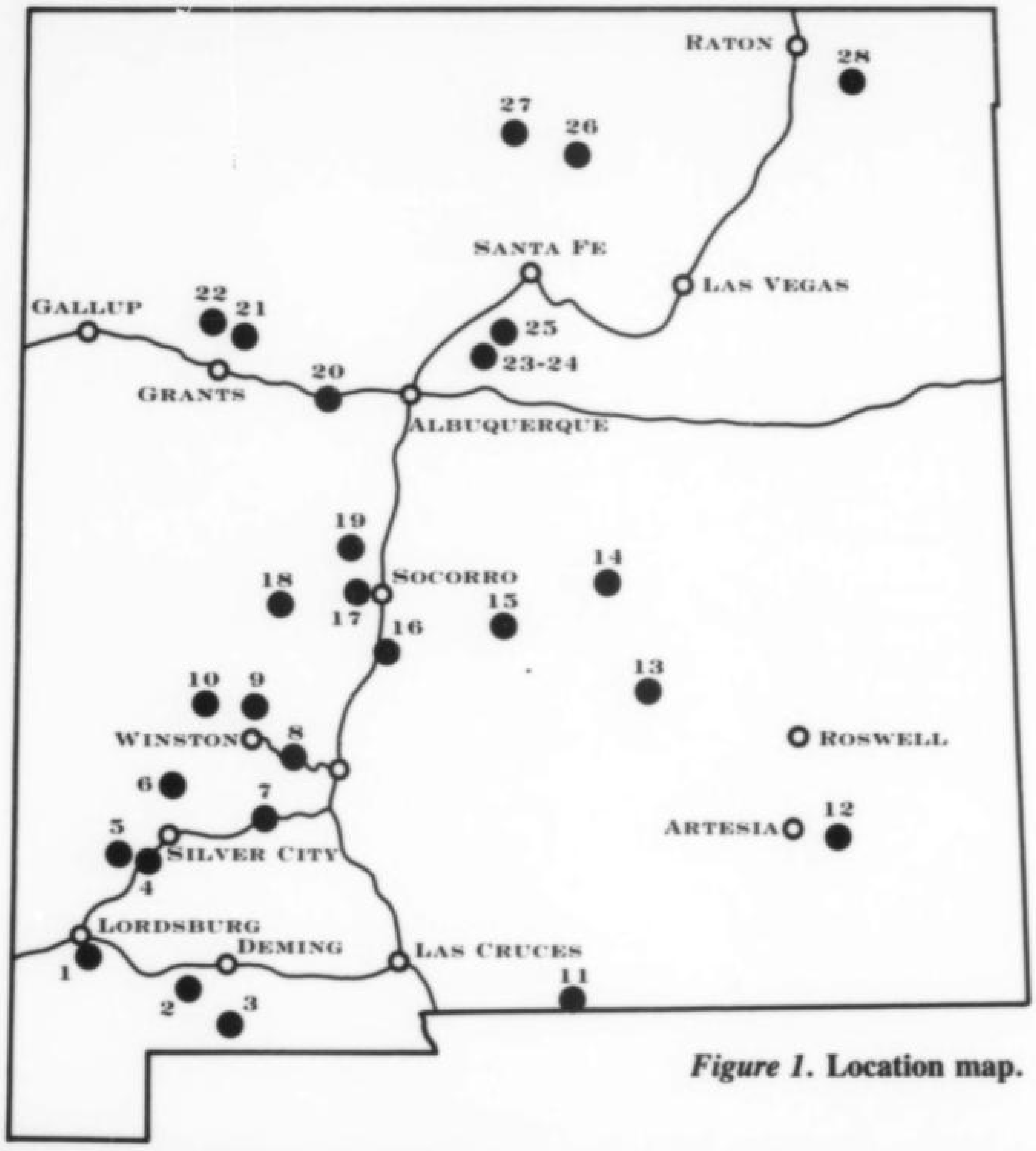


Figure 1. **Location map.**

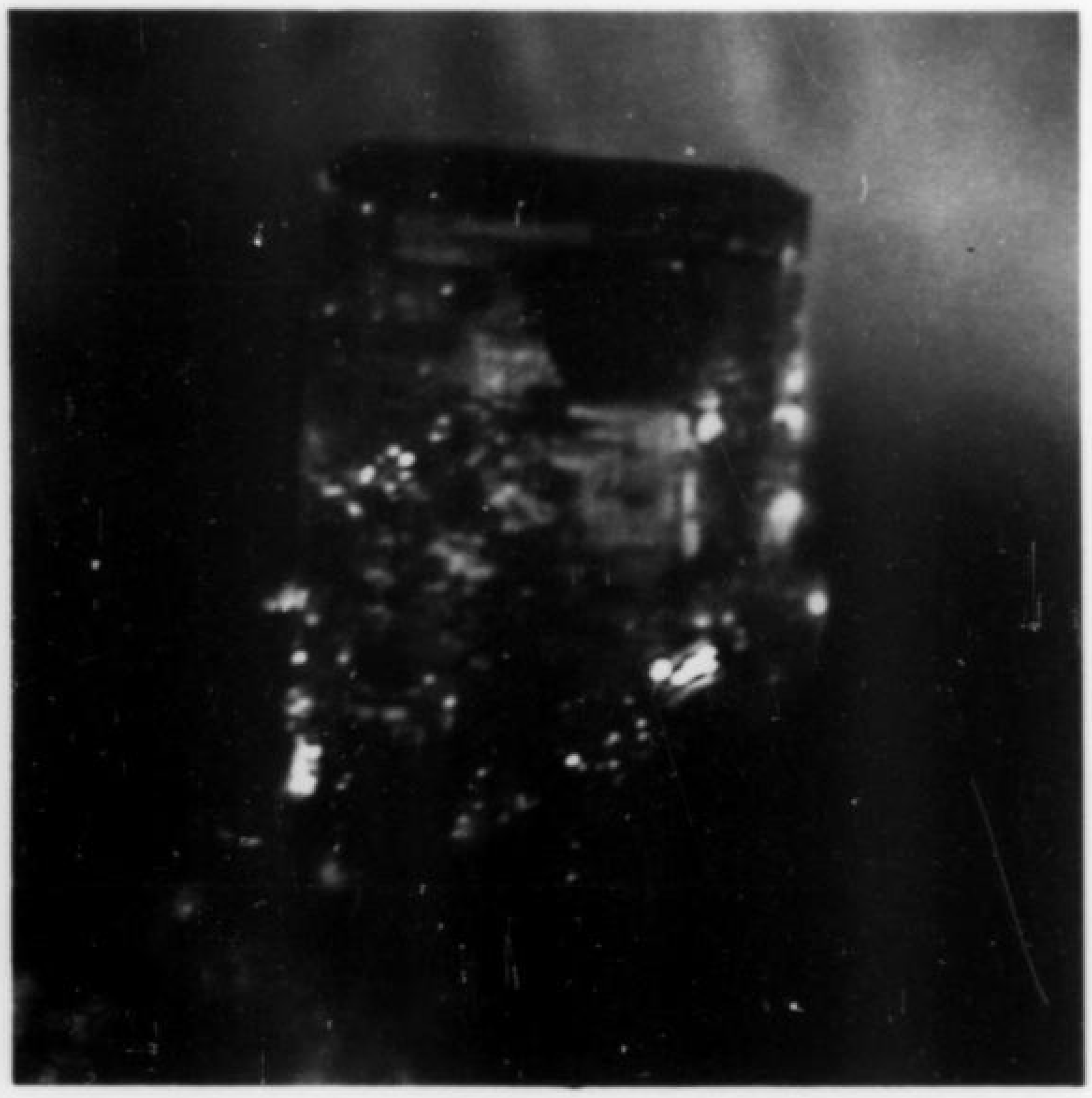


Figure 2. **Molybdofornacite crystal, 1 mm, from the Mahoney district. Author's collection; Julius Weber photo.**

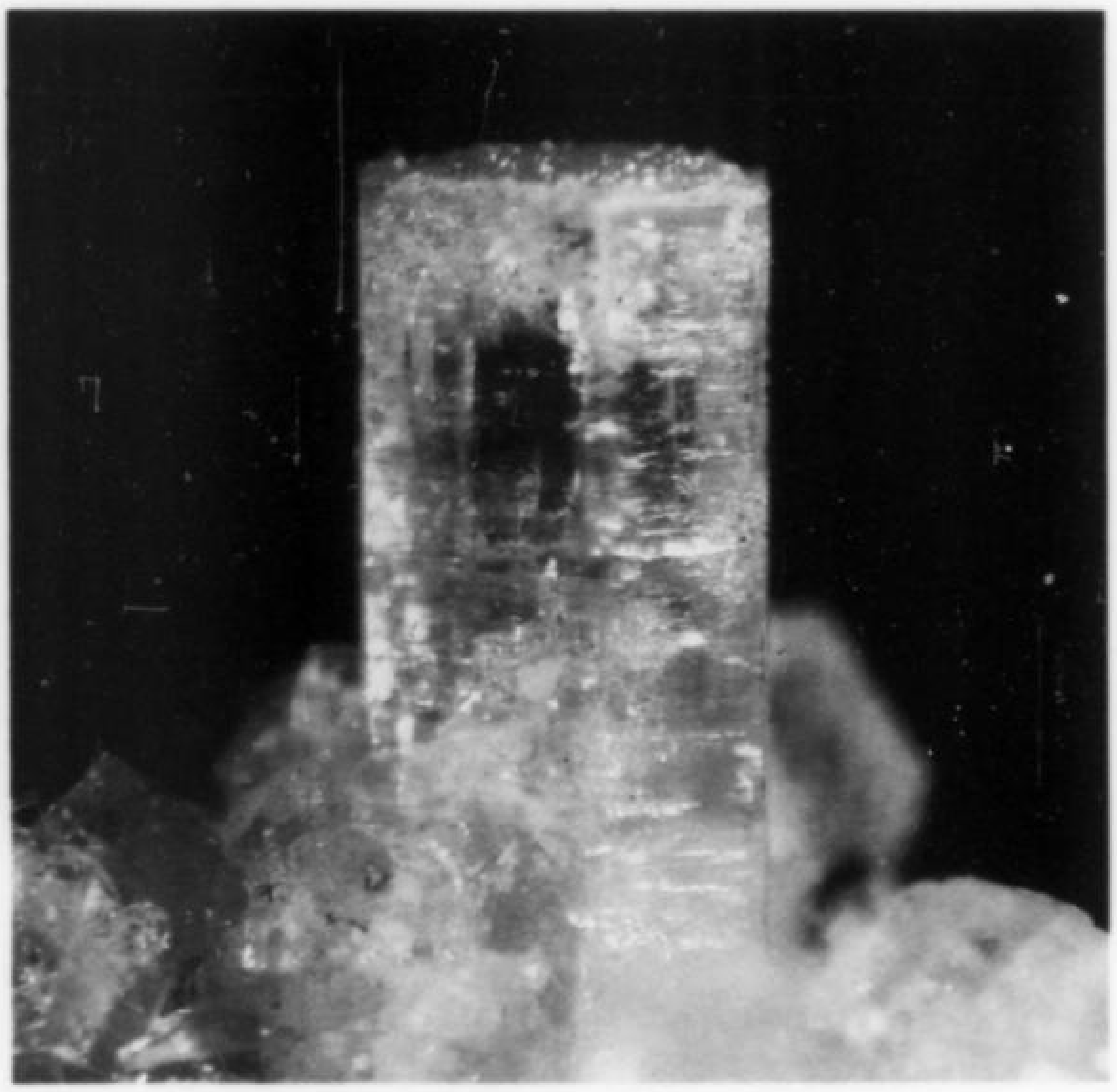


Figure 3. **Vanadinite crystal, 3 mm, on calcite from the Bobbi-Dee claim, Hillsboro. Author's collection; Julius Weber photo.**

less than 0.5 mm, in association with chalcosiderite. Recently, Ron has also found some very nice spheres and sprays of bright yellow cacoxenite. Fluorapatite crystals with an unusual pearly luster and particularly nice, bipyramidal, colorless to gray wulfenite crystals to 1.5 mm are also found.

Stop 5: Alhambra Mine

The Alhambra mine offers the micromineral collector several rare and attractive species. The mine is located in the Burro Mountains west of Silver City, and is owned by Sharon Steel Corporation. This is the original location for nickel-skutterudite (Hillebrand, 1889); superb groups of cubic crystals perched on wires of silver may be uncovered by etching away the carbonate host rock (usually ankerite) with hydrochloric acid. Many of the cubes are modified by the octahedron and are usually 1 mm or less in size. Single crystals and

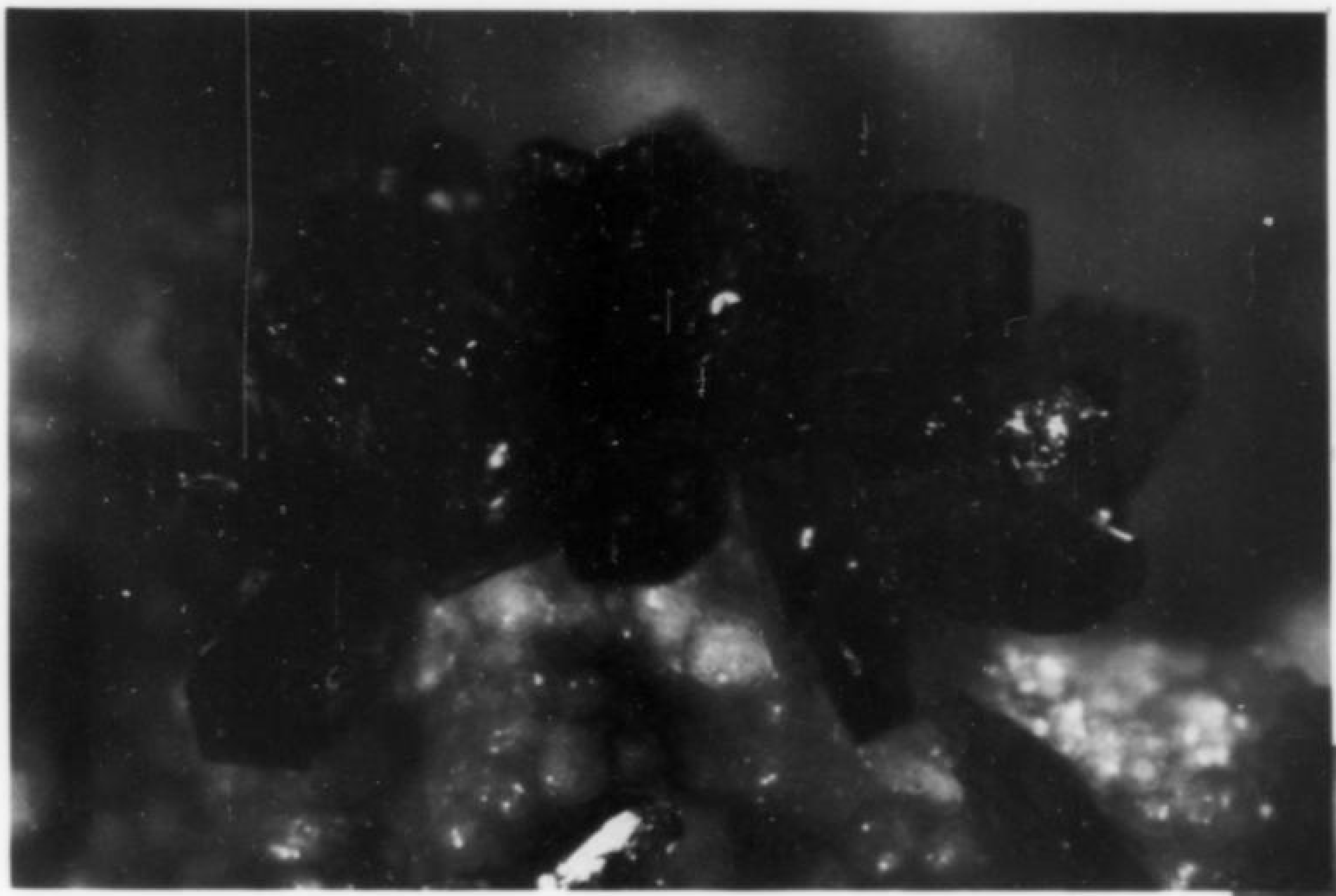


Figure 4. **Libethenite crystal group, 3 mm, from the Tyrone pit. Author's collection; Julius Weber photo.**

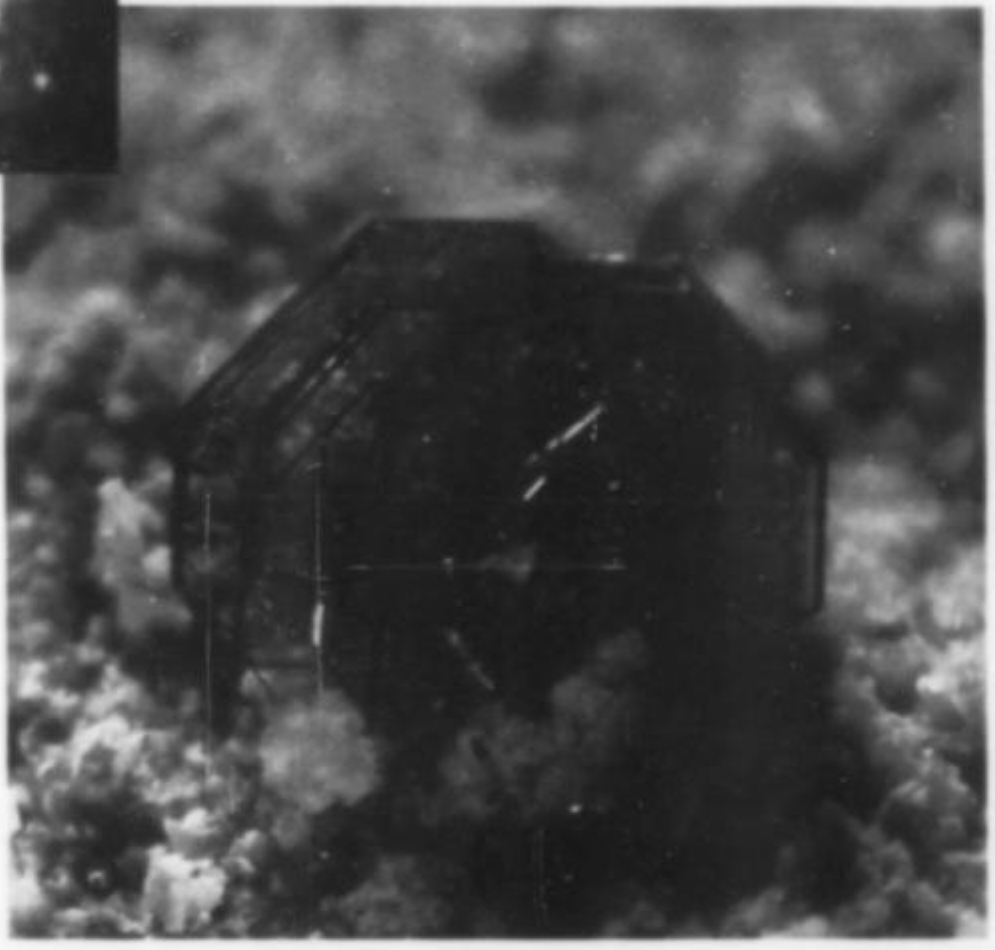


Figure 5. **Torbernite, parallel crystal group 2 mm across, from the Tyrone pit. Author's collection; Julius Weber photo.**

arborescent growths of silver may be found in cavities in the ankerite. Acanthite provides the micromounter with some of the most fascinating crystals. They occur as single cubic crystals up to 1 mm and as intergrown, complex crystal groups. Sphalerite crystals of exceptional clarity are found in cavities within the ankerite; their color varies from colorless to amber to green. Attractive microcrystals of galena and chalcopyrite are not uncommon. Erythrite and annabergite crusts usually coat chunks of ore containing nickel-skutterudite and niccolite respectively. The crusts are finely crystalline masses and only marginally suitable as microminerals.

Stop 6: Gila River Zeolites

Leaving the Burro Mountains and traveling east to Silver City, our next stop will be in the Gila National Forest about 40 miles north of the city on NM 15. At the confluence of the Gila River and the East Fork, a number of zeolites occur both as good microcrystals and as attractive hand specimens. Chabazite in white to colorless rhombs is the most common mineral here, but beautiful balls of mesolite up to 1.5 cm across are also common. Individuals and sheaves of stilbite crystals and thick, hexagonal, platy crystals of levyne as much as 1 cm across occur here as well. Many pockets in the basalt host rock are lined with transparent, colorless crystals of analcime and heulandite. Much less common are small (1 mm or less), white balls of thomsonite which, curiously, will often have a tuft of mesolite hairs protruding from the surface. Pagoda-shaped quartz crystals line some pockets; these can be found particularly in the basalt along the river's edge. Along the Middle Fork of the Gila River, fluorapophyllite is occasionally found in equant white to colorless crystals up to 5 mm in size, along with vermiform celadonite. Calcite is quite common in the area but it does not occur in good microcrystals.

Stop 7: Hillsboro

Leaving the Silver City area and traveling east on NM 90 across the Black Range (scenic but lots of hairpins), you will reach the small town of Hillsboro, which at one time was the hub of a great deal of mining activity, particularly for gold. About 2 miles east of town are several old mines of interest to the micromineral collector. The Petroglyph mine is only about 50 meters south of the highway, 1½ miles east of Hillsboro, and is visible from the road. It has some small dumps with excellent honey to brown, transparent descloizite crystals. Beating apart the boulders will also expose orange, tabular wulfenite crystals and sprays of white hemimorphite. Hexagonal prisms of willemite also occur here but are less common than the hemimorphite.

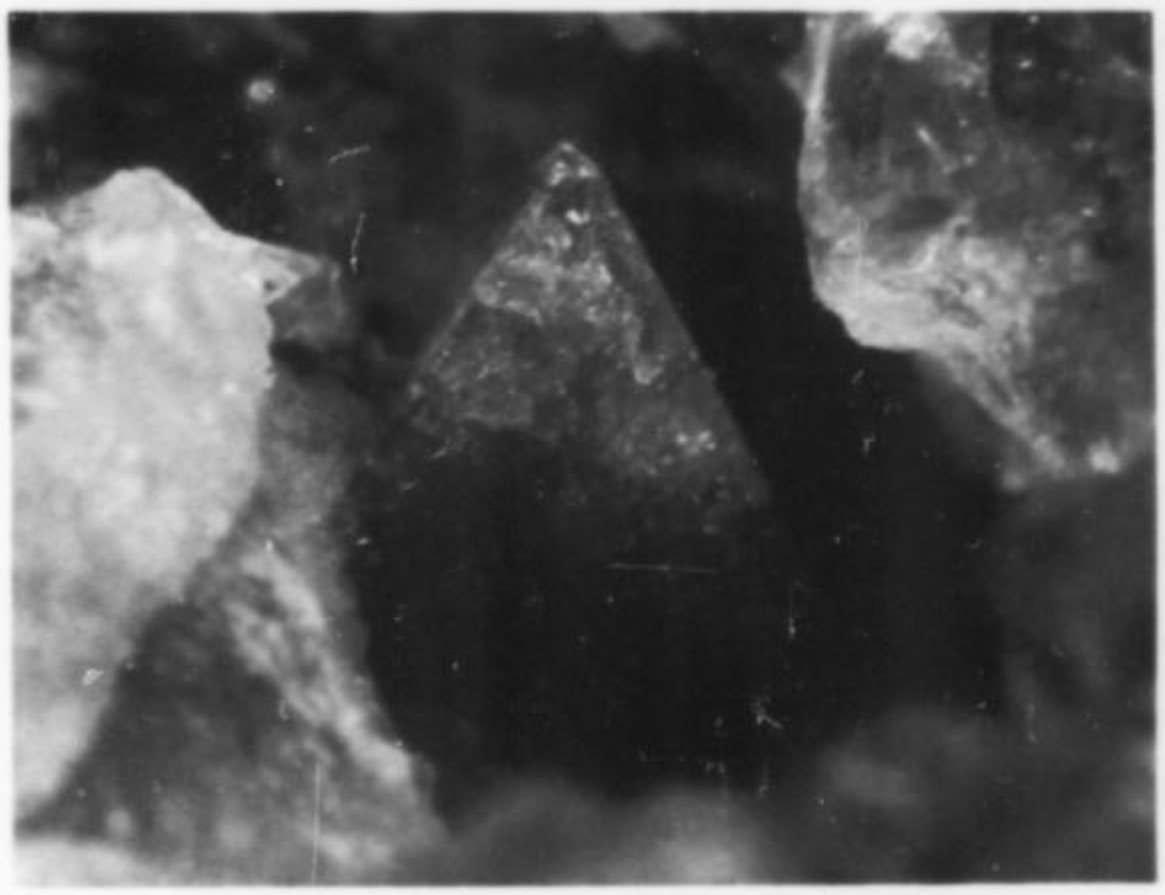


Figure 6. **Helvite crystal, 1 mm, from Iron Mountain. Author's collection; Julius Weber photo.**

Orange to brown vanadinite crystals are quite abundant. At mile marker 102 (2 miles east of town), a dirt road leads to the south; it forks after about a mile and the right fork across a wash leads to the Rex and Smuggler mines. Colorless heulandite crystals and white, straw-like mordenite occur at the adit opening. Taking the left fork for 2 miles will lead you to an area called "the box" at the edge of a canyon. A small, unnamed prospect slightly below the parking area is a location for the rare mineral kentrolite. To my knowledge, this is the only U.S. occurrence for crystals of this mineral. The crystals are black and lustrous and occur on a tough jasperoid matrix. Maximum size of the crystals is about 1 mm. Pale yellow vanadinite may also be present. An old mine is located across the canyon. Formerly known as the Macy claim, then the Barking Frog, it is currently under claims as the Bobbi Dee. It is best known for lemon-yellow vanadinite crystals that are elongated along the *c*-axis producing very attractive, slender prisms. This is an arsenic-rich vanadinite and the color ranges from white to orange. Although the prism modified by the pinacoid is the most common form, pyramidal crystals may also be found. The underground workings are quite dangerous but have produced rhombohedral calcite crystals, modified by the negative rhombohedron, up to 5 cm long. Occasionally these crystals have lemon-yellow prisms of vanadinite perched on the edges. Tabular wulfenite crystals, although not common, may be found on the dumps. Colorless fluorite cubes and dark brown descloizite occur with the vanadinite in some areas.

Stop 8: Willow Creek

Continuing east on NM 90, we will cross Interstate 25 (I-25) at the Caballo Resevoir and then travel north to NM 52. At this point, we turn west again and proceed 11 miles past the small town of Cuchillo along Willow Creek. A small mine/prospect about 100 meters north of NM 52 provides good micromineral hunting for pseudobrookite, hematite, augite and titanite. The host rock is a porphyritic rhyolite. The pseudobrookite occurs as black, lustrous prisms that reach 3 mm and which may have smaller pseudobrookite crystals radiating from the point of attachment. The hematite occurs as flat rhombohedral crystals to 1 cm which are noteworthy because of the very unusual etching of the mirror surface of the crystals, imparting the appearance of a topographic map. Augite is not abundant but appears as very fine, transparent, burnt-orange prisms, some of which are almost hairlike. Titanite having the same burnt-orange color as the augite is quite common; the wedge-shaped crystal habit allows easy identification.

Stop 9: Iron Mountain

If we continue west on NM 52, turn north at the town of Winston and travel for 10 more miles, we will find ourselves about 1 mile west of Iron Mountain. This area is best known for an occurrence of helvite, but the presence of beryl, idocrase, epidote, hematite, fluorite, zoisite and other minerals make micromount collecting worthwhile. The host rock is primarily a tactite and the best microminerals come from an area called the scheelamite area (Jahns and Glass, 1944) where the tactite is coarsely crystalline. Helvite tetrahedra range in size from 0.5 mm to 1.5 cm; color varies between pale yellow and mahogany. Danalite has also been reported (Jahns and Glass, 1944) from Iron Mountain, but microprobe analyses (Paul Hlava, personal communication) of several specimens exhibiting a wide range of colors has revealed only helvite. Beryl, although not previously reported from Iron Mountain, does occur in opaque, blue prisms often coated by small helvite crystals or as aquamarine included in colorless to pale purple fluorite. Idocrase is common as pistachio-green crystals in rosettes and balls up to 1 cm across. Magnetite and andradite are abundant in the tactite but not exceptional as microminerals. Clinozoisite and pink zoisite are common along fracture seams in a hornfels found on a ridge south of Discovery Gulch (Glass *et al.*, 1944).

Stop 10: Paramount Canyon

Another area certainly well worth visiting in this vicinity is the bixbyite location of Paramount Canyon. Well known to micromineral collectors in the region, it can be easily reached by continuing west from Iron Mountain on NM 59 for 20 miles and then turning south for a half mile to the north rim of Paramount Canyon. This site was the location of some minor tin prospecting; tin-bearing (cassiterite) rhyolites occur at several points in this vicinity. Crystals of bixbyite, pseudobrookite, cassiterite, hematite and red beryl can be found in lithophysae within this rhyolite. The bixbyite mostly occurs as simple cubes from 1–5 mm in size, although some are modified by the octahedron and trisoctahedron. They have a brilliant luster and make superb mounts. Lustrous, black prisms of pseudobrookite are commonly found in association although generally not in the same pockets as the bixbyite. Transparent, red to brown cassiterite crystals are common, usually in direct association with hematite and often as epitaxial overgrowths. The crystals are generally small (0.1–0.5 mm), however, and easily overlooked. Attractive, flat, rhombohedral crystals of hematite are common. Red beryl is found about 50 meters north (away from the canyon) of the bixbyite location. The crystals resemble those from Topaz Mountain, Utah, but are small (1–4 mm) and easily overlooked.

Stop 11: Wind Mountain

Reversing our direction of travel and jumping across state, we will now visit the Cornudas Mountains on the New Mexico/Texas border. Of course, all the good stuff is in New Mexico! The area can be reached from the south through El Paso or by NM 506, south of Alamagordo. There are a number of intrusive peaks in this area but the most productive to date for microminerals has been Wind Mountain. Dr. Russell Boggs first brought this area to the attention of mineral collectors at the 1984 New Mexico Mineral Symposium with his discussion of the new mineral georgechaoite. Georgechaoite, $\mathrm{KNaZrSi_{3}0_{9}\cdot 2H_{2}0}$, occurs in association with excellent microcrystals of tan-colored catapleiite and needles of acmite. The georgechaoite crystals are equant, white to colorless, often with a pearly luster and usually less than 0.5 mm. Reedmergnerite, the boron-containing member of the feldspar group, has also been found in brown, diamond-shaped crystals that are thin and mica-like in appearance. Very small (0.1–0.5 mm) brown crystals of monazite also may be found but they are scarce. Liver-colored eudialyte crystals to 1 mm are common in a dike on the east side of Wind Mountain. Nepheline, analcime, natrolite and thomsonite crystals may also be found in the vugs. A word of caution; unweathered rock containing vugs with microminerals is extremely scarce. A day-long trek up and down the mountain may result in finding only two or three promising boulders to break up. The best reference for this area is an unpublished master's thesis (Zapp, 1941).

Stop 12: Red Lakes Prospect

The next location is on the eastern side of New Mexico near the town of Artesia (between Roswell and Carlsbad on U.S. 285). We take U.S. 82 east from Artesia 8 miles, then north on a dirt road for 0.7 miles to the Red Lakes prospect, known locally as the "Turquoise" mine. There is no turquoise here but chrysocolla is common and seems to be the culprit for the misnomer. This location is virtually unknown to macromineral collectors but is quite productive for the micromineral collector. Bright orange, tabular crystals of wulfenite up to 1 cm have been found here along with spear-shaped and blocky crystals of descloizite varying in color from honey to dark brown. Twinned cerussite crystals to 5 mm are relatively common and sprays of hemimorphite, although not common, may be collected. By the way, watch out for the rattler that has taken abode in the wall of one of the pits.

Stop 13: Mina Tiro Estrella

Heading north to Roswell on U.S. 285, then west on U.S. 380, we will approach the Capitan Mountains to the north as we pass through the town of Lincoln. Forest Road 57 leads northeast from U.S. 380 for 6 miles and intersects with a pipeline road that terminates near the Mina Tiro Estrella claim, a prospect which has produced superb Japan-law twin crystals of quartz. Of more interest to the micromineral collector is the occurrence of lustrous black allanite crystals that are often perched on the smaller quartz crystals. Prismatic allanite crystals to 2.5 cm have been found here but 2 to 5 mm is more common. Bright, cinnamon-colored, wedge-shaped titanite crystals are also found here; they are commonly 2 to 5 mm in size. See the article by Tim Hanson on page 51 of in this issue.

Stop 14: Red Cloud Mines

Continuing west and then north on U.S. 54, we soon approach the Gallinas Mountains to the west and south of the small town of Corona (site of the famous Road to Ruin Bar). The Red Cloud copper and fluorite mines here are best known for the occurrence of fine bastnaesite crystals and sprays of agardite-(La). Mimetite, wulfenite, mottramite, fluorite and barite also occur here (for detailed information see DeMark, 1980).

Stop 15: Blanchard Mine

No discussion of New Mexico microminerals would be complete without mention of the famous Blanchard mine in the Hansonberg district near Bingham. The article by Taggart, Rosenzweig and Foord in this issue covers the minerals in a comprehensive manner; however, some very recent discoveries deserve mention. The Sunshine #4 tunnel has produced superb groups of hemimorphite crystals with inclusions of cuprite lending a reddish brown color. Groups range from micromount to cabinet size, and are far superior to all hemimorphite previously found in the district. Very attractive malachite pseudomorphs after linarite have also been found in the Sunshine #4 tunnel, with "crystals" from micromount-size up to 3 cm in length. Linarite cores remain in some specimens.

Stop 16: San Marcial Quarry

The San Marcial exit is about 25 miles south of Socorro on I-25. A non-working quarry on the east side of the highway in Tertiary lava has produced some excellent microminerals. Acicular to stout prisms of orange magnesiohornblende up to 4 mm in length are quite common here. Unusual pseudo-octahedral crystals of hematite are also common. The octahedral appearance may result from equal development of opposing rhombohedral faces, or possibly pseudomorphs replacement of magnetite. Crystals of tridymite, titanite and a dark brown prismatic pyroxene occur in vugs associated with the magnesiohornblende and magnetite. In most cases, the minerals are coated with a thick layer of sugary quartz, although uncoated crystals also occur. Mordenite hairs are common in many of the vugs and carnotite is found as crusts on fracture seams.

Stop 17: Socorro Peak

Traveling north again on I-25 to Socorro, our next stop will be at the abandoned mine workings on the east face of Socorro Peak. Access to this area is only possible by obtaining permission from a state agency called TERA located at the New Mexico Institute of Mining and Technology. The area of interest is high on the east face, and about a half-hour climb is necessary (not recommended in summer). Reaching this area, we will be rewarded with outstanding black mottramite crystals that coat many of the rock surfaces and which may also be found on blades of barite. Bright orange balls of mimetite and attractive prismatic crystals of orange to brown vanadinite are also common here, as are orange wulfenite crystals that tend to be prismatic and grow in perpendicular directions similar to pyrite from Hall's Gap, Kentucky. Sprays of hemimorphite are associated with the mimetite/vanadinite and wulfenite. Colorless prisms of willemite although not abundant may be located by diligent search. Underground workings in this area are dangerous and produce the same minerals as found on the dumps.

Stop 18: Lynchburg Mine

Leaving Socorro and traveling west on U.S. 60, we reach the town of Magdalena, famous in New Mexico mining and cattle history and the gateway to the Kelly mine area south of town. There are many mines in this area, all productive of beautiful microminerals such as azurite, smithsonite, aurichalcite, rosasite and malachite. As most of these occurrences are well known to collectors and Ron Gibbs' article on the Kelly mine is included in this issue, I will discuss only the Lynchburg mine, which is perhaps more obscure to most collectors. The Lynchburg mine is about 1 mile south of the Kelly mine and collecting can be done on the dumps. No single mineral stands out here but superb honey-yellow to green sphalerite crystals perched on quartz are certainly noteworthy. Black, tabular to equant crystals of ilvaite to 3 mm occur on quartz crystals and are quite attractive. The sulfide minerals galena, chalcopyrite and pyrite are common in bright microcrystals along with gray cerussite and colorless radiating crystals of hemimorphite. Crystals of fluorite, hematite, calcite and siderite suitable for micromounting are quite common.

Stop 19: Lemitar Mountains

Returning east to Socorro and then north on I-25 to the Lemitar exit, we can visit a series of mine prospects on the east-central side of the Lemitar Mountains. Lead and silver seem to have been the objectives of the early miners in this area. Secondary lead minerals, as might be expected, are the predominant minerals of interest here. Wulfenite in bright orange bipyramids and lustrous, twinned cerussite crystals are common, as are attractive rosettes of hemimorphite. Galena is found only as masses and cleavages unsuitable for micromounting. Fluorite is quite common in these prospects but the crystals are generally too large (1–2 cm) to be of interest to the micro collector and they are not very attractive as thumbnail specimens. Wulfenite crystals can be collected further up the mountain from natural exposures, along with massive galena and sprays of hemimorphite. These wulfenite crystals range in size from 0.5 mm to 1.5 cm in blocky to tabular habits; the color varies from yellow to orange-brown.

Stop 20: Cerro Colorado

Moving to the northern section of the state, our first stop will be at a volcanic cone called Cerro Colorado west of Albuquerque on I-40 at the point where the Rio Puerco crosses the interstate highway. The cone is south of the highway and we must exit several miles east of the Rio Puerco and travel west on a feeder road to reach this site. Several old uranium prospects are located on the eastern side of the cone and crystals of carnotite are found in the vesicles of the extrusive rock. The crystals are bright canary-yellow but small (0.1–0.3 mm).

Stop 21: East Grants Ridge

Continuing west on I-40 to Grants, we next visit the well-known East Grants Ridge garnet/topaz location. This area is reached by taking NM 547 northeast from Grants for 7 miles. The collecting area is along the roadside, in boulders which must be pulverized. Garnets here have been determined by microprobe analysis (Paul Hlava, personal communication) to be spessartine. They are exceptionally clear, with a wine-red color, and measure up to about 2 mm. They occur in lithophysae in a rhyolite commonly associated with colorless topaz crystals that may reach 1 cm in length. Quartz crystals are ubiquitous in the lithophysae. Some garnets may have a thin hematite coating giving the crystals a steel-gray to black appearance. (See Henderson, 1985, for excellent photographs of these minerals by Bill Hunt.)

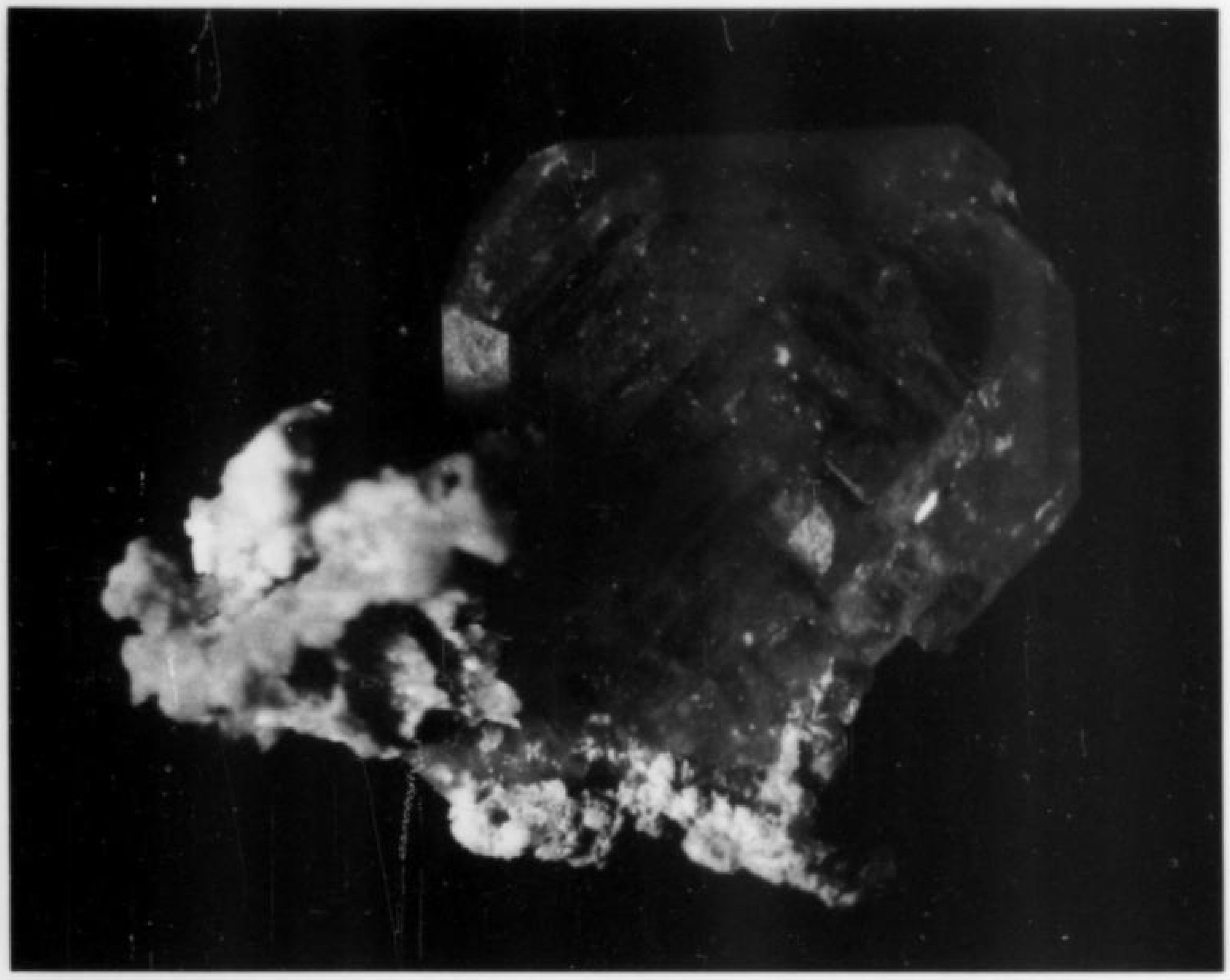


Figure 7. **Wulfenite crystal, 3 mm, from Socorro Peak. Author's collection; Arnold Hampson photo.**

Figure 8. **Antlerite crystal, 2 mm, from the Sunshine #4 mine, Hansonburg district. Author's collection; Arnold Hampson photo.**

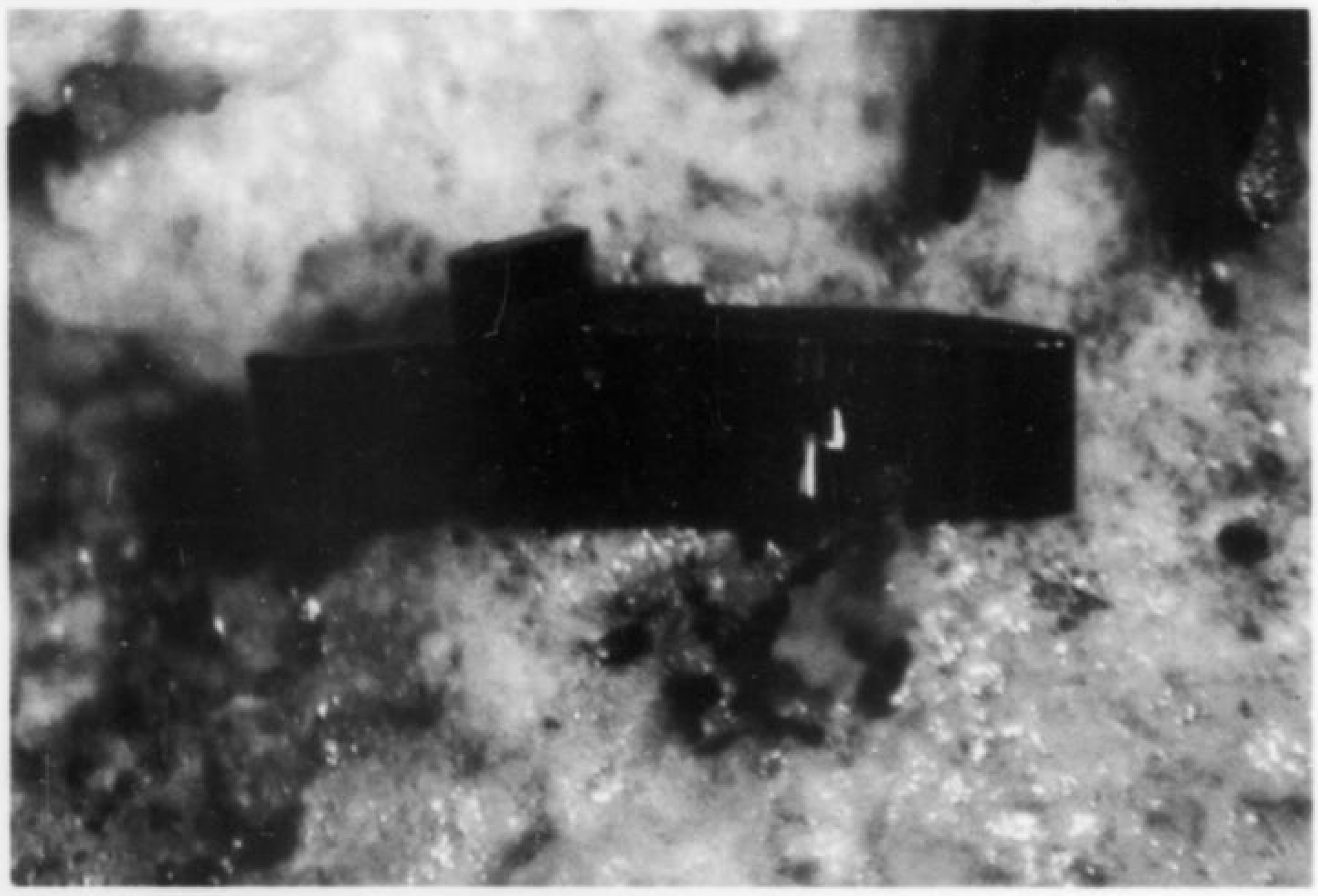
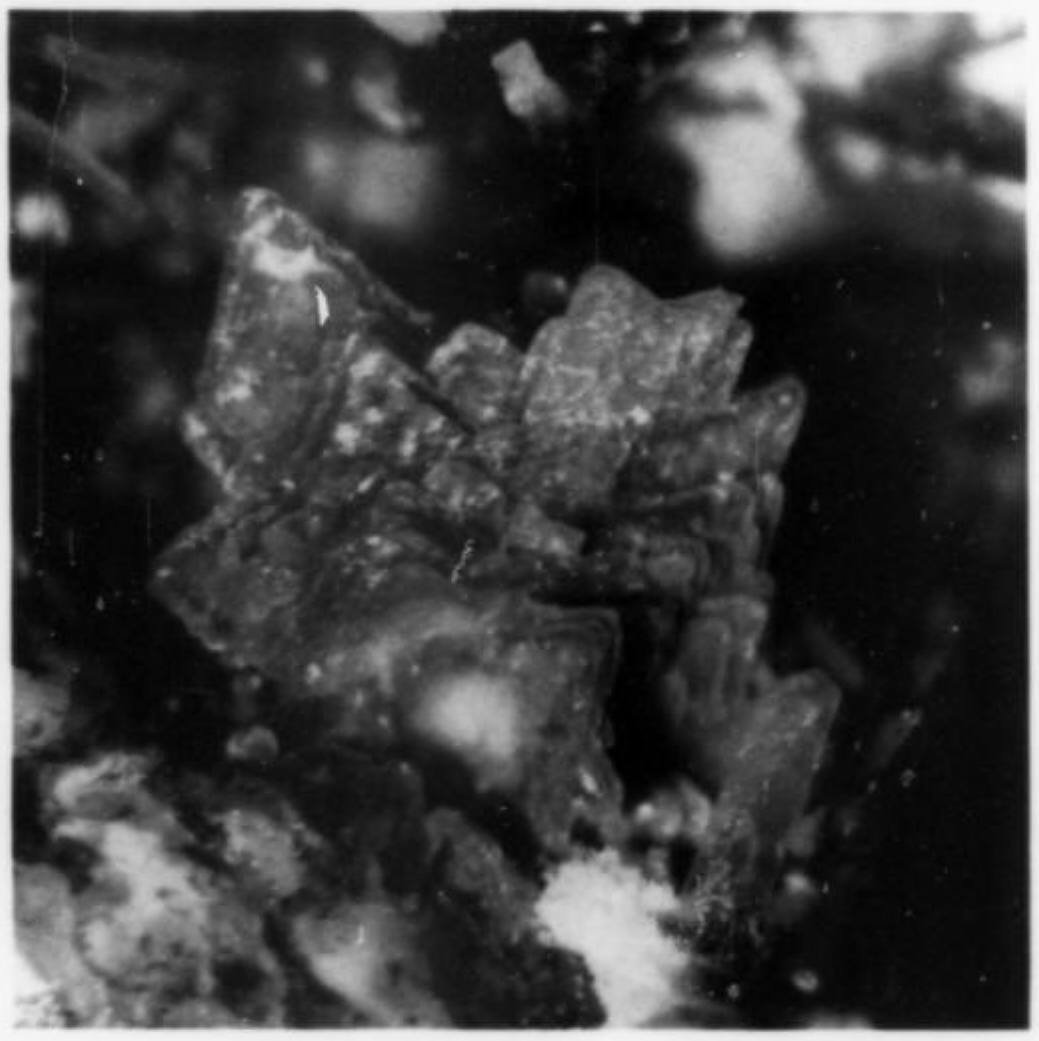


Figure 9. **Linarite crystal, 3 mm, from the Sunshine #4 mine, Hansonburg district. Author's collection; Arnold Hampson photo.**

Figure 10. **Reedmergnerite crystal, 3 mm, from Wind Mountain. Author's collection; Arnold Hampson photo.**



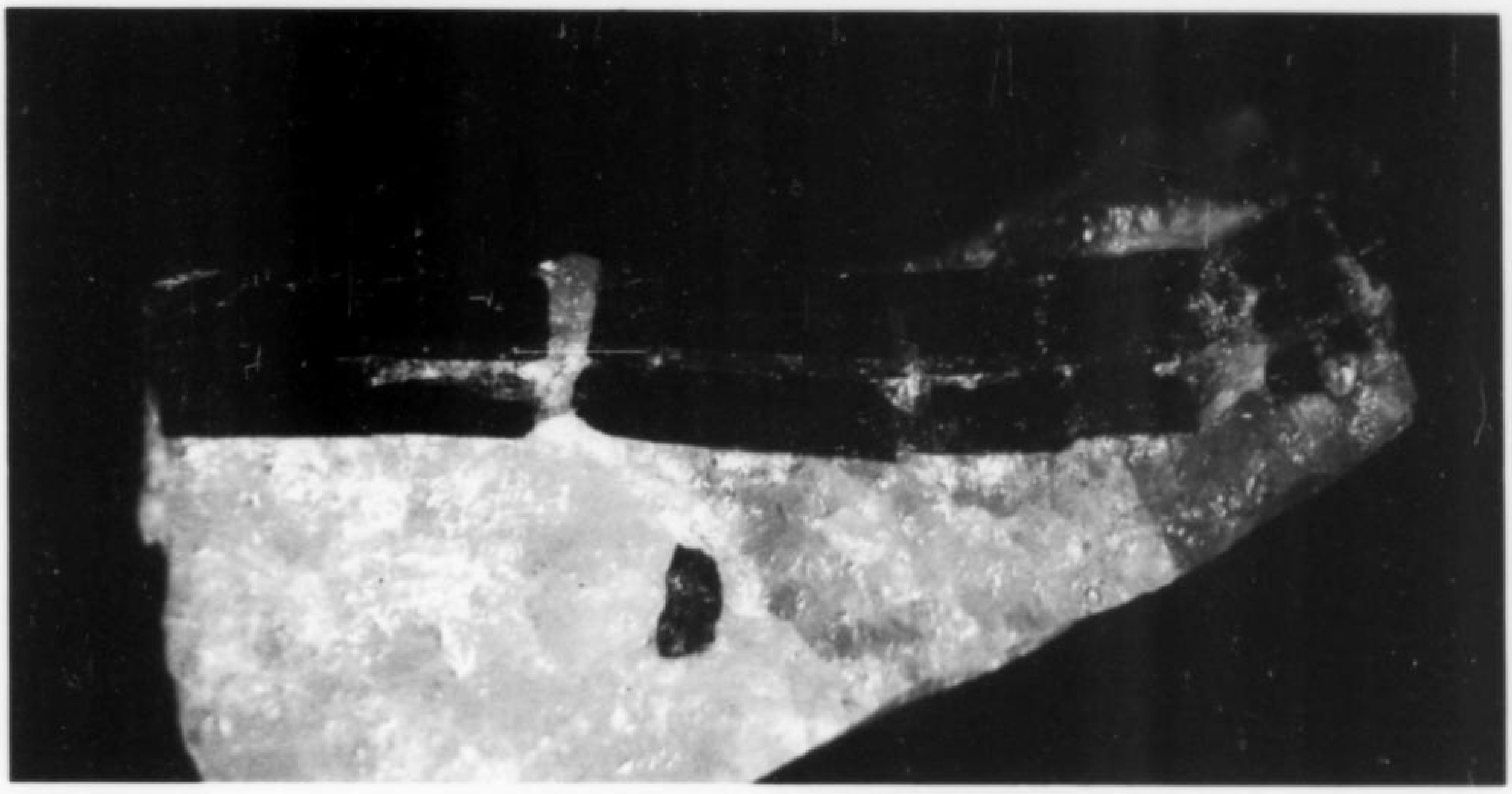


***Figure 11.* Piemontite crystal, 1 cm, in quartz from Pilar. Author's collection; Arnold Hampson photo.**

Stop 22: Poison Canyon

Another location of interest in this area is Poison Canyon. It was surface-mined in the 1950's for uranium. Collecting can be done on the old dumps. It is reached by taking NM 53 north from Grants for 10.6 miles, then turning west on a dirt road for 2.8 miles to the dump area south of the road. The uranium minerals most commonly found here are uranophane and tyuyamunite. They occur in vugs and on fracture seams in the Jurassic Todilto Limestone. Jackstraw uranophane crystals may reach 1–2 cm in length; the tyuyamunite crystals are rhombohedral and rarely exceed 0.5 mm. Both minerals are bright yellow although the tyuyamunite may be yellow-orange. Greenish yellow films of schroekingerite also occur here but this mineral is uncommon. Small cubes of uraninite may be found, usually as inclusions in calcite; they should not be confused with the uranian fluorite which is also black. Large scalenohedral crystals of calcite and yellow, bladed barite crystals are common in the Todilto Limestone, as are microcrystals of pyrolusite and pyrite.

Stop 23: Carnahan Mine

Jumping east across the state back through Albuquerque, we will visit three mines reached by taking NM 14 north toward Santa Fe. The Carnahan and San Pedro mines are located in the San Pedro Mountains about 2 miles east of the town of Golden, and the Ortiz gold mine is about 15 miles north. The Carnahan mine is a non-operating lead mine; collecting is only possible underground, as there are no significant dumps. The mining property is believed to be currently under private ownership but no information is available about possible permission to enter the mine. Brecciated and fractured rock in some areas of the mine is coated with snow-white sprays of hemimorphite which occasionally rest on a drusy coating of chalcophanite crystals. The contrast of white against black is stunning. Brilliant black, pyramidal crystals of hetaerolite are abundant in some sections of the mine. Thin hexagonal crystals and reniform coatings of chalcophanite are also common in many areas. Prismatic cerussite pseudomorphs after anglesite crystals up to 2.5 cm in length have been found in the mine; the smaller crystals, although opaque, have a bright luster and are suitable for micromounts. Transparent cerussite twins to 2 mm are localized in some areas of the mine. Plattnerite, rosasite, aurichalcite and attractive malachite pseudomorphs after cuprite octahedra can be found, as well as "rice grain" crystals of smithsonite and very small (less than 0.5 mm) rhombohedral crystals of smithsonite. Unusual white or pale bluish to greenish balls of gibbsite about 1 mm in diameter coated with opal and calcite are interesting but are not particularly aesthetic.

Stop 24: San Pedro Mine

The San Pedro mine is about a half mile northeast of the Carnahan mine and is currently inoperative. The mine has operated intermittantly since the 16th century, first by the Spanish for gold, later by Mexicans and then Americans for copper, and most recently for gold. Collecting can only be accomplished with permission of the owner. The mine is well known for superb tetragonal disphenoids of chalcopyrite, ranging, in size from 1 mm to 10 cm, and transparent Japan-law twins of quartz. The quartz twins are often associated with rosettes of hematite and laumontite and are very attractive microminerals. Malachite and other primary and secondary copper minerals can also be found here along with large rhombohedral crystals of calcite. Transparent, colorless acicular crystals of laumontite are found coating some of the calcite crystals. Native gold in calcite occurs as wires, ribbons and crystals and the contrast between the two minerals does indeed provide for stunning micromounts.

Stop 25: Ortiz Gold Mine

The Ortiz mine is about 7 miles southeast of the town of Cerillos. The mine is currently inoperative and collecting is prohibited, but high-quality, sharply terminated crystals of scheelite occur here that are worthy of note. The crystals are a tan to orange color, lustrous, and have been found up to 2 cm in size. The smaller crystals are generally more transparent. Bright octahedra of pyrite, many modified by the pyritohedron and diploid, and rosettes of hematite are found associated with the scheelite.

Stop 26: Harding Mine

Continuing north through Santa Fe and Espanola and then east on NM 75 at Embudo we reach the Harding mine. The mine is under lease to the University of New Mexico (UNM) and approval must be obtained from the Geology Department at UNM in Albuquerque before entering the property. The UNM Geology Department publishes a walking-tour guide (marked by numbered posts at the mine) which covers the history, geology and to a minor extent mineralogy of the mine (an excellent example of the academic community aiding the collector). Collectors are urged to keep out of the underground workings and limit their collecting to 10 pounds of material. The mine was operated in a complex pegmatite for beryl and for microlite (a source of the tantalum) and yields many species of interest. Honey-yellow to almost black octahedrons of microlite modified by the dodecahedron are common, as are bipyramidal, purple crystals of zircon. Both occur in a very attractive matrix of rose-colored muscovite with spodumene and cleavelandite (albite). Prismatic crystals of thorite are less frequently found and are always metamict. Bismuth blebs about 1 mm across are sometimes associated with small (0.1 mm), bright orange to brown tabular crystals of the rare mineral pucherite. Cream-colored beyerite balls and massive yellow-green bismutite are often found as alteration rims around the bismuth. Colorless, transparent crystals of bertrandite, less than 0.5 mm and, rarely, acicular elbaite crystals up to 3 mm long can be found in miarolytic cavities in albite feldspar. The elbaite varies from a dark blue to almost pink. These last two minerals are new finds, visually identified by the author and Paul Hlava in 1985 and tentatively confirmed by microprobe (Paul Hlava, personal communication). Black, equant crystals of columbite-tantalite are not uncommon and can be found throughout the mine dumps. The predominant minerals at the mine are albite, microcline, quartz, spodumene, muscovite (rose), lepidolite and beryl, but these are generally not suitable for microminerals. (For details on the mine see Jahns and Ewing, 1977.)

Stop 27: La Madera

For those interested in zeolite minerals, continuing north from Espanola on U.S. 285 to the small town of La Madera and then east on NM 519 for 3 miles will put you at an interesting heulandite location. The road, snaking up a hill, cuts through basalt, and heulandite crystals are abundant in the vesicles. Coffin-shaped crystals to 6 mm are sometimes associated with hairs of mordenite.

Stop 28: Point of Rocks

The last stop on this itinerary will be Point of Rocks Mesa which is in the northeast corner of New Mexico about 22 miles east of the town of Springer on I-25. For micromineral collectors, this location must be considered the *crème de la crème* of New Mexico locations; no collecting trip to New Mexico would be complete without at least a short visit. This site has been previously described in the *Mineralogical Record* (DeMark, 1984) but additional minerals have been identified since that time. Unknown #1 remains unidentified, but unknown #2 is now known to be cryolite. Unknown #3 is kenyaite, and unknown #4 is lovdarite. Less exotic, however, was unknown #5, which turned out to be quartz! (Identification of these minerals was accomplished by Peter Modreski.) Rhodochrosite in orange to red scalenohedrons and rough rhombs has been found on the east-center side of the quarry, and titanite has been identified in very rough, wedge-shaped crystals with a "sugary" surface texture. All of the crystals are tan colored and have a vitreous luster when broken. Kupletskite, as bronze-colored, long, very thin, bladed crystals, also occurs in the east-central part of the quarry. Fluorite has been found throughout the quarry as inconspicuous white granular coatings on nepheline and other minerals. Pectolite is found as white, acicular, brush-like sprays and also as prismatic crystals, colorless to white with a slight pink tint resembling serandite. These prismatic crystals of pectolite are the Mn-rich variety. Thorbastnäsite has been found in very small (about 0.1 mm) spheres of intergrown hexagonal plates. They are flesh-colored with a slight bluish opalescence.

Note

Although many of the locations noted in this article are on public land and readily accessible to the mineral collector, others are on private or restricted land and approval should be obtained before entry. Publication in this article does not imply in any manner that collectors have access without obtaining permission.

Acknowledgments

As all collectors of microminerals know, finding interesting specimens and identifying the crystals are two separate and distinct tasks. The physical characteristics such as hardness, cleavage, gravity and streak are often difficult if not impossible to determine in small crystals; other means must be resorted to for positive identification. Microprobe analysis has proven to be without doubt a "great leap forward" for the micromineral collector as an aid in identifying mineral species. In this regard, I wish to gratefully acknowledge the work of Paul Hlava of Sandia National Laboratories for his dedicated efforts in helping to identify many of the minerals mentioned in this article. Without his curiosity, skill and knowledge, many of the minerals in this article would be sitting in boxes labeled "unknown." I would also like to thank Dr. Peter Modreski with the U.S. Geological Survey in Denver for his many efforts in the identification process using X-ray diffraction and optical determinations. Also, many thanks to Pete and Paul for critical comments during the development of this article. The photomicrographs by Julius Weber and Arnold Hampson are much appreciated as well.

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THE NEW MEXICO BUREAU OF MINES
MINERAL MUSEUM

Robert M. North
New Mexico Bureau of Mines and Mineral Resources
Socorro, New Mexico 87801

The New Mexico Bureau of Mines maintains a collection of over 10,000 specimens, specializing in the minerals of New Mexico. Paleontological specimens and mining artifacts supplement the fine collection of minerals.

INTRODUCTION

The Mineral Museum of the New Mexico Bureau of Mines and Mineral Resources had its beginnings as the mineral collection of the geology department of the New Mexico School of Mines in Socorro (now the New Mexico Institute of Mining and Technology). A major contribution was made by C. T. Brown, who willed his collection to the School of Mines upon his death in 1928. Brown, a prominent mining engineer and speculator in the Socorro area, also served as regent for the School of Mines from 1899–1913 and 1917–1922. The New Mexico Bureau of Mines and Mineral Resources, a division of the New Mexico Institute of Mining and Technology, acquired responsibility for the collection in 1960, when the Bureau moved into an addition to Workman Center. Through donations, purchases and trades, the museum collection has grown to more than 10,000 specimens.

The museum's major purpose is to serve as an educational asset to New Mexico Tech and the public. The collections are designed to introduce the student and other interested visitors to the beauty and variety of the mineral kingdom, especially the diversity and occurrence of minerals in New Mexico. Mining and mining history are also emphasized where possible, and a paleontological collection is maintained.

MUSEUM COLLECTIONS

The most important element of the New Mexico Bureau of Mines Museum is the mineral collection, which consists of three sub-collections: the display collection, the reserve collection and the reference collection. In addition to the museum collections, the Bureau maintains an extensive historic photo collection, and a large fossil collection.

Display Collection

The display collection (on display in the museum) is subdivided into six sections (see floor plan). The New Mexico section contains minerals found within the state, including a fine collection of smithsonite and other minerals from the Kelly mine, Magdalena district, Socorro County. Other specimens from the district, many donated by C. T. Brown, include azurite, malachite, cerussite, aurichalcite and native copper. The New Mexico section also boasts a fine suite of minerals from the Hansonburg district (Blanchard Claims, Bingham) which includes linarite, brochantite, fluorite, barite, galena and other less common minerals. Representative suites of minerals from many other districts are displayed, with especially fine and interesting specimens from the Organ Mountains (Stephenson-Bennett mine), Harding pegmatite, Santa Rita-Hanover area (Santa Rita, Groundhog, and other mines), the Grants uranium region, and the Carlsbad potash district. Currently, the museum is acquiring gold specimens for a special display of gold from the state. At present, the exhibit contains gold specimens from the San Pedro mine, Piños Altos, White Oaks, Mogollon, and the Magdalena Mountains.

The second section of the display collection is devoted to minerals from other states. Fine specimens from Franklin, New Jersey; the Tri-State district of Missouri-Oklahoma-Kansas; and from various localities in Colorado, California, Utah and Arizona highlight this section. The minerals have been grouped by state (or mining district, in some cases) to show important mineral associations. In all, some 40 states are represented with emphasis on the Western states.

The third section contains minerals from foreign countries. Noteworthy specimens from Mont St-Hilaire, Quebec, Canada; Tsumeb, Namibia; England; Brazil; and Mexico are on exhibit. An especially fine suite of minerals from Mont St-Hilaire (donated by the late Peg Marble and her son, Bill) is on display. Included in the display are fine serandite, natrolite, analcime, rhodochrosite and other rare and unusual minerals from Mont St-Hilaire. More than 35 countries are represented in the display.

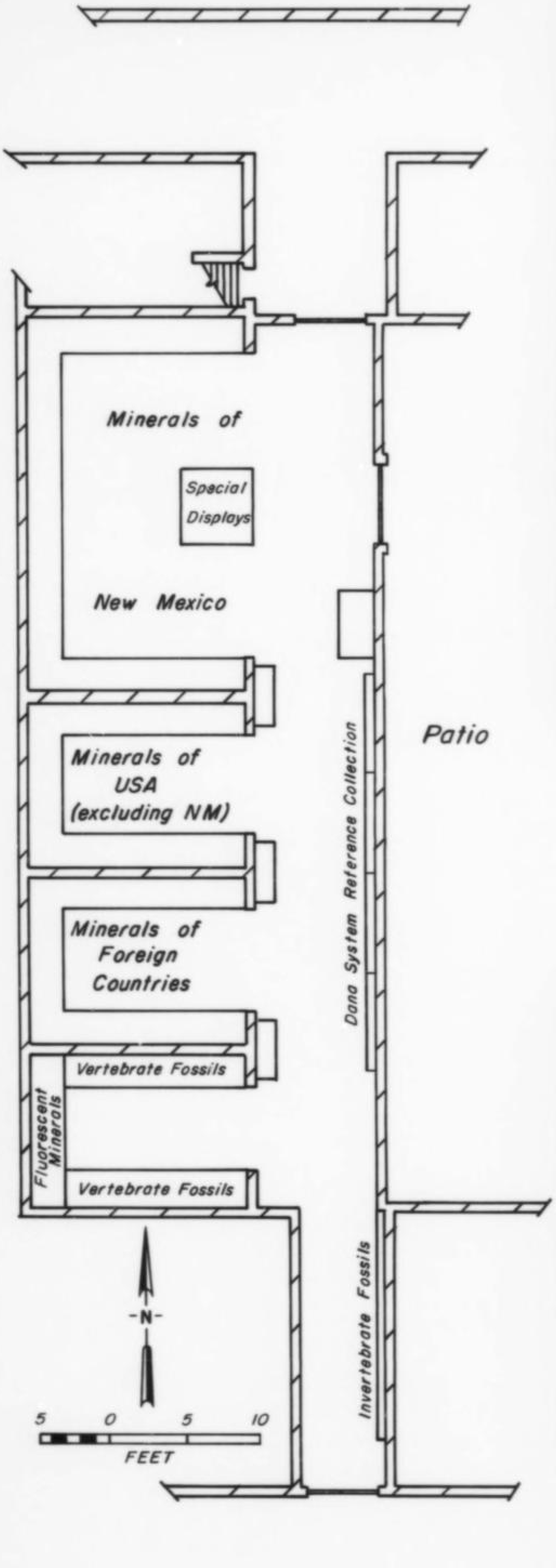

Figure 1. **Floorplan of the New Mexico Bureau of Mines Mineral Museum.**

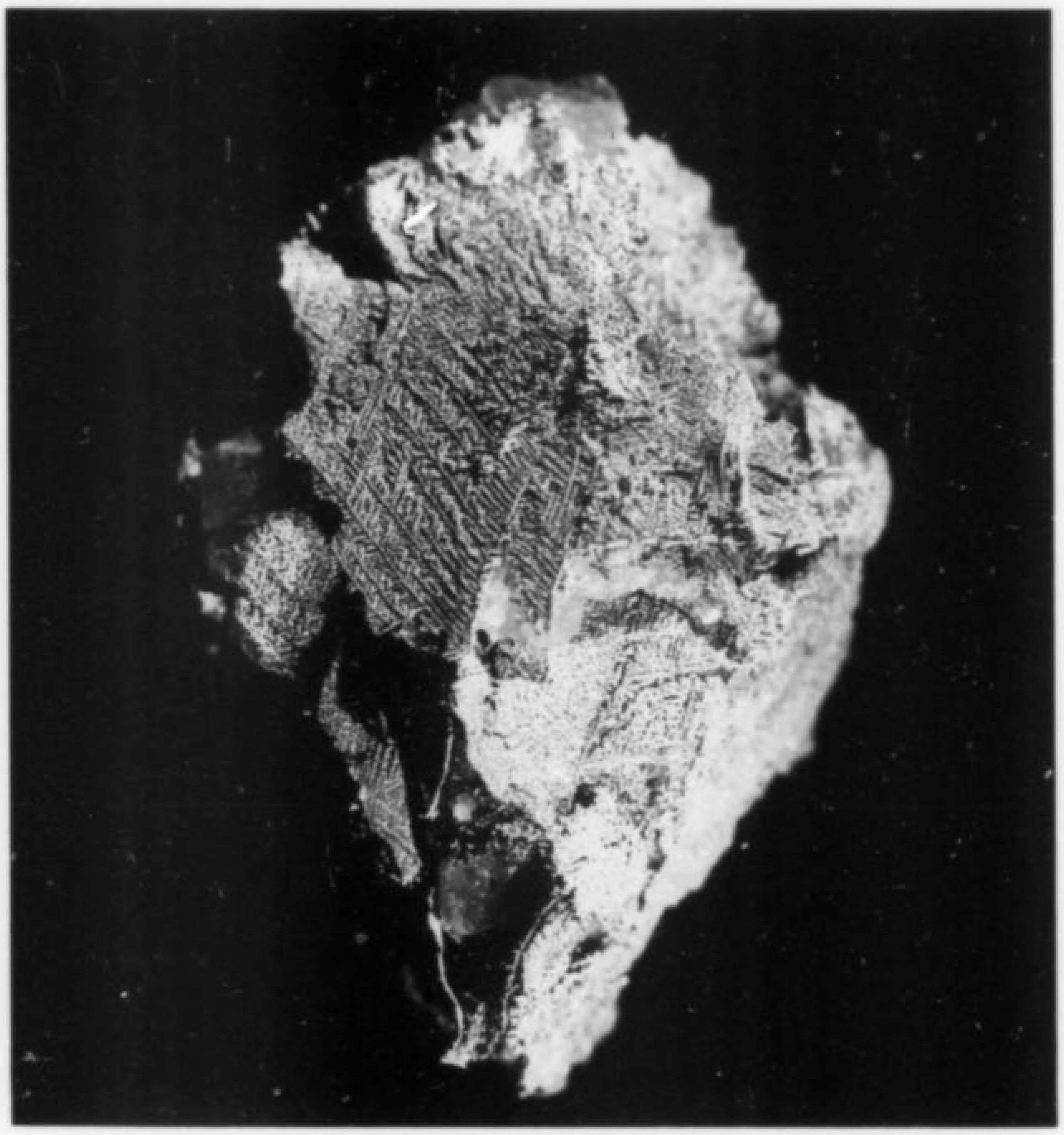

Figure 2. **Gold on pale green fluorite, Catron County, New Mexico (probably from the Mogollon district). Overall length, 5.5 cm. New Mexico Bureau of Mines Mineral Museum (NMBMMM) catalog #10734. Photo by R. M. North.**

Figure 3. **Dioptase crystals on matrix, 9.5 cm tall, from Tsumeb, Namibia.**

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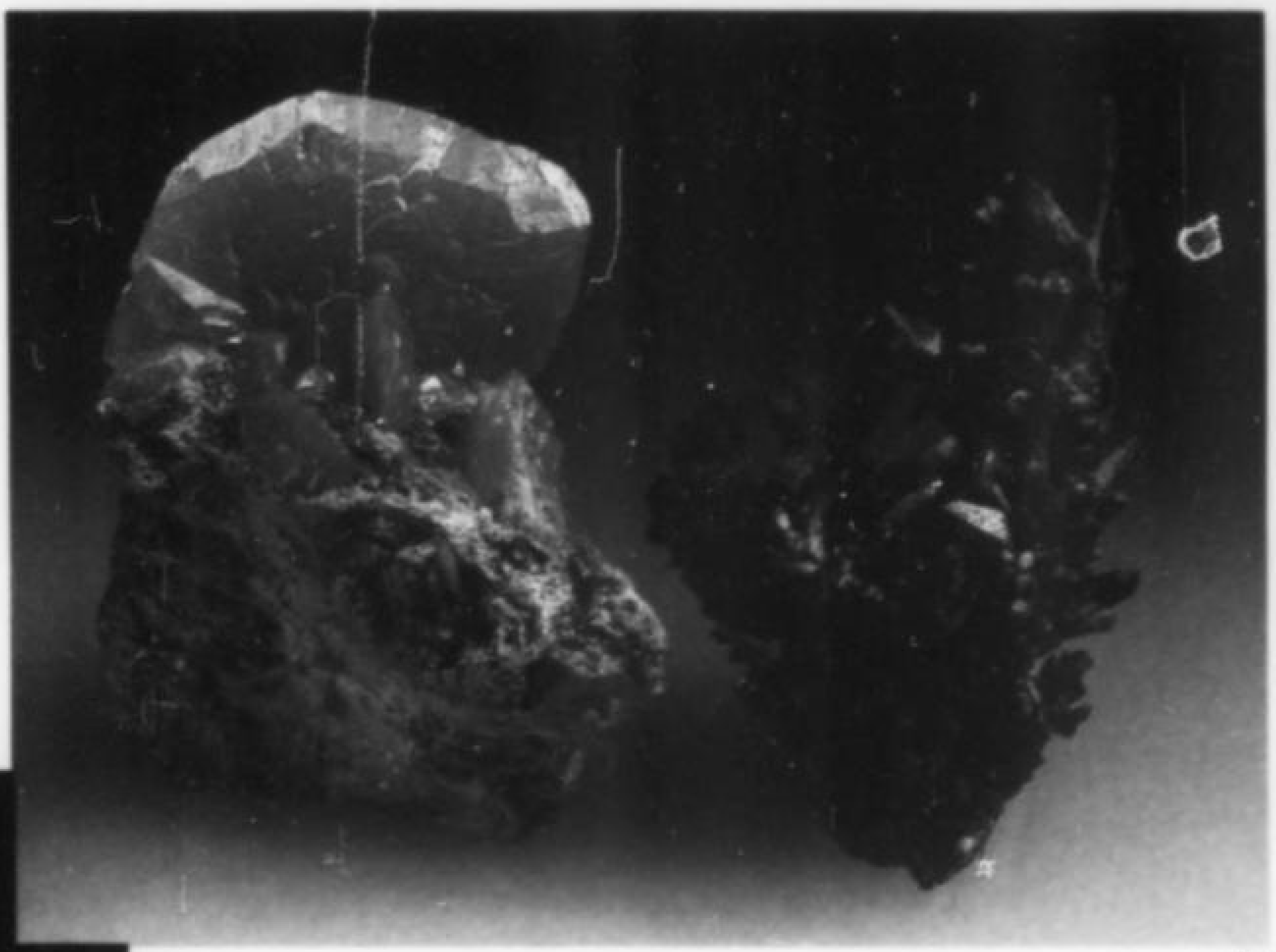

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Figure 4. **Wulfenite crystal, 2.1 cm, from the Denver shaft, Bayard district, near Vanadium, Grant County, New Mexico; and a group of silver crystals, 3.8 cm tall, from the Chloride Flat district, Silver City, New Mexico.**

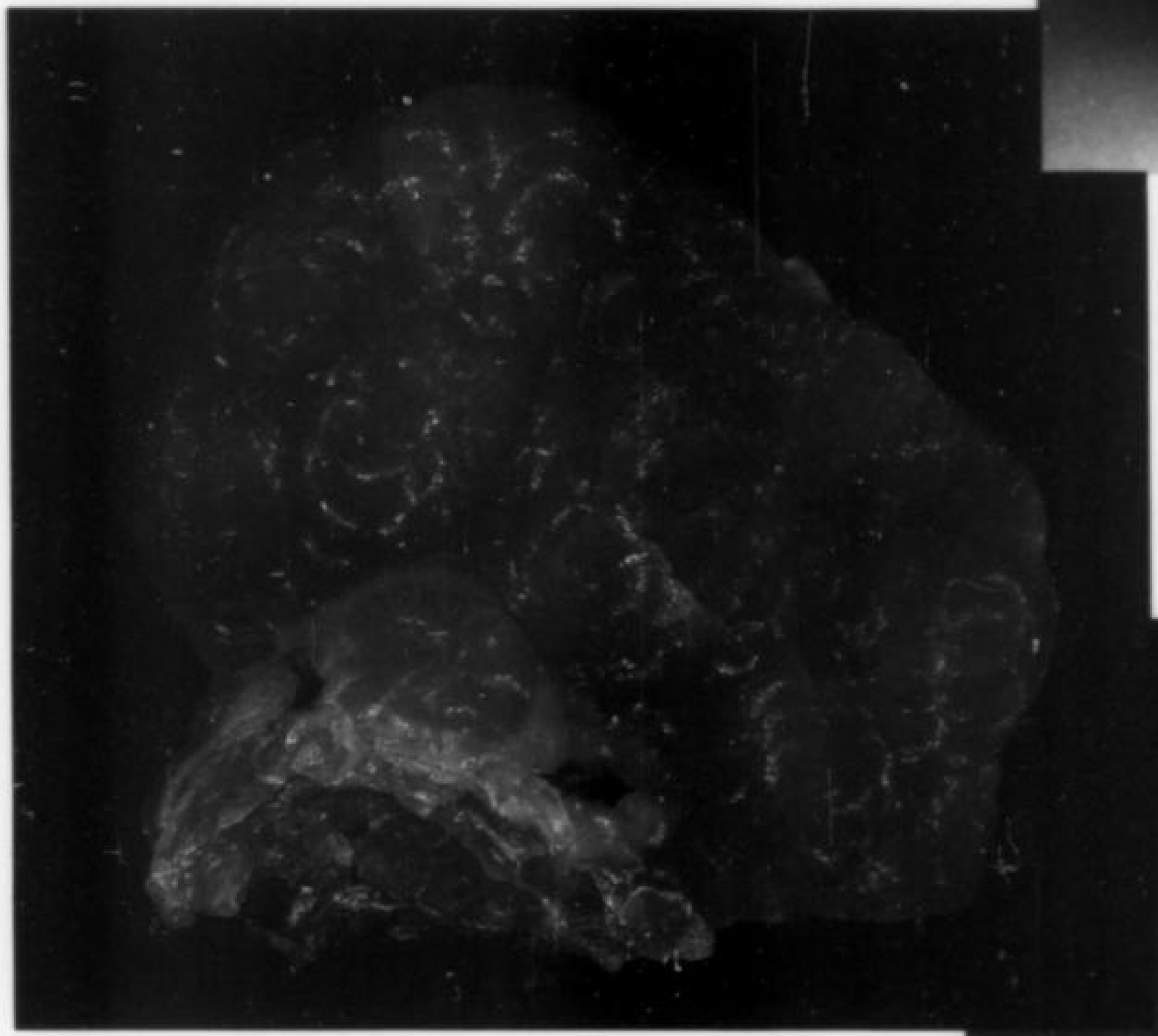
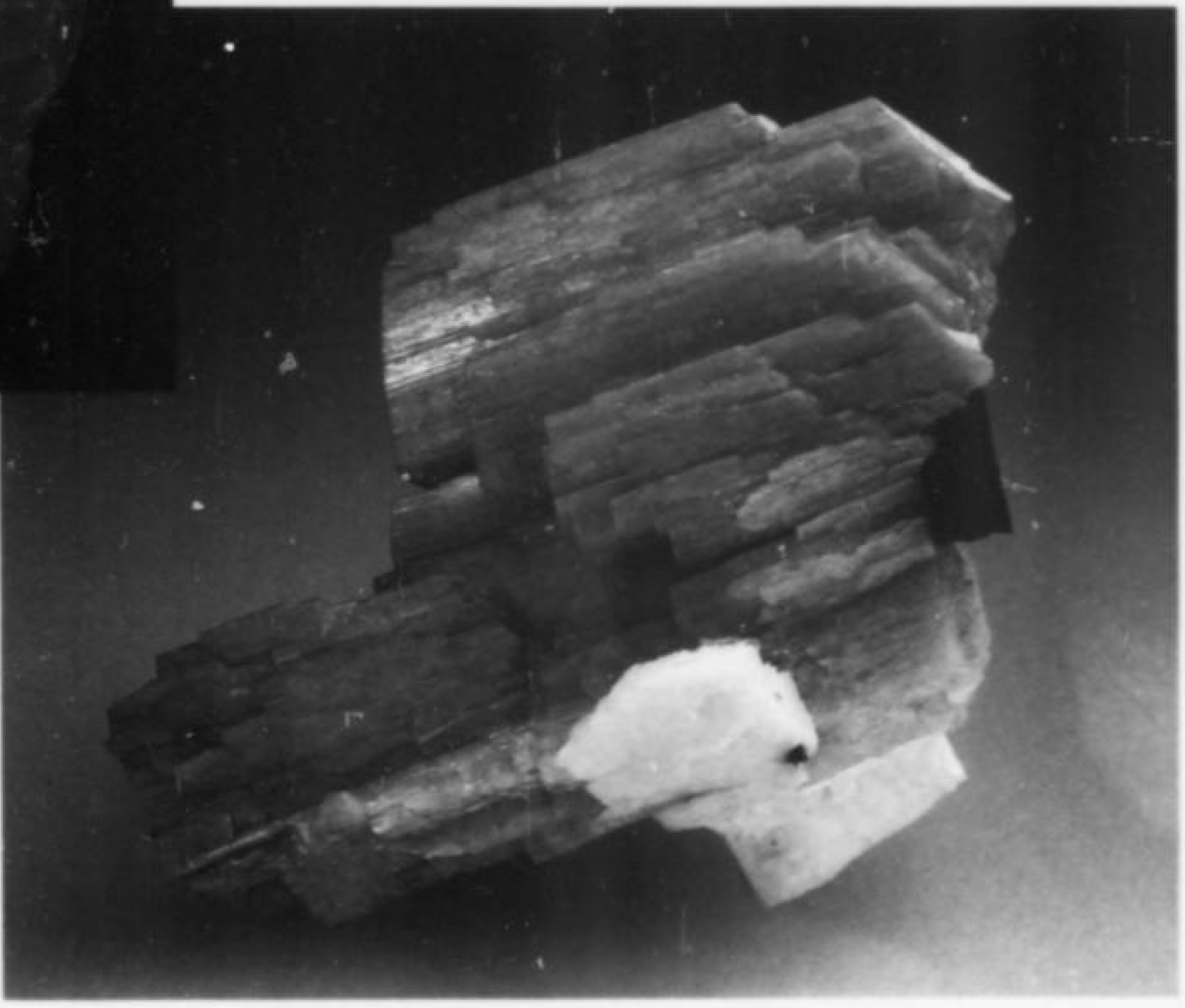


Figure 6. **Smithsonite, Kelly mine, Magdalena district, Socorro County, New Mexico. One of a number of fine smithsonite specimens in the museum collection. Specimen is 6 cm x 8 cm x 9 cm. Photo by R. W. Eveleth.**

Figure 5. **Serandite from Mont St-Hilaire, Quebec. Overall specimen length: 6.6 cm.**



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The southernmost bay in the museum houses two sections: fossils and fluorescent minerals. The fossil display contains fossils from New Mexico and other Western states, including the lower jaw of a mastodon that was found in Socorro County by one-time New Mexico School of Mines President, C. E. Needham, and the tail section of a duck-billed dinosaur (hydrosaur), recently found at the Fossil Forest south of Farmington, New Mexico. Invertebrate fossils are grouped by class and are highlighted by Cretaceous ammonites from South Dakota, Wyoming and New Mexico. Several New Mexico plant fossils are also displayed.

The fluorescent mineral display features minerals from around the world. Although specimens from Franklin, New Jersey, highlight this display, many New Mexico minerals are included.

The Dana reference collection is displayed along the east wall of the museum. Here minerals are arranged according to the Dana System, by chemistry and crystal structure (it was proposed by James Dwight Dana in 1837, and has been periodically revised and updated, incorporating new species as well as changes resulting from advances in chemistry, physics and X-ray crystallography). This display exhibits 487 specimens representing 475 species. The minerals are not always beautiful, well-crystallized specimens, but rather the more common, massive varieties that would likely be found by prospectors and collectors. The Dana display includes some examples of relatively rare minerals. Prospectors often study this exhibit to familiarize themselves with the appearance of the ore minerals.

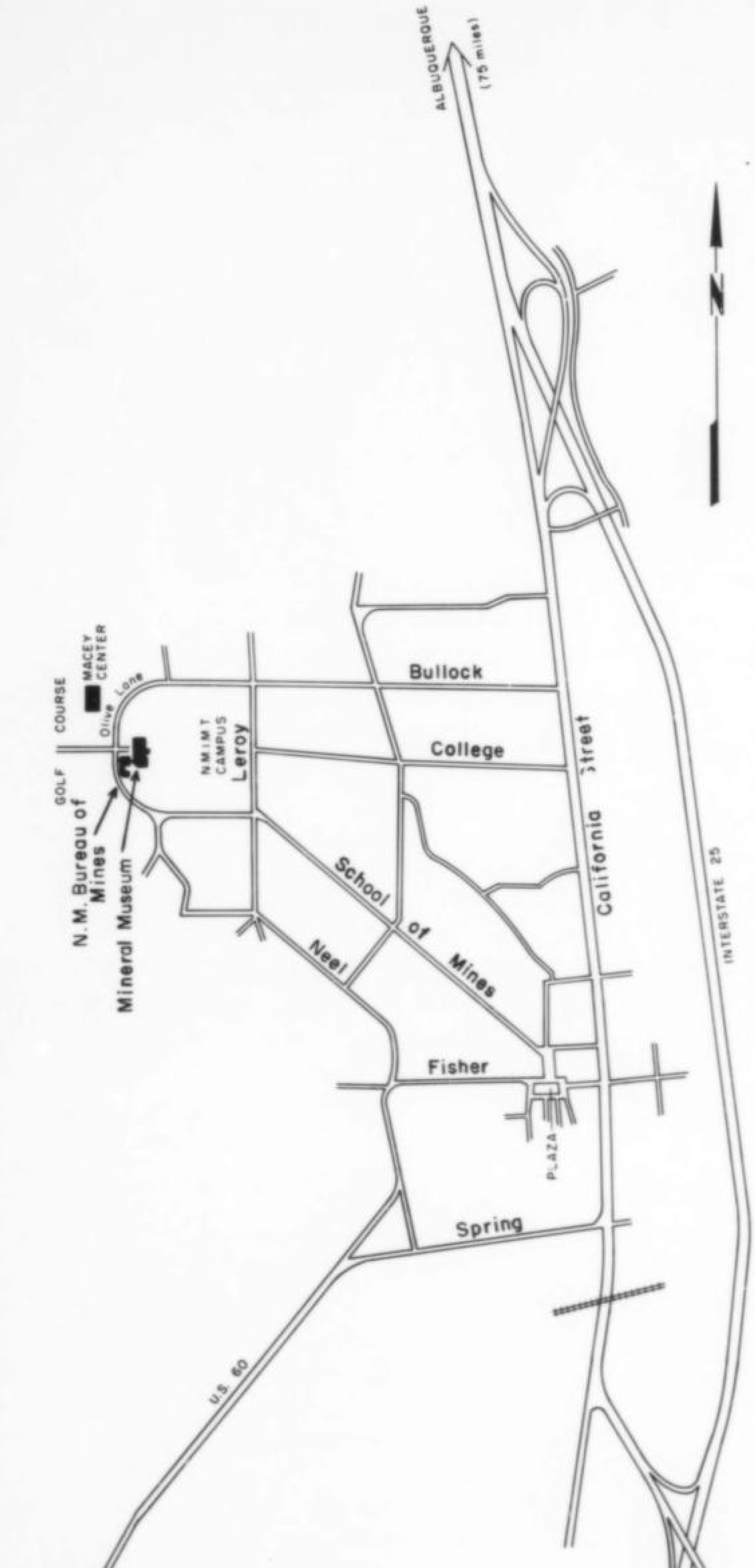

Figure 7. **Map of Socorro, showing location of the New Mexico Bureau of Mines Mineral Museum. Scale, approximately 1 cm = 0.25 km; 1 inch = 0.4 miles.**

Reserve Collection

The reserve collection is housed in the museum storage area. Specimens that will eventually be used in the display collection or for the preparation of special displays in the museum or elsewhere are kept here. The reserve collection may be viewed for study purposes upon request.

Reference Collection

The reference collection consists of specimens for study. These specimens exhibit typical characteristics of the various mineral species and illustrate variations within species. The reference collection is used by student, prospectors and geologists as a learning aid and for comparison with unidentified specimens; it is open to all interested persons. An appointment should be made if extensive use of the reference collection is desired. A 7 to 45-power microscope can be made available for study of the reference collection.

The micromount collection is a special section of the reference collection. Many species do not occur as large crystals and can be collected only as micromounts. Small, often beautifully crystallized specimens have been mounted in 2.5-cm boxes for viewing with a stereo microscope. This rapidly growing collection contains many of the rare minerals that occur in New Mexico. The micromount collection is available for viewing by appointment only.

Mining Artifacts Collection

In recent years, the mineral museum has sought mining artifacts and ephemera to display with mineral specimens. Included in this collection are mine lamps, powder boxes, mine and district maps, photographs, prospectuses, surveying equipment and stock certificates. The museum actively seeks material on New Mexico mines, and has some artifacts and ephemera from other states available for exchange. In addition to the museum's mineral collections, the New Mexico Bureau of Mines and Mineral Resources maintains a large collection of photographs, negatives and slides of mines, mills, minerals and other subjects of interest to the mineral enthusiast. copies of materials in the photo collection are available to the public at minimal cost.

MUSEUM SERVICES

To supplement the permanent displays in Socorro, the museum provides special exhibits for in-state gem and mineral shows, as well as for special events (such as the State Fair, special meetings of the New Mexico Mining Association, and others). A slide show of minerals from the Museum collection is available for groups who cannot visit the museum. Museum personnel also give lectures on geology, paleontology, mineralogy, mining and mineral collecting in New Mexico to local gem and mineral clubs and to school children. The New Mexico Bureau of Mines and Mineral Resources has on its staff a mineralogist-museum curator who identifies minerals and rocks as a service to the public. This service has been extended to mineral shows around the state.

HOURS AND INFORMATION

The mineral museum is open daily, except holidays, from 8 a.m. to 5 p.m. During the summer months (Memorial Day to Labor Day) the museum is open Saturdays from 9 a.m. to 4 p.m. Other hours can be arranged in advance. Admission is free.

Special tours and information on traveling displays, slideshows and lectures can be arranged by writing or calling:

Mineralogist
N.M. Bureau of Mines & Mineral Resources
Campus Station
Socorro, N.M. 87801
Phone: 505-835-5246

ACKNOWLEDGMENTS

Thanks are due to all the many people who, through the years, added to the collection through their kind donations of specimens, artifacts and time. Robert W. Eveleth and Dan Crum read the manuscript, and made helpful comments. Angela Kirkman and Dr. Wendell E. Wilson assisted with photography. Thanks are also due to Cindie Salisbury for drafting the figures and Norma Baca for word processing.

What's New in Minerals?

DENVER SHOW 1988

The Denver Show is held each year in mid-September at the Denver Merchandise Mart and independently at several satellite locations. This event has grown and improved so much in recent years that it is now clearly second to none in the country, excepting, of course, for the phenomenal Tucson Show. The "main" show at the Merchandise Mart, presented by the Denver Council of Gem and Mineral Societies, now carries guest exhibits from prominent mineral museums across the U.S.; this is a major advance over their exhibitors list of just a few years ago, which was almost entirely local then. Within the main show and satellite shows one could find most of the major American mineral dealers, a very large selection of Rocky Mountain dealers, and a significant number of European dealers as well.

The hit of the show was generally acknowledged to be the several hundred new cuprite specimens from the Mashamba West mine, Zaire, brought in by Gilbert Gauthier. Sharp octahedral crystals to 3 cm, as individuals and groups, and a few parallel-growth crystals to 4 or 5 cm are certainly some of the finest cuprites ever seen. Bill Larson (Pala International) had visited Gilbert first and had selected three flats of the best pieces for immediate resale, but Bill's prices (and Gilbert's) were still remarkably low (half of what I would have expected). The specimens carry two generations of cuprite. The earlier crystals tend to show small truncations of the octahedral points and edges by cube and dodecahedron faces respectively, and are usually coated by a thin layer of pale blue chrysocolla. Over these are scattered a second generation of sharp, lustrous, unmodified octahedrons without any chrysocolla coating. These later crystals, in a few cases, have popped off their bases because the intervening chrysocolla layer does not provide the best adhesion surface; specimens should thus be handled carefully.

Carlos Barbosa had some interesting, water-clear and colorless beryls of tabular "poker chip" habit, as singles and as stacked groupings from Minas Gerais, Brazil. The individual crystals are 2–3 cm across and a few millimeters thick.

Bill Schneider (*Schneider's Rocks and Minerals*) had some unusual quartz cabinet specimens from Sichuan province, China. The crystals, up to 18 cm, are smoky colored and flattened, with a gwindel twist. About a dozen pieces comprised the lot.

Dennis Belsher (Worldwide Resources) had some extremely large and fine octahedral pyrite crystals from Huanzala, Peru, up to perhaps 12 or 15 cm across. He also had two flats of well crystallized tetrahedrite from the Mercedes mine, about 10 km west of Huanzala. The crystals are typical tetrahedral habit with very low-angle modifications and bright metallic luster; crystals measure up to 5 cm on edge. They are generally rather intergrown with each other, and have been broken from matrix as plates of crystals, although a few smaller pieces with matrix were available too.

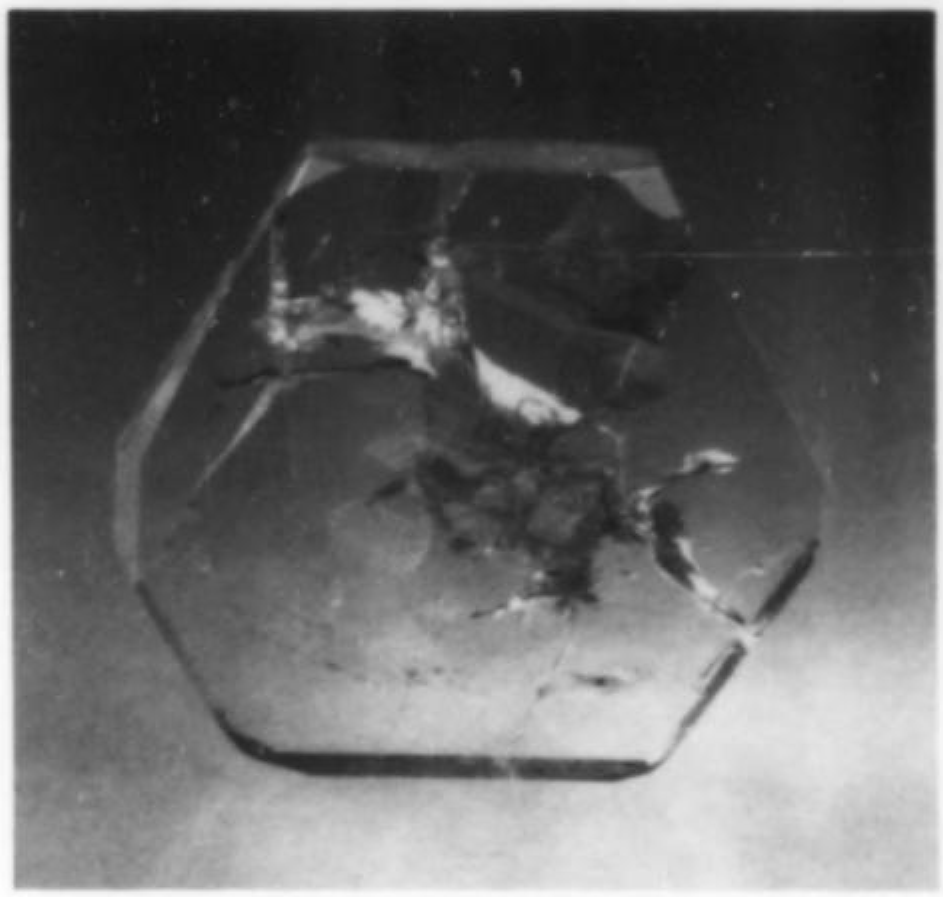

***Figure 1.* Colorless beryl crystal, 2 cm, from Minas Gerais, Brazil. Carlos Barbosa specimen.**

Alain Carion (Paris, France) had something surprising: large native silver specimens from Morocco. The location was given as Imiter, in the southern part of the country, in the same formational unit at the Bou Azzer deposits. The specimens are not very well crystallized, but they range from miniature to cabinet-sized sheets and masses, and contain about 15% mercury.

Don Olson had several dozen new hematite crystals from Wessel's mine near Kuruman, South Africa. These are mostly 3–10 cm in size, and tabular hexagonal in habit with many modifications around the edges of the thick, frosty tablets. A druse of red garnets coats the backs of some crystals. Don reports having seen such hematite crystals up to 7 by 20 by 30 cm while on a recent buying trip to southern Africa.

Doug Parsons (2670 Del Mar Heights, Del Mar, CA 92014) carried a wide range of new Chinese material including some excellent arsenopyrite crystals to 4 or 5 cm from Leiyang, Hunan Province; stannite, bornite and wolframite from Hengyang, Hunan Province, attractive blue fluorite in modified cubes (Leiyang), and the usual cinnabars.

Several collections were for sale at the show this year. Among the most notable was the 1500-piece thumbnail collection of Beth Gordon, being sold by Cal and Kerith Graeber. This was the finest large lot of thumbnails I've seen for sale in one place; as an example, there were not one but *three* fine thumbnail phosphophyllite crystals from Bolivia. Everything showed virtually no damage and a high level of aesthetic taste, quite a tribute to the late Mrs. Gordon. Also for sale was the collection of Harry Roberson (Phoenix, Arizona). Wayne Leicht obtained these, roughly 300 very fine miniatures, and brought half of them to Denver (reserving the other half for the Pasadena Show). They sold out within a very short time.

Victor Yount had a half dozen fine phosgenite crystals from the Touissit mine in Morocco. These are up to an amazing 9 cm in size, dark smoky brown and gemmy. The habit is blocky and the faces are highly lustrous and striated. Vic had quite a selection of recently collected Touissit minerals, including fine, gemmy, yellow anglesite crystals of many different habits, large botryoidal smithsonites of sea-green color, V-shaped cerussite twins, and so on. From the T-West mine at Mibladen Vic had several flats of odd-looking, opaque, variegated yellow-brown to red-brown vanadinite in plates of miniature to cabinet size. It is nice to see material coming form Mibladen again, after roughly two years of dormancy.

Miriam and Julius Zweibel (Mineral Kingdom) had what is clearly among the finest epidote specimens in the world. In fact, it is tempting to call it one of the finest mineral specimens of any kind. It is a

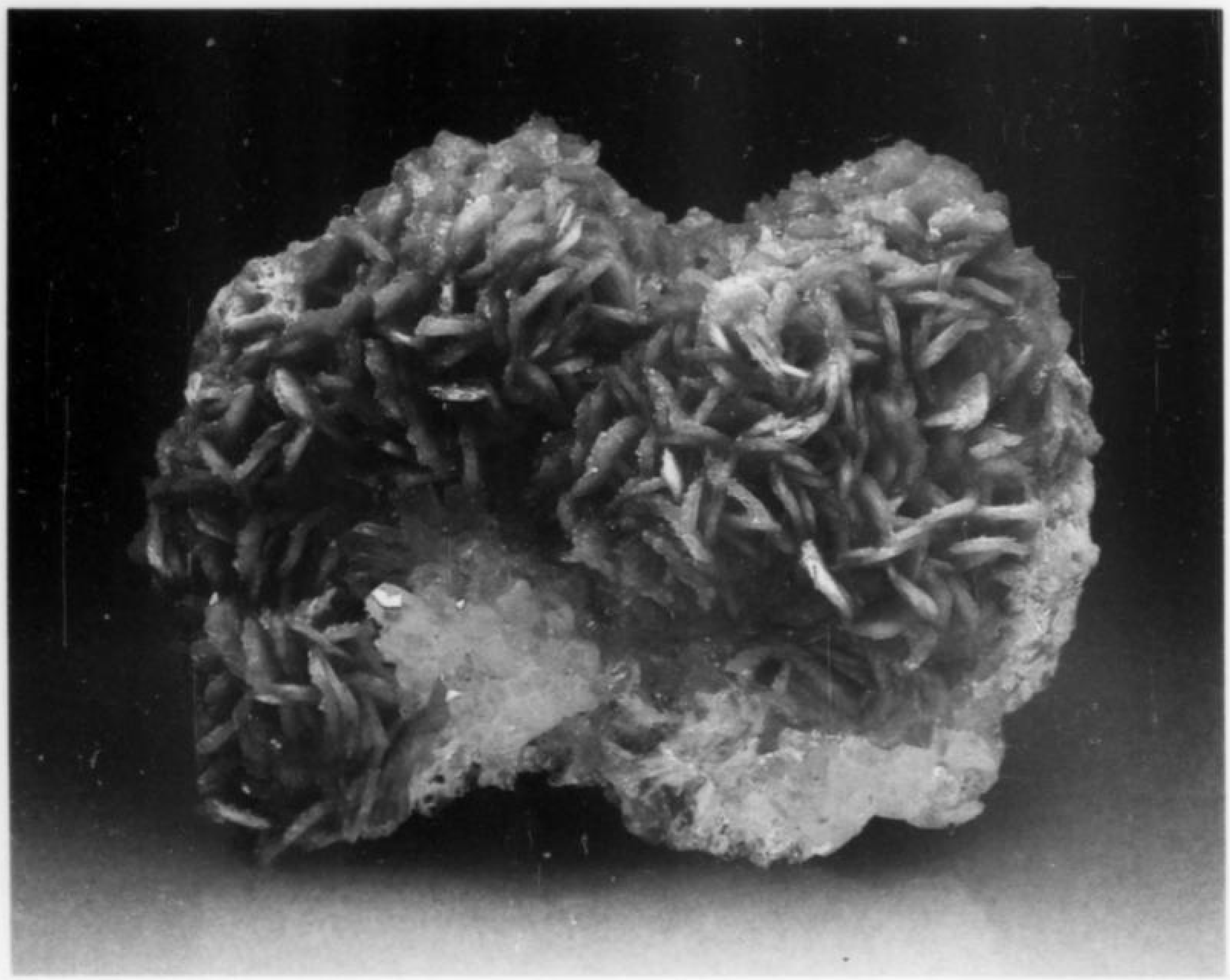

Figure 2. **Rhodochrosite crystal group on quartz, 6 cm, from Cavnic, romania.**

Figure 3. **Andradite crystals to 2 cm on matrix from Dashkesan, in the Caucasus, USSR. Fersman Mineralogical Museum specimen.**

Pakistan piece, perhaps 15 cm long, with gemmy green "wings" to 2 or 3 cm flaring off left and right along its length. Condition and luster are superb. The price, of course, is enough to buy a small fleet of Yugos, and probably worth it . . . who knows about prices and values in this range?

Many other dealers had interesting specimens; I'll list briefly only a few here: phenakite crystals to 1 cm from Wheeler Peak, White Pine County, Nevada (David Shannon), mendozavilite from Gold Hill, Utah (David Shannon), dioptase crystals to 3 mm on chrysocolla from the Magma mine, Superior, Arizona (Dave Shannon, John Mediz), purple/green fluorite from Okarusa, Namibia (Mitch Abel), colemanite crystal groups from the Billie mine, Death Valley, California (Walter Lombardo), galena, sphalerite, etc. from the 19th of September mine, Madan, Bulgaria (Ben De Wit), newly collected Red Cloud mine, Arizona, wulfenite (George Godas), and black acicular actinolite with yellow-orange titanite from the Metals mine, Churchill County, Nevada (John Seibel).

QUARTZ TROUBLES

A serious situation has developed with respect to the recent discovery of smoky quartz in New Mexico (vol. 18, no. 6, p. 429–430). A U.S. Forest Service press release dated July 28, 1988, reads in part:

"Federal agents from the USDA Forest Service and the USDI Bureau of Land Management today searched [mineral] businesses in Santa Fe and Albuquerque, New Mexico, as part of a continuing investigation of the theft of smoky quartz crystals from national forest lands.

"Search warrants were issued . . . Agents were seeking smoky quartz crystals which were stolen from the White Mountain Wilderness of the Lincoln National Forest in southern New Mexico. Since the quartz crystals are located on government land, their removal without permit becomes theft of government property under 18 U.S. Code 641.

"Searches are being made of retail outlets where the crystals may be on sale to the public since the store owners may have purchased them from the suspected thieves. At least 50 retail outlets may have purchased the crystals.

"The suspected thieves have been identified . . . No suspects are in custody.

"The loss to the government has been estimated in the 'tens of thousands of dollars.' Conviction of the theft can result in 10-years imprisonment and up to a $10,000 fine."

A further release dated August 5, adds:

"Federal agents . . . searched two businesses in Tucson on Thursday as part of a continuing investigation . . . [following] searches of businesses in Santa Fe and Albuquerque. Agents said that [smoky quartz] crystals were found in all of the searches."

An article by Susan Landon in the *Albuquerque Journal* (July 30) quoted Noel Johns, special agent for the U.S. Forest Service in Albuquerque, as saying that the New Mexico crystals are a type of smoky quartz "found nowhere else in the world." According to the Associated Press, the accused men told federal agents they had filed a claim in Carrizozo, New Mexico, for the area where they took the quartz. But federal agents in the warrant said the claim was "improperly filed." The men had removed approximately 100 flats of quartz from the wilderness, the warrant said.

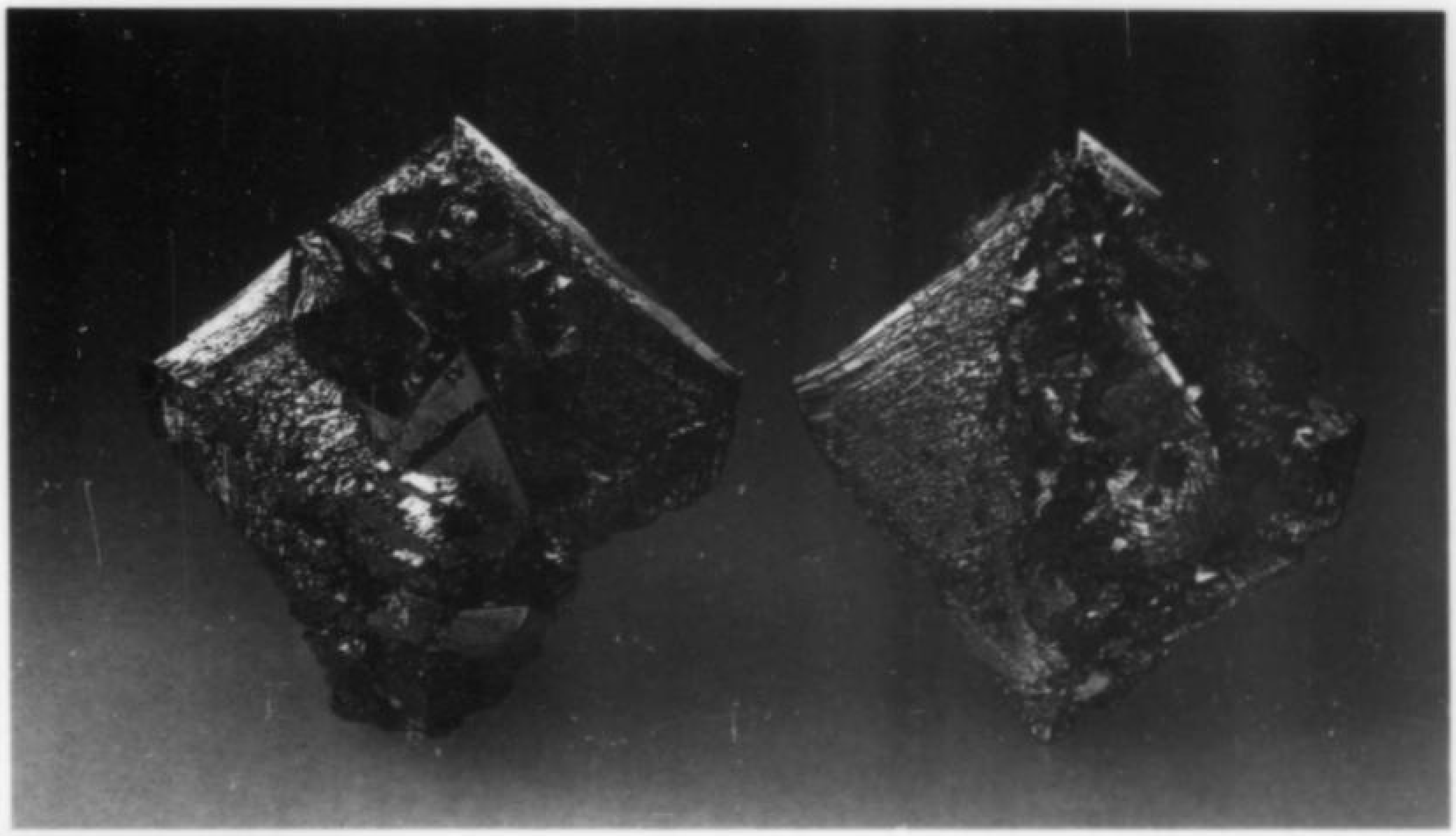

Figure 4. **Marcasite crystals to 3 cm from Misburg, West Gerrmany. Tom Gressman collection.**

Figure 5. **Cuprite crystal group, 4.6 cm tall, from the Mashamba West mine, Zaire. Bill Larson specimen (from Gilbert Gauthier).**

It is important to note that the Japan-law smoky quartz twins from Mina Tiro Estrella (see the article in this issue) were legally collected from a neighboring mountain range, and are not a subject of the investigation.

MUNICH SHOW 1988

The thousand year-old city of Munich, West Germany, hosted its 25th annual mineral show this past October. The Mineralientage München, as the event is known, is generally acknowledged to be the world's no. 2 mineralogical exposition (after Tucson). That being the case, your editor feels obliged every few years to travel to Germany in order to observe and report. Our regular German correspondent, Thomas Moore, will be redistributing his travel days so as to range a bit wider afield this year, in lieu of attending Munich.

The show theme for this special anniversary year chosen by organizer Johannes Keilmann was *Wer sammelt macht Geschichte*. . . . "Those who collect make history." We in the U.S. might have expected native silver to be featured for their "silver anniversary," but they've already done that topic a few years ago; and in any case the Germans don't consider silver to be quite as exciting as the rest of us do. (Perhaps it's because they've grown up surrounded by so many famous and historic silver mining districts that the subject is too familiar.) The special exhibits featured highlights from many historic collections; more on those in due course.

The Munich Show is structured differently from most others worldwide. To begin with, *two* days are alotted for set-up (Wednesday and Thursday) because of the large amount of construction necessary for dealer booths, exhibit areas, the information stand and temporary office space. The whine of power saws echoes through the enormous Hall for most of those two days, and full-scale mineral shops, complete with walls, ceilings, carpeting and lighting, are built around the circumference of the hall. The special exhibit area is like a small museum (redesigned and constructed anew each year), with potted plants and framed pictures on the wall spaces between exhibit case. There are no competitive exhibits or independent displays, only what Keilmann has solicited in support of the year's theme. In fact, there is no longer the exhibit of best specimens of the show dealers, as in previous years, and no corresponding awards.

By Thursday evening most of the booths are completed and ablaze with kilowatts, and the dealers are engaged in vigorous and unrestricted sales (mostly to each other and anyone else who has managed to leak in). Commercial activity is the *raison d'être* for this great show, and Keilmann does not get in its way with any strictures against pre-show selling.

Friday is the wholesale day, requiring a special pass easily obtainable in advance by anyone remotely involved in mineralogical commerce. This "trade show" day applies to the entire community of show dealers; there is no segregated wholesale section as at many American shows. Most really serious mineral buyers do their best to arrange entry on this day, and the restricted attendance means the wide aisles do not become congested.

On Saturday and Sunday the general public is admitted, and the crowds arrive in force. Every dealer, every exhibit becomes two or three deep in eager browsers, and the wide aisles are choked. By around 11 a.m. Sunday it looked as crowded as I thought it could get; then someone told me that the *real* crowds were yet to arrive, since almost everyone was still in church! Ochlophobiacs beware. Total attendance was about 22,000 people . . . down a thousand from last year (because the weather was too nice on Saturday) but still jammed.

A major improvement in show-goer comfort was initiated this year by Keilmann; a large sign at the entrance asked people not to smoke inside the show hall. As a result, the air was quite clear (in contrast to previous years when the haze became so thick it made your eyes burn).

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***Figure 6.* Entrance to the temporary museum-style exhibit room at the Munich Show. The theme:"Those who collect make history."**

Now to the minerals:

There were few really outstanding and voluminous new mineral discoveries at this year's show, but many small new finds and resurgences were in evidence throughout the hall. A surprisingly large number of fine specimens were available from the old classic locality of Cavnic (or Kapnic), Romania: delicate groups of colorless platy barite crystals to several centimeters, attractive quartz groups (singles to small cabinets), some truly lovely specimens of transparent, equant amethyst crystals to 3 or 4 mm thickly sprinkled across pink rhodochrosite mounds, lustrous black sphalerites, beautiful groups of bright pink, platy rhodochrosite, and more. Guiseppe Romero (via Pedemonte 15, Ch-6962 Viganello, Switzerland) and Ella Edel (Sommerhofenstrasse 179, D-7032 Sindelfingen, West Germany) were particularly heavy in these specimens, and had several hundred fine pieces laid out.

Another locality that has recently enjoyed a renewed outpouring of specimens is the Machow sulfur mine, located near Tarnobrzeg in southeastern Poland. The latest discovery includes some unprecedentedly fine cabinet specimens of golden brown barite, in thickly clustered sparkling spears several centimeters long, with sulfur and white celestite. Many specimens of large white celestite crystals were also available. These had spread to many dealers, but the mother lode was clearly from K. Fritsche (Eichhornseckerstrasse 17, D-8342 Tann, West Germany), who specializes in Polish and Peruvian minerals; his booth was almost entirely devoted to the Machow material.

Trepča, Yugoslavia, continues to yield large quantities of fine specimens, especially the familiar black sphalerite, white quartz, calcite, pyrite and pale pink rhodochrosite. Hundreds of excellent specimens were available, particularly from Gijasedin Lyusta (Schneidemülerstrasse 91, D-4800 Bielefeld 1, West Germany), in small to large cabinet sizes.

Christian Gobin (Chemin des Terres, Longues, F-13770 Venelles, France) had a recently collected batch of very fine erythrite crystals from the classic occurrence at Bou Azzer, Morocco. Single crystals and fanned crystals to 2 cm were available, typically as groups of 5-10 mm crystals lining pockets in dark matrix of thumbnail to cabinet sizes. Gobin also had some large (to 10 cm), lustrous, well formed yellow anglesite crystals from the Touissit mine, Morocco.

Purple fluorites on white barite from the well-known Spanish localities at Berbes and La Collada were available from several dealers including Guillaumette Deberstrand (5, place de la Liberté, F-34150 Saint Guilehm le Desert, France), Fabre Minerals (c/Sant Joan de Malta 5, baixos, E-08018 Barcelon, Spain), Emme K2 (Via Stradella 16, I-20052 Monza, Italy) and Bertelli Luca (Via Valiversi, 22, Sesto Fiorentino, Italy). Small to large cabinets and a very few miniatures were available. The Berbes crystals are water-clear and deep purple, 1-3 cm in size, with generally very flat, lustrous cube faces. The La Collada crystals are typically cubes modified by dodecahedron faces and are large in size, up to 15 cm or so. Emme K2 and some other dealers also had some attractive, octahedral green fluorite in frosty crystals to 1 cm on matrix, from Papiol, Spain.

Olivier Szentessy (centered in Geneva, Switzerland, at B. P. 445, Petit-Lancy 1, CH-1213, but currently working out of 2 Durley Close, Frankston 3199, Victoria, Australia) had several interesting Australian discoveries including some attractive smoky quartz miniatures (2-6 cm crystals) from Moralla, Black River, northwest of Melbroune, and some Tasmanian purple-brown axinite crystals on matrix, lining vugs.

Peter Drexler (Augustinerstrasse 18, D-8700 Würzburg, West Germany) had some very sharp, lustrous octahedrons of northupite from Lake Kattwe, Uganda. These are pale yellow to gray-brown and transparent but with a crazed or cracked interior.

Siegbert Zecha (Windecker Pfad 1, D-6369 Schöneck 2, West Germany), who, in my opinion, has the niftiest looking labels of any

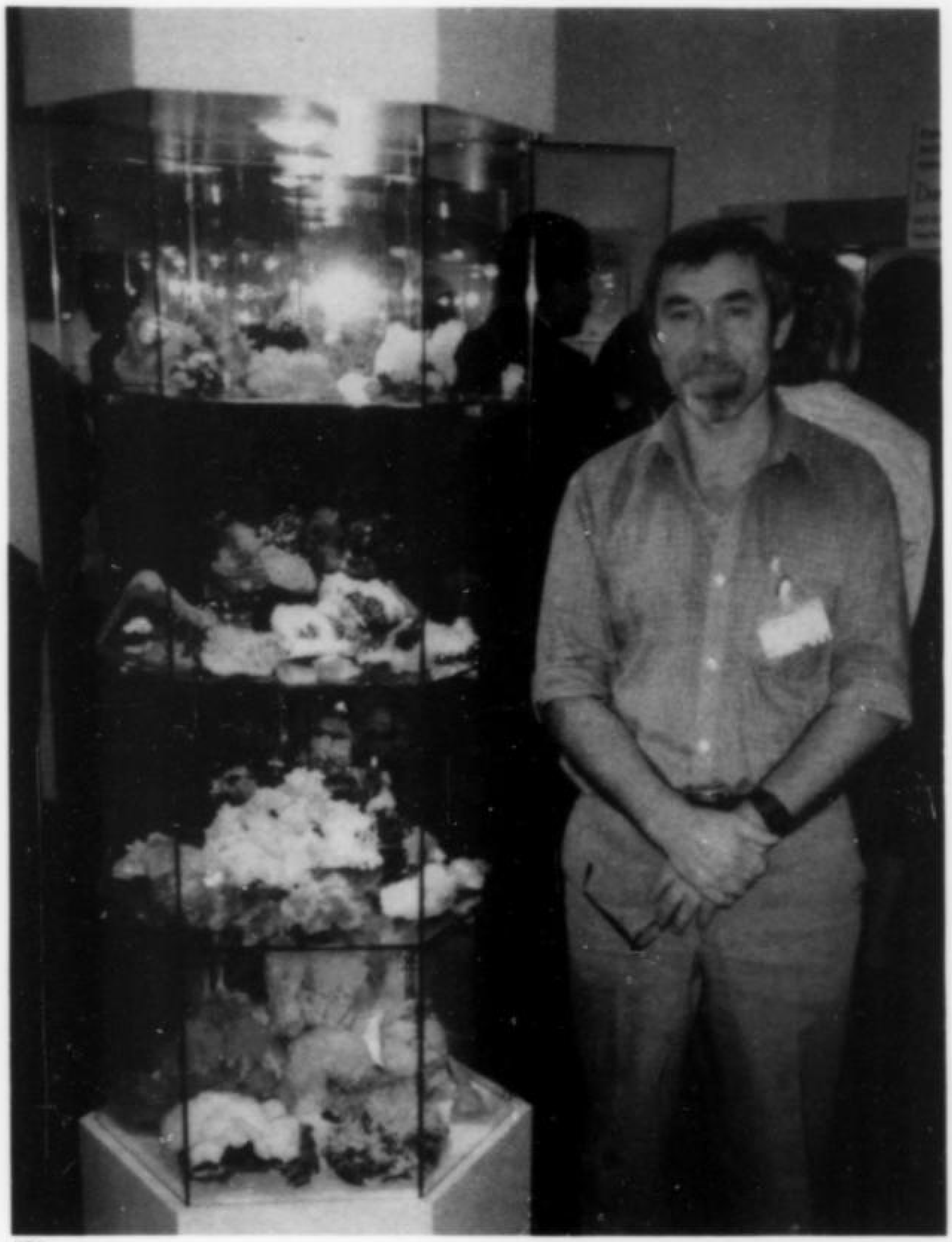

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Figure 7. **Vladimir Pelepenko, Russian collector, standing next to portion of his fine private collection on exhibit at the Munich Show.**

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Figure 8. **A case of antique Russian specimens and historical photographs exhibited by the Fersman Mineralogical Museum at the Munich Show.**

mineral dealer, had a fine selection of antique mine lamps, many rare Czechoslovakian mineral books, and a new lot of Turkish kämmererite (chromian clinochlore). The crystals, carried by several other dealers as well, are sharp and well formed although not usually exceeding a few millimeters in size.

Werner Radl (Elsässer Strasse 23, D-8000 München 80, West Germany), had some new Norwegian anatase crystals from near the old locality at Hardangervidda. The crystals are the typical steep dipyramids, black in color with lightly striated faces, and measuring up to about 2 cm in size. Some occur on quartz crystals. Several dozen pieces were available.

Rüdiger Hesse (Beethovenstrasse 41, D-7920 Heidenheim, West Germany) is one of those fortunate dealers who has his own private specimen-producing mine. Rudiger's is St. Anne's mine in Zimbabwe, where blue topaz crystals to 5 cm are found, along with blackish green tourmaline and sharp, white microcline crystals.

It was pleasing to see a sizeable lot of cinnabar specimens from Almaden, Spain, so close on the heels of our recently published article on that locality (vol. 19, p. 297–302, by Jack Crawford). Crystals to 1 cm on matrix were available by the dozen in the booth of Paul Muller (Rue Henry Dunant, F-79800 Pamproux, France). Muller also had some very large and fine crystals of gemmy red-orange sphalerite from the famous occurrence at Picos d'Europe, Spain. The crystals are up to about 10 cm each in size and, even in such large thicknesses, are brilliantly colorful when backlit. Victor Yount, while at the show, obtained (from *Myneyd*, Vargas 55, E-Santander, Spain), what is probably the finest sphalerite specimen in the world: a group of large Picos d'Europa crystals, roughly 30 cm across, with white calcite; to see this piece backlit is to forget all other sphalerites.

Bailey Minerals (PO. de la Castellana, 171, Madrid 28046 Spain) had a nice lot of new Spanish dolomites from Navarra. Crystals 1 to 8 cm, some on matrix, were available. As is typical for this occurrence, the crystals are white to gray and translucent, sometimes nearly pearly, in lustrous, very lightly striated rhombohedrons and twinned rhombohedrons.

Another very fine batch of marcasite crystals and groups from Misburg, West Germany, was available in the booth of Rohsteinquelle (Postfach 12-2150, D-6580 Idar-Oberstein 2, West Germany). These are collected from an undisclosed quarry which normally yields limestone for making portland cement. The crystals, which are extremely sharp and lustrous and up to 3 cm in size, are freed from enclosing limestone by acid. Exquisite groups with their limestone matrix are

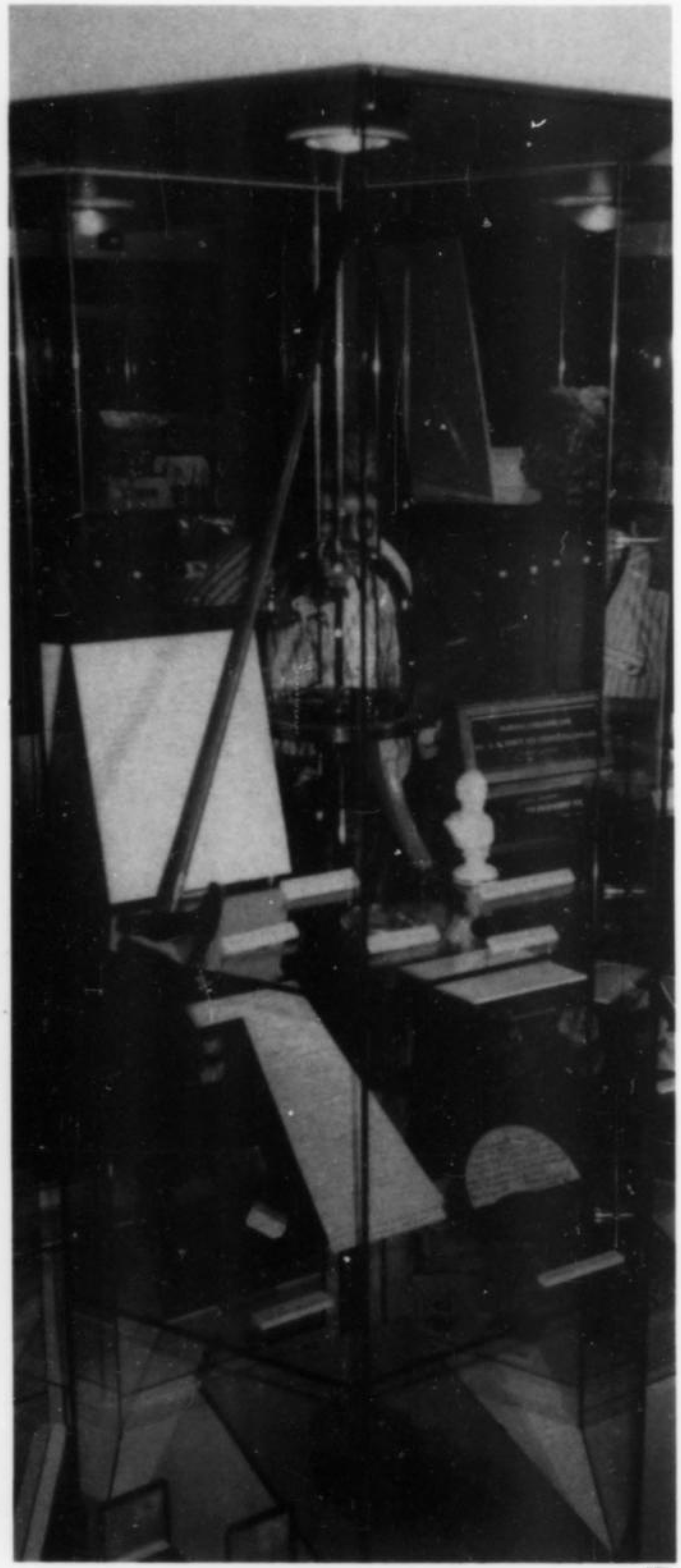

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Figure 9. **Historical materials relating to Friedrich Mohs (1773–1839), including his initialed hiking stick, a contact goniometer, and his original hardness set.**

very aesthetic and reasonably priced. The crystals also appear to be relatively stable; specimens purchased several years ago show no sign of the disintegration or tarnishing that has been known to afflict the marcasites from some other localities.

Some interesting new specimens were available from the Soviet Union, being sold directly by Moscow's Fersman Mineralogical Museum via a small booth space at the show. Fersman curator Dr. Leo Bulgak himself was there to give background data on the specimens. (Dr. Bulgak is pictured at top-right on page 38 of the recent *Mineral Museums of Eastern Europe* issue, standing on the *left*, along with the late Dr. Victor Stepanov.) It was a pleasure to see the Soviets benefitting from the recent relaxation of restrictions on travel, and to visit and *sell* at a major Western mineral show. (In fact, there was even some discussion about trying to organize some type of mineral show in Moscow!) As to minerals, there were some interesting titanite specimens from Dodo in the Ural Mountains, lustrous brown twins to 1 cm on matrix. From the same locality were some fine, lustrous, blue anatase crystals to 3 mm. The classic dioptase locality at Altyn-Tyube, Kazakhstan, has produced some nice specimens as recently as last June, as equant crystals up to 4 or 5 mm thickly sprinkled on dark matrix. Some sharp, dark brown andradite crystals in dodecahedrons to 2 cm were collected about two years ago near Dashkesan in the Caucasus. Some nice cabinet pieces of vivianite in dense acicular groups on matrix have come from the Crimea. And several large and beautiful heliodor (beryl) crystals from Wolodarsk were available (exported legitimately).

Of course there were thousands upon thousands of other fine specimens for sale at such an enormous show, and only a few can be mentioned here. Many fine golden barite crystals and groups from the Pohla mine in East Germany were available, as well as many Yukon phosphates collected during the recent field season. Moroccan vanadinites, in any significant quality and quantity, were generally scarce. Mohler Mineralien (Am Bründlbach 13, A-8054, Graz, Austria) had many rare and expensive mineral and mining books including an 18th-century history of Schneeberg (for about $3300). Book dealers, magazine publishers (including the *Mineralogical Record*), many fossil dealers, postage-stamp dealers and lapidary dealers rounded out the commercial establishments represented.

Now to the special exhibits. These were comprised of 54 vertical display cases, each of them hexagonal in cross-section, about 30 cm on a side and over 2 meters tall, with 4 interior shelves. Each case was labeled as containing items from particular private and public collections of the last four centuries. The oldest collection represented was that of Archduke Ferdinand of Tyrol (1529–1595).

Some highlights: a cabinet specimen of pyrolusite about 15 cm across, with individual, slightly divergent prismatic crystals to 3.5 cm, from Ilfeld, East Germany (Kremsmunster Museum, founded 1761). A 13-cm group of 2-cm green pyromorphite crystals from Bad Ems, West Germany (collection of Adam August Krantz, 1808–1872). Original specimens from the Mineralogische Staatssamlung München which were illustrated by the artist Claus Caspari (1911–1980) in his beautiful collection of plates entitled *Mineralien*, including lorandite, Madagascar spinel, a 6-cm Freiberg proustite and a large English barite. An 8-mm octahedral diamond in matrix from Kimberley, South Africa, and a group of perovskite crystals to 2 cm on an edge, from the Ural Mountains (Franz von Kobell collection, 1803–1882). A classic specimen of 2.5-cm Chessy azurite crystals on a 10-cm matrix, and an excellent galena on matrix from Neudorf, East Germany (Archduke Johann of Austria, 1782–1859). The initialed *Bergstock* or Alpine walking stick with steel axehead owned by Friedrich Mohs (1773–1839), and his *original* hardness set of specimens. And beryl crystals from Volin, Ukraine, and Adun Chilon, Siberia (Fersman Museum, Moscow).

With regard to these special exhibits, I have saved the most surprising by far, for the last. Approximately 160 specimens from the collection of Vladimir Andreevich Pelepenko were on display at the center of the special exhibits room. Pelepenko is probably the leading private mineral collector today in the Soviet Union. He began collecting in 1971, and his specimens now total roughly 2500. His work at a research and development facility in the city of Sverdlovsk, close by the Ural Mountains, placed him in an ideal position to collect at various Uralian mines a few tens of kilometers north of Sverdlovsk. Pelepenko himself accompanied the specimens to Munich this year . . . his first visit to the West, and surely the first such trip for any Soviet mineral collector/exhibitor.

The Pelepenko specimens were unfortunately not labeled, but most were from mines near Sverdlovsk. They revealed a highly refined aesthetic sensibility, and remarkably skillful field collecting . . . damage of any kind was almost non-existent. Most are small to large cabinet size, and are slightly reminiscent of the very best specimens from the Naica, Charcas and Santa Eulalia districts of Mexico. It was a stunning experience for knowledgeable Western collectors to survey so many superb specimens of so many different species, and yet, as to locality, recognize *none* by their habit. Some examples: no less than 16 specimens of lustrous pyrrhotite crystals, mostly 5 to *15 cm each*, as singles and groups associated with attractive quartz, sphalerite, galena and chalcopyrite. A colorless, water-clear crystal of euclase 2.3 cm across, nicely perched on matrix. Tetrahedrite crystals to 6 cm, with chalcopyrite. Lustrous arsenopyrite crystals to several centimeters, as singles and groups. A wide range of fine calcite specimens, perhaps three dozen pieces, some with very large crystals, and with colors ranging from white to yellow and bright pink. Sperrylite crystals (modified cubes) to 1.3 cm, in matrix . . . I counted nearly a dozen more crystals in the 4-10 mm range in this one miniature.Single chalcopyrite crystals to 6 or 7 cm. A 5-cm group of beautiful purple-lavender creedite crystals. Fine and large galena, sphalerite, copper, pyrite and ilvaite. And a spectacular array of fluorites including water-clear and colorless cubes (to 5 cm on edge), transparent green cubes (to 10 cm on edge), colorless cube/dodecahedron crystals (to 3.5 cm), purple octahedral crystals (to 5 cm on edge) in fine groups, green octahedral crystals (to 5 cm on edge) with milky quartz, and blue cubes (to 5 cm, on a 15-cm matrix) associated with dozens of bright red cinnabar twins to 1 cm! All, as I said, are virtually undamaged. It was quite a sight.

One memorable evening we dined with the Russians (Pelepenko and Dr. Bulgak), the curators of the Vienna Museum of Natural History (including Dr. Gerhard Niedermayr), Dutch dealer Ben DeWitt, Polish-Russian dealer Anna Chrapowicki, American dealer Bill Larson and others. With some help from Anna and Ben as translators, we talked about the precious nature of mineral specimens, the common passion for minerals which unites collectors of distant countries, the fact that we are all only temporary custodians of the specimens that will be handed down to our children and grandchildren, that the exchange of fine specimens between true collectors is often a transaction of the heart more than of money. It became clear that in our passion for minerals we were far more alike than different. In fact, it turned out that most of us at the table had begun our collecting lives with an agate, a small fact symbolizing some universal similarities.

With luck (and the survival of *glasnost* permitting) we will be seeing much more of the Soviets at Western mineral shows, and more Soviet minerals on the world specimen market. This would have been impossible only a short time ago, but today there is developing a new and unprecedented opportunity for a broad increase in our communications with Soviet collectors and mineralogists. According to Pelepenko, there are at least 100 serious mineral collectors in the Soviet Union; field collecting regularly turns up an increasing number of fine specimens as mine operators become better informed and indoctrinated to the value-system of mineral specimens. How similar, too, is the struggle between collectors and mine operators in every country!

As a final note on the show, commendation must be given to Johannes Keilmann's editor, Max Glas, for assembling a truly book-quality show program . . . 176 pages devoted in large part to the history of mineral collecting. This catalog is certainly one of the finest reference works ever published on the subject. It includes no less than 34 biographies of famous collectors, many articles on pertinent subjects by authoritative authors, fine illustrations (many in color) and elegant graphic design.

The 1989 Munich show will be held October 27-29. For more information (and for trade-show passes) write to Johannes Keilmann, Münchner Mineralientage Fachmesse GmbH, Hahilingastrasse 15a, D-8024 Oberhaching, West Germany (telephone from the U.S., 011-4989-613-4711).

NAICA FLUORITE; ARKANSAS QUARTZ TWIN

[The following notes were kindly supplied by Evan Jones, *Bitner's*, 42 W. Hatcher Rd., Phoenix, AZ 85068.]

A new find of pale green, cubic fluorite on lustrous galena has recently surfaced from Naica, Chihuahua. Some of the specimens we've obtained are world-class caliber. One piece consists of a domed grouping of bright, undamaged galena 33 x 38 cm, studded with three 8-cm cubes of fluorite and numerous smaller cubes. Bob Jones considers this to be the finest Mexican fluorite he's ever seen. A somewhat smaller but equally choice specimen was also found, consisting of a 10-cm stepped cube on bright galena. Apparently a fair amount of material was recovered, although I have not seen it all. A number of dealers, including Gene Schlepp, have obtained portions of the lot.

A remarkable Japan-law quartz twin has recently been found in Arkansas, at Mt. Ida, and may be the only such twin known from the state. It measures 8 cm from tip to tip, with individual crystals to 5 cm. It is typically flattened and intergrown in the area of the contact plane. It was collected by Ken Manley at the Manley Quartz mines in the spring of 1988 (and is now at *Bitner's*). E.J.

TOMBSTONE WULFENITE, FLUORITE

In August of last year Peter Megaw and Jim Walker discovered a pocket of wulfenite at an undisclosed mine in the Tombstone district, Cochise County, Arizona. Tombstone has historically been a source of some wulfenite, but not for many years, and specimens have been quite scarce. Ten to twelve flats of very good specimens, plus another 16 flats of lesser material were removed. This latest discovery includes a fairly wide range of habits, from square tabular and lustrous to octagonal and also to composite crystals more or less identical in appearance to some Moroccan material. Color is generally bright yellow to orange, with some crystals verging on red, or with red-zone centers. Most of these are very lustrous, almost adamantine, and they sparkle beautifully. Crystal size is typically up to about 1 cm, but a few crystals including some loose singles measure up to about 2 cm. Many thumbnails but also a few nice miniatures and a fair number of fine, small cabinet pieces were recovered in the lot.

Associations are generally limited to mimetite in greenish to reddish balls up to 4 or 5 mm, and as powdery pale yellow coatings on matrix. (See Sid Williams' article on the Tombstone district in vol. 11, no. 4, page 251–257; he mentions the Empire, Emerald and Grand Central mines as sources of fine wulfenite.)

From another unspecified mine at Tombstone, Megaw and Walker found some interesting fluorite specimens, pale gray-green to purple, in cubes 1 to 2 cm across. The cubes have "rounded" edges and corners which, upon close inspection, consist of many tiny cubic stair-steps. Some specimens have yellow-orange wulfenite microcrystals liberally sprinkled over them. Most pieces are small cabinet-size, about eight flats of specimens total.

MEXICAN MIMETITE

Back in 1978 the El Potosi mine, Santa Eulalia district, Chihuahua, Mexico, yielded some very fine and large groups of yellow mimetite. (A good example is pictured in vol. 11, no. 4, pages 237, labeled Santo Domingo mine.) These are probably the finest mimetites Mexico had produced, consisting of thick bundles of nearly distinct crystals, rather than simple botryoidal growths. Now this same locality has yielded roughly 200 more fine specimens of identical character, taken from a pillar which no doubt had preserved part of the original occurrence. Specimens range from thumbnail to cabinet size. Peter Megaw (340 S. Columbus, Tucson) has nearly all of these; perhaps a dozen specimens reached other dealers in the area. W.E.W.

Congratulations to the *Tucson Gem & Mineral Society*, recipient of the 1987 Carnegie Mineralogical Award!

The Carnegie Mineralogical Award was established in 1987 to recognize outstanding contributions which "promote mineralogical preservation, conservation and education. The Award is open to individuals, groups, organizations, or institutions—thus private mineral enthusiasts, collectors, educators, curators, mineral groups or societies, as well as museums and universities, are eligible." The Award carries with it a $1500 cash prize, a certificate of award and a cast bronze medallion that will be awarded each year during the main Tucson Show. The *Mineral Museums Advisory Council* will be administering the Award and overseeing the selection process.

Please plan to attend the presentation of the **1988 Carnegie Mineralogical Award** during the *T.G.M.S. Awards Ceremony*, 9:00 pm Saturday evening, February 11th, at the Tucson Community Center.

Nominations for the **1989 Carnegie Mineralogical Award** will be accepted until December 31st. If you have a candidate for the Award, please send your nomination to the address below. An official form will be sent to you by return mail. Thank You!

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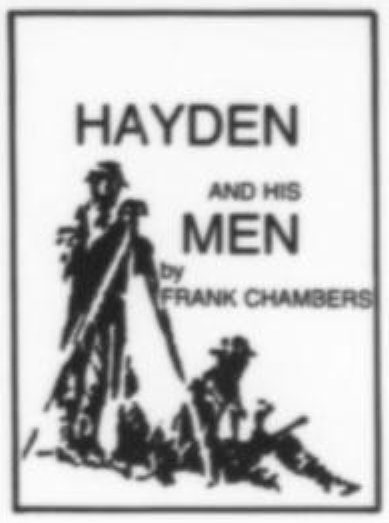
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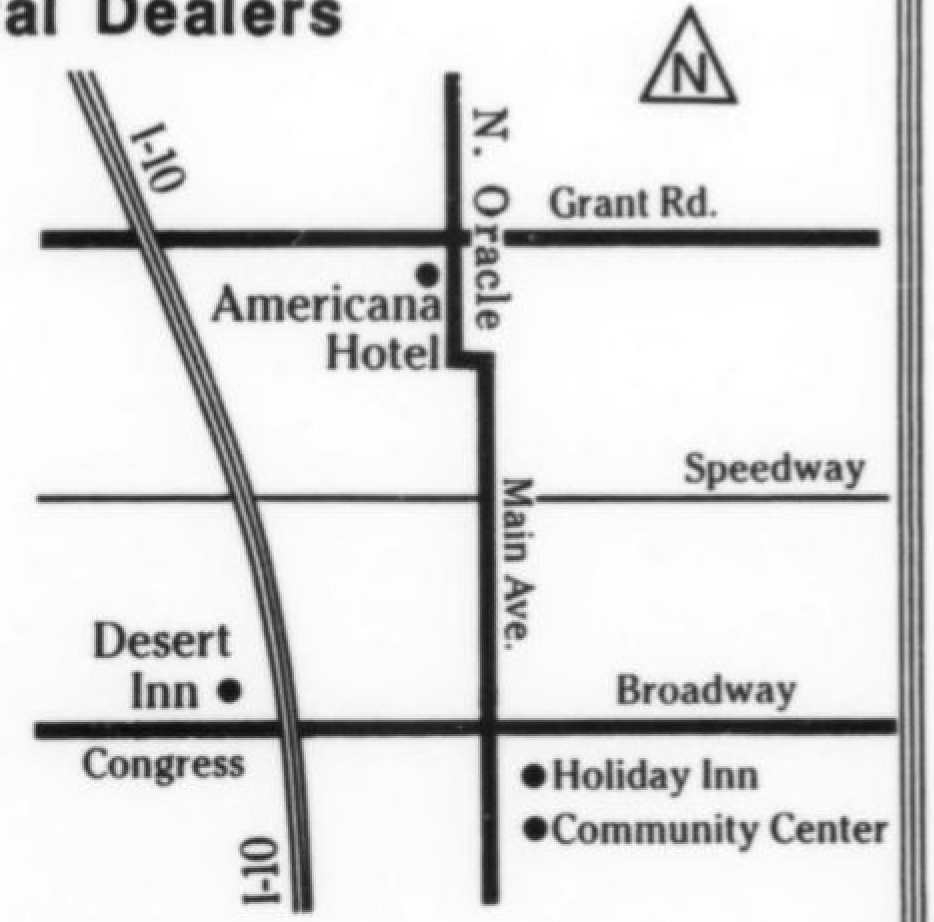

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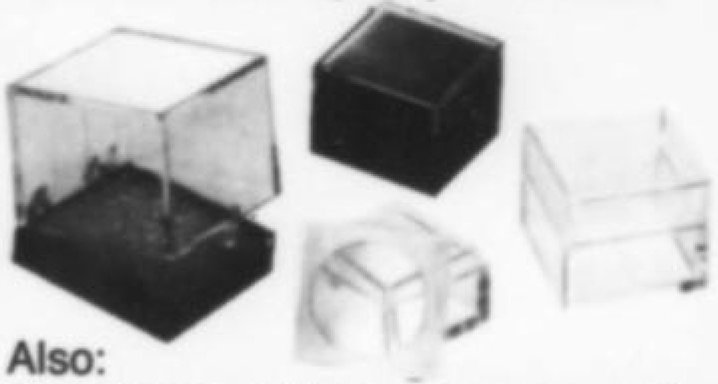

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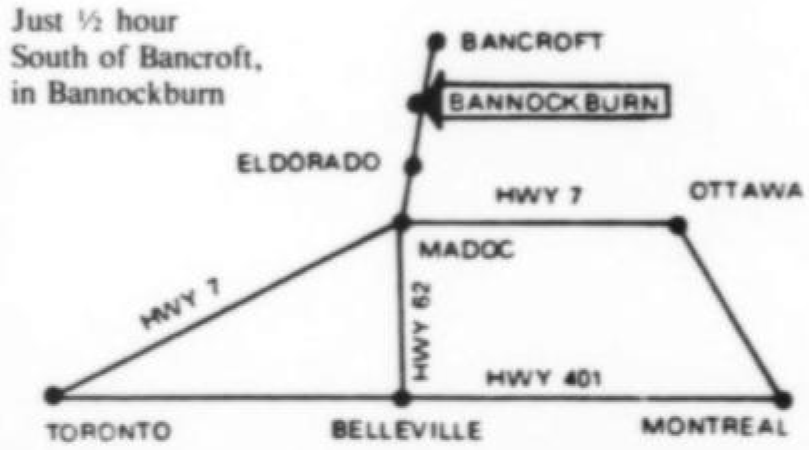

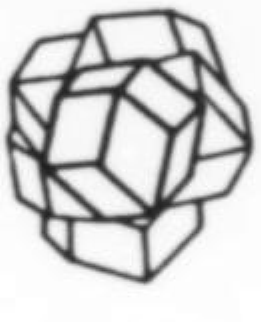

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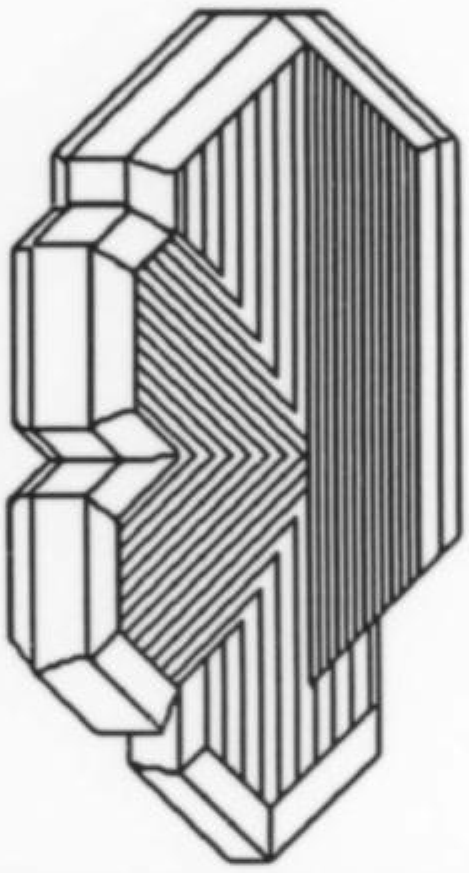

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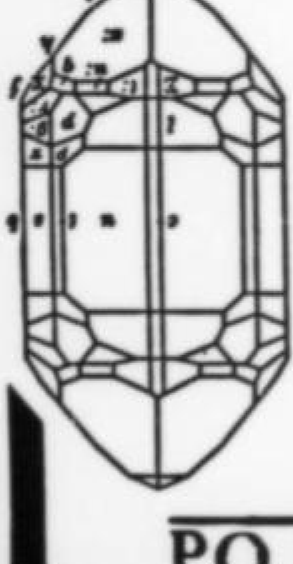

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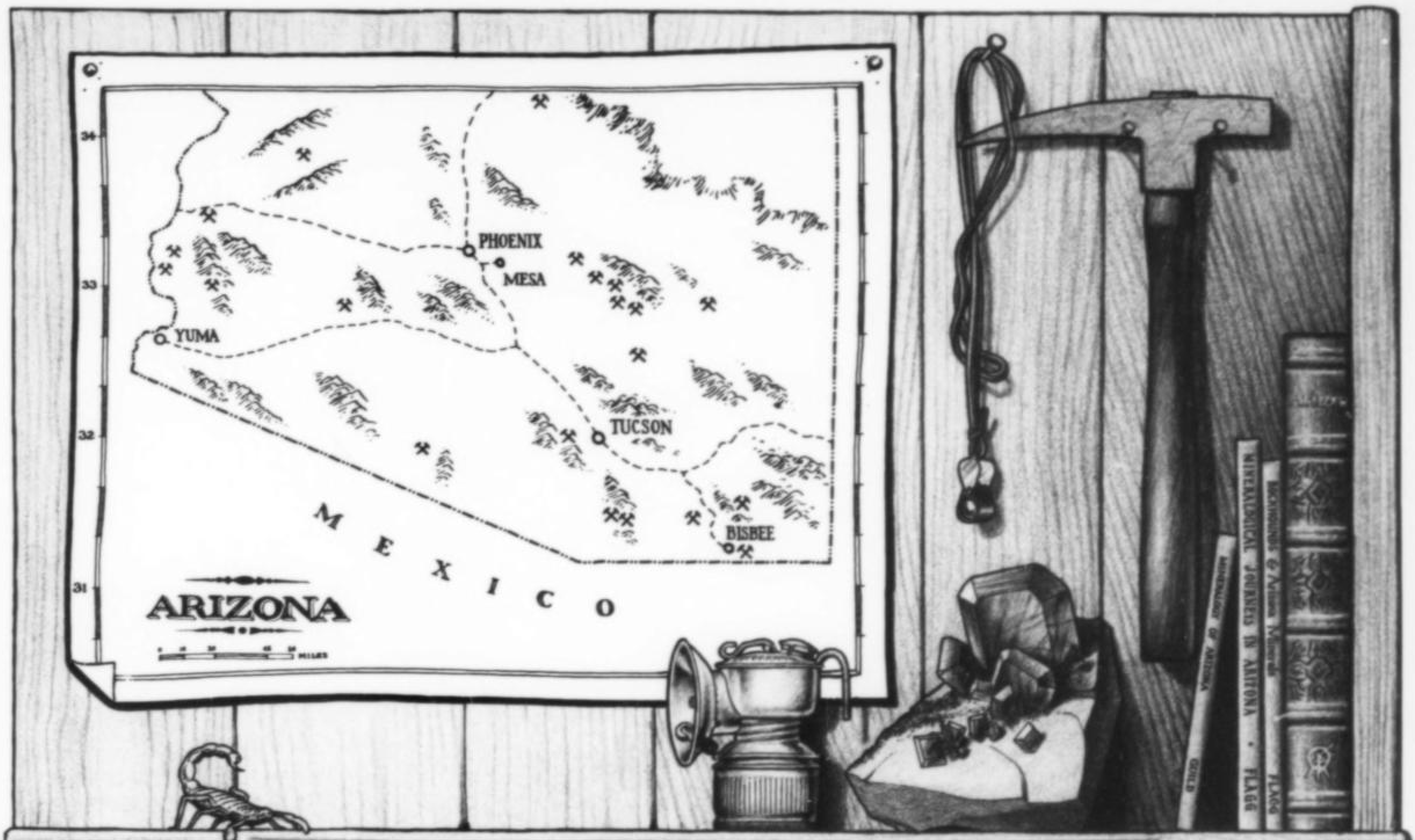

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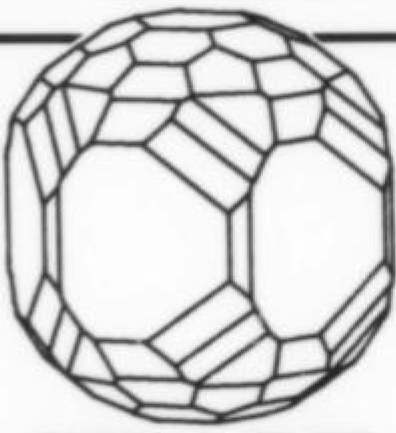

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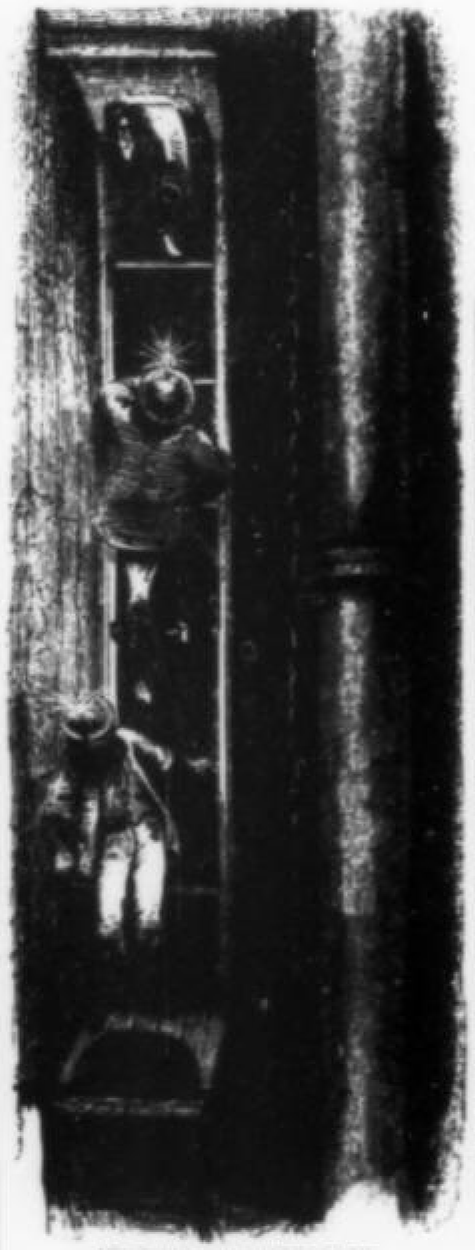

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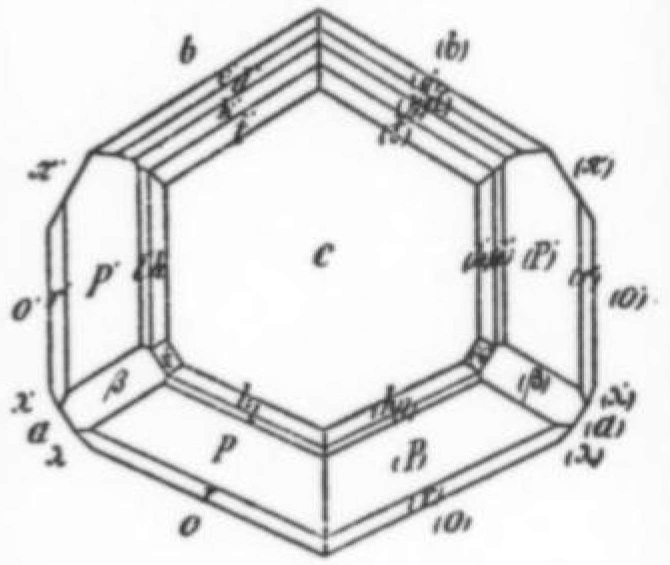

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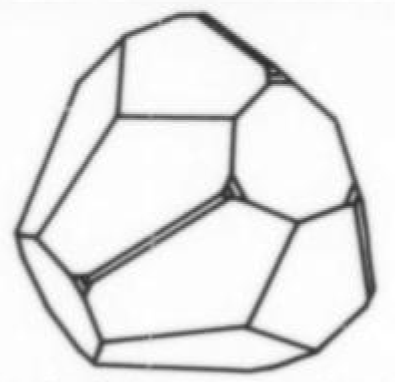

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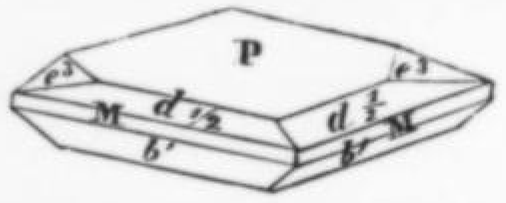

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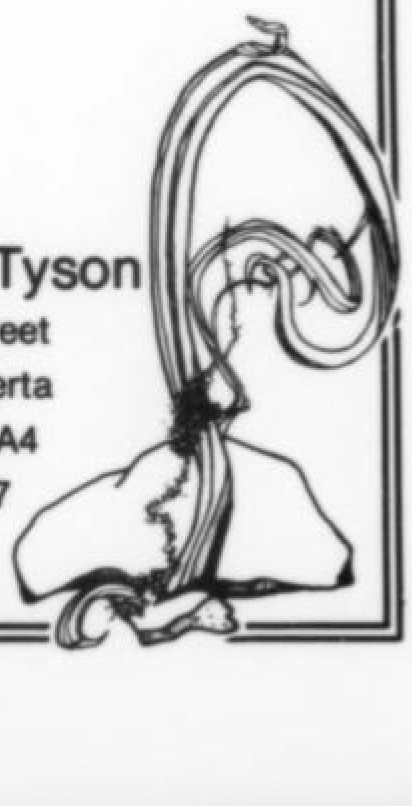

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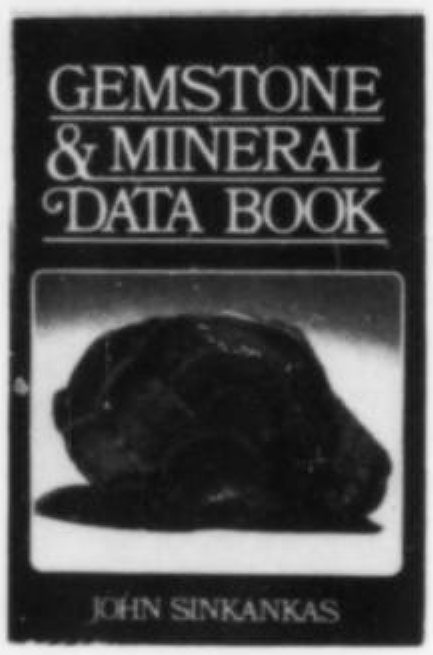

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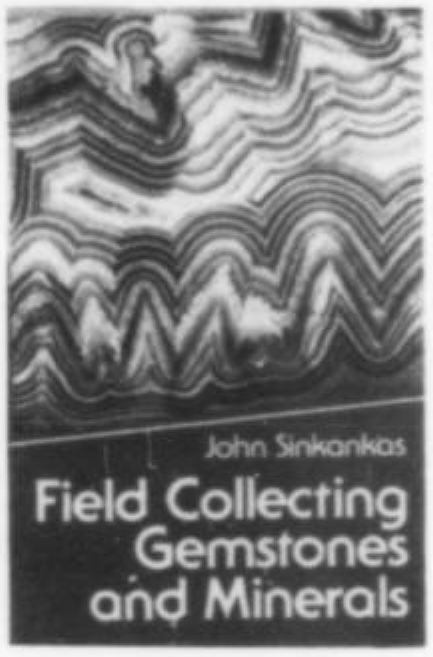

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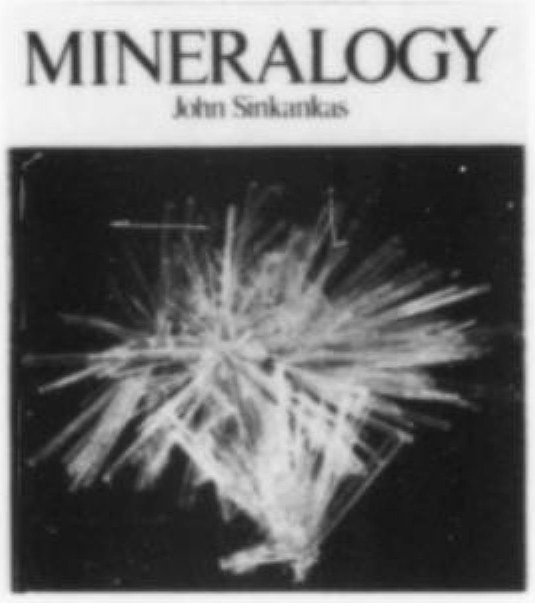

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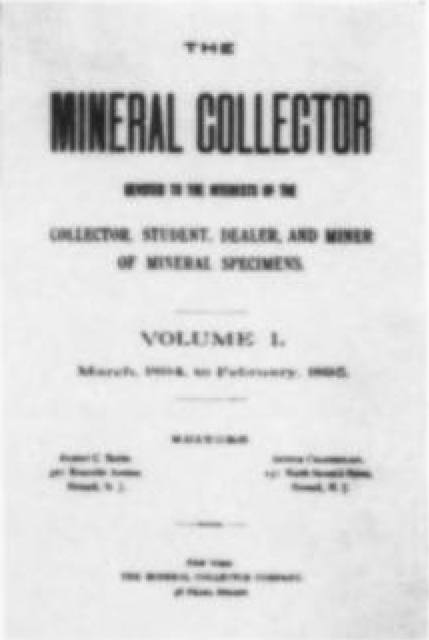

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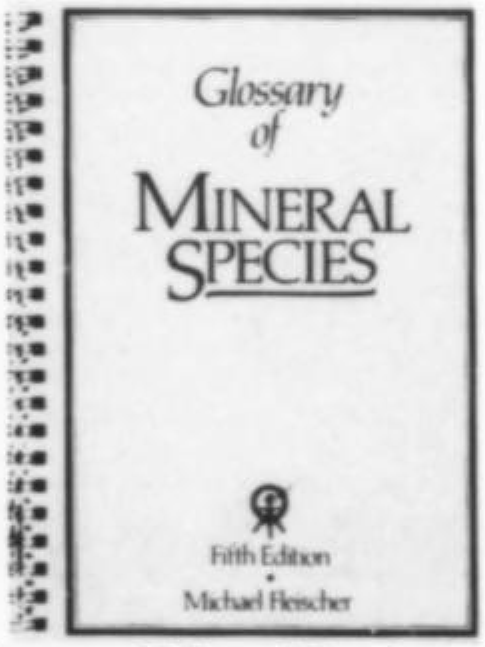

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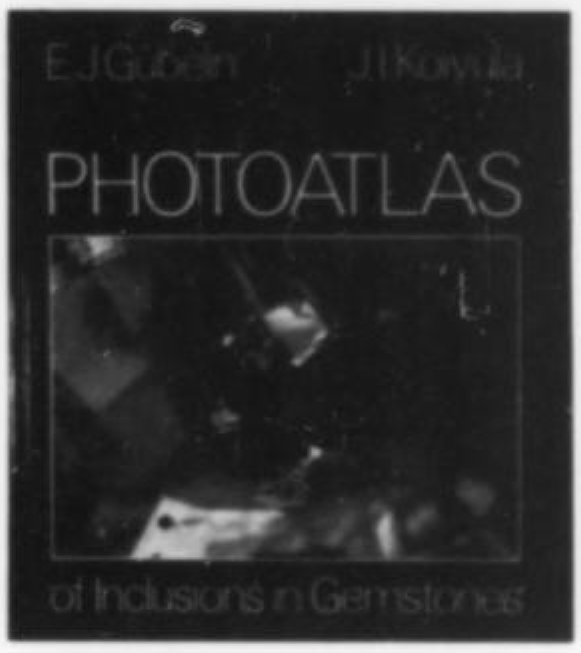

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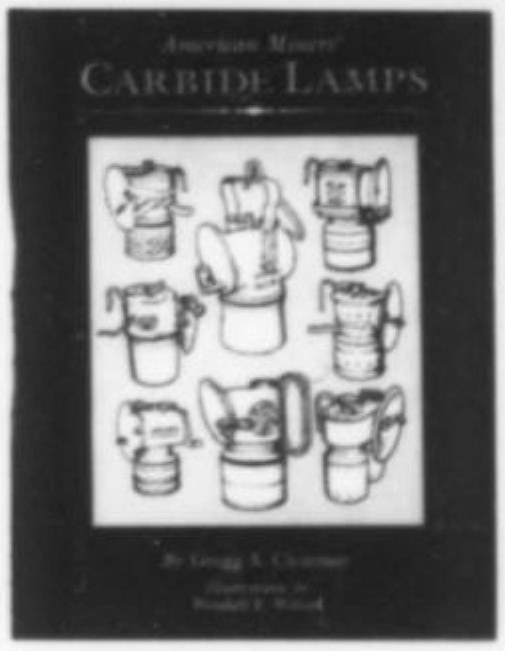

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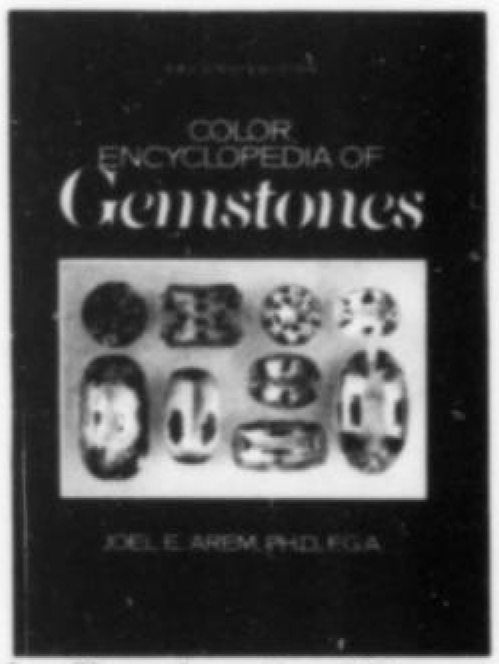

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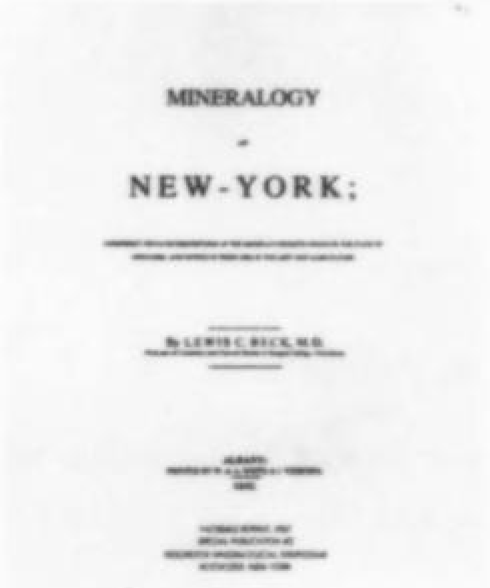

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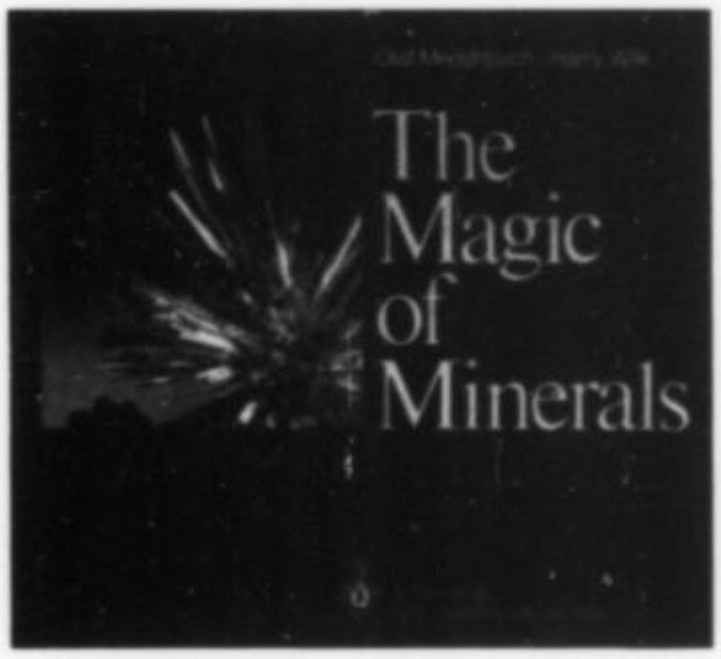

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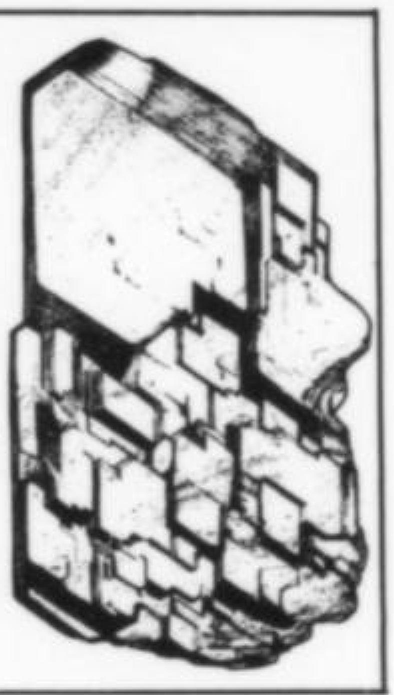

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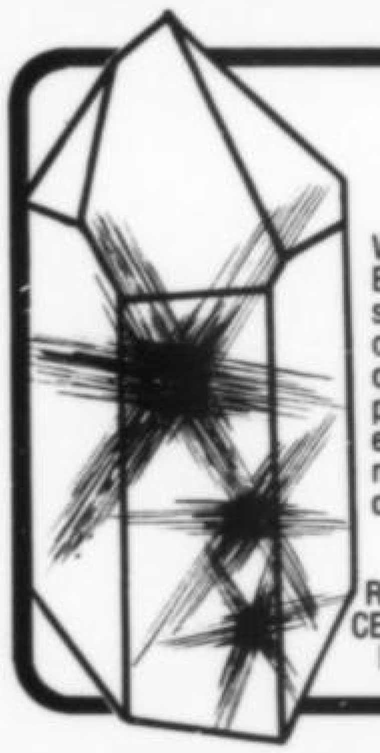

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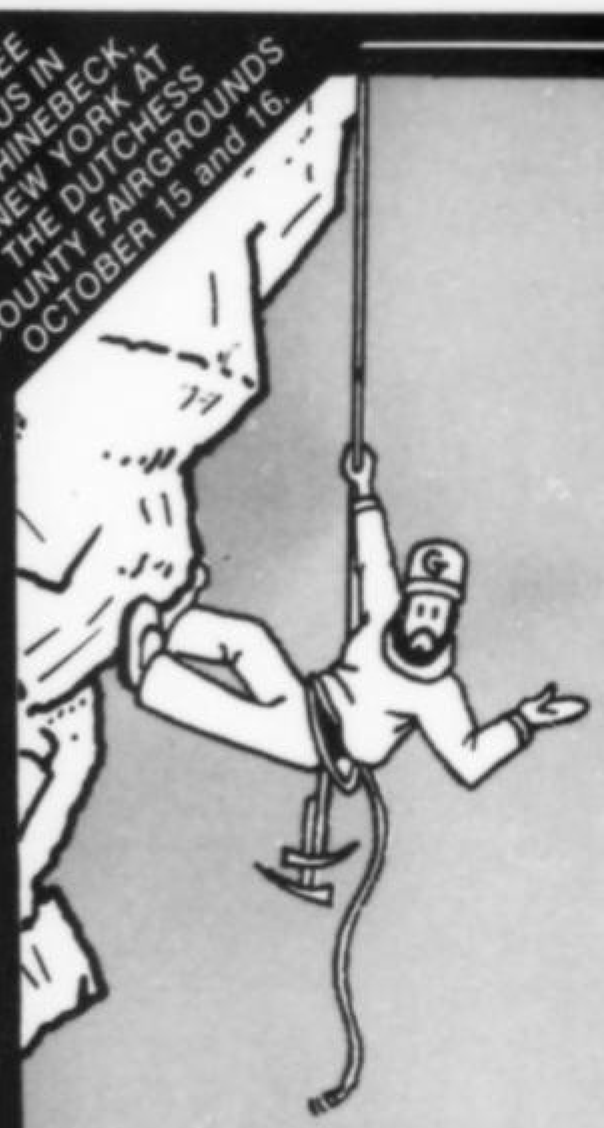

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West Germany
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