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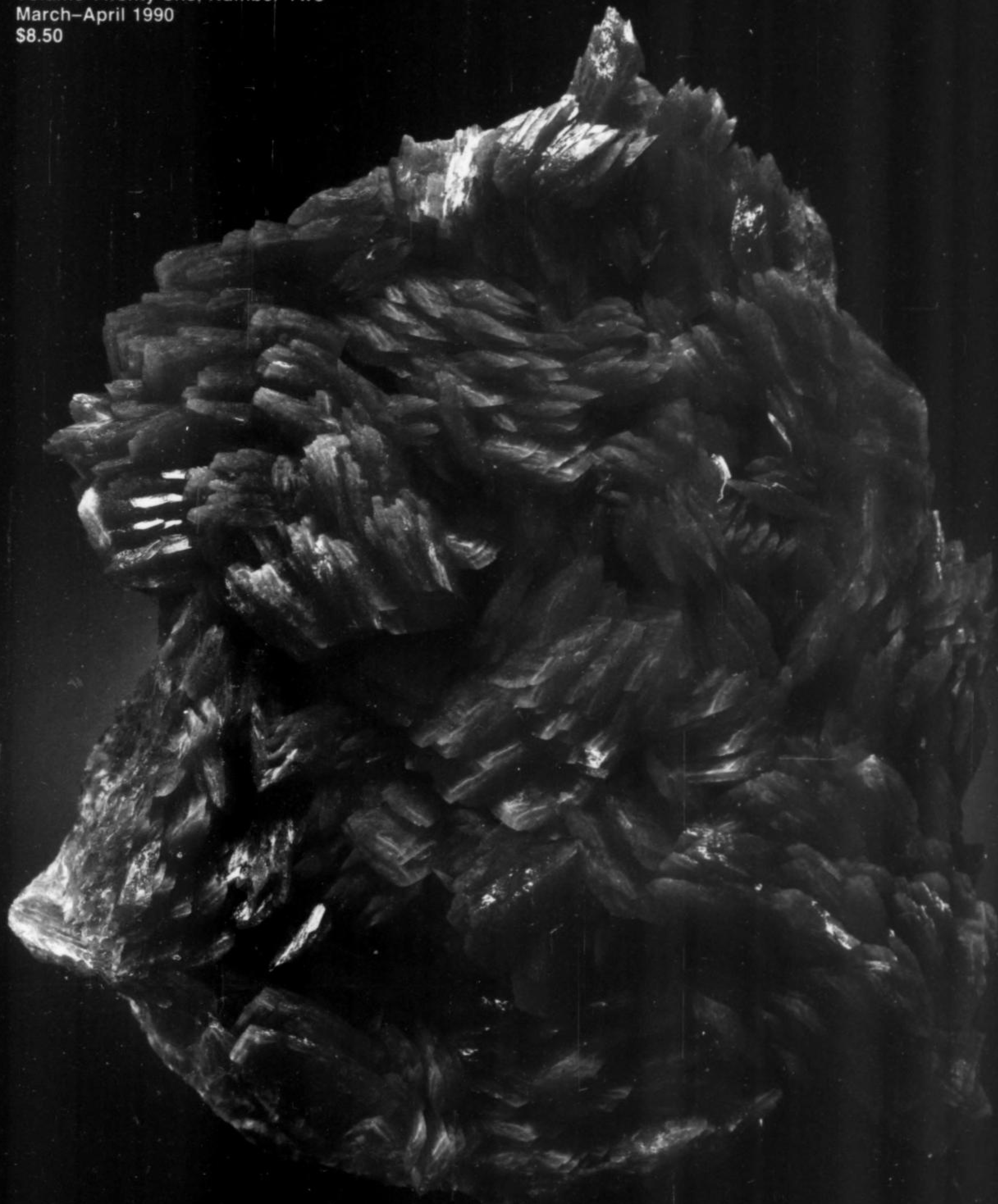


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Articles

Columns

COVER: RHODONITE cabinet specimen, 13 cm, from the Chiurucu mine, Huanuco dept., Peru. Dennis and Dan Belsher specimen; now in the collection of Hyman and Beverly Savinar. Photo by Harold and Erica Van Pelt.

notes from the EDITOR

GOLDSCHMIDT INDEX

Some years ago the *Mineralogical Record* magazine was favored with a gift from F. John Barlow and Forrest Cureton: a complete set of Victor Goldschmidt's *Atlas der Krystallformen*. This work subsequently proved to be of great value to us, as a source of crystal drawings to use as illustrations in articles on famous mineral localities worldwide. The principal difficulty was that Goldschmidt's *Atlas* is arranged alphabetically by mineral species, whereas our need was typically for crystal drawings of any species from a particular locality. Consequently it was necessary to go through all nine volumes of the supporting text, page by page, in order to extract all the drawings representing a specific locality. This was so impractical that it became clear a locality cross-index was needed.

A notice for volunteers published in the *Mineralogical Record* brought seven responses from people willing to help, who each had access to a set of the *Atlas*. Volumes were assigned, and I took one myself. All entries, except those for synthetic crystals, were painstakingly copied out, mineral names translated into English, countries determined where not noted (Goldschmidt assumed a familiarity with European geography that few people today possess), along with the volume, page and figure number for each crystal drawing.

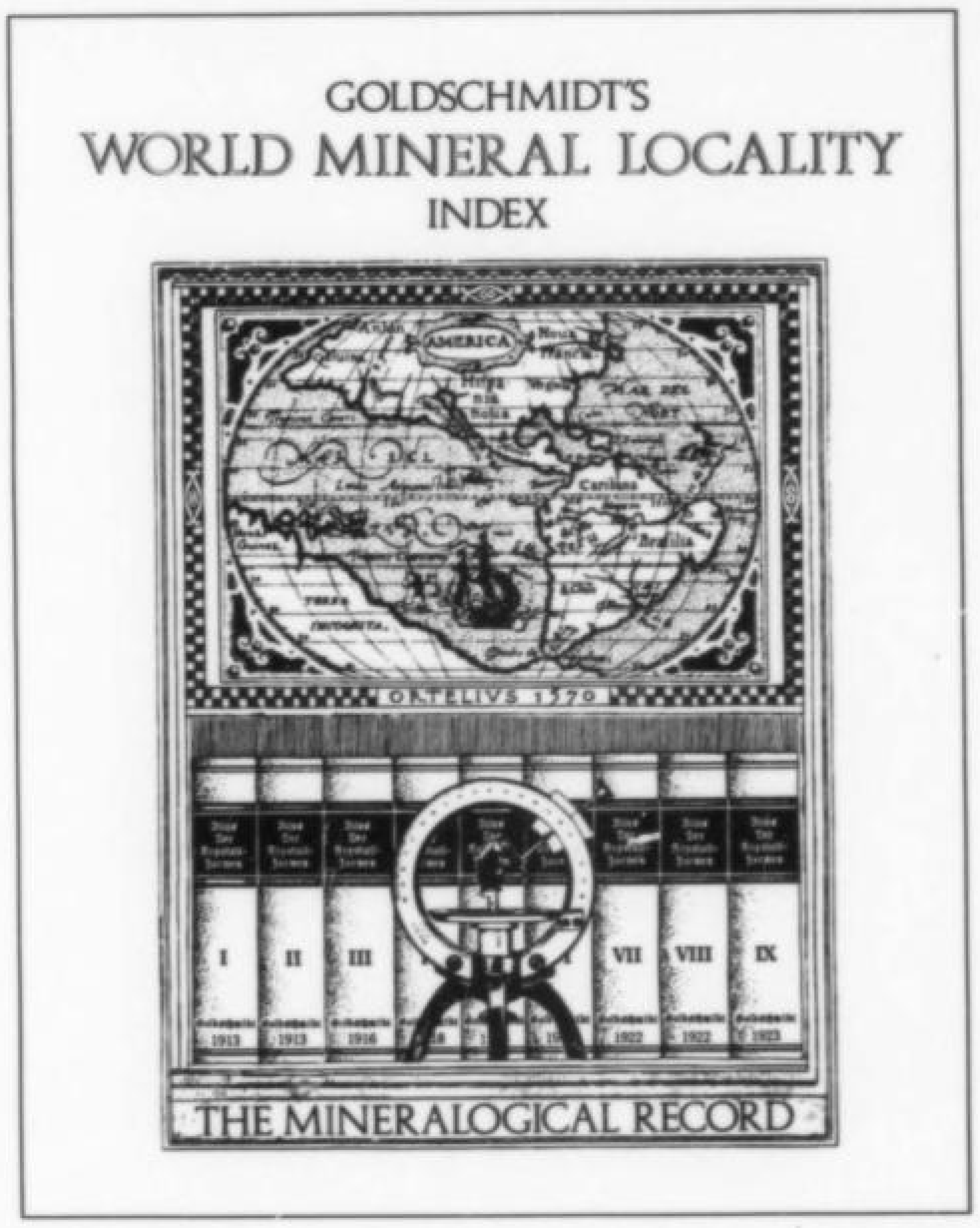
The transcriptions were then entered on computer, were sorted by locality and then edited. The transcription was a surprisingly difficult task. Goldschmidt had a confusing habit of sometimes noting more than one locality for a single drawing; thus, for an entry like "Liederschnitz, Smolenberg Valley," one had first to determine what country they were in, and secondly to determine whether Liederschnitz was *in* Smolenberg Valley, the latter term modifying the former, or whether they were intended to indicate two different occurrences. In a few cases the two (or more) were found not even to be in the same country!

Another problem was the extensive change in European geography that followed the two world wars. A great many locality names are no longer to be found on modern maps, and many occurrences have come to be included in different countries from those noted in Goldschmidt. In general, we indexed according to the original locality name (to facilitate rechecking with Goldschmidt), but using the current country name if possible. (However, the sorting between Hungary, Romania and Czechoslovakia probably needs further updating.) In the case of East and West Germany, which did not exist separately in Goldschmidt's time, there were so many unfamiliar localities that, rather than risk assigning them to the wrong side, we combined them all under "Germany." (Current events may soon render the distinction moot anyway.)

We have by no means solved all the mysteries behind the localities cited in Goldschmidt. Some may be "lost" localities, others may require extensive study of Goldschmidt's original references as cited in his text volumes. Such research was beyond the scope of the index.

Although the index was originally required for internal use by the *Mineralogical Record*, it provides such a comprehensive look at prewar mineral occurrences around the world that we felt it should receive wider distribution. This is particularly true following the recent reprinting of Goldschmidt's *Atlas* by the Rochester Academy of Science, which removed the work from the "rare book" category and gave many readers new access to it. The index by itself is nevertheless a useful reference on mineral localities worldwide, even for readers without access to the *Atlas* itself. Consequently we have decided to publish it as a 48-page softcover book.

A cross-index by locality of Goldschmidt's *Atlas* should naturally be very useful to people involved in the study of the comprehensive mineralogy of specific mineral localities. In combination with Goldschmidt's text volumes, it can provide quick access to the early mineralogical literature on a given locality. But it is unique in its own right for the species lists of the various localities worldwide that produced crystallized minerals before 1923. The lists do not include all those species that were found massive or unsuitable for goniometry,



but probably reflect a major portion of museum and private collection species available for study before that time. Thus it implies something not only of the mineralogy but of the history of specimen availability and of mineralogical research at various localities in the nineteenth century.

As a final note on its usefulness, Goldschmidt himself noted in his preface to volume one that the *Atlas der Krystallformen* "will also be welcomed by mineral collectors and mineral dealers. It will allow them to judge the value and significance of their collections, and will help them make better decisions on new acquisitions." For those who specialize in specific localities, similar benefits may result from this locality cross-index.

Copies are available from the Circulation Manager (P.O. Box 35565, Tucson, AZ 85715) for $10 plus $1 postage. I must express our thanks to Donald R. Cooke, Russell E. Guy, Kenneth L. Keester, Florence LaBruzza, James Shigley, Astrid Smart and Kenneth M. Wilson for their work in transcribing Goldschmidt's original text; and to Richard A. Bideaux for computer assistance.

BOOKBINDING

Subscribers to the *Mineralogical Record* and other journals naturally like to protect their back issues, and the best way to do so is to have each volume hardbound. It keeps individual issues from getting scuffed or lost, and it looks nice on the bookshelf.

Of course there are many ways to have a book bound, from plain and simple buckram to ornate leather. Everyone will have his own preference, with the understanding that a fancier binding will cost more. These days most binderies will charge around $16–$25 for a "standard class A library binding" in buckram; you'll pay more for options like a label patch on the spine, hand-sewing or extra gold bars. Leather binding comes in three general styles: "quarter-calf" (the spine in leather and the boards in paper or cloth), "half-calf" (spine and fore-edge corners in leather) and "full leather." Different kinds and colors of leather can be combined, and the possible variations in tooling (either in gold or "blind embossing") are infinite. Prices for full-leather bindings start around $75–$100 and go up. Buckram, incidentally, lasts and wears longer, in archival terms, than leather.

There are several different methods binderies use to join the separate issues of a journal together before attaching the hard cover over them. It is wise to be familiar with these so you can select the best method for your needs and budget. These include:

1. Perfect binding
2. Micro-notch binding
3. Cleat-sewing
4. Oversewing
5. Double fan gluing
6. Sewing through the fold

Perfect binding consists simply of stacking up one book's worth of individual issues, slicing off their spines, and applying glue to the resulting edge face; only the cut edge of each page touches the adhesive.

Micro-notch binding is an improved variation of perfect binding in which small grooves or notches are cut across the spine, perpendicular to the long direction of the page edges. Glue is then applied under pressure so that it fills in the notches, producing a somewhat stronger binding.

Cleat-sewing is a further improvement in which notches are cut and threads are laid in the notches before the glue is applied. The threads add strength to the binding, but not as much as actual sewing punched through holes.

Oversewing is one of the two strongest methods of binding: the stack of issues, with spine cut off, is stitched through the side of the spine, from front to back, as well as having glue applied to the spine edge as in perfect binding. Unfortunately oversewing does not allow the volume to be opened flat for photocopying or laying open on a desk.

Double fan gluing is a major improvement over perfect binding. The stack of issues, with spine sliced off, is canted or fanned to one side, so that when glue is applied it adheres not only to the page edges but also to the flat surfaces of the pages for a short distance in from the edge. The stack is then fanned in the other direction, and glue is applied to the same edge a second time, before the stack is returned to 90°. This assures that the glue has penetrated between the pages a short distance.

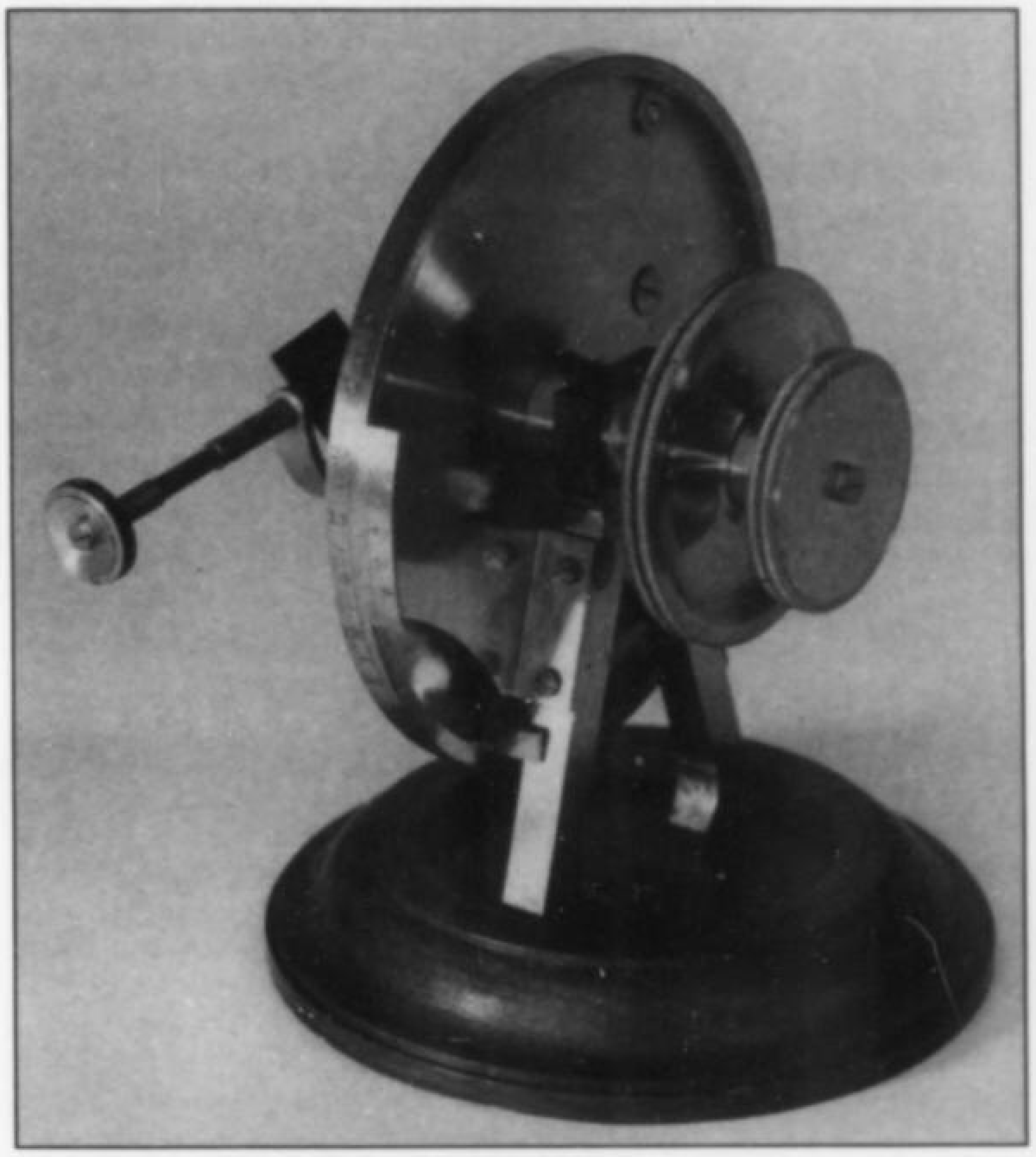
Sewing through the fold is the best method of all because, like oversewing, it relies almost entirely on the strength of sewn threads rather than on adhesive (which can age and crack). And yet the volume can be opened almost flat for photocopying or desk work. Of course, it's also generally the most expensive method, and can only be used on journals that *have* folds, i.e., that are bound in sewn signatures (like the *Tsumeb!* issue of the *Mineralogical Record*) or are saddle-stitched with staples (like this issue). It cannot be used with journals like the *American Mineralogist* and *Gems & Gemology* which are perfect bound individually by their respective publishers.

To find a good local bindery for standard library binding, call the librarian in charge of periodicals at the nearest large university or legal library and ask where they send their journals for binding. Then write or call for rates, binding options available, and a swatch book showing the colors of buckram they stock. Most binderies can also attach "skivers" or spine labels made of very thin, black, red or dark green leather (legal books, for example, are traditionally bound in tan buckram with two or three such spine labels); these can look rather elegant, but must be specifically requested, and there is usually an extra charge. If you like, sketch out a diagram showing the way you'd like the spine to look, indicating labels and label color, buckram color, placement and number of horizontal bars, and precise lettering (bars and lettering can usually be stamped in gold, black or white, or some of each). They will generally do their best to duplicate your sketch. If you want them to match the binding of an earlier-bound portion of a set of books or journals, include a sample bound volume for comparison.

Many binderies are accustomed to removing and discarding journal covers and advertising sections before binding. If you **don't** want them to do this, be sure to wrap up your journals by volume and write "bind as is—do not remove covers or ads" on the wrapper.

Good binderies specializing in antiquarian restorations and handcrafted leather bindings are difficult to find. The best I know of is Allan ("Skip") Carpenter, Green Dragon Bindery, 265 Boylston Street, Shrewsbury, MA 01545. You've seen examples of his work in many of the *Kristalle* ads on the inside-front cover of the *Mineralogical Record* over the years. But don't be reluctant to investigate local craftsmen as well. There are some excellent custom binderies around the country and in Europe, especially Scotland. Prices can vary quite a bit. Do a lot of asking around before sending your best treasures off to be expensively bound.

In any case, whatever your taste or budget, try not to put off binding. It's money well spent, which will add to your enjoyment of your personal library while preserving it for later generations.

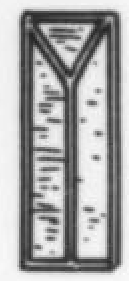


THIRD GONIOMETER REPLICA

Uli Burchard (Schlosstrasse 6, D-8050 Haindlfing Freising, West Germany) has in recent years commissioned replicas of two different models of antique goniometers, pictured in vol. 19, p. 2 and vol. 20, p. 100. These are fully functional display pieces which lend elegance to any exhibit case or den/office decor. Now he has announced a third model, examples of which he plans to bring to the September Denver Show (see photo). The price of this one is expected to be around U.S. $1,000. Production is always limited to a small number, so be sure to let him know soon if you think you might like to purchase one.

CRESTMORE REOPENED

The Jurupa Mountains Cultural Center has announced that collecting trips to the famous Crestmore quarries in Riverside County, California, will once again be permitted. Recent blasting has reportedly opened up new exposures of the rare contact-metamorphic minerals for which the quarries are known. Visits must be scheduled exclusively through the Jurupa Mountains Cultural Center (7621 Granite Hill Drive, Riverside, CA 92509), at least one month in advance.



ATACAMITE PIN

The Mineralogical Society of South Australia has issued a burnished copper lapel pin in the shape of an atacamite crystal from the famous Moonta mines (source of the world's finest atacamite; see vol. 19, no. 6, p. 407). Atacamite has been chosen by the society as their emblem, hence the pin. According to John Toma, editor of the society's bulletin, the pin was deliberately designed without wording, and has proven to be quite a conversation opener because of the curiosity it causes. Anyone interested in minerals is invited to wear the pin, which is available for U.S. $10 postpaid from the Secretary, South Australian Mineralogical Society, G.P.O. Box 1089, Adelaide, South Australia 5001, Australia. Most of the profits from sales of the pins will go toward the purchase of mineral specimens by the society for donation to Australian museums.

VICTOR GOLDSCHMIDT *and his* ATLAS OF CRYSTAL FORMS

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The science of crystallography, before the discovery and application of X-rays in 1912, was based entirely on crystal morphology. Since the time of Haüy and Romé Delisle, whose groundbreaking works of 1772, 1783, 1801 and 1809 virtually invented crystallography, it was hoped that crystal structure might eventually be understood if enough raw morphological data could be accumulated. This was a vain hope; a true understanding of crystal structure was impossible to achieve until X-ray crystallography allowed mineralogists to actually "see into" minerals rather than merely observe the surface expressions of their structures.

Unaware that the morphological approach was inherently limited in what it could reveal, and spurred by curiosity, nineteenth century mineralogists meticulously measured and drew every reasonably well-formed crystal they could find or borrow. Carefully constructed, sometimes idealized crystal drawings rather than specimen photographs were the standard illustrations in all professional and technical mineralogy published for over a century. The result, in total, was a remarkably thorough documentation of crystal habits and their localities.

Unfortunately, these crystal drawings were scattered throughout the world's mineralogical literature, in the journals and books of many languages. Someone was needed to pull them all together.

Victor Goldschmidt was born the son of a well-to-do family in Mainz, Germany, in 1853. He entered the mining academy at Frieberg and, after his graduation, stayed on for a time as an instructor in assaying, metallurgy and blow-pipe analysis. Following graduate work at the universities of Munich, Prague and Heidelberg, he was awarded his PhD in 1880.

Goldschmidt worked with Aristedes Brezina at the University of Vienna from 1882 to 1887, where he became interested in morphological studies. Returning to Heidelberg in 1888, he submitted a paper on graphical and projection methods of producing crystal drawings. In 1893 he was made associate professor, and later became an honorary full professor.

In the same year that he returned to Heidelberg, Goldschmidt married Leontine von Portheim, also of a wealthy family, whose large dowry enabled him to work with little help from the University. In 1916 they established the Victor Goldschmidt-Institut für Kristallforschung.

Together with E. S. Fyodorov in St. Petersburg and Paul von Groth in Munich, Goldschmidt was considered as the founder of "modern" (albeit pre–X-ray) crystallography. His contribution centered on the complete indexing and recording of mineral crystal forms, the gathering together of all previously published morphological studies, the improvement of existing instruments for crystal measurement, and the inventing of new ones such as the two-circle goniometer. In his instrumental work he was assisted by a skilled technician and craftsman named Stoe, whose goniometers (marked "P. STOE HEIDELBERG") are even today functional and beautiful collector's items; one is pictured on the cover of the January-February issue.

Goldschmidt's three outstanding works, *Index der Krystallformen der Mineralien* (1886–1891), *Kristallographische Winkeltabellen* (1897), and *Atlas der Kristallformen* (1913–1923), are milestones of science which are still useful despite the present-day concentration on X-ray crystallography. In addition, Goldschmidt published more than 100 papers on the crystal forms of various minerals, and also some interesting articles and books on harmony in music theory, a subject which he found to be philosophically related to crystallography.

Goldschmidt's *Atlas*, the first volume of which was published the year after Von Laue's breakthrough in the application of X-ray diffraction, came at an ideal time to summarize for future generations the work of an era in mineralogy. Certainly crystal drawings have continued to be published in the X-ray era, but in greatly reduced and ever dwindling numbers. Few mineralogists today are skilled in their preparation. Generally only new mineral descriptions now carry crystal drawings, and in minimum number due to the ability of scanning electron micrographs to so accurately show the non-idealized crystal habits of minerals. On the other hand, computer programs for crystal drawing developed in the last few years have brought this nearly lost art back from the brink of extinction, and have made it available to almost everyone, thus giving Goldschmidt's work new relevance.

***Figure 1.* Victor Goldschmidt posing dressed as a medieval miner during his student days in Freiberg around 1880. Photo courtesy of the Mainz Natural History Museum.**

The *Atlas* is indeed an impressive and even daunting mass of data and figures. Combining his own work with that of all previous crystal morphologists, Goldschmidt assembled 23,606 crystal drawings representing 669 mineral species. These he published, over an eleven-year period, as nine volumes of figures and nine volumes of related text, 3,448 pages in all. The ten most common species account for a third of all the crystal drawings: calcite (2,544 drawings), quartz (855), barite (739), pyrite (691), orthoclase (633), diopside-augite (575), topaz (541), cerussite (478), anglesite (460) and hematite (413). The just-published cross-index by locality (see Notes from the Editor in this issue) reveals some other interesting statistics, such as the most examples of a single species figured from one locality (calcite from Derbyshire, England; 466 drawings), and the largest number of different species from a single locality (Mt. Vesuvius, 63 species).

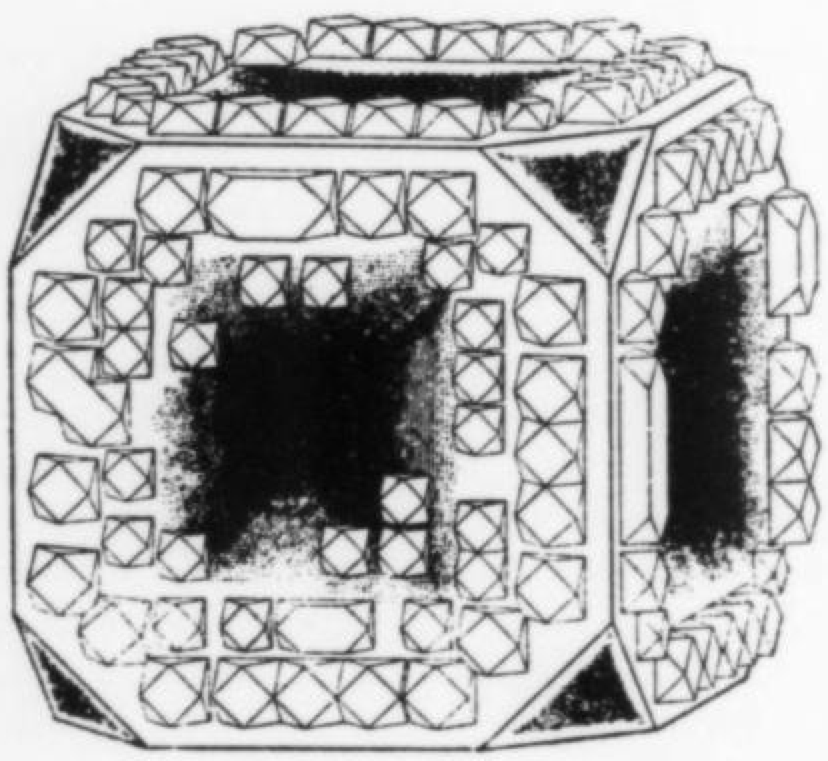

***Figure 2.* One of the 691 pyrite drawings in Goldschmidt's *Atlas,* this one from the Isle of Skye, in Scotland, originally published in Heddle's *Mineralogy of Scotland* (1901).**

Not only does Goldschmidt's *Atlas* preserve crystal drawings from the early mineralogical literature which may be very difficult to locate today, it also preserves data on specimens which may long ago have been lost or destroyed. In his preface to volume one, Goldschmidt made this comment:

> Crystals differ with every place of discovery, and when the occurrence is exhausted, the crystals are like extinct animals, sometimes remaining in collections or vanishing completely. They are represented now by the descriptions and studies of authors who had knowledge of them. Their written records are pathfinders for the young and, at the same time, memorials to the achievements of this science's founders, who must not be forgotten.

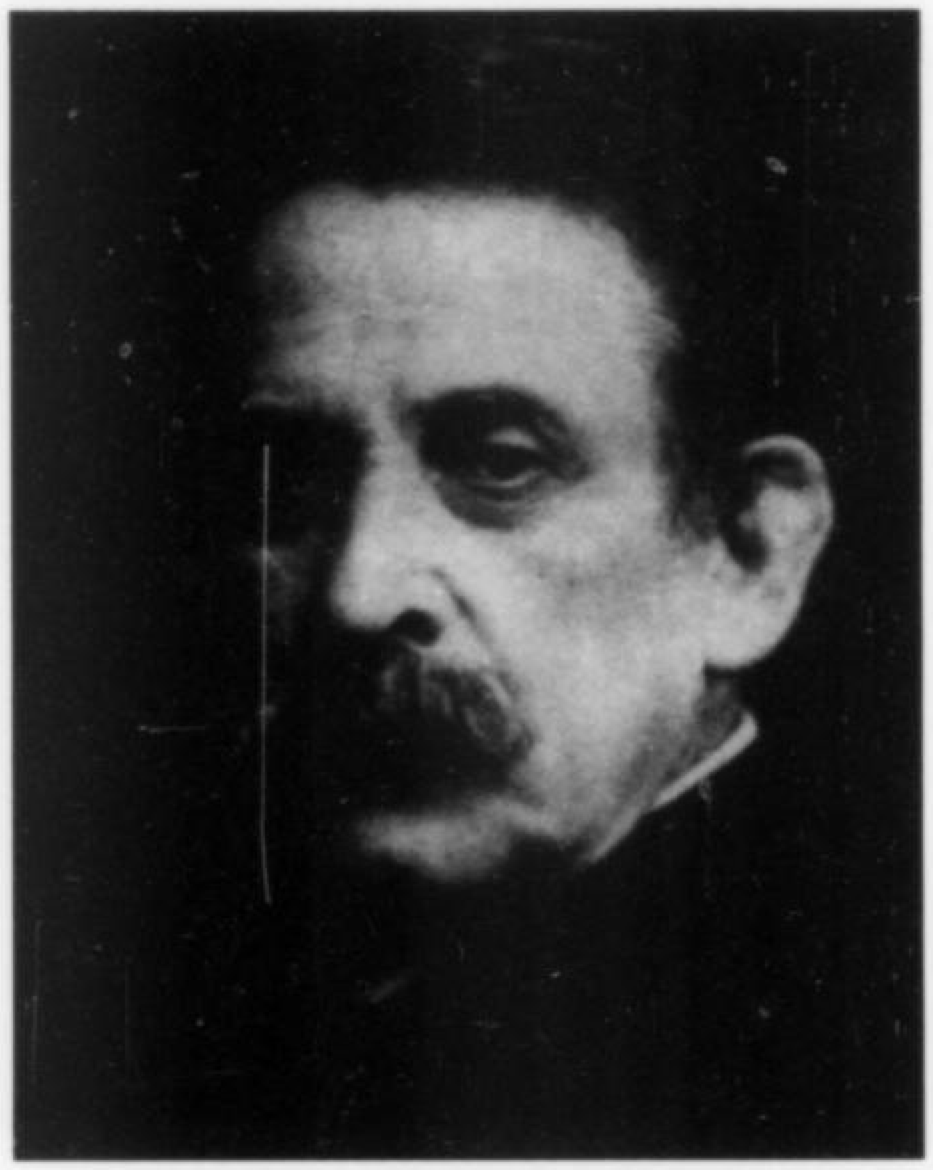

***Figure 3.* Victor Goldschmidt in his later years. Photo courtesy of J. Keilmann.**

Goldschmidt died in 1933, in Salzburg, Austria. Alexander Fersman, who studied with Goldschmidt for nearly two years and who collaborated with him on another important work (*Der Diamant,* 1911), wrote in his obituary: "The three works, *Index, Winkeltabellen* and *Atlas,* are basic materials for the study of crystals. Without them it is impossible to do crystallographic work. They translate the work of a complete century into a new language."

Complete sets of the reprinted *Atlas,* bound in nine volumes, each with text and figure volumes combined, are available for $300 postpaid (softcover) from the Rochester Mineralogical Symposium, c/o Harry Simon, 500 Long Acre Road, Rochester, New York 14621-1019.

BIBLIOGRAPHY and ACKNOWLEDGMENT

Biographical information presented here was drawn from *Dictionary of Scientific Biography.* A translation of the introduction to Goldschmidt's *Atlas,* parts of which are quoted here, was provided by Ingrid Hatschorn.

The Rediscovery of Axinite at Thornberry Mountain near Coarsegold, Madera County, California

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The American Northeast seems to have more than its share of lost mineral locations, but there is no state in the union immune to this problem. During the latter half of the last century, and in this century as well, a good many lesser-known and obscure mineral locations were found and produced a small quantity of desirable specimens, only to be lost for lack of proper locality documentation. This is the story of just such a location.

INTRODUCTION

Rediscovering the axinite locality at Coarsegold, California, was not particularly difficult. It was a case of doing the proper research, following the necessary leads, and defining and seeing the task through to completion, regardless of how doubtful one may feel at any given moment. Also, a little luck helps.

This story goes back almost 20 years, to May-June 1968. Some of the data presented here have come from notes taken during that time, and the rest of it from memory. My original interest in this location started the previous year after reviewing John Sinkankas's *Gemstones of North America,* Volume 1. Under the axinite heading on page 415, Captain Sinkankas describes a lost location for axinite as follows:

> Magnificent, large, brown axinite crystals associated with dark grayish green fibrous actinolite (byssolite) and sphene occur in cavities in a pegmatite about 2 miles north of Coarse Gold [sic], Madera County (some say 5 miles northeast of this town). From an unspecified locality near Springerville in this same county, some astonishingly fine specimens of axinite were obtained some years ago, providing what are probably the world's finest crystallized examples of this mineral. One matrix group in possession of the United States National Museum is about 5 inches across and shows magnificent perfect crystals, some well over an inch across and at least ¼ inch thick, resting upon a matrix of rock associated with actinolite. The color is rich brown and at least one of the crystals is almost flawless. The occurrence was exploited in great secrecy and no one seems able or willing to tell where it is.

There must have been some confusion in crediting the location to Coarsegold or Springerville in Madera County, but the location is definitely nearer Coarsegold. Poor specimens gleaned from the location's dump in 1968 show the same matrix association of axinite, albite and actinolite and are definitely from the same pocket as the specimen figured by Sinkankas. Today this same specimen is on public view in the Mineral Hall of the National Museum of Natural History in Washington, D.C.

What is noticeable about this specimen "in the flesh" that is not apparent in Sinkankas's black and white photo is its contrasting colors. The blocky, ivory-white albite crystals and the prismatic, fibrous dark green blades of actinolite form a rather striking matrix for the sharp plum-brown axinite crystals.

I felt this location was well worth finding for three reasons. First, this specimen material has beauty, color and contrast. Second, at the time it was the location of the best North American axinite. Though not quite as glassy as the best Bourg D'Oisans, France, material, the sharpness and color of the well-formed Coarsegold crystals make them among the world's finest (and North America is not especially gifted with fine axinite locations). Third and lastly, for rarity, because finely crystallized axinite is definitely *rare*. If this occurrence could be relocated and specimens similar to the USNM piece could be found in any quantity, it would become a modern-day classic locality.

THE SEARCH

Checking through all the data I could find, it became apparent that references to this location are scarce. The one I was able to find, at best enigmatic and tantalizing, was from Bradley (1940): "Large violet-colored axinite crystals, some of gem quality, with accessory sphene, occur in a small pegmatite, about 5 miles N.E. of Coarsegold."

In May of 1968 I stopped in San Francisco to visit the mineral museum of the California State Division of Mines and Geology, then located in the Ferry Building. It was there I had my first break in this search. On display there was a partial axinite crystal, specimen number 21021. The label read "Donated by Hugh R. Paden, August 1940. Found five miles east of Coarsegold." I duly noted this down and left. In any case, I was planning to visit the Coarsegold area and any information gleaned indoors would surely help later field work. Nothing is more fruitless and time-wasting than attempting to carry out this type of work in the field with little or nothing to go on.

All I had was a name "Hugh R. Paden" and a date "1940." Who was "Hugh R. Paden"? Was he the property owner? Did he still own it? Was he a miner, or a mineral collector? Or worse, was he just someone who donated the specimen second or third-hand and knew nothing of its occurrence? That the specimen was donated 28 years prior wasn't going to help me at all. People can change residence several times in 28 years and they can also forget a lot in that span of time.

My next step was to obtain the Bass Lake, California, quadrangle, the topographic map which covers the Coarsegold area. The map reveals a range of hills running northwest-southeast between the towns of Coarsegold and Oakhurst, connected by California Highway 41. These hills range in altitude from 3400 to 4000 feet above sea level. Driving northeast on route 41 from the fertile and flat San Joaquin Valley of central California in Madera County, one continually rises and the countryside becomes decidedly mountainous. This is the foothill country of the great Sierra Nevada range to the east.

The map shows a few abandoned gold mines within a mile or two northwest of Coarsegold, but I felt it unlikely that axinite would be found in a gold mine. Checking with local residents turned up nothing, as I expected. No one knew or had heard of a Hugh R. Paden. Nobody knew of any local mineral collectors or, for that matter, anything about mineralogy.

The following day I visited the county court house in Madera to check the property and mine records of the Coarsegold area. I located the name "Paden" under a property listing, but in comparing it to their maps, it turned out to be a farm in the San Joaquin Valley. A good location for grapes, perhaps, but not for axinite. I drove out there anyway, and learned that there was no family member named Hugh. I was at a dead end, temporarily at least. It dawned on me that Hugh Paden could have moved out of the area in the past 28 years. In fact, he could have moved to anywhere on the globe. Most disconcerting of all, maybe Hugh Paden wasn't even from the Madera area at all!

The evening found me at a local drive-in movie theater watching the latest hit, "Bonnie and Clyde." That particular movie on that particular evening didn't help my dark mood one bit. I had a queasy feeling then and there that trying to find this place might make as much sense as that rootless couple on the screen. Unless I get some solid information, I thought to myself, it was pointless to continue searching. My plan was to spend another day or two in the area and then, if no further leads developed, to drop the search and leave.

The next day I traveled south a short distance to the city of Fresno, and while having some minor auto work done in a gas station I sat there in their office pondering what to do next. The view out of the window was a typical American street corner, no different from thousands of others from sea to shining sea. A store on one corner; another gas station across the street. Cars came and went. The green lights went to yellow and red and then back to green again. Off to one side of my corner, nestled under a not-too-large tree, was a public phone booth. It struck me that I had neglected to check the telephone book! Walking to the phone book I figured quickly that if Hugh Paden wasn't in the Fresno area, to also try phone books of other major California cities. Thumbing through the local directory, I saw a listing for a "Ralph F. Paden," but no "Hugh Paden." The investment of a dime brought Mr. Ralph Paden to the phone and he said yes, he did have a brother named Hugh, who did gold prospecting during the late 1930's in the hills of Madera County. He gave me his phone number and address. Another dime bought a call to Mr. Hugh R. Paden, who said he'd be happy to talk to me! Paying the mechanic and with electricity again returning to my feet, I hopped into the car and was off.

I located Mr. Hugh Paden living near the hospital in Fresno. A pleasant retired gentleman greeted me at the front door, and ushered me into his comfortable living room. He was both a little surprised and delighted that after 30-odd years someone would still be interested in a find of some rare mineral specimens he had made. Looking at the topographic map, he put an "X" on the spot where he sharply remembered finding the axinites.* He handed the map back to me, now blessed with an "X marks the spot." Funny, the map suddenly felt a little bit heavier. With a sigh of relief and a smile, I thanked him. Less than an hour had passed since I was sitting in that gas station, staring into space dejectedly. Sometimes the answer to a problem is so simple it eludes us at first; and sometimes you can get lucky.

THE 1938 PADEN DISCOVERY

Hugh Paden and I went over the few specimens he had left from his original find. It was well picked over and there wasn't anything a collector would want, save for a few study pieces. I noticed one large piece of iron-stained albite with a small zircon crystal in a vug.

He then told me the story of his axinite discovery. In 1938 he was prospecting for gold east of Coarsegold, though not in the professional sense. (This is probably what gave rise to the rumor over the years that the axinites were found by a "gold miner," or "gold miners.") He came upon what he first thought was a quartz vein outcropping on a steep hillside. After digging by hand for a while, he realized it wasn't a quartz vein at all, but proved to be a dike of albite feldspar. A few feet in he hit a pocket he described as "watermelon-sized, around two feet deep." This pocket yielded all the fine axinite specimens we know of today from this location. Not knowing what he had, he took it all home with him. Sometime later he abandoned his mining there and any further prospecting. All the specimens were thoroughly iron-stained and at first sight were not exactly dazzling (or potentially valuable). Some of the loose, gemmy axinite crystals he had already given away to local children by the time he had his specimens identified and learned that he had made a significant mineralogical discovery.

We have to remember that back in the 1930's a fine mineral specimen was worth only a particle of what it would bring today, and there weren't hoardes of aggressive, competitive, knowledgeable collector-dealers as there are now. Whereas today newly collected specimens reach dealer's shelves as fast as fresh bread in a bakery, back then it is entirely possible that a year or two could have elapsed before the axinites were found to be something unique, especially if the finder was not a main-stream collector or dealer. Regardless, it was a unique find, one made purely by chance.

THE GISLER CONNECTION

During the 1940's there were three well-known mineral collectors in the San Francisco area: Magnus Vonsen, R. M. Wilke and Julius

*NE¼ of the SW¼ of Section 36, R21E, T7S, Bass Lake 15-minute quadrangle.

Gisler. Julius and Oscar Gisler were actually a father-and-son collecting team. They were especially known for handling specimens from two well-known locations: the famous San Benito County benitoite mine, and the Plumas County location at Thompson Peak (for sprays of black tourmaline with muscovite). The senior Gisler had the reputation for being a close-mouthed individual and rather secretive in his work. Whether he actually self-collected specimens himself or bought from others he never elaborated. No doubt this is what made him the successful collector he was.

Sometime after his discovery, Mr. Paden recalled, he was visited by the younger Gisler, accompanied by his girlfriend. Oscar, like a good mineral dealer, purchased all the better axinites, including the USNM piece. Only a few scraps were left behind. Thereafter, any specimens from this find were distributed by the Gislers. Years after the purchase from Hugh Paden, the best specimen was sold to the U.S. National Museum. Sometime after my work was finished at Coarsegold, I learned that Oscar Gisler was the owner of the "Ore Bin Bar" just outside of Las Vegas, Nevada (Rock H. Currier, personal communication). A year later, passing through Las Vegas, I stopped in briefly to visit him. His father had since passed away and Oscar had no more of the famous axinites to which their name had been attached for so many years.

My very fruitful visit at an end, I thanked Mr. Paden and prepared to leave, making a promise to visit his discovery site with him soon. He wished me good luck and good hunting.

after pulling this away, I could see it was a very shallow, collapsed, exploratory adit. Everything was exactly as Paden said it would be.

Peering into the rear of this adit, I saw an exposure of the dike. After a quick examination, I saw that it wasn't a pegmatite at all, as described by Bradley. It lacked totally any mica or quartz, and looked like a thin veinlet up to 10 cm wide of fractured and iron-stained albite. Near its wall-rock contacts were numerous, small, thin, black blades of actinolite. Happy with seeing the location for the first time and glad to flee the ravenous mosquitoes, I made it to the car and headed for the sanctity (and sanity) of a bug-free motel room. Checking the topographic map again, I could see that Bradley's orientation wasn't far off. His original description of "about 5 miles northeast of Coarsegold" was actually measured as 4[1]/8 miles northeast by east.

After some checking, I next secured a verbal agreement from the property owner to do exploratory mining on the site. Some blasting was going to be necessary, so I located a six-cylinder air compressor locally and rented the needed air hose, rock drill and drill steel in Madera. Mechanized removal of waste was out. I wasn't well enough financed at the time to assume ballooning exploration costs, and I felt that until something terrific was turned up, I would do the digging the hard and cheap way, by hand with pick, shovel and wheelbarrow. As a mineral location it was actually tiny and was well suited for hard work. Only a few yards of horizontal ground existed around the adit. The ravine below could swallow up any waste I would dump with the wheelbarrow. Actually, when I started widening the cut at its lip,

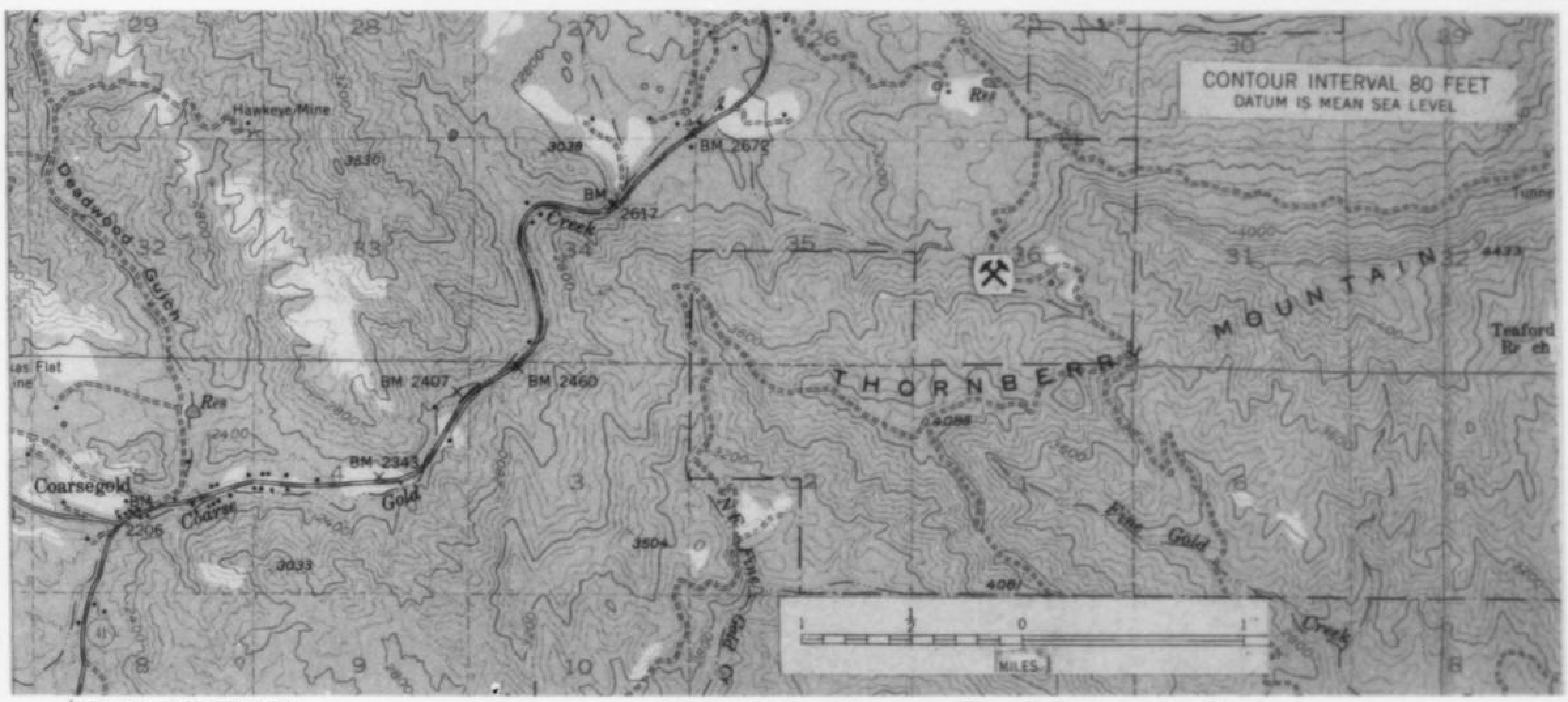

Figure 1. **Location map (Bass Lake quadrangle).**

FIELD WORK, MAY-JUNE 1968

Locating the axinite site was no problem at all. I followed a dirt road that branched east from route 41 just before the crest of the hills is reached 4 miles above Coarsegold. After almost 3 miles this dirt road starts climbing a steep hill, shown on the topographic map as "Thornberry Mountain." After what couldn't have been more than 200 meters, I parked the car and walked down the steep embankment. It was actually a ravine with steep sides. Down at the bottom a small brook flowed. After scouting the embankment between the road and the brook for a while, I came across Paden's dump. The area was heavily forested with small pine trees and, being springtime, I was in this place at the worst possible time: it was infested with mosquitoes. Following Paden's dump upwards a few meters I came to a small cut in the hillside with what appeared to be a cave in the rear of the cut. There were roots and organic material covering this little cave, and I just shoveled the dirt and rock down the hillside below.

First, I began digging through the Paden dump. A number of interesting specimens were found. The best hand-sized specimen showed the typical crystallized albite-actinolite matrix with a few small (6-mm) broken and partial axinite crystals. Larger pieces were composed of only blocky white albite, occasionally crystallized on one side. Also uncovered were a few broken fragments of axinite. The most interesting specimen found was a single, flat, honey-brown titanite crystal, 3.5 cm in size. All these specimens were from Paden's watermelon-sized pocket . . . material he had thrown over the side as worthless. They were all well stained by iron oxide which I later removed with a warm solution of dilute oxalic acid.

Compared to the narrow width of this dike, the Paden pocket may have looked anatomically like the classic textbook figure of the "bean in a pod" structure for a dike pocket: a dike a few centimeters wide

Figure 2. **The inspiration for the search: a cabinet specimen (19.5 cm) of gemmy brown axinite crystals with green fibrous actinolite and yellow-brown titanite, from "near Madera, California." Smithsonian specimen #R9238.**

suddenly swelling to several times its width. Paden told me the pocket was found only 2 meters in from the lip of the cut, and as he mined into the hillside for an equal distance, he found nothing more except albite.

Already I had a fair number of specimens from Paden's dump. Looking over the crystallized albite and the small titanite crystal, this location was starting to resemble more and more (if it could be compared to any other world mineral location) the famous titanite location at Capelinha, Minas Gerais, Brazil. There, superbly crystallized titanite and albite occur together in open veinlets cutting metamorphic rocks.

Later I parked the air compressor on the steep roadside and ran the connecting air hose down to the small cut below. After a week of hand-labor I had opened up the cut considerably, but the surrounding rock in the cut was becoming seriously unstable. Mixed in with the dirt in the walls of the cut was a peculiar red shaly rock. Every so often masses of a dark and dense igneous rock were encountered. (Unfortunately, in the rush to find axinite at the time, no close observations of these rocks were made nor were any samples taken to help later in determining their relationships.) Small landslides were becoming more frequent as masses of unstable rock mixed with dirt would come down without warning. The roof of Paden's short tunnel collapsed and was dug out. Now I could see why Paden gave up. In the back of his tunnel the albite dike was surrounded by the same dark igneous rock. He mined his location by hand until the rock became too hard.

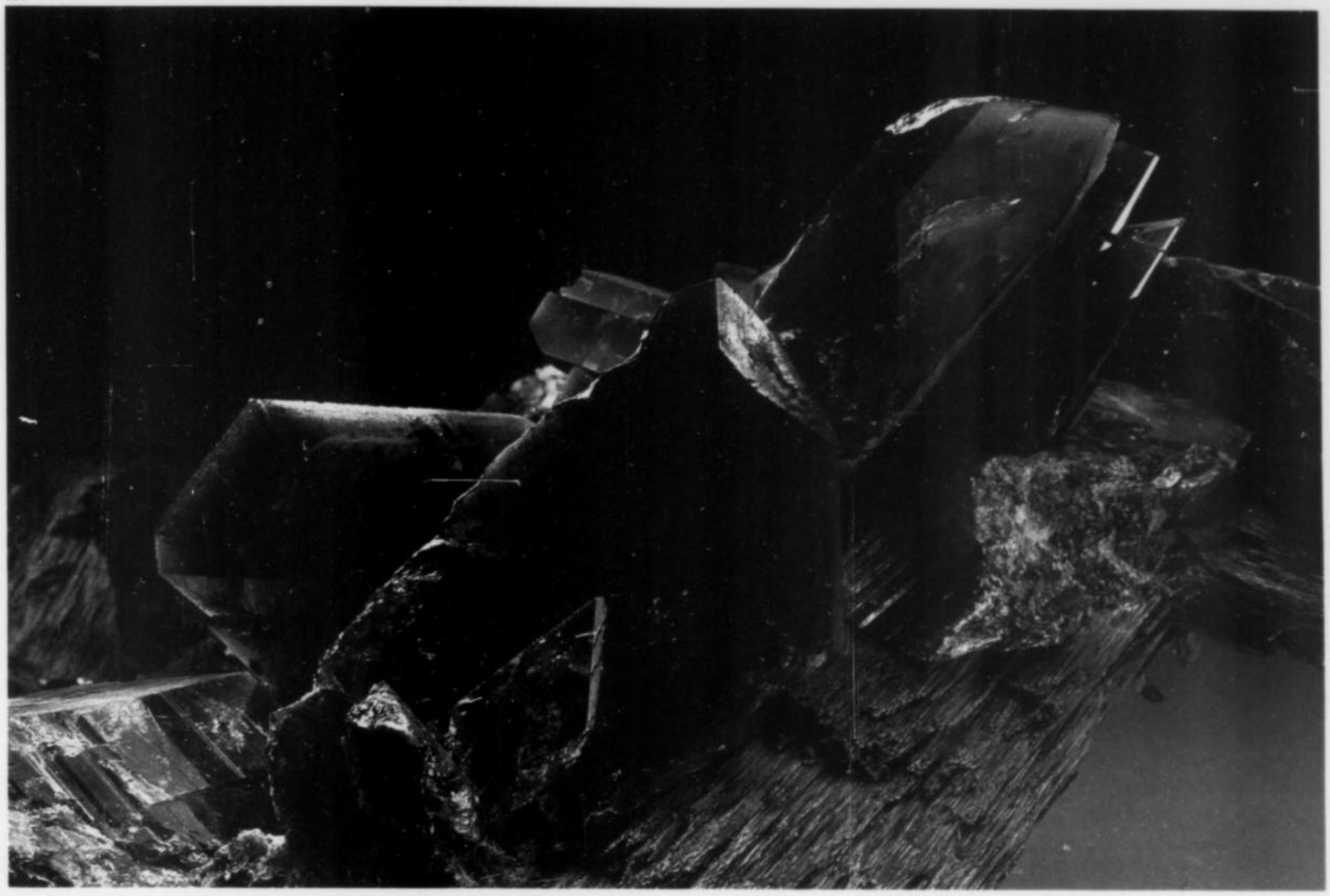

Figure 3. **Close-up showing crystals to 5.5 cm on the Smithsonian specimen.**

Figure 4. **The axinite occurrence; the small trench at lower left is the dike, composed mainly of albite with minor actinolite. Szenics photo, taken in June of 1968.**

Figure 5. **Close-up showing crystals to 3.5 cm on the Smithsonian specimen.**

As I dug back further and further into the hillside, the amount of waste to be removed went up geometrically and the mini-slides became such a nuisance I decided to blast it out. I drilled holes through the fractured rock mixed with dirt (very difficult going as it is hard to keep a hole from collapsing internally in such ground). The only explosives I could obtain locally were some low-grade material that wasn't dynamite at all. It was a blasting agent on the order of a tubed ANFO that would give good "heaving" characteristics but not a strong breaking, or shattering force necessary for hard rock. I loaded up the holes with more than was necessary to compensate for this weakness; the resulting blasts sent rock and dirt flying all over the ravine.

Next I began to work on the albite dike carefully along its strike. Most of it could be removed by hand because it was quite fractured. Occasionally a vug up to 7 cm wide was encountered. These vugs were in solid albite and contained nothing more than bladed albite crystals up to 1.2 cm in size. A small etched mass of quartz was found in one vug. Also found were two hexagonal, pale apple-green crystals up to 2.5 cm. They are opaque and have no luster. Interesting specimens, but worth nothing. I saved them anyway, thinking they could be only one of two minerals: apatite or beryl. (Recently they were identified at Harvard as apatite.)

By lightly blasting into the rock encasing what remained of the albite dike in the rear of the cut, I could see to my disappointment that the dike was starting to pinch out in the space of 60 cm or so. Already I had mined the dike along the strike for a total distance of 5 meters. This rear area was worked down until the dike just about disappeared. Very quickly I could see my work coming to an end. Lastly I worked downdip on various points along the strike of the dike. It appeared to dip to the north at a steep angle of about 60°. Work here was also unrewarding. To continue here any further would require starting all over again at a lower level. With small trees and a considerable dump already in the way, I decided to stop completely.

I recovered very little for my efforts in fresh ground. In fact, the worst specimens found initially in Paden's dump were by far better than anything I found mining. So after two weeks, I returned the rental machinery. In sum, the work yielded several flats of interesting specimens, none of it really marketable. Towards the end of my stay, I brought up Hugh Paden from Fresno for a visit. He was pleased to visit "his mine" after 30 years absence. He showed me where he found his famous pocket. It was very close to the original surface and must have been quite easy to clean out. Later, on my last visit to his home in Fresno, he came up with two thumb-sized partial axinite crystals with gemmy areas. These he sold to me at a very reasonable price. It's the story of the fisherman who came back from the sea empty-handed and bought his fish on the pier. Later these two crystals were sold for cutting.

CONCLUSION

It was unfortunate that after using all resources available, I wasn't able to continue at Thornberry Mountain. After finishing there, I made a mental promise to return someday and do the job right with heavy equipment. It was never to happen. Memories fade and time has a way of passing and making fools of us all. What was important to us in the past is now quaint. My overriding feeling back in 1968 was always that if this location could produce such an interesting (and productive) pocket as the one Paden found, and such a fine axinite specimen as the USNM specimen, then there must be more of it. There is the possibility that it is a "one pocket" location. But human nature being what it is, it's always preferable to think there must still be "more and better" of a good thing.

By not continuing on a larger scale, I broke the first law of successful mineral specimen mining: *"The Quantity of Specimens Uncovered is Directly Proportional to the Amount of Rock Removed."* There are still distinct possibilities at the site if heavy equipment could be brought in. The downdip extension of the dike was never fully explored. By cutting a roadway down to the dike and then making a series of terraces down the hillside below the discovery site, whatever remains of this dike will come to light.

No attempt on my part was made to explore the area around the site. The dike may very well continue on the other side of the ravine directly across from the discovery site. Or there may be other dikes in the local area. Again, I made no search of the streambed for any alluvial material that might indicate dikes-in-place upstream. The area is densely forested and covered with forest soil. Outcrops are few and far between, and are not conducive to rapid mineral deposit discovery, except perhaps for trenching at selected sites by a bulldozer. Any future work would require an extensive program of trenching and terracing to expose any other dikes if they exist. Geologically and mineralogically speaking, that shoulder of Thornberry Mountain is virtually unexplored.

ACKNOWLEDGMENTS

Many thanks to Captain John Sinkankas of San Diego, California, for providing the initial spark. The mineral collecting fraternity owes him a debt of gratitude for the reams of information and enjoyable reading he has provided in the ever-popular and useful books he has produced over the years. Thanks to Wayne Leicht of *Kristalle* in Laguna Beach, California, and Rock H. Currier of *Jewel Tunnel Imports* in Arcadia, California. Also many thanks to Bill Moller of Santa Barbara, California, for providing background information on the Gisler family.

DISPOSITION OF SPECIMENS

All the specimens collected at Thornberry Mountain in 1968 have been donated to the Department of Mineralogy of Harvard University, Cambridge, Massachusetts.

CAUTIONARY NOTE

This article may generate some interest among West Coast collectors, and it is *essential* that anyone visiting the location observe the common rules of etiquette among field collectors, and (especially) ask permission before entering private land. The ownership and status of the land surrounding the axinite location may have changed since 1968.

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THE EL DRAGÓN MINE, POTOSÍ, BOLIVIA

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The El Dragón deposit, discovered in the early 1970's, is among the most complex selenium occurrences in the world. Over 20 selenium-bearing minerals have been found there, including the selenide krutaite, which occurs in veins up to 6 cm thick, sometimes in fine euhedral crystals. The mine still produces superb miniature and micromount specimens of krutaite, often in association with chalcomenite, mandarinoite, ahlfeldite, olsacherite, schmiederite and others. It will eventually be the type locality for several as-yet unnamed selenium species.

INTRODUCTION

The El Dragón locality was first discovered in 1970 by Bolivian field geologists of the GEOBOL company. El Dragón is located in the classic silver-tin mining district of Potosí in Bolivia, 30 km southwest of the famous Cerro Rico de Potosí, near the village of Sala Khuchu (Fig. 1). The mine can be reached in 2.5 hours by car from Potosí. The area lies in the upper reaches of the Topala River at an altitude of 4100 meters. The topography is mountainous with poor grass vegetation.

Since the famous Bolivian selenium deposit of Pacajake, about 90 km north of Potosí, was closed and the old workings filled in, the recently discovered El Dragón mine 30 km southwest of Potosí has become the most important accessible selenium deposit in South America. With vein fillings consisting of almost pure krutaite, $(Cu,Ni,Co)Se_2$, the El Dragón occurrence is the richest natural selenium concentration in the world. It also contains native gold, and chemical analyses show high contents of palladium and platinum. Furthermore, the vein contains many selenites and selenates including the rare species mandarinoite, ahlfeldite, olsacherite, schmiederite, kerstenite and cobaltomenite, commonly in superb euhedral crystals.

Selenium veins like those of Pacajake and El Dragón are classified as apomagmatic-hydrothermal veins (i.e., far away from the magmatic source body) of the "Tilkerode-Zorge-Lerbach" type (Ramdohr, 1980).

The El Dragón mine has produced several hundred kilograms of krutaite. The krutaite is found in almost pure vein sections up to 6 cm thick which commonly contain crystal cavities lined by secondary selenites and many other secondary minerals. Recently some very good octahedral crystals of krutaite up to 1 mm have been found.

HISTORY

The intense blue color of the main secondary copper selenites chalcomenite and clinochalcomenite captured the attention of the local Indians in pre-Columbian times. They tried to recover copper or silver from the gray, silvery, primary minerals exposed in a thin vein cutting the sedimentary country rock. The very low silver content and the unfamiliar mineralogy must have discouraged these first attempts at exploitation.

In the early 1970's the mine was brought to the attention of Senor Fernand Ascarrunz in Potosí, who claimed the property and tried to analyze the vein minerals. However, the very complicated mixture of minerals and elements defeated his attempts. In October of 1976 an internal analytical report of the Instituto de Investigaciones Minero-

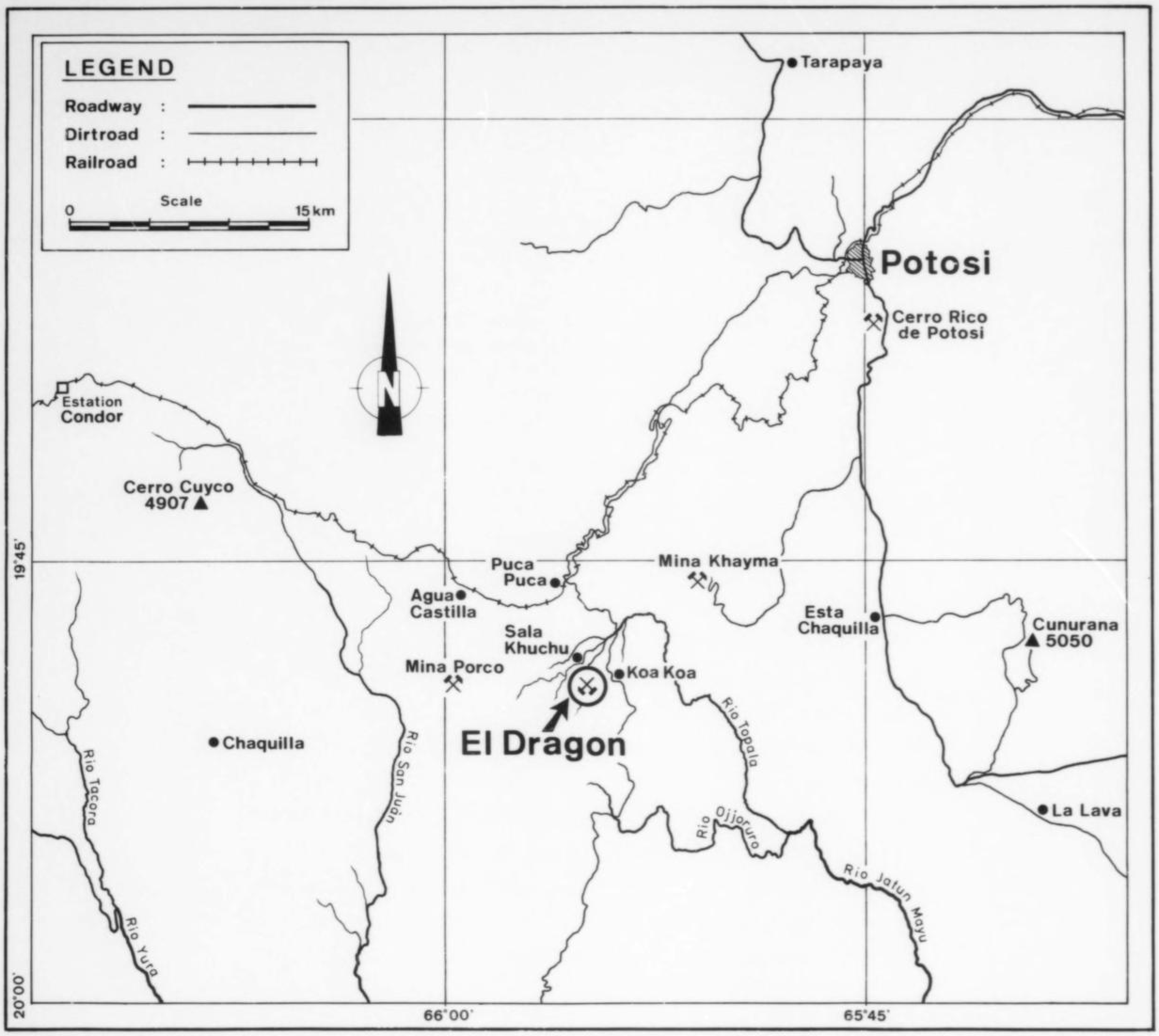


Figure 1. **Location map of the El Dragón mine.**

Metalurgicas (IIMM) in Oruro (Soux and Quiroga, 1976) gave the first chemical and mineralogical analyses of the selenium mineralization. Fifteen mineral species were described. In 1985 Franz and Wetzenstein X-rayed the vein material and found cubic $NiSe_2$ as a submicroscopic component. They named the El Dragón mine "Caracoles" which is a misnomer for this location.

Recent mining activities have consisted only of mucking out the old workings and some hand-drilling and blasting to collect samples.

GEOLOGY

The El Dragón selenide vein is hosted by interbedded gray sandstone and shale of probable Devonian age (Ahlfeld 1972). A minor angular unconformity separates these rocks from a sequence of reddish fossiliferous sandstones of probable Permian age. Both Devonian and Permian rocks strike east-west and dip 40–50° to the north. The Paleozoic sediments are overlain by andesitic lavas up to 20 meters thick. The lavas flowed over a relatively steep relief and sealed off the former topography. The andesitic lavas at El Dragón are part of a large lava flow which covers large areas between Potosí and the Altiplano in the west.

The El Dragón area is in the antimony subprovince of the Bolivian tin-silver belt (Ahlfeld and Schneider-Scherbina, 1964; Ahlfeld, 1967). Numerous Sb and some Pb-Zn-Ag mines are found in the neighborhood of the deposit. The abundance of Sb mineralization indicates ore formation at moderate to low temperatures typical of selenium precipitation. Recently, the mineralization at El Dragón was described and classified as auriferous nickel-selenide veins in clastic sediments (Morteani and Fuganti, 1988).

MINE WORKINGS

The El Dragón selenium mineralization consists of one vein which has been mined on a very small scale. Since the discovery by local Indians, an adit approximately 15 meters long has been driven into the sandstone-siltstone country rock about 20 meters above the river level. The adit, like the vein, runs northwest-southeast and is roughly 2.5 meters high and 1.5 meters wide. The first 9 meters are cut into the footwall of the subvertical vein, then the adit splits into a footwall raise (4 meters) and a hanging wall incline (6 meters long). A sketch map of the mine and a cross section of the underground workings are shown in Figure 7.

Figure 2. A view of the El Dragón area. F. Grüner photo.

Figure 3. Entrance of the El Dragón mine. A. Zwicker photo.

Figure 4. Selenium vein, underground, El Dragón mine. F. Grüner photo.

Figure 5. Secondary minerals on the hanging wall of the underground workings of the El Dragón mine. F. Grüner photo.

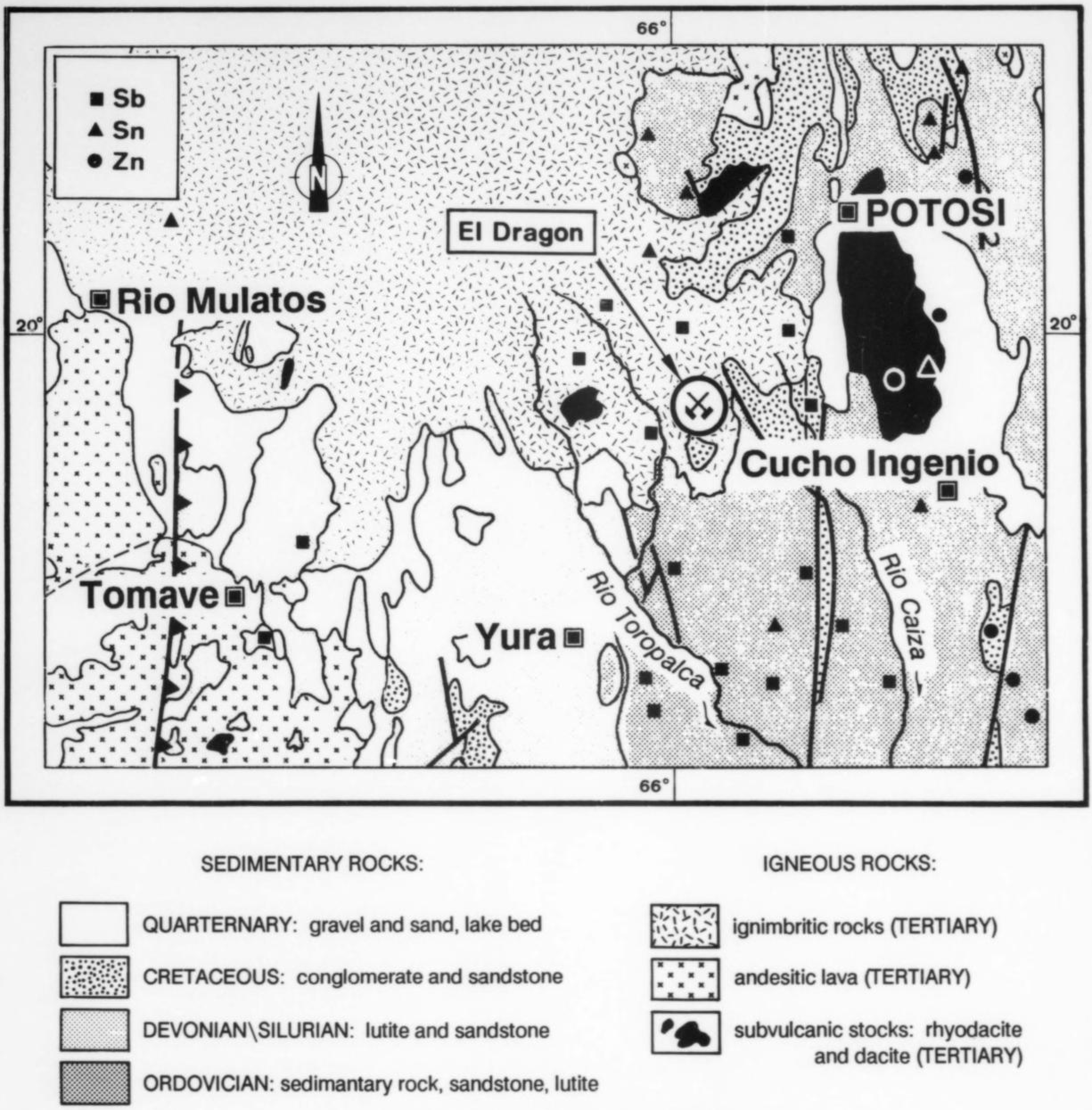


Figure 6. **Geological sketch map of the neighborhood of the El Dragón mine.**

The dump material outside the mine contains only traces of primary mineralization, but secondary selenium minerals and iron hydroxides can be found in the oxidized material.

No information exists about the total extent of the selenium mineralization. The vein most likely contains several more kilograms of krutaite, so the number of specimens available to collectors and museums will probably increase.

MINERALIZATION

As described above, the selenium mineralization consists of a single vein up to 6 cm thick, but ranging mostly from 0.5 to 2 cm in thickness. The vein is recognizable in the underground workings either by its sulfide-like appearance or, more readily, by the greenish blue colors of the oxidized selenium and copper minerals in the vein. On the surface the typical oxidation products are absent. The vein can only be traced as a zone of strong fracturing. Outcrops of this mineralized fracture zone and other subparallel fractures with similar characteristics but without selenium mineralization are found in the nearby riverbed as well. The fracture zones strike east-west and dip approximately 40° to the north.

Stream sediment sampling in the neighborhood of the El Dragón mine shows that gold is also present upstream from the deposit, suggesting the possibility of additional Se-Au–mineralized veins. The gold grains in the stream sediments are up to 0.1 mm in size and resemble in size and shape the minute inclusions of native gold in the krutaite vein samples.

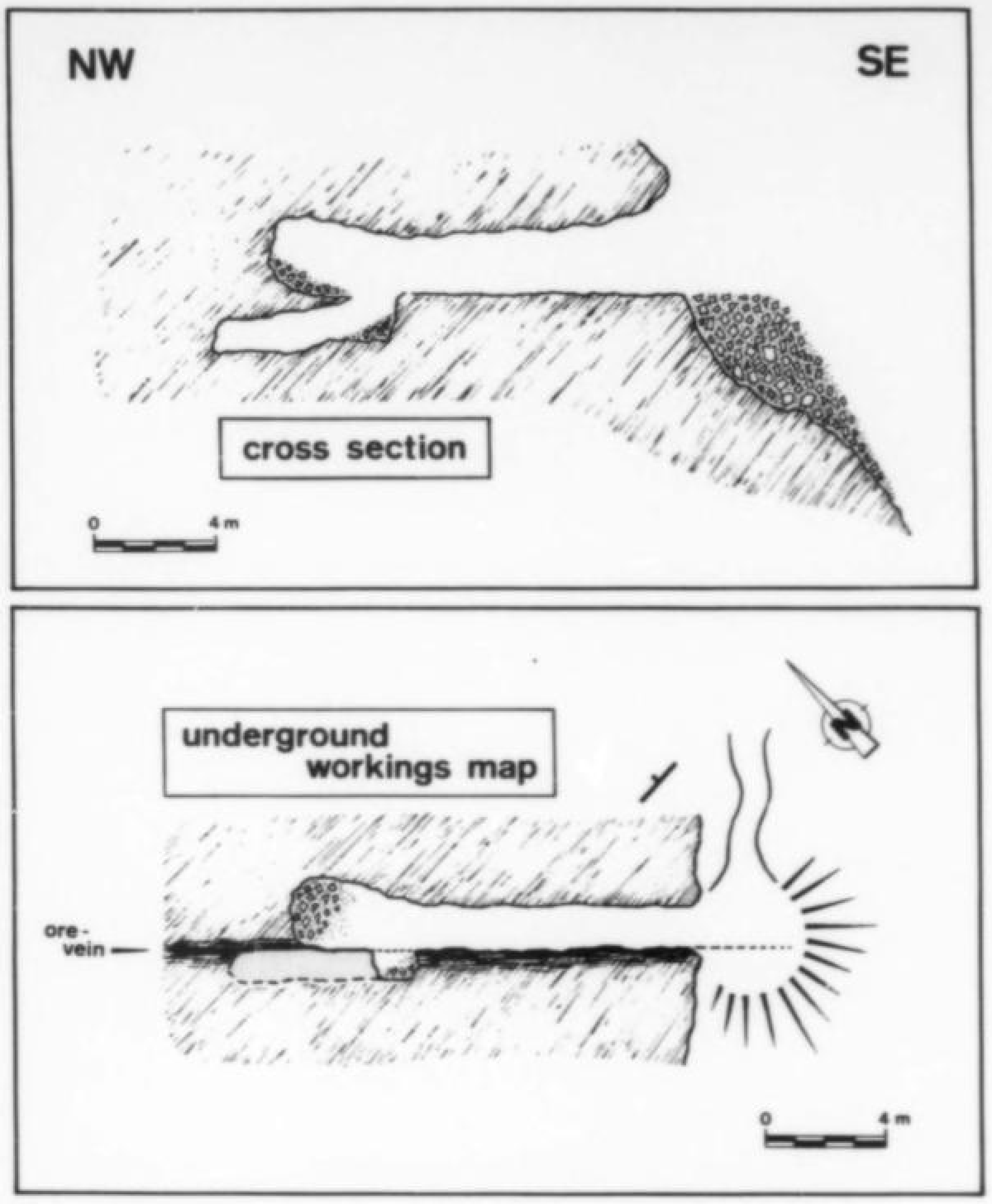


Figure 7. **Sketch of the El Dragón mine workings.**

Table 1. **Minerals from the El Dragón vein.**	
Ahlfeldite	$NiSeO_3 \cdot 2H_2O$
Allophane	amorphous hydrous Al silicate
Alunite	$KAl_3(SO_4)_2(OH)_6$
Anglesite	$PbSO_4$
Aragonite	$CaCO_3$
Barite	$BaSO_4$
Basaluminite	$Al_4(SO_4)(OH)_{10} \cdot 5H_2O$
Bellidoite (?)	Cu_2Se
Berzelianite	Cu_2Se
Calcite	$CaCO_3$
Chalcomenite	$CuSeO_3 \cdot 2H_2O$
Chalcopyrite	$CuFeS_2$
Clausthalite	PbSe
Clinochalcomenite	$CuSeO_3 \cdot 2H_2O$
Cobaltomenite	$CoSeO_3 \cdot 2H_2O$
Coronadite	$Pb(Mn^{+4},Mn^{+2})_8 \cdot O_{16}$
Covellite	CuS
Dolomite	$Ca,Mg(CO_3)_2$
Eskebornite	$CuFeSe_2$
Esperite	$PbCa_3Zn_4(SiO_4)_4$
Goethite	$Fe^{+3}O(OH)$
Gold	Au
Gypsum	$CaSO_4 \cdot 2H_2O$
Hematite	Fe_2O_3
Kerstenite	$PbSeO_4$
Klockmannite	CuSe
Krutaite (nickeloan)	$(Cu,Ni,Co)Se_2$
Linarite	$PbCu(SO_4)(OH)_2$
Magnetite	$Fe^{+2}Fe_2^{+3}O_4$
Malachite	$Cu_2(CO_3)(OH)_2$
Mandarinoite	$Fe_2^{+3}(SeO_3)_3 \cdot 6H_2O$
Marcasite	FeS_2
Molybdomenite	$PbSeO_3$
Lepidocrocite	$Fe^{+3}O(OH)$
Olsacherite	$Pb_2(SeO_4)(SO_4)$
Penroseite (cobaltian)	$(Ni,Co,Cu)Se_2$
Penroseite (cuprian)	$(Ni,Cu,Co)Se_2$
Petrovicite (?)	$PbHgCu_3BiSe_5$
Pyrite	FeS_2
Quartz	SiO_2
Reevesite	$Ni_6Fe_2^{+3}(CO_3)(OH)_{16} \cdot 4H_2O$
Schmiederite	$(Pb,Cu)_2SeO_4(OH)_2$ (?)
Selenium	Se
Siderite	$FeCO_3$
Tiemannite	HgSe
Trogtalite (nickeloan)	$(Co,Ni,Cu)Se_2$
Umangite	Cu_3Se_2
unnamed cubic $NiSe_2$	$NiSe_2$
unnamed copper-bismuth-selenide	$Cu_{11}(Ni,Co)_{0.4}Bi_2Se_{13}$
unnamed copper-lead-bismuth-selenide	$CuPb(Ni,Co)_{0.3}Bi_3Se_6$
unnamed copper-lead-mercury-bismuth-selenide	$Cu_2Pb_{0.4}HgBi_2Se_8$

MINERALOGY

This description is based on 200 specimens of average size 3 x 3 cm and average weight 50 g. The largest specimen from the selenium veinlet is 6 x 10 cm and 5 cm in thickness. A total of over 50 mineral species have been identified from the primary vein and cavities. Two of these, bellidoite and petrovicite, are considered unconfirmed because of incomplete chemical analyses. The chemical formulae given below are from Fleischer (1987) or have been recalculated based on our microprobe analyses.

Primary Minerals

The primary assemblage from the selenium veinlet has been previously described as "penroseite, clausthalite, chalcopyrite and unnamed cubic $NiSe_2$" (Franz and Wetzenstein, 1985). The "penroseite and clausthalite" occur only subordinately and the main selenide is actually a nickel-rich variety of krutaite. The essential selenium minerals are, in order of abundance, krutaite (nickeloan), penroseite (cuprian), chalcopyrite, clausthalite, klockmannite, umangite and the unnamed cubic $NiSe_2$ described by Franz and Wetzenstein (1985). Rare accessory minerals include selenium, berzelianite, eskebornite, tiemannite, cobaltian penroseite, nickeloan trogtalite, gold, pyrite, magnetite, hematite, marcasite, petrovicite (?), bellidoite (?) and three unnamed copper-bismuth-lead selenides. Only krutaite, clausthalite and chalcopyrite are visible with the naked eye. All other metallic minerals and their intergrowth relationships are only visible by hand lens or microscope.

The principal gangue minerals are dolomite, quartz and barite throughout the veinlet.

Barite $BaSO_4$

The primary barite occurs in milky white tabular crystals intergrown with the selenium minerals and goethite. The size of the barite crystals reaches 2 cm.

Berzelianite Cu_2Se

Greenish blue isotropic inclusions (grain size up to 0.2 mm) of berzelianite in krutaite have been identified by microprobe.

Chalcopyrite $CuFeS_2$

Chalcopyrite is the major sulfide mineral associated with the selenide vein. It usually occurs as veins, crusts and fracture fillings up to 3 mm in thickness crosscutting the selenides. Because of intensive alteration the chalcopyrite is generally covered by brown crystalline crusts of secondary iron hydroxides.

Clausthalite PbSe

Clausthalite was found within the krutaite crystal aggregates as well as in cavities and fracture fillings between the other selenides. It generally occurs in aggregates up to 2 mm in diameter and in microscopic grains as irregular inclusions together with umangite, klockmannite, gold and others, and as fillings of cavities and cracks between and also replacing krutaite crystal aggregates. The fracture fillings indicate late-stage clausthalite formation.

Dolomite $CaMg(CO_3)_2$

Dolomite is the most abundant gangue mineral in the veinlets. It forms good, visible, subhedral to euhedral $\{10\bar{1}0\}$ crystals and locally fine drusy vugs. The dolomite crystals are commonly partly altered or completely pseudomorphed by secondary Fe-hydroxides. The crystal sizes reach up to 6 mm. Yellowish dolomite crystals contain more Fe, the whitish ones less.

Eskebornite $CuFeSe_2$

Eskebornite has been found as minor inclusions up to 0.1 mm, associated with umangite, klockmannite and clausthalite in krutaite.

Gold Au

One of the most interesting features of the El Dragón selenium deposit is the unusually high concentration of native gold. In more than half of the polished sections gold occurs in grains up to 0.2 mm mainly intergrown with the krutaite and clausthalite. The bulk analysis (Table 2) gave an average gold content of 40 grams per ton. In addition

***Table 2.* Bulk analysis of the selenium ore vein from El Dragón (data from this study).**

Se	49%	Au	38 ppm
Cu	11.1%	Pt	0.2 ppm
Ni	8.2%	Pd	0.1 ppm
Co	1.7%	Cd	50 ppm
Pb	7.2%	Mn	300 ppm
Fe	7.5%	Tl	<20 ppm
S	1.3%	In	<5 ppm
Hg	0.23%	Ga	<10 ppm
Bi	0.24%	Ge	<5 ppm
Zn	0.05%	As	50 ppm
Ag	0.06%	Sn	50 ppm
Sb	0.03%	W	100 ppm

to gold, remarkable contents of platinum (up to 2 grams per ton) and palladium (up to 4 grams per ton) were detected.

Klockmannite CuSe

Klockmannite commonly forms bluish white grains up to 0.3 mm as inclusions in krutaite. It is generally associated with umangite and berzelianite.

Krutaite (nickeloan) $(Cu,Ni,Co)Se_2$

The main primary selenium mineralization at El Dragón has proven to be a complex mixture of minerals in the krutaite-penroseite-trogtalite series, with nickeloan krutaite most common. Because of the rarity of these minerals, a short discussion of their discovery and nomenclature may be of interest. Krutaite was first described from Petrovice, Czechoslovakia, by Johan *et al.* (1972). The authors found crystals up to several tenths of a millimeter embedded in other selenides, and determined krutaite (cubic $CuSe_2$) to be a member of the pyrite group. Penroseite (cubic $NiSe_2$) was first described from Pacajake, Bolivia, by Gordon (1925). The nickel selenide "blockite" (cubic $NiSe_2$), as described by Herzenberg and Ahlfeld (1935), has been found to be identical to penroseite. Trogtalite (cubic $CoSe_2$) was first described

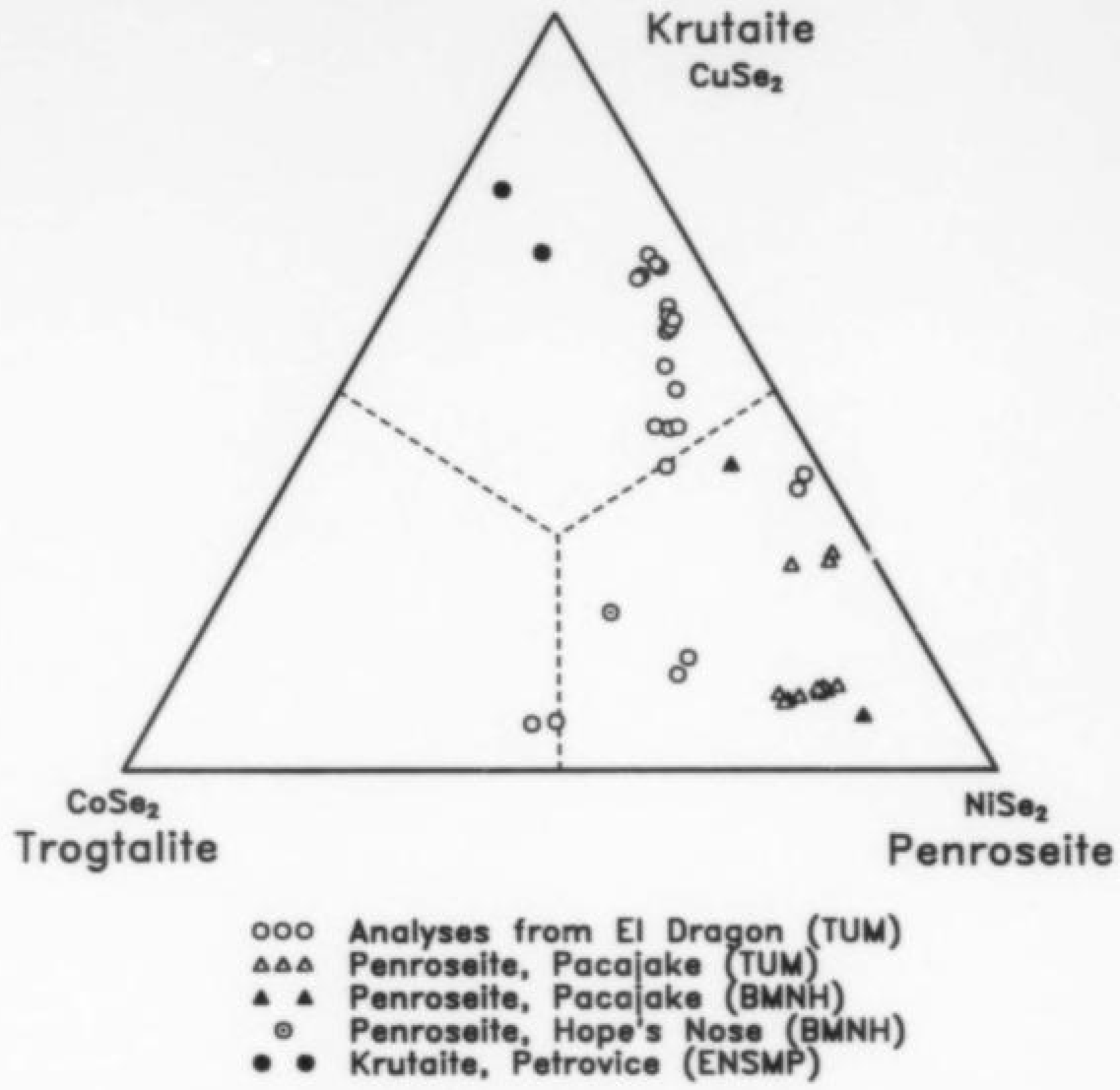


***Figure 8.* Ternary diagram of the trogtalite/krutaite/penroseite series.**

by Ramdohr and Schmitt (1955) from Trogtal in the Harz Mountains, Germany.

Our electron microprobe analyses of krutaite from El Dragón are graphically represented in Figure 8. In this figure we also show analyses of krutaite and penroseite from their type localities and additionally from Hope's Nose, England (Criddle and Stanley, 1986). No analyses were found for the type trogtalite. It is clear from Figure 8 that there is complete miscibility between krutaite and penroseite, and that the type specimens are not pure end-members. The extent of miscibility towards trogtalite is unknown.

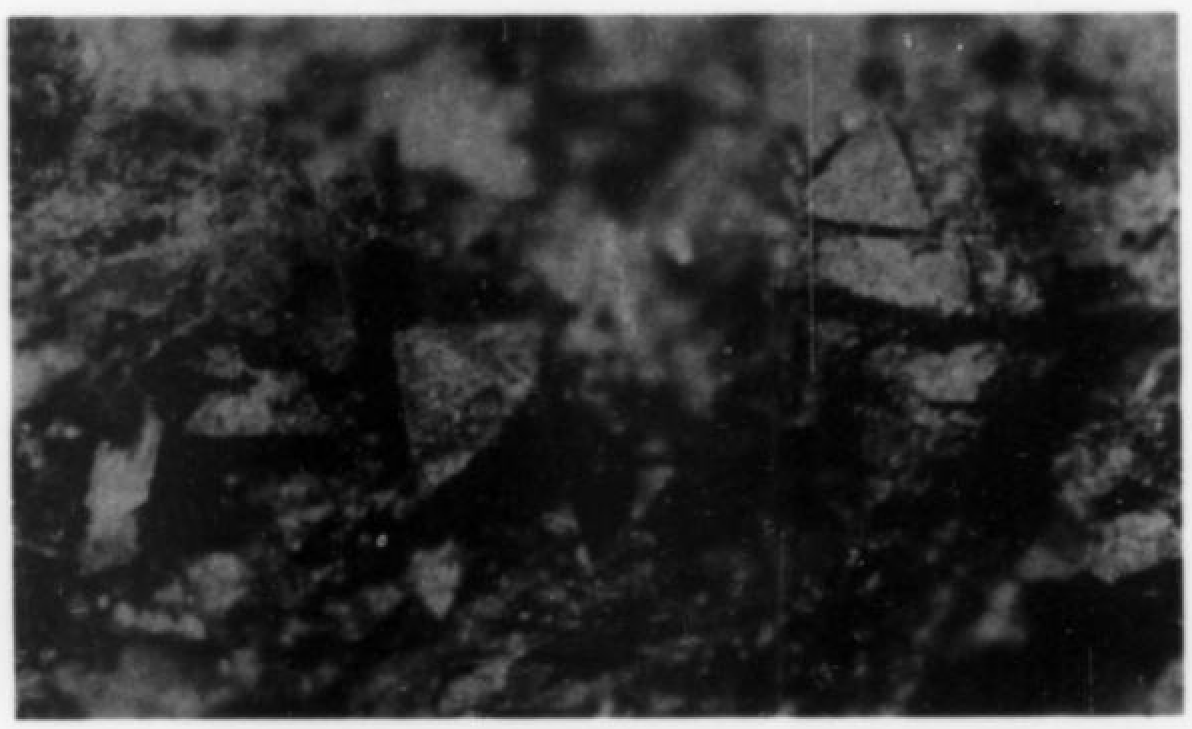
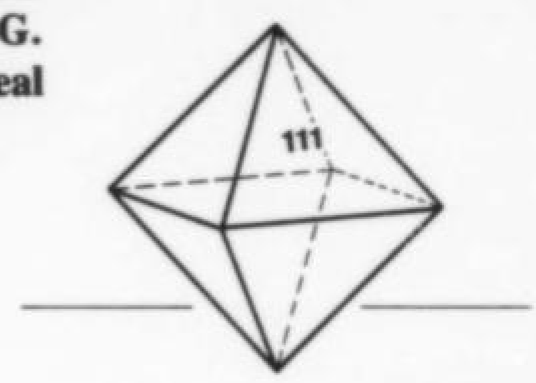


***Figure 9.* Krutaite in octahedral crystals up to 1 mm in diameter. G. Grundmann photo. Right: an ideal octahedral krutaite crystal.**



Crystal faces and fresh broken surfaces of krutaite from El Dragón have a grayish blue color and a silvery metallic luster (Fig. 9 and 9a) very similar to gersdorffite, and a distinct cleavage parallel to the cube, like that of penroseite, making the orientation of the crystals easy to determine.

Figure 10 is a polished section of subhedral krutaite crystals which

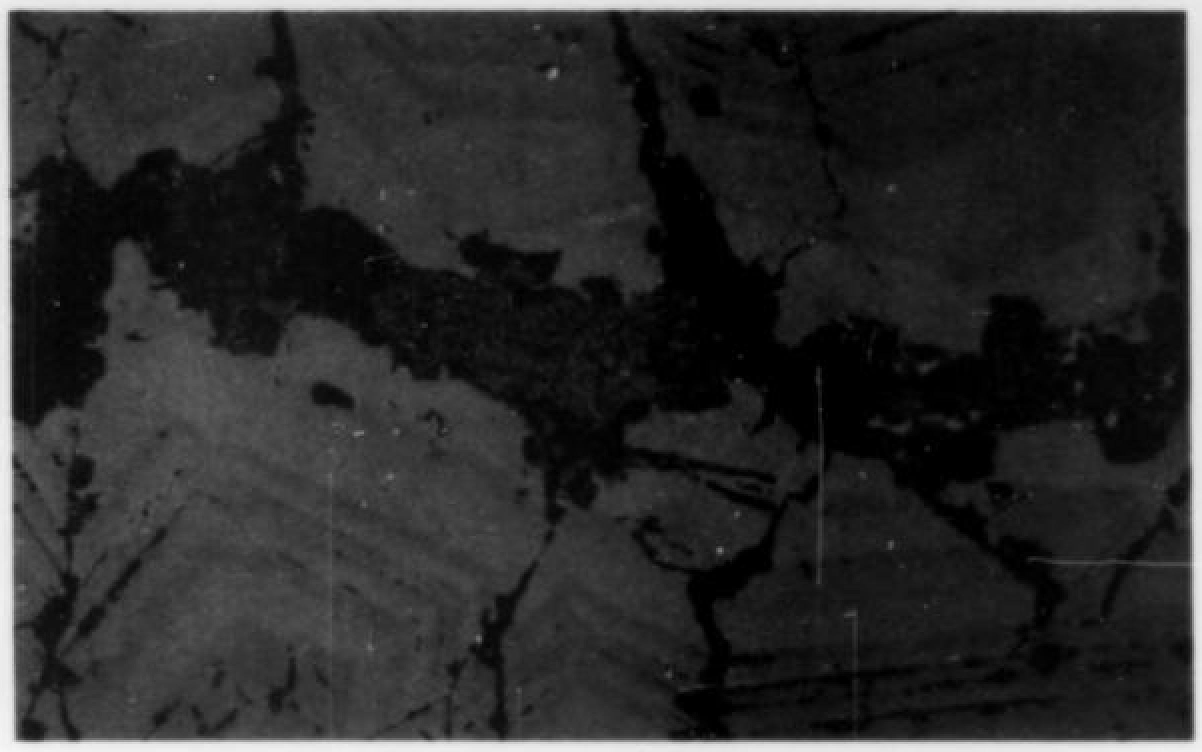


Figure 10. **Krutaite partly replaced by native selenium (brown felty aggregates) and other secondary minerals. Width of photo 0.3 mm. Polished section. G. Grundmann photo.**

show a distinct zonal structure with darker cores and lighter rims. The cores are generally richer in copper and are commonly filled with other copper selenides like klockmannite and umangite. The rims of the krutaite crystals are generally richer in nickel and in some cases are overgrown by cuprian penroseite and partly replaced by clausthalite and other secondary minerals (see Fig. 10). Very often the krutaite varieties are in part submicroscopically and rhythmically intergrown with penroseite (Fig. 10).

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

Magnetite is found in association with hematite as irregular microscopic grains in the center of euhedral krutaite crystals. It is one of the earliest minerals to form. The maximum grain size is 0.2 mm.

Marcasite Fe_2S

Marcasite occurs in irregular microscopic grains and rarely as euhedral crystals up to 0.2 mm in size. Often it is found with pyrite and chalcopyrite.

Penroseite (cobaltian and cuprian) $(Ni,Co,Cu)Se_2$ and $(Ni,Cu,Co)Se_2$

Cobaltian penroseite and cuprian penroseite were detected by microprobe analyses in five samples (see Fig. 8). They form aggregates and crystals throughout the krutaite and clausthalite, outlining the idiomorphic, partly copper-rich inner and partly cobalt-rich outer growth zones of the krutaite. Compared to krutaite the penroseite varieties are very similar in color but slightly paler and more creamy in reflected light. (For discussion of the krutaite-penroseite-trogtalite series see the description of krutaite.)

Pyrite FeS_2

Pyrite is found only very rarely at El Dragón, in microscopic anhedral grains up to 0.3 mm in size in association with chalcopyrite.

Quartz SiO_2

One of the most common gangue minerals is quartz, which is present in most of the specimens in two forms: as euhedral crystals up to 3 mm long, and as irregular microscopic grains intergrown with the metallic minerals and the secondary minerals.

Selenium Se

Native selenium occurs as dark gray, metallic, microcrystalline, felted aggregates commonly intergrown with copper selenides and other secondary selenites and selenates filling cavities in krutaite (Fig. 10). The felted selenium aggregates reach 0.5 mm in diameter.

Tiemannite HgSe

Tiemannite has been identified in only one polished section, by reflected light microscopy and by microprobe analysis. It forms gray, metallic, anhedral grains (average grain size 0.1 mm) in association with clausthalite and other copper selenides.

Trogtalite (nickeloan) $(Co,Ni,Cu)Se_2$

Nickeloan trogtalite was detected by electron microprobe in two samples (see Fig. 8). It forms microscopic, often hypidiomorphic grains (maximum grain size 0.2 mm) throughout the krutaite and clausthalite. In reflected light the mineral is pink in color as described by Ramdohr and Schmitt (1955) and Ramdohr (1975). Compared to krutaite, trogtalite is slightly darker and more pinkish. (For discussion of the krutaite-penroseite-trogtalite series see the description of krutaite.)

Umangite Cu_3Se_2

Umangite is generally associated with klockmannite and berzelianite as microscopic inclusions (average grain size 0.2 mm) in krutaite. The umangite grains occur more frequently in the central zones of the krutaite crystal aggregates, outlining the growth zones.

Unnamed cubic $NiSe_2$

Franz and Wetzenstein (1985) described but did not name a cubic $NiSe_2$ from "Caracoles" (which is a misnomer for the El Dragón mine, Potosí). The new mineral cannot be detected optically in reflected light because of its similarity to "penroseite" (krutaite), but X-ray powder diffraction patterns show extra lines identical to those of the synthetic $NiSe_2$ (ASTM identity card No. JCPDS 11-552). Our own X-ray powder diffraction study confirms the observation of Franz and Wetzenstein, but numerous electron microprobe spot analyses could not detect any pure $NiSe_2$. This suggests that the unnamed cubic $NiSe_2$ is only present as a submicron-scale intergrowth with krutaite and penroseite.

Unnamed Cu-Bi selenide $Cu_{11}(Ni,Co)_{0.4}Bi_2Se_{13}$

This selenide was detected by electron microprobe in two samples. The chemical composition of the two samples is: Cu 32.9, 32.3; Bi 19.1, 19.6; Se 46.4, 47.8; Ni 0.8, 0.5; Co 0.2, 0.1 (sum 99.4, 100.3%), yielding the general formula $Cu_{11}(Ni,Co)_{0.4}Bi_2Se_{13}$. In reflected light the mineral is slightly darker than krutaite, and is creamy-gray in color with distinct bireflectance and anisotropy. The mineral occurs as patches of irregular grains in krutaite up to a few tenths of a millimeter in size.

Unnamed Cu-Pb-Bi selenide $CuPb(Ni,Co)_{0.3}Bi_3Se_6$

This mineral was detected by electron microprobe in two samples. The chemical composition of the two samples is: Cu 4.3, 4.5; Pb 12.3, 12.9; Bi 44.7, 45.8; Se 34.3, 34.1; Ni 1.3, 1.1; Co 0.2, 0.4 (sum 97.1, 98.8%). The general formula is $CuPb(Ni,Co)_{0.3}Bi_3Se_6$. In reflected light the mineral is slightly paler than krutaite, creamy-white in color and with distinct bireflectance and anisotropy. The mineral occurs in irregular grains in krutaite up to a few tenths of a millimeter in size.

Unnamed Cu-Pb-Hg-Bi selenide $Cu_2Pb_{0.4}HgBi_2Se_8$

The only mercury-bearing mineral at El Dragón other than tiemannite was detected by electron microprobe analysis in two samples. The composition is: Pb 4.8, 5.6; Cu 9.6, 10.2; Hg 14.5, 15.1; Bi 28.6, 29.1; Se 40.9, 40.1 (sum 98.4, 100.1%), similar to the rare selenide petrovicite described by Johan *et al.* (1977). The general formula is $Cu_2Pb_{0.4}HgBi_2Se_8$. The mineral is cream-colored with metallic luster, strong bireflectance and distinct anisotropy. It occurs in free irregular grains up to a few tenths of a millimeter in size, as well as patchy inclusions in krutaite.

Secondary Minerals

The secondary minerals were all identified by X-ray diffraction. Where necessary the minerals were further characterized by semiquantitative electron microprobe analyses.

Ahlfeldite $NiSeO_3 \cdot 2H_2O$

Ahlfeldite forms directly from krutaite. It occurs in pale green, pale beige-green, apple-green and occasionally olive-green spheres and lumps up to 0.3 mm in diameter (Figs. 11, 12 and 13), made up of prismatic crystals showing {011}, {110} and {010} crystal forms. They replace penroseite *in situ* or form crust-like aggregates with basaluminite and kerstenite on allophane and chalcomenite. Anglesite, with either goethite or reevesite plus dolomite, is always associated with ahlfeldite and chalcomenite in this paragenesis.

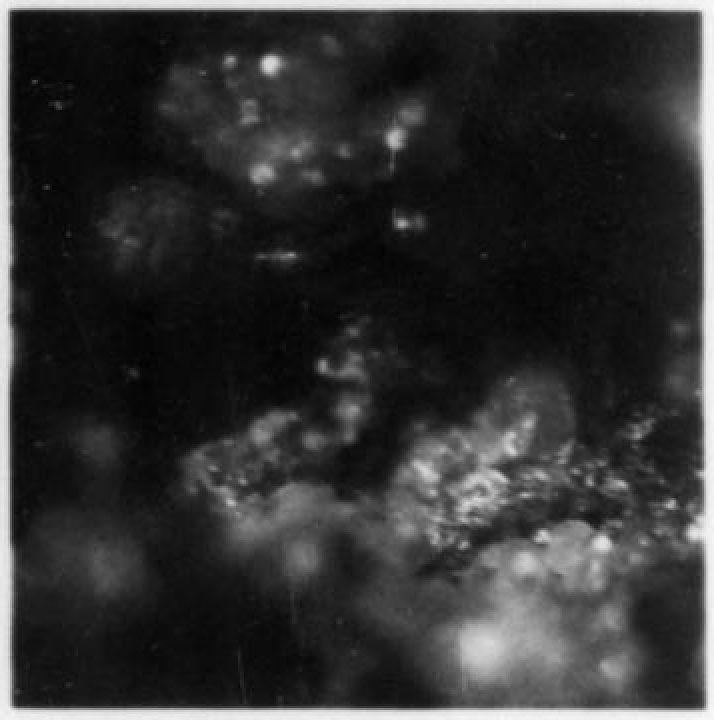


Figure 11. **Spheres of ahlfeldite on chalcomenite. Width of photo 2 mm. Photo by GSK.**

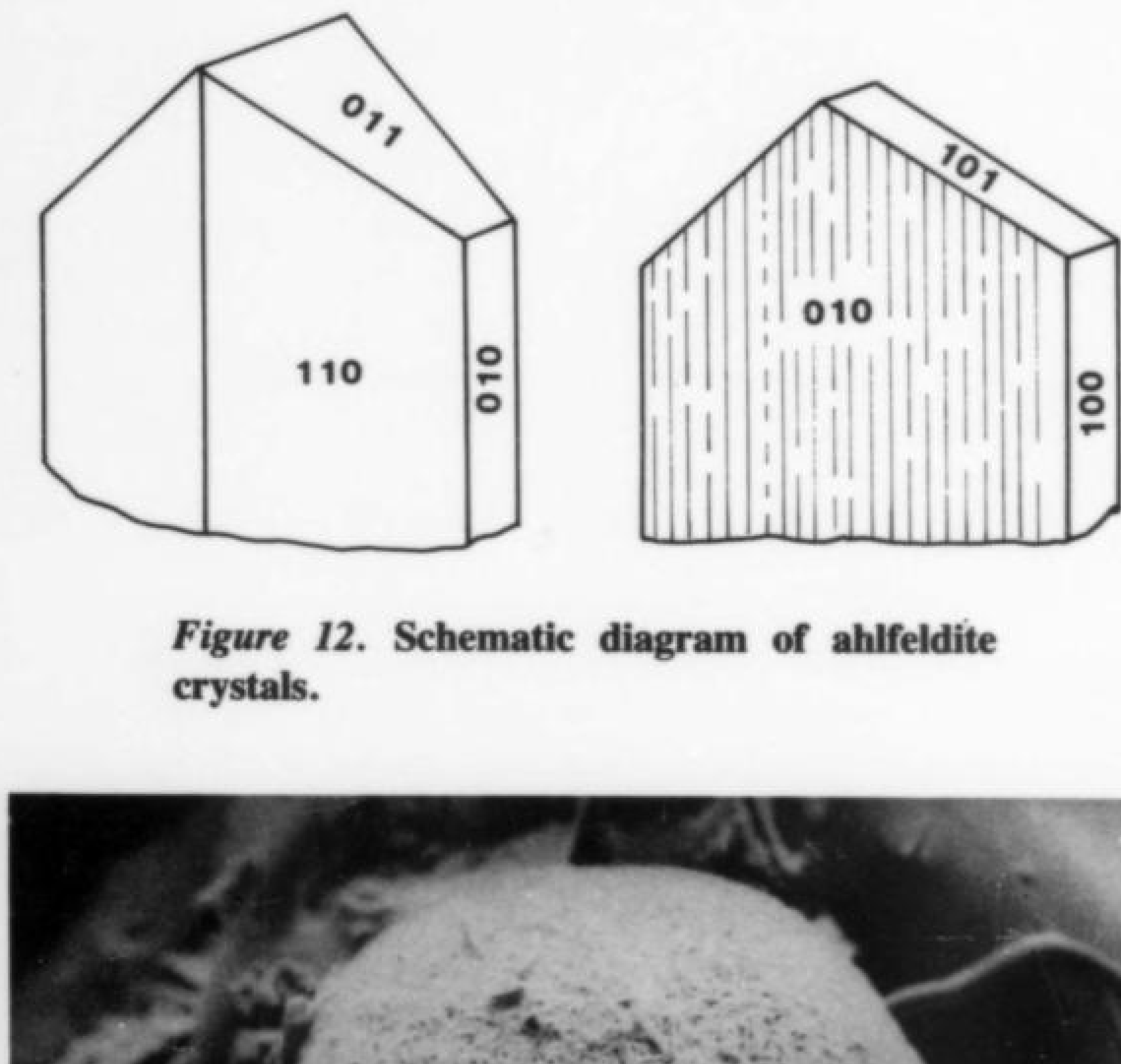


Figure 12. **Schematic diagram of ahlfeldite crystals.**

Figure 13. **Sphaerolites of ahlfeldite on chalcomenite. SEM photomicrograph.**

Allophane $xAl_2O_3 \cdot ySiO_2 \cdot zH_2O$

Allophanes are amorphous weathering products of silicate rocks. On many hand specimens from El Dragón this material was the last to form before the selenites. White allophane occurs as reniform masses, either alone or in association with basaluminite, chalcomenite and (occasionally) esperite. Blue aggregates, which have either incorporated copper into the crystal lattice or are intergrown with chalcomenite, are rare.

Alunite $KAl_3(SO_4)_2(OH)_6$

Alunite was identified by X-ray analysis of white spherical aggregates, some of which have yellow surfaces. It formed as a result of reaction between the sulfate solutions and the host rock. The spheres, which are up to 1 mm in diameter, occur on chalcomenite and/or clinochalcomenite.

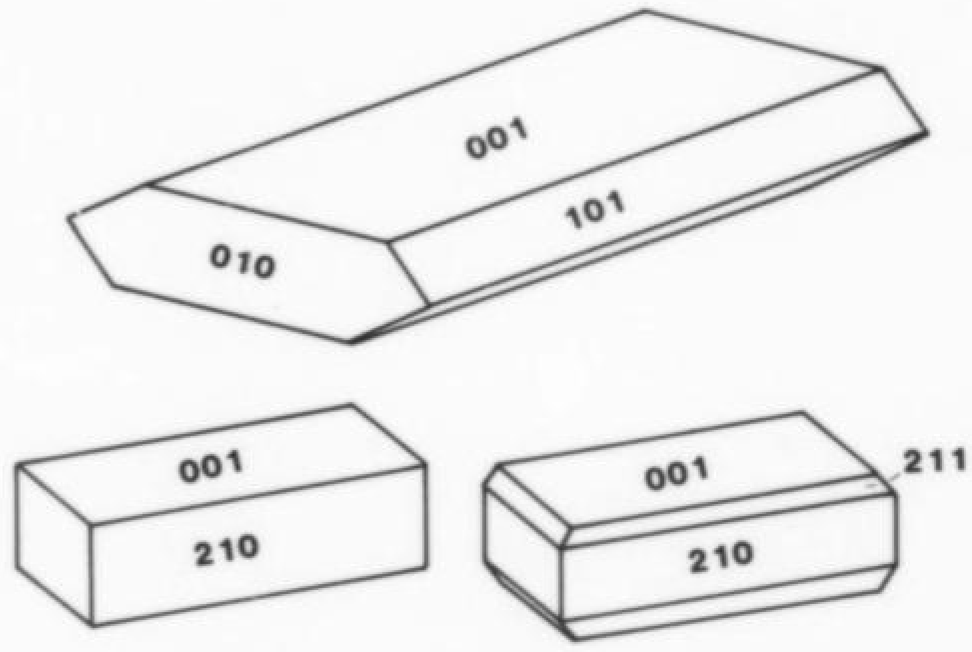


Figure 14. **Schematic diagram of anglesite crystals.**

Anglesite $PbSO_4$

Idiomorphic crystals are tabular (parallel to (001)), and often measure up to 2 mm on an edge (Fig. 14). Apart from {001} and {010}, only {210} is developed. This form is also often intergrown in a herringbone pattern parallel to (001), or in elipsoidal globules. A combination of {001}, {010} and {101} is less common—these crystals are also tabular parallel to (210). Forms which are elongated parallel to [001] exhibit only the orthorhombic pyramid {211} and the prism {210}. The habits may also be acicular. They have a satiny luster like kerstenite, with which they may easily be confused. The crystals are usually colorless, but may have milky cores. Anglesite is always associated with chalcomenite and basaluminite, and has been observed on goethite.

Aragonite $CaCO_3$

Aragonite occurs in thin needles up to 0.1 mm in thickness and up to 2 mm long. These often form botryoidal spheres of up to 5 mm in diameter on goethite pseudomorphs after dolomite and/or calcite (?).

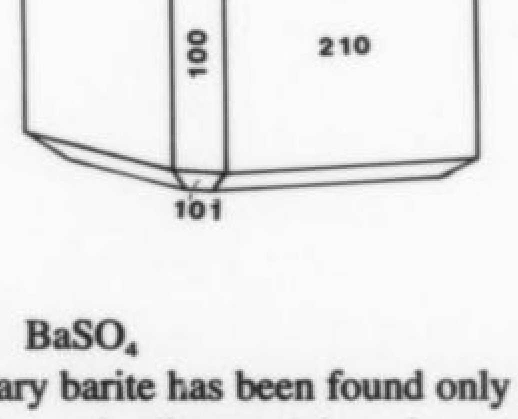


Figure 15. **Crystal drawing of a barite crystal.**

Barite $BaSO_4$

Secondary barite has been found only as a single crystal tabular on (001) (0.2 mm in diameter) in a drusy vug (Fig. 15).

Basaluminite $Al_4(SO_4)(OH)_{10}\cdot 5H_2O$

The formation of basaluminite is presumably due to reaction between the sulfate-bearing solutions and the host rock. Basaluminite usually forms granular masses on allophane. Chalcomenite crystals are commonly embedded in these masses. Basaluminite also forms 0.1-mm crystals, which aggregate to form white spheres with a mother-of-pearl luster, on goethite.

Calcite $CaCO_3$

At least some of the calcite present formed in the weathering zone, as evidenced by the 0.1-mm idiomorphic rhombohedral crystals in cavities in the goethite pseudomorphs after an older generation of the calcite. They form spherical aggregates which have malachite crusts. Ahlfeldite and chalcomenite are observed nearby, but not in direct contact with the calcite.

Chalcomenite $CuSeO_3\cdot 2H_2O$

Chalcomenite is the most common secondary mineral, occurring in every paragenesis. In many cases it is, with allophane and basaluminite, the earliest phase. It occurs in many different habits. Crusts and subhedral aggregates are common. Stubby crystals show mainly the forms {110}, {010} and {011}, and also the combination of {110}, {120}, {101} and {011}. Wedge-shaped crystals which are tabular parallel to (010) are most common (Fig. 16 and 17). Platy crystals often form spheres up to 4 mm in diameter. Other forms could not be measured because of the spherical shape of the aggregates. The color varies with transparency, from pale to dark blue and from green to blue-green. Malachite occurs encrusting chalcomenite. The crystals show conchoidal fracture but no cleavage.

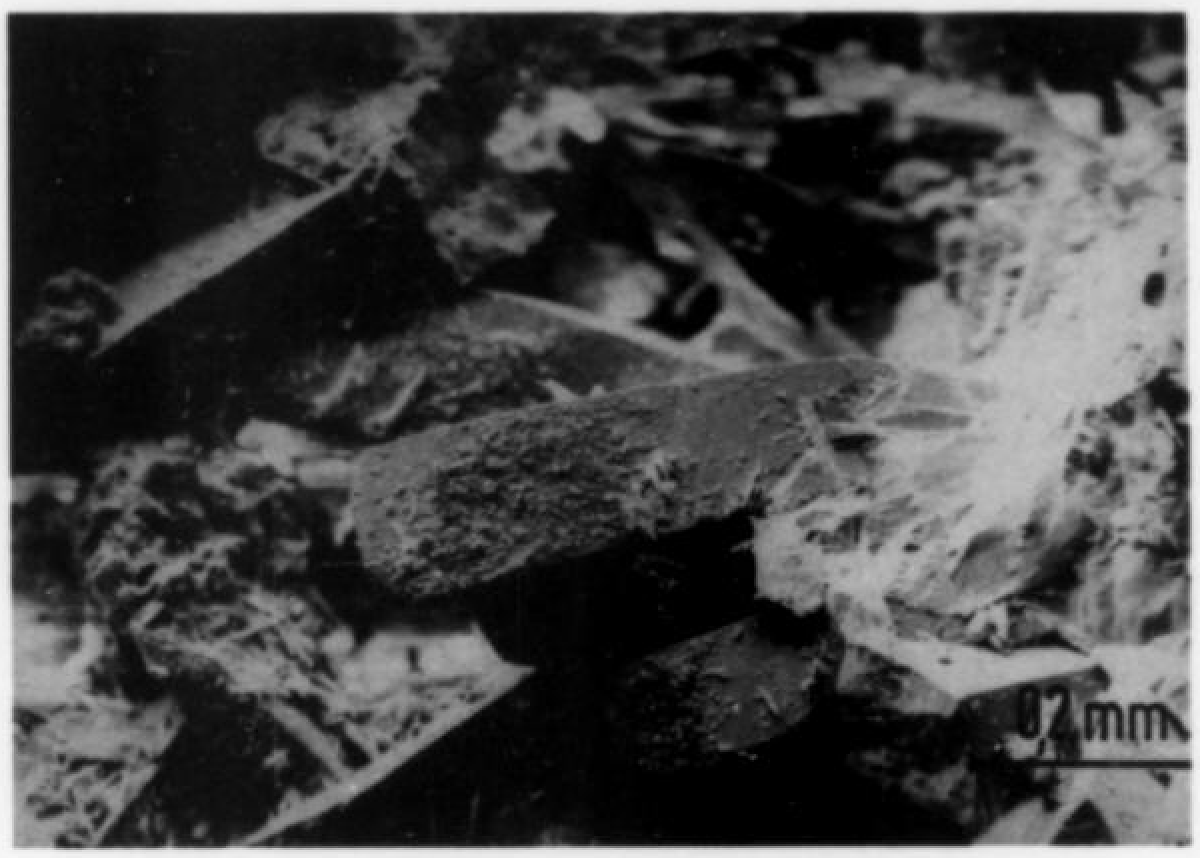


***Figure 16*. Wedge-shaped chalcomenite crystals partially overgrown by kerstenite crystals. SEM-photomicrograph.**

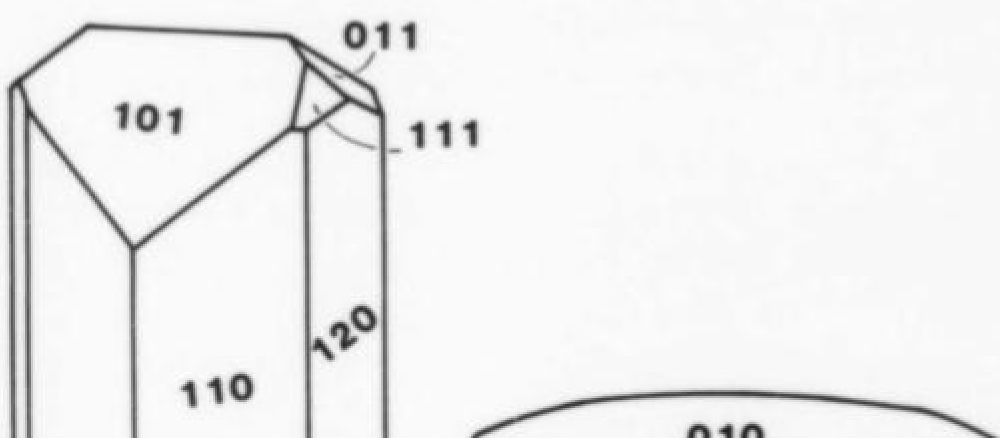


***Figure 17*. Schematic diagram of chalcomenite crystals, adapted from Palache *et al.* (1951).**

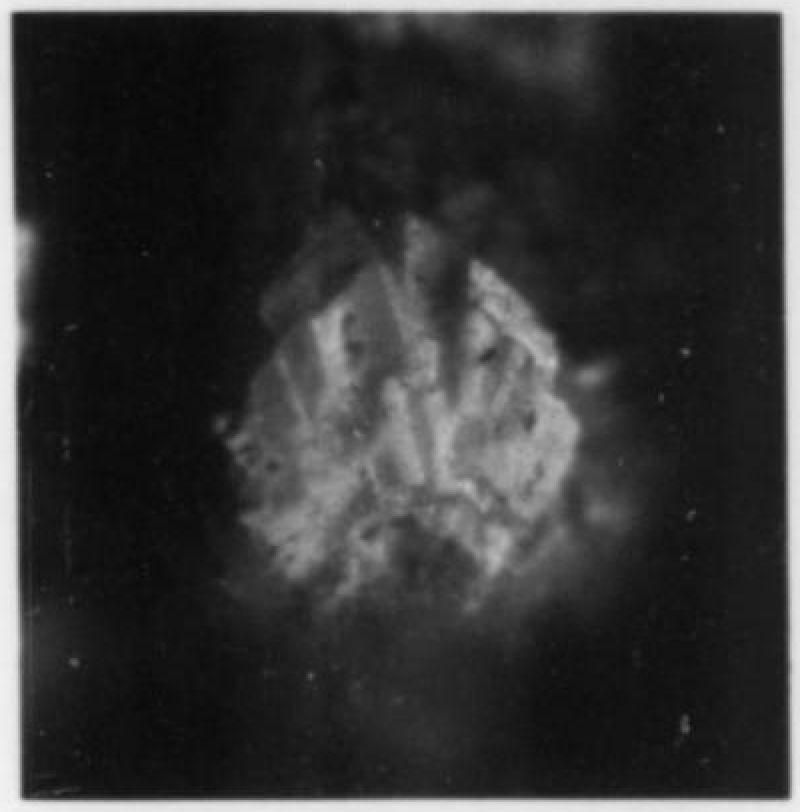


***Figure 18*. Clinochalcomenite on chalcomenite. Width of photo 2.3 mm. Photo by GSK.**

***Figure 19*. Clinochalcomenite aggregates with well-developed cleavage. SEM photomicrograph.**

***Figure 20*. The typical habit of clinochalcomenite, showing the forms {001}, {010} and {100}, on altered chalcomenite crystals. SEM photomicrograph.**

Clinochalcomenite $CuSeO_3\cdot 2H_2O$

Clinochalcomenite was reported in China in 1980 by Lo *et al.*, although Des Cloizeaux and Damour apparently described this monoclinic polymorph of chalcomenite as early as 1881. Clinochalcomenite is much less common than chalcomenite at El Dragón. It forms partly from chalcomenite, as patchy crusts or powdery coatings or as pseudomorphs. Up to two-thirds of the chalcomenite crystals may be replaced. Clinochalcomenite may be easily distinguished from chalcomenite by its pale green to pale blue-green color. The crystals, which may be rather poorly developed, reach up to 0.3 mm in length (Fig. 18, 19 and 20). The forms {100}, {010} and {001} are developed, which are typical of the monoclinic selenites. It has a well developed cleavage, which chalcomenite lacks. Clinochalcomenite is associated with chalcomenite, cobaltomenite, kerstenite and occasionally alunite.

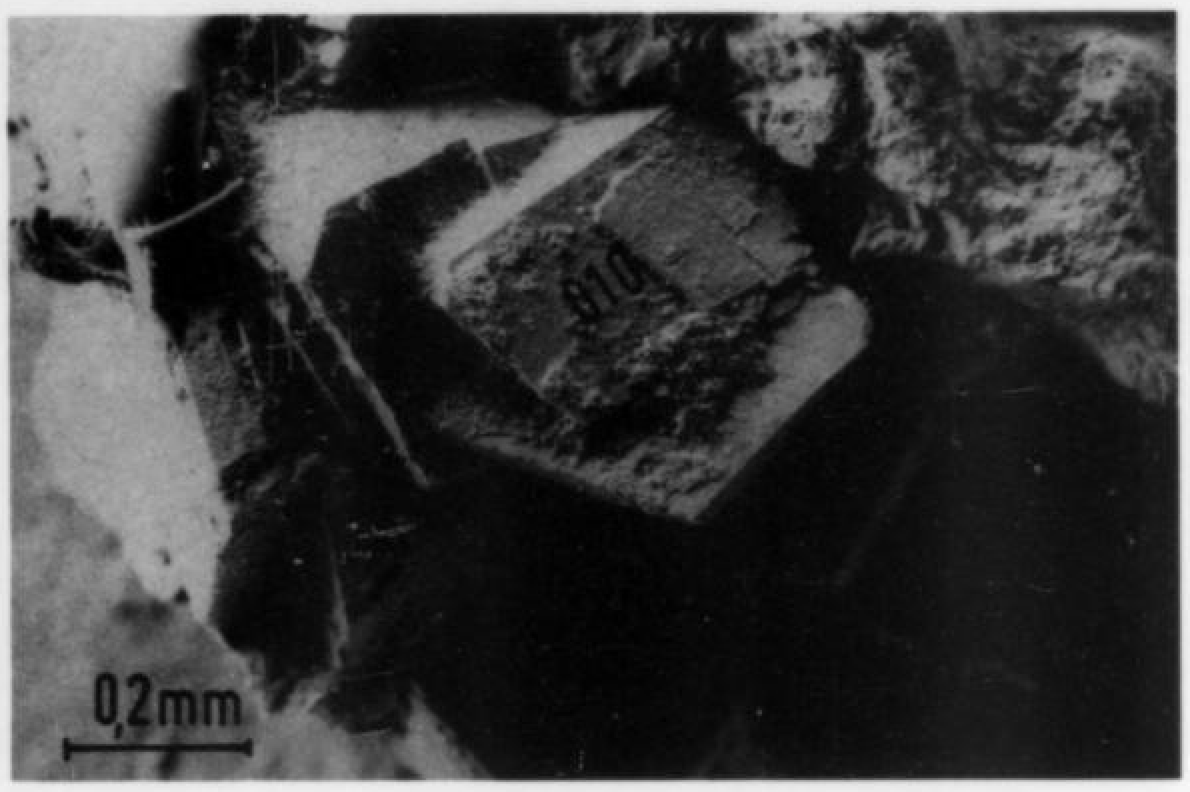


***Figure 21.* Cobaltomenite crystals on chalcomenite. SEM photomicrograph.**

Cobaltomenite $CoSeO_3 \cdot 2H_2O$

Crystals of cobaltomenite are obviously monoclinic, rarely transparent, and up to 1 mm long. They are flesh-colored, peach-blossom pink to brownish pink, and pale beige or yellowish beige in color, with a brilliant luster. Simple combinations of {001}, {100}, {010} and subordinately {101} crystal forms are observed (Fig. 21). The crystals occur as intergrown spheres or crusts under gypsum. They are usually late-stage developments, but may occur under chalcomenite and/or clinochalcomenite, suggesting that cobaltomenite and chalcomenite are of about the same age. Transparent crystals have been observed in association with lepidocrocite. Cobaltomenite may form directly from penroseite or from trogtalite.

Coronadite $Pb(Mn^{+4},Mn^{+2})_8O_{16}$

Coronadite has been identified on only one specimen, on powdery iron hydroxides. It occurs in black reniform masses which have very lustrous surfaces. The aggregates are up to 0.5 mm in diameter.

Covellite CuS

Covellite occurs in microscopic-scale intergrowths and is usually the first alteration product of chalcopyrite. The replacement of chalcopyrite by covellite is often observed at the border of chalcopyrite grains or veins.

Esperite $PbCa_3Zn_4(SiO_4)_4$

Esperite is very rare. It has been found on three specimens, in prismatic crystals up to 1 mm long which may be pseudohexagonal. Only {001} and {210} are developed, and the ends of the crystals taper off gradually (Fig. 22). Radial bundles of esperite crystals with well-developed cleavage are often observed on allophane. Esperite is also associated with chalcomenite, clinochalcomenite and (once) barite.

The identification of a zinc-bearing secondary mineral was a surprise, as an appropriate primary precursor has not been found. There are several indications that it may have been sphalerite.

Esperite has been previously described only from the high-temperature assemblage at Paterson, New Jersey. The present discovery of esperite at El Dragón in a low-temperature environment is therefore surprising. The diffraction pattern of the El Dragón material corresponds exactly to that of the type material from Paterson (see Table 3). The semiquantitative microprobe analyses show the main components Pb, Ca, Zn and Si. Traces of Fe and Al were also detected. These probably come from intergrowths of allophane. The El Dragón esperite fluoresces yellow under shortwave ultraviolet light, as does the type material from Paterson, New Jersey.

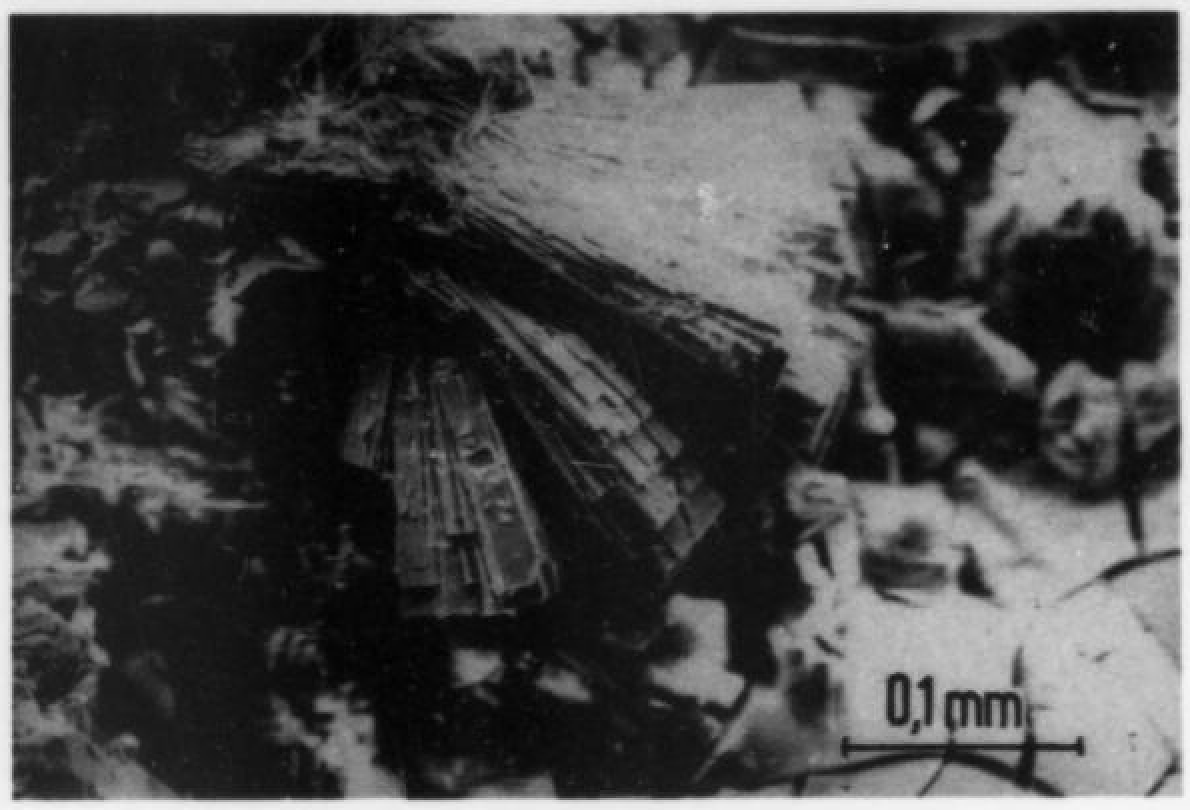


***Figure 22.* Esperite crystals with well-developed cleavage (parallel (100)) on allophane.**

***Table 3.* X-ray powder diffraction data for esperite.**

New Jersey		*El Dragón*	
d_{obs}	I/Io	d_{obs}	I/Io
7.62	45	7.597	50
4.41	16	4.458	10
3.02	100	3.021	80
2.884	35	2.898	30
2.543	75	2.555	100
2.367	40	2.340	20
1.944	45	1.950	30

(Comparison of the strongest lines)

Goethite $\alpha\text{-}Fe^{+3}O(OH)$

Goethite replaces krutaite to a depth of up to 2 mm, forming crusts made up of radial goethite needles. Reniform occurrences are pitch-black, while powdery aggregates are yellow. These powdery aggregates are often closely associated with chalcomenite and/or lepidocrocite, and rarely with younger coronadite. Goethite crusts sometimes form pseudomorphs after calcite in cavities, associated with ahlfeldite and chalcomenite. Goethite was observed once on siderite.

Gypsum $CaSO_4 \cdot 2H_2O$

Tabular (parallel to (010)), colorless and transparent gypsum crystals up to 2 mm on a side are occasionally observed on crusts of cobaltomenite.

Kerstenite $PbSeO_4$

Kerstenite from the El Dragón mine usually occurs as tiny needles (up to 0.5 mm long) on chalcomenite. They are milky white to somewhat yellowish in color and have a satiny luster. They are commonly aggregated in layers—in this case with a platy habit which may easily be confused with olsacherite (Fig. 23). However, kerstenite may also form prismatic crystals up to 1 mm long, formed by the orthorhombic prism {210} and the pyramid {211} (Fig. 24). These idiomorphic crystals are very similar to anglesite. In one case yellowish kerstenite crystals were observed on colorless anglesite.

Although the existence of kerstenite was questioned by Ramdohr and Strunz (1978), crystals from El Dragón in which selenium and lead are the only cations were confirmed by EDAX-analysis. X-ray

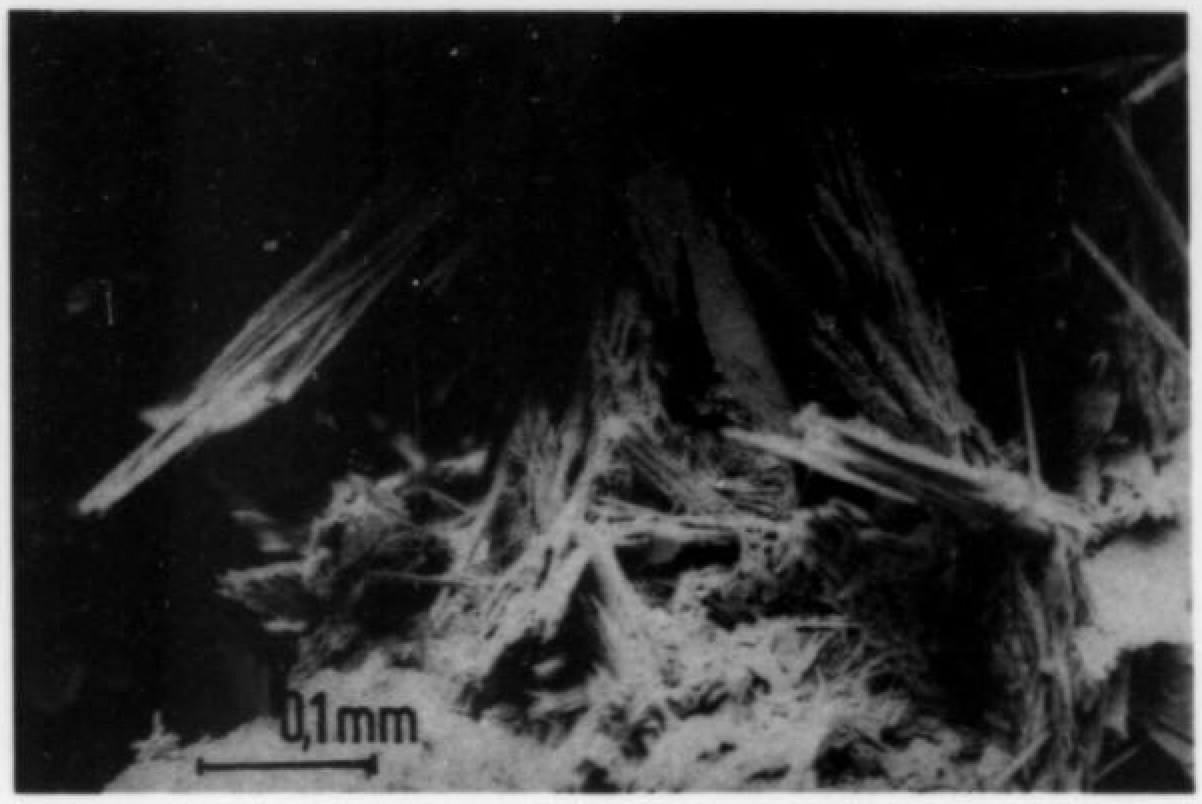


Figure 23. **Acicular kerstenite crystals intergrown with platy olsacherite. SEM photomicrograph.**

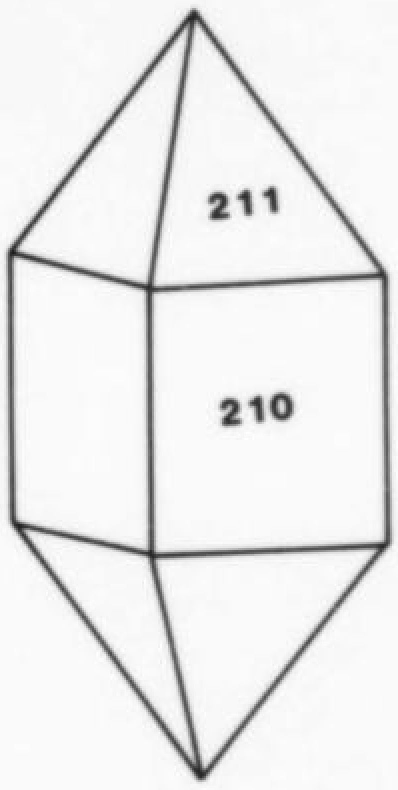


Figure 24. **Schematic diagram of a kerstenite crystal.**

analysis indicated *d*-values similar to those of anglesite. These results suggest that kerstenite exists as a distinct phase.

Lepidocrocite γ-$Fe^{+3}O(OH)$

Apart from the lepidocrocite which is associated with goethite, crystals tabular on (010) have been observed which are up to 0.1 mm long and orange or orange-red in color (Fig. 25).

Figure 25. **Tabular (parallel (010)) crystals of lepidocrocite on goethite. SEM photomicrograph.**

Linarite $PbCu(SO_4)(OH)_2$

X-ray analysis of lath-shaped, azure-blue crystals 0.5 cm long revealed the presence of linarite. The forms present cannot be determined, as the crystals are radially intergrown. They are observed on chalcomenite and associated with schmiederite, with which they may be epitaxially intergrown, as a result of their isotypy. Linarite also occurs both under and on malachite, indicating that it formed at about the same time.

Malachite $Cu_2(CO_3)(OH)_2$

Malachite is also always associated with older chalcomenite, but strikingly there is no direct contact between the two. Malachite occurs as green acicular crystals which usually form spherical aggregates up to 1 mm in diameter. It is further associated with schmiederite on goethite, older basaluminite and ahlfeldite, and linarite and kerstenite of the same age as the malachite.

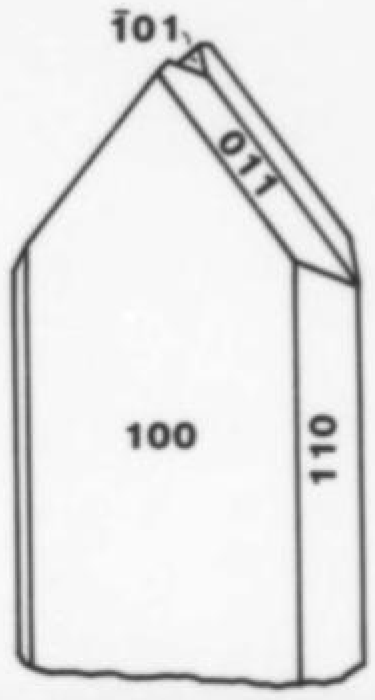


Figure 26. **Schematic diagram of twinned crystals of mandarinoite.**

Figure 27. **Group of mandarinoite crystals on chalcomenite. SEM photomicrograph.**

Mandarinoite $Fe_2^{+3}(SeO_3)_3{\cdot}6H_2O$

Mandarinoite was described by Dunn *et al.* (1978) from Hiaco, Colquechaca, Bolivia, where it is associated with ahlfeldite, cobaltomenite, chalcomenite and molybdomenite. In the El Dragón mine mandarinoite has only been observed on krutaite, in association with chalcomenite and kerstenite. The pale to olive-green crystals are elon-

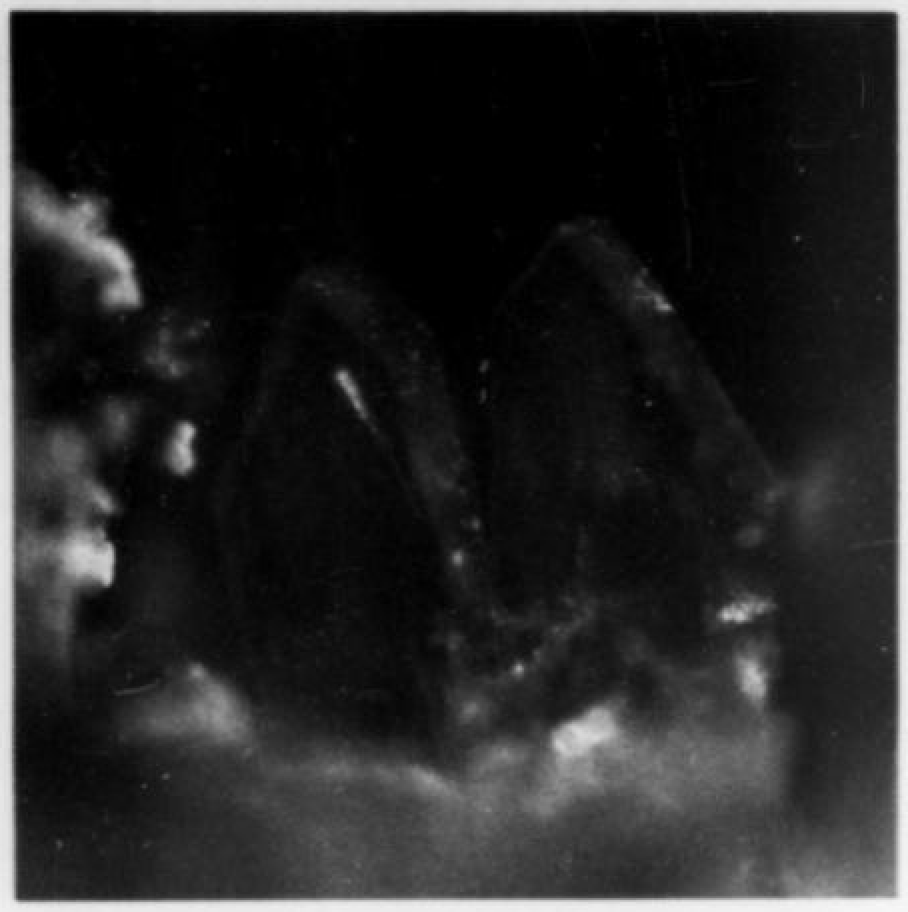


Figure 28. **Group of mandarinoite crystals. Width of photo 1.8 mm. Photo by GSK.**

gated parallel to [001] and twinned parallel to (100) (Fig. 26). As the {101} form is not well developed, the twinning cannot always be seen macroscopically. Apart from {101}, the crystals exhibit {100}, {110} and {011}. The crystals are up to 1 mm long and occur in groups and in hedgehog-like bundles (Figs. 27 and 28).

Molybdomenite $PbSeO_3$

Molybdomenite has seldom been found, as there is little lead in the El Dragón system. It is also easily confused with anglesite. Molybdomenite occurs in colorless, 0.1-mm pseudo-orthorhombic crystals combining {001} and {110}. They occur near or on chalcomenite and cobaltomenite in cavities in krutaite. Tabular (010) crystals, banded parallel to (001), may be up to 2 mm on a side. Molybdomenite may also form crusts, or needles parallel to [001], or yellowish white lumps associated with schmiederite. It is always associated with chalcomenite.

Figure 29. **Olsacherite crystal aggregates (pale yellow, needle-like) in association with chalcomenite (blue). Width of photo 5 mm. G. Grundmann photo.**

Olsacherite $Pb_2(SeO_4)(SO_4)$

Olsacherite was first discovered at the Pacajake mine in Bolivia. It was described by Hurlbut and Aristarain (1969). The olsacherite crystals found in the El Dragón mine are usually acicular (elongated parallel

Figure 30. **Platy olsacherite crystals underlying acicular kerstenite crystals. SEM photomicrograph.**

to [010]). They are always white and have a satiny luster. Olsacherite is also often platy, like kerstenite, and may be bent, or form "fir tree" shapes, which reach 2 mm in length (Figs. 29 and 30). It is associated with chalcomenite, ahlfeldite, goethite, lepidocrocite and younger kerstenite.

Reevesite $Ni_6Fe_2^{+3}(CO_3)(OH)_{16}\cdot 4H_2O$

The identification of reevesite was a surprise, because this very rare mineral has only been recognized previously in the Wolf Creek meteorite and in South African nickel ore. Yellowish green to pale blue crusts on krutaite/penroseite from the El Dragón mine formed on the $\{10\bar{1}0\}$ cleavage of the altered dolomite. X-ray diffraction analysis revealed the same pattern as the original material from South Africa. The reevesite may be associated with a little ahlfeldite and chalcomenite.

Figure 31. **Radial spray of schmiederite in association with chalcomenite crystals (deep blue). Width of photo 3 mm. G. Grundmann photo.**

Schmiederite $(Pb,Cu)_2SeO_4(OH)_2$ (?)

Schmiederite was discovered by Olsacher in 1962 at the Condor mine in Argentina (Hintze, 1965). In 1987, Effenberger determined the crystal structure and found that both selenite and selenate groups occur in schmiederite. Furthermore, the structure is closely related to that of linarite, which permits epitaxial intergrowth of these phases. Schmiederite has now also been identified in the El Dragón mine, where it occurs as acicular crystals up to 1 mm in length with a characteristic satiny luster. These form radial aggregates up to 2 mm

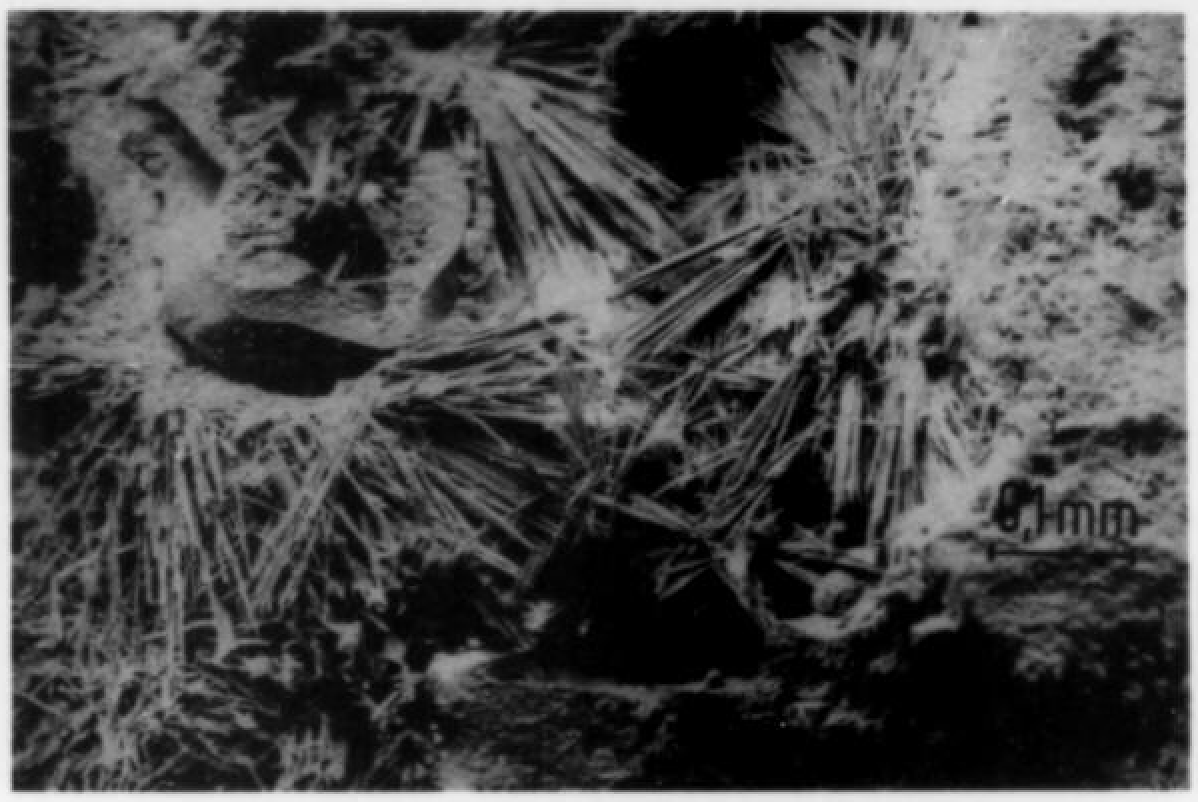


Figure 32. **Acicular schmiederite crystals in chalcomenite relicts. SEM photomicrograph.**

across (Figs. 31 and 32), pale to deep Prussian-blue in color and usually occurring on or near chalcomenite. The other selenites may also occur in this paragenesis. Schmiederite may replace chalcomenite radially, and be epitaxially intergrown with linarite.

Siderite $FeCO_3$

Siderite also occurs in the weathering zone, in the form of flesh-colored rhombohedra up to 0.2 mm on weathered krutaite/penroseite, associated with chalcomenite, clinochalcomenite and goethite.

PARAGENESIS

Secondary minerals are newly formed or replacement minerals which occur in the oxidation zone. They result from the reaction of the primary ores with O_2, CO_2 and H_2O. Where sulfides are the principle minerals, their alteration products, after reaction with sulfuric acid and sulfurous acid, are often sulfates of the metal ions involved. However, deposits containing mainly selenides form selenium-bearing acid (H_2SeO_3) which is much more stable than sulfurous acid. Furthermore, this acid is a particularly good oxidizing agent, which explains the more common formation of selenites as opposed to selenates, and the relative rarity of sulfates. Selenium-bearing acids, in the presence of rare sulfides which form the sulfurous acid during weathering, oxidize sulfurous to sulfuric acid. The latter reacts with the ores to form sulfates. Selenites are therefore more common than selenates, and sulfates are more common than sulfites. The formation of selenites is further promoted by the Andean climate in the Potosí region.

It is assumed that the selenide mineral krutaite was the main primary mineral involved in the alteration processes in the El Dragón vein, and that it provided most of the selenium which formed the selenium-bearing acids. Accessory minerals played only a minor role. The sulfates formed mainly from the sulfide minerals chalcopyrite and pyrite.

Six paragenetic sequences have been observed (Fig. 33); in five of these the primary mineral is known. (1) During the first sequence, chalcomenite and/or clinochalcomenite formed from the copper contained in the krutaite, although clinochalcomenite may also have formed from chalcomenite. (2) The cobalt from the penroseite/trogtalite was incorporated in cobaltomenite, and its nickel in ahlfeldite. Reevesite formed from iron in the presence of carbonic acid. Most of the cobaltomenite formed during the second sequence. Trogtalite was the primary mineral. (3) Mandarinoite, goethite and/or lepidocrocite formed the third iron-rich paragenesis, with secondary siderite.

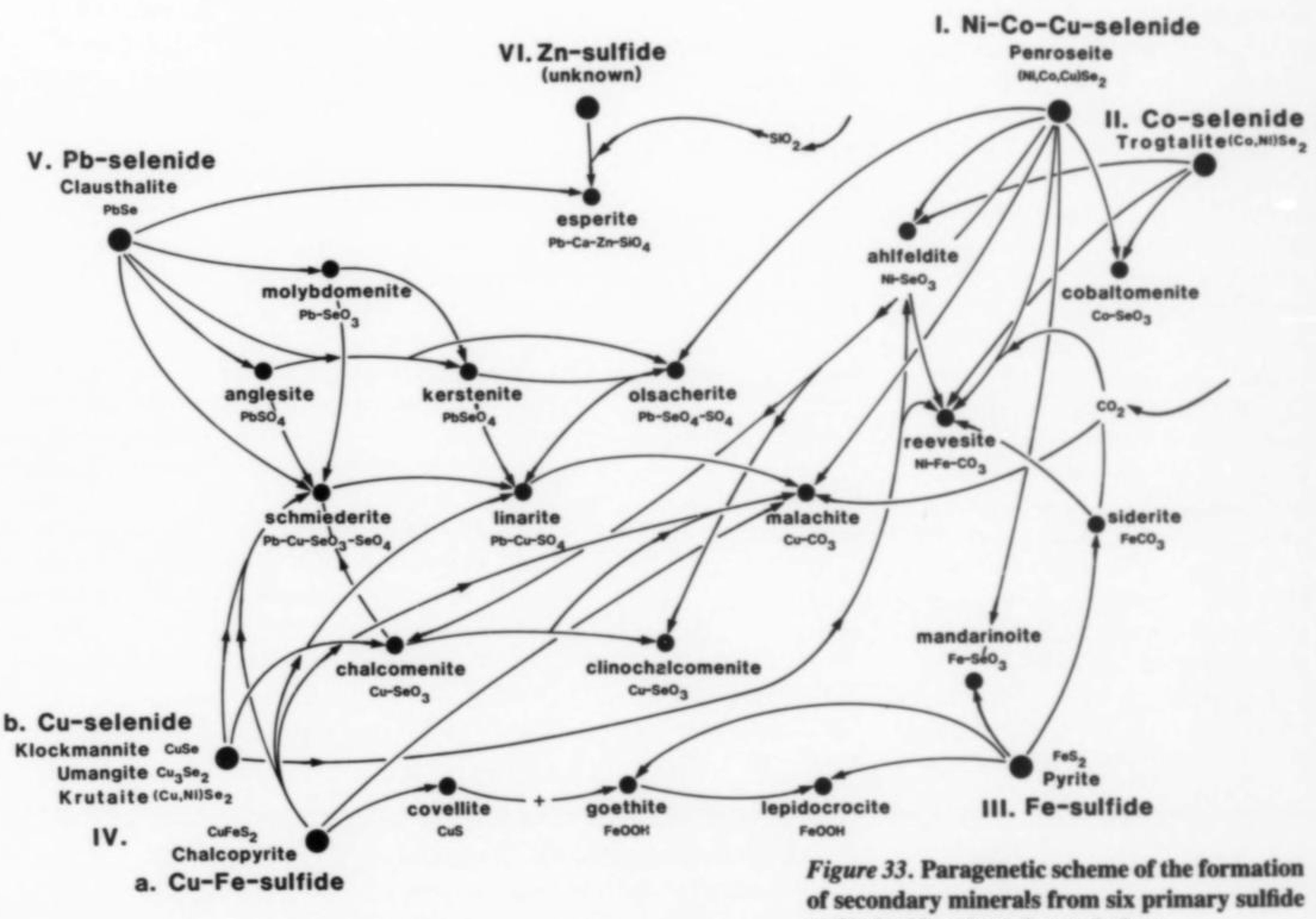


Figure 33. **Paragenetic scheme of the formation of secondary minerals from six primary sulfide and selenide mineral associations.**

(4) The fourth paragenesis formed from the primary copper minerals, and may be subdivided into Cu selenides and Cu sulfides. Covelline and goethite formed from the chalcopyrite, which in turn formed from the sulfide phases. Most of the copper, however, reacted with the selenium-bearing acids to form chalcomenite, which may have been altered to clinochalcomenite. Chalcomenite and clinochalcomenite, however, mainly formed as the result of alteration of the copper selenide krutaite. (5) Schmiederite formed from the lead from the fifth sequence. Sulfuric acid reacted with the lead and copper ions to form linarite, or malachite in the presence of carbonic acid. Clausthalite provided the lead ions to form molybdomenite, schmiederite, linarite, kerstenite, olsacherite and esperite. (6) Esperite (Pb-Ca-Zn silicate) was formed in the sixth sequence from an as-yet unknown zinc mineral (probably sphalerite), lead from the fifth sequence, calcium and SiO_2.

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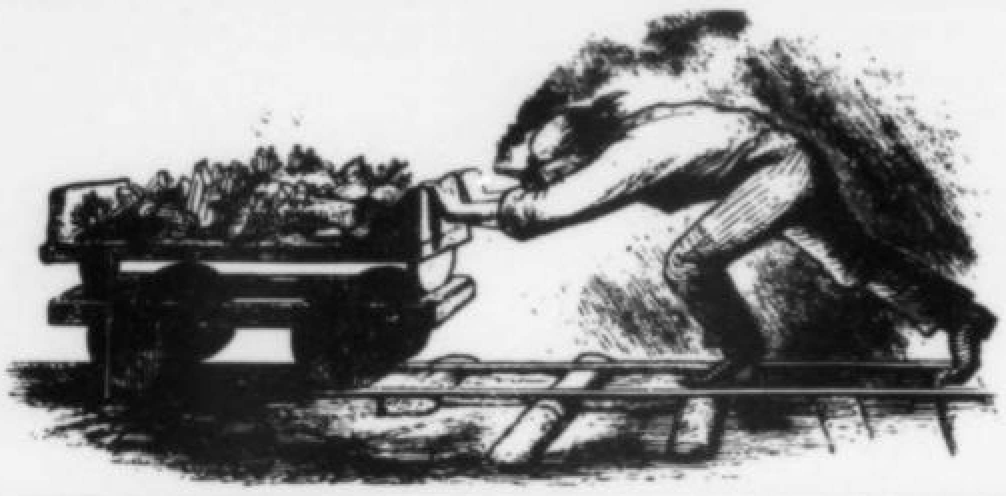
Colorado  Dealers

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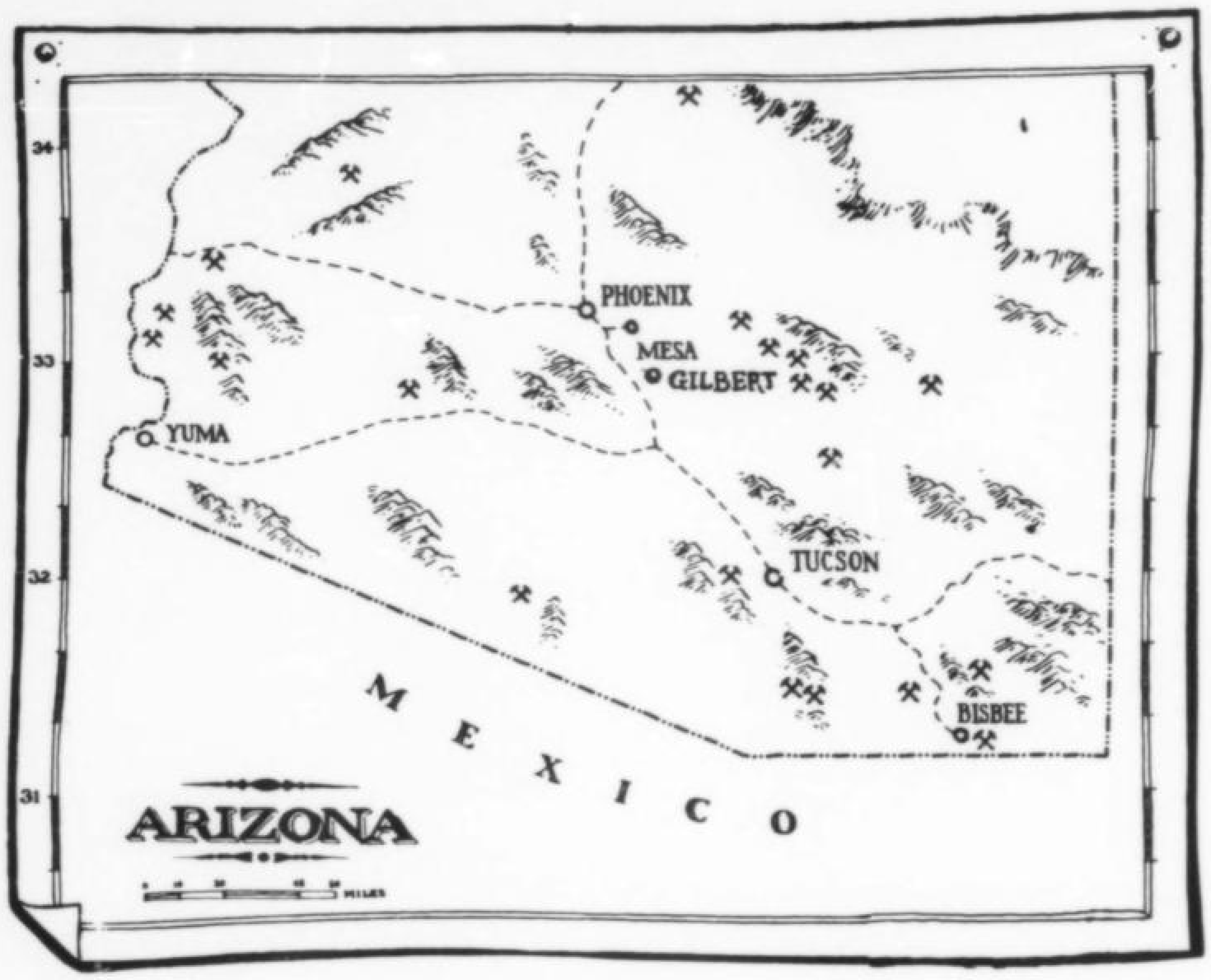
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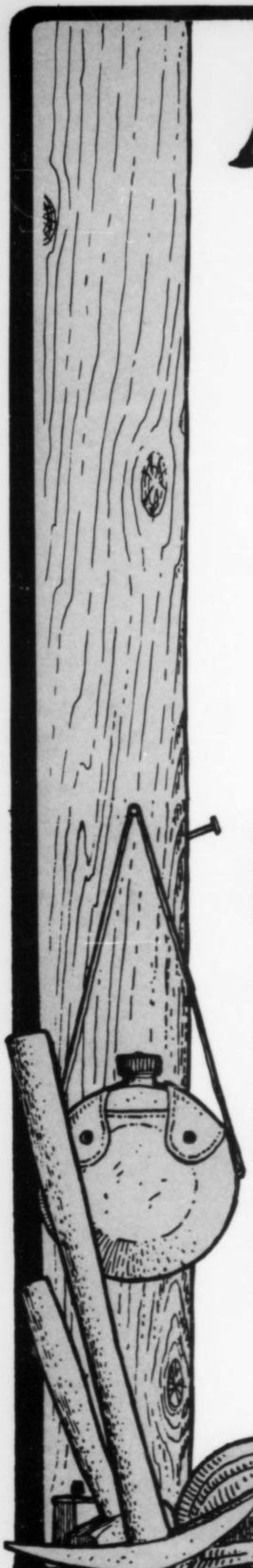


WULFENITE
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ARIZONA'S SILVER MINING DISTRICT

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One of the American West's most bleak, dangerous and, until recently, remote areas is the Silver mining district located some 30 miles north of Yuma, Arizona. Men have died of thirst while searching for mineral wealth in the district's jagged mountains when only miles from the Colorado River. In spite of the dangers the Silver district has provided the mineral collector with a wealth of superb micro-sized specimens and many of the world's finest wulfenite crystals.

EARLY HISTORY of SOUTHWESTERN ARIZONA

Probably as early as A.D. 1000 small bands of Yuma Indians inhabited bits of land along the banks of the Colorado. The Yumas were warlike, barely clothed, carrying five-foot bows, long arrows and sharp pointed lances. Living quarters were primitive rectangular-shaped *wickiups* made of brush before whose doorways dung was burned during the mosquito season to keep insects away (Waldman, 1988).

One of the first white men to enter the Yuma region was Melchior Diaz, who in 1540 marched north from Mexico into Arizona along a portion of a route later to be known as the Camino del Diablo ("road of the devil"). Most travelers were simply unprepared for such a long trail, nearly devoid of water and blistered each day by intense heat. Many did not survive the journey. The greatest loss of life occurred during the gold rush to California when scores of lonely graves appeared along the barren route (Wilson, 1933).

In 1699 the Jesuit Padre Eusebio Kino and later Franciscan Monk Fray Garces attempted to convert the Yuma Indians, but without much success. Priests established a mission and presidio on the Colorado River near the present site of Yuma only to see it destroyed during the Indian rebellion of 1781. Thereafter the Spaniards were not a force along the Colorado (Wilson, 1933). Indians continued to prey on wagon trains crossing their territory, finally closing Colorado River crossings at the mouth of the Gila River and at Yuma. In 1850 the U.S. Army built a fort at Yuma and the Indians were finally subdued (Hamilton, 1881). Settlers and miners took the most workable lands from the Indians, but a handful of Indians remain today, most of them living on the Yuma and other Indian reservations.

HISTORY of the SILVER DISTRICT

It is not known when minerals were first discovered in the Silver district, but surface workings and the remains of crude smelters now overgrown by mesquite and palo verde trees, and possibly dating as far back as the 1600's, have been found in the nearby Castle Dome lead district (Raymond, 1872).

It is believed that Jacob Snively became the first prospector to discover ore in the Trigo Mountains when he found silver in 1863. He did not pursue his discovery, feeling the ore was of insufficient value to be mined (Anonymous, 1878).

In the winter of 1877 George Norton of Yuma grubstaked Neil Johnson and others to prospect the Trigo mountain range. Within a short time Johnson discovered the Black Rock and Pacific mines and filed notices at the Yuma County Court House (Anonymous, 1895). A year later Warren Hammond pawned his shotgun in Yuma for a grubstake and promptly found the Red Cloud deposit (Anonymous, 1895). Serious mining began within weeks but shortages of building materials forced miners to construct brush huts at the Red Cloud mine and to dig rooms into cliffs on Black Rock Wash.

The Silver district was officially established when a group of miners held a meeting on January 20, 1879. Warren Hammond chaired the meeting and Walter Millar was elected to be official claims recorder. Approved resolutions prohibited Chinamen from working in the district and liquor from being sold at the mines. The sale of liquor would be permitted at Norton's Landing (Anonymous, 1879c).

At the time of its establishment the Silver district was in Yuma County, but in 1982 county residents voted to divide the county, with the northern portion becoming the new county of La Paz. The Silver

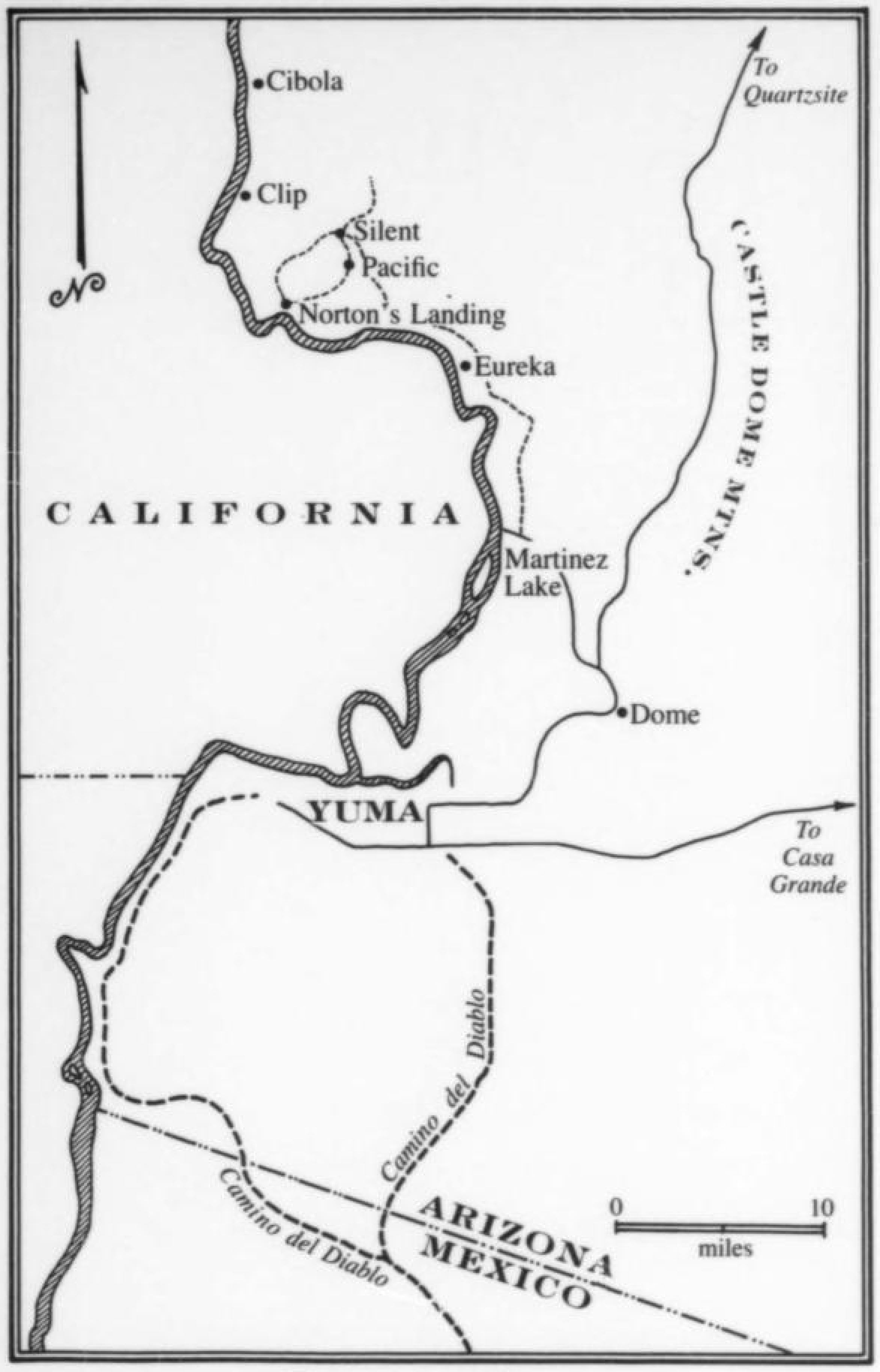


Figure 1. **Location map.**

district, now entirely within La Paz County, covers an area approximately 36 square miles. The district's main feature is the rugged Trigo (Spanish for "wheat") Mountain range with peaks reaching 3000 feet above sea level.

In the district's larger mines ore was sorted underground. Selected ore was carried to the surface on human backs or was drawn up in rawhide buckets. Burros carried ore to the Colorado River where it was loaded aboard steamers bound for the gulf of California. There the cargo was placed aboard ocean-going vessels headed for Wales. Later ore concentrates were sent to the Selby smelter in San Francisco (Wilson, 1933). On June 10, 1879 Julius Liebeck, a graduate of the Freiberg School of Mines in Germany, reported to Prescott's *Daily Miner* that the Silver district was a "true bonanza," precipitating a rush of miners and speculators to the district.

Unfortunately the Silver district's early recorded mining history is seriously flawed by frequent inconsistencies in the literature. There is disagreement about mine ownership, production records and even the location of towns and smelters. Considering the district's isolation, primitive living and working conditions and poor communications, some inaccuracy is understandable. But various documents are so incompatible as to suggest careless reporting and deliberate attempts to hide facts.

An extensive review of U.S. Postal records, Yuma County mining claim notices and assessment documents, as well as the general literature, has cleared up numerous inaccuracies permitting a much more accurate profile of conditions as they were. Most of the confusion involves the Red Cloud mine, the nearby small settlements of Pacific City, Norton's Landing and Silent, and two smelters.

Discovered in 1878, the Red Cloud mine was sold the following year to the nearly bankrupt Iron Cap Mining Company, apparently a "front organization" for mining promoters Governor Charles Fremont and Arizona Supreme Court Justice Charles Silent (Love, 1974). Fremont, nationally known pathfinder, politician and owner of the 40,000-acre Mariposa Ranch in California, had lost his fortune attempting to extend the Texas Pacific, and Memphis and El Paso railroads across Arizona to San Diego, California. On June 8, 1878, President Rutherford B. Hayes appointed Fremont as Governor of Arizona Territory with offices at the State Capital in Prescott (Fireman, 1964; Nevins, 1928). At this time Fremont's finances were so low that he was forced to borrow $1,700 from a Prescott bank for living expenses (Fireman, 1964).

In 1879 Fremont appointed his longtime friend, Charles Silent, to the Arizona Supreme Court. Silent had grown up in Drytown, Amador County, California, during the gold rush and had built narrow-gauge railways, roads, wharves and occasionally had invested in mines. As a token of friendship, Fremont gave Silent the sextant he had used to chart much of the West (the sextant is now in the Bancroft Library, University of California). In an attempt to recoup their financial losses, the two men formed a partnership aimed at buying Arizona mines and offering them for sale in the East (Love, 1974). Fremont maintained a hidden role in his mining operations, using Silent to sign contracts, and as he said, "I being governor, it avoided unnecessary talk" (Fireman, 1964).

Governor Fremont and Judge Silent left for Washington on official business in the Spring of 1879. They were successful in persuading the Congress to prevent the resettlement of Pima Indians from Casa Grande Valley to the Salt River Valley, which showed great promise for irrigated farming (Fireman, 1964). Their next stop was New York where they made "barrels of money back east selling mines" (Anonymous, 1879a). Later that fall, Fremont's wife, Jessie, moved to New York to be his agent for mining and land promotions (Fireman, 1964).

Silent returned to Arizona and immediately bought the Red Cloud and 19 other claims for a reported $100,000 with a down payment of $10,000 in gold coin (Anonymous, 1879b). Governor Fremont wrote to a business associate in New York on July 31, 1879, that "Messrs. John Hoey and J. C. Babock of the Adams Express Company have executed a contract with me for the sale of some twenty mines" (Love, 1974). The Adams Express people sent a Mr. Maynard to inspect the mines and, while in Arizona, he was a house guest of Silent. Maynard told the *Arizona Sentinel* "the Red Cloud fully met his expectations" (Anonymous, 1879d).

Fremont invested in mines all over Arizona, including the Silver Prince in the Bradshaw Mountains south of Prescott; the Copper King and the Green Crystal claim (later to become the great United Verde mine at Jerome); and a 100-square-mile mineralized area between Tombstone and Nogales; all in addition to his interests in the Silver district (Fireman, 1964). Fremont's long absences from the capital while engaged in mining ventures received wide condemnation throughout the territory. Leading the attack was editor John P. Clum, of the *Tucson Citizen* (who later was founder of the Tombstone *Epitaph*), who used every editorial opportunity to discredit Fremont (Fireman, 1964).

A number of Arizona Territory legislators were upset with the Fremont/Silent mining transactions. Congressman Campbell preferred charges against Silent in April of 1880 for buying and selling mines within the jurisdiction of his court. Silent was also accused of drawing three salaries set up by Fremont cronies. Republican Attorney General Devens reviewed the charges and stated "they were politically motivated since Campbell was a Democrat" (Anonymous, 1880a). In spite of his exoneration, Silent resigned his judicial post a few months later (Love, 1974). Finally, in October of 1881, President Chester A. Arthur asked for and received Fremont's resignation. In its October 25 issue the New York *Herald* noted that Fremont "seemed to regard

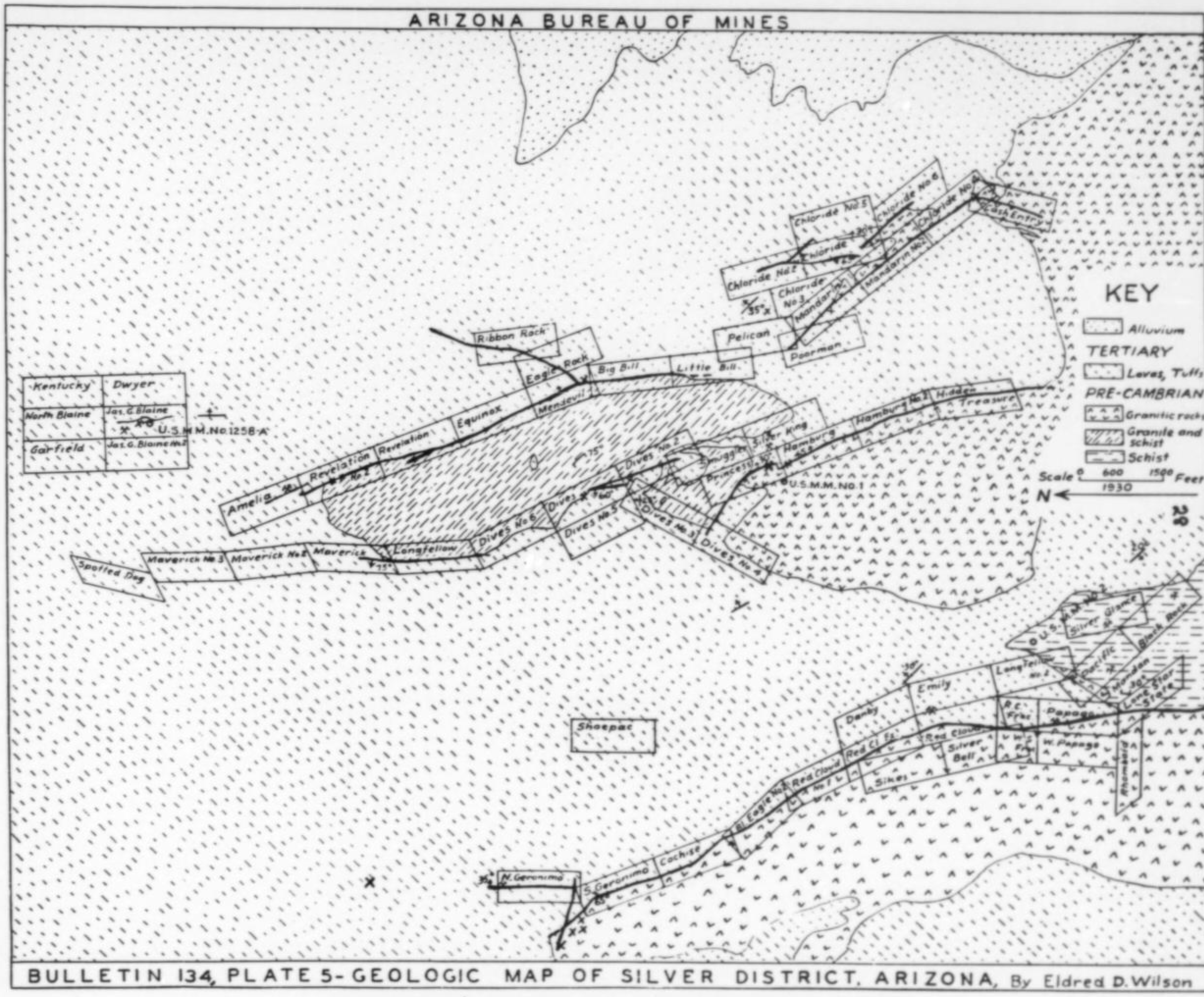


***Figure 2.* Claim map of the Silver district (from Wilson, 1933).**

the climate and society of New York as more agreeable and attractive than that of the Territory of Arizona."

There is no evidence that either Fremont or Silent were directly involved in any form of criminal conspiracy as they traded mining properties. Yet it is inconceivable that two of Arizona's most active mining brokers could be unaware and entirely free of the promotional shenanigans so prevalent in the Silver district.

The origin and location of Silent Township continues to puzzle historians. One reference placed Pacific City in Black Rock Wash and believed the town later became Silent. Another has Silent changing its name to Pacific. The *Arizona Sentinel* in its November 18, 1880 issue said the new post office at Norton's Landing would be named Silent Post Office. But U.S. Post Office records show a post office opened in Silent on November 8, 1880. Why wasn't the *Sentinel* informed? The Silent Post Office closed March 13, 1884; Pacific City Post Office opened November 30, 1880 (closed three weeks later on December 20, 1880); and Norton's Landing Post Office opened June 4, 1883, and closed August 24, 1888.

A preponderance of evidence places the town of Silent immediately adjacent to the Red Cloud mine. Further, Silent was *the* major town of the Silver district. One can only wonder if the town's location and importance were compromised to assist in closing mining deals with persons unfamiliar with the Silver district.

Various reports have placed the Red Cloud smelter at Silent and at the Red Cloud mine, and the Black Rock smelter at the Black Rock mine. Actually both smelters were built on the Colorado River (the only source of water in the district) at Norton's Landing, which is more than 10 miles from the reported locations. Visits to these areas in 1988 showed slag dumps at Norton's Landing, and none at the Red Cloud and Black Rock mines. These rather devious bits of information may not be of particular significance except that in all likelihood they were aimed at altering the extent of mining properties being offered for sale. The mystery deepens when two identical photographs of the same smelter are compared. Someone has printed on one: "Red Cloud Mine, A.T." The problem is that the photo is not of the Red Cloud mine, or even of the Red Cloud smelter. It is a photo of the Black Rock smelter (photo on file at the California State Library in Sacramento). Strangely, it shows only the lower portion of a man on horseback in front of a smelter. The man's upper body and head have been removed by a touch-up artist creating a silly image of a leg hanging from the saddle with the bridle held only by a hand. The other print is from the Carol Woolery photo collection and shows the entire man in the saddle, and there is no printing on the image. It is safe to assume the first print was doctored to hide the horseman's identity and to place the smelter at the Red Cloud mine. All facets of Silver district mining deals may never be known, but these examples illustrate a widespread public tolerance of attempts to mislead those who would invest in mining properties.

Figure 3. **Dr. Edwin A. Stanley, second from left, with a group of miners at the Red Cloud mine. From an 1881 tintype in the collection of Carol Woolery.**

The early 1880's were boom years in the Silver district. The Red Cloud mine became a big producer, employing nearly 100 miners. But hauling ore to the company's smelter on the Colorado River was expensive and time consuming. On March 19, 1880, the Colorado and Silver District Railroad was incorporated; the organizers were Milton Santee, J. D. Wilson and G. W. Norton. The company planned to build a railroad from Norton's Landing on the Colorado River to the Red Cloud mine. Alternate routes were surveyed up Black Rock Wash and Red Cloud Wash. Subsequent studies showed a road route for wagons could be cheaper; the railroad project was abandoned (Myrick, 1975), and instead Jesus Contreras and Joe Redondo were hired to transport ore, wood and charcoal by wagon to the smelter at Norton's Landing.

On May 10, 1880, the Yuma County Board of Supervisors ordered a wagon road built from Yuma to Pacific City. The road was soon extended to Silent whereupon a stage service operated three times a week between Silent and Yuma and Ehrenberg.

Steamers regularly plied the Colorado River. They made connections from Yuma to Silver district landings at Eureka, Norton and Silver Clip, and on up river to Cibola, a small ranching area devoid of gold (hardly one of the fabled Seven Cities of Cibola romanticized by Spanish explorer Francisco Coronado in the 1540's). Steamboats were built as stern-wheelers of shallow draft—some drawing as little as 2 feet of water. Submerged rocks, changing sandbars and floating debris could strand passengers and cargos of mining supplies for days. Riverboat schedules were irregular, to say the least.

The town of Silent grew rapidly. New buildings, crudely constructed of rough stones and lumber, included an assay office, hotel, general merchandise stores, a number of saloons and the La Cantina de la Plata, a combination saloon and dance hall. A. D. Crawford was appointed Justice of the Peace, becoming a busy man trying to keep the wild town under control.

Silent's first killing occurred in 1880 when a miner named Jesus Osuna got drunk and attempted to enter the bed of a married step-daughter who was ill. Forced to leave the house, Osuna was confronted by Juan Martinez who was irate over the incident. Osuna drew his pistol and missed with two shots before Martinez killed him (Anonymous, 1880b).

The next year saloon owner Paul Billeck, using a shotgun, put an end to rival Don MacLeod who operated the Pacific Exchange Saloon. A Yuma coroner's jury ruled the killer had acted in self-defense. In 1882 Billeck became Silent's postmaster (Love, 1974).

In 1881 reports circulated that the Red Cloud mine was not being handled properly and was in financial difficulty. Creditors attached a shipment of silver bullion enroute to San Francisco, and mine superintendent S. S. Draper was fired. His replacement was Charles Knapp, but when the mine continued to lose money, he too was fired. Dr. Edwin Stanley, who had just been hired to run the Black Rock smelter, was given a second job as "mine agent" in charge of the Red Cloud mine. Stanley sent for his wife Setti and three children (Tom, Cleo and Yula) and built a small house on the river. On October 5, 1881, Stanley's wife wrote a letter to her family in the East. The following excerpts have never been published and are graphic testimony to the trying times of all who lived in that inhospitable land. (Spelling and grammar have not been corrected.)

2 Norton's Landing
Oct 5th. 1881

Dear Home Folks All

Well we had a very pleasant trip down the Colorado by steamer. I have never enjoyed anything more. We went as far as old Mexico. We had all the quail, duck and plover we could eat—it got so I could cook by campfire firstrate. We came all

***Figure 4.* The steamer *Colorado* (at right) tied up at Norton's Landing on the Colorado River in 1881. The stacks of cut brush are fuel for the steamboat. Carol Woolery collection.**

the way from Yuma home in a carriage. Well we got home safe found all well. Well Clara & I washed all day Wensday and till noon Thursday. We both ironed all day saturday.

The children are the only white children ever been in the camp and the miners all humor and pet them & give them mony, candy, oranges & nuts.

The weather is getting cooler here now but we still sleep out doors. Yet expect we will have to go in by November. You can't do a single thing but mine ore & there is no vegetation what ever, only where you carry water from the river to water what you have growing. Doc thinks his mines are looking well as they go down deeper.

I killed a big rattle snake & a big Scorpion the other day in the kitchen under the woodbox. We had two hogs, the only ones in camp, but wolves carried off one of them early last summer.

Their has been a white lady living in camp ever since there has been a camp here. She was about 40 years old. Her husband is an easy kind of a fellow. She was a very dirty woman & hard to get along with. She was not a bad woman. She had not been very well all summer & she has had a man sinking a shaft in her mine & they quarreled about the pay for his work & one night about a month ago he got drunk & threating her & she got very badly frightened & was *confined*. Her husband sent for Doc but the child was born about 2 hours before he got their in fact just before they sent for him & she only lived a half hour after he got their. Their was no one their but Doc & the family when she died. They had to make a kind of a coffin but covered it on the out side with black and the inside with white muslin and it looked decent at least.

She was brought down here and buried here. It was dark before we got ready to start down so you know how I felt driving down the wash in the dark, not even a moon to give light, with a corpse in front of me, the driver & her husband set on the seat & her grown son set on her coffin to hold it in the spring wagon. Clara & I behind in the little buggy composed the funeral procession.

Well its very late & I must go to bed. I think this a very dreadfully long letter, please write soon all of you.

Our Love to All

Your daughter & sister Settie

(Letter courtesy of Carol Woolery)

On October 29, Stanley put the Red Cloud and Silver Mining Company mill and furnace into operation at Norton's Landing. But increasing debts led creditors to place the Red Cloud at sheriff's auction in October 1882. The highest bidder was the Deposit Bank of New York, but the bank made no effort to operate the mine (Love, 1974).

Silent's glory days were also over, and its businesses struggled to stay alive. Miners from other nearby mines continued to use the little town as a base for supplies and liquor and, as late as 1884, Julius Liebec was still operating his Silver District Assay Office. Then on March 13, 1884, Silent's post office closed with mail being forwarded to Clip.

The Clip mine was destined to be the district's biggest silver producer. By 1884 Clip owners Hubbard and Bowers had built a mill on the Colorado River and the Clip mine was producing between ten and fifteen thousand dollars in silver a month (Love, 1974). But diminishing ore supplies and a disastrous slide in silver prices in 1893 closed most district mines still in operation. Frank Vomocil tried working some remaining ores in the Red Cloud but several attacks of lead poisoning, allegedly brought on by contact with Red Cloud concen-

***Figure 5.* The Black Rock smelter at Norton's Landing, ca. 1881 (not the Red Cloud mine as indicated on the photo). Note man on horseback at left who has been "removed" by an early touch-up artist for reasons that remain a mystery (his leg is still visible). Pigs of silver are stacked just to the right of the horse. Photo courtesy of the California State Library, Sacramento.**

trates, finally killed him in 1899 at the age of 47 (Anonymous, 1879).

During 1929 the Silver Clip made a small shipment of 700 tons of ore. In November 1951 sixty mining claims including the patented Red Cloud, Pacific, Black Rock, Silver Glance, Princess and Mendevil properties, were incorporated by Yuma Metals, Inc. Most claims were updated by adding the word "new" to their titles, thus the Spotted Dog claim became the New Spotted Dog. Eight new claims were staked, including the Hardscrabble and New Trapper. The names of four claims were changed—the Red Cloud extension was switched to Gladys, the Shoepac to New Solo, the Red Cloud Fracture to Red Top, and the Longfellow to New Celt. Yuma Metal's operation lasted but a few years.

Between 1880 and 1949 the Silver district produced 1457 tons of lead and 49 tons of silver worth over $1,897,000 (Parker, 1966).

Nothing else of note occurred in the district until the hot summer of 1955 when Walter Nelson, caretaker of the Red Cloud mine, attempted to drive down Red Cloud wash to the Colorado River. His car bogged down in deep sand. Nelson was found beside his car, dead of heat and thirst, a few days later.

In the early 1980's the Red Cloud was reopened by the Red Cloud Mining Company of Yuma, Arizona. A mill was constructed and much rubble was cleaned out of the mine. Most recent reports indicate that no ore was ever mined during this time, nor were concentrates shipped. However, a review of company records shows mining was underway, with the mill operating a number of times between July 1981 and April 1984. Interesting log entries are:

Oct. 14, 1981. A memorandum to miners stated: "If there are certain men in our employ who do not like the food, they don't have to continue in our employ."

Mar. 2 and 17, 1983. "Rained!"

Dec. 14, 1983. "The State mine Inspector ordered our hoist not to lower or hoist men at any time."

April 22, 1984. "We Higraded galena from stopes to bring up concentrate levels."

Most recently, New Jersey Zinc Corporation conducted extensive core drilling explorations at most of the Silver district claims and mines. Roads were graded to these sites and remain open to four-wheel drive vehicles. At the present time all mining has ceased in the Silver district.

MINERALOGY

The mineralogy of the Silver district is essentially the same for most of the mines. Epithermal orebodies related in time and space to intrusions of granodiorite (Parker, 1966) were deposited at moderate temperatures of less than 174° C (Bradley, 1986). Mineralization is restricted to a series of oxidized lead-zinc veins which occur along major fault zones. Shallow ore shoots formed where transverse faults intersect main faults. Oxidized fissure veins vary in width from a few centimeters to about 3 meters, and dip to 150 meters. Supergene enriched zones are unknown (Parker, 1966).

Most of the silver-lead and barite veins are of irregular form with richer sections occurring nearer the surface and generally not below 60 meters deep. Many of the mines have shown little mineral deposition of economic importance, and mineralized veins were generally worked out in a short time. Detailed mineralogy of the Hamburg mine is given by Shannon (1980), the Red Cloud mine by Edson (1980),

Figure 6. **The Black Rock mine, ca. 1881. Carol Woolery collection.**

and some mineralogy for most of the district's mines by Wilson (Wilson, 1933 and 1951).

The primary gangue mineralogy consists of manganiferous calcite, quartz, barite and fluorite. Veins and ore shoots are heavily oxidized, resulting in secondary minerals including willemite, cerussite, vanadinite, hemimorphite, chlorargyrite, mimetite, hematite, cinnabar, tocornalite, wickenburgite and wulfenite (Bradley, 1986).

The district-wide paragenetic sequence of primary mineralization is described by Bradley (1986).

Stage I—Deposition of massive black calcite, fluorite, and quartz with minor barite; virtually all sulfides, and most silver deposited.

Stage II—Brief stage of banded quartz-calcite deposition, with accessary fluorite; minor silver values in silver-bearing manganese oxides.

Stage III—Massive white barite, with intergrown quartz and calcite; much hematite and manganese oxide content but no silver values.

Stage I is best developed in the south and to the west of the district along the Red Cloud fault zones; Stages II and III predominate to the north and east. Galena appears exclusively within Stage I where zinc is also abundant.

NOTES on INDIVIDUAL MINES

Nineteen of the Silver district's most important mines are discussed in this section, arranged in geographical order, from south to north.

To reach the Silver district, leave Yuma following U.S. Highway 95 northeast 16 miles to the Martinez Lake turnoff. Travel on a paved road west 10.2 miles to a point past the Yuma Proving Grounds Airfield where a gravel road takes off to the right. Drive 2.1 miles to a fork in the road, veering right (north) on gravel road marked Red Cloud Road. While this road can be quite rough it will normally accommodate both two and four-wheel drive vehicles. Follow this road 12.9 miles to the Black Rock mine (Dohms *et al.*, 1980).

Most of the district's mines have been visited by the authors, some a number of times. As an aid to collectors, mines still retaining collectible crystals will be identified by an asterisk (*). Particular minerals still available for collecting will also be marked with an asterisk. It must be mentioned, however, that historically only the Red Cloud and a few other mines have ever produced quality crystals of any species larger than thumbnail size. But from dumps and along veins in accessible tunnels at many mines, energetic collectors can still gather beautiful microcrystals of a number of mineral species. Two minerals which fluoresce, calcite (red) and fluorite (blue), are abundant on various tailings.

Black Rock mine*

Remaining workings are immediately east of the Red Cloud Road. The Black Rock, one of the district's oldest mines, was discovered by Neil Johnson in the late winter of 1877. In 1881 miners sank a 30-meter inclined shaft which intersected rich orebodies. On December 21, 1881, Charles Jenkins sold the Black Rock mine to the Black Rock and Pacific Corporation. By 1883 the shaft had been deepened to 130 meters. Mine owners constructed the Black Rock furnace on the Colorado River which, for a time, turned out a ton of bullion a day. All equipment at the mine and smelter has been removed.

The Black Rock vein strikes N65°W and dips 40°NE. The vein is

Figure 7. **Judge Charles Silent, ca. 1898. Photo courtesy of Carol da Rosa.**

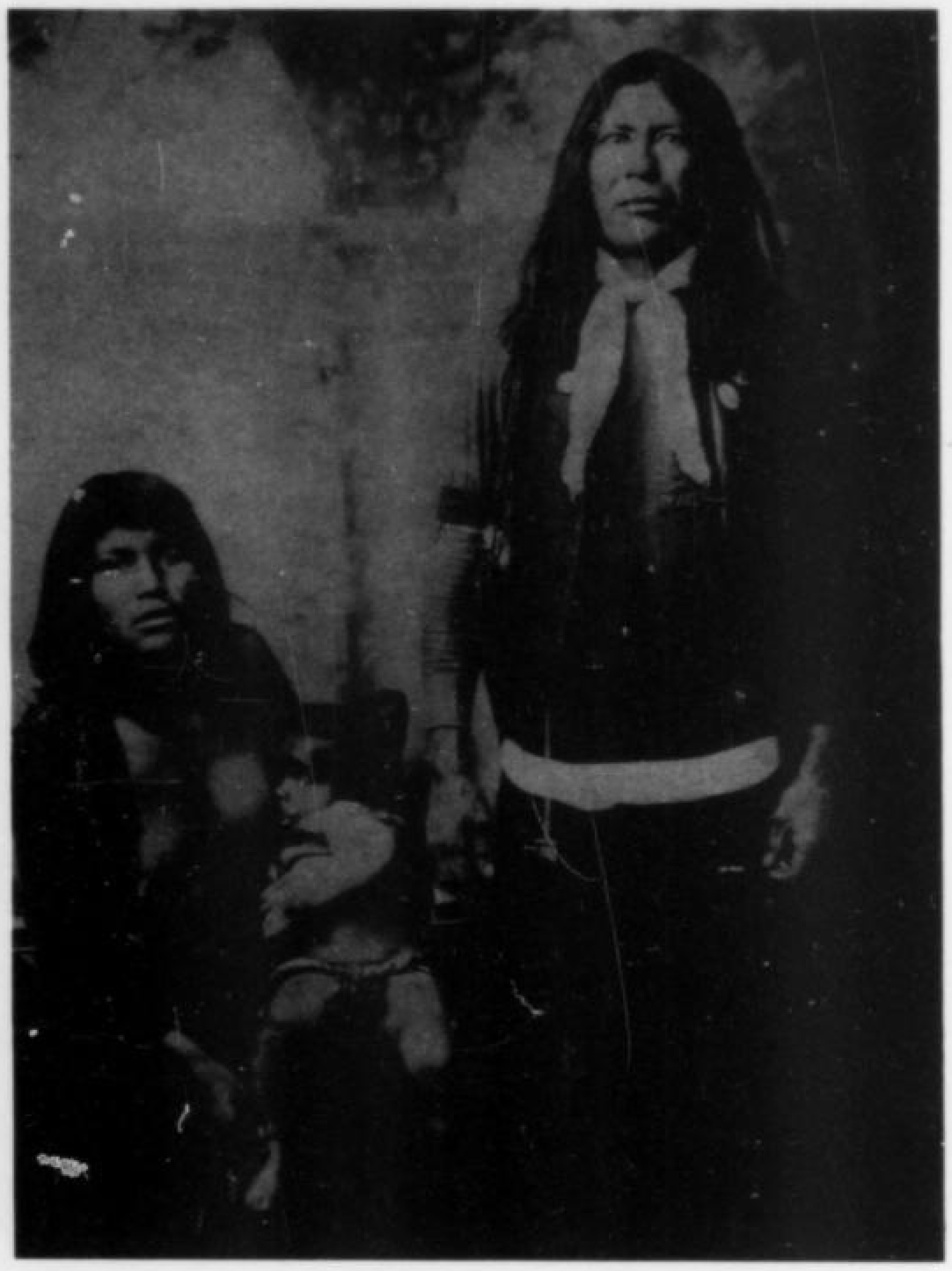


Figure 8. **Heel Port Jasper with wife and child (Yuma Indians), 1881. Carol Woolery collection.**

composed of manganese-stained calcite and smaller amounts of silicified breccia. It surfaces for a length of 185 meters and has a maximum width of 5.5 meters. Near the hanging wall numerous mineralized vugs have been found. Underground workings, in addition to the main shaft, include more than 280 meters of tunnels and drifts. The shaft is open and the underground workings are accessible.

Fluorite	Galena
Quartz	Anglesite
Goethite	Wulfenite*
Manganese-stained calcite	Vanadinite*
Pyrolusite	Pseudomorphs of quartz after calcite*
Cerussite	

Silver Glance mine

The Silver Glance mine is located due north of the Black Rock and approximately 300 meters east of the Red Cloud Road. This mine was surveyed for patent in 1881 for A. H. Cargill. A brecciated fault zone strikes S15°W and dips 45°SE.

At some unknown time a 60-meter shaft was sunk on the vein at a point on the eastern edge of the claim. Later a tunnel was driven westward which intersected the vein about 46 meters from the portal. The tunnel continues for another 30 meters where it connects to the old shaft. Both workings are filled with rubble and cannot be entered.

Quartz	Anglesite
Goethite	Cerussite
Manganiferous calcite	Massicot
Galena	Wulfenite

Pacific mine*

The Pacific mine is located north of the Black Rock and immediately east of the Red Cloud Road. Late in 1877 Neil Johnson discovered the Pacific mine. On May 19, 1880, Thomas Hughes was the owner. On December 21, 1881, Charles Jenkins sold the Pacific mine to the Black Rock and Pacific Corporation. It was patented in 1887 by M. L. Keith. It is said to have produced some silver. Its orebody strikes N and dips 85°E. Sometime before 1887 a 30-meter shaft was sunk on an exposed zone on the northern bank of Black Rock Wash. Some vugs lined with crystalline cerussite were located. The shaft is partly filled with rubble.

Goethite	Pyrolusite
Quartz	Cerussite*
Hematite	Calcite

Mandan mine

The Mandan mine is adjacent to the Pacific mine on the southwest. The vein strikes SW and dips about 85°E. Small cuts have been sunk on the vein.

Altered galena

Papago mine*

The Papago mine is located less than 600 meters west of the Pacific mine, west of the Red Cloud Road and down (southwesterly) the Black Rock Wash about 250 meters. In its earliest days while under a different name, the mine was a good silver producer. A small cyanide plant operated on the property but without much success. The fault

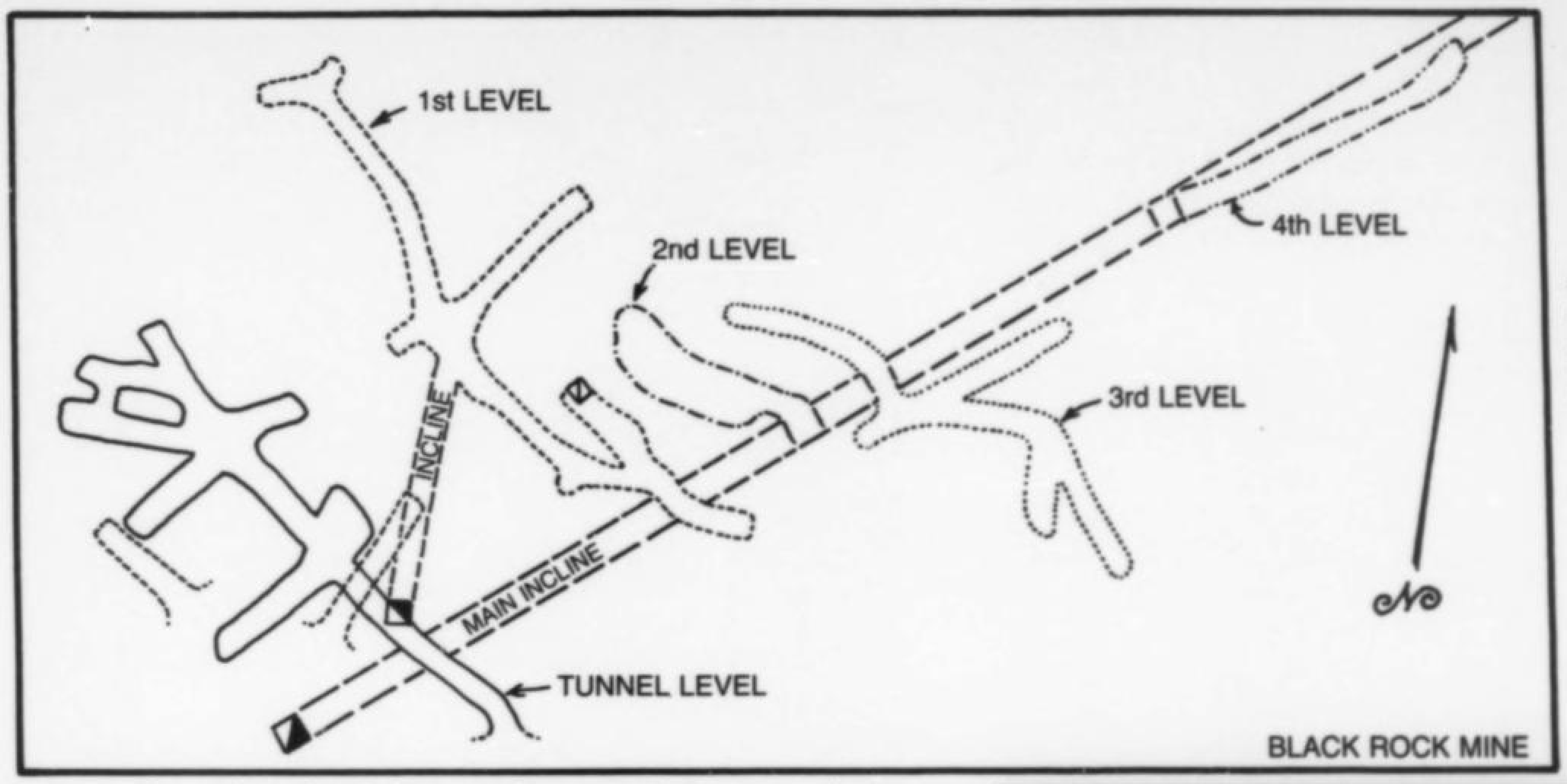


***Figure 9.* Underground workings of the Black Rock mine (courtesy of C. E. Batton).**

zone trends northward and dips steeply eastward. The ore vein has been tapped by several shafts to a depth between 40 and 80 meters, connecting a large series of tunnels and stopes. Dumps at the main shaft contain ores somewhat similar to those of the Red Cloud and show traces of wulfenite and mimetite. The workings are nearly filled with stream gravels. Although a great amount of work would be necessary to reopen one of the shafts, there is potential on the property for the recovery of wulfenite and vanadinite crystals. Entrance can be made with a rope ladder.

Goethite	Vanadinite*
Quartz	Hematite
Wulfenite*	Calcite

Red Cloud mine*

The Red Cloud mine is on the Red Cloud Road 1.3 miles northwest of the Black Rock mine. From 1880 to 1889 the Red Cloud produced 552 tons of lead and 5.6 tons of silver worth $250,000, becoming the second most important mine in the district. Prior to 1881 the mine was operated by the Red Cloud Mining Company of New York which sank an inclined shaft 84 meters down the vein, and built a twenty-ton furnace at Norton's Landing on the Colorado River. At the mine the town of Silent became the business center for the Silver district. The inclined shaft was extended downward to water level at 165 meters, making the Red Cloud the deepest mine in the district. In 1885 the mine was patented for Messrs. Horton and Knapp.

The first evidence of fine quality wulfenite crystals being mined at the Red Cloud was when Harvard University bought a suite of excellent specimens from George L. English (?) on November 11, 1889. A. E. Foote also had a role in the early distribution of Red Cloud wulfenites.

The Red Cloud was idle from 1889 to 1917, when it was purchased by the Red Cloud Consolidated Mines Company. A dry-concentrator mill was built, but it burned down before it could be put into full operation. Subsequent ownership of the mine was held by E. L. Boericke, the Neal Mining Company, the Primos Chemical Company, the Yuma Metals Company, and finally by a Mr. McDaniels of Oklahoma who cleaned much debris from the mine, reinforced some old timber and erected an elaborate mill at the surface. In spite of these efforts, new bodies of ore were not located; the mine shut down and remains closed today.

The main shaft (incline) follows the Red Cloud fault downward at an angle of from 45° to 60°E. The strike is irregular to the north. The Red Cloud vein is mainly composed of quartz, fluorite, manganiferous calcite and goethite. The principal silver mineral is chlorargyrite, while numerous vugs were lined with wulfenite, vanadinite, cerussite, smithsonite and pyrolusite. The most important high-grade silver values

***Figure 10.* Red Cloud mine headframe in 1988 (watchman, left, with Garth Bricker). Photo by P. Bancroft.**

were found in the workings above the 270-foot level where the vein averaged 1.2 to 5 meters in thickness. Below the 270-foot level the vein steepens, and although the oxide zone extends into this area, smaller veinlets are of lower grade ore. Typically, the richest oxide zone is in the upper levels and it is there that the best crystals of wulfenite and mimetite are found.

Extraordinary, flat, bladed wulfenite crystals up to 7.6 cm on an edge, with colors ranging from carmine-red to red-orange, have been found in large numbers. In 1938 Ed Over discovered some of the world's most beautiful wulfenites in the Red Cloud, and since then scores of collectors have mined many hundreds of superb wulfenite specimens which grace mineral collections throughout the world. The only other minerals which crystallize in sizes larger than 1.2 cm are cerussite and amethystine quartz. Most crystals form in micro-sizes.

Today collecting is not permitted at the Red Cloud. The caretaker should be contacted for further information.

Galena	Pyrolusite
Barite	Quartz
Fluorite	Wulfenite*
Gypsum	Vanadinite*
Massicot	Mimetite*
Willemite	Plattnerite
Malachite	Quartz (amethystine)*
Cerussite*	Goethite
Calcite	Hematite
Argentite	Smithsonite
Minium	Chlorargyrite
Anglesite	Linarite
Wickenburgite	Caledonite

Hamburg mine*

The Hamburg mine is located about a mile northeast of the Red Cloud mine. It was discovered in the 1860's and is an old Dana locality. Julius Liebeck did assessment work there on December 7, 1883. During the early 1880's, William P. Blake sank an 18-meter inclined shaft on the vein from which a 12-meter horizontal drift exited on the eastern base of the hill. A hanging wall of polished slickenside extends downward on the incline to where at the 40-foot level a small stope was dug. In this area superlative, bright red vanadinite crystals to 1.5 cm in length lined fractured quartz and calcite veins. Individual crystals are transparent to translucent and form with bright unaltered faces, or cavernous prisms and terminations. The Hamburg No. 2 claim is contiguous to the Hamburg's southern boundary, and has produced calcite, goethite and a few scattered wulfenite crystals from a 2-meter-wide baritic vein on the southern edge of the claim. The mine is easily entered.

Wulfenite*	Argentite (acanthite)
Vanadinite*	Chlorargyrite
Mimetite	Quartz (amethystine)
Anglesite	Quartz
Cerussite	Barite
Minium	Hematite
Litharge	Fluorite
Massicot	Calcite
Galena	Aragonite
Smithsonite	

Princess mine*

The Princess mine is immediately due north of the Hamburg. This mine produced a quantity of silver ore during the 1880's but has since been idle. It was patented for Messrs. Norton, Crawford and Lambie. The Princess vein occurs within a fault zone that strikes NNW and dips 30°SW. Its hanging wall roofs an inclined shaft about 30 meters deep. A series of open stopes with depths to 15 meters lie south of the shaft. The Princess may be entered.

Barite	Smithsonite
Fluorite	Galena
Quartz	Vanadinite*
Hematite	Argentite
Anglesite	Chlorargyrite
Massicot	

Silver King mine

The Silver King mine adjoins the Princess and Hamburg claims on the east. Owned by S. P. Huss, this mine was a latecomer in the Silver district and produced but a few tons of silver ore in 1923. A 15-meter shaft and a few short tunnels penetrated a 30-meter-wide brecciated zone containing pockety quartz-fluorite veins. Small wulfenite crystals have been found in vugs along the vein.

Hematite	Cerussite	Wulfenite
Galena	Vanadinite*	Copper and manganese stains
Anglesite	Massicot	Fluorite*

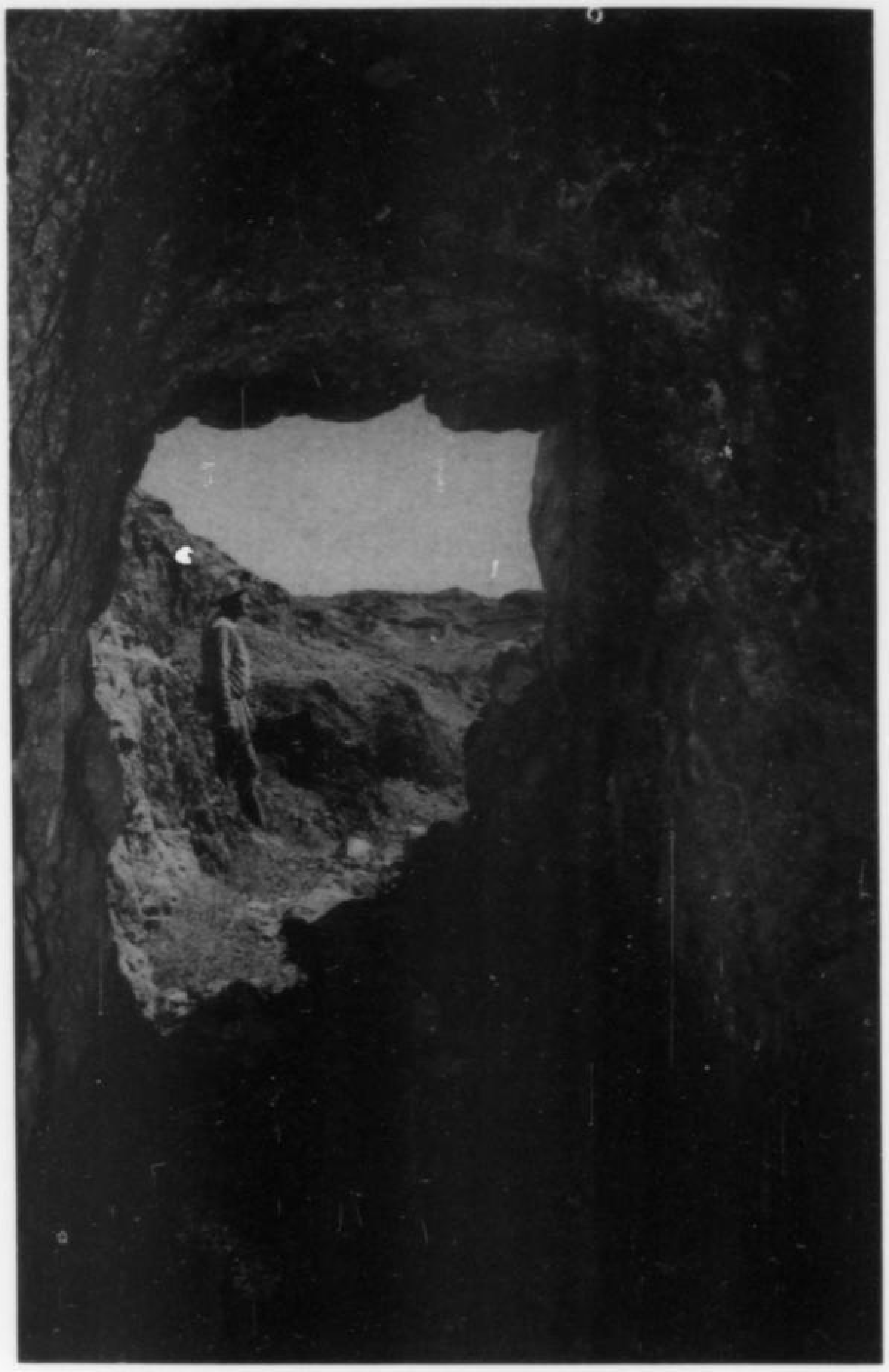


Figure 11. **View from the portal of the Princess mine. Photo by P. Bancroft.**

Geronimo mines*

The Geronimo mines are located about 1.25 miles NW of the Red Cloud. A fault zone on the South Geronimo claim striking N27°W and dipping 65°NE contains two veins, one a meter or two and the other 15 meters wide. A tunnel penetrates the wider vein which contains irregular masses of smithsonite, cerussite, wulfenite and vanadinite. About 90 meters northwest an old shaft possibly 30 meters deep was dug on the vein. Farther south another adit and winze proved to be barren of minerals. Adits are open for collecting.

The North Geronimo mine is in a fault zone with a northerly strike and a 35°E dip. At the claims' northern edge a 25-meter shaft was dug. At the 25-foot level, two short drifts lead to vugs containing abundant wulfenite and vanadinite crystals. The ore vein averaged 6% lead and 8 ounces of silver per ton.

Hematite	Massicot	Quartz
Manganiferous calcite	Wulfenite*	Galena
Cerussite	Vanadinite*	Anglesite

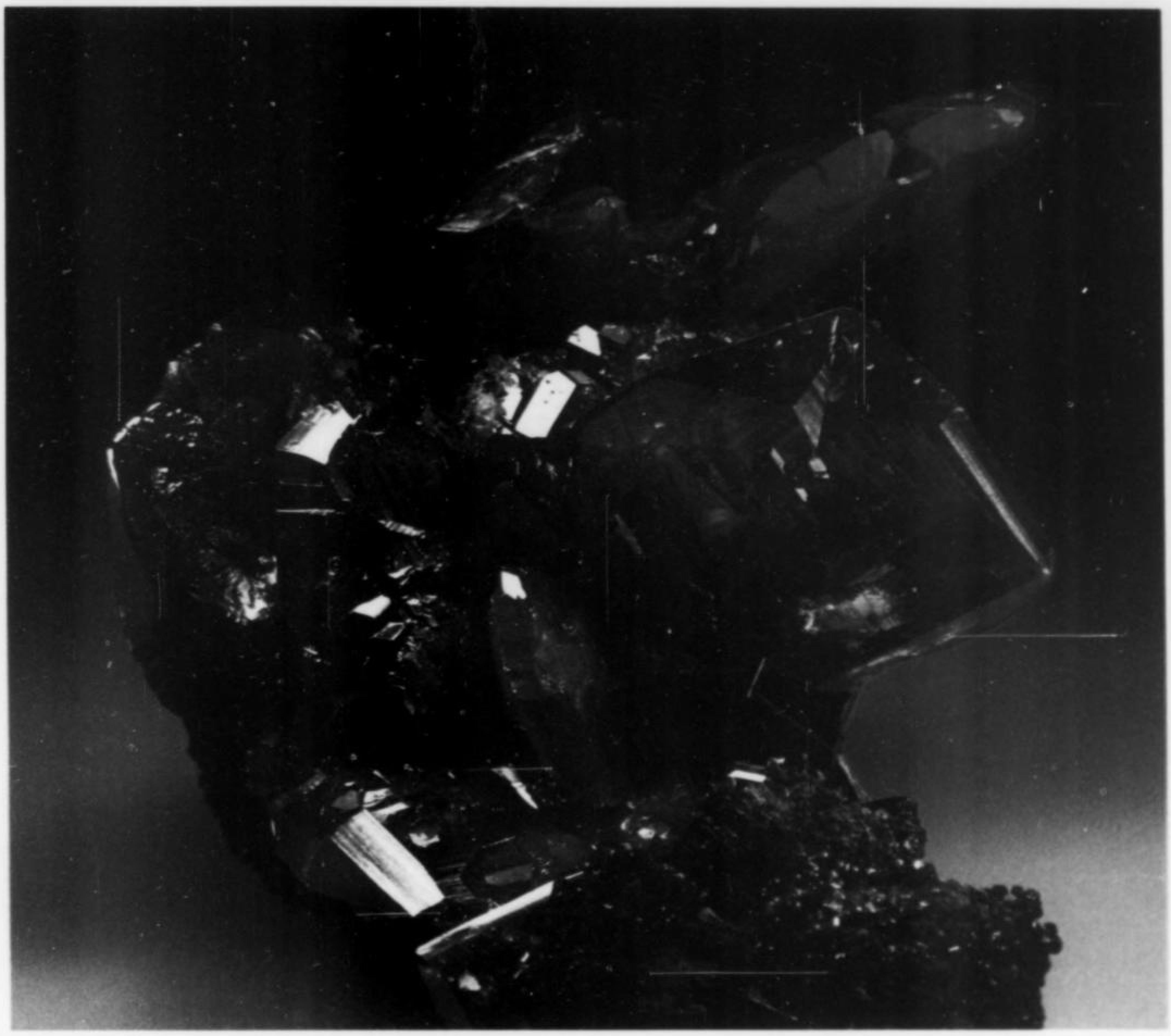


Figure 12. **Wulfenite crystals to 4 cm from the Red Cloud mine; found in 1986. Bob Lane collection.**

Melissa mine*

The Melissa mine (could be part of the Geronimo claims or Hardscrabble claim) is located about 1.3 miles NW of the Red Cloud. Mining reports on the Silver district give little or no information about the Melissa. A report was filed at Silent on October 15, 1883, stating that a ten-foot shaft was sunk on the Melissa mine for $100 in gold coin. Fine red to orange-red bipyramidal crystals of wulfenite on goethite, in sizes to 1 cm, have been found. Examples are in the collection of the American Museum of Natural History in New York, among others.

Wulfenite*

Mendevil mine

The Mendevil mine is located about 1.7 miles NE of the Red Cloud. It was located by H. M. Mendevil in March of 1879, and later owned by Milton Santee. It was surveyed for patent in 1887 for S. S. Draper, but there are no records of any mineral production. Ore veins, portions of which contained 5% lead and 15 ounces of silver, run through a fault zone which strikes N10°W and dips steeply NE. A few shallow cuts represent the mine workings.

Calcite	Massicot
Barite	Cerussite
Quartz	

Chloride mine*

The Chloride mine is located about 1.7 miles NE of the Red Cloud. The main fault strikes N10°W and dips from 60° to 70°SW. Its main vein is 1 to 2 meters thick, cut by bladed crystals of barite and calcite stringers. Crystals of wulfenite, cerussite and smithsonite are found along fractures and in vugs. Massive galena and yellow lead oxide are also seen. Information is unavailable on surface workings.

Quartz	Wulfenite*
Fluorite	Chrysocolla
Barite*	Smithsonite*
Calcite (manganiferous)	Cerussite*
Galena	Malachite
Massicot	Goethite

Mandarin mine

The Mandarin mine is located 1.5 miles NE of the Red Cloud. A NW-trending fault zone surrounds a narrow brecciated vein of fluorite, barite and calcite. Small amounts of silver and lead were found in several shallow pits. Information is unavailable on surface workings.

Fluorite	Barite	Calcite

Cash Entry mine

The Cash Entry mine is located approximately 1.8 miles E of the Red Cloud. A fault zone contains a few small veins of manganiferous calcite and finely crystalline fluorite. Cherry-red and yellow microcrystals of vanadinite line some fissures. A small tunnel has been dug on the property.

Manganiferous calcite	Vanadinite*	Fluorite

Figure 13. **Entrance to the Dives (or Padre Kino) mine, 1988. Photo by P. Bancroft.**

Dives mine*

The Dives mine (a.k.a. Saxon, Pryor, Padre Kino) is located about 1.5 miles NNE of the Red Cloud. Its main fault strikes N20° and dips 60°SW. The largest vein is about 3 meters at the widest spot and is fairly heavily mineralized. Vein minerals are goethite, hematite, pyrolusite, barite and manganiferous calcite. Small beautifully formed orange wulfenite crystals of pseudo-octahedral habit are found lightly attached to black gossan along fissures in the vein. There is a 26-meter vertical shaft with a 14-meter crosscut and several small stopes and tunnels. A portion of the crosscut exists vertically on the surface, and during the authors' last visit was home to barn owls and a pair of canyon wrens. Easy entry is made at the main tunnel, but lower levels are difficult to reach. In its early days the mine shipped one or two cars of highgrade silver ore removed from shallow surface cuts. The Dives mine is a fine collecting location.

Hematite	Massicot
Pyrolusite	Gypsum
Barite*	Cerussite
Manganiferous calcite	Smithsonite
Quartz	Wulfenite*
Mimetite (orange, yellow)	Chlorargyrite
Wickenburgite*	Fluorite*
Tocornalite*	Galena
(R. Grant, pers. comm.)	Goethite
Willemite*	

Revelation mine

The Revelation mine is located approximately 2.3 miles NNE of the Red Cloud. The mine sits on a fault zone striking NNE and dipping 80°E. Over 150 meters of vein, with widths varying from 6 to 12 meters, have been worked by a series of shallow cuts. Its constituents are manganiferous calcite, barite and brecciated wall rock. In 1933 the mine was owned by H. L. Duty.

Hematite	Barite
Cerussite	Quartz
Manganiferous calcite	Smithsonite

Amelia (a.k.a. Gallo) mine

The Amelia or Gallo (Spanish for "rooster") mine is located adjacent to the Revelation on the north. Gallo, the original name, was given to the mine in recognition of a nearby outcrop which resembled a rooster's head complete with a window through the formation which was the "eye."

The main vein was within a fault zone which strikes S35°E and dips 60°E. It consists of barite, crystalline quartz, calcite, goethite and hematite. Crystalline cerussite lines vugs in the vein.

In the 1880's this mine produced a considerable amount of silver ore. Underground developments included more than 90 meters of tunnel, two raises to the surface, two winzes, and a stope to the surface. The stope is 15 meters long, 15 meters high and 3 meters wide, and shows a vein 1.2 to 1.5 meters wide. Ore from this body averaged 9 ounces of silver per ton.

Another vein, a hundred meters or so to the west, has been prospected by a short tunnel connecting with a short winze and a 9-meter stope.

Barite	Hematite
Quartz	Cerussite
Manganiferous calcite	Goethite
Ferruginous calcite	

Clip mine

The Clip mine (also known later as the James C. Blain; Silver Clip) is nearly 3 miles NNE of the Red Cloud. Discovered in the early 1880's by Jose Maria Mendevil, the mine was predicted to be a winner. Mendevil sold his mine to Milton Santee for $150; he in turn sold it to A. G. Hubbard and George Bowers for $11,500. Charles Pickenback was hired as mine superintendent. A ten-stamp mill built on the Colorado River was in production by 1883. The town of Clip was established next to the mill. Mine production that same year was over $160,000. During the next four years the production of silver bullion passed the million dollar mark, making the Silver Clip the richest mine in the Silver district. When the output of ore slowed down, tailings were milled. Declining silver prices in 1888 forced the mine to shut down. The Clip post office was terminated on October 13, 1888. In 1897 the mine was patented as the James C. Blain property but remained idle for 25 years.

Figure 14. **Timbering in the upper workings of the Silver Clip mine, 1979. Photo by G. Bricker.**

In 1925 the Silver Mines Company built a 100-ton cyanide mill at the mine, but a series of misfortunes befell mill and mine. The mill proved to be poorly designed, silver ore was in short supply, and the whole operation slowed down even further when a steamer carrying cased cyanide for the mill capsized on the Colorado River. In 1929 7000 ounces of silver were milled and shipped, after which the mine closed for the last time.

The Silver Clip vein is more than 230 meters long and varies in width from less than 30 cm to nearly 3 meters, with at least half its length exceeding 1 meter. The vein occurs within a fault zone which strikes N30°E to N10°W and dips from 60° to 70°W. Vein components are calcite, quartz, fluorite, barite, hematite, goethite, pyrolusite and brecciated wall rock. Ore in the upper levels ran from 20 to 40 ounces

***Figure 15.* The Silver Clip mine site, 1988. Photo by P. Bancroft.**

of silver per ton, but ore of commercial value reached only a maximum depth of 37 meters.

There are five levels at 12-meter intervals. Two large stopes extend from the fourth level to the surface. One can stand on the surface at the edge of the largest stope and, looking down, see old timbers and mine doors still in place 30 meters below.

It is a pity that a mine which produced so much highgrade ore contained so few crystals. An inspection of the dumps in 1988 revealed no interesting crystals of any size. Mine entrances are bulldozed shut, although entrance could be made with the aid of a long rope ladder down the main stope.

Calcite	Cerussite	Dumortierite
Quartz	Chlorargyrite	(downstream from the mine)
Fluorite	Vanadinite	(Diller & Whitfield, 1889)
Barite	Malachite	Kyanite
Hematite	Pyrolusite	(downstream from the mine)
Chlorite		(Wilson, 1951)

SUGGESTIONS FOR VISITORS

"Large crystal" collectors will work long and hard for *any* suitable specimens in the Silver district. But the micromineral enthusiast should find an abundance of crystals. While micros are confined to only a few mineral species, crystal perfection, association and spectacular colors will more than offset this deficiency.

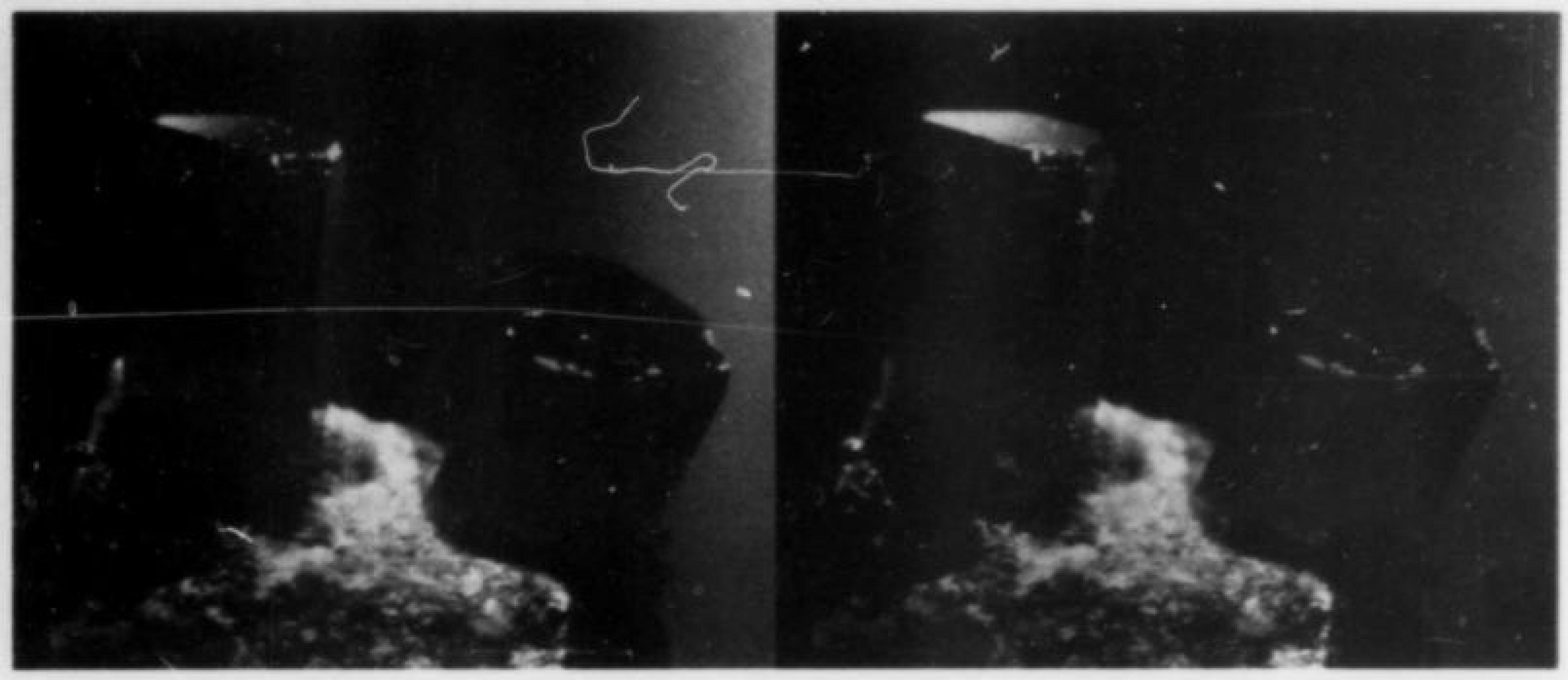
The Silver district is a great place for field trips, but certain precautions must be adhered to. In a barren land utterly devoid of water, with the exception of the Colorado River, the traveler must carry an adequate supply of liquids. Extra water should be carried in case of an overheated engine or a breakdown.

Daytime summer temperatures generally are above 100°F and may rise to a scorching 120°. Shade trees are few and are usually restricted to sandy streambeds. Under these conditions it is advisable to avoid prospecting in remote areas of the district during summer months when travel could be downright dangerous.

During the rest of the year daytime temperatures range from the 70's to the 90's and living conditions are much more comfortable. It is always desirable to travel with at least two vehicles in the party in case one breaks down. One seldom comes across a poisonous varmint, but there are scorpions and rattlesnakes.

Roads frequently follow sandy streambeds which are best handled by four-wheel-drive vehicles. The Silver district borders the western boundary of the U.S. Army Weapons Proving Ground with large quantities of petrified wood, an area which unfortunately cannot be entered. Recently many Silver district roads have been graded and therefore may appear better than they are. A single flash flood can take out a mile of road. Don't drive off roads. The desert can be mutilated for years by spinning tires.

Since many of the mines have tunnels which can be explored, collectors should follow standard underground safety procedures. Be sure there is sufficient good air. Take plenty of light. Battery-powered lights are convenient, but for longer stays gasoline or propane lanterns provide superior light. Take extra lamps. In the depths of mines it can be *really dark!* Remember the way out. When exploring a tunnel be constantly alert for holes in the floor (winzes, stopes or cave-ins to lower levels). Wear a hardhat and beware of loose rocks overhead. Hard-toed work shoes are best. A long pry bar is frequently needed,



WEW

Figure 16. **Vanadinite crystals to 3 mm from the Hamburg mine. David Shannon collection. (Stereopair)**

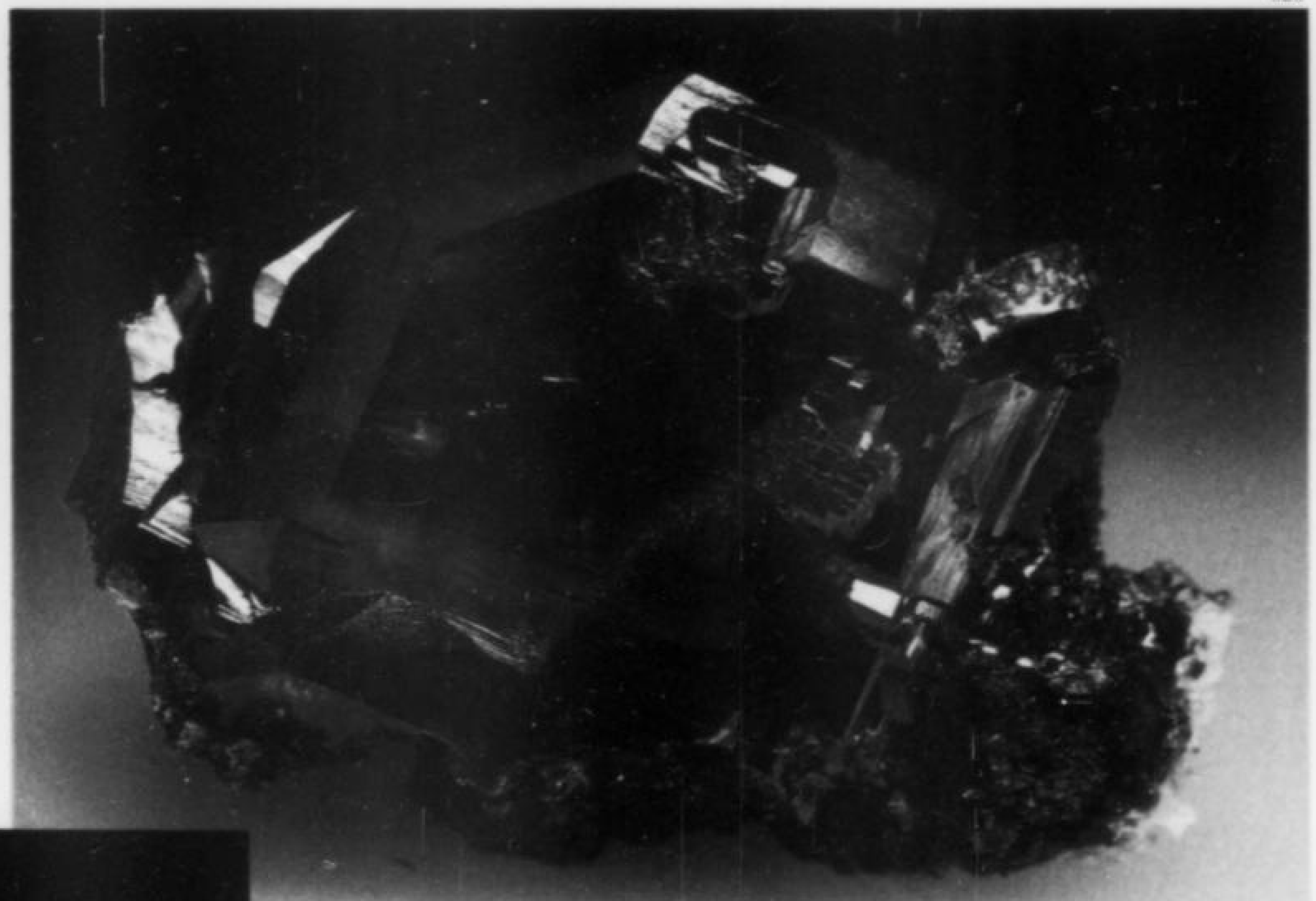


Figure 17. **Wulfenite crystal, 3 cm, from the Red Cloud mine; found in 1986. Bruce Barlow collection.**

WEW

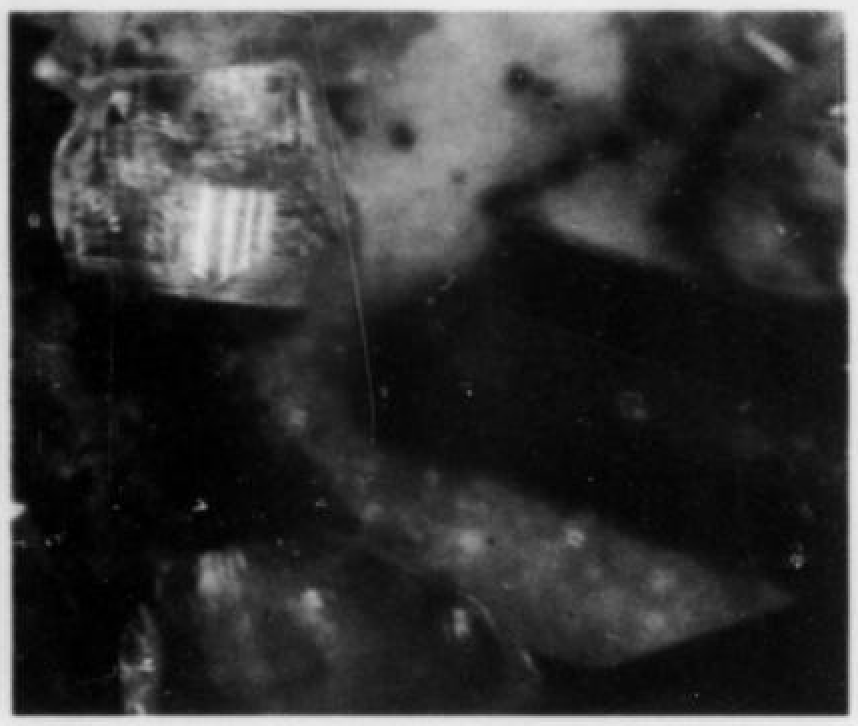


Figure 18. **Vanadinite crystal, 0.5 mm, with calcite from the Black Rock mine. G. Bricker collection; photo by Art Roe.**

WEW

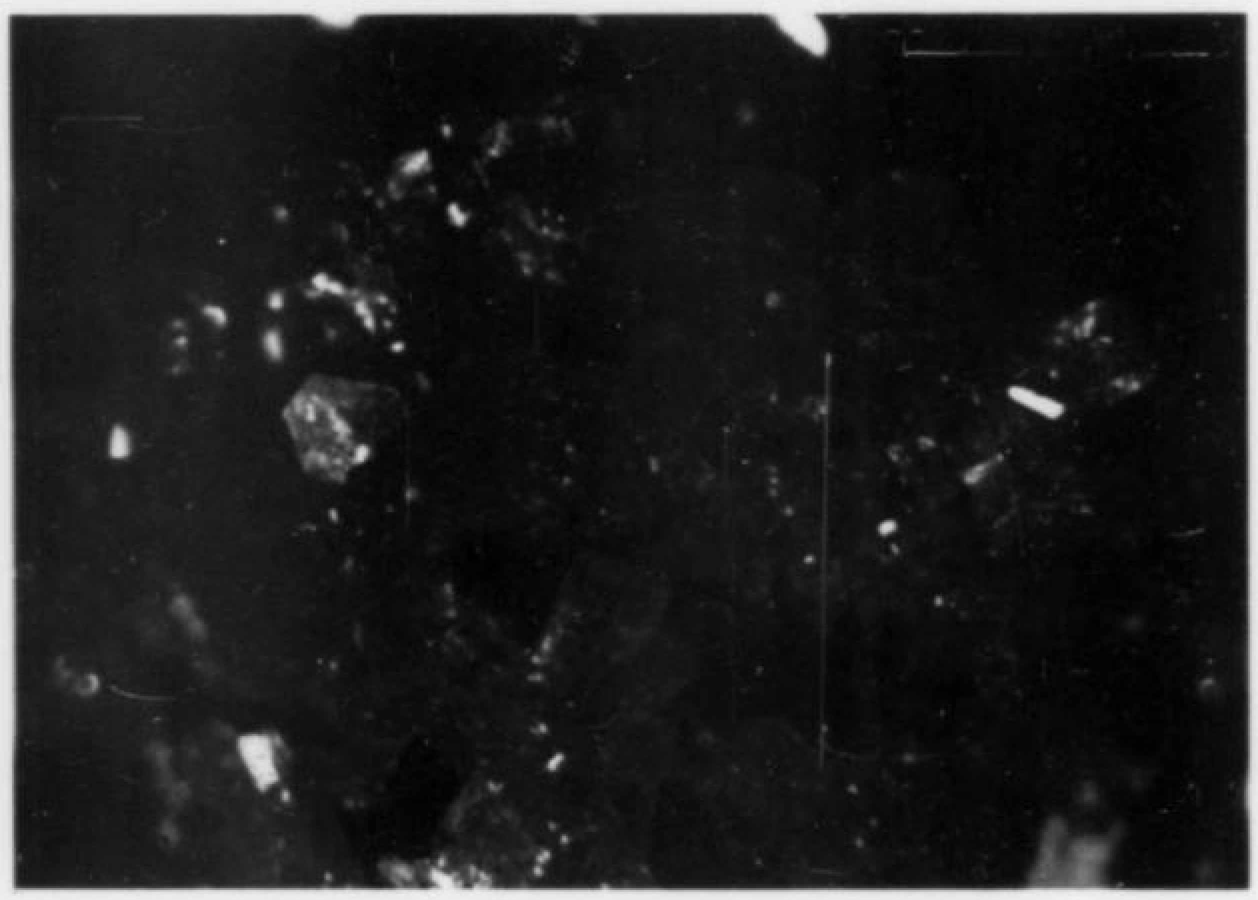


Figure 19. **Vanadinite crystals to 0.13 mm from the Princess mine. P. Bancroft collection; photo by Art Roe.**

Figure 20. **Wulfenite crystal group, 2.5 cm, from the Melissa mine. The bipyramidal habit is characteristic of the locality. Smithsonian specimen.**

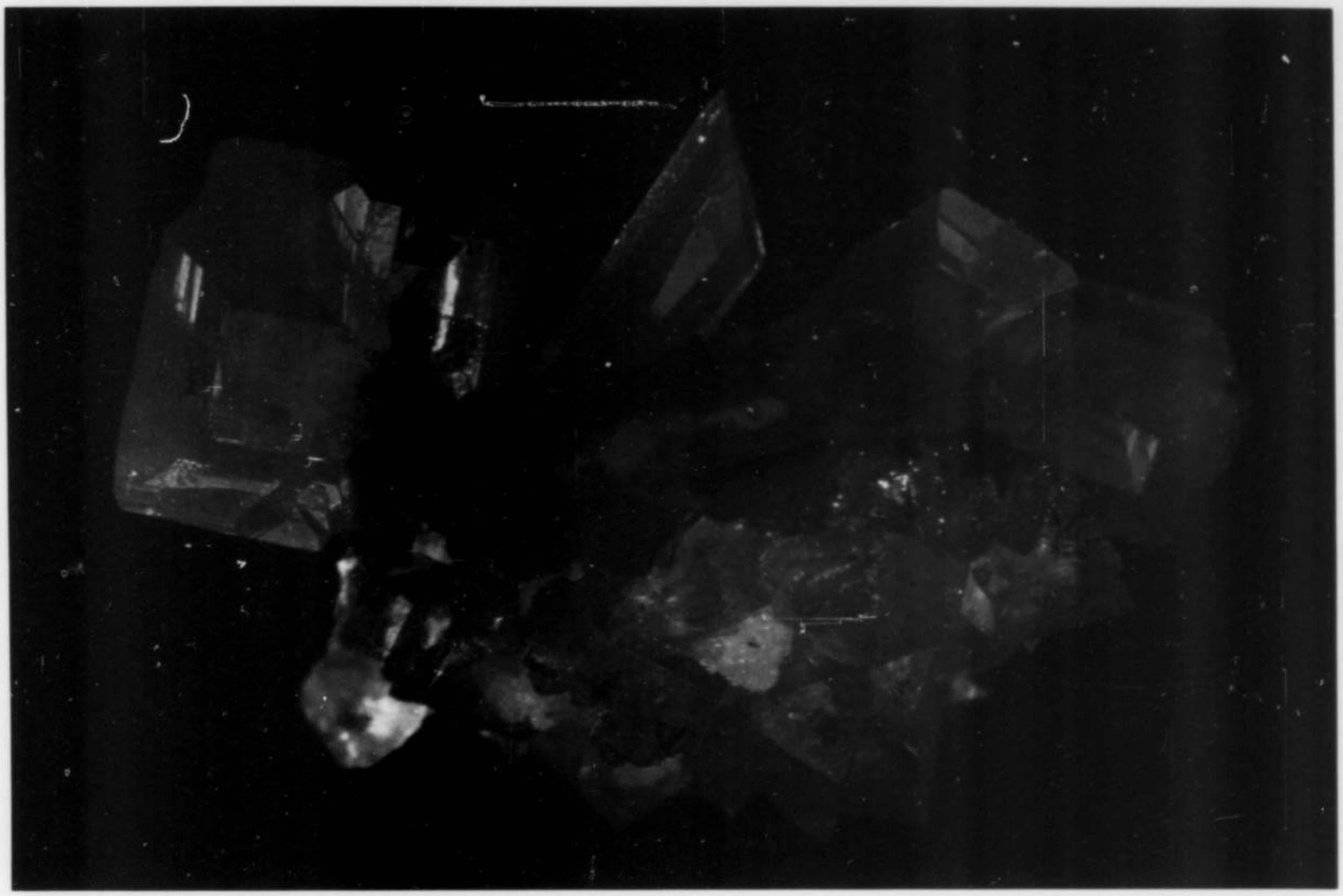


Figure 21. **Wulfenite on quartz, 3 cm, from the Red Cloud mine. Garth Bricker collection; photo by Harold and Erica Van Pelt.**

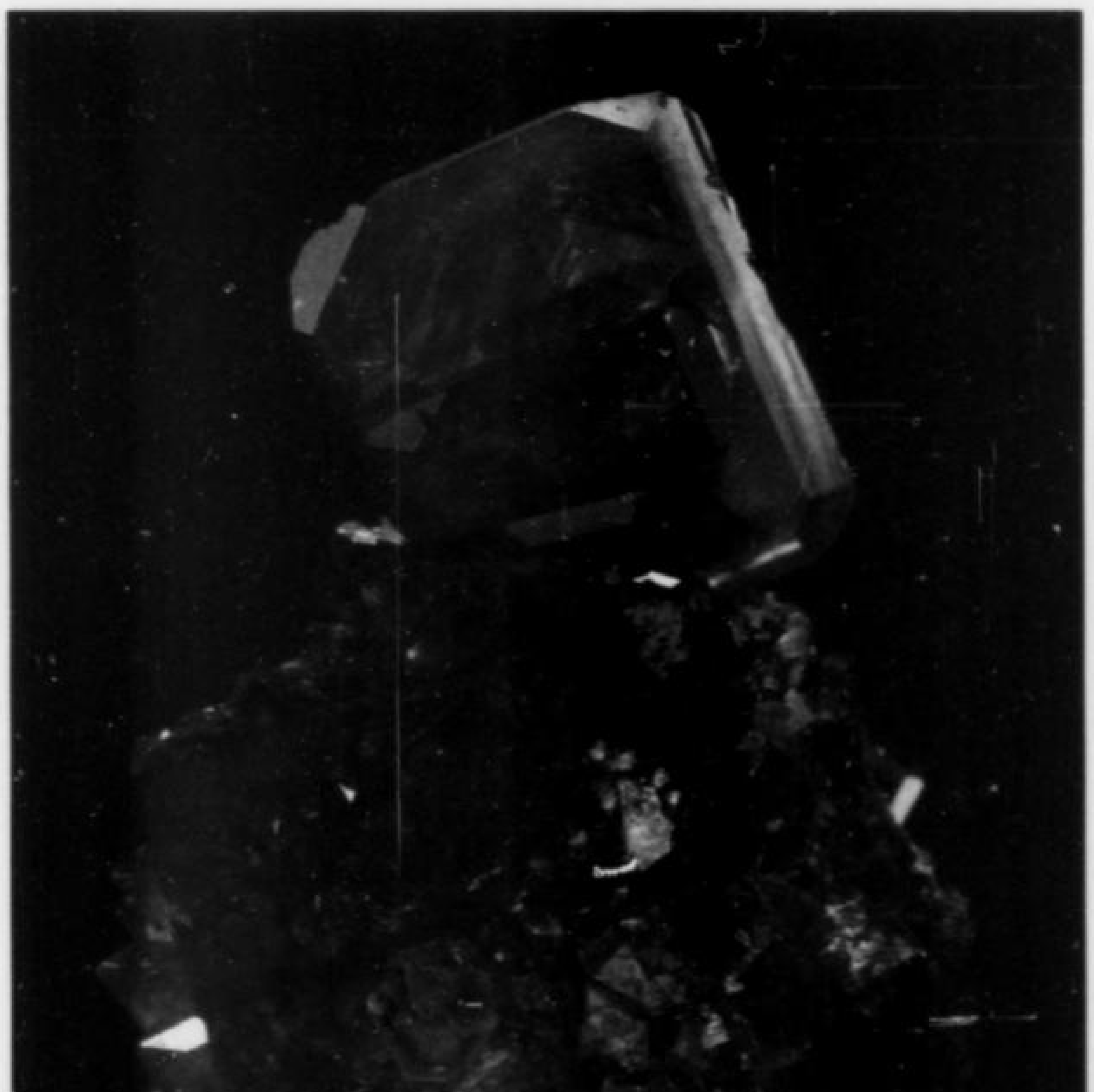


Figure 22. **Wulfenite on quartz, 3 cm, from the Red Cloud mine. Garth Bricker collection; photo by Harold and Erica Van Pelt.**

Figure 23. **Chlorargyrite crystal, 0.3 mm, from the Dives (Padre Kino) mine. University of Arizona collection; photo by Art Roe.**

OTHER SILVER DISTRICT CLAIMS

Many hundreds of claims have been located in the Silver district. Most have been abandoned with little or no remaining evidence of mining activity ever having been accomplished on their locations. These are the more important claims:

Claim	*Assessment filed*	*Other information*
Alberta	1883, 2-28-84, 2-9-85*, 6-20-87	*by Frank Burroughs
Black Bird	12-16-86	
Blue Rock		on 12-26-81 Charles Jenkins sold mine to Black Rock & Pacific Co.
Caledonia		Near Princess
Camel's Teat		near Mandevil mine
City of New York	2-28-83	
Clenched Nail Placer	12-26-82	owned by C. B. Norton of New York
Clipper	1-2-84	by Julius Liebeck
Emma		filed by George W. Norton and John D. Wilson on 1-1-1880
Empire		near Mandevil mine
Engineer	3-6-84, 12-15-85, 12-15-86	
Friend	1-19-83	owned by A. W. Cargill, Julius Liebeck and Samuel Pindy
Georgia	1-6-86	
Great Western		near Mandevil mine
Hardscrabble		located immediately N. of Geronimo claim
Homeward	1883	
Iron Cap		located near Black Rock mine
Ironside	12-7-83	
Kaladomie		on 1-16-81 Frank Vomocil sank an 8-meter shaft @ $11 a foot for P. Asbill. Wasn't paid, filed suit. Near the Mandevil mine
Klara	1883, 2-28-84, 2-9-86*	by Frank Burroughs, 6-20-87
Last Hope	12-27-82	owned by S. S. Draper
Lost Mine	1883, 12-15-86	near Mandevil mine
May Queen	10-3-87	
Minerva	1-19-83, 12-11-85	owned by A. W. Cargill, Julius Liebeck and Samuel Pindy
Mountainside	12-7-83	
Nelly Kenyon	1884	
No Name		near Mandevil mine
North Star	12-30-83	adjacent to the Black Rock mine
Recovery	12-26-84	
Remnant		near Black Rock mine Thaddeus Johnson sank a 43' shaft @ $3.50 per day, 12-5-81
Rooster, alias Peacock	1882, 1883, 12-23-84	
Rover	6-22-87	by Frank Vomocil
Silver Buck		near Mandevil mine
Silver City	11-20-84	On Feb. 15, 1870 local miners gave this claim to Mrs. Dobson of Solano, CA, for her unsuccessful efforts to find a mine in the Silver district
Silver Queen	12-26-82, by E. A. Stanley, 12-30-83	
Yuma Chief	1883, 2-28-84, 2-9-83 by Frank Burroughs, 6-20-87	this mine is adjacent to the Princess mine

as are picks, chisels, shovels and wrapping materials for packaging crystals. If your vocation is a desk job you may appreciate work gloves.

The authors accept no responsibility for mileages and road directions given in this article. All are approximate and may change. Nearly all mines are patented or claimed, that is, they are owned by someone, so comments herein about entry must not be construed as permission granted. During the authors' last visit in 1988, however, the only posted mine was the Red Cloud.

Camping out at night in the Silver district can be an exhilarating experience. Grilled steaks taste better, and clean air and incredibly bright stars are rewards. Take along mosquito repellent and a good mattress. Happy collecting!

ACKNOWLEDGMENTS

The authors' sincerest thanks to Carol Woolery, Dr. Edwin Stanley's granddaughter, who provided heretofore unpublished photographs of early mining scenes in the Silver district and of Yuma Indians; to Carol da Rosa for use of Judge Silent's photograph; to David Shannon, Bob Jones, Richard Graeme, and Carol Woolery for proofing and suggesting corrections and additions to the text; to Evelyn Vandendolder, Arizona Geological Survey; Karen Roberts, Century House Museum, Yuma; Susie Marler, Clerk, Yuma County Recorder's Office, and Carl Francis, Curator, Harvard University; to Harold and Erica Van Pelt whose superb wulfenite photographs represent yet another step upward in their mastery of difficult subjects; and to Arthur Roe, premier photomicrographer, who in some instances made repeated attempts until successfully capturing incredibly tiny and elusive crystals on color film; and to Edward Bancroft who assisted with research in Yuma. Also thanks to Tom McGarvin, geologist, Arizona Geological Survey for special records, and especially to Raymond Grant for many excellent suggestions as well as for proofing the text a number of times.

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MUSEUM NOTES

by **Stan Dyl**

Karl P. Schmidt, Chief Curator of Zoology at the Chicago Natural History Museum once observed that the museum was "one of the fundamental expressions of the human spirit. By means of the museum we enable ourselves to touch reality, and to go back and touch reality again and again." These cogent observations are no less true when applied to the large number of mineralogical and geological collections preserved by governmental, private and university museums worldwide. Mineral museums, like any other museum, play to a broad audience—serving their constituencies through education, research and aesthetic enrichment. Herein lies their strength, and the fundamental reason why the activities and personnel of these agencies continue to be of great interest to the mineralogical community at large.

Here, too, is the *raison-d'être* of this column. At present, think of it as a bulletin board to what's happening with mineral museums. On one hand, this feature cannot hope to be an exhaustive gazetteer. We trust, however, that the information shared here will be significant, important and perhaps even entertaining. This initial offering will be modest. In time, we think it will provide substantial fare.

HARVARD MINERALOGICAL MUSEUM

"Substantial" is one word that describes a pioneering and amazing broad outreach program currently underway at the Harvard University Mineralogical Museum. Harvard is sending top-quality traveling displays to enhance the exhibit halls of North American museums and eventually some foreign ones as well. These satellite exhibits range in content from general suites of fine gem and mineral specimens to spectacular showings of crystallized gold, for which Harvard is justly famous. The impressive and certainly not exhaustive list of participating institutions includes: the California State Mining and Mineral Museum in Mariposa, Leadville's National Mining Museum, the New Mexico Museum at Albuquerque, and the Pink Palace Museum at Memphis. Additional exhibits are planned at the Cleveland Museum of Natural History, the National Museum of Natural History in Paris, France, and the University of British Columbia in Vancouver, Canada.

CLEVELAND MUSEUM OF NATURAL HISTORY

Paul Clifford, Curator of Mineralogy at the Cleveland Museum of Natural History, tells us that his institution is preparing to open a new 69,000-square-foot wing, that includes a 7,000-square-foot hall named the Kahn Exhibit Gallery. The Kahn Gallery will be used on a rotating basis for traveling displays from other museums, and, as such, will be inaugurated with an exhibit of special magnificence titled *Gem Fire*. The exhibit, which will run from April 7, 1990, to February 15, 1991, will consist of the Cleveland Museum gem collection, handsomely supplemented by some of Harvard's crystallized gold and Michigan crystallized silver from the Michigan Technological University's Seaman Mineral Museum.

SEAMAN MINERAL MUSEUM

Seaman Mineral Museum staff have been busy unpacking some 3000+ specimens from the newly acquired Donald C. Gabriel Collection. The collection is a bequest from Mr. Donald C. Gabriel, a retired automotive executive and lifelong mineral collector and lapidary. It is rich in material from the Lake Superior copper district, Clay Center, Ohio, and other well-known North American and European localities. Some 50 specimens from the Gabriel Collection were exhibited for the first time at the Oshkosh Show in October.

CANADIAN NATIONAL MUSEUM

A little further south, in the Ottawa Valley, Canada's National Museum of Natural Science is also digesting a major acquisition, the famous William W. Pinch Collection. Dr. George Robinson, one of the NMNS Curators, enthusiastically reports that fundraising to underwrite the purchase of the Pinch Collection was quite successful and that the collection will be acquired in its entirety.

NEW MEXICO BUREAU OF MINES

Moving from the snowbelt to the Sunny Southwest, one finds big doings at the New Mexico Bureau of Mines. Curator Marc L. Wilson is excited about plans for an expanded exhibit hall, with exhibit space ten times that enjoyed currently. Marc states that the preliminary architectural model is complete and that the next step is to sit down and devise an appropriate funding strategy. The main emphasis of the proposed mineral exhibits will be educational, but Marc assures us that many fine "gee-whiz" specimens will be included.

COLORADO SCHOOL OF MINES

John M. Shannon, former director of the Colorado School of Mines Museum (see vol. 16, no. 3, p. 239–245) is in the news again. On October 24 a jury awarded Shannon $400,000 for having wrongfully been fired from his position in 1985 after the *Rocky Mountain News* published accusations of curatorial misconduct. An earlier jury acquitted Shannon of those charges in 1986. Shannon's attorney, James Robinson, told the jury that school officials had reacted to pressure from the newspaper's investigation when they fired Shannon before he'd had the opportunity to be formally exonerated of the charges (*Rocky Mountain News*, Oct. 25).

FERSMAN MUSEUM

To end on a note of *glasnost*, history was made at this year's Denver Show as the U.S.S.R.'s Fersman Mineralogical Museum from Moscow exhibited for the first time in the U.S.A. Museum Director Alexandr A. Godovikov and members of his staff put together a fine display of specimens from Soviet localities, old and new. Outstanding, were a remarkable red topaz crystal from Sanarka in the Ural Mountains, a creedite "rosette" from Kazakhstan, Akchatan, and an incredible matrix specimen of sperrylite from northern Siberia that harbored crystals measuring nearly 1 cm on edge. Truly, this is one Soviet invasion that we hope will continue.

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Locality Index Project

It is said "The past is prologue," and with this in mind, a brief history of one of FM's earliest projects is in order.

There were two proposed programs covered by Arthur Montgomery in the *Mineralogical Record*, vol. 4, no. 4 (July/Aug. 1973). The first of these was referred to as the promotion of mineral locality preservation and is not to be confused with the second.

The second major FM project was to be the preparation of a standardized mineral locality-name register. This was to be a simplified, validated list of the names of mineral localities most commonly represented on specimen labels used in mineral shows and public exhibits. It was reported that the names were in a "chaotic state, with general confusion existing through lack of agreement on standardized spelling, accurate and simplified geographic location, and up-dated national designation." John S. White proposed the project and asked FM to carry through. Barbara Frank Muntyan served as general chairman.

FM members on a world-wide basis were asked to prepare lists from names of localities shown on specimen labels in exhibits at mineral shows and in museum displays. After review and the reaching of an agreement on the recommended list, the locality names were to be grouped according to country and region, printed and offered to interested persons. It was felt that such a list would be of great benefit to collectors and museum curators.

Barbara Muntyan (*Mineralogical Record*, vol. 5, no. 4 and no. 5) referred to the Locality Name Register as a "companion piece" to the *Glossary of Mineral Species 1971*. She recommended that the list be limited to reasonably prolific or famous specimen-producing contemporary locations. She anticipated receiving locality information until December 1, 1974, after which the data would be reviewed, verified, edited and published. Paul Desautels agreed to serve as a coordinator of the review panel; outstanding museum curators, mineralogists and collectors throughout the world had agreed to serve on the panel. The format was under consideration. Proposed was an alphabetical listing of mineral species and under each all the prominent collecting localities. Also considered was a second section listing the localities alphabetically with all known minerals. This would aid those who wished a complete suite of species from a given locality. It was also suggested that all previous names of a locality be given. The first edition was to be followed with revisions. By January 1976, the accumulated information was computerized. It was never published.

By 1978, Jack Murphy, President, was reporting that the Locality Index Project was temporarily dormant but was "back on top of the list for action."

Starting with Barbara Muntyan's Colorado Index in the *Mineralogical Record* in 1979 (vol. 10, no. 4), seven more indices have been published—one in the *Mineralogical Record* and six in *Rocks and Minerals*. The project has moved more slowly than had been foreseen. There are several reasons why this is so. A study of the eight indices published will indicate various methods of presentation. Not only must willing volunteers be found, but decisions must be made. It has been live and learn.

First and foremost, this index is to be a list of mineral localities. It is not a guide to the localities. Those who fear to give the source of some specimens lest the site be overrun need have no fear. Panczner, in *Minerals of Mexico*, describes vesuvianite from Municipio de Sierra Mojade, Coahuila, with a note that "This location is often referred to as being in the state of Chihuahua at Lago de Jaco." Perhaps this FM project can pick up and correct similar misinformation.

How many other purposes should a locality index serve? Which sites are to be listed? It is impossible to include every little prospect or building site. Roadcuts are often prolific specimen producers, and some are and should be noted. However, the building site where Connecticut's first identified synchysite was found and the old prospect pit in Loudville, Massachusetts, which produced plumbogummite are not listable. What about type localities? The Colorado and California Indices include such lists. A future list of type minerals with their localities has been discussed, so the information might well be noted during research.

A cross-index listing the localities alphabetically with their counties indicated is most helpful, and is missed when not present; the recommended format lists the locality under the county. Whether or not there should be a bibliography must also be decided. One published index indicates the status (open, demolished, fee, etc.) which applies at the time the research was done. It was proposed at one time to list the type of deposit and then decided to let the minerals listed give an indication.

The published indices are:

Arkansas, *Rocks and Minerals,* (Art Smith), 1988, vol. 63, no. 2
California, *Mineralogical Record,* (Tony Kampf), 1989, vol. 20, no. 2
Colorado, *Mineralogical Record,* (Barbara Muntyan), 1979, vol. 10, no. 6
Georgia, *Rocks and Minerals,* (Jennings Gordon), 1989, vol. 64, no. 3
Indiana, *Rocks and Minerals,* (Terry Huizing & Richard Russell), 1986, vol. 61, no. 3
Michigan, *Rocks and Minerals,* (Tom Morris, Jr.), 1983, vol. 58, no. 3
North Carolina, *Rocks and Minerals,* (W. F. Wilson & B. J. McKenzie), 1985, vol. 60, no. 2
Virginia, *Rocks and Minerals,* (D. Allen Penick), 1985, vol. 60, no. 4

Texas and Vermont are in process. Colorado and California are most like the recommended format, as is Arkansas' locality section. Locality indices published in *Rocks and Minerals* have carried mineral photographs. These are not necessary for the project.

The projections for the entire project look like a 250-page volume with about 6,500 locality entries to cover the United States, Canada and Mexico, and another volume, about the same size, to cover the rest of the world.

Guidelines have been developed over the years. FM members and interested persons are invited to volunteer by contacting Peter Modreski (8075 W. Fremont Drive, Littleton, CO 80123), who is the overall coordinator of the project. His letter to *Rocks and Minerals*, Jan.-Feb. 1989, further describes this work.

Several examples will illustrate the format and information.

COLORADO, Chaffee County

California mine, west of Nathrop (near head of Brown's Creek, west of Mount Antero): beryl (aquamarine, goshenite), molybdenite, ferrimolybdite, fluorite, topaz.

INDIANA, Allen County

May Stone and Sand quarry (Ardmore plant, France Stone Co.), southwest edge of Fort Wayne: fluorite, pyrite, calcite.

ROMANIA

Cavnic (formerly Capnic, Kapnik, or Kapnikbanya), Maramures or Crisana-Maramures district: formerly in Hungary: barite, bournonite, calcite, chalcopyrite, rhodochrosite, sphalerite, tetrahedrite.

Notes from Europe

by **Thomas Moore**

MUNICH SHOW 1989

Every year in Munich at Europe's top mineral-gem-fossil extravaganza there seems to be more, luxuriantly more, of everything: paid attendees (a near-record 23,000 this year), fine mineral specimens, lavish special displays, guests bringing exotic things from exotic places, and seemingly miles upon miles of aisles to make the lonely notebook-bearing reporter's feet ache. And every year that bemused, overworked and overwhelmed reporter is greeted by more of those unexpected, good-natured, extra Munich Show features, surprise fillips for which the first German word that comes to mind is *gross* (a more neutral term in German than in English: *gross* meaning mostly just *large*, no irreverent connotations need apply—honest). This year the show's most beguilingly *gross* surprise, confronting the visitor just inside the main entrance, was a huge pedestal, decorated sparsely with plausible ferns and scrub, on which stood three nearly life-sized model dinosaurs—a mommy triceratops, a baby triceratops, and a towering duckbill-like herbivore of some kind—all of which could turn their great gray heads, open great grey mouths (pink inside) and softly, decorously roar. Of course, this feature was surrounded more or less constantly during the show by crowds of small boys from the school groups brought in on even the dignified Friday "insiders' " day. The rather tortuous justification for the dinosaur exhibit, as I reconstruct it, was based on the show's theme (*Sternsteine* or "star stones"), which had been defined to encompass meteorites (Stones from the Stars). As a thorough article in the show catalog explained, the currently hot theory regarding the Late Cretaceous mass extinctions is that they were caused by a huge meteorite hitting the planet, visiting on it a months-long universal darkness, massive disruptions of food chains, and telltale iridium to enrich the Cretaceous-Tertiary boundary layer. And lots of dinosaur corpses. The *Sternsteine* display alcove was itself enriched with all kinds of meteorites and tektites, including very large examples, specimens of European-historical interest, and meteorites brought here by the dedicated collector/dealer Robert Haag of Tucson—last seen, also with diverse meteorites to show and sell, at Hamburg in 1987 (see my Note in vol. 19, no. 4).

Other "star stones" on display included crinoid fossils, stellate aggregates of quartz crystals, and, of course, *now* we come to it, dazzling cabochon-cut star rubies and sapphires, cat's eye-quartz and chrysoberyl, and asteriated rose quartz spheres. In the dimly lit little labyrinth of wall cases, the stars (so to speak) of the show were: a cut sapphire fully 10 cm long, brought from the Smithsonian by John White; an ethereal display of 13 enormous carved rose quartz spheres on nearly invisible pedestals of different heights, the whole like a dreamy-pink asteroid swarm; and a selection of enormous cut star corundums from the private collection of Carl Fabergé, 19th-century jeweler to the Czars, brought by the Fersman Museum of Moscow (of which more later). Touring this grotto of fabulous gems (and, all right, of crinoids and meteorites too) was quite enough to make any casual visitor feel seedy, clayey, impoverished, of-the-earth *gross* indeed. And show manager Johannes Keilmann is once again, of course, to be commended, this time for having managed to bring together from diverse heavily insured sources such an array of unimaginably precious things for us common folk to see.

A small secondary-theme display contributed by the Technical University of Munich was devoted to ores of *Sondermetalle,* i.e., rare but industrially crucial metals: bismuth, germanium, cadmium, tellurium, etc. Besides very clear explanatory text, the case presented samples of exotic ores (e.g., massive germanite from Tsumeb). One native bismuth specimen from Schneeberg taught me new things about this mineral's possibilities: a 5-cm matrix was covered with stacked, very sharp, pinkish gray metallic cuboctahedrons of bismuth to 1.5 cm on edge.

The show hosted 420 dealers this year—up about 70 from last year—and was held, not in *Halle* 16 as of old, but, as in 1987, in three doglegged halls. Walking through the complex, trying in one day to cover everything, gave me a paradoxically mixed sensation of high excitement and utter hopelessness. The main food concession area was an outdoor pavilion—a *Schnellimbiss*— where the trick was to make one's way from the serving window to a seat at one of the few small and primitive tables *before* one's bratwurst rolled entirely off one's doilylike paper plate, steam-rollering the mustard puddle onto one's clothes en route. But such was the show's immensity that there were, besides this outdoor pit stop, two indoor cafes with waitresses and ample table space, and a stand selling candied fruits by the pound.

For a Friday "insiders' " day the crowds were thick—nowhere thicker than around the modest stand presided over by some Soviet scientists from the renowned Fersman Museum of Moscow (see Peter Bancroft's article in vol. 19, no. 1). All day these gentlemen dealt as best they could—clearly, having a wonderful time at it—with shouted questions in German, English and French. People, sometimes from three layers back, kept elbowing forward to where they could see the various things from old and new Russian localities that the curators, like methodical Soviet Santa Clauses, kept unwrapping and laying out. In fact, this show in general was rich in Russian material. The Fersman specimens, it must be said, were not the most dramatic around, but the mystique of peering into the drawers of a great museum collection, hitherto closed, proved irresistible to the crowds. Among the notable Fersman offerings were some very large vivianites from a new source in the Kertsch Peninsula, Crimea; fair to very good quality cabinet-sized stibnites and miniature classic dioptases from the Kirghiz Steppe; good large wolframites from somewhere in Kazakhstan; and, my favorites, some very good thumbnail floater zircon crystals, in bright, glassy brown ditetragonal bipyramids with no prism faces, from Lovozero in the Kola Peninsula (proceed to northern Finland and hang a right). Less attractive but rarer, and from the same locality, were some floaters and matrix specimens of the Na-Ti silicate lorenzenite, in dull chocolate-brown, perfect orthorhombic forms.

It's a pleasure to report that mineralogical *glasnost* has been flourishing nicely, especially in Munich, ever since last year's exciting breakthroughs (see Wendell Wilson's report, vol. 20, no. 1), which included the displays at the 1988 Munich Show—first time in the West—by the Fersman Museum and by Soviet private collector Vladimir Pelepenko. All year the Pelepenko collection has been touring Europe from its home base in the Bavarian Natural Science Collections building here. And at the same institution, just ten days before the 1989 show, there opened a fantastic Fersman exhibit called "Russian Gems and Master Jewelers," featuring heroic Romanov-era cut gems

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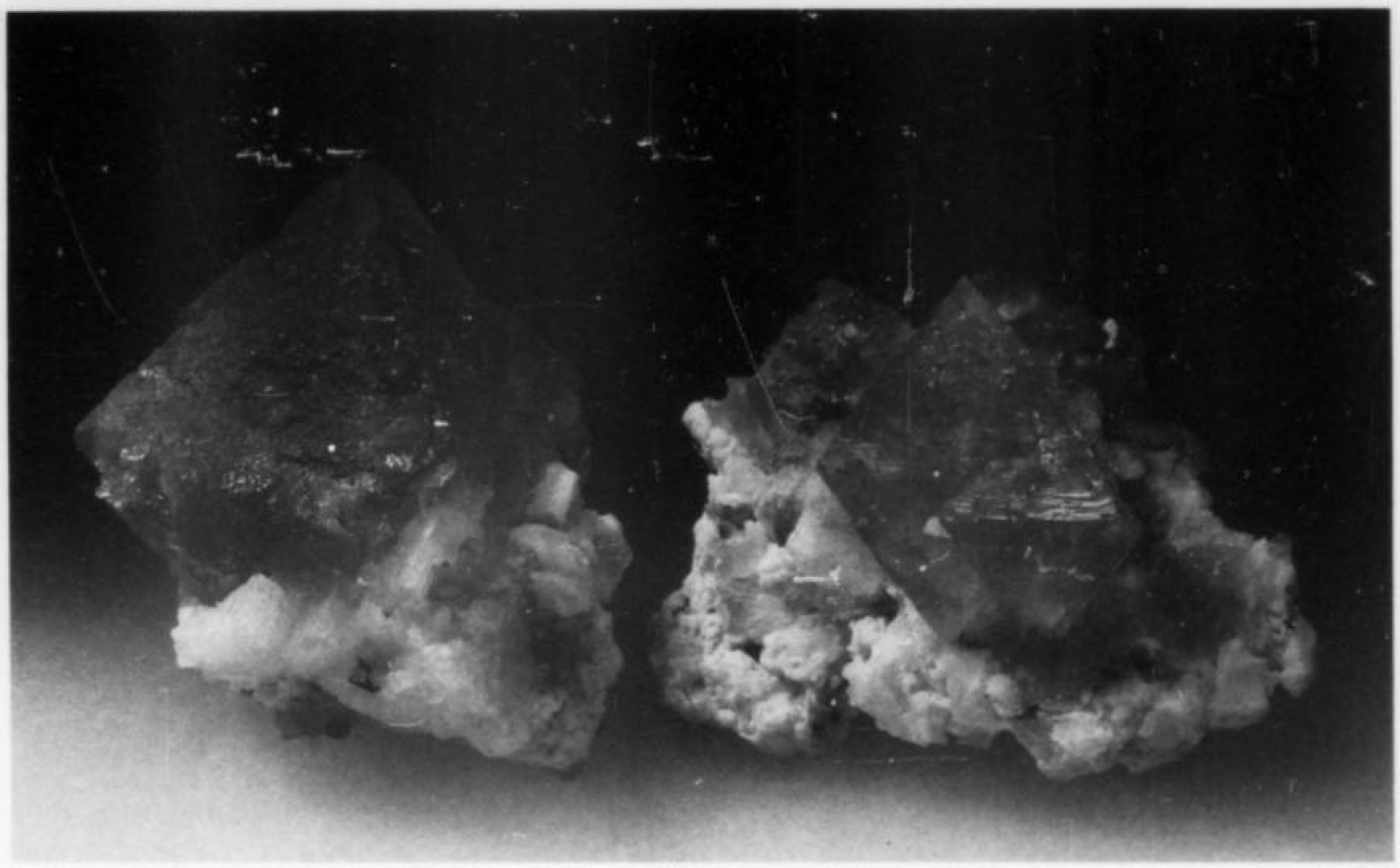

Figure 1. **Pink fluorite crystals to 2 cm, on granite matrix from Chamonix, France. Specimens: Mineralien & Fossilien Galerie, Frankfurt.**

on the order of (and including) the Fabergé star stones, as well as crystal specimens of oldtime Russian gem classics, e.g., blue topaz crystals on hulking matrixes from Mursinka, Urals.

Also, for crystal collectors of relatively modest means and goals, there were new, or at least interestingly unfamiliar, Russian things scattered at large around the show. To begin with the least "modest" of those I saw, Karin Burchard of *Mineral Exquisit* (Schloßstr. 6, D-8050 Freising-Haindlfing) had some wonderful specimens, mostly one-of-a-kind or very-few-of-a-kind, including a "sculptural" wire silver miniature that could pass as among the very best from Freiberg, but from Dzekascan, Kazakhstan; a 6 x 8-cm matrix of massive chalcopyrite in which about ten bright metallic sperrylite cuboctahedrons 5 to 10 mm across lay half embedded, from Talnach Norilsk, Siberia; and beautiful, clear, colorless fluorite cubes in several miniature-sized clusters from Tietiuche, 300 km northeast of Vladivostok.

One could further find, at various stands, such things as milky to translucent, yellow-green datolite crystals in enormous groups from Dalnegorsk; rosette pyrrhotites to 8 cm across from the same locality; and partially gemmy, pink elbaite on cleavelandite matrixes from the Pamil Range of Soviet Central Asia. A very honorable mention, Soviet subdivision, should go to Erich Schmidt (Friedhofstrasse 3, D-8591 Tröstau), a specialist formerly in Czech minerals, but presently in Russian specimens. He had (besides more of these zircons and lorenzenites from the Kola Peninsula) some very good native sulfur in clean, sharp, 1.5 to 3-cm crystals sprinkled over matrixes of white carbonates and massive sulfur, in cabinet specimens to 8 cm across and for only $35, from near Lvov, Western Ukraine. Even more striking at Schmidt's stand were some large matrix specimens to 10 cm of black spinel (*Pleonast,* as the Germans call it), showing glassy, bright black crystals to 6 cm clustered thickly on a matrix material that looks like crystalline diopside (dull green prismatic subhedra), these from Yakutsk, Siberia. The spinels are typically slightly rounded but still display combinations of cube, octahedron and dodecahedron faces.

Before leaving the Eastern Bloc (before we learn to stop calling it that), I will mention also that more of those very large, very fine groups of halite from Wieliczka, Poland, with or without gray/tan matrixes, were available here and there. I saw one cluster of perfect, nearly water-clear cubes, the whole 10 x 10 cm, for $30. And for the rare-species appreciator (though not for the aesthetician), the Jeziorka mine in Poland is sparsely producing some perfect, dull black dodecahedrons of hauerite (MnS), similar to the old classics from Sicily—some loose floaters to 2 cm ($150), and also some pieces with smaller hauerites in a gray clayey matrix.

The balmy European summer of 1989 had its good effects for the mineral market by allowing Alpine *Strahlers* a longer collecting season than usual, and *Mineralien und Fossilien Galerie* (Fahrgasse 88, D-6000 Frankfurt/Main 1) displayed one spectacular result: about 25 very beautiful pink octahedral fluorite specimens from the region of Chamonix in the French Alps. Chamonix fluorites have appeared intermittently and sparingly for years, never becoming as famous, somehow, as the pink octahedrons from the Göschener Alp, Switzerland, or, more recently, from the Huanzala mine, Peru. But they can be just as lovely, especially when pertly perched on their typical whitish coarse-grained granite matrix. At their best they are a deep translucent rose-pink with lustrous to slightly frosted faces, and sit either singly, or in tight groups of two or three, or as druses of rounded crystals on the quartz/feldspar matrix. These new specimens comprised the biggest swarm of high-quality French pinks I've ever seen in one place, ranging from outstanding miniatures for around $275 to equally impressive thumbnails for around $125. As always with Alpine minerals, we can't know whether or when or how liberally more will become available—but meanwhile let's note the falsity of conventional wisdom which maintains that only two localities exist for excellent octahedral pink fluorite. Chamonix, up against Mont Blanc and known as one of Europe's best ski resorts and capitals of spectacular scenery, is deserving of equal fame.

Only a couple of meters away from the pink fluorites, the Frankfurt folks were showing another intriguing new find, though from an old source: pyrargyrite groups from the El Solar mine, Taxco, Mexico. The crystals are hexagonal prisms arranged in tight parallel/columnar groups or in more loosely jumbled masses of crystals, the adamantine luster high, the color deep black-red, and the crystal terminations sparkly with small secondary-growth pyrargyrites. No associations are present on any of the 20 or so specimens; the matrix, where present, is massive pyrargyrite. But surely you didn't think that such good specimens of this species would be cheap—a 6 x 6-cm piece covered with fine crystals to 1.5 cm sold for $1400, and a few blue-ribbon thumbnails could be had for around $175; most of the others were middling-priced miniatures. And as if the pyrargyrites and pink fluorites weren't enough, the same dealership offered a few large (to 4 cm across) old malachite-coated cuprite crystals from the Emke mine, Onganja, Namibia, priced very much lower than these well-known classics have generally been in the past. Which reminds me to mention

Figure 2. **A 10-cm portion of a 40 x 40-cm realgar specimen from Guizhou province (?), China; *Tradewell* specimen.**

that the spectacular new cuprites with associated tufted malachite, white barite and chrysocolla from Zaire's Mashamba mine, amply covered in earlier show notes, are still abundant at prices that, in general, are still remarkably low.

This in turn brings me to Contemporary Occurrences Survey Corner. Touissit, Morocco, anglesites are still plentiful and still mind-bogglingly fine at their best; same for Chinese cinnabars; the newly mined Tsumeb azurites of blocky habit are not exactly abundant but a few dealers had outstanding examples of them; there has lately been a small flood of excellent wavellite, in the familiar pale green spherules of radiating needles in a gray rhyolite matrix, from near Mount Ida, Arkansas; the new finds of green "prase" quartz, handsome andradite, and large crystals of green hedenbergite from the skarn now under active development on Seriphos, Greece, are gracing several dealers' stocks. And I was stopped in my tracks, while rushing headlong down one aisle, by a fine spread of (of all things) muscovite, in mostly miniature crystal groups from Governador Valadares, Minas Gerais, Brazil. These are sharp, delicately thin hexagonal books which average 5 cm across and are often offset in rosettes, the rosettes in turn irregularly intergrown, matrixless, and an appealing, pale silvery brown color. Josef Enders (Eschenbachstrasse 10, D-6234 Hattersheim 1) was offering these at from $30 to $170 for wonderful 10-cm pieces.

The Austrian dealer Gerhard Gerhardinger (Bahnhofstrasse 13, A-8480 Mureck) had many striking Peruvian and Bolivian things, including much more and much better of the new Peruvian rhodonite which I mentioned having first sighted at Ste.-Marie last July. [Ed. note: see cover.] Gerhardinger's specimens are solid, bright pink rhodonite masses with many open cavity faces covered with parallel-growth blades, the biggest specimen a dazzler measuring 15 x 20 cm, for about $8000; the locality is the Chiurucu mine, Ancash Department, Peru. Furthermore, the Mercedes mine in Huancavelica, Peru, has lately been lavish in the production of brilliant, metallic black, flat plates of tetrahedrite to 15 cm across showing tightly clustered but very sharp crystals to 4 cm on edge; there were also some lustrous pieces with smooth-faced tetrahedrons sprinkled on quartz/pyrite matrixes. Also from Huancavelica, there were a few thumbnail and miniature pyrargyrites, the luster slightly dull but the 2-cm crystals showing excellent form. And there were immense, foam-like groups of pale pink manganocalcite in radiating prisms blanketing sulfide matrixes or in masses to 30 cm across, from Raura, Peru. And also good enargite and bournonite, and monstrous and extremely fine museum pieces of vivianite from Morococala, Oruro, Bolivia. And, of course, what would a stand like this be without more of those absurdly monstrous groups of octahedral pyrite from Huanzala?

But I have saved the best and most dramatic of the new discoveries for last. It was to be found at the block of stands called "Gäste aus Übersee"—the exclusive ghetto of "guests from overseas," including most of the top American dealers who come to Munich, where, experienced visitors learn, many of the show's most glamorous specimens can often be found. Here a small, perpetually busy, extremely friendly Chinese gentleman, Mr. Peter Wu of the firm of *Tradewell* (845 Howard St., San Francisco, CA 94103), had what are very clearly some of the finest realgar specimens ever found anywhere in the world. The particular part of the world where these were found is the southwest part of Guizhou Province, China: more specific than that Mr. Wu would not or could not be. The realgar crystals are deep red, absolutely transparent and gemmy prisms, lightly striated vertically, vaguely chisel-shaped, and up to 3 cm high; they grow richly clustered in vug linings or in vast blankets over matrixes of coarsely cleavable white calcite with interveinings of a dull gray mineral and massive realgar. Sharing the matrix surfaces with the unbelievable realgar crystals are very clean, transparent, grayish-white calcite "dogtooth" twins to 5 cm long, some of these stained yellow by orpiment dustings. One of the immense matrixes I saw was dominated by red realgar on one side, but on the other side was a magnificent calcite group with gleaming, intergrown, transparent dogteeth to 10 cm long. The specimen's overall aesthetic effect is highly unusual: grayish calcite amid yellow clouds and groundfogs of orpiment, and (the more closely one looks the more amazing they are) sharp, vivid red realgar crystals of unprecedented size.

And I haven't yet mentioned the overall size of the matrix pieces. The dozen or so median-sized specimens laid out on Mr. Wu's table, dominated in large part by realgar-red rather than calcite-white, were flat plates averaging 12 cm across. But on a table behind his stand reposed the aforementioned double museum piece (realgar and calcite on flip sides, about 12 x 20 x 30 cm), and, climactically, a great boulder measuring 35 x 40 x 40 cm and weighing (Wu's assistant informed me) 90 pounds, priced at $15,000—probably not unreasonable for what is, as Wu and I were able effortlessly to agree, the world's best realgar specimen. I tried to take some quick photographs of a few areas of this beast—with the results shown here. (Other Chinese realgars, perhaps actually from the same occurrence, were labeled "Shimen, Hunan province" by Doug Parsons at the August Springfield Show—see vol. 20, no. 6, p. 481.)

I should note that the next Munich Show, for reasons best known to the Inscrutable Ones who administer the Munich exhibition hall complex, will be held considerably later than usual—not until November 16–18, 1990.

PRAGUE, CZECHOSLOVAKIA SHOW 1989

[The following notes were supplied by Forrest Cureton, who attended the show.]

The Prague Show, held October 21, was a good one—well worth visiting, but not worth a special trip to Europe by itself unless it can be combined with a visit to the Munich Show.

This year the show had been moved to a much larger hall. It was not easy to find, and the parking accommodations were poor, but it was in a good building.

Attendance was around 1,000, with over 250 actual participants from East Germany, Czechoslovakia, the Soviet Union, Bulgaria, Poland, Yugoslavia, Hungary, and several Western countries. Perhaps 80% of the specimens to be seen were minerals, 15% fossils and 5% gem material and tektites.

It was a show arranged principally for trading, swapping and exchanging, with lots of enthusiasm and haggling. Although cash sales were supposedly forbidden, many transactions involving Western currencies took place anyway. Although we saw no really fine specimens, there were many good ones, and there was much interest in species collecting.

Aside from the show itself, Prague is one of the world's most beautiful cities, and the natural history museum there is not to be missed (see vol. 19, no. 1, p. 14–17).

In the future the show will be held nearer the time of the Munich Show in order to encourage more Western visitors to make it part of their itinerary.

F.C.

* * *

My next report will be coming, not from Zürich as I'd originally planned, but from Lyon, France, whose yearly show vies with that of Paris and with my cherished summer event in Ste.-Marie-aux-Mines for Best Rock-Type Event In France, or some such prestigious honorific. Read all about it next time.

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