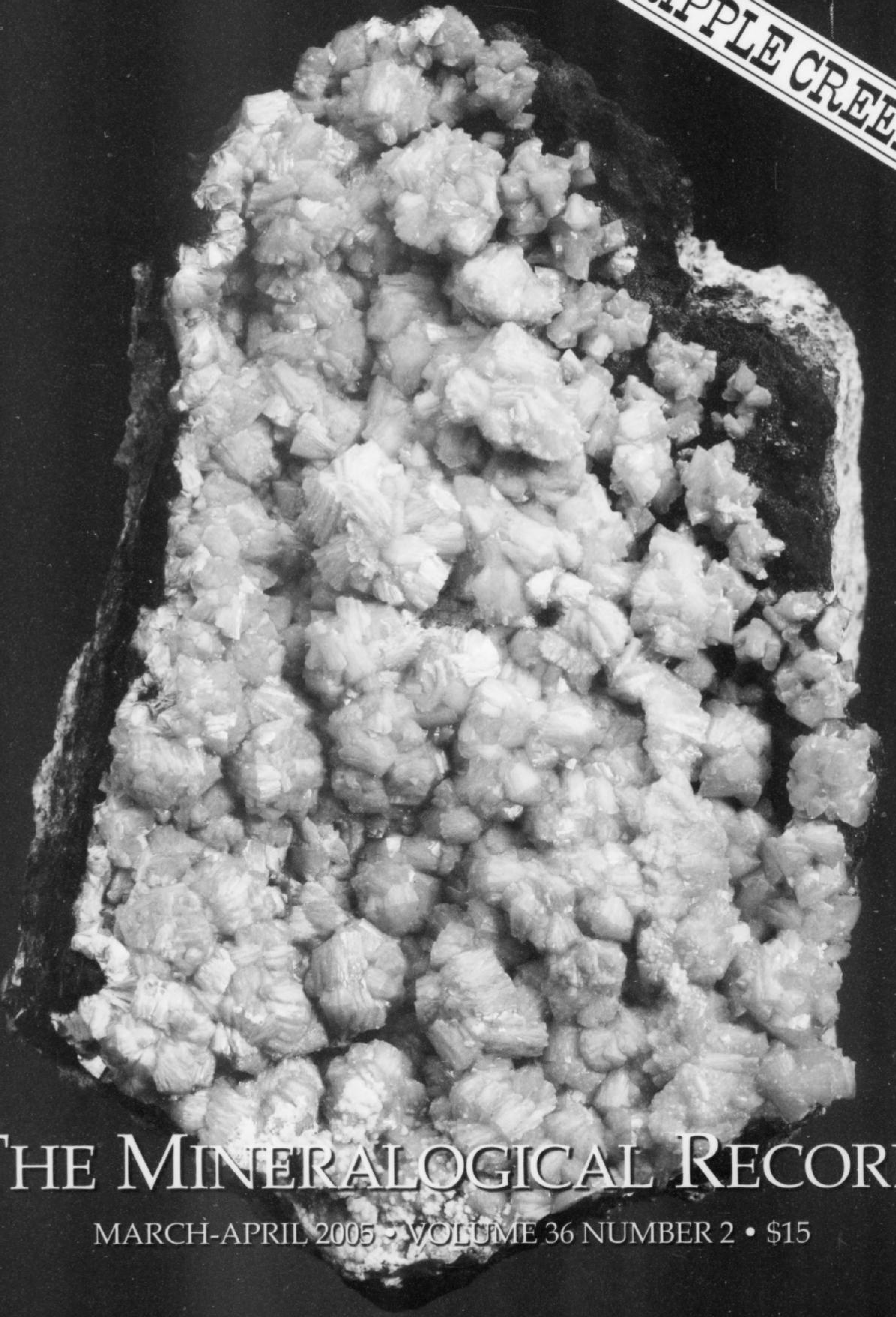

CRIPPLE CREEK!

THE MINERALOGICAL RECORD

MARCH-APRIL 2005 • VOLUME 36 NUMBER 2 • $15

A note from Dona

Wayne... These are some of Dick's specimens that I selected for the special Tucson display. A nice tribute I think. Geez, I'm going to miss him!! Such a special friend...

Dona

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*Continued on p. 232

THE MINERALOGICAL RECORD

March–April 2005 Volume Thirty-six, Number Two

Articles

Columns

COVER: FRANCEVILLITE [$Ba(UO_2)_2V_2O_8\cdot 5H_2O$] from the type locality, the Mounana mine, Franceville, Haute Ogooué, Gabon. See the article on this deposit in vol. 6, no. 5 (1975). Vanuralite from the same locality was pictured on the cover of vol. 18, no. 5 (1987). Martin Zinn collection; Jeff Scovil photo.

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notes from the EDITORS

Our New Website!

Check out our new website, at www.mineralogicalrecord.com! It has been completely remodeled, with many new features that we hope will be of broad use to our subscribers:

Tom's column

First of all, Tom Moore has his own new website column devoted to a timely reporting of new happenings in the mineral world. These can include new mineral offerings found on mineral dealer sites throughout the worldwide web, new publications, new events, museum news, new products, inside stories, and anything else mineralogical that strikes his fancy or comes across his desk. New installments will appear frequently, as the flow of news and discoveries dictates. Readers, dealers, authors and curators are welcome to contact Tom with items of potential interest for the column. E-mail him at tpmoore063@earthlink.net (digital-format photos can be used).

Sample Articles

A selection of articles typical of the kind we publish will be presented under "sample articles," mostly for the interest of non-subscribers who are checking out the site for the first time in order to learn more about the magazine.

Collector Basics

On-line articles presented under "Collector Basics" will primarily be educational articles aimed at relatively new collectors with an interest in becoming advanced collectors and ultimately connoisseurs. Topics covered will include labeling and cataloging, specimen storage, toxic minerals, fakes, connoisseurship, building a library to support a collection, and so on.

On-line Journal

Periodically we receive well-written, well-researched articles which nevertheless are not appropriate for publication in the *Mineralogical Record*. Some are too long relative to their level of collector significance, or address a subject having too limited an audience. Or they may require too many color photographs which are expensive to print. It pains us to reject these articles. Now we can present them in our new on-line journal, *Axis*. Visitors to the website are sure to find an ever-increasing amount of permanently archived esoteric and interesting mineralogical reading to complement what they receive in the *Mineralogical Record*. Submissions are welcome.

For Contributors

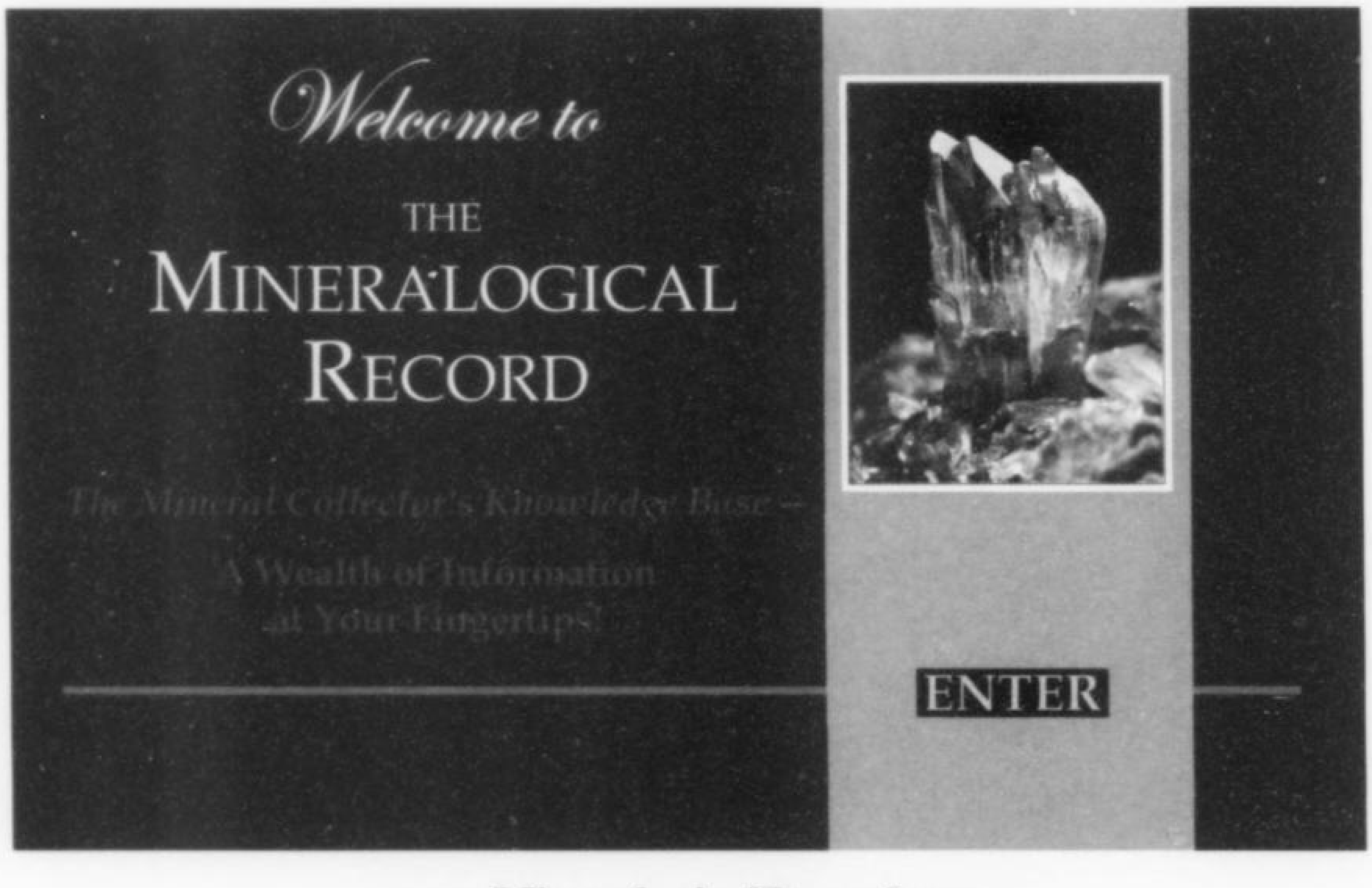
Our "For Contributors" section offers help to authors and photographers working on projects for submission to the *Mineralogical Record*. "Suggestions for Authors," a "Photographer's Guide," and a guide to preparing locality articles will be included. The information presented on photographic technique (some previously published and some new) will be of interest to anyone attempting to refine His or her skill as a mineral photographer.

Back Issues Available

This function allows you to see all of the covers for any given year, and then by clicking on a cover you can see the table of contents of that issue. If the issue is still in print, there will be a price and an "Add to Cart" button for making the purchase.

Search Function

In the *Back Issues* department you'll find an Author-Title search function which amounts to a continuously updated on-line Author-Title index for the entire run of the *Mineralogical Record*, back to volume 1. Just type in an author name or a key word from an article title, hit "search," and a list of all such articles will appear. Each entry in the list will show which issue that article appeared in, and whether that issue is still in print. If it is still available, the price will be given, and an "Add to Cart" button will allow you to select it for purchase. Want to know what else is in that issue first?



Welcome to

THE

MINERALOGICAL

RECORD

The Mineral Collector's Knowledge Base —

A Wealth of Information

at Your Fingertips!

www.MineralogicalRecord.com

Lou Perloff (1907–2004), left, and Julius Weber (1914–2003) at one of their micromounting sessions at Weber's home in Mamaroneck, New York.

Clicking on the article title will show you the table of contents for that issue, and the issue cover.

General Index

If an author-title search is not sufficient for your needs, we also have a full General Index on line. This includes the full text of the 240-page 25-year index by Ed Clopton, which we published in hardcover format ten years ago, and also a new 10-year General Index by Tom Moore which covers the years since then. The General Index goes into much more detail regarding contents than does the Author-Title Index.

Subscriptions

The Subscriptions section will allow you to quickly and easily renew your subscription on-line, or purchase a new subscription.

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Enter the Bookstore and you will find a list of all the books we carry, along with their prices and an "Add to Cart" button for selecting your purchase. Want to know more about the book first? Just click on the title and you will see a full description of the contents, and also perhaps a review if one has been published. The Bookstore may also include, from time to time, one-of-a-kind items and antiquarian titles being liquidated from the Mineralogical Record Library.

Advertising

In the Advertising Department you'll be able to access our current ad rates, deadlines and conditions at any time. In addition, if you are a new advertiser, you can go to our "Suggestions for new advertisers" section and receive sage advice born of long experience in making ads that work.

And More . . .

As time goes by we may be adding still more functions and services to our website, so be sure to check it out periodically and see what's new. You'll want to be keeping up with Tom Moore's column installments anyway. We look forward to having you as a regular visitor to *MineralogicalRecord.com* in the future!

WEW, TPM

Died, Louis Perloff, 96

The micromounting world experienced a grave loss with the death on January 16, 2004, of one of its most famous members, Louis (Lou) Perloff. Lou was the last of the real old-timers from the New York area; the last of the boyhood friends of Neal Yedlin, and one of the last to have come under the influence of Jack Boyle at the Brooklyn Children's Museum.

Born in New York City on December 3, 1907, Lou spent a large part of his working life practicing law in that city. Later, he spent more time in the South, working for 20 years with the Labor Relations Board in Winston-Salem, North Carolina. Although he kept a *pied-à-terre* in New York for many years, he settled finally in Tryon, North Carolina. Nevertheless, he frequently returned to the New York area to visit friends and especially to enjoy micromounting sessions with his close friends Julie Weber and Neal Yedlin.

Lou had a lifelong passion for minerals, but he did not begin micromounting until 1947, when he bought his first microscope. In the following fifty-odd years, he acquired 25,000 boxed mounts, stored in sixteen wooden cabinets for the general collection, three smaller cabinets for the 1,400 diamond mounts, and three large metal cabinets for silicates and uranium minerals. In collecting, he had a special fondness for the rarer sulfides and sulfosalts, pegmatite phosphates, and minerals of uranium and rare earth elements. His personal mounts were finished to a very high standard of specimen quality and crystal orientation. Lou also developed a deep interest in photomicrography, and in a few short years had established himself as an acknowledged master of the technique. But he was always quick to acknowledge the important role that Julie Weber played in helping him to develop his skills in photomicrography.

Although his formal training was in law (he earned his L.L.B. and L.L.M. degrees from Brooklyn Law School), he had a vast self-taught knowledge of mineralogy. He also had a bent toward teaching, and was anxious to pass on his knowledge to others in the hobby. Many speakers at micromount symposia give talks on the order of: "This is the XYZ mine, and these are pretty pictures of the minerals from that mine." Lou, however, took pains to work on talks that focused on such things as the minerals of the different valence states of uranium or vanadium, pointing out distinguishing features of each species in his photomicrographs. Never short of invitations to talk, he was a regular speaker at the Baltimore Mineral Society's annual symposium for close to 40 years. Displaying a formidable memory, he would take the floor and identify slide after slide as to species, chemistry, crystal system, identifying features, and mine of origin—all without notes. From his huge library of slides, he could pick out a series illustrating just about any mineral topic required, from crystal systems to pegmatite phosphates. As a consequence, his work was used in many publications, including the *Photo-Atlas of Minerals* (1998) (royalties from which he donated to the Mineralogical Record).

A member, both regular and honorary, of many organizations, including the Mineralogical Society of America, Lou was always willing to lend a hand or a specimen to fellow micromounters. His one difficulty in dealing with events was his increasing deafness. While listening to a talk, he would crank his hearing aid to its maximum volume, causing a piercing feedback squeal audible to everyone but himself. The esteem in which he was held, however, was such that no one would ask him to turn it down. His wide knowledge, skill in photography, and willingness to help, earned recognition in 1977 with the naming of the mineral perloffite [$Ba(Mn^{2+},Fe^{2+})_2Fe^{3+}_2(PO_4)_3(OH)_3$]. He was inducted into the Micromounters Hall of Fame at its inception in 1981, together with five other luminaries of the hobby: Rakestraw, Fiss, Desautels, Seel, and Yedlin.

In many ways, the passing of Lou Perloff marks also the passing of an era in micromounting. There are others, widely known and admired, who have been micromounting for longer periods, and who have equaled him in skill and knowledge, but Lou was half of a team. Yedlin and Perloff were as inseparable to micromounting as Abbot and Costello were to comedy. Now the last connection is severed, and the loss is great.

Quintin Wight

Died, Julius Weber, 89

Noted photomicrographer Julius "Julie" Weber died on March 9, 2003, at the age of 89, leaving behind one of the largest and most remarkable micromount collections ever assembled. For decades, Julie and his close friend Lou Perloff (1907–2004) collaborated in their micromounting efforts, each assembling important collections. In 1997, Perloff gave his 20,000+ micromount collection to Weber, bringing the combined total to well over 50,000 specimens. Earlier this year, Julie's wife Mary donated this combined collection to the Natural History Museum of Los Angeles County.

Julius Weber was well known in the mineral community for his work in photomicrography. He provided all of the photographs for the very popular first edition of the *Encyclopedia of Minerals* (Roberts, Rapp and Weber, 1974). He served as an associate photographer for the *Mineralogical Record* from 1976 to 1993, and he particularly enjoyed working on the photomicrographic needs of professional mineralogists such as Joe Mandarino, Paul Moore and Bill Roberts. He was a Research Associate in the Department of Mineralogy of the Royal Ontario Museum and in the Department of Earth and Planetary Sciences of the American Museum of Natural History. Lou Perloff, also well known as a prolific mineral photomicrographer, credited his own renowned photomicrographic acumen to Julie's tutelage.

Before directing his efforts toward minerals, Julie was already a highly accomplished and innovative professional photomicrographer, mostly in the medical field. He published the first Kodachrome (color) photomicrograph in 1939 (in *Leica Photography*) and published color fluorescent photographs of bacteria as early as 1946. He was the first to use electronic flash in medical photography and the first to photograph living cells using the Zeiss Phase Microscope. Throughout his career, Julie was an innovator, contributing to improvements in photomicrographs and the microscopes, cameras and film that produced them. His photomicrographs appear in no fewer than 61 books.

Julie attended Brooklyn College and Columbia University, but his photographic expertise was largely self-taught. In 1974, Jersey City State College awarded him an honorary Doctor of Science degree. He was a member of the New York Academy of Science, a Fellow of the Biological Photographers Association, a Fellow of the Royal Photographic Society of Great Britain, and a Fellow of the Royal Microscopical Society.

A comprehensive analysis of the combined Weber/Perloff collection will not be attempted here and actually would probably require years of study; however, several particular strengths worth mentioning are the diamond crystals (over 2,200 specimens!), crystallized gold (over 800), pegmatite phosphates (especially from the Palermo #1 mine in New Hampshire and various mines in the Black Hills of South Dakota) and secondary uranium minerals (especially from the Shaba region of the Democratic Republic of Congo). The scope of the collection, both in terms of mineral species and localities, is amazing. Assembled over the course of more than half a century, it actually represents a much longer collecting period, as hundreds of mounts from earlier collections, such as those of Clarence S. Bement and George W. Fiss, were obtained and incorporated by Weber and Perloff.

For more than 25 years, the Mineral Sciences Department of the Natural History Museum of Los Angeles County has placed a high priority on building its micromount collection into a valuable research, teaching and reference resource. With the addition of this collection, the museum's micromount collection has grown to nearly 100,000 specimens. Other significant collections donated to the museum include those of Wayne and Dona Leicht (1979), Benjamin J. Chromy (1985), William E. Davis (1986), Harold C. Hiebert (1987), Juanita and Charles Curtis (1988–2005), George Tunell (1989 & 1994), Jessie Hardman (1991–2000), Leonard Lobsenz (1999) and Hugh McCulloch (2004).

Anthony R. Kampf

Died, Willard L. Elsing, 93

Willard Elsing, consummate rockhound and founder of the Elsing Museum in Tulsa, was born in Kansas on July 22, 1911, and died at the age of 93 on October 17, 2004. His father Walter had emigrated to America from Germany in 1890 and established a cleaning business in Pittsburg, Kansas in the 1920's. As a young boy Willard became fascinated with all sorts of local collectibles, including arrowheads, ethnic artifacts, rocks and (especially) minerals.

In the 1930's he left home and opened a rock and mineral shop on Route 66 near the lead-mining center of Joplin, Missouri.

Miners from throughout the Tri-State District brought him specimens which he bought for the shop, keeping many of the more interesting examples for his own growing collection. It was a great sadness to him when the Tri-State mines finally closed down.

Elsing favored crystal collecting above all, and was an aesthetic collector rather than a scientific one. He preferred to buy many of his specimens at mineral shows rather than obtain them by field-collecting. He recommended comparing prices carefully to avoid being overcharged, and advised, "When you find a dealer who will take a little time to help you, stick with him." He always made a habit of reinvesting profits from specimen sales in new specimens for his collection, and he recommended joining a local club to meet other collectors and potential buyers. Elsing always kept the original labels showing what he had paid for specimens, and he endeavored never to sell anything at less than its inflation-adjusted purchase price. In his 90's, he could still quote the purchase price of specimens he had bought in the 1930's.

In the early 1970's Elsing made the acquaintance of Evelyn Roberts at a seminar being held at Oral Roberts University, and eventually he agreed to transfer much of his huge collection to the Learning Resource Center of Oral Roberts University in the University Village retirement center. In 2001 the collection, still referred to as the Elsing Museum, was moved onto the campus of the university, where it can be seen today. Proudly dubbed "God's natural art museum" (Oral Roberts University is a religious institution), the museum exhibits over 3,000 specimens including a 2,900-carat Australian opal, slabs of scenic agate, Oriental jade work, Native American rarities, fossils, mineral art, and a great many attractive and interesting crystallized mineral specimens. In response to increasing visits by school groups, some new educational exhibits are planned for the future, including an indoor man-made cave. More information about the Elsing Museum at Oral Roberts University is available on the museum's website: http://elsing.oru.edu.

WEW

Jean-Pierre Cand

Further to the obituary for Jean-Pierre Cand which appeared in the September-October 2004 issue (vol. 35, no. 5, page 363): It was stated that Cand died "from injuries caused by falling rock while collecting benitoite and neptunite" in San Benito County, California. Bryan Lees (current lessee of the Benitoite Gem mine) wishes us to note that the fatal accident happened at a collecting site in the Diablo Range, *near* the Benitoite Gem mine property but not within its boundaries.

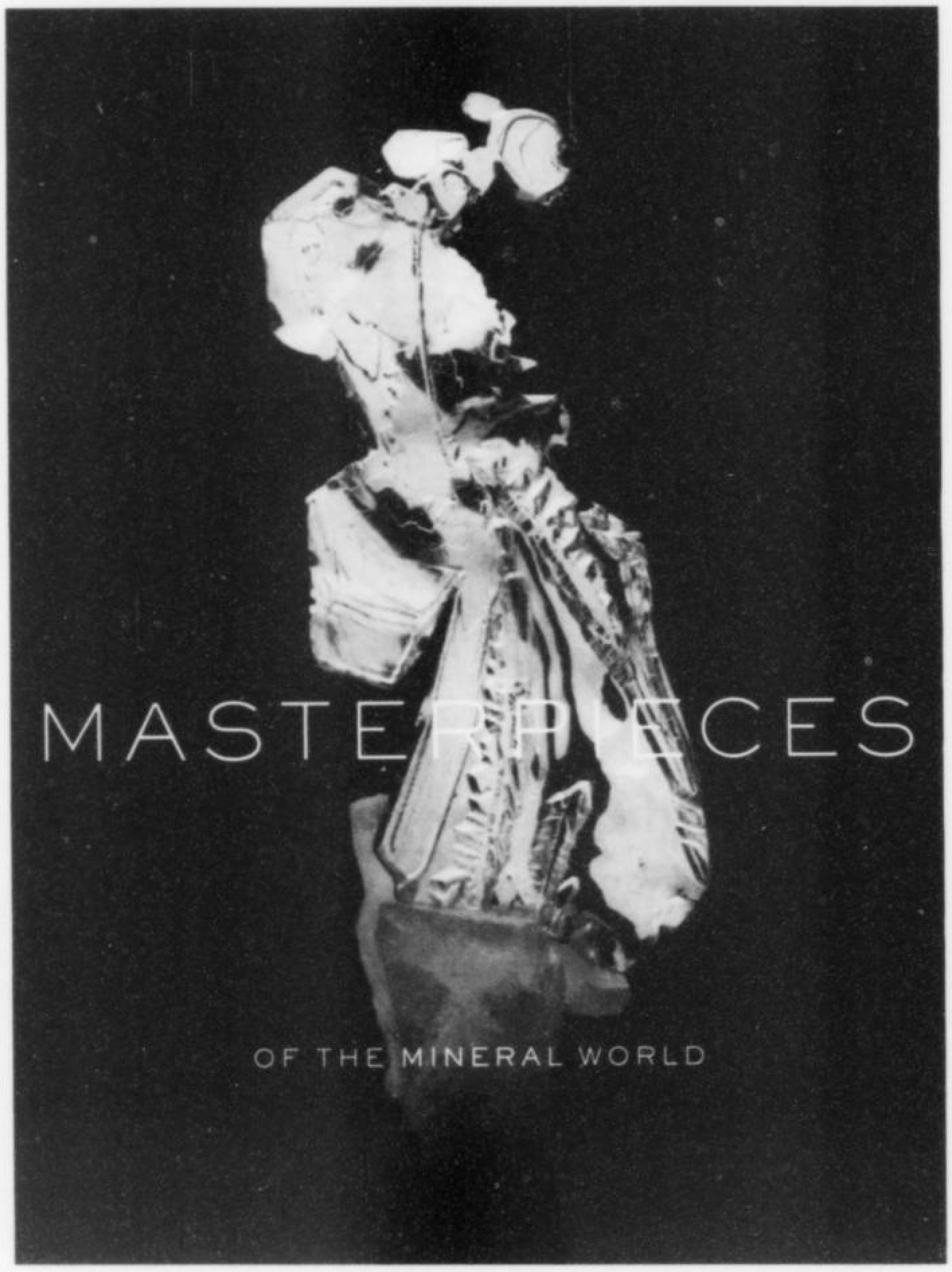
TPM

Masterpieces of the Mineral World

A new book published by the Houston Museum of Natural Science, featuring the treasures of the mineral collection. Distributed by the Mineralogical Record.

Written by **Wendell E. Wilson**, editor-in-chief and publisher of ***The Mineralogical Record***, and **Joel A. Bartsch**, president of the Houston Museum of Natural Science, with **Mark Mauthner**, associate curator of gems and minerals.

Photography by
Jeffrey A. Scovil
and
Harold & Erica Van Pelt



The magnificent mineral collection housed in the Houston Museum of Natural Science is among the finest and best known in the world. Now the treasures of this unique repository are shown in beautiful full-page photographs that will seduce both the connoisseur of beauty and the student of natural history. The spectacular and rare specimens on display here, from a huge imperial topaz weighing more than 2,000 carats to a 6.8-cm phosphophyllite crystal and crystallized gold clusters that are among the most highly coveted objects in the Mineral Kingdom, are true masterpieces, like the Rembrandts and Van Goghs of the natural world. Prized for their rare aesthetic qualities—their highly developed luster, color, size, and sculptural composition—as well as their often exotic provenances, these specimens have come to the museum from elite private collections such as that of Perkins and Ann Sams, and a remarkable, enormously valuable (anonymous) private collection just recently acquired. The majority of the specimens pictured have not been previously published, and many of the others have been rephotographed. All are accompanied by much more background information than was provided in the 1992 Houston Museum Supplement to the *Mineralogical Record.*

An introduction to the museum, its history and its collection is followed by an analysis of connoisseurship ("The Discerning Eye—What makes a mineral collectible?"). The history of aristocratic mineral collecting, from the 16th to the 20th centuries, is recounted ("A Royal Passion"). Eighty full-page color plates show the breathtaking highlights of the museum's collection, with each specimen described in full, its aesthetic qualifications analyzed, and its locality of origin described, often with interesting historical sidelights. Finally, a Selected Bibliography points the reader toward additional reading.

This book will be read with equal interest by seasoned long-time collectors and those new to the hobby. Produced in association with Harry N. Abrams, publisher of the widely known and respected Abrams art books, the paper, binding and production quality of *Masterpieces of the Mineral World* meet the same high standards. Size 9.5 x 13 inches, hardcover, 264 pages.

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Famous Mineral Localities:

THE CRIPPLE CREEK MINING DISTRICT

Colorado

Carl R. Carnein
Associate Professor of Geology
Lock Haven University of Pennsylvania
Lock Haven, PA 17745

Paul J. Bartos
Director/Curator
Colorado School of Mines Geology Museum
Golden, CO 80401

The Cripple Creek District, discovered in 1891 by Cowboy Bob Womack, was the last of the great Colorado bonanza camps. It has yielded over 600 metric tons (22 million troy ounces) of gold from its 500 mines, making it the third most productive gold district in the history of the United States. At least 120 mineral species have been reported, including fine specimens of calaverite, sylvanite, krennerite, melonite and creedite.

INTRODUCTION

Most collectors know of the Cripple Creek district from seeing souvenir-type specimens of roasted gold telluride ore. When telluride ore samples are heated above a few hundred degrees Celsius, the tellurium vaporizes, leaving bubble-like blobs of gold behind. However, fine specimens of melonite, calaverite, sylvanite, krennerite, amethyst, and turquoise from Cripple Creek can be seen in many museums and are occasionally available to collectors. In 2003, excellent specimens of creedite, some with gearksutite, celestine, and/or botryoidal rhodochrosite, were released from a 2001 discovery (Moore, 2004). However, considering the detrimental effects that current large-volume surface mining methods, stringent reclamation requirements, limited access, and limited reserves have on specimen recovery, the Cripple Creek area is unlikely to produce significant new finds for more than the next decade or so.

The senior author's interest in the district dates from the early 1970's, when he directed an annual geology field course headquartered in Florissant, about 20 miles north of Cripple Creek. Included in the course was a short field trip to examine the major rock types of the district; we also visited the Molly Kathleen mine (still operating today), where, each year, a dozen or so college students, their professor, and a tour guide were squeezed into a man cage that was not much larger than a phone booth.

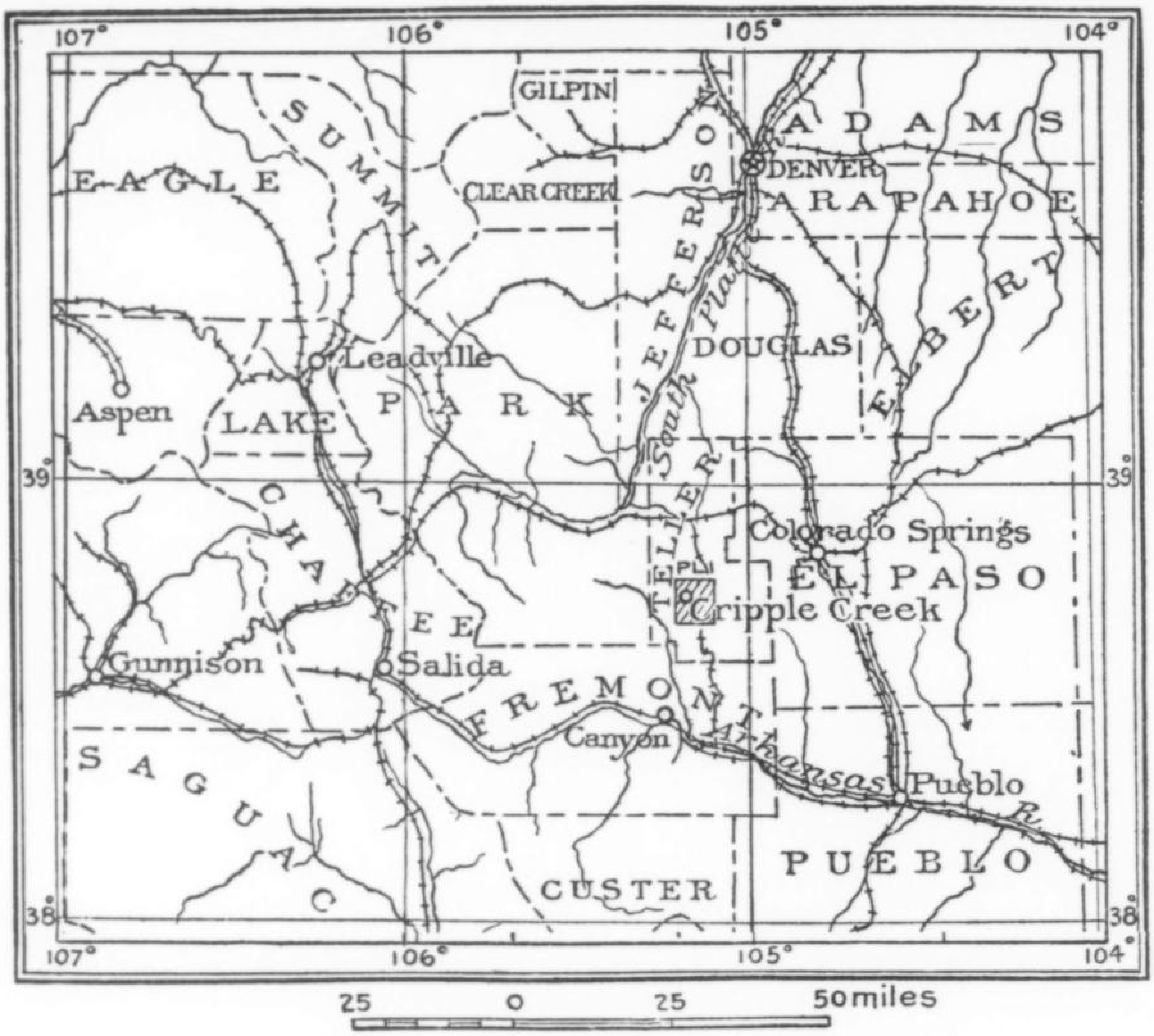

Figure 1. **Location map from Lindgren and Ransome (1906).**

The junior author actively mapped and explored the area from the late 1980's through the early 1990's. Ultimately he was unable to acquire the ground he wanted, and moved on. However, both authors today remain interested in the district and its minerals, and fascinated by the history of Cripple Creek, one of the most colorful of Colorado's mining camps.

LOCATION AND ACCESS

The town of Cripple Creek, in Teller County, lies 23 miles west of Colorado Springs and 10 miles southwest of Pikes Peak. The Cripple Creek gold mining district lies to the east of Cripple Creek town and to the north of the town of Victor. Covering only a few square km, it is the third most productive gold district in the United States (after the Homestake mine in Lead, South Dakota and the Carlin district in Nevada). Cripple Creek's roughly 500 mines have produced more than 22 million troy ounces (614 metric tons) of gold and an unknown quantity of silver since production began in 1891. This is about half of Colorado's total gold output of 44 million ounces since 1860 (Davis and Streufert, 1990) and about 5% of total U.S. production between 1900 and 2000. Except for a period from the 1960's through the 1980's, significant production has been nearly continuous since the commencement of mining in 1891.

A large open pit operation at Cripple Creek was opened in 1995, and since then it has produced approximately 12 million tons of ore yielding 250,000 to 300,000 ounces of gold per year. The ore is quite low-grade—on the order of 0.03 troy ounces of gold per ton (quite a contrast from the 1 to 2 ounces per ton from ore mined in the early 1900's!) Projections indicate that this mega-pit will produce an additional 3.5 million ounces of gold. Mining is permitted through 2012, with final reclamation scheduled for 2021 (AngloGold, 2001). However, additional known resources of approximately 1.4 million ounces (Pontius, 1996) may allow mining to continue beyond 2012.

The modern mine is a "standard" heap-leach facility. The ore is mined and crushed to small gravel size, then sent by conveyor or truck to leach pads where a dilute sodium cyanide solution is sprayed on the pile. The cyanide dissolves the gold; the solution is then collected from the base of the pile and is run through a precipitation plant, where gold is recovered by carbon adsorption. An electrowinning process follows, and the final product is cast into doré "buttons" containing about 75 percent gold and 25 percent silver. With an initial capital investment of some $150 million, the mine currently employs about 300 people (AngloGold, 2001).

About 90% of the Cripple Creek district (more than 4,800 patented mining claims) is now controlled by the Cripple Creek & Victor Gold Mining Company, a 33:67 joint venture between AngloGold North America and the Golden Cycle Corp. (Cripple Creek & Victor Gold Mining Co., 1999). This property is clearly posted, and trespassing is both prohibited and dangerous. However, CC&V staff offer tours for organized groups, and casual visitors can enjoy a well maintained trail system in the Vindicator Valley, just north of Victor. The trail provides access to many clearly identified, standing historic mine structures and ruins. The Golden Loop Historic Parkway, which offers a spectacular overlook at the American Eagle mine site, can be enjoyed by car. A few trails are marked, but visitors otherwise are strongly discouraged from exploring the district on foot without permission.

HISTORY

The Pikes Peak gold rush of 1859 largely bypassed the Pikes Peak region. The mountain was used as a landmark by westward-moving gold seekers, but the real rush was to the north, at Idaho Springs and Central City. The Pikes Peak area offered only unpromising red granite and gray volcanic rocks, and the local streams rewarded even the most persistent sourdoughs with little more than a show. Most prospectors who visited the area did not stay long, but instead continued their quest farther west and north.

Among those drawn west by the rush were Sam Womack and his son Bob, a 17-year-old eager to learn about mining. The Womacks came west from Kentucky in 1861, just as the Civil War was heating up. Soon the rest of the family followed them to the Clear Creek/Georgetown area, where Sam, Bob, and Bob's brother William busied themselves with gold and silver mining, milling and production. Although some later acquaintances thought of Bob as a drunken cowboy with little or no knowledge of mining, his experience in the 1860's made him a much more savvy prospector than most of the people who became involved in seeking valuable metals.

By 1867, Sam Womack had accumulated substantial wealth, but apparently at the cost of his health. Thinking that mining was bad for him, he moved his family to the Sunview Ranch in the Colorado City area, 3 miles west of Colorado Springs. There they took up cattle ranching on 640 acres along Little Fountain Creek. Bob became an expert rider and explored widely, hunting game and panning the streams. He had been bitten by the gold bug, and for most of the rest of his life he took far more interest in prospecting than in ranching or other occupations.

In 1871, friends of the Womacks named Welty decided to leave their ranch north of Colorado Springs and settle in the Pikes Peak country to the southwest. They built their squatters' cabin in Pisgah Park, southwest of Pikes Peak, near a spring that supplied a nearby creek. One story often told is that the Weltys needed to build a spring house to protect the spring from wild animals; while they were building it, somebody lost control of a log, a gun was accidentally discharged, and a "pet" calf, startled by the shot, jumped the stream, stumbled, and broke its leg (Sprague, 1953). Levi Welty supposedly said something like "Well, boys, this sure is some cripple creek," and the name stuck.

The Womacks continued to operate the Sunview Ranch on Little Fountain Creek through the middle 1870's. In 1873, Bob bumped into members of Ferdinand Hayden's Geographical and Geological Survey of the Territories, who were eating lunch in the nearby town of Fountain. Among those in the party was Theodore Lowe, a cousin of Bob's brother-in-law. Made curious, perhaps, by Bob's stories, the exploring party visited the Cripple Creek area, where they noted a gold show in volcanic rocks and then moved on. In 1874, a member of the group, H. T. Wood, returned with some enthusiasts from Fountain and dug a 100-foot prospect hole in the middle of what later became the richest part of the Cripple Creek district (Sprague, 1953). They found what was described as "white iron," meaning arsenopyrite; it was instead probably one of the gold-silver tellurides, but they thought it was worthless and left.

By 1875 the Womacks had realized that, as the population of the Colorado City/Colorado Springs area was booming, it would be useful to own summer grazing land in the mountains. In 1876 they bought the Weltys' squatters' rights in Pisgah Park, and Bob homesteaded an additional 160 acres 2 miles to the south, in Arequa Gulch. His brother William, with his new wife, moved into the Welty cabin, while Bob built a shack nearby, in a place he dubbed "Poverty Gulch."

Some writers, notably Cripple Creek historian Leland Feitz, think the name Cripple Creek came up Ute Pass with the Womacks. Although they came from Kentucky, the Womacks had roots near a place still called Cripple Creek, Virginia (MacKell, 2003), and they may have named the creek in memory of their roots. Like many stories that aren't very colorful, this one may be closer to the truth than others (such as the one involving the Weltys' pet calf, above).

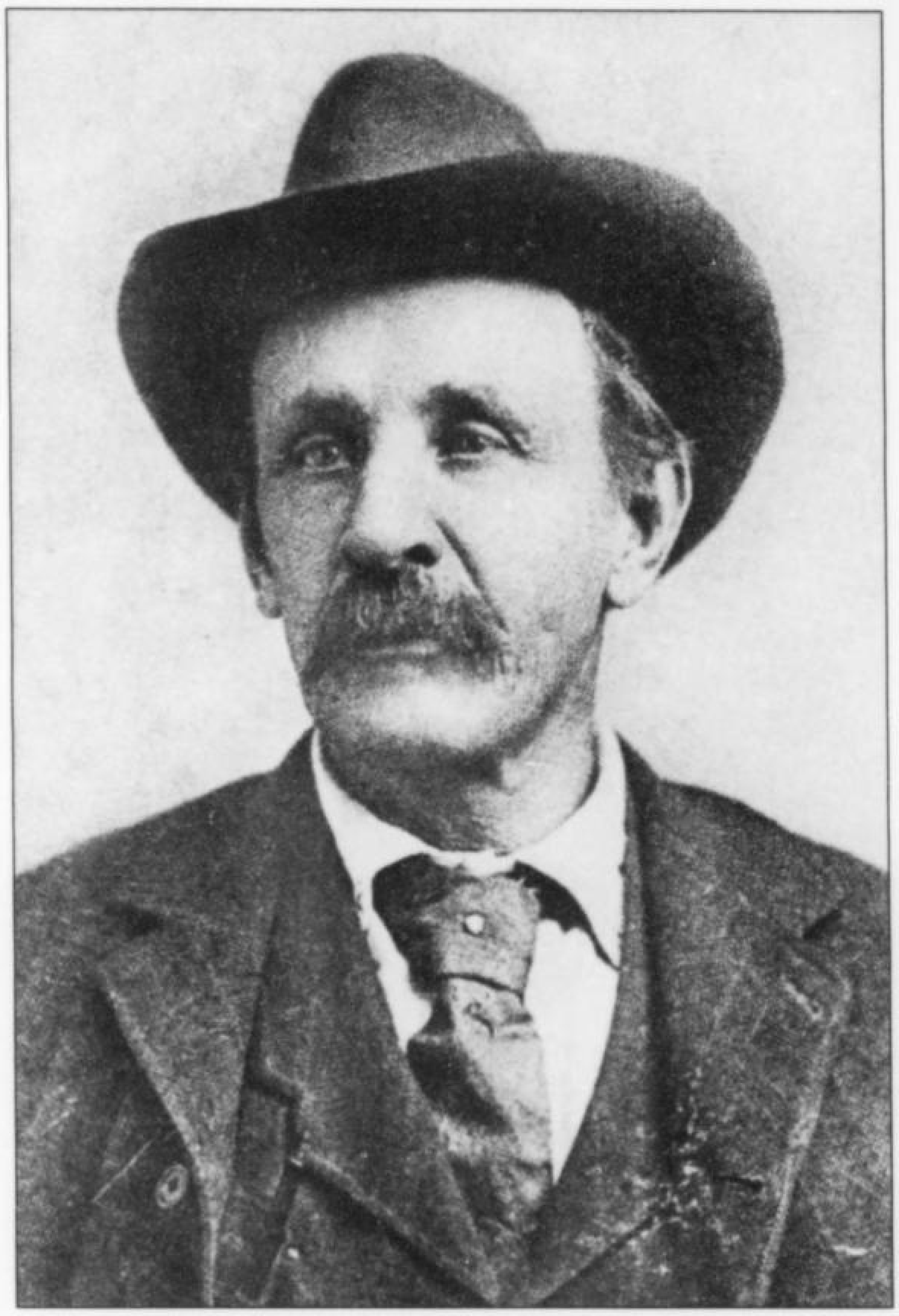

Figure 2. **The man who started it all at Cripple Creek, Robert Miller "Cowboy Bob" Womack (1844–1909). He found the first piece of "float" gold in 1878 and tracked it to its source, the El Paso lode. Lacking an interest in money or business, he later sold his holdings for a few hundred dollars and ultimately died penniless while others became millionaires. (Homer F. Davis collection photo)**

In May of 1878, Bob Womack picked up a piece of volcanic "float" in Poverty Gulch. Theodore Lowe talked a Denver assayer into analyzing it, and it turned out to be gold ore worth $200 per ton (nearly 10 troy ounces of gold per ton—good enough to cause a stampede in most places!). Bob recognized that the surficially altered sample, which he had found in the gravel scree, could have come from nearly anywhere upslope. He followed the "float trail" uphill for 2 miles, buoyed by the results of occasional assays. On periodic binges in Colorado City, Bob bragged about the gold deposit he was tracing up Poverty Gulch, but many viewed him as a crackpot, and only one man, Henry Cocking, took the trouble to visit the site and stake a claim. In 1881, Cocking drove an entry into the hillside at the highest point of Bob's float trail, stopping just short of a $3,000,000 vein.

In 1884, two men dug a prospect hole on the east side of a barren volcanic peak called McIntyre Mountain, 13 miles west of the

Womack homesteads. After erecting a sign naming the hole the Teller Placer, the two left for Canon City. Soon the claimants announced a $2,000-per-ton assay of material from the claim, and within a short time thousands of people were camped out on the slopes around McIntyre. Bob Womack, thinking McIntyre Mountain was a strange place for a placer, talked with local old-timers and confirmed his suspicion that the story was a hoax, possibly cooked up by Canon City merchants to drum up business (Sprague, 1953). Unfortunately, when word reached Colorado Springs, the press confused McIntyre Mountain with another volcanic peak, Mt. Pisgah, which happens to lie just west of Poverty Gulch and the future Cripple Creek town site. For most people, the incorrect news stories discrediting Mt. Pisgah dealt a fatal blow to any enthusiasm Bob Womack's stories about Cripple Creek gold might have generated.

The Womacks sold both of their Cripple Creek-area homesteads in 1885. Eventually they were bought by Horace Bennett and Julius Myers, who formed the Houseman Cattle and Land Company. Bob Womack stayed in the area, doing odd jobs for Bennett and Myers and continuing to follow his float trail. In 1886, he staked a claim (the Grand View) where the float trail appeared to end. After selling a two-thirds interest to Edwin Wallace in 1887, Bob talked a dentist friend, Dr. John Grannis, into grubstaking him for a half interest in 1889. (Notice that the shares of mining claims sometimes add up to some figure other than 100%!) Wallace abandoned the claim, and in 1890 Bob re-occupied, re-staked, and re-named the claim, calling it the El Paso. Dr. Grannis hired Colorado College professor Henry Lamb to check out the claim, and Professor Lamb's assays were encouraging; they suggested the presence of ore worth up to $250 per ton. However, the source of the gold wasn't clear.

Incredibly, Bob and Dr. Grannis still couldn't find anyone to take the area seriously. In frustration, they placed samples of their ore in a Colorado Springs store window, thinking someone might take an interest. The someone who did was Ed De La Vergne, an unemployed Colorado Springs resident whose brother owned a furniture store across the street. By this point in 1890, Ed had just finished taking Professor Lamb's assaying course. He suspected that the ore samples in the store window were sylvanite, a gold-silver telluride first described in Romania but relatively unknown to American assayers. Ed tracked down the samples' owners, and, a few days later, met with Bob Womack, Dr. Grannis, Professor Lamb and Fred Frisbee, a friend of Ed's. After Bob described the results of his 12-year search, Ed, keeping his suspicions secret, checked the area out for himself in January, 1891. He and Fred Frisbee wandered around for an adventurous month, supposedly eating pack rats, getting sick on snow water, and being bitten by a raven. They also collected samples and, while staying at the Broken Box ranch in Poverty Gulch, Ed put an ore sample on a hot stove. Golden bubbles appeared on the surface, confirming Ed's suspicions.

Ed De La Vergne's interest in the area suggested to others in Colorado Springs that maybe Bob Womack wasn't crazy after all. However, one last, untimely hindrance to a gold rush appeared in a news article in February, 1891. The story reported a find of something that had been misidentified as gold, saying that the find had occurred at Florissant, not far from Mt. Pisgah (actually the distance between them is about 15 miles). The story temporarily deflated interest in the Cripple Creek area for some, but Ed had already staked two claims adjacent to Bob's El Paso lode. Bob soon heard that others had staked claims, and that they planned to meet at Cripple Creek in April to form a mining district. The organizers focused on an area about 6 miles square (23,000 acres) that included most of the volcanic rocks of the Cripple Creek basin. By September, people were flooding into the district, staking hundreds of claims in the Poverty Gulch area and in the country immediately to the south.

Figure 3. **Count James Pourtales (1853–1908), owner of the Broadmoor Dairy and several other properties in Colorado Springs, was the first big investor in the Cripple Creek mines, spurring further investment by others. He also built the Broadmoor Hotel and resort. (Tutt Collection photo from Mazzulla and Mazzulla, 1964.)**

Despite all of the interest, not much money followed the immigrants in the first rush to Cripple Creek. Few of the early prospectors had the resources needed to turn a prospect into a mine. However, in August, 1891, Count James Pourtales, owner of the Broadmoor Dairy and several other properties in Colorado Springs, met Ed De La Vergne. Ed had the prescience to predict that the district would create many millionaires. Pourtales decided he needed to check the area out for himself, and in mid-August he and a friend, an experienced prospector, visited the district. In November, Pourtales announced that he had bought a claim for $80,000. In a very short time, dozens of other potential investors sent agents to look into the district, and by 1892 hundreds of claims had changed hands. Stock sales and prices skyrocketed. Unfortunately for Bob Womack, he had sold his remaining half interest in the El Paso lode to Dr. Grannis for $300. The doctor then sold 80 percent of it for $8000, and shortly thereafter a judge paid $10,000 for a ten-percent interest (Sprague, 1953). In 1892, the sheriff of Colorado Springs supposedly claimed that the town had seen a precipitous drop in crime because the criminals had all moved to Cripple Creek.

Gold mining wasn't the only way to make a killing in Cripple Creek. Several Colorado Springs investors staked 140 acres of geologically unpromising land around the north and east sides of Bennett and Myers' Broken Box Ranch, naming the site Hayden Placer. Before they even had a patent, they began subdividing the site and selling lots. By February, 1892, the Hayden Placer town site was broken into 1320 lots (Sprague, 1953). Recognizing the danger of losing a golden opportunity, Bennett and Myers platted the hilliest part of the Broken Box Ranch, naming their new town

Figure 4. **Placer mining at Cripple Creek, 1893. Although many early settlers had high hopes for placer mining, very little of the district's 25 million ounces of gold production came from placer deposits. Carnein collection.**

site "Fremont." Its 30 blocks and 766 lots showed no regard for topography, as can still be observed by flatlanders who gasp their way up and down the hilly streets of what was once Fremont (now a part of modern-day Cripple Creek).

The founders of Hayden Placer, which was already popularly called Cripple Creek, barred most of the businesses most typically in demand in a raw mining town. Saloons, dance halls and bordellos were forbidden, and so were forced to locate in Fremont. With 1000 new residents arriving each month, the demand for lots soon consumed Hayden Placer, Fremont, the rest of the Broken Box Ranch, and much of the surrounding country. Finally, in February of 1893, residents of the two communities voted to combine the towns and formally name the new metropolis "Cripple Creek."

As is often the case, some of the richest mines in the district were discovered and developed in unlikely ways. For example, the deposit exploited by the Gold Coin mine, located in the heart of downtown Victor, was accidentally discovered when the property was excavated for the foundation of a new hotel. The deposit worked by the Pharmacist mine was supposedly discovered by a druggist who threw his hat into the air near the (now) ghost town of Altman and started digging where it landed. He is said to have become one of the district's 30 millionaires (Lewis, 1982).

Especially unlikely is the story of how the Portland mine, the district's biggest producer, came into being. Several characters were involved in the saga. Winfield Scott Stratton, a Colorado Springs carpenter, was one of the early visitors to Bob Womack's cabin in 1891. Having spent at least 17 unproductive summers prospecting for gold in various parts of Colorado, Stratton recognized the importance of training. He took a course in blowpipe analysis, worked in a gold mill, and studied metallurgy. However, he didn't like most people, and when he visited Cripple Creek in 1891 he picked Battle Mountain, north of the present town of Victor, partly to get away from tenderfeet and partly because the area straddles the boundary between the volcanic rock units and the surrounding granite. Most people had considered that area to be "unpromising," but on August 4, 1891, Stratton filed the

Figure 5. **Winfield Scott Stratton (1849–1902), a Colorado Springs carpenter, filed the Independence and other claims in 1892 and ultimately became one of the wealthiest of the Cripple Creek mining barons. (Cripple Creek Museum photo)**

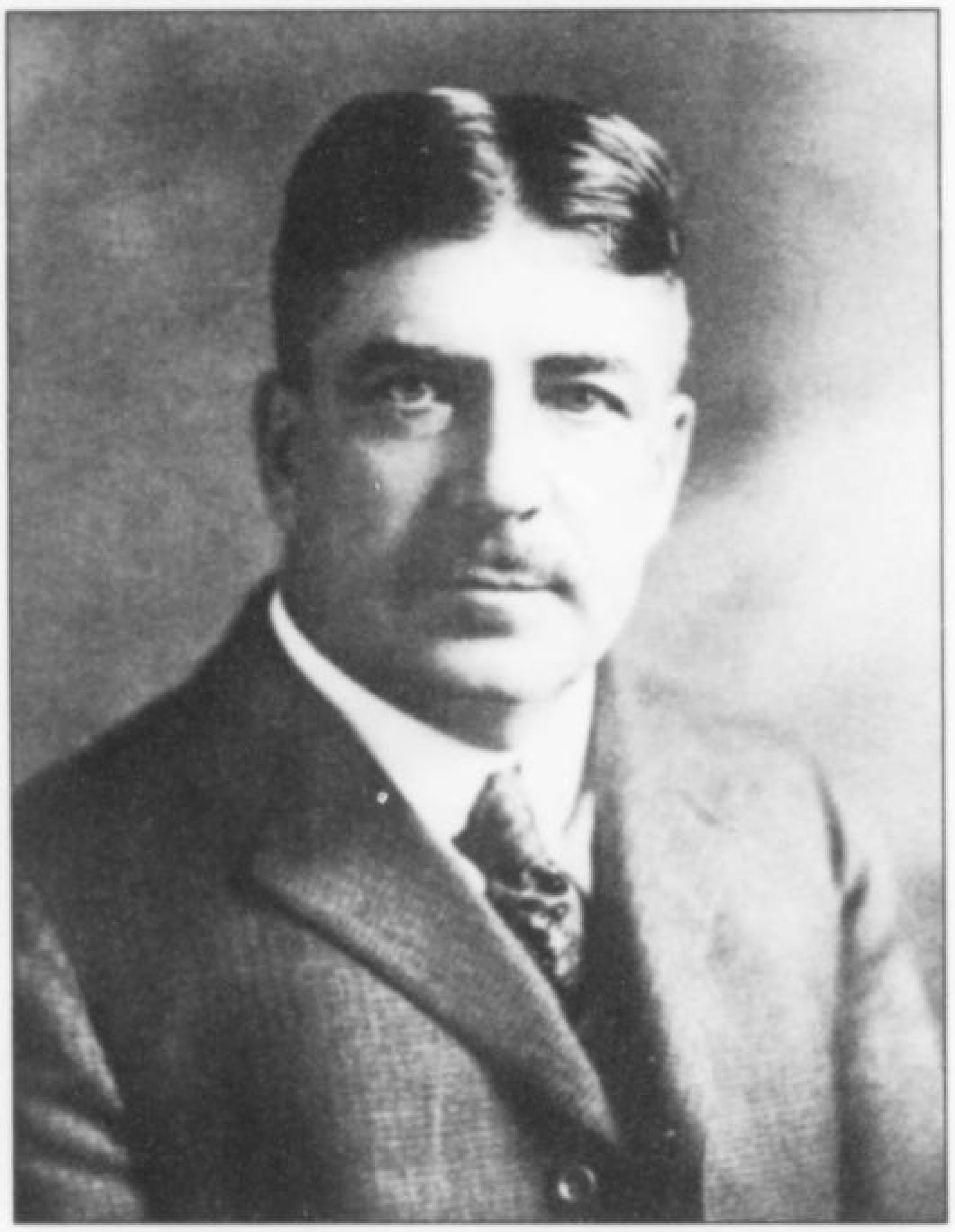

Figure 6. **James A. Doyle (1869–1939), a Colorado Springs fireman, and his partners found the rich sylvanite vein that became the Portland mine, the leading producer in the district which eventually yielded a total of 3 million troy ounces of gold (Courtland Doyle photo).**

Independence and other claims, collecting samples that assayed to $360 per ton.

Jimmie Burns was a true tenderfoot, and it's odd that he and Stratton developed a liking for each other. In January of 1892, Burns and his partner, Jimmie Doyle, discovered that, in the confusion of shifting, relocating claims, a tiny piece of Battle Mountain remained unstaked. The orphan plot, measuring just 0.069 acre, was nestled among surrounding claims, any of which might have the legal rights to minerals occurring there, since, according to the apex law, if the high point of a vein occurs on or under your land, you have the right to follow and exploit it indefinitely along its dip (Bates and Jackson, 1980).

With the help of John Harnan, Burns and Doyle found a rich sylvanite vein, which they eventually named the Portland vein. Recognizing the legal problems that were sure to develop when the surrounding groups learned of the find, Burns, Doyle and Harnan removed ore at night, carrying it to Pueblo to be smelted. In this way they accumulated $70,000 in a year or so. In August of 1893, Burns couldn't keep the secret any longer and confided it to his friend Stratton.

About this time, Stratton was having troubles of his own. By 1893, his Washington and Independence claims seemed to be eating up more money than they produced. In frustration, and despite his dislike for the vultures waiting to buy out the little guys in the district, Stratton sold a 30-day option on his Independence mine to a San Francisco mining syndicate. He could hardly believe it when they agreed to pay his asking price of $155,000 if they liked what they saw during the option period. Just before the 30

Figure 7. **For those who could not afford the meals at the big hotels in Cripple Creek there were less expensive alternatives. (Cripple Creek District Museum photo)**

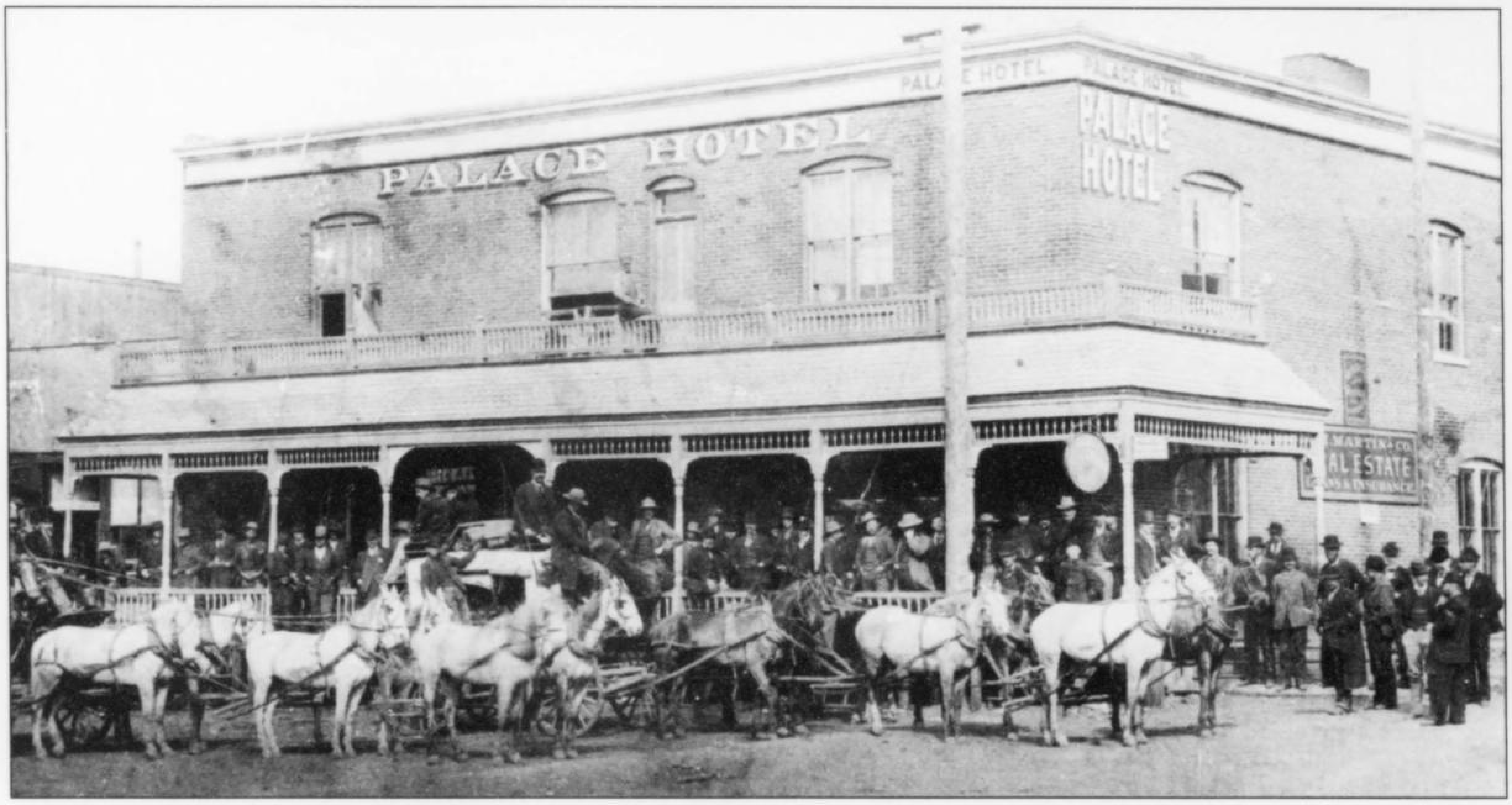

Figure 8. **Before railroads reached the district, dozens of stagecoaches brought passengers up from Colorado Springs each day. Passengers were treated to a leisurely climb of 4,000 feet, followed by a spectacular gallop down into the Cripple Creek Basin, ending up at the Palace Hotel. Carnein collection.**

days were to begin, Stratton went into an abandoned crosscut to clear out his equipment. There, he discovered a vein that assayed $380 per ton. He covered it up as well as he could and spent the next four weeks biting his nails. Incredibly, the syndicate's crew moved in but missed the vein. A few days before the option was up, they abandoned the effort, and the legal rights to the Independence, which eventually became one of the district's top four producers, reverted to Stratton. By September of 1893, the mine's prospects looked so good that Stratton vowed to cap his income at $2000 per day. Nevertheless, he became the district's first millionaire six months later.

After Burns' revelation about the Portland, Stratton grasped three important facts. First, he recognized that Burns' and Doyle's $70,000 wasn't nearly enough to resolve the legal problems that were about to fall on their heads. Second, he realized that the Portland find probably related to his own Independence discovery, 700 feet away. Finally, he recognized that his own rapidly accumulating wealth might help to keep at least a few of the most important mines out of the hands of the speculators and absentee owners. Stratton therefore proposed an alliance. To finance the coming battle, he increased production from the Independence, and by October of 1893, Burns, Doyle and Harnan had accumulated an additional $50,000 from the Portland.

When the truth about the Portland find came out, 27 people filed suit, asking for a total of $3,000,000. Stratton hired Verner Z. Reed to defend the Portland. Using Stratton's money, Reed bought out some claimants and countersued others, claiming that Stratton's properties contained the apexes of their veins. Reed then brought out his "shock and awe" weapons, arranging for the Portland Gold Mining Company to declare a $90,000 dividend. Its stock soared, and the remaining plaintiffs, recognizing the strength of their adversaries, sold out for $1,025,000, much of which was borrowed by Stratton. The resulting Portland property now covered 183 acres. Reed issued 3 million shares of Portland stock, of which Stratton received 731,000 shares. Over the next 90 years The mine produced a total of more than 3 million ounces of gold, worth over $60,000,000 (Vanderwalker and Levine, 1989). Some of Reed's acquisitions were also joined to the Stratton properties. The Independence ended up covering 112 acres, eventually producing over $27,000,000 in gold. In 1899 Stratton sold it to a British company for $11,000,000.

The district's population rapidly grew from an estimated 500 scattered souls in 1890 to 55,000 by 1900. At the peak of the mining boom there were 15 separate towns scattered over the hillsides. (Only two remain: Cripple Creek at the north end of the district and Victor to the south.) Increasing production through the 1890's allowed the district to shake off disasters that might have proven fatal elsewhere. Two fires in April of 1896 destroyed about a third of Cripple Creek, including many ramshackle buildings in the center of town. But recovery was rapid, and new, more permanent brick and stone structures were built (these survived intact until the arrival of gambling in 1991). Similarly, most of Victor went up in smoke in August, 1899. As at Cripple Creek, the fire was a blessing in disguise, leading to construction of stronger brick structures.

In 1900, the year after Stratton sold the Independence mine, Cripple Creek's gold production peaked at 878,067 ounces (Lovering and Goddard, 1950). Total production through 1900 was 3.4 million ounces. By this time, the district had almost 500 active mines, operated by 8000 miners (Feitz, 1967) earning an average of $3 per day (Lewis, 1982). These wages were often spent in the usual ways associated with miners (e.g. in the notorious red-light district on Meyers Avenue). Cripple Creek alone was estimated to contain 150 saloons. The district was served by three major rail lines (making 56 trips per day) as well as two trolley cars (AngloGold, 2001). Most of the gold ore was shipped to roasting plants in Colorado City, on the west side of Colorado Springs. (More than 12 million tons of tailings still reside there.) Victor's

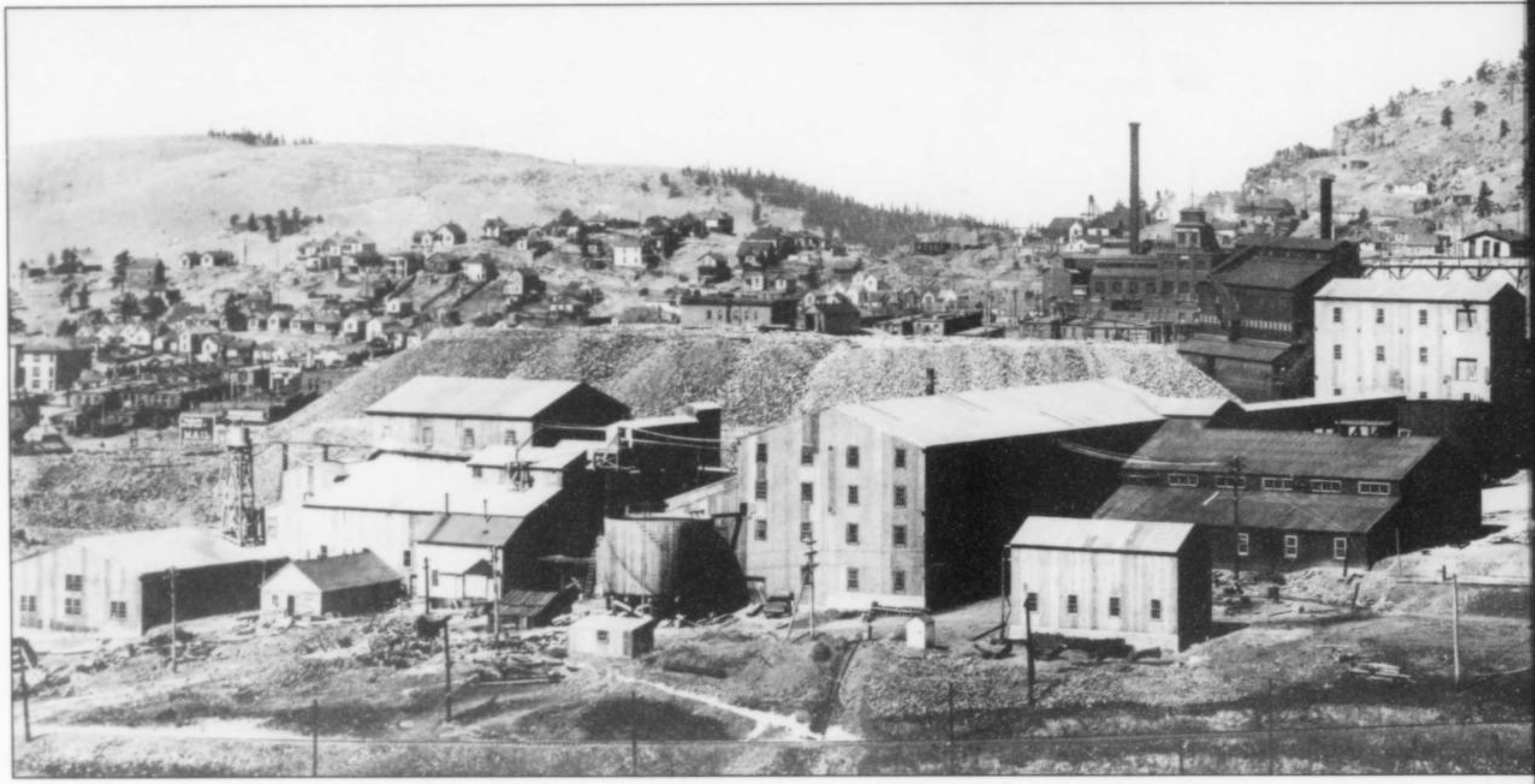

Figure 9. **Winfield Scott Stratton's Independence mine and mill. Located on Battle Mountain between Goldfield and Victor (in the background), the Independence ranked third in production and made Stratton the district's first millionaire. Stratton's modest home is visible just below the mine buildings on the right. Carnein collection.**

streets were literally paved with gold, as the low-grade dump material from many of the nearby mines was mixed with the gravel road base. This was the era when Lowell Thomas worked at the Victor newspaper, Jack Dempsey mucked ore in the Independence mine, and promoters in Gillette staged the only "legal" bullfight ever permitted in the United States.

By 1900, the deeper mines were having trouble with water, and plans were begun to drill drainage tunnels in several places. The El Paso tunnel, begun in 1903 and completed in 1904, gave a brief respite, but rapidly deepening mines and limited pumping technology had rendered it useless by 1906. Serious flooding crippled the El Paso mine and drove down stock values in 1906, stimulating planning for a new tunnel. The Roosevelt tunnel, begun in 1907, was 800 feet deeper than the El Paso. Eventually 4.6 miles long, the tunnel took 10 years and $815,000 to complete (Sprague, 1953), but it permitted mining in many new parts of some of the

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Gillett. Cripple Creek District.

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WILD WEST!

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LA CHARITTA,

The Only Lady Bull Fighter in the World. Show for the first time in the United States.

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RACES! RACES!

Ladies' Chariot Races! Ladies' Hurdle Races! Cowboy Tournament.

Free For All to Enter.

$3,000 IN PREMIUMS.

Box of Five Seats,	$25.00,	First-class Seat,	3.00,
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J. H. WOLFE, Manager, Palace Hotel, Cripple Creek.

C. MEADOWS, Director of Amusements.

BUTLER & DETMER, Advertising Agents.

Doors Open at 10 a. m. Performance Commences at 1 p. m

Note—Parties desiring to secure privileges for sporting and refreshment [illegible] call on J. H. Wolfe, Palace Hotel, Cripple Creek.

Figure 10. **Printed poster for the Joe Wolfe Spanish Guard National Bull Fight, staged near Cripple Creek in 1895. It was the only bull fight ever to be held in the United States (over the objections of U.S. Government officials, Humane Society representatives and Colorado Springs church leaders). Wolfe built a 5,000-seat bull ring at a race track outside of town and charged $5 for box seats. Some 3,000 people bought tickets, and after the first bull was killed all of the principals were arrested and fined $5 each. Three hundred spectators showed up the next day, and everyone was arrested and fined again. Joe Wolfe left town ahead of his creditors, and opened a restaurant in New York with his profits. (Mazzulla and Mazzulla, 1964)**

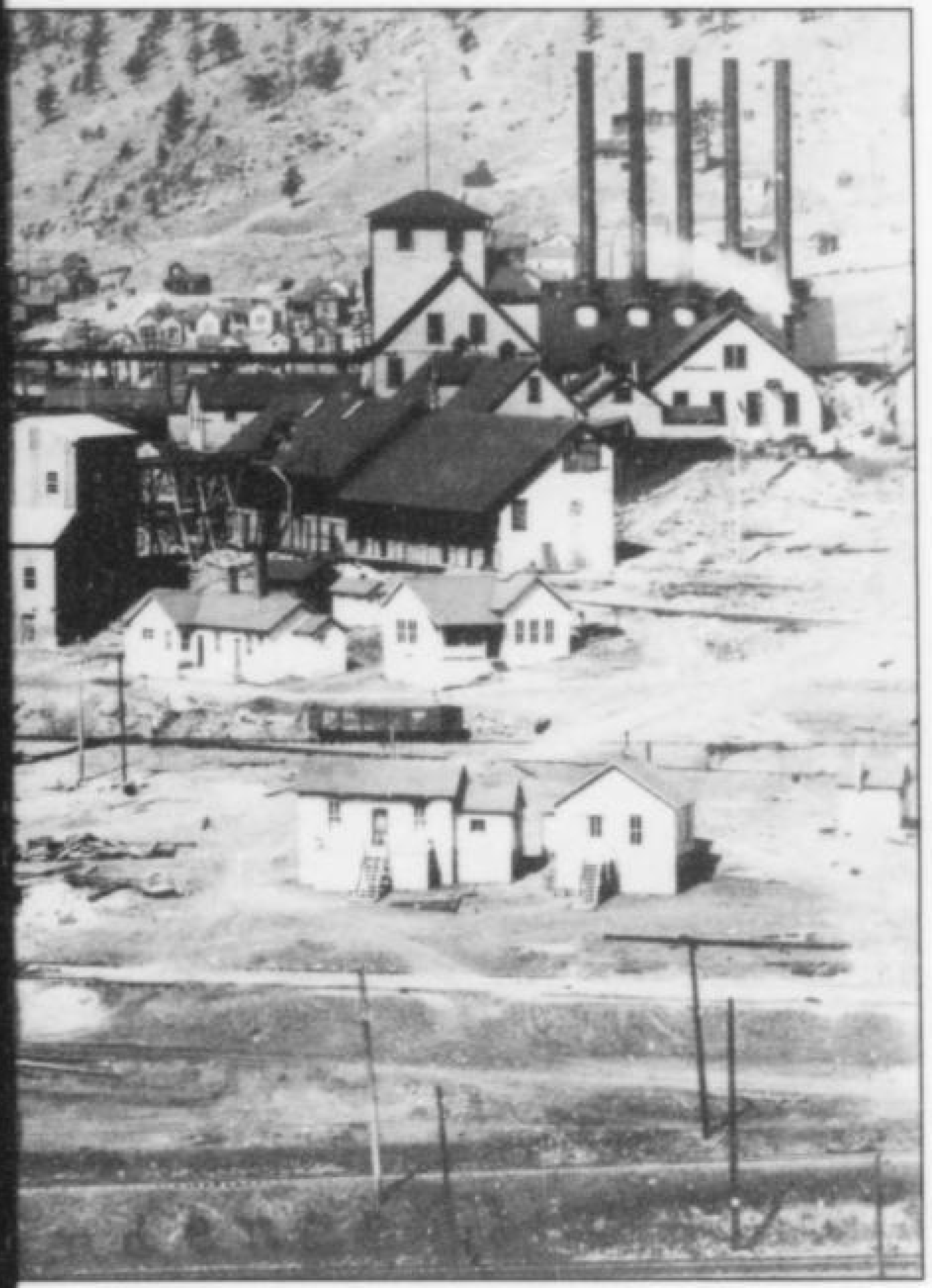


Figure 11. **The Portland mine (shown here ca. 1910) included two major shafts overlooking Victor. Winfield Scott Stratton, the district's first millionaire, lived for a time in the modest house in the center of the photo. Carnein collection.**

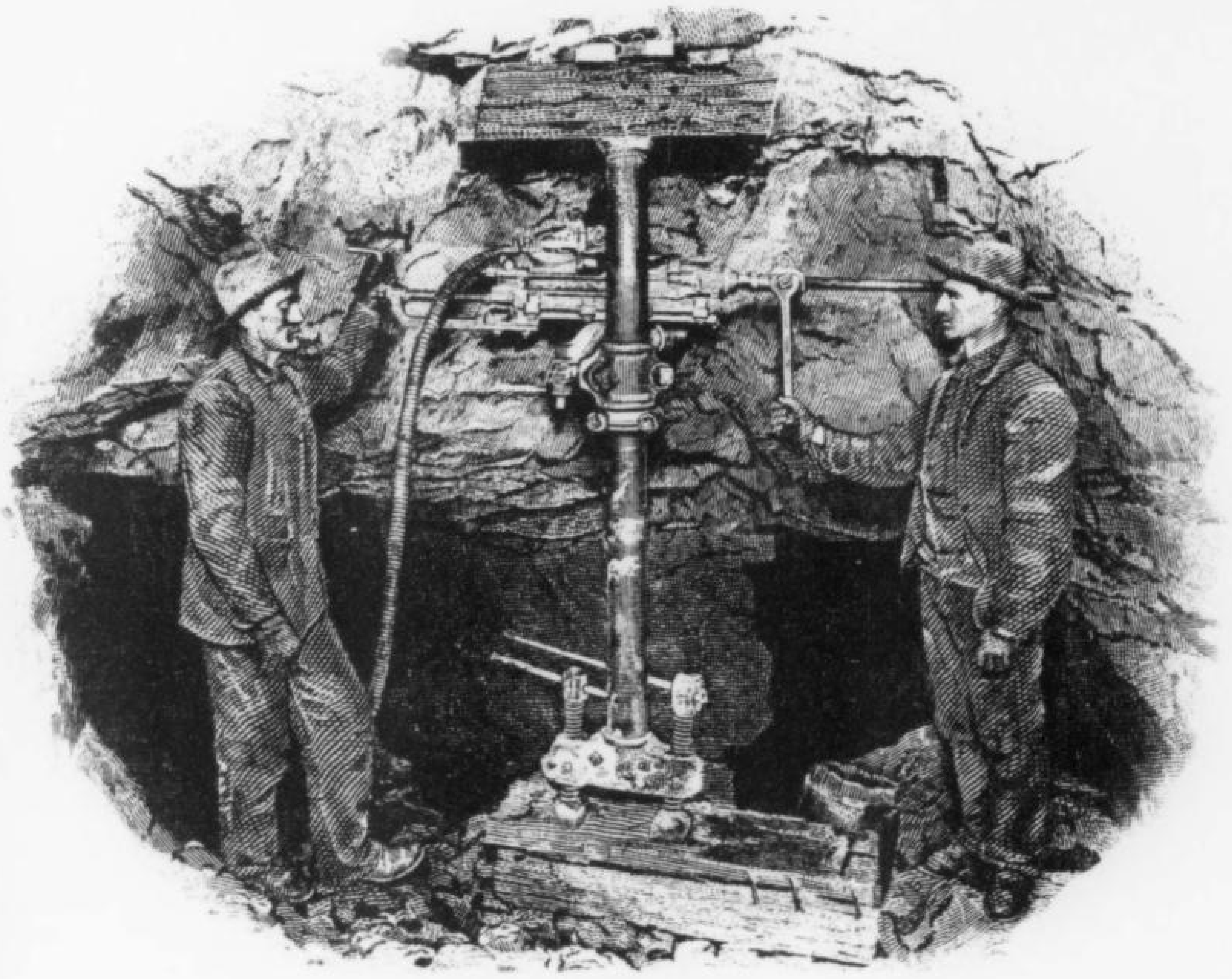
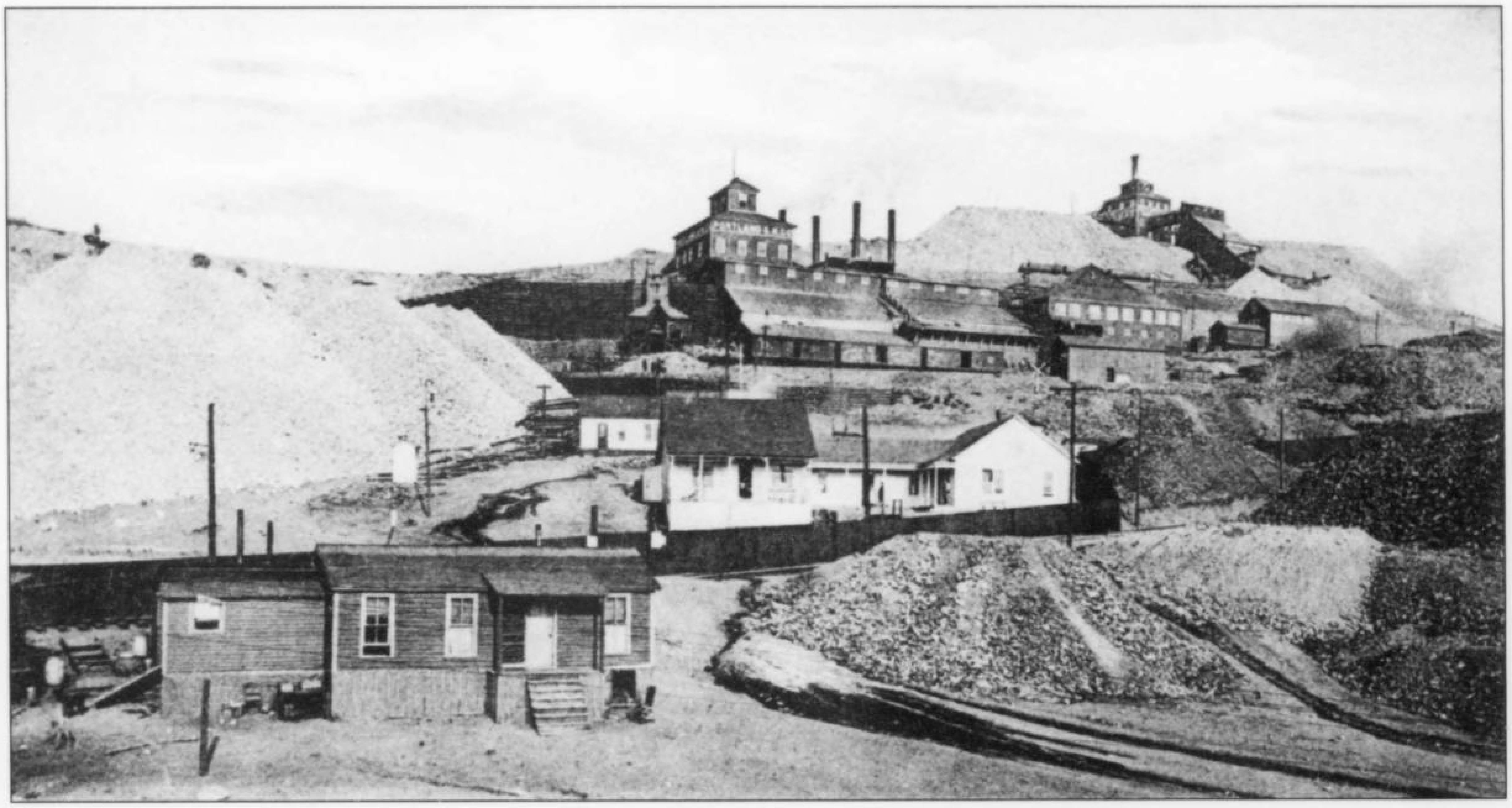


Figure 12. **Miners working a steam-powered "slugger" or Burleigh drill in the Independence mine ca. 1910. This engraving was created from a photograph by the American Bank Note Company for use on stock certificates (Mineralogical Record Library).**



best mines and restored some of the confidence that had been lost after production peaked. The Roosevelt tunnel remained effective until the 1930's, at which point work began on the last of the district's drainage tunnels: the Carlton tunnel. Over 6 miles long, it was finished in 1941, and presently drains everything above an elevation of 6900 feet. Ironically, no sooner was the Carlton Tunnel completed than World War II began, with gold mining ceasing shortly thereafter by Presidential decree.

Another blow to confidence in the district came with labor problems that began in 1903. By this time, the Western Federation of Miners union had enrolled over 3,500 men in the Cripple Creek area, the largest contingent in the west. The area was reputed to offer better pay and working conditions than most, but an attempt by mine owners to increase the length of the working day and a

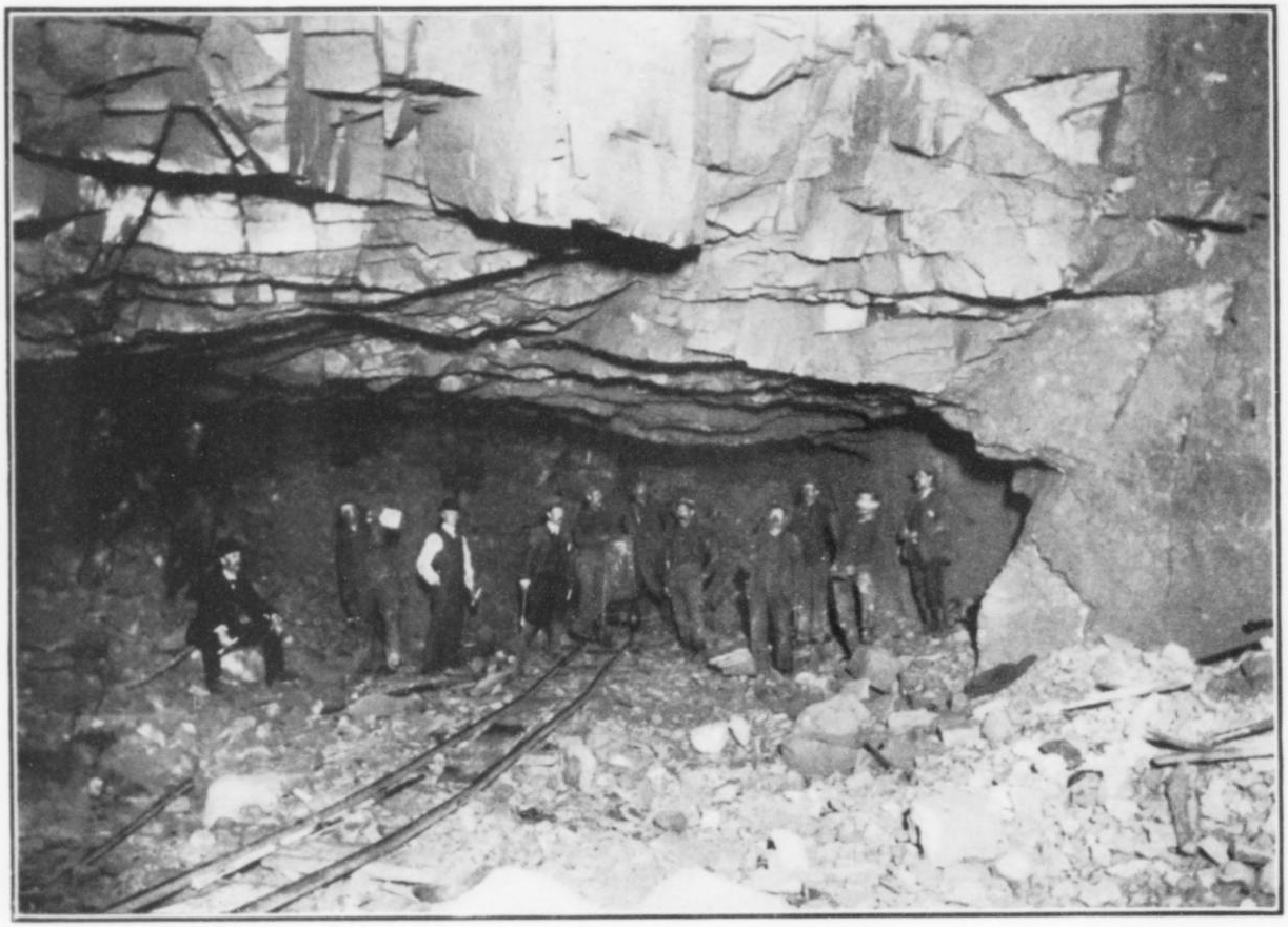


***Figure 13.* Underground at the Portland mine, Captain vein, level 4, in 1906 (USGS photo.)**

power play by W.F.M. officials started a violent, bitter battle between the miners and owners. By the time the dispute ended in 1904, shootings and bombings had killed at least 17 men, and the W.F.M. was on its way out of the district.

Although production from the district declined after 1900, a few mines produced spectacular surprises late in the district's history. The Cresson mine, located in the south-central part of the district, is an example. Begun in 1894 and obtained by J. R. and Eugene Harbeck during a night whose events were clouded by booze, the mine had to be financed through stock sales that relied more on the reputation of surrounding properties than on anything that had been found on the Cresson property (MacKell, 2003). By 1908 the mine was $80,000 in debt. The owners hired Dick Roelofs, a heretofore unpromising engineer whose record didn't suggest that he would improve things; surprisingly, though, he did. Roelofs blossomed at the Cresson, finding ways to increase the efficiency of the mine and make a profit on relatively low-grade but abundant ore. By 1910, the mine was paying healthy dividends.

In November of 1914, something happened that would make the Cresson world-famous. On the 12th level, workers broke into a 4.5 × 8 × 13-meter cavity in altered breccia. Unlike most open cavities in the district, the Cresson vug was lined with crystals of calaverite. The gold telluride occurred as 1 to 3-mm free- standing crystals in solution cavities and as thin, fragile, leaf-like, deeply striated crystals to over 2.5 cm embedded in the less altered parts of the host rock (Patton and Wolf, 1915). Quartz (including chalcedony), dolomite and celestine were present, and the chamber lining contained a chalk-like, whitish material with abundant celestine, slightly altered calaverite and native gold. One notable characteristic of this occurrence was a lack of fluorite (Smith *et al*., 1985) and a scarcity of pyrite.

As noted by Smith *et al*. (1985), although specimens from the Cresson mine are not uncommon, documented material from the Cresson vug is very rare. This great rarity probably is a result of the tight security that accompanied removal of the contents of the vug. Vault doors guarded the mine entrance, and miners had to change clothes before leaving (MacKell, 2003). In a period of four weeks, about 1,400 sacks of ore (crystals scraped off the vug walls) were shipped out in sealed boxes protected by armed guards. The cavity yielded over 60,000 troy ounces of gold worth $1,200,000. Between 1903 and 1959, the once unpromising Cresson mine produced over $45,000,000 in gold. Present-day open-pit operations, which are centered on the Cresson mine, continue to yield about a quarter of a million ounces per year.

After Stratton sold the Independence mine, consolidation became the major theme for the district. First, more than one hundred mines were joined to form the United Gold Mines Company. This became a part of the Golden Cycle Mills Company in 1908. By building a modern, efficient cyanide mill in Colorado City in 1906, Golden Cycle took control of milling most of the district's mineral output.

Tunnel builder, railroad owner and freight hauler Albert "Bert" Carlton, with the backing of friends who owned the Utah Copper Company, and through a series of complicated maneuvers during the period from 1915 to 1931, gained control of all of the major Cripple Creek mills, railroads and mines, with the exception of the

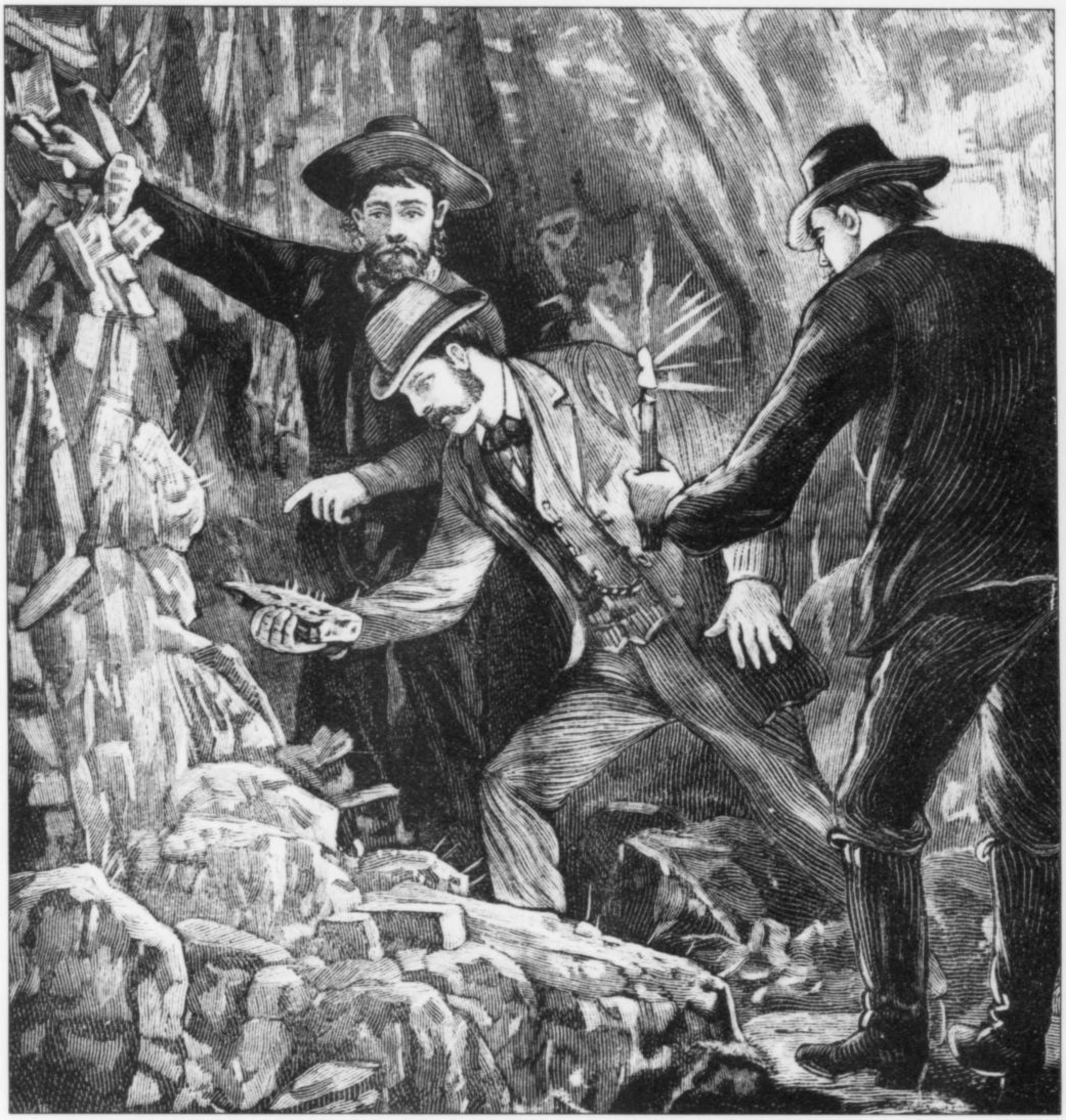


***Figure 14.* The greatest single discovery in the history of Cripple Creek was the celebrated "Cresson Vug," a 4.5 × 8 × 13-meter cavern lined with 60,000 ounces of gold in the form of sylvanite and calaverite crystals. Depicted above is miner Dick Roelofs, who became known as "the miracle miner of Cripple Creek," showing the discovery to Hildreth Frost in 1914. (For the full story see Smith *et al.*, 1985.)**

Portland and Strong mines (the Portland too joined Carlton's Golden Cycle Corporation, but only in 1933, after Carlton's death in 1931.)

In the mid-1930's, the price of gold rose from $20.67 to $35 per ounce, triggering a small boom in the district (Koschmann, 1947). At that time, 135 mines produced about $5 million in gold per year. Production through the early 1940's held steady at 125,000 to 145,000 ounces per year. Although production did not entirely cease during World War II, it was reduced to 30,000 to 45,000 ounces per year (Koschmann, 1947).

After the war, Golden Cycle started construction of the Carlton mill in order to save the cost of rail haulage to Colorado Springs. This triggered another small boom. In 1951, about 30 mines in the district produced over $2 million in gold. From then on, production significantly declined; in 1961 the Carlton mill closed, and in the following year the last mine in the district closed as well (Pontius, 1996). But Golden Cycle continued to acquire ground. By 1965 the corporation controlled 4,500 acres, approximately two-thirds of the district. In the mid-1970's, interest in gold properties increased sharply, following the "floating" of the U.S. dollar and the subsequent sharp rise in the price of gold. In 1976, Golden Cycle entered a 33:67 joint venture with Texasgulf Minerals, forming the Cripple Creek and Victor Gold Mining Company (CC&V). For the next 15 years, Texasgulf financed sporadic exploration in the district. In 1977, a junior company, Newport Minerals, began mining the Globe Hill breccia pipe in the north part of the district. All told, some 680,000 tons of ore were mined there (Trippel, 1985). This was followed shortly by the inauguration of Silver State Mining Company's open pit mine in the Ironclad breccia pipe.

Silver State is a very interesting company. It was founded and controlled by two brothers in their early 30's named Reid. Both were geologists, and both got their start working for Texasgulf in

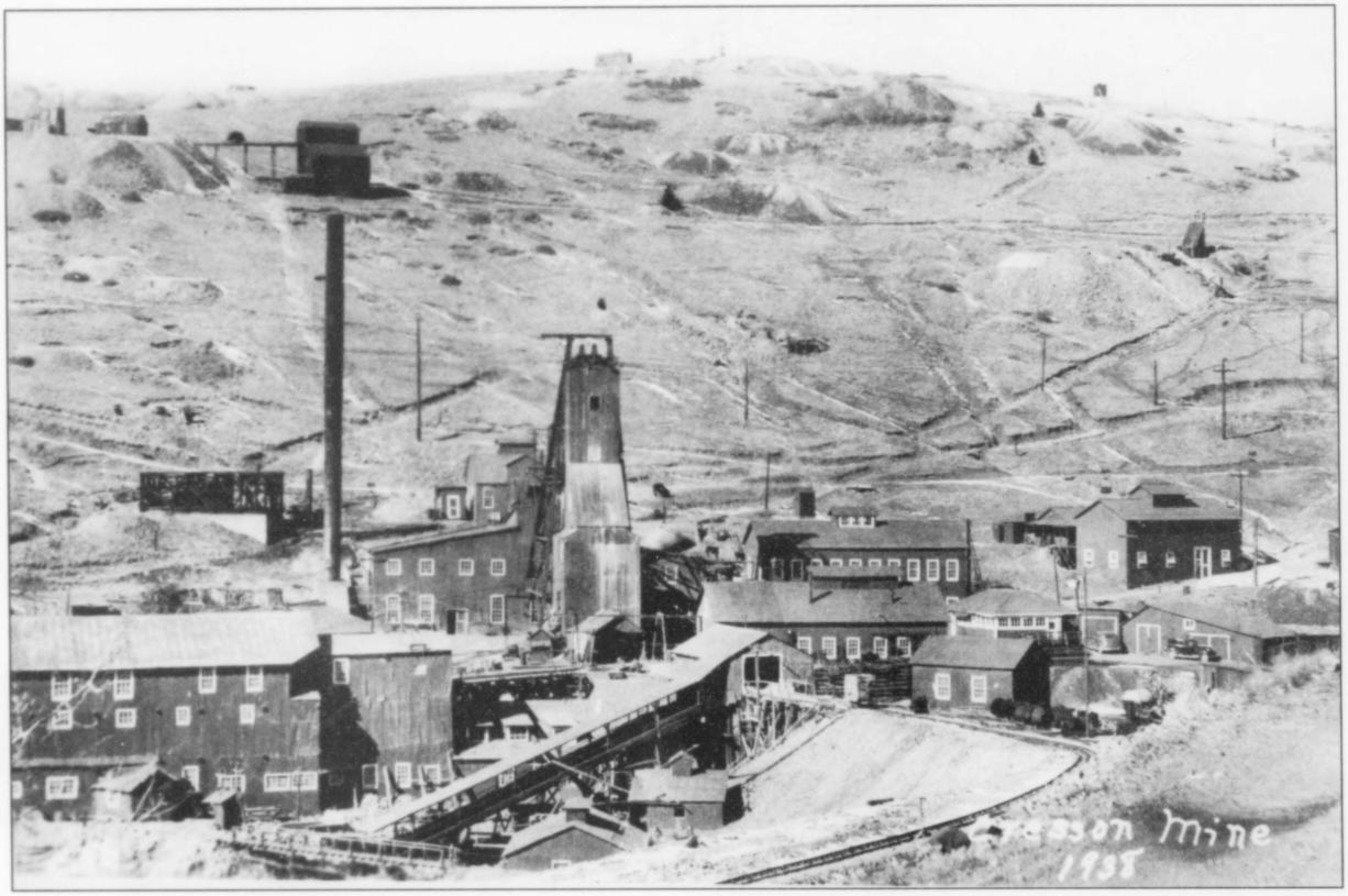


Figure 15. **The Cresson mine, shown here in 1938, was the site of the discovery of the fabulous Cresson Vug in 1914. Located in the upper part of Eclipse Gulch, between Cripple Creek and Victor, the Cresson was the district's second most productive mine and is today the site of the Cresson open pit. Carnein collection.**

the district. They left Texasgulf, formed a company and, a few years later, acquired the Ironclad ground, after which they raised $3.5 million from the Denver equities market and put the property into production (Lewis, 1982). They mined out most of the breccia pipe (3.5 million tons averaging 0.06 oz/t Au), leaving an open pit with relatively small amounts of deep ore and steep high walls. This they were able to sell to Nerco Minerals for $3.5 million, plus the assumption of $4.5 million in debt (*Business Week*, 1985). The Reids then moved on to another successful venture at the Tomkin Spring gold deposit in eastern Nevada.

At about the time the Reids were operating at Ironclad, Texasgulf started heap-leaching the oxidized dumps scattered throughout the district. All told, some 3 million tons of dump material—most of the district's dumps—averaging 0.05 ounces of gold per ton, were processed. Texasgulf also started small-scale open-pit mines at the Portland mine and Pharmacist vein (in Altman) in 1988. Both pits were on the order of 500,000 tons, with ore averaging 0.07 ounces of gold per ton. These pits mined the newly discovered disseminated halos surrounding high-grade vein structures (Pontius, 1996). In 1989, Nerco bought out the Texasgulf interest in the Cripple Creek and Victor Gold Mining Company. In 1993, Independence Mining Company bought the Nerco interest and resumed mining at Ironclad and Globe Hill. Also at this time, the last major non-CC&V property was acquired by the company: CC&V now controlled 85 percent of the district. (On a personal note, the

Figure 16. **Cripple Creek freight tycoon Albert E. Carlton (left) completed the Roosevelt Deep Drainage Tunnel in 1910, the most ambitious such project of its time. Scotsman James McElwee (center) served as his crew boss, and miner T. R. Countryman (right) was the engineer. The tunnel penetrated over 15,000 feet of granite in order to drain the Cripple Creek mines and keep production going for another ten years. Miners dug from both ends and, thanks to precise engineering, met up in the center with only a quarter inch error. (Penrose Public Library photo.)**

Figure 17. **In April of 1896, two fires destroyed hundreds of buildings in Cripple Creek, killing and injuring an unknown number of people. Within six months, however, the wooden structures had been rebuilt (many in brick) and the town's population had increased by 10,000. E. A. Yelton photograph; Carnein collection.**

Figure 18. **After The 1896 fires, most of the businesses on Bennett Avenue were rebuilt in brick and stone. And Cripple Creek was soon among the first towns in Colorado to be serviced with electricity (note the power poles). Carnein collection.**

Figure 19. **Miners about to descend into the Last Dollar mine, ca. 1923. Photo courtesy of the C. Perko family.**

second author was at this time trying desperately and unsuccessfully to acquire the last major claim block for his employer. That prize proved to be quite significant—a considerable part of the present day reserves lie in that ground.) Design work for a new mega-pit centered on the old Cresson mine began in 1992, with permitting in 1993, construction in 1994, and first production in 1995 (AngloGold, 2001). In 1999, AngloGold acquired Independence Mining and its share of CC&V. AngloGold's new mega-pit was designed to exploit disseminated gold mineralization similar to that in the Altman and Portland pits. All told, an estimated 260 million tons of rock will be removed before mining ends—a far cry indeed from Bob Womack and his early attempts to generate any kind of interest in the district.

The Cripple Creek & Victor Gold Mining Co., which controls over 90 percent of the district today, is a joint venture between Pikes Peak Mining Co. (wholly owned by AngloGold North America) and Carlton's Golden Cycle Gold Corp. (CC&V, 1999). Thus, Carlton's legacy lives on at Cripple Creek, as elsewhere: the money that he and his friends made there and at Bingham Canyon financed businesses all over Colorado and the United States.

GEOLOGY

Within the western United States, a north-south-trending belt of alkaline igneous rocks extends from the Black Hills of South Dakota to the Capitan Mountains of New Mexico. Many of these rocks have associated gold deposits; examples include Annie Creek and Richmond Hill in South Dakota, Grayback in Colorado, and Elizabethtown-Baldy in New Mexico. But none of these deposits rivals Cripple Creek, whose estimated 25.5 million ounces of gold contained in a localized area less than 6 miles square constitutes some of the richest mineralized ground (in terms of dollar value) anywhere on the planet.

Central Colorado underwent major uplift during the Laramide Orogeny, a widespread compressive episode which took place

Figure 20. **The Cripple Creek district was a tangled mass of overlapping claims. The heavy line indicates the geological boundary of the gold-bearing rock. Only the major mines are indicated, with total productions as of 1958. (From Drake and Grimstad, 1983.)**

between 70 and 40 million years ago. At this time, alkaline to calc-alkaline intrusive activity occurred in the Colorado mineral belt (Kelley *et al*., 1996). During the Early Oligocene, extension came to dominate central Colorado, resulting in the formation of the Rio Grande rift. West of the Cripple Creek district, a north-striking horst-graben system that includes the Fourmile and Oil Creek faults (Wobus *et al*., 1976), along with dozens of other faults, was produced or reactivated at this time. Extension was accompanied by a resurgence of volcanism, as shown by the San Juan and 39-Mile volcanic fields (Lipman, 1981). These and similar volcanic rocks are parts of a gigantic volcanic episode in the western U.S. and northern Mexico that generated some 500,000 km^3 of ignimbrites and up to 5,000,000 km^3 of intermediate to silicic magmas (Johnson, 1991).

Extension associated with the Rio Grande rift provided the impetus for igneous activity over a large part of the interior of the western U.S. As the rift began to open in the Oligocene, confining pressure was reduced in the underlying mantle, resulting in pressure-release melting and formation of a volatile-rich, alkaline magma (Wilson, 1989; Kelley *et al*., 1996). As it moved upward, the parent magma assimilated lower crustal rocks and underwent fractional crystallization (Birmingham, 1987). Apparently, the magma rose rapidly enough so that it suffered little contamination by upper crustal rocks (Kelley *et al.*, 1996). Faults and shear zones in Proterozoic rocks provided local pathways for migration of magma and volatiles, once they reached the upper crust.

During and after the first shallow intrusions, the magma body underwent further differentiation, its upper parts becoming enriched in water, carbon dioxide, chlorine, sulfur, arsenic, bismuth, molybdenum and antimony (Kelley *et al.*, 1996). At this point, a feedback-loop process as described by Burnham (1985) probably took over, contributing to the formation of the brecciated host rocks of Cripple Creek's gold deposits. In this process, as water-saturated melts move upward, the decreasing pressure allows water-rich fluids to expand, which, in turn, yields mechanical energy. At depths of 10 to 8 km or less, the pressure of escaping fluids may exceed the strengths of common wall rocks. The wall rocks fractured, which further reduced pressure on the confined fluids. In the resulting feedback loop, more water then came out of solution, generating more fractures. Increasing effervescence at depth combined with gas streaming and fluidization of the shattered rock may propel wall-rock fragments for hundreds of meters upward (Burnham, 1985).

The Cripple Creek mining district occupies a composite Oligocene volcanic-sedimentary subsidence crater (diatreme) associated with subsilicic alkaline rocks. The diatreme formed between 33 and 28 million years ago (Kelley *et al.*, 1996), roughly synchronous with the onset of extension in Colorado. The district is centered over a gravity and magnetic low that suggests the presence of a batholithic body at depth (Kleinkopf *et al.*, 1970). The diatreme occurs at the intersection of four Precambrian granite and gneiss units and is centered on a compressionally formed Laramide-age dome. There appears to have been an ancestral structural weakness in the area that focused igneous and mineralizing activity. Present exposures are at the subvolcanic level; any traces of a tuff ring or maar have been eroded off. Remnants of the volcano form a group of rounded hills that range between about 3170 and 3570 meters in elevation.

The diatreme consists of a large mass of breccia intruded by bodies of phonolite, plagioclase phonolite (historically called latite phonolite), tephriphonolite (historically called syenite), and lamprophyre (historically called alkali basalt) (Kelley, 1996; Pontius, 1996). The breccia, with a surface exposure of roughly 18 square kilometers, fills an irregular basin up to 1 km deep that contains three separate sub-basins. Previously, each sub-basin was interpreted as a separate vent area; present interpretations are that there were multiple vents associated with a central, northwest-trending fissure zone (which is also the main mineralized trend), as well as discrete lesser vents at local structural intersections (Pontius, 1996).

In cross-section, the Cripple Creek breccia body flares outward toward the surface, with the deepest part centered on the Cresson "blowout" (Thompson *et al.*, 1985). The basin's walls generally dip inward at 65° to 80° and are irregularly configured, with local overhangs, especially in the southwest (Koschmann, 1949). At the Ironclad and other mines, microbreccias show evidence of subsurface fluidization, including channeling, graded bedding, and flow around large clasts (Seibel, 1996). Mineralized pipe-like breccia bodies formed by explosive activity occur in the south-central part of the complex (the Cresson "blowout" of Loughlin and Koschmann, 1935) and in the North basin (Ironclad mine; Seibel, 1996). In places, the basin also contains intact, deeply buried fluvial and lacustrine sedimentary rocks with mudcracks, raindrop imprints, bird tracks, and plant fossils. Such sedimentary rocks were found at great depths within the mines, supporting the idea that the basin owes its origin mostly to intermittent subsidence (Koschmann, 1949).

Although sediments and breccia pipes are important components of the basin, the main fill materials are breccias. The fill resulted from repeated mild deformation and brecciation, subsidence and consolidation of the brecciated rock, and recurrent explosive volcanic eruptions (Gott *et al.*, 1969). Typically, the breccia consists of poorly sorted clasts of phonolite, phonolite tuff and granitic country rock within a tuff matrix. The breccia was intruded by a series of plugs, domes, flows, dikes and sills of varying alkaline subsilicic composition. Gold mineralization was one of the latest events, but minor igneous activity producing lamprophyre dikes continued before and after. Some breccia-dike activity appears to have followed emplacement of the lamprophyre dikes, and there is some controversy with regard to whether gold in the breccia dikes represents introduction of new gold mineralization or just reworking of previously deposited gold (Seibel, 1991, 1996; Thompson, 1996).

Within the district, major faults are rare. Rather, the area is characterized by a series of slips and fractures with minimal displacement. Typically, relatively short individual veins define long, narrow ore runs. Well formed, strongly outcropping veins were not the norm at Cripple Creek. Instead, there were sheeted zones of subparallel fractures, particularly in hard, brittle rocks such as the phonolite. (Within the breccia, the veins were much more anastomosing and irregular.) When hosted by the Proterozoic rocks that encircle the basin, the veins exhibit a radial pattern. Within the basin they generally trend northwest or northeast, and most dip at angles of 75° or more. Because quartz is typically only a minor constituent of the veins (where it is present at all), the sheeted zones and veins did not crop out prominently; as a result, gold was discovered much later here than elsewhere in Colorado.

Ore runs at Cripple Creek typically strike in directions between northwest and northeast but are centered on a master northwest-trending zone that runs through the approximate center of the diatreme. This zone extends through the gold-breccia body at Carbonate Hill (at the far northern end of the diatreme), and through the breccia pipes at Ironclad, Globe Hill and Cresson, ending at the Portland mine at the southern end of the diatreme. In addition, there are several subparallel splits in the southern portion of the district; famous mines such as the Vindicator, Last Dollar and Victor exploited these.

Cripple Creek ore concentrations are of three major types: (1) narrow, high-grade gold/silver telluride veins; (2) broad zones of low-grade disseminated native gold/pyrite; and (3) breccia pipes, in which disseminated gold and tellurides occur primarily in clasts, and with widespread associated sericitization/argillization (Pontius, 1992; Burnett, 1995; Seibel, 1996). All three types are hydrothermal in origin.

The vein deposits were found first and were the richest in metal values, commonly containing concentrations of 0.5 to 2 ounces of gold per ton. The veins exhibited minimal changes in ore grade as mining continued to depths of more than 1000 meters, although with increasing depth the veins grew thicker and fewer, i.e. vein density expanded upwards in a pattern resembling the branching of a tree. The distribution of gold and other elements suggests that mineralizing solutions worked their way upward and outward from a few deep-seated fissures (Gott *et al.*, 1969).

The disseminated mineralization consists of microscopic native gold, commonly attached to pyrite and associated with fine-grained orthoclase ("adularia"). This material occurs as an alteration halo surrounding the high-grade vein structures, particularly at vein intersections. Disseminated deposits occur in the upper 300 meters of the diatreme complex, and contain gold concentrations measured in hundredths of an ounce per ton. This type of ore is the target of present-day mining. Today, exploration consists of plot-

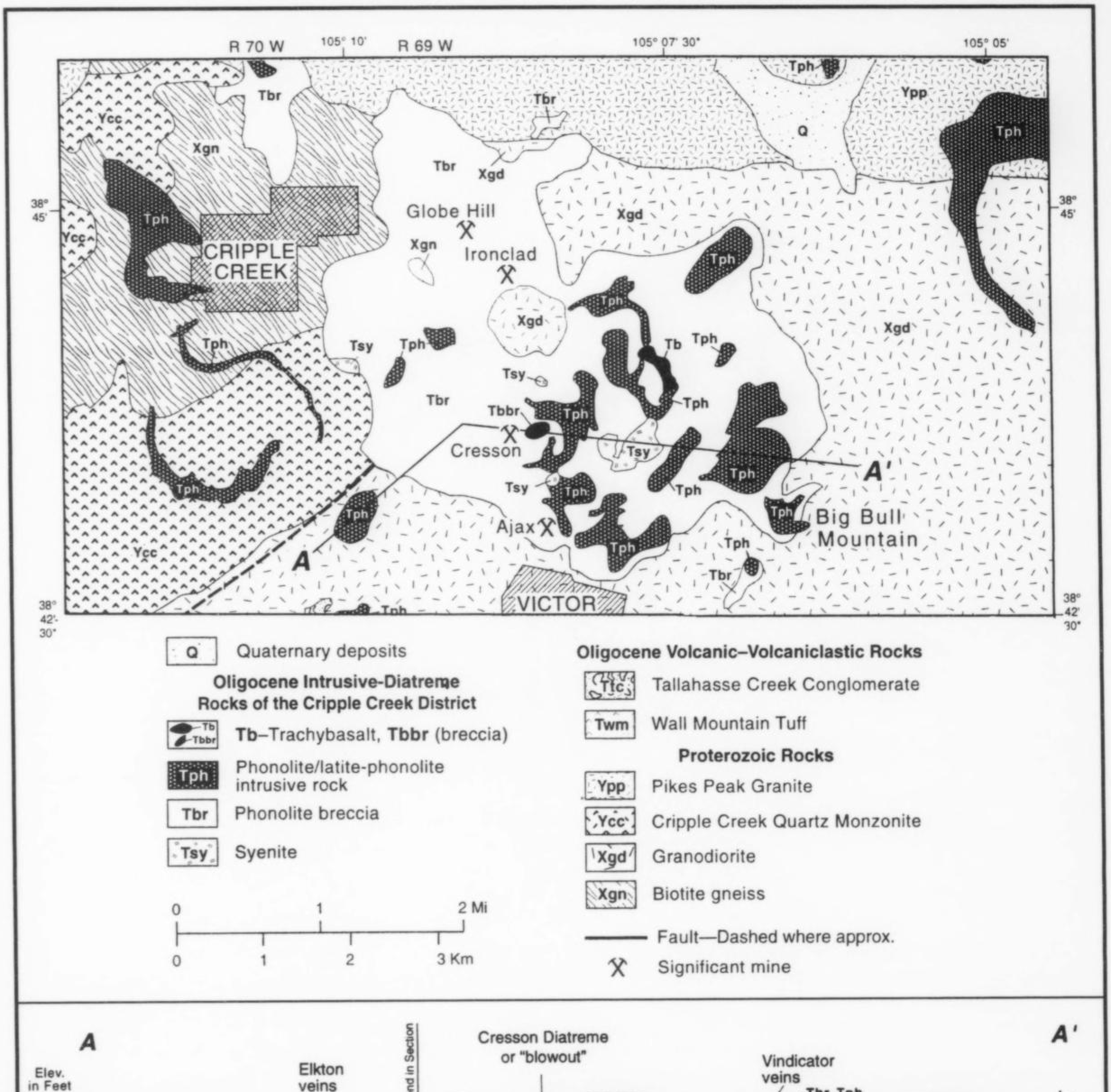


Figure 21. **Geologic map and cross-section of the Cripple Creek Basin showing the Oligocene rocks of the Cripple Creek Intrusive/Diatreme Complex. Modified from Cappa (1998) and Thompson *et al.* (1985).**

Figure 22. **Map of the Cripple Creek basin showing the approximate extent of the Master Fissure Zones containing the principal underground workings.**

ting historic vein workings and testing their perimeters for the disseminated gold halo. In order to do this, a truly phenomenal GIS database has been constructed by AngloGold.

The third type of mineralization is associated with breccia pipes. Here, the gold (which occurs as native gold and in tellurides) is accompanied by orthoclase, fluorite, dolomite, and pyrite, the same general mineral assemblage as in the veins. The Carbonate Hill breccia pipe also contains molybdenite and hübnerite. Rarely, native gold coating hübnerite has been observed at this locality. Native gold that occurs in the breccia pipes is considered to be both hypogene and supergene (derived from the oxidation of tellurides) in origin and can be quite coarse. Breccia pipes also contain celestine, hematite, barite, anhydrite, and manganese oxides. Widespread sericitization/argillic alteration is associated with breccia pipes but is not seen in the vein deposits.

Thompson (1996) interpreted the breccia pipes as the shallow-level equivalents of vein systems. Local blockage by earlier mineralization or by late sills may have allowed pressure to build until it exceeded lithostatic pressure to depths of as much as 1000 m. This caused brecciation of the wall rock and boiling of the ore fluid. The resulting hydrothermal breccias were localized along pre-existing zones of weakness (Thompson *et al.*, 1985).

Recent work has helped to clarify the origin of the ores and the physical conditions of their formation. At the time of ore formation, temperatures were less than 200°C (Thompson *et al.*, 1985; Saunders, 1988; Seibel, 1996). Data from fluid inclusions show that ore-fluid salinities decreased with time, and that near-surface fluids were less saline than deeper fluids at the time of gold deposition (Thompson, 1996). The high initial salinity and oxygen-isotope data support the idea that the fluids came from a magmatic source (Kelley, 1996); also, isotopic data suggest a mantle source for sulfur and a crustal source for lead and, possibly, gold (Fears *et al.*, 1986). The compositions of the ore, gangue, and alteration mineral assemblages, supported by observations of geochemistry and field relations, support the theory that the hydrothermal activity was most closely related to the lamprophyre dikes and breccias. These mafic rocks generally contain higher gold concentrations than other possible source rocks in the district.

Thompson (1996) suggests that the deeper hydrothermal veins and shallow disseminated deposits represent the extreme ends of a continuum of fluid evolution. As they ascended, the fluids became more oxidized. At depth, the fluids were alkaline, becoming neutral or weakly acidic near the surface. Oxidation of H_2S near the surface produced sulfate anions, which combined with magmatic Ca and Sr to produce anhydrite and celestine respectively (Thompson, 1996; Thompson *et al.*, 1985). Abundant CO_2 in the fluids resulted in abundant carbonates in the gangue. Pyrite and minor base-metal sulfides (enargite, galena, sphalerite, tetrahedrite) formed where H_2S was not oxidized. Gold and tellurium enrichment occurred in the later stages of vein formation, after deposition of orthoclase, fluorite, dolomite, and pyrite.

Aqueous tellurium complexes may have transported the gold (Saunders, 1988). Gold is relatively soluble as $AuTe_2$ complexes in the temperature range indicated by fluid-inclusion studies of the Cresson and other deposits. $AuTe_2$ complexes would have been precipitated by oxidation, with native gold deposition following telluride precipitation (Saunders, 1988; Thompson, 1996). In contrast, under neutral to slightly alkaline pH (as implied by the presence of sericite and orthoclase) and oxidizing conditions, gold should be relatively insoluble as bisulfide or chloride complexes. Interestingly, the lack of any significant change in gold content upward in the veins suggests that temperature gradients had no major effect on the deposition of gold or gold tellurides.

All workers agree that mineralization occurred in several stages, but there is some disagreement about the details. Loughlin and Koschmann (1935) and Gott *et al.* (1969) recognized three stages of mineralization. Stage I includes deposition of quartz, orthoclase, dark purple fluorite, coarse pyrite, and minor specular hematite. This stage corresponds with intense alteration of the country rock. Stage II includes deposition of milky to smoky quartz, pale purple fluorite, fine-grained pyrite, specular hematite, dolomite or ankerite, celestine, barite, roscoelite, sphalerite, galena, tetrahedrite, calaverite, krennerite, sylvanite, petzite, hessite, and native gold. Stage III minerals include smoky to colorless quartz, yellowish to orange chalcedony, fine-grained pyrite, calcite, cinnabar, and minor fine-grained fluorite.

Thompson (1996) posited five stages of mineralization for major veins at Cripple Creek and summarized corresponding fluid temperatures determined by various workers. His vein sequence is as follows:

Stage I: feldspar + quartz + fluorite + dolomite + pyrite/marcasite
Stage II: pyrite/marcasite + galena + sphalerite + chalcopyrite
Stage III: specular hematite + quartz + fluorite + pyrite + rutile
Stage IV: quartz + pyrite + tellurides
Stage V: vug-filling quartz/chalcedony + fluorite + dolomite.

Thompson (1996) also recognized three stages of mineralization in diatreme (e.g. Cresson mine) and hydrothermal breccia (e.g. Ironclad and Globe Hill mines) deposits:

Stage I: feldspar + quartz + apatite + pyrite/marcasite + fluorite + hematite
Stage II: celestine + sericite + dolomite + barite + galena + sphalerite + chalcopyrite + fluorite + pyrite + quartz + rutile
Stage III: tellurides + pyrite + dolomite + quartz + sericite + native gold + Fe, Mn oxides.

Further, Thompson (1996) summarized the vertical distribution of common minerals in the Cripple Creek hydrothermal system. Major veins occur throughout the 1000-meter vertical range that has been explored. Hydrothermal breccias are relatively shallow systems, and the Cresson diatreme extends from the surface to moderate depth. Native gold, chalcedony, sulfates, stibnite, cinnabar, Fe and Mn oxides, sericite, and smectite all occur at shallow to moderate depths. Roscoelite is confined to deeper deposits; orthoclase, carbonates, fluorite, galena, pyrite, sphalerite, specular hematite, tellurides, quartz, and marcasite occur over the whole range of depths that have been studied. These zoning features are quite subtle; what stands out is the relative consistency of grades and mineralization over thousands of vertical feet of workings.

Pontius (1996) summarized a more detailed depositional model that combines the work of several colleagues. It starts with an initial stage of high-temperature, high-salinity hydrothermal activity that coincided with decreasing volcanism (Dwelley, 1984). This stage coincided with a period of resurgent phonolite doming when the fluids associated with doming, although essentially barren, created extensive zones of permeability. During a second stage, episodic, low-temperature, low-salinity (Reynolds, 1992) hydrothermal activity occurred over a period of about 2 million years. Potassium metasomatism, represented mainly by sericite and orthoclase, and pyritization are common features of this event; this is also the time of both gold telluride and disseminated native gold deposition. The last stage was characterized by the formation of the hydrothermal breccia pipes in which mineralization is almost entirely confined to clasts. This stage corresponds with emplacement of lamprophyre intrusives that marks the end of igneous activity (Pontius, 1996).

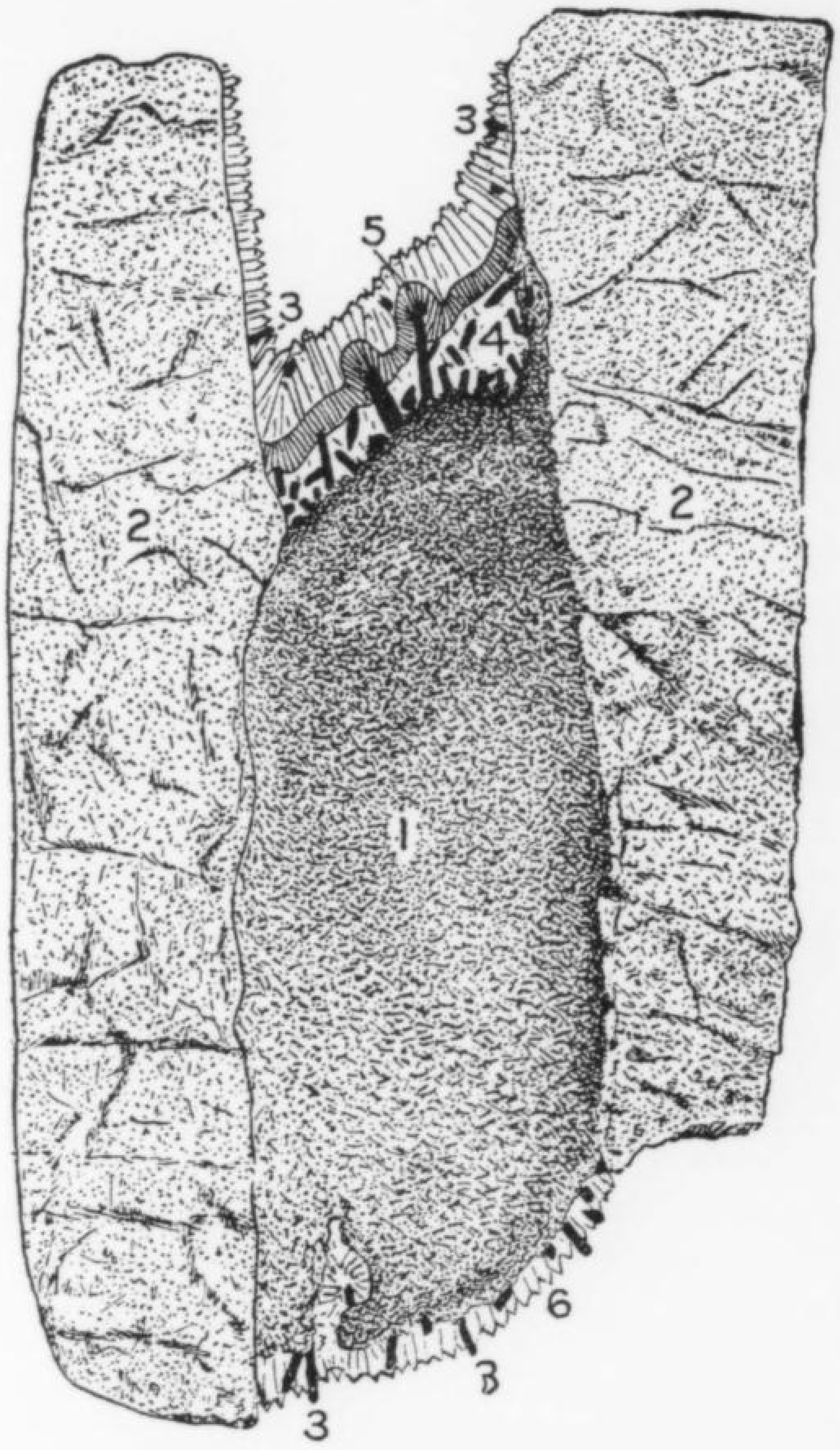


***Figure 23.* A drawing illustrating local structure in the C.K. & N. vein at Cripple Creek. The fragment of altered rock jammed in the fissure (1) is encrusted by calaverite (3), quartz (4, 6) and radial pyrite (5) (Lindgren and Ransome, 1906).**

Supergene alteration caused by descending sulfate-bearing waters derived from the decomposition of nearly ubiquitous pyrite bleached the breccia, granite, and "dikes" near the largest and most persistent mineralized zones (Loughlin and Koschmann, 1935). Calcite and dolomite were dissolved in places, and analcime, sodalite, nepheline, and feldspars in the phonolitic host rocks were locally altered to clay. In basaltic rocks, secondary zeolite minerals resulted. Some iron in solutions from near the surface formed secondary pyrite or marcasite by reduction at depth. In other places, the iron formed green, iron-rich clay (nontronite). In the ores, oxidation and interaction with meteoric water leached tellurium, leaving gold pseudomorphs after telluride minerals. In such cases, the gold may be embedded in a soft mass of iron-stained quartz and clay with fluorite and celestine. The tellurium may form "green oxide" (Loughlin and Koschmann, 1935) (the mineral emmonsite?). Rare occurrences of crystallized and wire gold probably result from redeposition of gold dissolved near the surface.

MINERALS

More than 120 minerals have been identified in rocks from the Cripple Creek district. Although relatively few of these are of collector interest, a complete listing of reported species has not been available until now; such a listing, as presented here, should be of use to Colorado collectors.

Mineral specimens from the Cripple Creek district are rarely flashy or even attractive. To the casual collector, the ores resemble pyrite, marcasite, or arsenopyrite. The fact that pyrite is nearly ubiquitous complicates matters for those unfamiliar with the ore minerals. Even well crystallized specimens of the major telluride ore minerals are notoriously difficult to distinguish in hand specimen; more sophisticated analytical techniques are required for their certain identification.

Because of the district's fame, the lack of large numbers of spectacular specimens, and the absence of specific locality information to accompany many specimens, some dealers and collectors have exercised more than a little imagination in their attributions. If a specimen obviously came from Cripple Creek but information on the particular mine was lacking, some apparently have felt safe in claiming that the specimen came from the famous Cresson mine. The senior author has seen (and, in his early years, purchased) specimens with fanciful labels detailing where and when specimens were collected and by whom, only to find that they were not even from North America. Such specimens are well known to Colorado specialists, but others may lack the background to recognize them for what they are. Let the gullible beware. On the other hand, the occasional spectacular melonite specimen that reaches the market most likely really did come from the Cresson mine. The almost equally uncommon groups of distinctive, large amethyst crystals found in many museum collections certainly originated in the district, but the exact locality is at this time unknown to the authors. The provenance of many of the telluride specimens can be recognized by their associations and by the characteristics of the host rock. If you are interested in Cripple Creek minerals, don't despair. As always, learn all you can and be skeptical of offerings that seem too good to be true.

In the following treatment, the minerals are listed alphabetically. Each is placed into at least one of five categories: rock-forming minerals *(R)*; ore minerals *(O)*; gangue minerals *(G)*; alteration minerals *(A)*; and supergene minerals *(S)*. Rock-forming minerals are subdivided into two categories: essential *(RE)* or accessory *(RA)* minerals. Similarly, ore and gangue minerals are classified according to their occurrence in vein deposits *(OV* or *GV)* or in disseminated deposits *(OD* or *GD)*. Alteration minerals may occur in veins *(AV)*, in disseminated deposits *(AD)*, or in the host rocks *(AH)*. Finally, supergene minerals may occur in the oxidized zone *(SO)* or in the zone of supergene sulfide enrichment *(SS)*. Brief descriptions are included for each mineral, with more information on those of collector interest.

Acanthite Ag_2S *(OV)*

Acanthite is a minor late-stage vein mineral, reported at the Ajax mine and elsewhere and with gold and jarosite in oxidized outcrop samples (Thompson, 1992; Thompson *et al.*, 1985; Hildebrand and Gott, 1974).

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

Actinolite is abundant in schist in a railroad cut west of Victor (Eckel, 1997).

Adularia See orthoclase.

Aegirine; Aegirine-Augite $NaFe^{3+}Si_2O_6$ *(RA)*

Aegirine is common in all Oligocene intrusive rocks of the district. It occurs as phenocrysts in plagioclase phonolite; as acicular, prismatic and blunt crystals in phonolite, where it may occur included in analcime or in sheaves of acicular crystals wrapped around nepheline; as small crystals in phonotephrite; as a constituent of lamprophyre dikes; and as phenocrysts in tephriphonolite (Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Lindgren and Ransome, 1906; Birmingham, 1987).

Allanite (undivided) *(RA)*

Allanite occurs as an accessory mineral in the Cripple Creek "granite" (Lindgren and Ransome, 1906).

Altaite PbTe *(OV; OD)*

Altaite is uncommon, occurring at the Cresson mine as silvery white massive ore (Saunders, 1988; Geller, 1993).

Alunite $K_2Al_6(SO_4)_4(OH)_{12}$ *(SO)*

Alunite is described as hard, compact, fine-grained, kaolin-like masses in the oxidized veins of the Last Dollar and Modoc mines (Lindgren and Ransome, 1906).

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

Admixtures of alunogen and epsomite are reported, with no details (Eckel, 1997).

Analcime $NaAlSi_2O_6 \cdot H_2O$ *(RE)*

Analcime is a common constituent of all of the Oligocene rocks of the district, including phonolite, plagioclase phonolite, phonotephrite, tephriphonolite, vogesite, and monchiquite It occurs as drusy crystals in cavities, as irregular masses, as phenocrysts, and surrounding nepheline crystals (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Birmingham, 1987).

Ancylite-(Ce) $SrCe(CO_3)_2(OH) \cdot H_2O$ *(RA)*

Ancylite-(Ce) is described by Birmingham (1987) as grains less than 15 μm in phonolite.

Andradite $Ca_3Fe_2(SiO_4)_3$ *(RA)*

Andradite occurs as zoned crystals (Standish, 1971).

Anglesite $PbSO_4$ *(SO)*

Anglesite resulted from alteration of galena by oxygenated meteoric water at the Gold Hill mine (Thompson *et al.*, 1985).

Anhydrite $CaSO_4$ *(GD)*

Anhydrite is described as a late-stage gangue mineral in the matrix of the hydrothermal breccias at the Gold Hill mine (Thompson *et al.*, 1985).

Ankerite $Ca(Fe^{2+},Mg,Mn)(CO_3)_2$ *(GV)*

Ankerite occurred as small, white, rhombic middle-stage crystals in vugs in plagioclase phonolite and in the wall rock of the Gold King and other mines (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935).

Anorthoclase $(Na,K)AlSi_3O_8$ *(RE)*

Anorthoclase is a constituent of phonolite, restricted to groundmass (Birmingham, 1987).

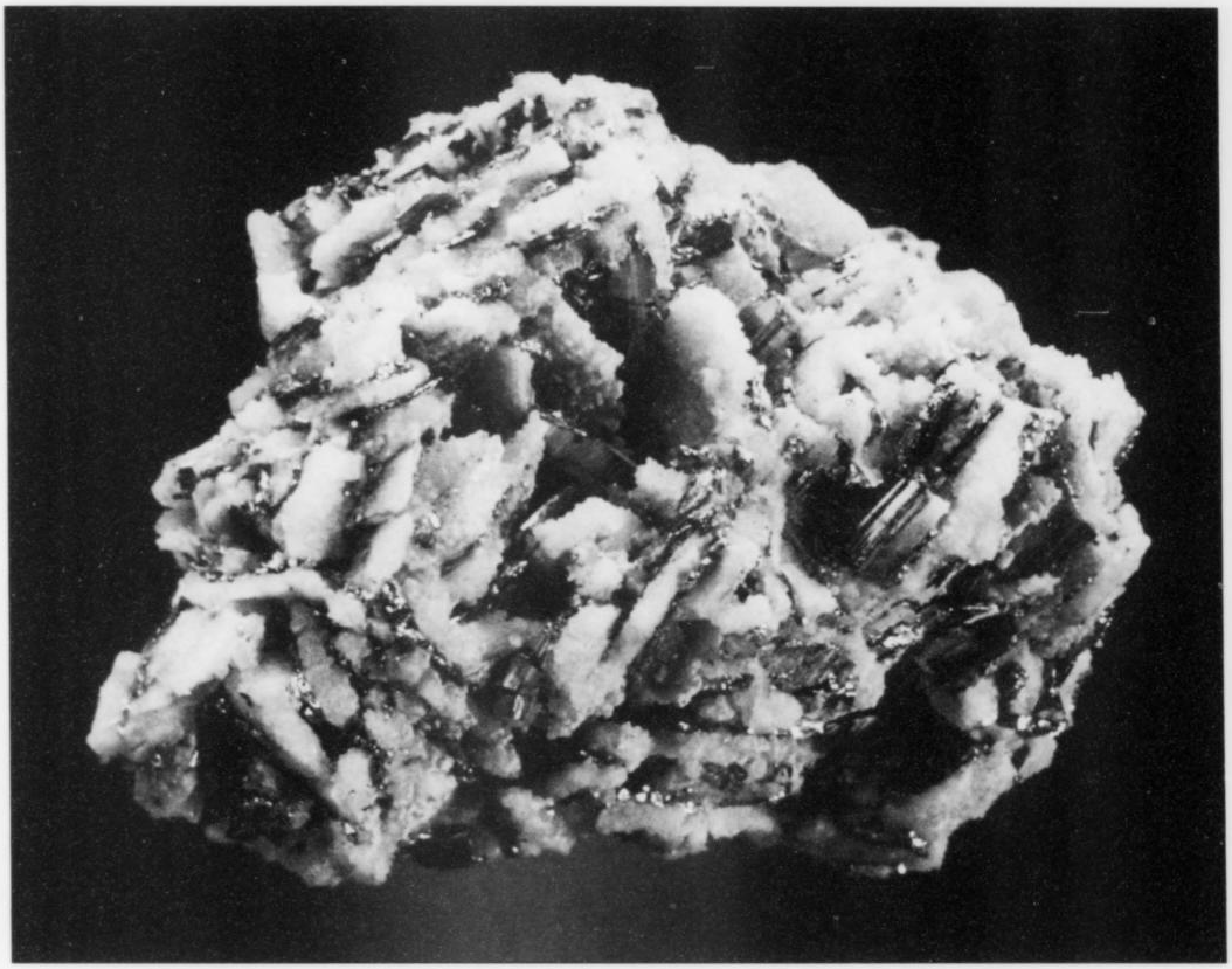


Figure 24. **Calaverite with quartz, 2.6 cm. This small thumbnail specimen in the collection of the Colorado School of Mines has been attributed to the Cresson vug. The date of collection and the provenance are consistent with that attribution, however the specimen is not unlike other specimens known to have come from other levels of the Cresson mine. Jeff Scovil photo.**

Apatite Group (undivided) *(RA; GV; GD)*

Apatite-group species occur as gray, euhedral, prismatic crystals in extremely porphyritic plagioclase phonolite; as minor constituents in phonolite, tephriphonolite, phonotephrite, lamprophyre, and in Proterozoic rocks, including Pikes Peak Granite, Cripple Creek "granite," gneiss, and schist; in hydrothermal veinlets in the host rocks; as early to middle-stage alteration minerals in the hydrothermal breccias at the Gold Hill mine; and in slender micro-prisms, as abundant secondary minerals with orthoclase at the Elkton mine (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Thompson, 1992).

Arfvedsonite $Na_3(Fe,Mg)_4FeSi_8O_{22}(OH)_2$ *(RA)*

Needles and microscopic stout prisms of arfvedsonite occur in phonolite (Lindgren and Ransome, 1906; Birmingham, 1987).

Arsenopyrite FeAsS *(GV)*

Lindgren and Ransome (1906) report arsenopyrite from the Ajax mine.

Autunite/Meta-autunite $Ca(UO_2)_2(PO_4)_2 \cdot 2\text{–}6H_2O$ *(SO)*

Autunite has been reported as a very minor supergene mineral produced by weathering of alteration products of early- stage veins at the Globe Hill mine, and associated with other secondary uranium minerals in Tertiary volcanics (Thompson *et al.*, 1985; Young and Mickle, 1976; Nelson-Moore *et al.*, 1978).

Baddeleyite ZrO_2 *(RA)*

Birmingham (1987) reported baddeleyite as very small crystals in the groundmass of a phonotephrite dike at the Isabella mine.

Barite $BaSO_4$ *(GV; GD)*

Barite is a middle-stage mineral, occurring as massive aggregates and small crystals in the El Paso and Portland veins and commonly intergrown with tellurides at the Cresson mine (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Saunders, 1988; Thompson, 1992). Barite commonly has been confused with celestine.

Biotite $K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2$ *(RA; GV)*

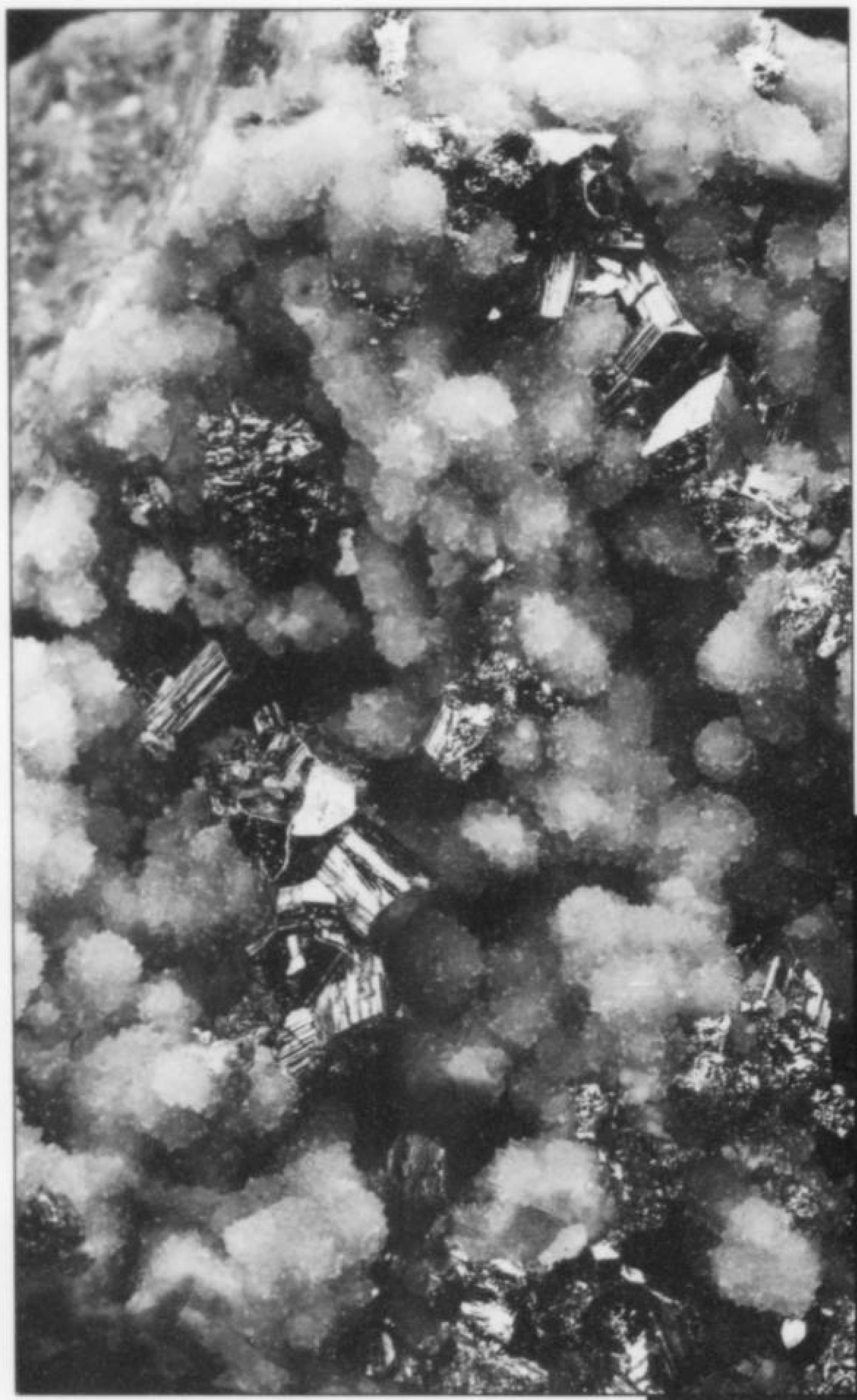
Biotite occurs as phenocrysts or as a minor groundmass constituent of all Cripple Creek volcanics and most Proterozoic host rocks. It also occurs with apatite and pyrite in hydrothermal veinlets penetrating the host rocks and in the Dolly Varden vein (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Thompson, 1992).

Boulangerite $Pb_5Sb_4S_{11}$ *(OV)*

Boulangerite may occur as irregular grains enclosed in bournonite from the El Paso mine (Lane, 1976).

Bournonite $PbCuSbS_3$ *(OV)*

Bournonite is reported as rims around galena grains and associated with tetrahedrite-tennantite from the El Paso mine (Lane, 1976).



Cacoxenite $(Fe,Al)_{25}(PO_4)_{17}O_6(OH)_{12}\cdot75H_2O$ *(SO)*

Cacoxenite is locally common in fractures in dump samples from the John A. Logan mine, where it occurs as acicular crystals to 0.3 mm in radially intergrown mats covering areas of several square cm. It occurs in partly oxidized gray orthoclase-quartz-pyrite rock, following earlier strengite and followed by an unidentified green member of the rockbridgeite family (Eckel, 1997).

Calaverite $AuTe_2$ *(OV; OD)*

Calaverite is the most common telluride in the district, occurring as a late middle-stage vein mineral (Loughlin and Koschmann, 1935; Thompson *et al.*, 1985) and as a minor stage-two (of four) mineral of disseminated deposits at Globe Hill (Thompson *et al.*, 1985). It occurs as silvery white to pale yellowish, flat to slender, striated, prismatic crystals, commonly to several mm, in vugs; and as thin, bladed crystals to 20 cm, some in radial aggregates. In places, calaverite is intergrown or associated with other vein minerals (chalcedony, fluorite, celestine, pyrite, stibnite, etc.) (Lindgren and Ransome, 1906; Patton and Wolf, 1915). Less commonly it is massive. At Cresson, calaverite crystallization

Figure 25. **Calaverite crystals to 2 mm, Cripple Creek district. Carnein collection. Scovil photograph.**

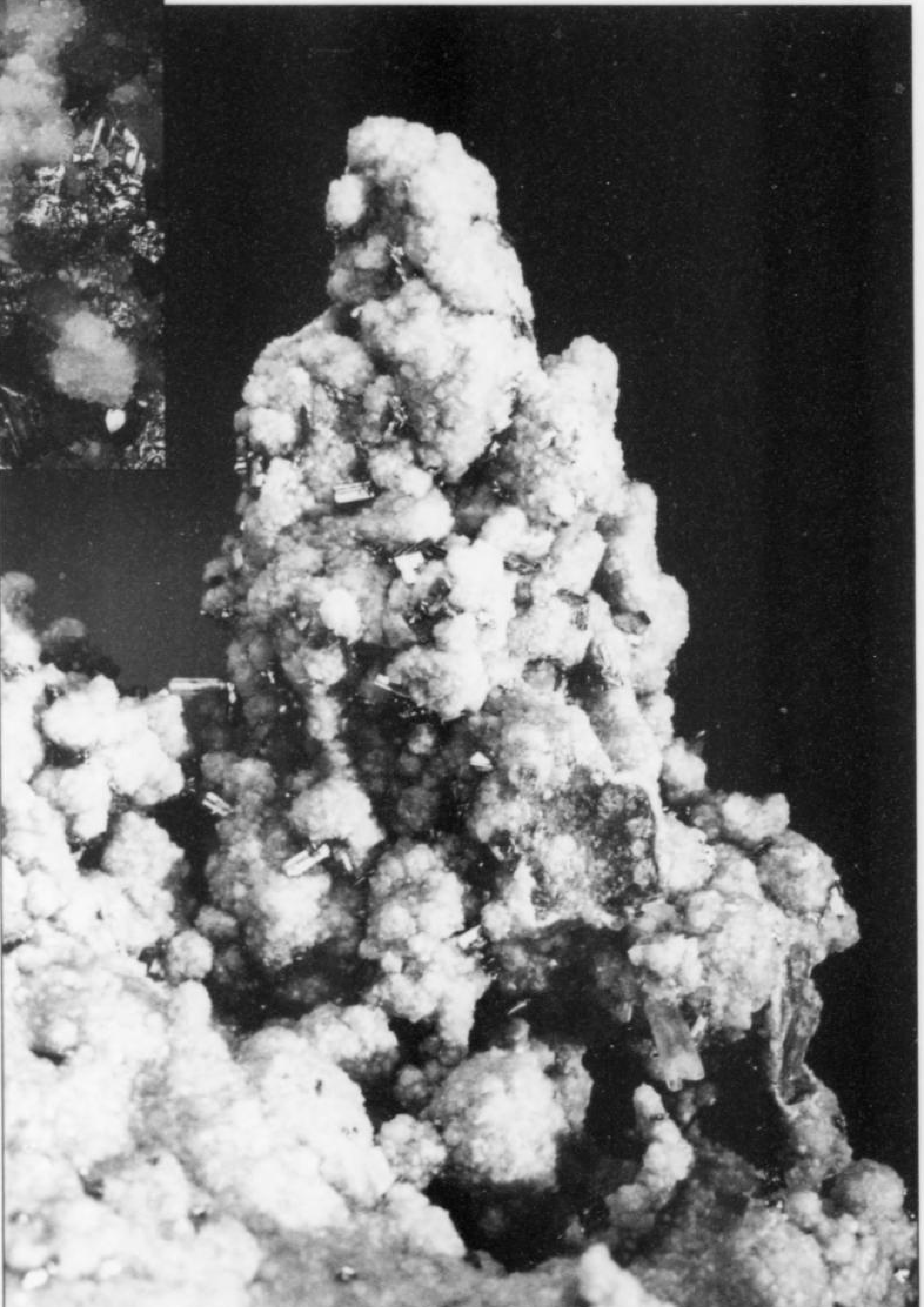


Figure 26. **Calaverite crystals to 4 mm on calcite, from Cripple Creek. Colorado School of Mines collection; Jeff Scovil photo.**

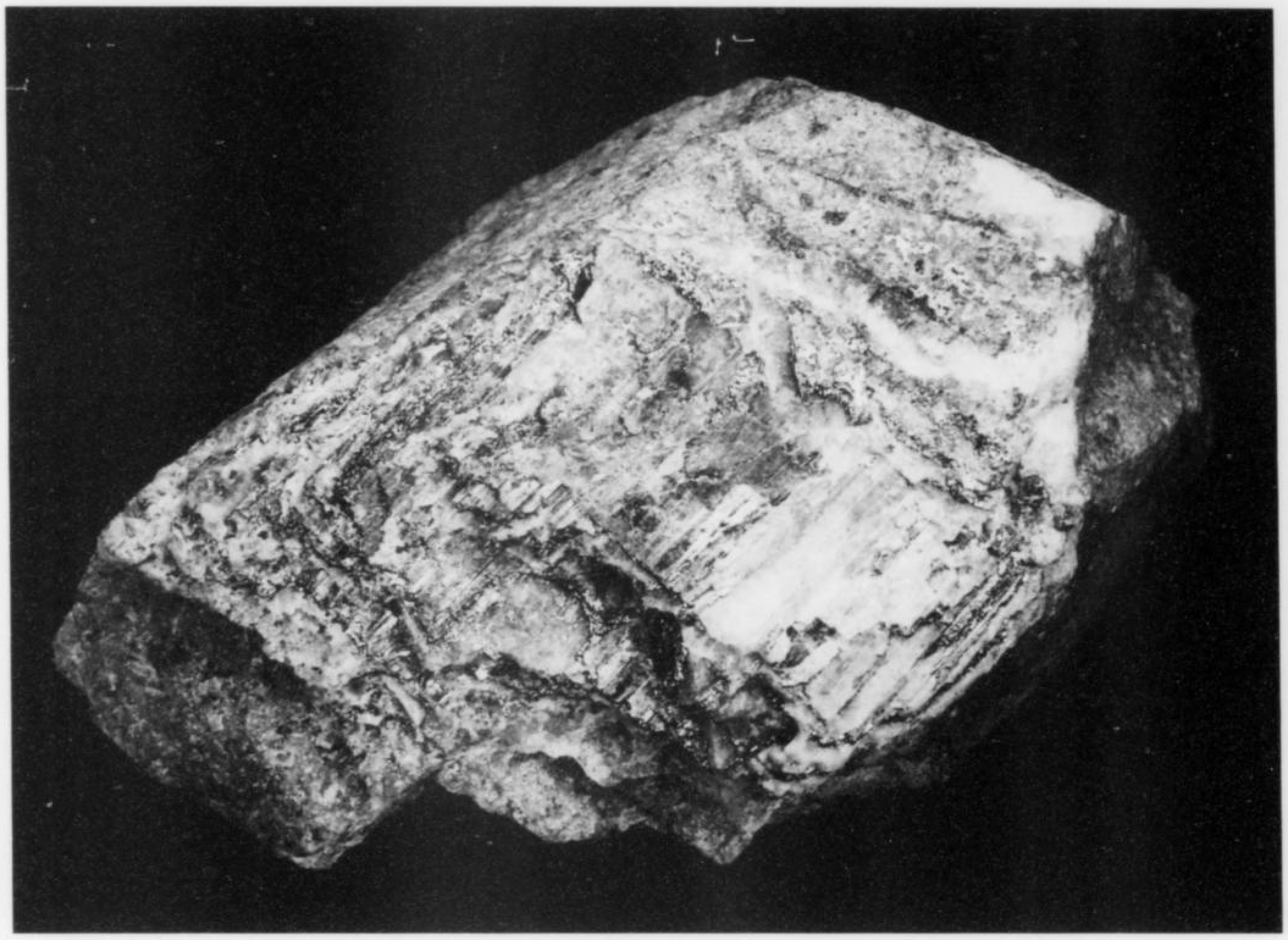


Figure 27. **Calaverite on and in quartz, Cripple Creek district. Field is 9.5 cm wide. Carnein collection. Scovil photograph.**

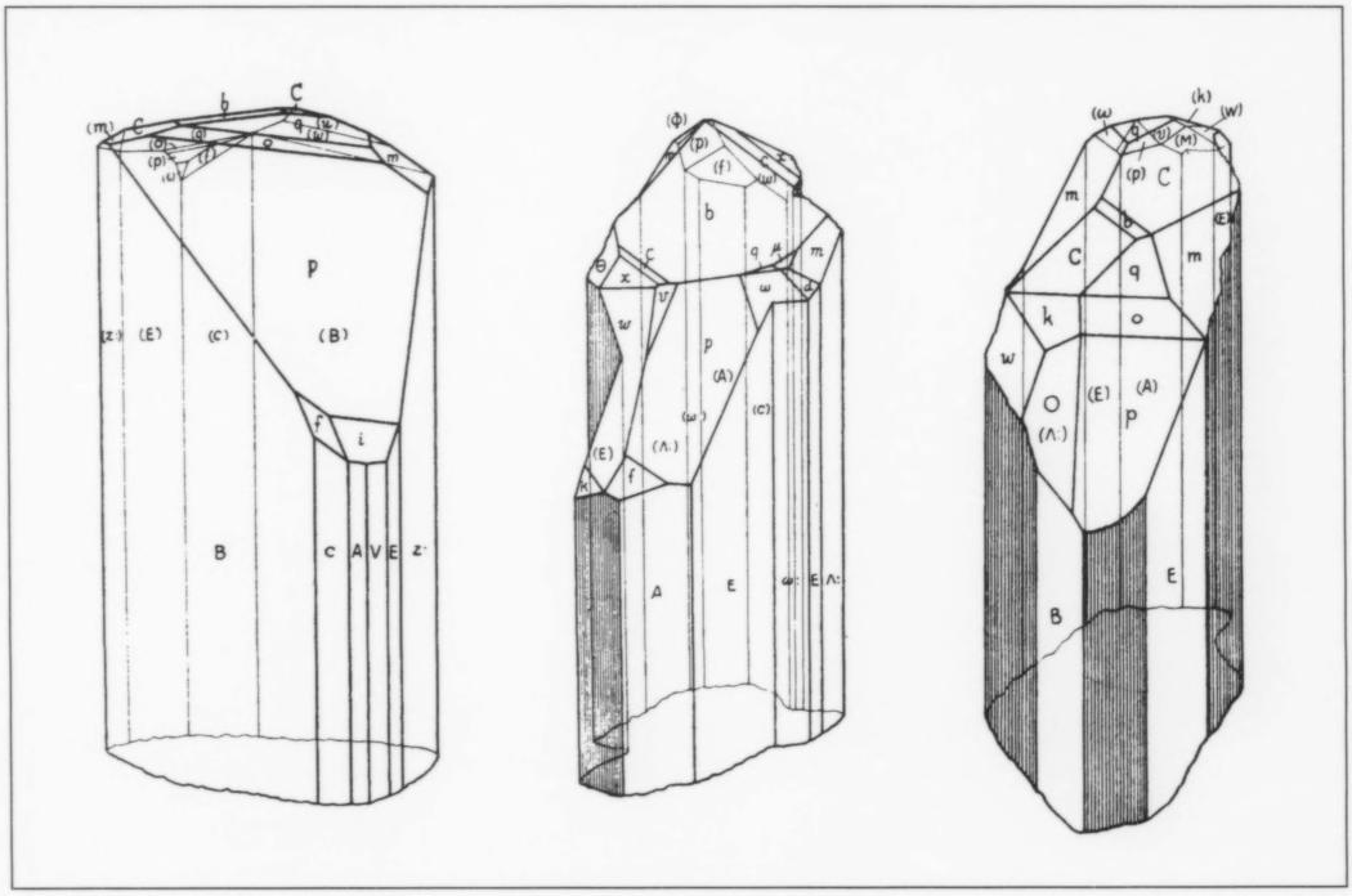


Figure 28. **Calaverite crystals from the Cresson vug (Goldschmidt *et al.*, 1931).**

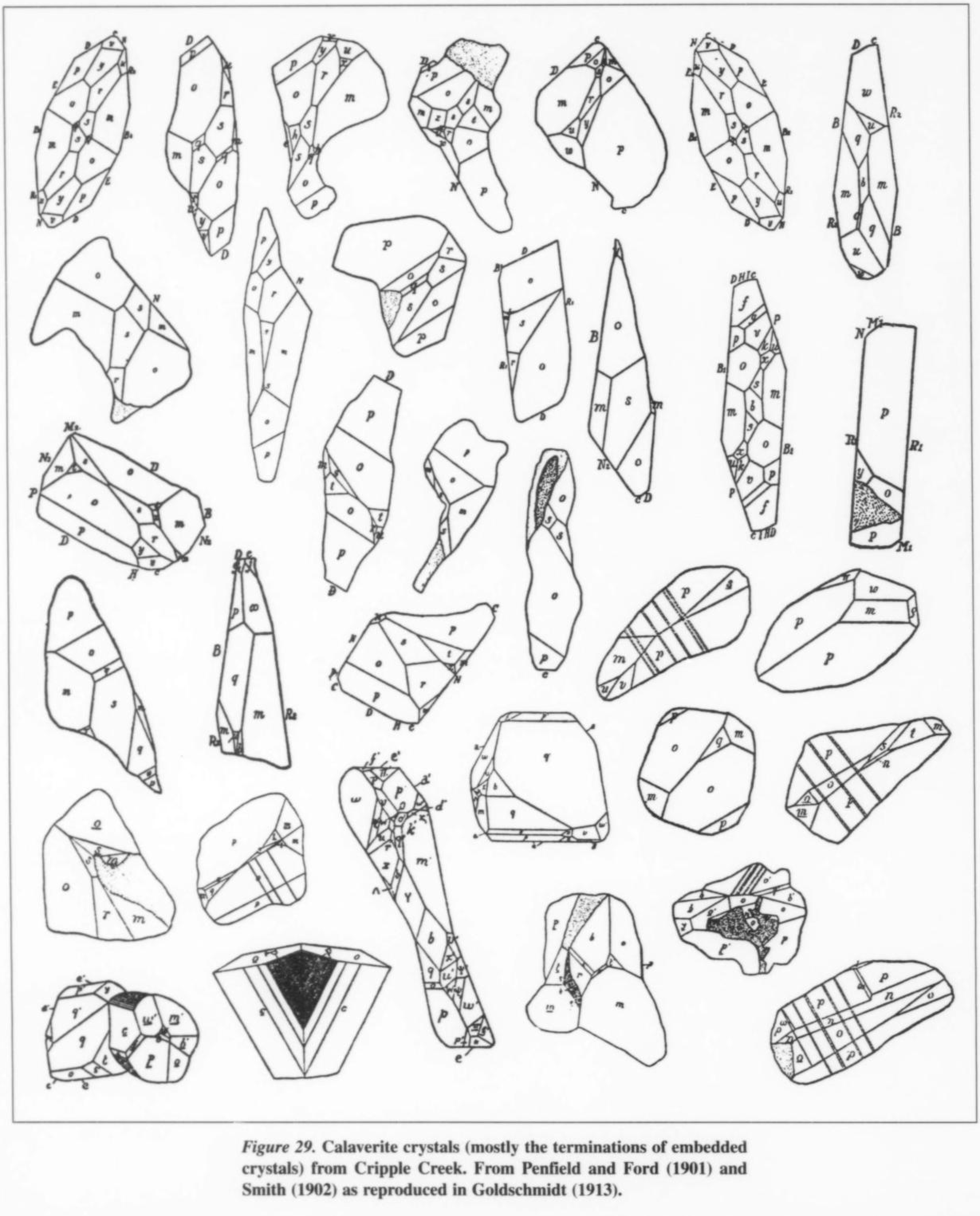


Figure 29. **Calaverite crystals (mostly the terminations of embedded crystals) from Cripple Creek. From Penfield and Ford (1901) and Smith (1902) as reproduced in Goldschmidt (1913).**

overlaps but has primarily occurred after the crystallization of base-metal sulfide minerals, and in some cases it is replaced by petzite, melonite and altaite (Saunders, 1988). It commonly is coated and obscured by later vein minerals, especially chalcedony. In oxidized deposits, calaverite may be partly replaced by native gold and rusty-looking iron oxides. In the past, a common practice was to call yellowish telluride minerals calaverite and to call silvery tellurides sylvanite. However, the physical properties of both minerals are variable, and analytical work is necessary for certain identification.

Calcite $CaCO_3$ *(GV; AH)*

Calcite is uncommon in veins, occurring as colorless to white, rarely yellow, scalenohedrons formed in the middle stage of

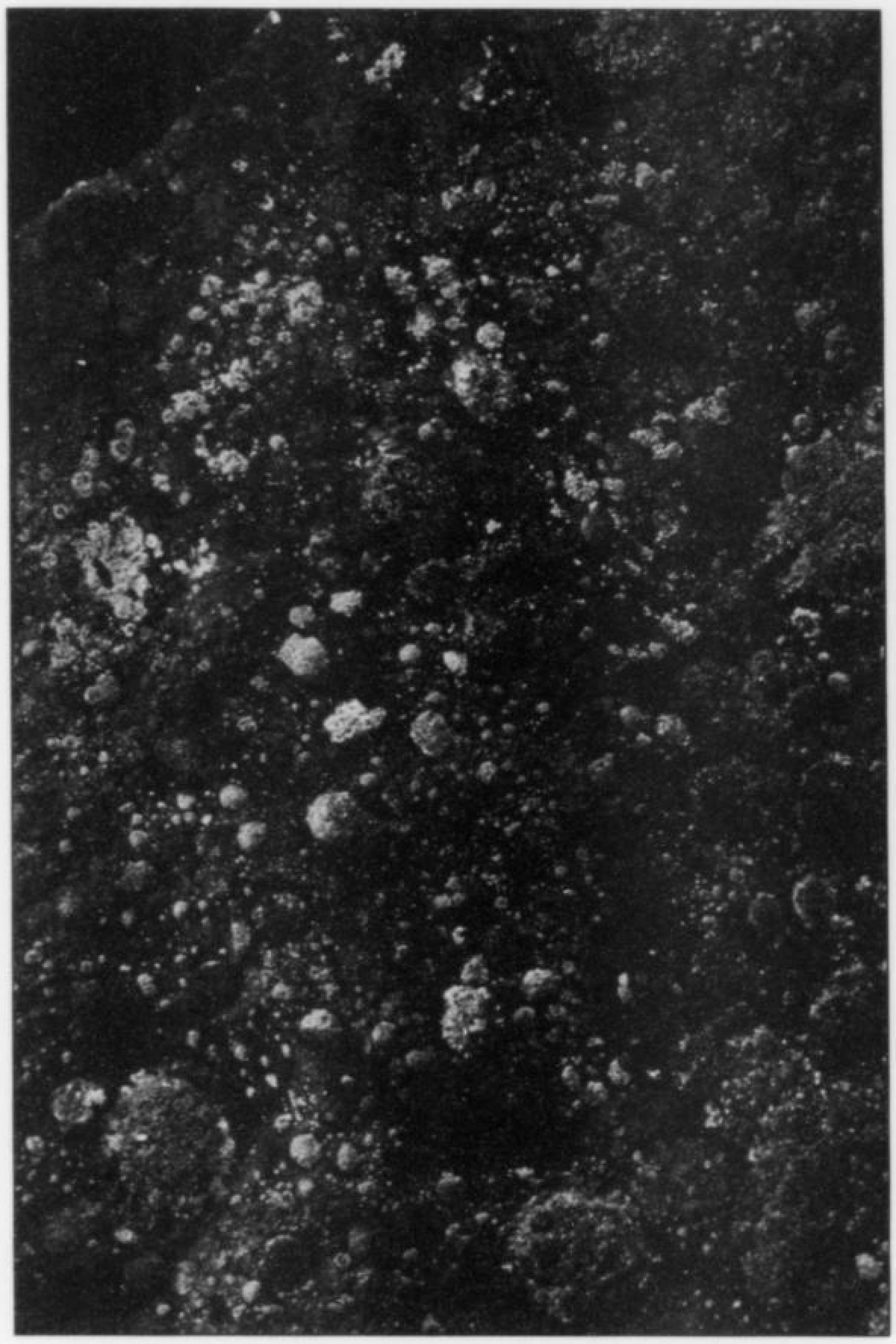


Figure 30. **Gold blebs on rock, the residue of roasted calaverite, 7 cm, from Cripple Creek. Colorado School of Mines collection; Jeff Scovil photo.**

mineralization. It also occurs as a minor alteration product in plagioclase phonolite and Ca-rich lamprophyre (Loughlin and Koschmann, 1935).

Celadonite $KFe^{3+}(Mg,Fe^{2+})\square Si_4O_{10}(OH)_2$

Birmingham (1987) described celadonite in vesicles and cracks in volcanic breccia and altered tephriphonolite.

Celestine $SrSO_4$ *(GV; GD)*

Celestine occurs as an early-stage vein mineral (Loughlin and Koschmann, 1935) of the disseminated deposits at Globe Hill (Thompson *et al.*, 1985). It is also found in vein fragments and as a gangue mineral in hydrothermal breccias, and occurs as small, white, bluish, or bright yellow slender prisms or needles coating the walls of vugs in veins. It commonly is intergrown with tellurides at Cresson and other mines, and is associated with "limonite," kaolinite and native gold in oxidized veins. It may be coated or replaced by quartz, and in some cases dissolved out, leaving hollow quartz coatings sometimes labeled as "quartz after stibnite" (Lindgren and Ransome, 1906). At the Cresson open pit, celestine collected in 2001 occurred as bluish, white or yellow prisms to 2.5 cm associated with creedite, rhodochrosite and gearksutite. It also has been described as an accessory mineral in monchiquite and gray plagioclase phonolite (Birmingham, 1987).

Chalcanthite $CuSO_4{\cdot}5H_2O$ *(SO)*

Chalcanthite was scarce in oxidized veins at the Gold King and Lone Jack mines and in the Ophelia, Chicago, and Cripple Creek tunnels (Lindgren and Ransome, 1906).

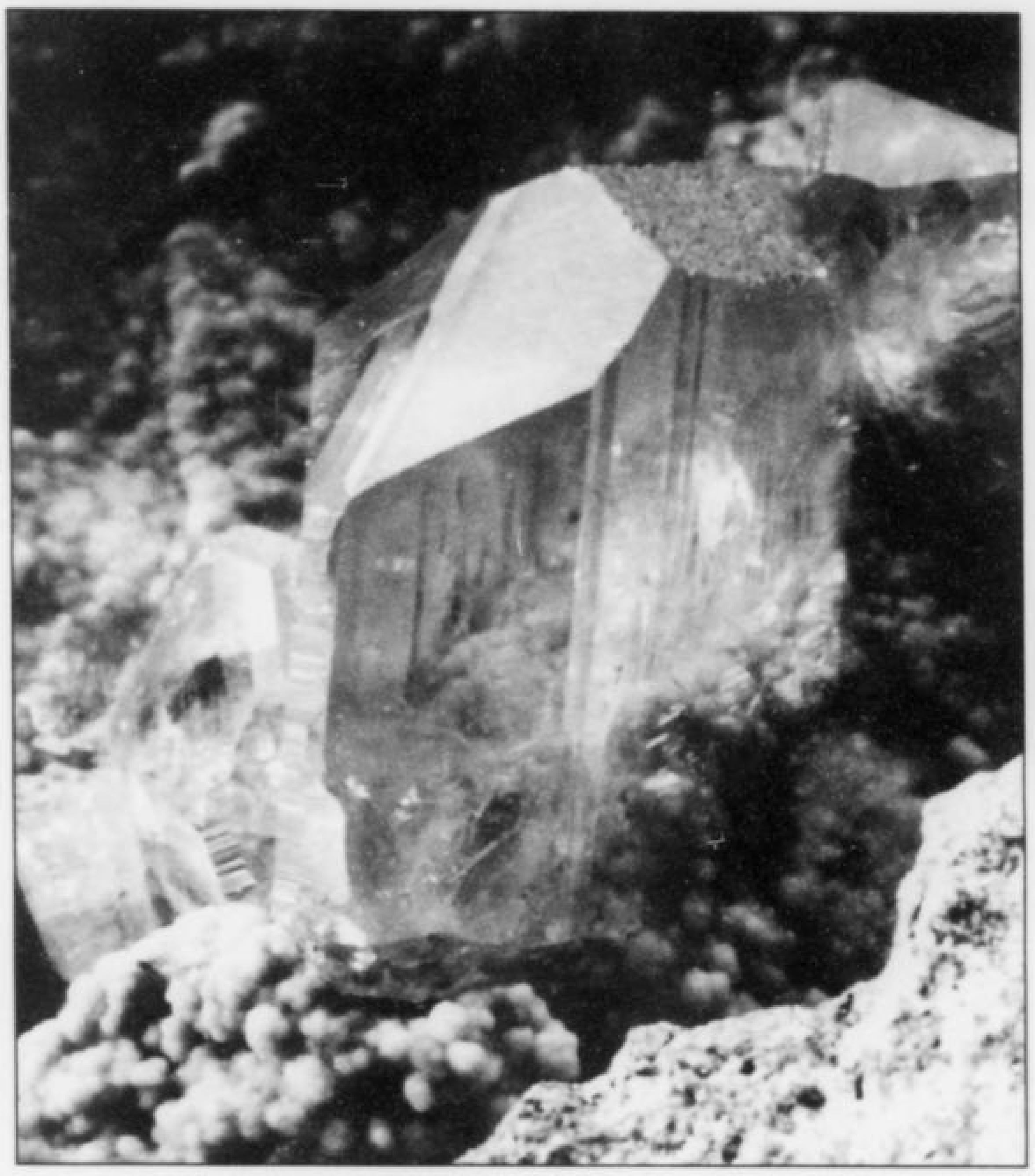


Figure 31. **Celestine crystal, 1.2 cm, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Chalcocite Cu_2S *(OV)*

Chalcocite was questionably identified from the Uncle Sam mine (Lindgren and Ransome, 1906).

Chalcopyrite $CuFeS_2$ *(OV; OD)*

Chalcopyrite was locally abundant at the Cresson mine (Saunders, 1988). It occurred as a stage-three (of five) vein mineral and in stages 1, 2 and 4 (of 4) in breccias at Globe Hill (Thompson *et al.*, 1985). Lindgren and Ransome (1906) describe rare thin coatings of chalcopyrite on tetrahedrite at the Blue Bird mine.

Chlorite Group (undivided) *(AH; AD; AV)*

Chlorite formed by alteration of biotite and/or amphibole in most rocks of the district, including veins and breccias (Lindgren and Ransome, 1906; Thompson *et al.*, 1985; Thompson, 1992).

Chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4{\cdot}nH_2O$ *(SO)*

Lindgren and Ransome (1906) reported chrysocolla as a product of oxidation of tetrahedrite at the Ironclad mine.

Cinnabar HgS *(OV)*

Cinnabar was a widespread but rarely obvious stage-3 mineral in veins and in open breccias in the Dante mine (Loughlin and Koschmann, 1935; Eckel, 1997). It occurred as disseminated coatings on pyrite and as small botryoidal druses in vugs. With other species, it may coat tellurides. Cinnabar also occurred with native mercury at the Moon Anchor mine (Lindgren and Ransome, 1906).

Coloradoite $HgTe$ *(OV)*

Coloradoite has been reported from the Moon Anchor mine (with native mercury) and Clara D claim (Gold Hill) (Eckel, 1997), and intergrown with galena and krennerite and associated with acanthite and jarosite at the Cresson mine (Hildebrand and Gott, 1974).

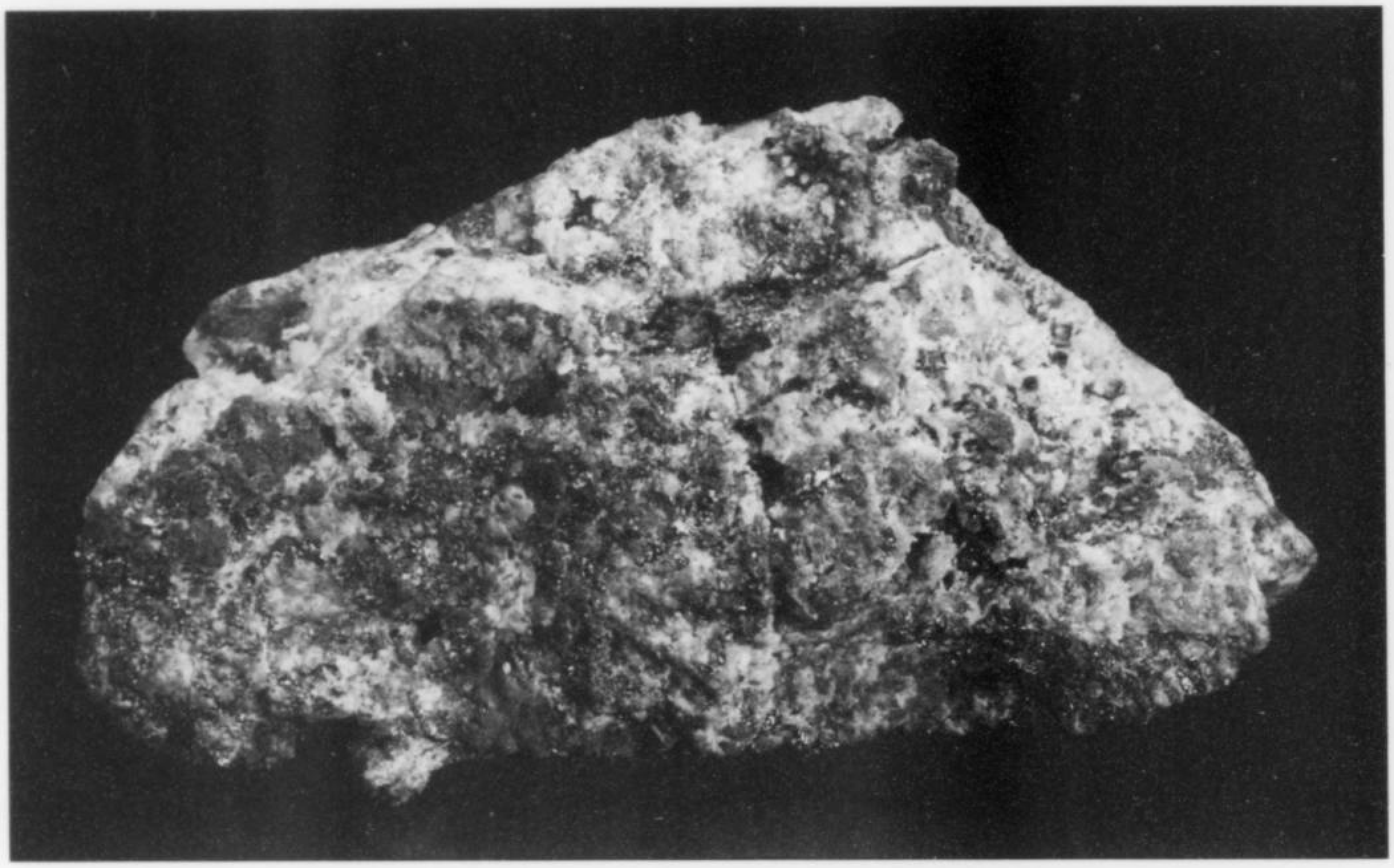


Figure 32. **Cinnabar on matrix, 5.4 cm wide. Cripple Creek district. Carnein collection. Scovil photograph.**

Copper Cu *(AH)*

Lindgren and Ransome reported a single specimen of native copper in an oxidized lamprophyre dike on Mineral Hill, possibly derived from oxidation of tetrahedrite. It was also found when sinking the shaft for the Logan mine (Bancroft, 1903).

Corkite $PbFe_3(PO_4)(SO_4)(OH)_6$ *(SO)*

Corkite occurred at the John A. Logan mine, as thin, shiny plates to 0.3 mm intergrown to form irregular rosettes coating vug walls in comb quartz and associated with pyrite, fluorite, and tetrahedrite (Eckel, 1997).

Corundum Al_2O_3 *(RA)*

Corundum was described by Lindgren and Ransome (1906) as occurring in Proterozoic sillimanite schist south of Red Mountain.

Covellite CuS *(SS)*

Covellite has been reported as a supergene mineral formed by alteration of chalcopyrite and as distinct, minute grains associated with other copper sulfides (Lane, 1976; Thompson *et al.*, 1985).

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

Creedite was first found at Cripple Creek in the Cresson open pit in 2001, as colorless/white to pale and medium purple aggregates of small (to 1 cm), radiating crystals associated with blue, white and yellow celestine, gearksutite, cubic pyrite and botryoidal rhodochrosite. Gearksutite generally is the last of these minerals to form (D. Bunk, personal communication). Some specimens show celestine intergrown with or overlying creedite.

Crossite $Na_2(Mg,Fe)_3(Al,Fe)_2Si_8O_{22}(OH)_2$ *(RA)*

Blue amphibole found in some Cripple Creek volcanic rocks is allied to crossite (Cross and Penrose, 1895; Birmingham, 1987).

Dolomite $CaMg(CO_3)_2$ *(GV; GD; AH)*

The most widespread (but seldom obvious) carbonate of veins and wall rocks, dolomite occurs as small, white to greenish, rhombohedral crystals in altered breccia and intrusives, as crusts in

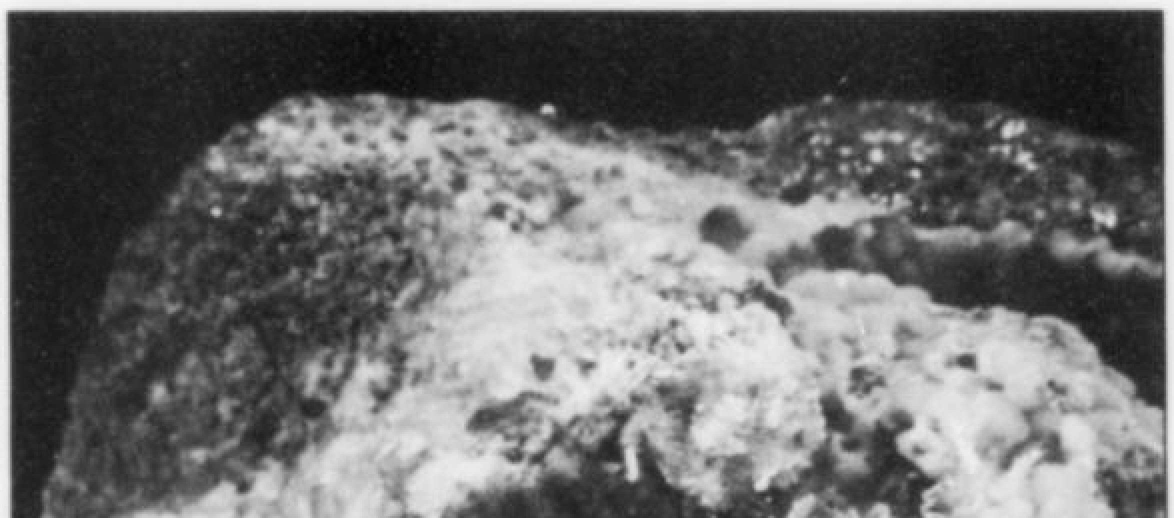


Figure 33. **Spheroidal creedite crystal cluster, 1.1 cm, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

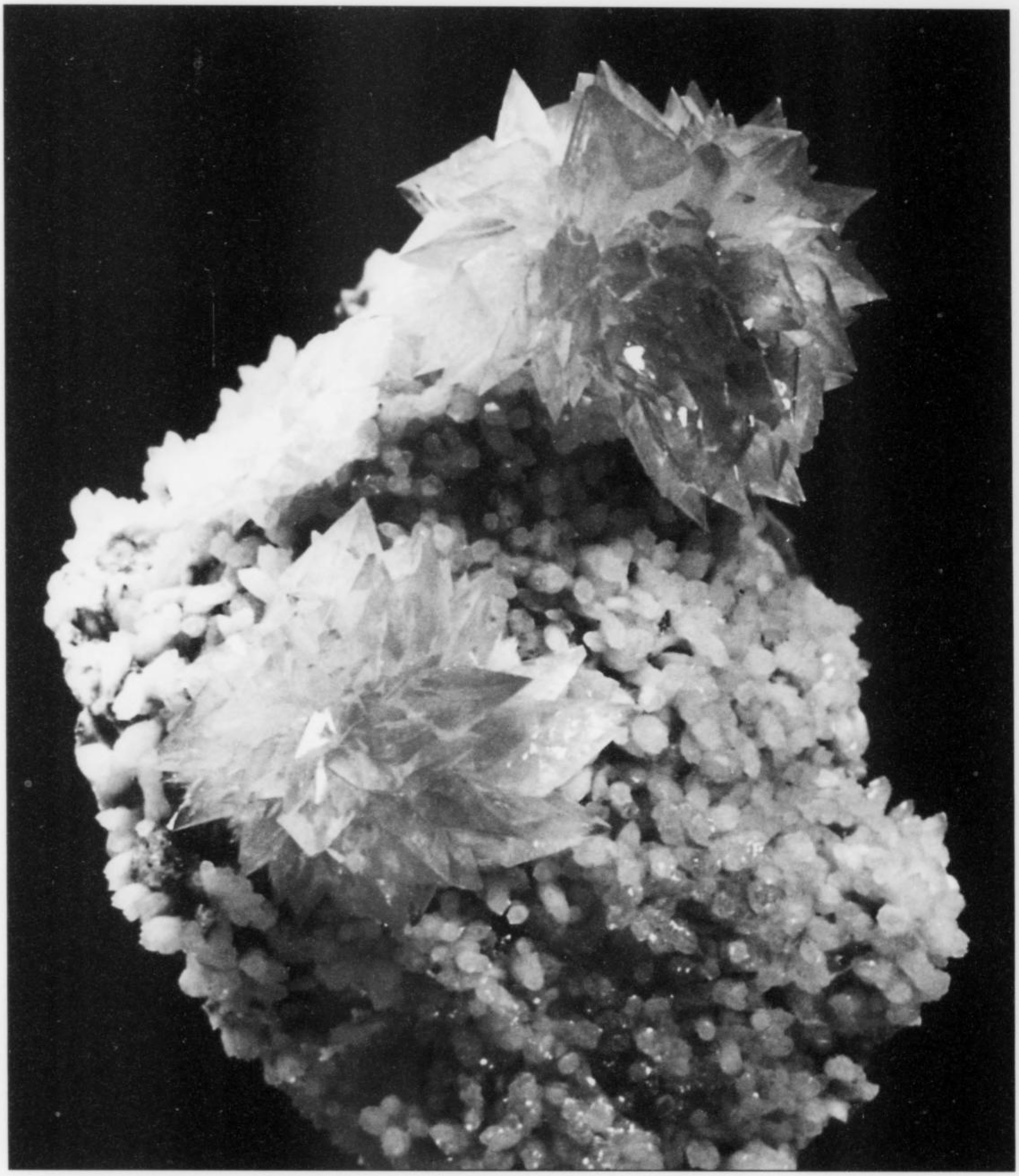


Figure 34. **Creedite crystal clusters on drusy calcite, 4.1 cm, from the Cresson mine open pit, Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

veins, as an alteration product in wall rocks, where it replaces biotite and analcime and permeates margins of felsic rock fragments, and as a cementing material of breccia and tuff host rocks (Loughlin and Koschmann, 1935; Thompson, 1992). It also formed hollow pseudomorphs, where coated by opal (Lindgren and Ransome, 1906). It preceded and overlapped the occurrence of calaverite at the Cresson mine (Saunders, 1988).

Emmonsite $Fe_2Te_3O_9 \cdot 2H_2O$ *(SO)*

Emmonsite is a green oxide of tellurium deposited as a result of alteration of tellurides by meteoric water (Loughlin and Koschmann, 1935). As small, often mammillary yellowish green masses, emmonsite occurs with native gold, tellurite and partially oxidized calaverite (Lindgren and Ransome, 1906; Eckel, 1997). Emmonsite has been reported from the WPH, Moose and Deadwood mines.

Enargite Cu_3AsS_4 *(OV)*

Enargite is reported as minute grains in tetrahedrite, bournonite, and sphalerite at the El Paso mine (Lane, 1976).

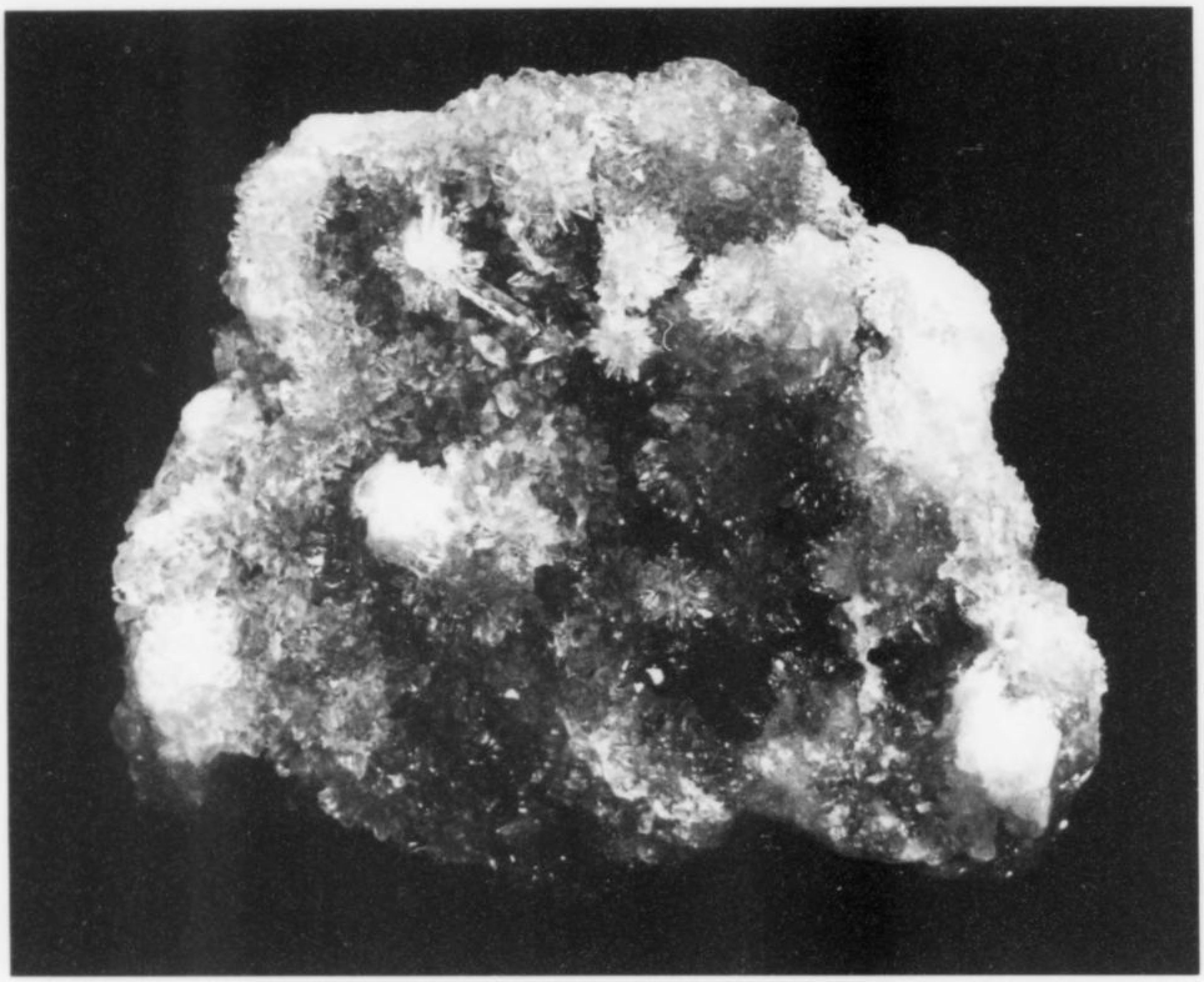


Figure 35. **Creedite crystal crust, 5.2 cm, from the Cresson mine open pit, Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Epidote $Ca_2Al_2(Fe^{3+},Al)\ Si_3O_{12}\ (OH)$ *(AH)*

A widespread alteration mineral found in Proterozoic granite, schist, and gneiss, epidote has also been reported in lamprophyre, plagioclase phonolite, and tephriphonolite (Lindgren and Ransome, 1906; Thompson, 1992).

Epsomite $MgSO_4{\cdot}7H_2O$ *(SO)*

Epsomite occurred as secondary encrustations where ground water emerged into openings (Loughlin and Koschmann, 1935). It was reported from the 1000 level of the Portland mine, where it was mixed with other sulfates (Lindgren and Ransome, 1906).

Fayalite Fe_2SiO_4 *(RA)*

Gross (1962) reported the occurrence of fayalite in an "augite syenite."

Ferrimolybdite (?) $Fe_2(MoO_4)_3{\cdot}8H_2O$ *(SO)*

Ferrimolybdite or a closely related mineral occurred on the north side of Battle Mountain as bright yellow, capillary crystals in cracks and joints of weathered plagioclase phonolite, and with ilsemannite as an alteration product of molybdenite in a vein exposed in the Ophelia tunnel (Lindgren and Ransome, 1906; Eckel, 1997).

Fluorite CaF_2 *(GV; GD; AH; RA)*

Fluorite is an extremely common species (but rarely found in aesthetic specimens) in almost all stages of mineralization of both vein and disseminated deposits, in sedimentary-hosted deposits, in the oxidized zone with free gold, as fragments in breccia, replacing biotite in some host rocks, and as a minor primary mineral in the granitic host rocks (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Thompson, 1992). In the veins, it occurred mostly as purple cubic crystals, less than 5 mm, coating vugs and crevices with quartz and dolomite. At the Cresson mine, it formed bright yellow, cubic crystals to 2 cm (Eckel, 1997), with quartz. Birmingham (1988) reported tiny purple crystals enclosed in sodalite and nosean in the Tertiary intrusives.

Forsterite Mg_2SiO_4 *(RE)*

Forsterite occurs as phenocrysts to 1 cm in the lamprophyre dikes (monchiquite and vogesite) and as small grains, some serpentinized or altered to "iddingsite," in phonolite, phonotephrite, and tephriphonolite (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Birmingham, 1987; Thompson, 1992).

Galena PbS *(OV; OD)*

Galena was locally conspicuous as an early component of hydrothermal breccias and veins, with other base-metal sulfides. It was especially abundant in the western part of the district, where it occurred in veins and in the oxidized zone, in which it had altered to anglesite and cerussite (Thompson *et al.*, 1985).

Gearksutite $CaAl(OH)F_4{\cdot}H_2O$ *(GD)*

Gearksutite was first found in the Cresson open pit in 2001. It occurs as small, white, irregular vug-filling masses and as colliform aggregates to several cm with orange botryoidal rhodochrosite, bluish, white, or bright yellow celestine and colorless to purple creedite. Gearksutite is the last mineral to form in this assemblage (D. Bunk, personal communication). It resembles kaolinite and may have been misidentified as such in the past.

***Figure 36.* Fluorite crystals to 7 mm on quartz from the Jackpot mine, Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

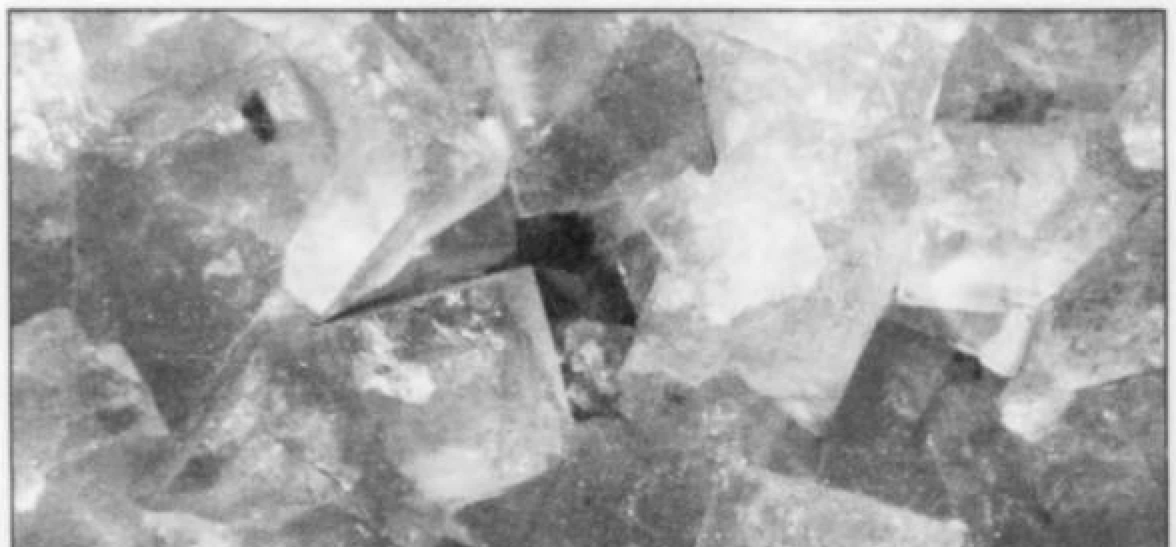


***Figure 37.* Fluorite crystal crust, 8 mm, from the Jackpot mine, Cripple Creek. Colorado School of Mines collection; Jeff Scovil photo.**

***Figure 38.* Gearksutite lump, 8.4 cm, from the Cresson mine open pit, Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Goethite α–$Fe^{3+}O(OH)$ *(SO)*

Goethite is a supergene mineral, formed by weathering of alteration products and vein minerals by oxidizing water at the Globe Hill mine (Thompson *et al.*, 1985) and elsewhere.

Gold Au *(SO; OD; OV)*

Gold is uncommon as large grains, spongy masses, thin sheets, plates and grooved pseudomorphs after calaverite and other tellurides. It is commonly found coated by iron oxides and associated

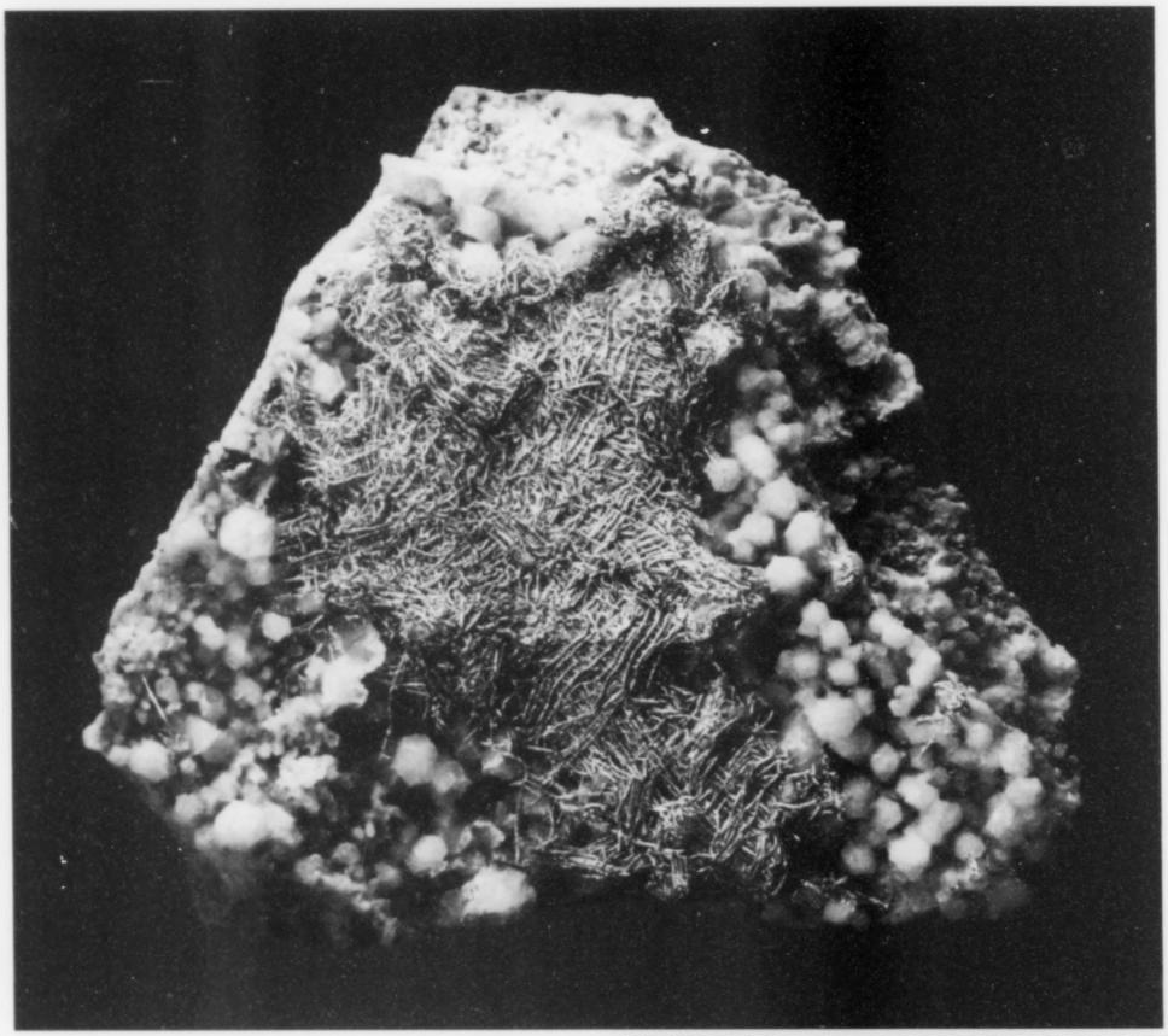


Figure 39. **Reticulated wire gold on milky quartz, 6 cm, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Figure 40. **Gold replacing calaverite with fluorite and iron hydroxide. Field is 3.5 cm across. Carnein collection. Scovil photograph.**

with iron-stained quartz and clay with minor to abundant celestine and fluorite (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935). Gold in the oxidized zone may be so coated with iron oxides that it is, at first glance, nearly invisible. Grains or wires of free gold, pea-sized clusters of gold crystals, and cubic crystals to 2 cm have been described (Eckel, 1997). Some of these are associated with tellurides in hypogene deposits. At the Cresson open pit, disseminated microcrystalline native gold attached to pyrite is associated with orthoclase in permeable host rocks adjacent to major structures (Pontius, 1996). The Carbonate Hill breccia pipe contains hübnerite which, on rare occasion, is found coated by gold.

Greenockite (?) CdS *(OV)*

Dark brown sphalerite in the Last Dollar mine contained much cadmium, possibly as greenockite inclusions or coatings (Lindgren and Ransome, 1906).

Gypsum $CaSO_4 \cdot 2H_2O$ *(SO; AD; AH; AV)*

Gypsum occurred in large masses associated with fluorite and pyrite in the Deerhorn mine and was widespread in oxidized ores, where it resulted, in part, from hydration of anhydrite. It also formed secondary encrustations where groundwater emerged into open spaces (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985).

Haüyne $(Na,Ca)_{4-8}Al_6Si_6(O,S)_{24}(SO_4,Cl)_{1-2}$ *(RA)*
Haüyne is common in small quantities as phenocrysts in phonolite and monchiquite (Loughlin and Koschmann, 1935; Birmingham, 1987).

Hematite α-Fe_2O_3 *(GV; GD; RA; AH; SO)*
Specular hematite occurs in small vugs in plagioclase phonolite and in cleavages in microcline in the Pikes Peak Granite. It also formed as an early to middle-stage vein mineral, as an early to late-stage component of disseminated deposits, in both intrusive and hydrothermal breccias, and in altered rocks associated with disseminated deposits. It replaces clay and carbonates in supergene deposits formed by descent of sulfate-bearing water (Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Thompson, 1992).

Hessite Ag_2Te *(OV)*
Hessite occurs as an early-stage mineral in microscopic, interstitial grains in calaverite in the Portland mine, where rich pyritic ore was shattered and recemented by tellurides, quartz and fluorite (Loughlin and Koschmann, 1935; Eckel, 1997).

Hornblende (undivided) *(RA)*
Hornblende is a rock-forming mineral that occurs as an inconspicuous component of phonolite. It also occurs in tephriphonolite dikes and stocks, in plagioclase phonolite, and in vogesite (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985).

Hübnerite $MnWO_4$ *(OV)*
Lindgren and Ransome (1906) reported an occurrence of hübnerite in the Puzzle vein, where it formed radial, dark brown to dark green aggregates of striated prisms in a small vein associated with sphalerite and galena and intergrown with quartz. The Carbonate Hill breccia pipe also contains minor amounts of hübnerite, which in extremely rare cases has been observed coated with native gold.

Hyalophane $(K,Ba)Al(Si,Al)_3O_8$ *(RA)*
Hyalophane occurs as oscillatory zoned phenocrysts and rims on sanidine and anorthoclase phenocrysts in plagioclase phonolite (Birmingham, 1987).

Ilsemannite (?) $Mo_3O_8 \cdot nH_2O$ *(SO)*
Ilsemannite was reported as dark blue, mammillary, water-soluble crusts associated with comb quartz, molybdenite, sphalerite, galena and ferrous sulfate; it formed by oxidation of molybdenite in a vein in the Ophelia tunnel (Eckel, 1997).

Jarosite $K_2Fe_6(SO_4)_4(OH)_{12}$ *(SO)*
Jarosite occurs as orange-brown, shiny crystals filling small quartz druses and as pseudomorphs after cubic pyrite crystals in oxidized breccia, sometimes associated with white barite. It also formed by alteration of early stage vein minerals and other alteration products by oxygenated water at the Gold Hill mine (Hildebrand and Gott, 1974; Thompson *et al.*, 1985).

Kaersutite $NaCa_2(Mg,Fe)_4Ti(Si_6Al_2)O_{22}(OH)_2$ *(RA)*
Kaersutite occurs as reddish-brown, 1 to 2-mm crystals in the groundmass of plagioclase phonolite, tephriphonolite, and, rarely, vogesite (Birmingham, 1987).

Kaolinite $Al_2Si_2O_5(OH)_4$ *(AH; SO)*
Kaolinite forms by weathering and alteration of feldspars in Proterozic rocks and by hydrothermal alteration in the hydrothermal breccias and volcanics (Lindgren and Ransome, 1906; Thompson, 1992).

Krennerite $(Au,Ag)Te_2$ *(OV)*
Krennerite occurs in the vein deposits as small, vertically striated silver-white to pale brass-yellow prisms that commonly have been misidentified as sylvanite or calaverite. It may be intimately intergrown with calaverite (in parallel growth) and embedded in celestine or a "kaolin-like" material on pyritic quartz gangue (Lindgren and Ransome, 1906; Chester, 1898; Loughlin and Koschmann, 1935; Eckel, 1997).

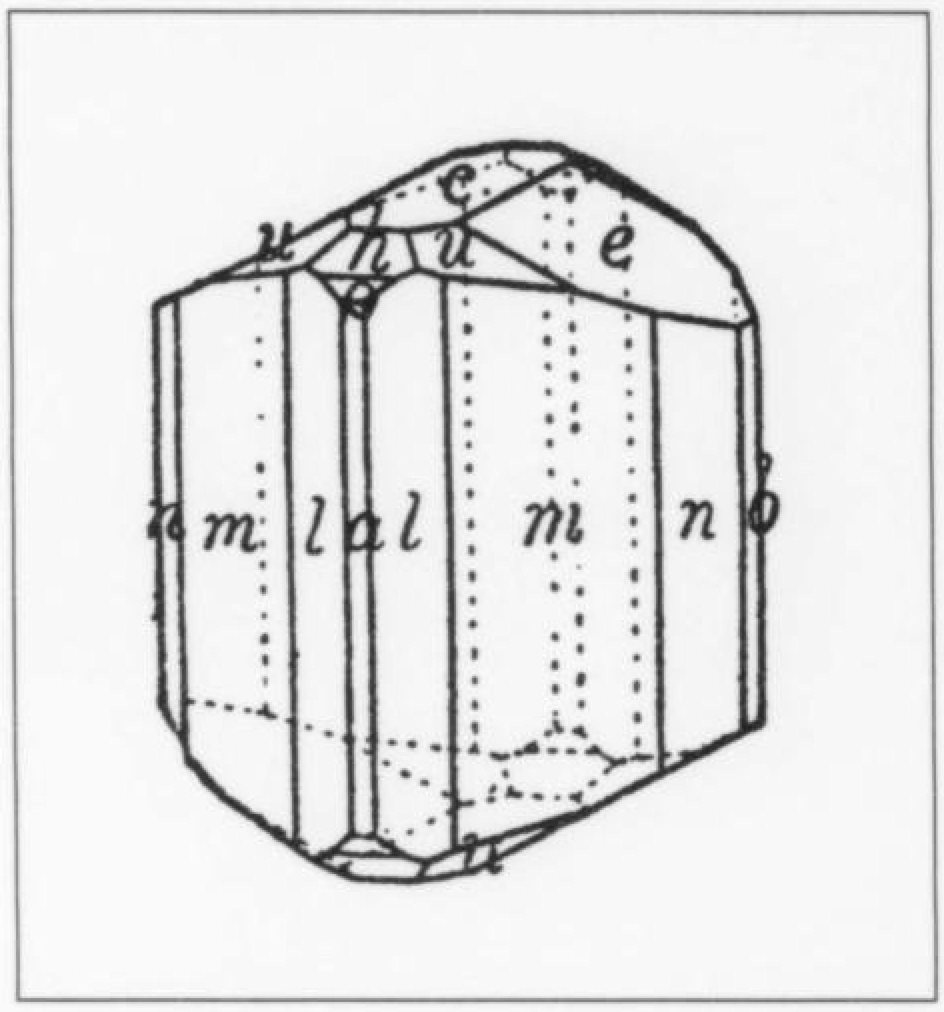


Figure 41. **Krennerite crystal from Cripple Creek. From Penfield and Chester (1898), as illustrated in Goldschmidt (1918).**

Låvenite (?) $(Na,Ca)_2(Mn,Fe)(Zr,Ti)Si_2O_7(O,OH,F)_2$ *(RA)*
Låvenite has been reported as an accessory constituent of phonolite "near Cripple Creek," as minute, colorless or pale yellow needles either isolated or as groups of loose crystals. It was not found in the extensive work by Birmingham (1987) (Eckel, 1997).

Magnesiochromite $MgCr_2O_4$ *(RA)*
Birmingham (1987) reported the occurrence of magnesiochromite as dark brown inclusions in olivine in monchiquite, phonotephrite and tephriphonolite.

Magnetite $Fe^{2+}Fe^{3+}_2O_4$ *(AH; RA)*
Magnetite is an accessory mineral in lamprophyre, tephriphonolite, phonolite and plagioclase phonolite and in Proterozoic gneiss and granite. It also occurs as a minor component of wall-rock alteration of mafic rocks, and replacing biotite in the outer zone of alteration associated with vein deposits (Lindgren and Ransome, 1906; Thompson *et al.*, 1985; Thompson, 1992).

Mallardite $MnSO_4 \cdot 7H_2O$ *(SO)*
Mallardite was reported as efflorescences in the Moon Anchor mine (Lindgren and Ransome, 1906).

Manjiroite $(Na,K)(Mn^{4+},Mn^{2+})_8O_{16} \cdot nH_2O$ *(SO)*
Manjiroite formed by weathering by oxygenated water at the Globe Hill mine (Thompson, *et al.*, 1985).

Marcasite FeS_2 *(GV; GD; SS)*
Marcasite was an early-stage component of vein and diatreme-hosted deposits such as the Cresson and Ajax deposits. It was

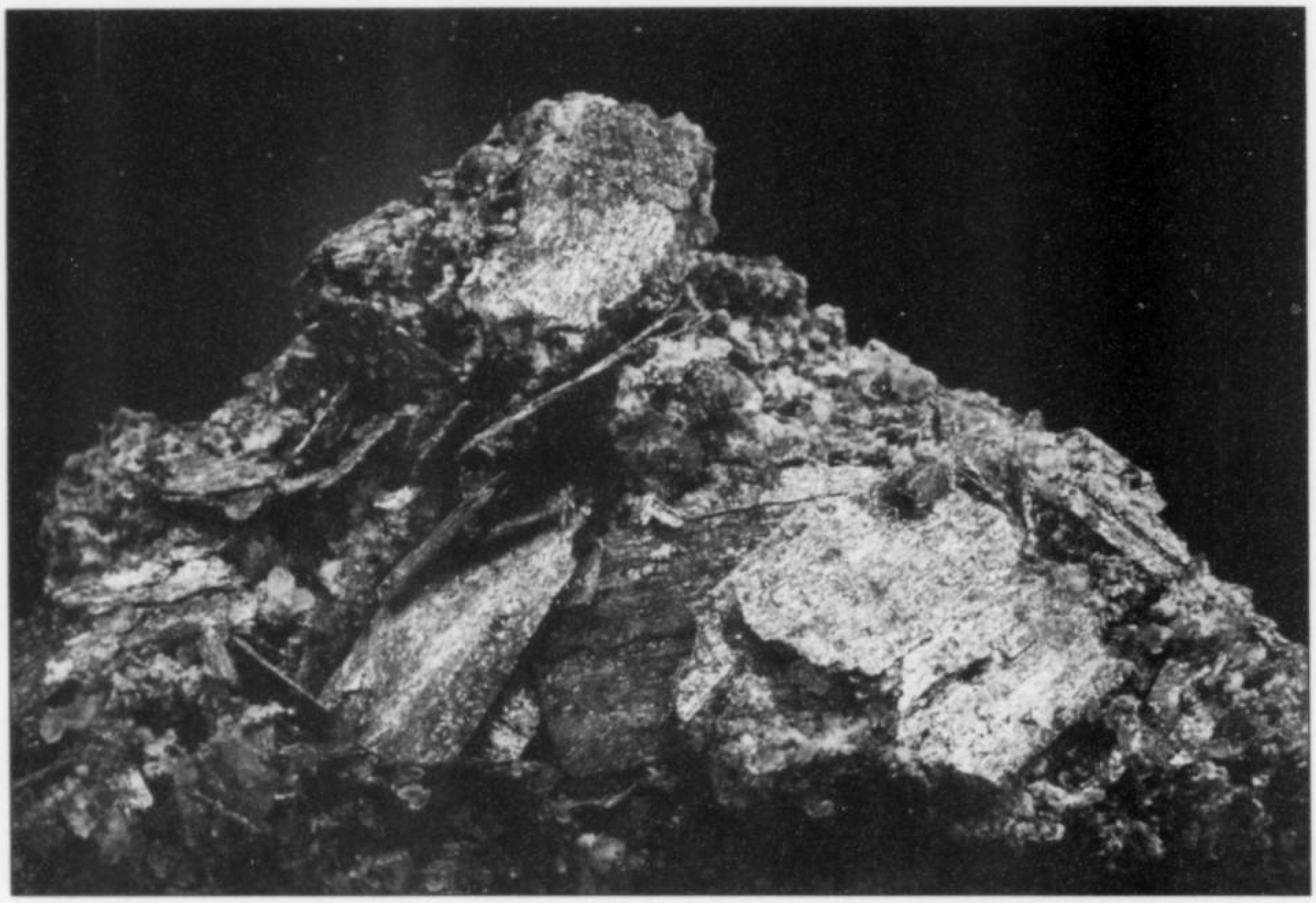


Figure 42. **Melonite in platy pseudomorphs to 1.6 cm after calaverite, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

doubtfully identified as crusts in dolomite at Stratton's Independence mine. It also occurs as a supergene mineral formed by reduction of dissolved iron sulfates (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al*., 1985; Saunders, 1988; Thompson, 1992; Eckel, 1997).

Melilite $(Ca,Na)_2(Al,Mg)(Si,Al)_2O_7$ *(RA)*

Melilite was reported from a "basalt" (lamprophyre) dike by Loughlin and Koschmann (1935).

Melonite $NiTe_2$ *(OV)*

Melonite was found on the 2100, 2200 and 2300 levels of the Cresson mine, where it occurred as probable pseudomorphs after calaverite. The melonite forms oriented overgrowths on calaverite, which is partly replaced by melonite and native gold (Saunders, 1988; Eckel, 1997).

Mercury Hg *(OV)*

Native mercury has been reported in small amounts associated with cinnabar and coloradoite at the Moon Anchor mine (Lindgren and Ransome, 1906; Eckel, 1997).

Mirabilite $Na_2SO_4 \cdot 10H_2O$ *(SO)*

Mirabilite was reported as delicate efflorescences in old drifts in the oxidized zone in the Anaconda-Raven tunnel and the Last Dollar mine (Lindgren and Ransome, 1906).

Molybdenite MoS_2 *(OV)*

Molybdenite was common in vein deposits, where it formed soft, lead-gray scales and small masses, often intergrown with pyrite and sphalerite, at all depths below the oxidized zone (Lindgren and Ransome, 1906).

Montmorillonite $(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$ *(AH; AD; AV)*

Montmorillonite is a common hydrothermal alteration mineral, replacing plagioclase in wall rocks associated with veins and in both the matrix and fragments in hydrothermal breccias (Thompson *et al*., 1985; Thompson, 1992).

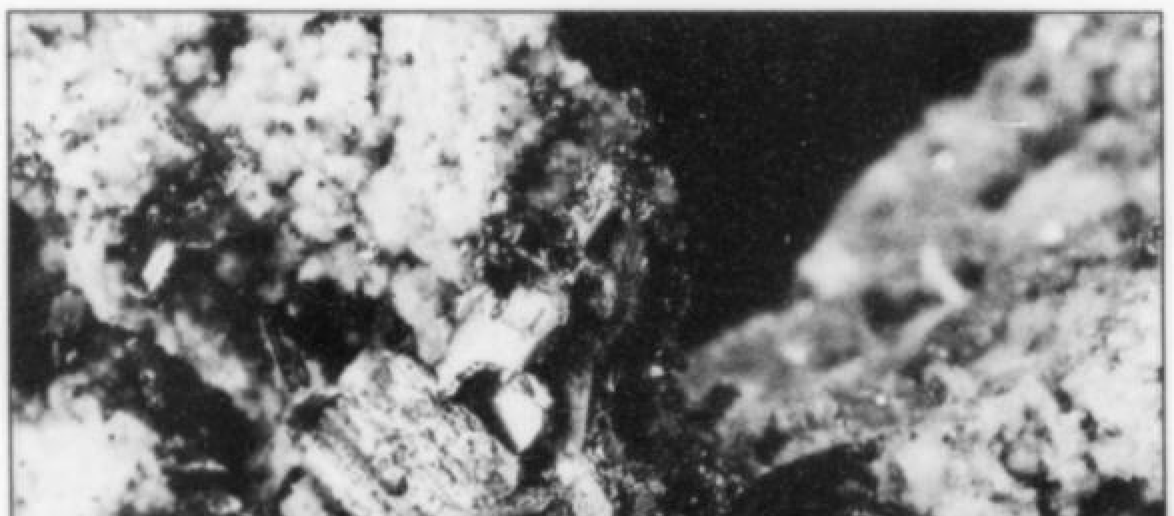


Figure 43. **Melonite replacing calaverite, Cripple Creek district. Field is 2.4 cm across. Carnein collection. Scovil photograph.**

Muscovite $KAl_2(Si_3Al)O_{10}(OH,F)_2$ *(RA; AH)*

Muscovite occurs as a primary component of the Cripple Creek "granite" and Proterozoic schist. It is common as an alteration product ("sericite"), replacing nepheline in phonolite and replacing plagioclase and biotite in various volcanic rocks and breccias of the district (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Thompson, 1992).

Nagyagite $Pb_5Au(Sb,Bi)Te_2S_6$ *(OV)*

Nagyagite coated by altaite is reported to form zones around sylvanite crystals (Stumpfl, 1970, Eckel, 1997).

Natrolite $Na_2Al_2Si_3O_{10}\cdot 2H_2O$ *(AH)*

Natrolite was reported as an occasional constituent of altered phonolitic rocks (Lindgren and Ransome, 1906).

Nepheline $(Na,K)AlSiO_4$ *(RA)*

Nepheline is abundant as hexagonal prisms from microscopic size to 2 mm, some red, many partly altered to stilbite and other zeolites, and sometimes enclosed in analcime in phonolite (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Eckel, 1997).

Nontronite $Na_{0.3}Fe_2(Si,Al)_4O_{10}(OH)_2\cdot nH_2O$ *(SO)*

Nontronite occurs as soft, light yellow to greenish aggregates formed, in part, from iron derived from oxidation of pyrite near the surface and redeposited below. It has been reported from the Ida May and El Paso mines (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Lane, 1976; Eckel, 1997).

Nosean $Na_8Al_6Si_6O_{24}(SO_4)\cdot H_2O$ *(RA)*

Nosean is a common constituent of rocks of the district, including phonolite, plagioclase phonolite, and tephriphonolite. One of the first minerals to form, it occurs as well formed, pale blue to green, 0.1 to 2-mm, dodecahedral crystals with inclusions arranged in two or more series, more abundant near the peripheries of the crystals (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Eckel, 1997).

Opal $SiO_2\cdot nH_2O$ *(GV)*

In the Zenobia mine, opal was locally an abundant last-phase primary vein mineral reported in vugs to great depth, as yellow masses of tangled wires and rods and as hyalite (Lindgren and Ransome, 1906).

Orthoclase $KAlSi_3O_8$ *(RE; GV; GD; AH)*

Orthoclase occurs with microcline in Proterozoic rocks of the district, as phenocrysts in plagioclase phonolite, as a major constituent of tephriphonolite and vogesite, as a part of the groundmass in monchiquite and as transparent to translucent crystals ("adularia") in both the veins and the inner and outer parts of altered host rocks (replacing biotite and microcline) of vein and diatreme-hosted deposits. "Adularia" was one of the first minerals deposited by hydrothermal activity in the district, sometimes occurring as dense masses intergrown with quartz (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Eckel, 1997).

Pargasite $NaCa_2(Mg,Fe)_4Al(Si_6Al_2)O_{22}(OH)_2$ *(RA)*

Pargasite is very common as brown to olive-green microphenocrysts in vogesite, as tan megacrysts in monchiquite, and in tephriphonolite and plagioclase phonolite (Birmingham, 1987).

Pentahydrite $MgSO_4\cdot 5H_2O$ *(SO)*

Pentahydrite was reported with epsomite in one analysis and with alunogen in another (Hobbs, 1905; Palache *et al.*, 1951; Eckel, 1997).

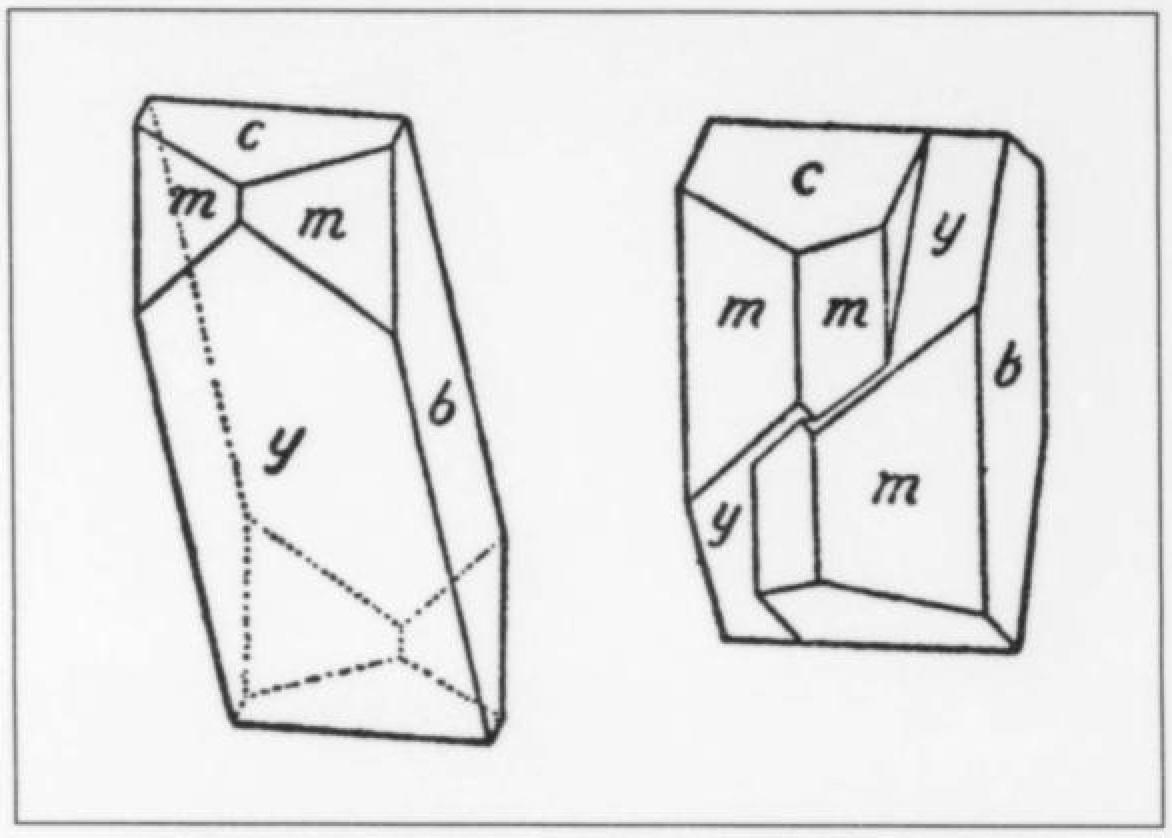


Figure 44. **Orthoclase crystals from Cripple Creek. From Warren (1901) as illustrated in Goldschmidt (1916).**

Petzite Ag_3AuTe_2 *(OV)*

Petzite is uncommon at Cripple Creek. It has been reported from the Gold King mine and, in small amounts, elsewhere in the district (Lindgren and Ransome, 1906; Geller, 1993).

Phlogopite $KMg_3Si_3AlO_{10}(F,OH)_2$ *(RA)*

Phlogopite occurs as phenocrysts and as a constituent of the groundmass in vogesite and monchiquite (Birmingham, 1987; Thompson, 1992).

Plagioclase (undivided) *(RE)*

Plagioclase ranging in composition from albite to oligoclase occurs in plagioclase phonolite, phonotephrite, and tephriphonolite and in Proterozoic rocks. In vogesite its composition ranges from andesine to bytownite, and minor albite occurs in the groundmass of monchiquite (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson, 1992).

Planerite (?) $Al_6(PO_4)_2(PO_3OH)_2(OH)_8\cdot 4H_2O$ *(SO)*

Pale blue 5 mm to 1 cm-thick veinlets in altered granitic rocks are probably planerite (C. E. Raines collection, reported in Eckel, 1997).

Psilomelane; Wad (mixed Mn oxides) *(SO)*

Both hard, massive and soft, "sooty" unidentified manganese oxides were common as stains and fracture fillings, sometimes as irregular masses or nodules, in the Pharmacist and Summit mines (Lindgren and Ransome, 1906).

Pyrite FeS_2 *(GV; GD; SS; AH)*

Pyrite is the most common sulfide in the district, forming in most stages of vein formation and alteration. Pyrite occurs as subhedral cubic or pyritohedral crystals rarely larger than 1.5 cm, as masses and, rarely, as reniform coatings of radial, fibrous crystals on quartz. It occurs in veins (with most other vein minerals), in disseminated deposits (intergrown with native gold), and in altered rocks associated with both. In some cases it replaces original dark-colored mineral fragments (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Thompson, 1992).

Pyroxene Group (undivided) *(RA; RE)*

Pyroxene, commonly not specifically identified, is an important constituent of many of the rocks of the district. Aegirine and aegirine-augite occur as phenocrysts and groundmass in plagioclase phonolite and tephriphonolite; augite in phonotephrite,

Figure 45. **Pyrite crystal with quartz, 3.2 cm, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

monchiquite, and vogesite; and aegirine, aegirine-augite, and salite as acicular bundles to blunt crystals, some wrapping around nepheline or included in analcime, in phonolite (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Birmingham, 1987).

Pyrrhotite $Fe_{1-x}S$ *(GV; GD)*

Pyrrhotite occurs as an early-stage mineral of veins and hydrothermal breccias and as a late-stage mineral in the matrix of hydrothermal breccias (Thompson *et al.*, 1985).

Quartz SiO_2 *(RE; GV; GD; AH; AV)*

Quartz is a major constituent of the Proterozoic granites, gneisses, and schists, a component of sediments buried in the basin, a principal vein mineral, and a component of hydrothermal breccias, intrusive breccias, and altered rocks associated with hydrothermal activity. In the veins, it occurs as crusts, combs, and granular masses, as colorless to somewhat smoky druses, as replacements of celestine, dolomite and calcite, as coatings concealing the tellurides and as late-stage yellow druses and droplets of chalcedony that coat earlier quartz and most other vein minerals. It frequently occurs intergrown with calaverite. Excellent amethyst crystals, in doubly terminated groups to 12.5 cm and clusters up to 15 cm across, were reported from the district as early as 1901 and can be found in many museum collections. However, the exact mine in which they were found remains unknown. The amethyst crystals are characterized by transparent, pale purple rhombohedron faces,

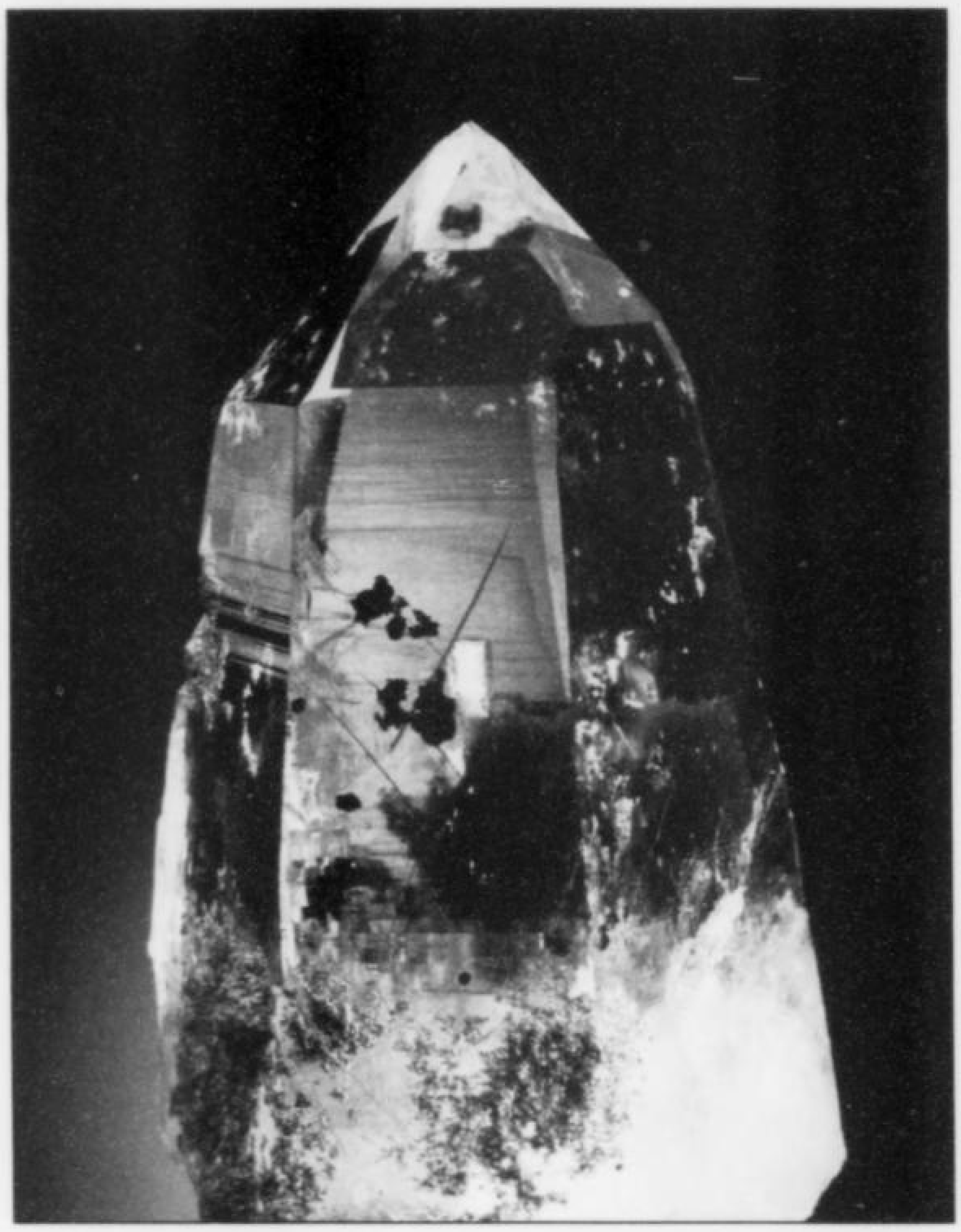


Figure 46. **Quartz crystal, 3.7 cm, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Figure 47. **Chalcedonic quartz, 2.5 cm, from the Jackpot mine, Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Figure 48. **Amethystine quartz crystal cluster, 14.5 cm, from Cripple Creek. Colorado School of Mines collection no. TM-12267; Jeff Scovil photo.**

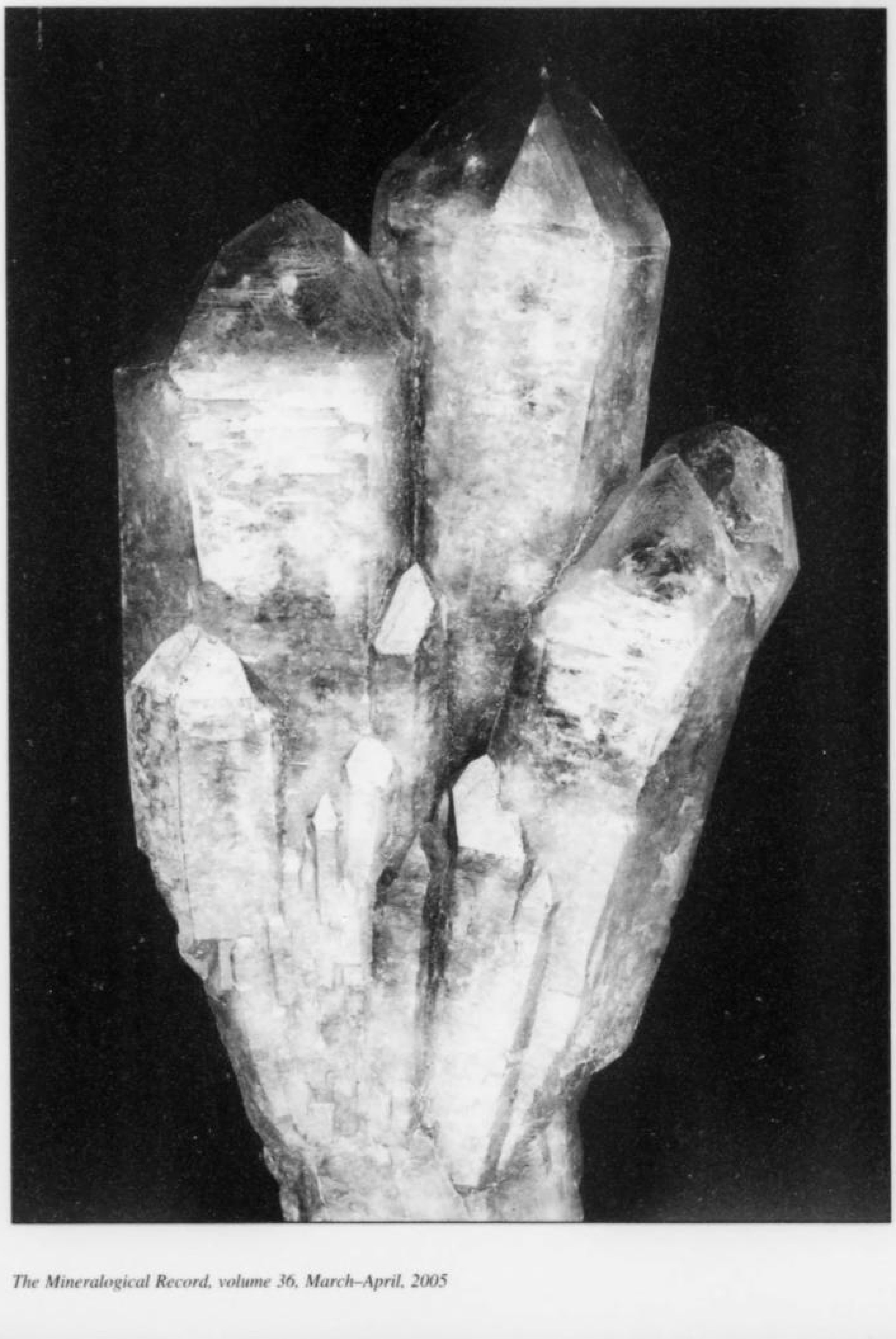


Figure 49. **Amethyst crystals, 10.6 cm high, from the Cripple Creek district, Teller County, Colorado. Carnein collection. Scovil photograph.**

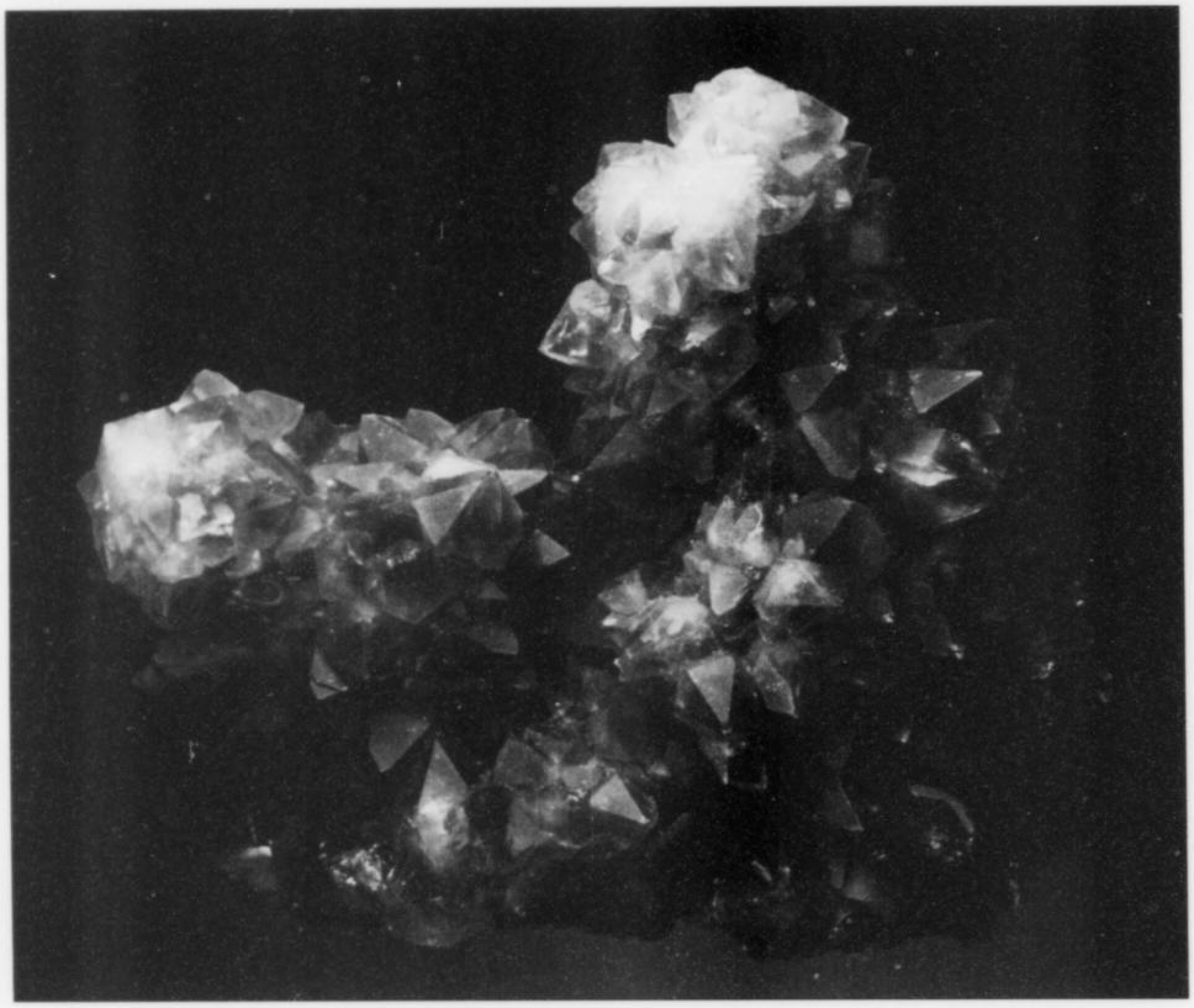


Figure 50. Quartz crystal cluster, 7.6 cm, from the Jackpot mine, Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.

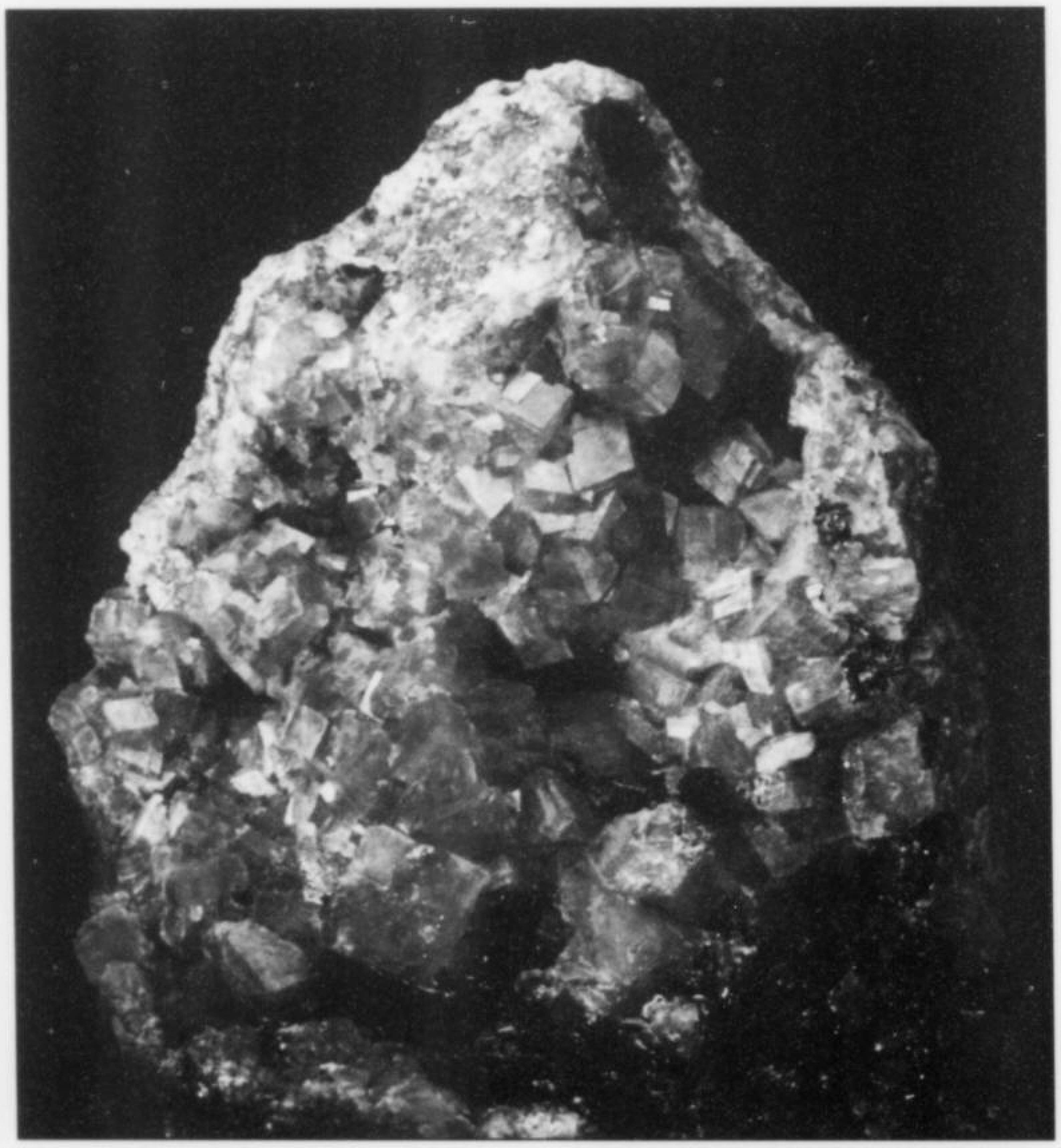


Figure 51. Rhodochrosite crystal cluster on matrix, 7 cm, from Cripple Creek. Thomas Hughes collection; Jeff Scovil photo.

some with purple phantoms, and elongated gray to pale lavendar striated prism faces. Divergent groups are typical. In the Bluebird mine, drusy quartz casts of large orthorhombic crystals (possibly barite) have been reported (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson, 1992; Eckel, 1997).

Rhodochrosite $MnCO_3$ *(GV)*

Rhodochrosite is relatively rare, as pink rhombic crystals with fluorite, pyrite, galena and sphalerite in veins at the Moon Anchor, Fluorine, and Pointer mines (Lindgren and Ransome, 1906). In 2001, it was found in small amounts at the Cresson open-pit mine as bright, pinkish orange botryoidal crusts coated by celestine, creedite and gearksutite.

Roscoelite $K(V,Al,Mg)_2(AlSi_3)O_{10}(OH)_2$ *(GV; AH)*

Roscoelite occurs mostly as a product of wall-rock alteration, replacing plagioclase and biotite in the inner alteration zone of veins (e.g. Ajax mine). It occurs as small, soft, drusy masses or green colorings on the edges of veins or in inclusions. At the Mary McKinney mine, massive roscoelite occurred with quartz, fluorite and calaverite. Roscoelite and celestine were considered to be good ore indicators at the Cresson mine (Loughlin, 1927; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985; Thompson, 1992; Eckel, 1997).

Rutile TiO_2 *(GV; RA; AH)*

Rutile occurs as a middle to late-stage vein mineral, a minor accessory in the Cripple Creek "granite," and as microcrystals formed by alteration of titanite in plagioclase phonolite (Lindgren and Ransome, 1906; Thompson *et al.*, 1985; Thompson, 1992).

Sanidine $(K,Na)AlSi_3O_8$ *(RE)*

Sanidine is a major constituent of various volcanic units, occurring as phenocrysts in phonolite and tephriphonolite (Birmingham, 1987; Thompson, 1992).

Serpentine (undivided) *(AH)*

Serpentine is a product of wall-rock alteration replacing olivine in mafic rocks of the district (e.g. monchiquite) and in altered plagioclase phonolite (Lindgren and Ransome, 1906; Thompson, 1992).

Sillimanite Al_2SiO_5 *(RA)*

Sillimanite is abundant in Proterozoic gneiss near Cameron and in schist (Lindgren and Ransome, 1906).

Sodalite $Na_8Al_6Si_6O_{24}Cl_2$ *(RE or RA)*

Sodalite is common as small (0.001 to 2-mm) dodecahedral crystals with transparent borders and dull brown interiors in phonolite, plagioclase phonolite and tephriphonolite (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Eckel, 1997).

Sonoraite $FeTeO_3(OH)\cdot H_2O$ *(SO)*

Sonoraite is very rare as platy, vitreous, yellow-green crystals less than 1 mm in size, with native gold on gossan at the Hoosier mine (Eckel, 1997).

Sphalerite $(Zn,Fe)S$ *(OV; OD)*

The second commonest sulfide at Cripple Creek, sphalerite occurred in veins as small reddish brown masses intergrown with pyrite, galena and fluorite at all depths below the oxidized zone.

It was an early-stage mineral in the veins and early to middle-stage in disseminated deposits and breccias (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985).

Stibiconite $SbSb_2O_6(OH)$ *(SO)*

Stibiconite occurred as a yellow-brown alteration product of stibnite from the Independence mine (Eckel, 1997).

Stibnite Sb_2S_3 *(OV)*

Although uncommon in collections, stibnite was locally abundant as bunches of striated crystals weighing up to 50 pounds (at the C.K. & N. mine); this stibnite is frequently rich in gold because of admixed calaverite. Stibnite also occurs with "gray copper" (tetrahedrite), chalcedony and fluorite. Locally, quartz coated stibnite that subsequently dissolved, leaving hollow quartz casts called "splinters." Stibnite alters to stibiconite (Bancroft, 1903; Lindgren and Ransome, 1906; Saunders, 1988).

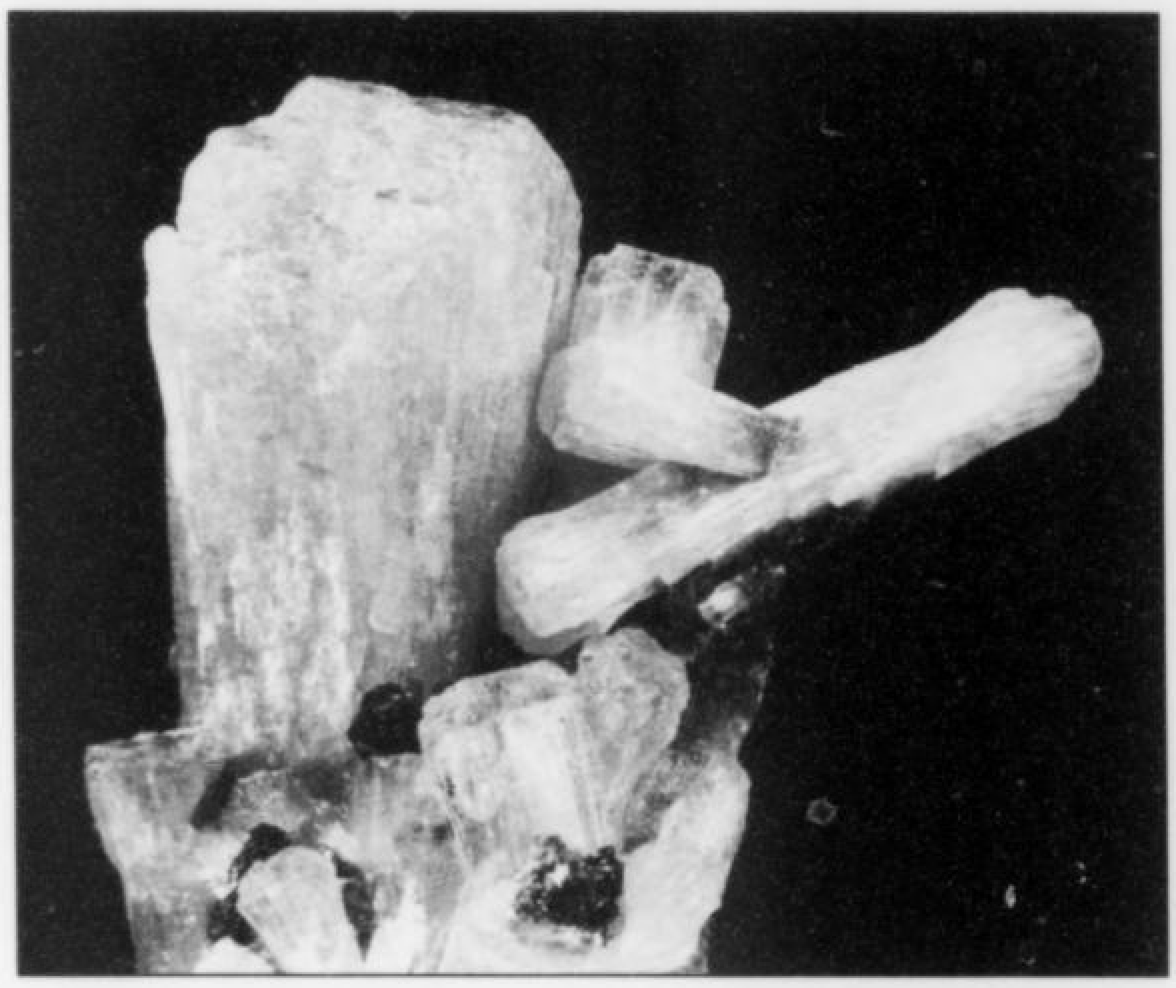


***Figure 52.* Stilbite crystal cluster, 1.9 cm, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Stilbite $NaCa_2Al_5Si_{13}O_{36}\cdot 14H_2O$ *(AH)*

Stilbite is reported as an alteration product of analcime (Lindgren and Ransome, 1906) or nepheline (Eckel, 1997) in vogesite dikes.

Strengite $FePO_4\cdot 2H_2O$ *(SO)*

Strengite was reported from the John A. Logan mine, where it occurred in two generations in thin limonitic fractures in a gray, partly oxidized orthoclase-quartz-pyrite rock. The first generation consists of spherules of radiating white to colorless concentrically zoned crystals. The second occurs as crusts and spherules of shiny gray crystals to 0.03 mm. Strengite is associated with cacoxenite and a member of the rockbridgeite family (Eckel, 1997).

Sylvanite $(Au,Ag)_2Te_4$ *(OV)*

Sylvanite is a middle-stage mineral of vein deposits, occurring with calaverite and krennerite. It is found as brilliant, steel gray to silver-white (sometimes yellowish) simple prismatic or bladed crystals, contact twins and penetration twins that result in arborescent or reticulated aggregates on fracture surfaces. Some authors (Tunnell, 1954) report that most material identified as sylvanite is really krennerite, but other workers have found the opposite to be true (D. Bunk, personal communication). Reported from the Anchoria-Leland, Blue Bird, Elkton, Independence, Little May, Mabel M, Moon Anchor, Portland, and Victor mines, among others (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Tunnell, 1954).

Talc $Mg_3Si_4O_{10}(OH)_2$ *(AH)*

Talc is a minor product of wall-rock alteration of mafic rocks (presumably olivine). It is also reported from the Lady Stith claim, associated with kaolinite, gypsum, fluorite, and tyuyamunite (Nelson-Moore *et al.*, 1978; Thompson, 1992).

Figure 53. **Sylvanite crystals on quartz, 5.9-cm view, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

Figure 54. **Sylvanite crystals partially coated by quartz, 2.5 cm, from Cripple Creek. Dave Bunk specimen; Jeff Scovil photo.**

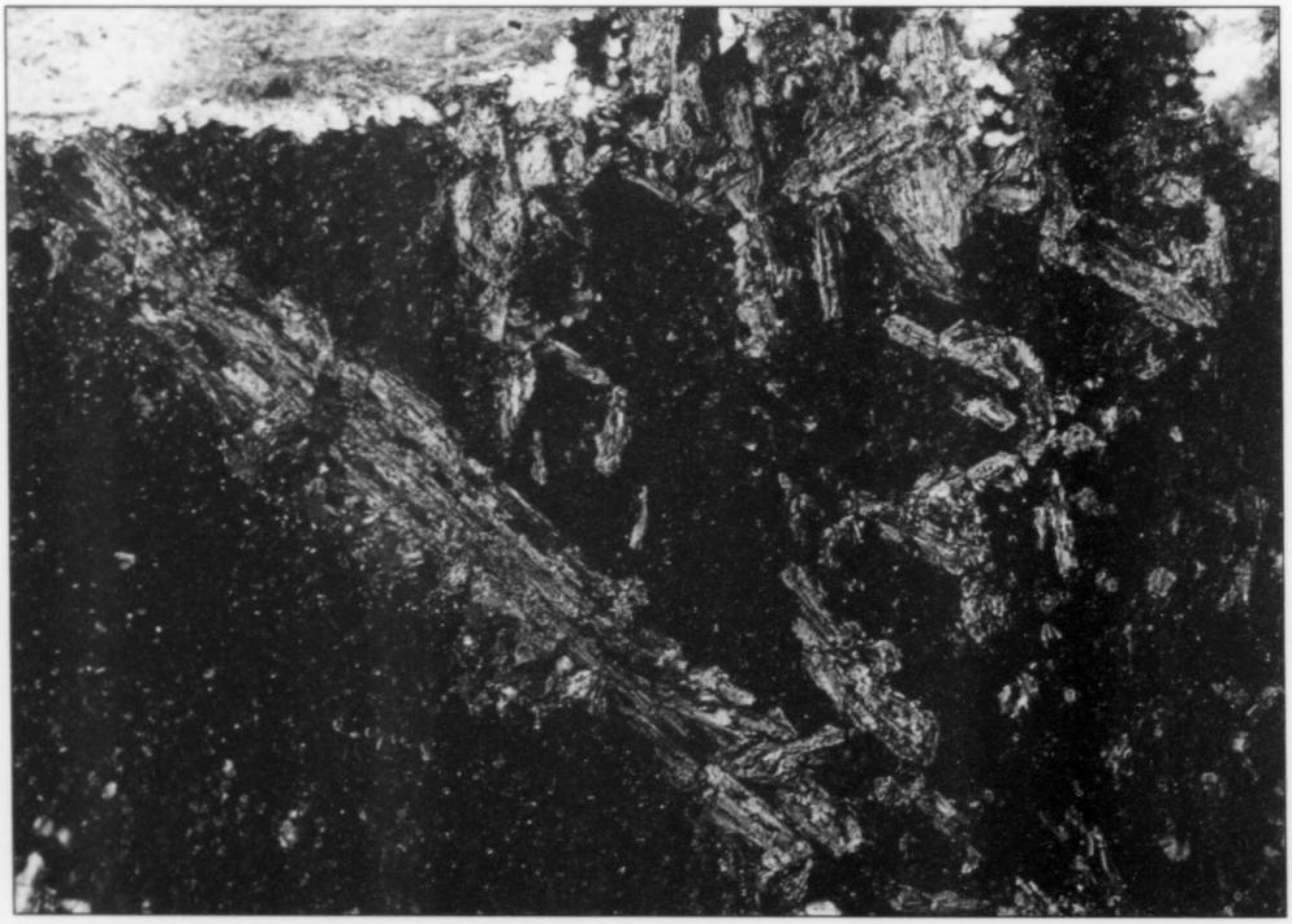


Figure 55. **Gold pseudomorphs after sylvanite, 4.5 cm, from Cripple Creek. Colorado School of Mines collection no. 1730; Jeff Scovil photo.**

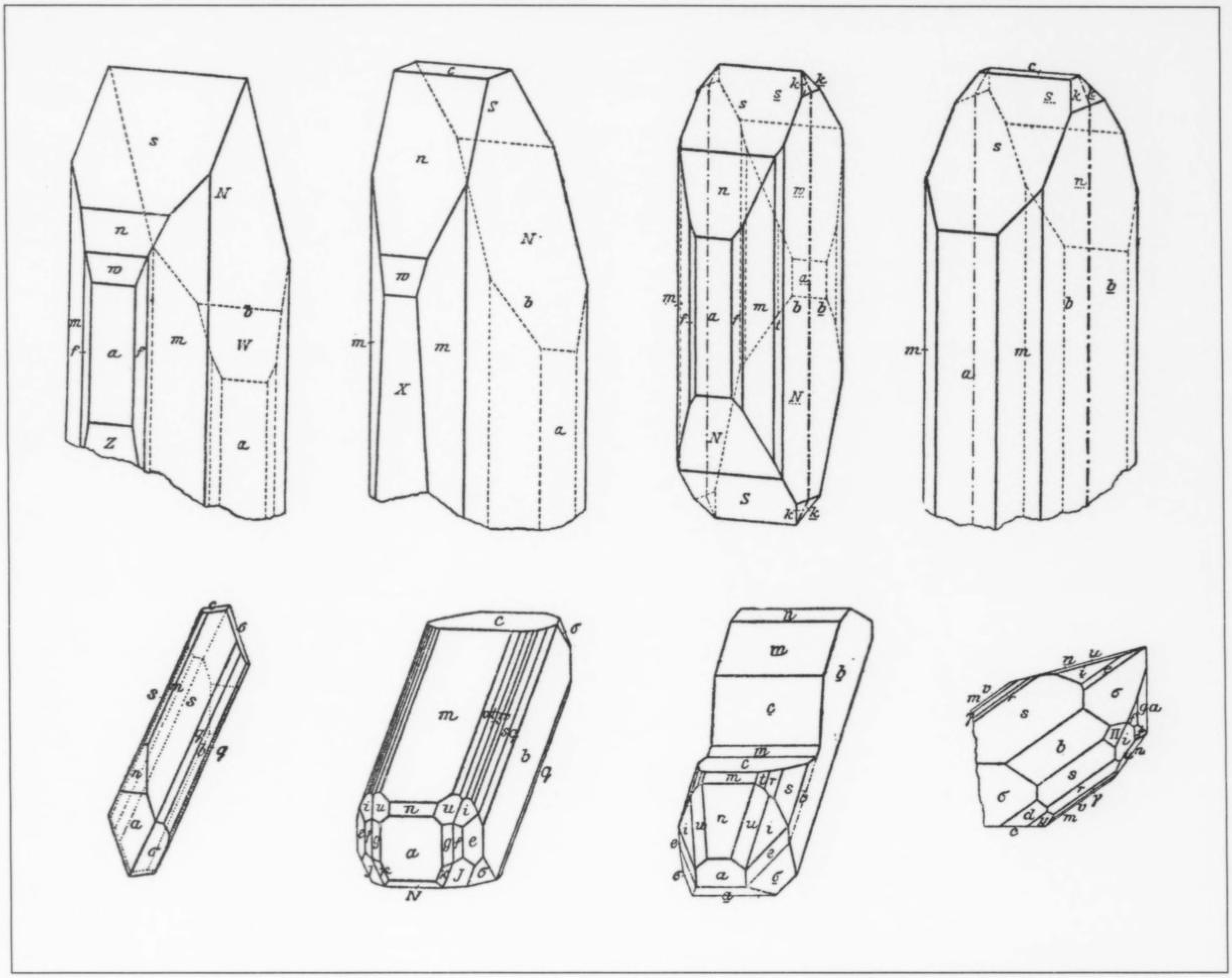


Figure 56. **Sylvanite crystals from Cripple Creek. From Hobbs (1899) and Palache (1900), as illustrated in Goldschmidt (1922).**

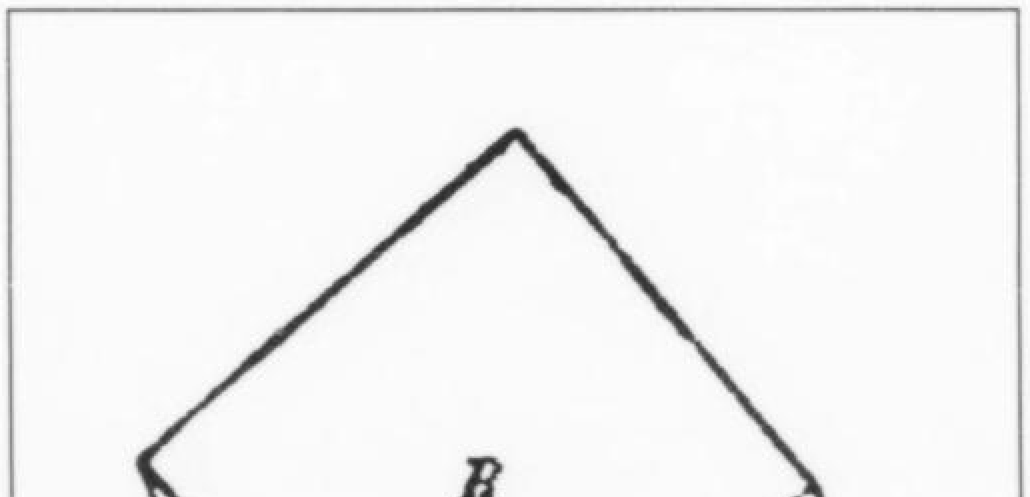


Figure 57. **Tellurite crystal from Cripple Creek. From Schaller (1905) as illustrated in Goldschmidt (1922).**

Tellurite TeO_2 *(SO)*

Tellurite occurs as slender, transparent soft white or yellowish white, prismatic to tabular crystals to 2 mm, many with vicinal faces, and as small spherical masses in the oxidized zone of the WPH, Gold Sovereign and Blue Bird mines. Occurs with emmonsite and native gold (Lindgren and Ransome, 1906; Eckel, 1997).

Tellurium Te *(OV)*

Native tellurium has been reported in crystals from vein deposits on Raven Hill (Lindgren and Ransome, 1906).

Tennantite $(Cu,Ag,Fe,Zn)_{12}As_4S_{13}$ *(OV)*

Tennantite occurred with tetrahedrite in vein deposits of the El Paso mine (Lane, 1976).

Tetrahedrite $(Cu,Fe,Ag,Zn)_{12}Sb_4S_{13}$ *(OV)*

Tetrahedrite is a locally conspicuous and very widespread early-stage vein mineral at Cripple Creek; dark steel-gray masses may also result from secondary sulfide enrichment. Tetrahedral crystals occurred at the Abe Lincoln and Doctor Jack-Pot mines. It always contains silver; the richest silver ore in the district is tetrahedrite-rich. Overgrowths show concentric zones successively enriched with zinc, silver and antimony (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Geller, 1993).

Figure 58. **Cripple Creek ca. 1900. The town eventually ate up most of the land and timber surrounding the original Fremont and Hayden Placer townsites. By 1900 the population was over 25,000, making Cripple Creek Colorado's second largest city after Denver. Carnein collection.**

Thalenite-(Y) $Y_3Si_3O_{10}(F,OH)$ *(RA)*

Birmingham (1987) reported uncommon thalenite-(Y) as very minute crystals in the groundmass of phonolite.

Titanite $CaTiSiO_5$ *(RA)*

Titanite occurs as small yellow crystals in plagioclase phonolite and as a minor accessory in phonolite, tephriphonolite, and Proterozoic rocks (Lindgren and Ransome, 1906; Loughlin and Koschmann, 1935; Thompson *et al.*, 1985).

Topaz $Al_2SiO_4(F,OH)_2$ *(RA)*

Birmingham (1987) reported an occurrence of topaz in syenitic fragments in hydrothermal breccia from Globe Hill (Thompson *et al.*, 1985; T. B. Thompson, personal communication, 2003).

Torbernite/Metatorbernite $Cu(UO_2)_2(PO_4)_2 \cdot 8H_2O$ *(SO)*

Torbernite occurred with autunite in an altered Tertiary plug on Rhyolite Mountain (Nelson-Moore *et al.*, 1978; Eckel, 1997).

Tourmaline Group (undivided) *(RA)*

Tourmaline is a minor accessory in Proterozoic rocks of the district (Lindgren and Ransome, 1906).

Turquoise $CuAl_6(PO_4)_4(OH)_8 \cdot 4H_2O$ *(SO)*

Turquoise has been found at scattered occurrences in the district, including Mt. Pisgah. On the south flank of Mineral Hill, two small cuts are now being intermittently worked for turquoise by Wally Burtis (Florence claim) and the Bad Boys of Cripple Creek Mining Company (Elkhorn claim, higher upslope), respectively. Both operations typically mine thin, irregular veinlets of turquoise, to 1 cm wide, which cut altered Precambrian granite (P. Modreski, 2004, personal communication). Specimens up to six pounds are known (Murphy and Modreski, 2002).

Rare visible gold intergrown with limonite has been reported to occur within the turquoise from the Elkhorn claim (Murphy and Modreski, 2002).

After a heavy rain, small chips and fragments of turquoise can be found in the streets of Cripple Creek; this turquoise is believed to have originated from Mineral Hill, some of whose old dumps were used as gravel road fill (P. Modreski, 2004, personal communication). Turquoise pseudomorphs after prismatic quartz or apatite crystals have been found at the O'Haver claim. Elsewhere, specimens of excellent color, containing pyrite inclusions, are reported (Eckel, 1997).

Tyuyamunite/Metatyuyamunite $Ca(UO_2)_2V_2O_8 \cdot 3H_2O$ *(SO)*

Tyuyamunite was reported from a shear zone associated with Tertiary intrusives at the Lady Stith claim, just east of Cripple Creek, where it occurred with fluorite, talc, kaolin and gypsum (Nelson-Moore *et al.*, 1978; Eckel, 1997).

Wavellite $Al_3(PO_4)_2(OH,F)_3 \cdot 5H_2O$ *(GV)*

Small, white, spherical, radial masses of wavellite occurred at the Raven and Bertha B mines. It was also reported as yellow microcrystalline clusters and tufts of radiating acicular crystals at the Moon Anchor mine, and at the May mine and elsewhere (Lindgren and Ransome, 1906; Eckel, 1997).

Zinkenite $Pb_9Sb_{22}S_{42}$ *(OV)*

Zinkenite occurred as microscopic, long, slender, hexagonal prisms in cavities at the Ramona mine, associated with krennerite (Eckel, 1997).

Zircon $ZrSiO_4$ *(RA; AH)*

Zircon occurs as an accessory species in Proterozoic rocks of the district and in phonolite and plagioclase phonolite. It is locally abundant in the Pikes Peak Granite (Lindgren and Ransome, 1906).

Zirkelite $(Ca,Th,Ce)Zr(Ti,Nb)_2O_7$ *(RA)*

Birmingham (1987) reported sparse, microscopic crystals of zirkelite in phonotephrite and tephriphonolite on the surface at the Vindicator mine.

ACKNOWLEDGMENTS

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Scientific accounts of the Cripple Creek area begin with F. V. Hayden's Territorial Survey of 1873 (Hayden, 1874). Important detailed studies didn't occur until the district's importance was finally recognized in 1891. These include Cross and Penrose (1894, 1895), Cross (1896), Lindgren and Ransome (1906), and Rickard (1900, 1903). As mining continued and knowledge expanded, U.S. Geological Survey scientists such as Loughlin (1927), Loughlin and Koschmann (1935), Koschmann (1949), and Lovering and Goddard (1950) provided updated information. More recently, as interest in the district has increased and mining has revived, studies have focused on the low-grade, near-surface deposits. Theses by Birmingham (1987), Burnett (1995), Dwelley (1984), Erikkson (1987), Kelley (1996), Nelson (1989), Saunders (1986), Seibel (1991), Trippel (1985), and Wood (1990), several of whom were students of T. B. Thompson at Colorado State University, have filled in many details of the origin of the deposit. Eckel and others (1997) provide a wealth of information on Cripple Creek mineral occurrences. Many other references treat the minerals of the district in passing or as a part of broader studies.

Cripple Creek history is the subject of hundreds of books, pamphlets, and articles. Sprague (1953), Lee (1958), and Waters (1937) provide readable accounts that range from general histories to biographies of important characters. Drake and Grimstad (1983) and Mazzulla and Mazzulla (1964) provide photographic histories of the district. A more recent summary is that written by MacKell (2003). These are a good starting point for the history buff. For those with a deeper interest, the resources of the Mining History Association and the Cripple Creek Historians and Collectors Club may be of interest. The latter has, since 2002, published a newsletter dealing with Cripple Creek history and artifacts. In addition, the Cripple Creek & Victor Gold Mining Company publishes a quarterly newsletter, *The Gold Connection*, that updates information about ongoing gold mining in the district. The Cripple Creek District Museum preserves extensive collections of historical items, including photographs, mining artifacts and mineral specimens.

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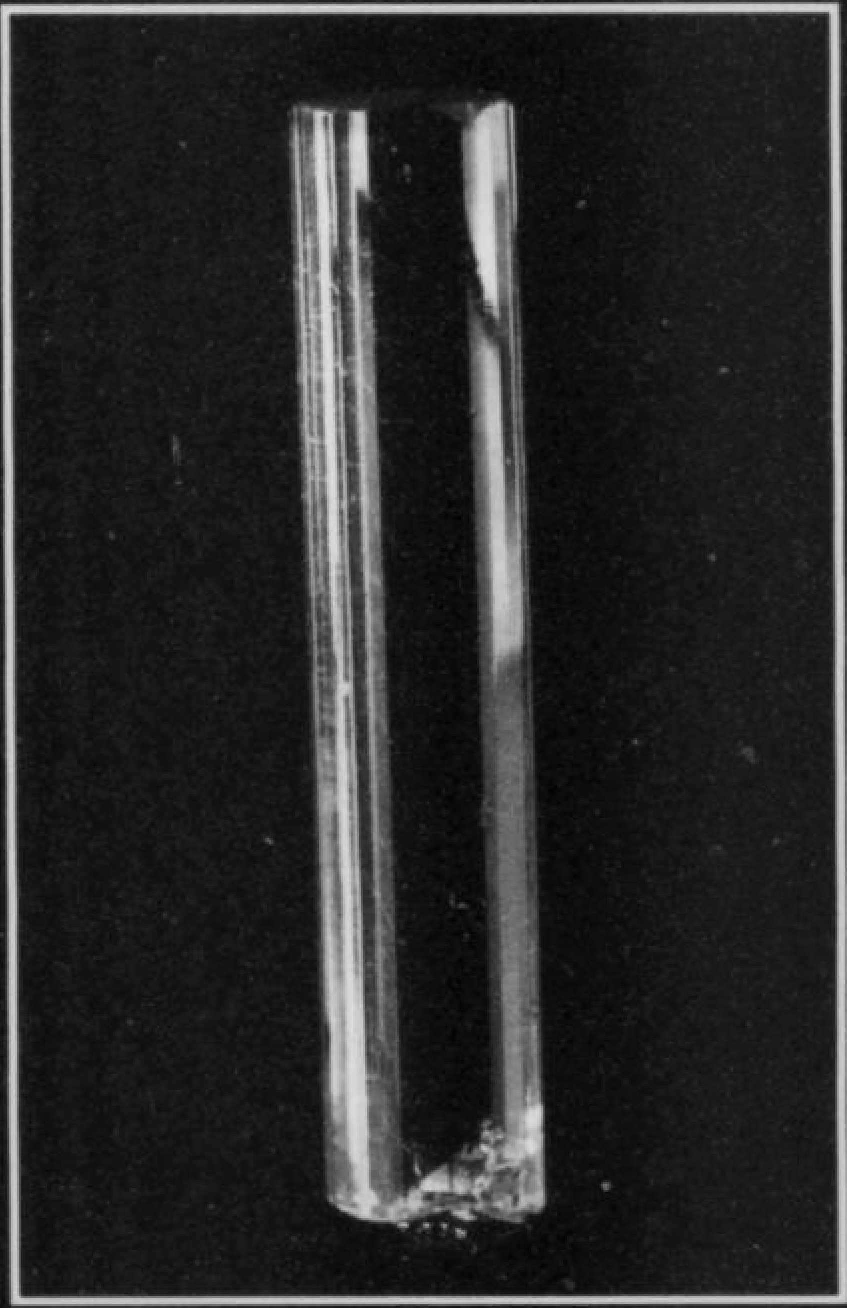

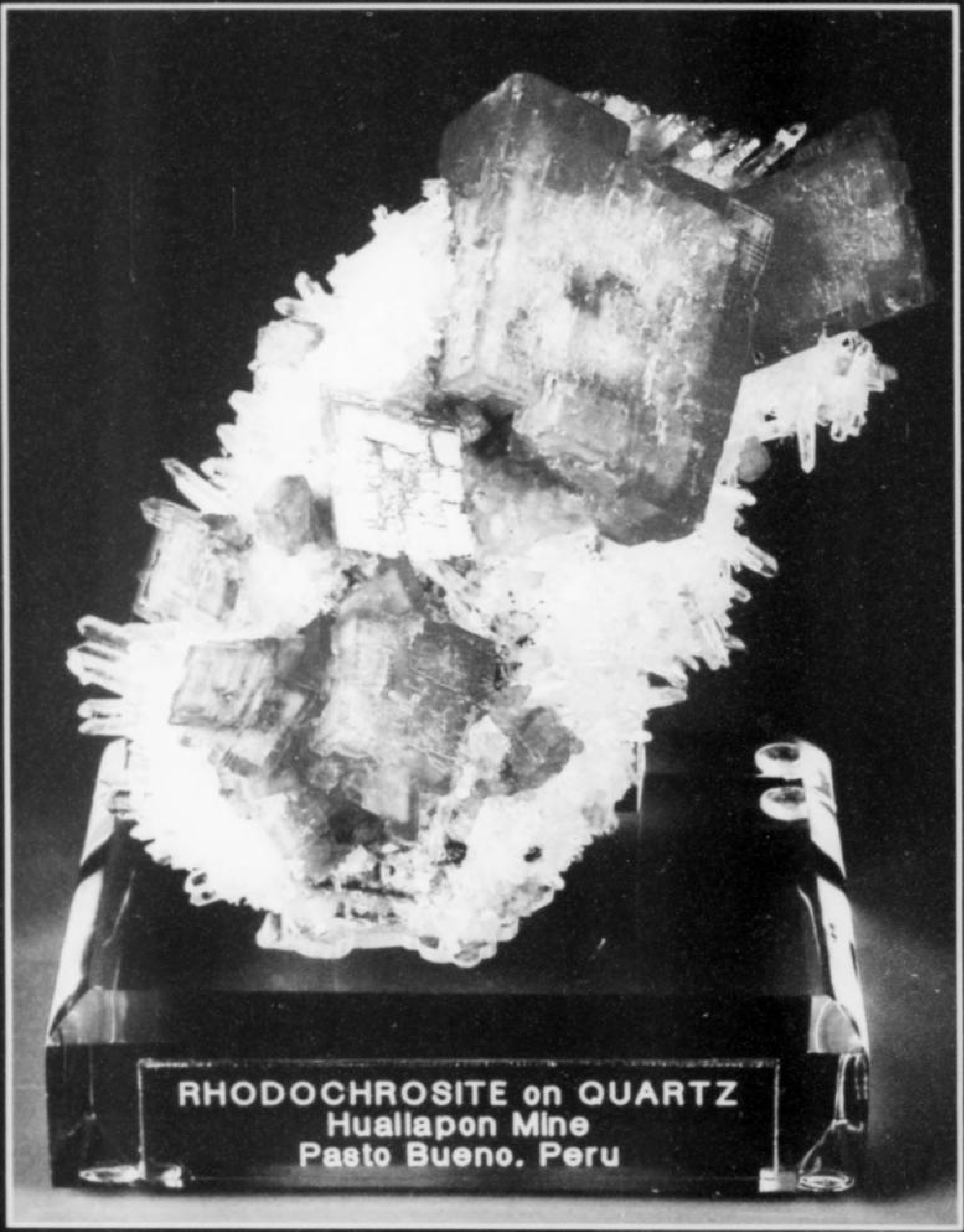

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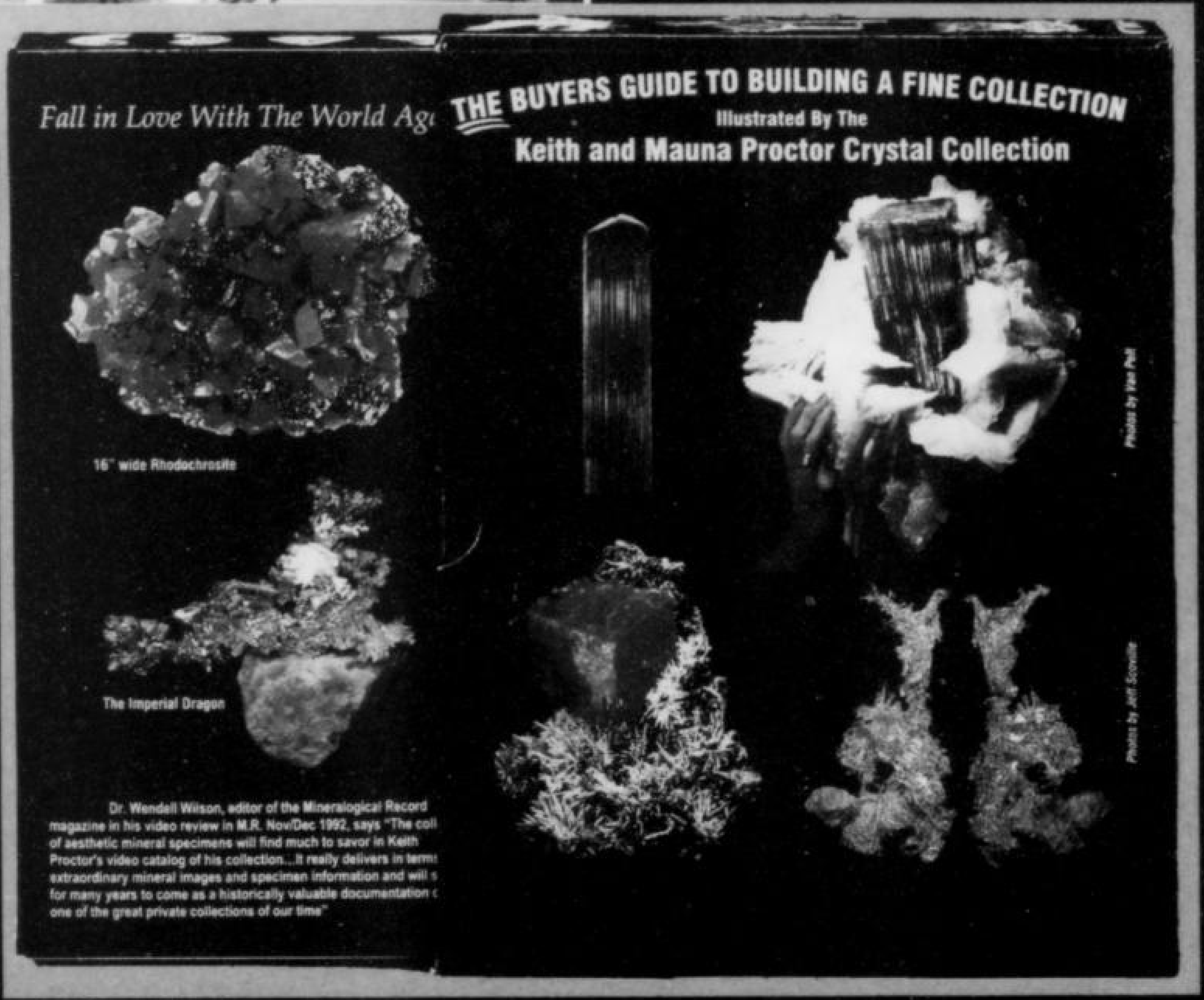

Fall in Love With The World Ag
THE BUYERS GUIDE TO BUILDING A FINE COLLECTION
Illustrated By The
Keith and Mauna Proctor Crystal Collection
16" wide Rhodochrosite
The Imperial Dragon
Photos by Van Pelt
Photos by Jeff Scovil

A Lucky Man:

JACK HALPERN

AND HIS COLORFUL COLLECTION

William F. Larson
912 South Live Oak Park Road
Fallbrook, California 92028

Jack Halpern's 43 years of experience as a collector of aesthetic mineral specimens has given him a feeling for connoisseurship and a deep appreciation for the joys of the hobby. His basement collection of over 3,000 fine specimens is overwhelming to first-time visitors and to returning admirers alike.

Those in the mineral-collecting hobby fortunate enough to know Jack Halpern would all agree on one thing: Jack is a gentleman. In our high-speed 21st Century world he is that rare man with gentility, warmth, manners, true kindness and a spirit of generosity. This was amply demonstrated in his guest editorial for the *Mineralogical Record* (1996). I remember reading his final paragraph: "In giving, one enjoys the satisfaction which stems from opening a child's awareness to an exciting world. By so doing, you may well broaden youthful lives. At the same time, you will enrich your own spirit with a glow, which comes from sharing. Give a crystal. Instill a passion. Spark a life!"

Born in 1920, Jack was raised in Brooklyn, New York. But, as he was not yet a mineral collector in those days, he never crossed paths with Jack Boyle, Neal Yedlin, Lou Perloff and the rest of that early group of Brooklyn mineral enthusiasts. He attended New York University and graduated with a degree in Accounting—a profession he was never to practice, because a few days later the Japanese bombed Pearl Harbor. Jack enlisted in the Navy as a seaman second class and was sent for six months to a radar school that had been set up on Treasure Island in San Francisco Bay. It was in that beautiful city that he met his future wife, Leslie, and when he was later transferred to the MIT Naval Training Center in Boston as an instructor in radar navigation (the LORAN system) she traveled to join him and they were married. Jack ultimately left the Navy at the rank of Lt. Commander and taught radar navigation for the U.S. Maritime Service until 1954 (when that training program was ended), then spent the rest of his working career as a salesman for UARCO, a business forms manufacturer; he retired in 1982. Jack and Leslie lived their married life together in San Francisco, and were blessed with two daughters, Jean and Lynn. Sadly, Leslie died in 1995—she was some years older than Jack—and he still speaks fondly of her.

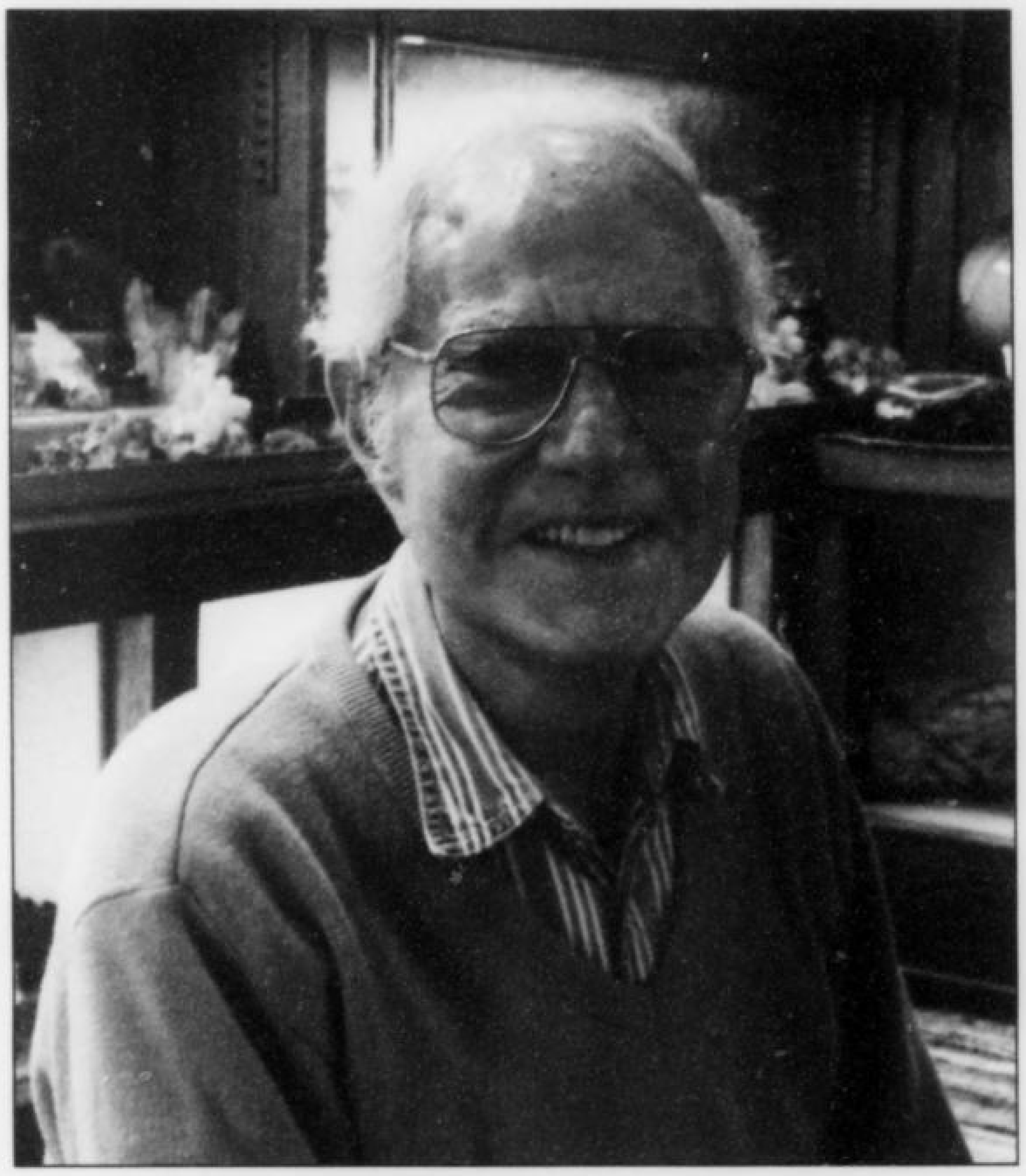


Figure 1. **Jack Halpern in his mineral room. Michael Ferguson photo.**

In his own words Jack was "reborn" in San Francisco around 1962, while touring the California Academy of Sciences. Walking into the mineralogy department, his eyes were immediately drawn to the sight of attractive and brightly colored objects in a myriad array of geometric shapes. Jack remembers remarking out loud how wonderfully these things had been carved. The person next to him happened to be on the mineral staff of the academy and corrected Jack, saying: "These have not been created by man, but are objects of nature," termed in his words "mineral crystals." Jack thought the man was pulling his leg; only after a lengthy interrogation did he understand that these objects are completely natural.

***Figure 2.* Cobaltoan calcite crystal, 5 cm, on malachite, from the Mashamba West mine, Zaire. Jack Halpern collection; Wendell Wilson photo.**

His interest piqued, Jack wanted to learn more. The academy gentleman put him in contact with Dr. William Sanborn. Shortly thereafter, Sanborn invited him for a cup of coffee and thus was born a love affair with minerals. Jack was soon on his way to becoming a world-class collector. Bill Sanborn took him to local mineral shows, introduced him to dealers and taught him the difference between fine specimens and also-rans.

Later in the 1960's Jack met a gentleman who would also be instrumental in forming his collection: Dr. Peter Bancroft. Jack had already set aside money for travel and specimen purchases when he met Pete—at the time he was trying to make up his mind between a Kongsberg silver and a Grass Valley gold. He ended up buying them both. These pieces remain in his collection today and are as beautiful now as they were then. However, their appreciated values have made them first-class investments.

Having the help of a good mineral dealer is always critical in starting a collection, and Jack had the good fortune to make the acquaintance of Walt Lidstrom (1920–1976; see Sorenson, 1976). Walt became a legend in the mineral business, for his kindness, his square dealing, and the high quality of his specimens. It was natural that he and Jack should become good friends. For the first 15 years that Jack worked at building his collection, he purchased 99% of his specimens from Walt.

SELECTIVITY

Over the years Jack has developed rigorous criteria for selecting mineral specimens for his collection. He understands that every collector is different, but still there are common features we all look for. Jack has described these in detail elsewhere in this issue, but I will review them briefly here as well:

First, is ***appealing overall form***—an architectural shape. And, like all of us, Jack has learned from all of the people he has come into contact with. Dr. Steve Smale (see Wilson, 1992), also from San Francisco, has had a strong influence on the development of Jack's criteria. Steve uses the term "Good Horizons" in referring to a specimen bearing a pleasing outline.

Jack next looks for ***good crystal form***—crystal shapes should be clearly revealed, complete and undamaged.

His third criterion is for ***clean bright colors***, adding that he has a personal attraction to red. Hence the high value he places on his rhodochrosites, rubies, red beryls and cinnabars.

He then tries to look for ***good luster*** on the crystal faces, choosing lustrous examples over the dull. While Jack loves the high luster on his stibnites, cassiterites and especially his golds, he is accepting of the satiny luster on his benitoites, barites and rhodonites.

In terms of size, Jack generally prefers ***hand-sized specimens or smaller***, but can accept larger specimens if they are exceptional and the price is not prohibitive. He recognizes that the smaller the specimen, the greater the chance of perfection. Looking through his collection, which we will do in the next section of this article, we will see that Jack has embraced all sizes, from thumbnails and miniatures to large cabinet specimens. That said, he does generally stick to the Wendell Wilson rule: an investment grade specimen should measure between 1–6 inches.

Freedom from damage is always important. Jack calls it "*Dings Deliver Demerits.*" In the past he has accepted slight damage to a specimen, but has often regretted it later. The more educated a collector becomes, the more he tends to shun even minimal damage.

Jack also likes ***crystals on matrix*** since it helps pin down the geological environment in which the crystal developed. Matrix specimens are rarer and generally command far higher prices than the same crystals unattached. Jack also takes into account the ***ratio of crystal size versus matrix***—a small crystal on a large matrix is not a good balance for him. He also likes the crystals to ***boldly stand out*** from the matrix. Isolated crystals on matrix seem to please him.

A love for ***transparency*** is also obvious in the Halpern collection. To Jack, it implies purity. And if a crystal is transparent rather than translucent or opaque, it must also be free from distracting factors.

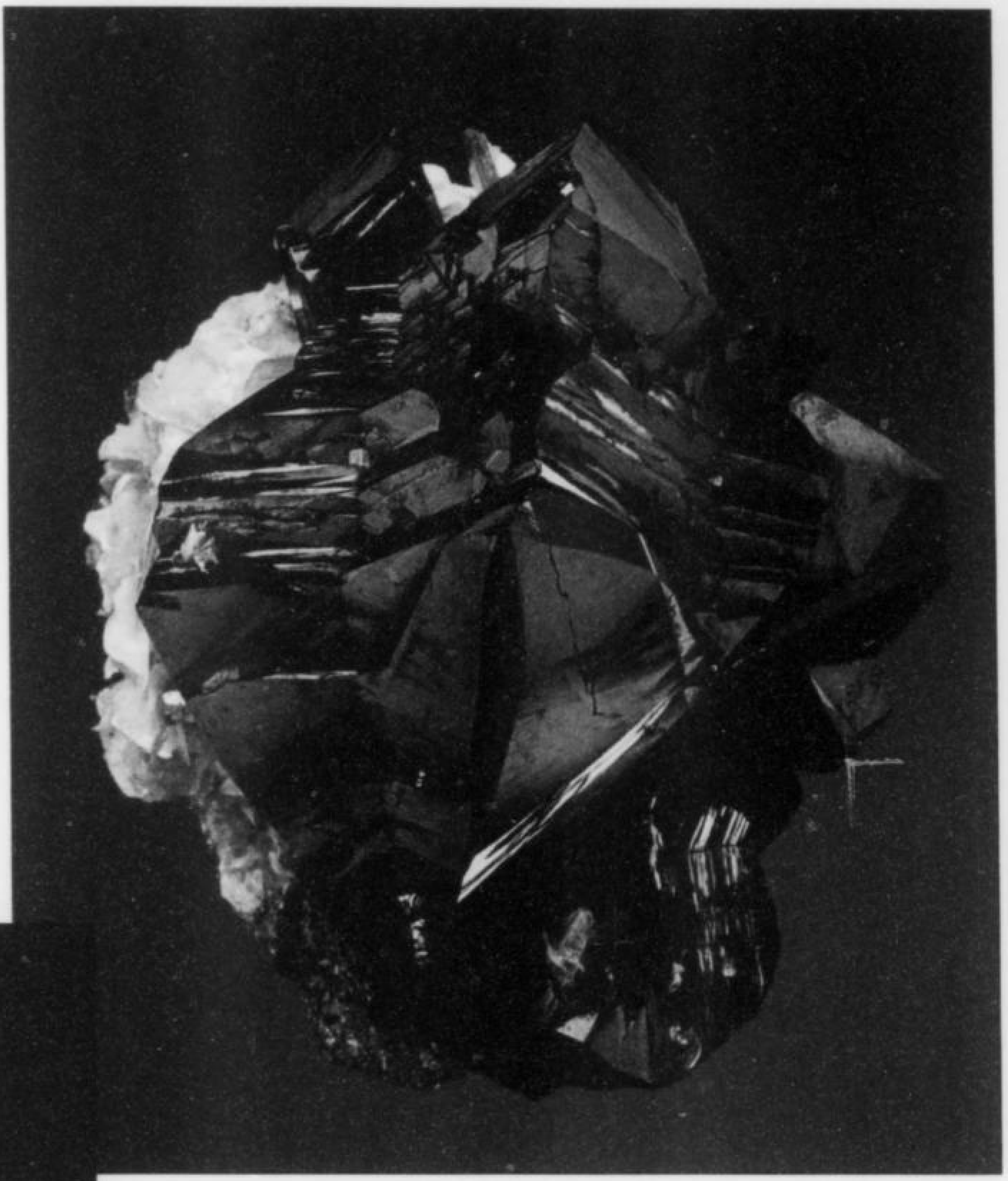


Figure 3. **Cassiterite twin on matrix, 5 cm, from the Xuebaoding Mountain area, Sichuan, China. Jack Halpern collection; Jeff Scovil photo.**

Figure 4. **Wulfenite crystal, 1.8 cm, on matrix, from the Ahumada mine, Los Lamentos district, Chihuahua, Mexico. Jack Halpern collection; Jeff Scovil photo.**

Durability has also become an important issue for Jack since the 1989 Loma Prieta earthquake damaged many of his most fragile specimens. Up to 400 were damaged and 31 were totally destroyed. But Jack, being a lucky man, was fully insured. Even in the absence of earthquakes, however, with very fragile specimens, even careful handling can present a danger.

All of us would like to own something considered ***among the best of its kind***, and so does Jack. He also likes it when the ***species*** itself is a rarity. And in each potential specimen purchase, he tends to look for a ***focal point***. If he doesn't find a focal point he believes that this often relegates the specimen to the realm of the ordinary.

Classic localities have always been interesting for him, as I believe they are for all of us in the hobby. John Sinkankas rightly points out in his *Mineralogy For Amateurs* (1964) that classics do not even have to be advertised—they are always desirable.

Like all of us, Jack continually puzzles over the question of whether to buy examples from the first lots of a new find or wait to see if something better pops up. This "crystal ball dilemma" affects each of us. Everyone has a limit on his budget, requiring some self-control. Recognizing that each specimen is unique, Jack simply tries to apply as many of his criteria as he can when making this difficult decision.

Jack also likes and carefully preserves the ***old labels*** that some specimens carry from previous owners. The presence of historic, informative and authentic labels always adds to the value of any specimen that he can get hold of. He has created a well-organized system for document preservation, with envelopes for each specimen in his collection. Each envelope contains all of the past labels for a particular specimen, as well as Jack's own personal label, together with any background information related to the specimen and its acquisition. Seeing the extensive work he has done preserving data on each single specimen causes me some anxiety, since I myself must tackle this enormous job for my own collection in the near future.

Jack's final criterion involves ***specimen enhancement***. Mechanical trimming and certain types of chemical cleaning are acceptable, but Jack would like to see any other enhancements clearly described on the label. This gets into the realm of what the Carnegie Museum's Marc Wilson has described as the *Four R's of Mineral Specimen Enhancement:* reinforcement, repair, restoration and reconstruction.

Like myself, Jack does not want too many specimens that have gone through the four R's, but if one is told the truth up front, then one can make a purchase decision based on the merits. I myself will respect a cleanly repaired specimen if I cannot get one that is unrepaired. But restoration and reconstruction are features neither of us want in our specimens.

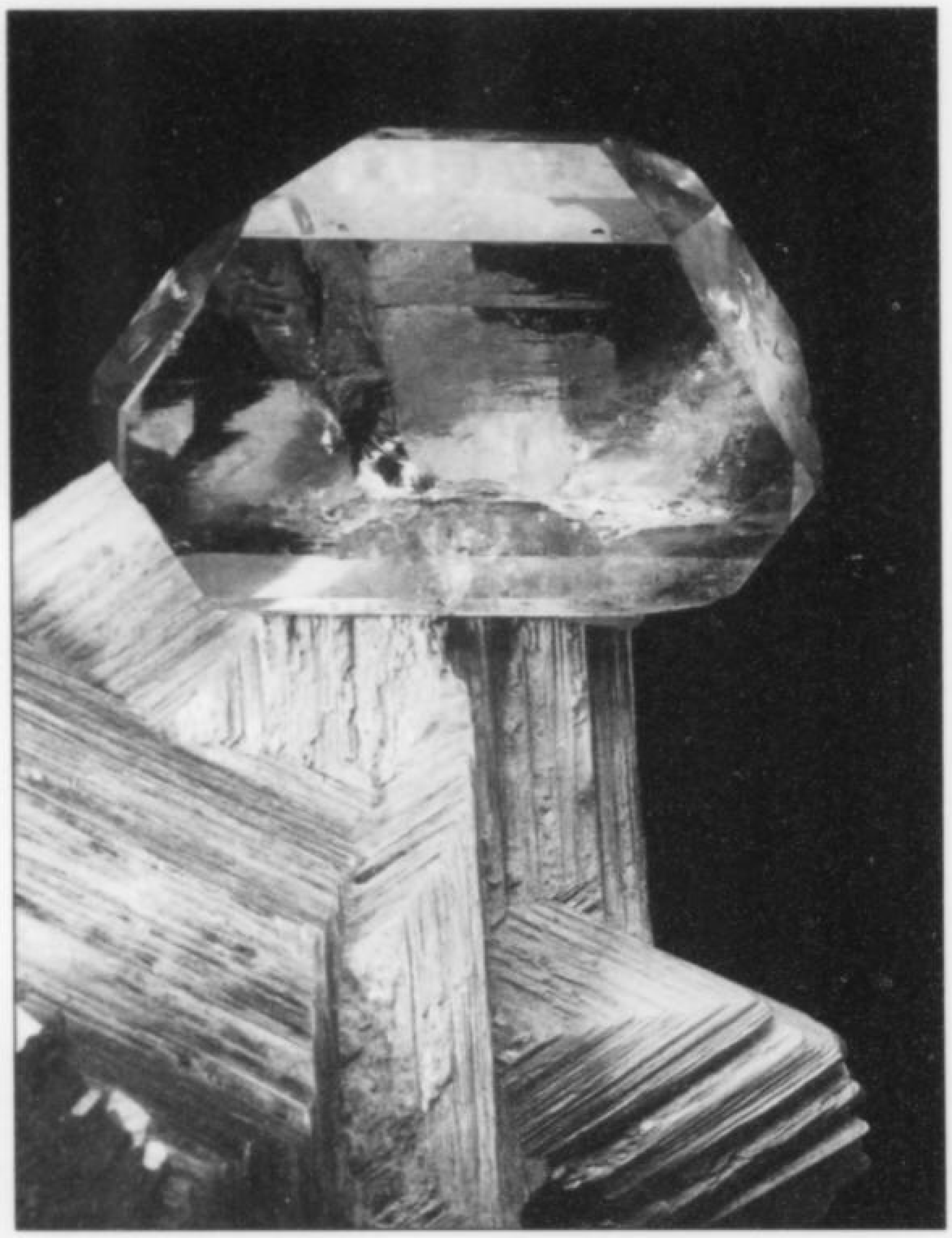


Figure 5. **Brazilianite crystal, 2.3 cm, on muscovite from the Corregо Frio type locality, Minas Gerais, Brazil. Jack Halpern collection; Jeff Scovil photo.**

THE HALPERN COLLECTION

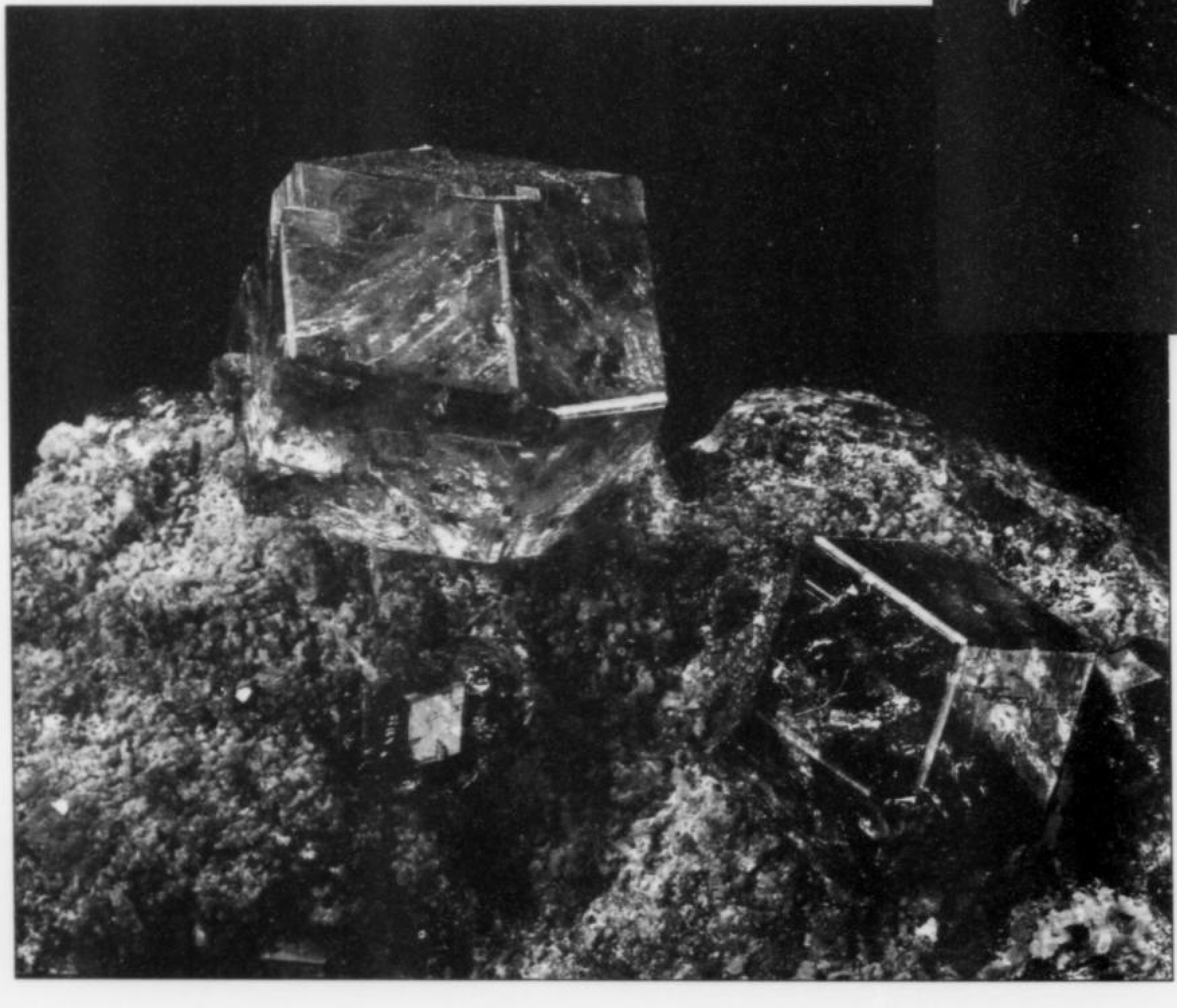
I phoned Jack in December of 2003, asking about the possibility of paying him a visit, and he wrote me a friendly letter (on paper—Jack doesn't do e-mail) inviting me to visit him in early January. He ended his invitation to me with a very large handwritten "WELCOME!" and I felt a keen excitement about having the chance to look over his fine collection once again. I paid my visit in the company of Jack's long-time friend, Steve Smale—it is always interesting to see a collection through the eyes of another collector.

We parked below Jack's beautiful home and walked to the front door, noting the great selection of magnificent flowers gracing the walkway. His other great collecting passion is gardening. Possessed of a green thumb, he has raised some of the world's classic flowering plants, particularly roses and orchids. This is an interest shared by many other mineral collectors, including the late, great Paul Desautels.

Jack greeted us at the front door with enthusiasm and excitement, then provided a brief preamble about what we were to see.

"Why do I get along?" says Jack. "Because I am a lucky guy! Luck has smiled upon me, so I participate actively in life. One of the facets in which I participate is mineral collecting. I get such a big pleasure out of displaying specimens to their best advantage. But when we now go to see the collection you will see that it is

Figure 6. **Grossular crystal, 1.4 cm, on matrix, from the Jeffrey quarry, Asbestos, Quebec. Jack Halpern collection; Jeff Scovil photo.**



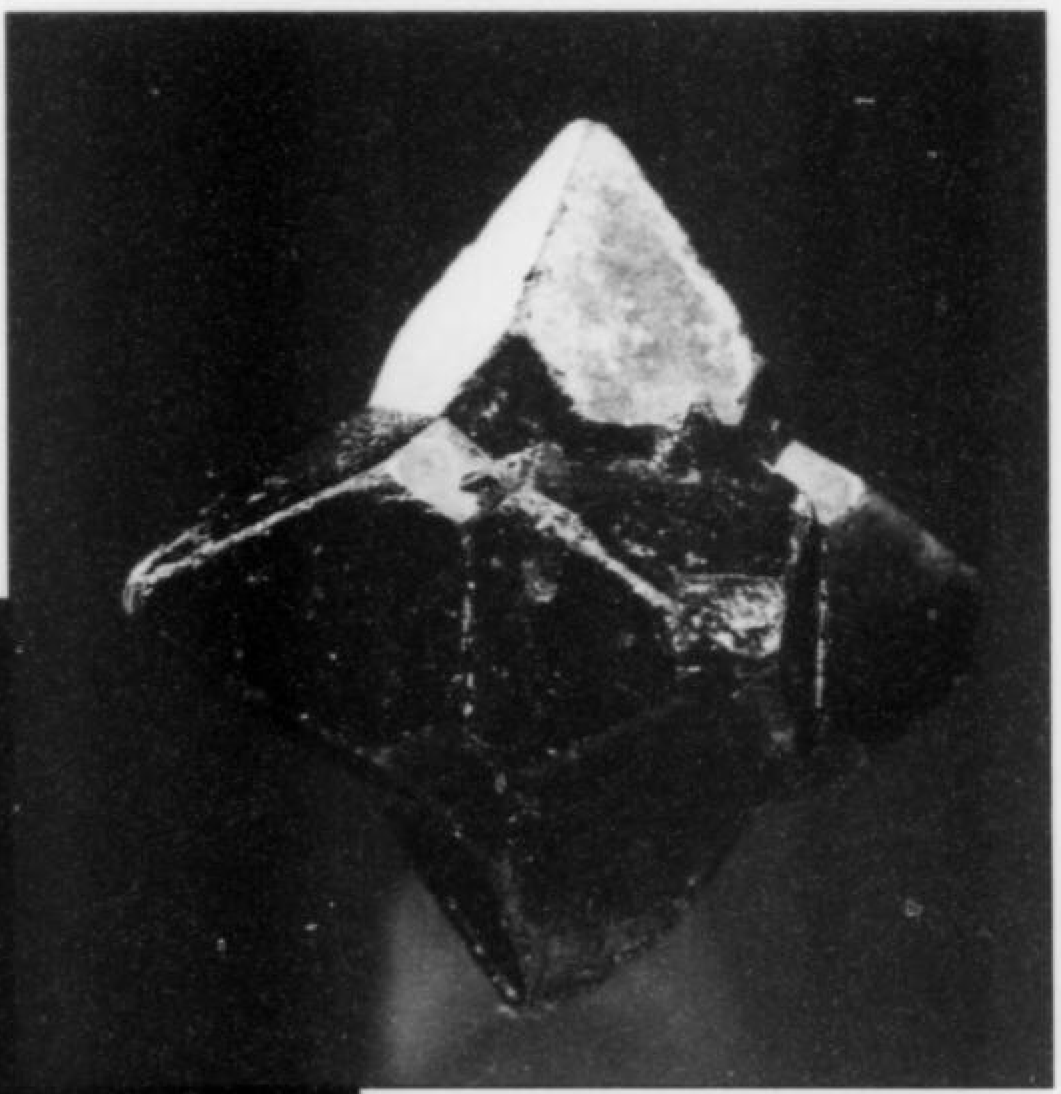


Figure 7. **An extremely rare sixling of cumengite crystals epitaxial on a boleite crystal, 1.1 cm, from Santa Rosalia, Boleo, Baja California, Mexico. Jack Halpern collection; Jeff Scovil photo.**

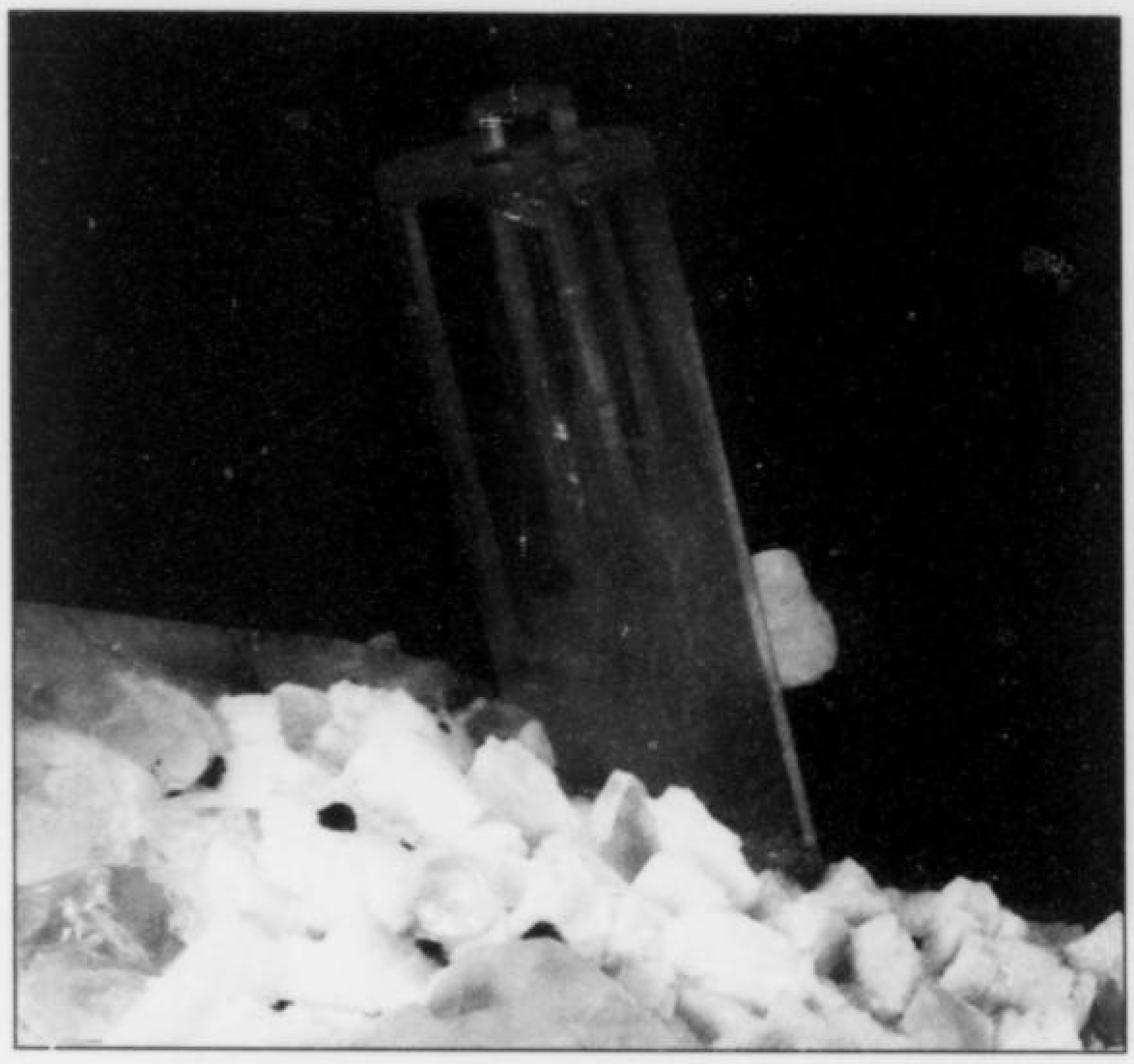


Figure 9. **Aquamarine beryl crystal on matrix, 15 cm, from near Dusso, Shigar Valley, Northern Territories, Pakistan. Jack Halpern collection; Jeff Scovil photo.**

Figure 8. **Zoisite (variety tanzanite) crystal, 7.3 cm, from the Merelani mine, Arusha, Tanzania. Jack Halpern collection; Jeff Scovil photo.**

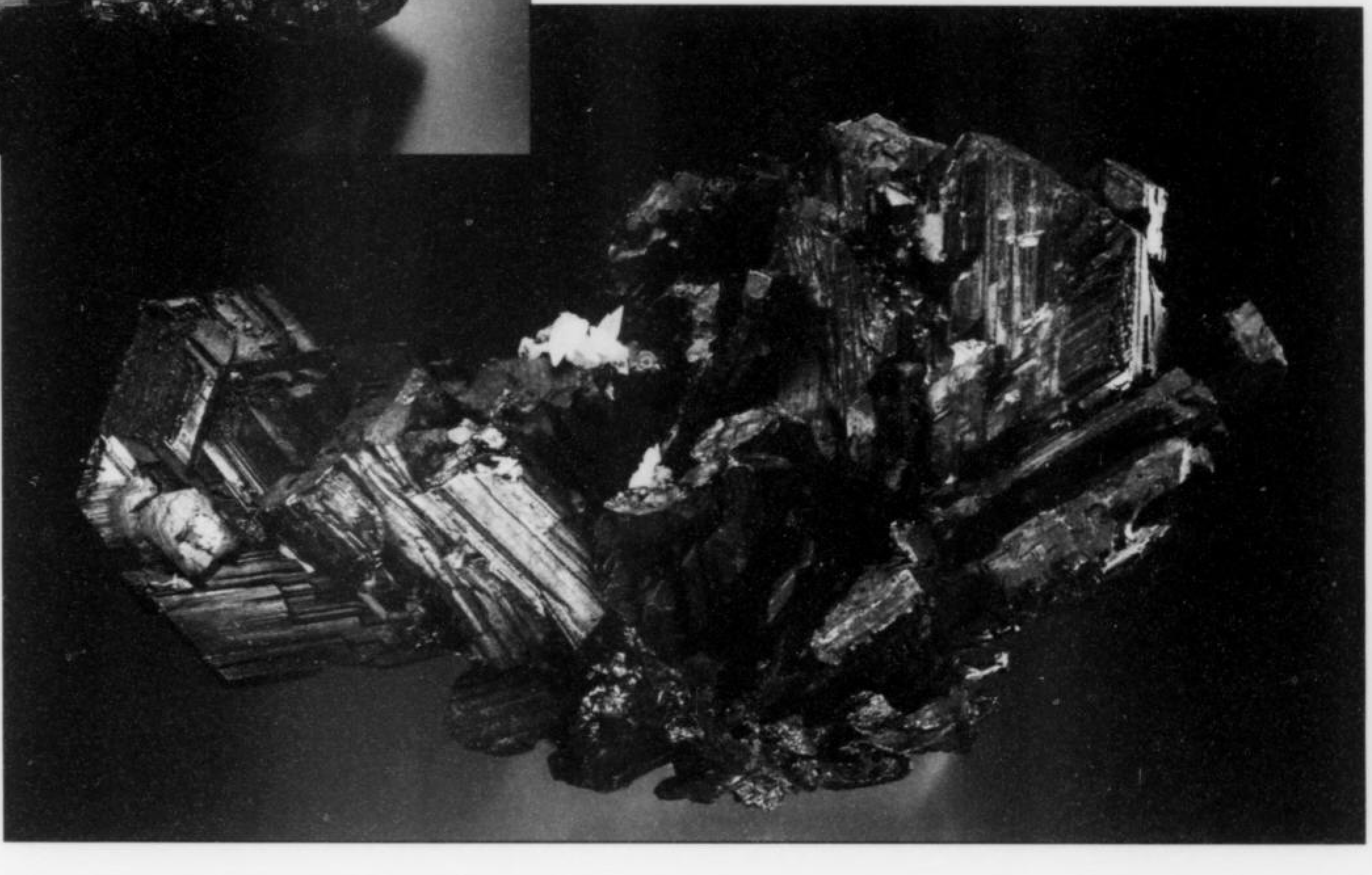


Figure 10. **Chalcocite crystal cluster, 11.7 cm, from the Bristol copper mine, Connecticut. Jack Halpern collection; Jeff Scovil photo.**

horribly overcrowded even though I have a big room. Years ago, they started out nicely spaced and then, as you add crystals, tucking one between a pair of others, it soon becomes crowded. But at least I have a good system of mapping, as you shall see. Shall we go downstairs?"

Both Steve and I agreed enthusiastically and descended the staircase, entering a large room, probably 500 square feet, and as usual the sight left us utterly speechless: wall-to-wall cases, approximately 21 of them, absolutely filled with minerals. By his count there are roughly 3000 pieces on display. It is very obvious that he loves color—it explodes from every case. Even though he has strict criteria, it is clear that he loves all types of minerals. As Paul Gefner, another local San Francisco collector and friend of Jack once said: "Jack is the only advanced collector I know who has ten-cent minerals next to twenty-thousand dollar pieces."

As I looked around I saw that he does collect most sizes, from thumbnails to very large cabinet pieces. He has many species, not just the most popular twenty or thirty that you see at mineral shows, although he does not seem to go in for extreme rarities.

I cruised the cases noting his obvious favorites, and these he has in abundance. Tourmalines, azurites, rhodochrosites, even polished agate slices . . . too many to recall. Wendell Wilson had to resort to a video camera when he visited Jack last year. "Otherwise," Wendell says, "you walk out of Jack's house afterward and your brain is so oversaturated with fine minerals that you lose the ability to recall much of it." I saw a polished malachite here, an azurite

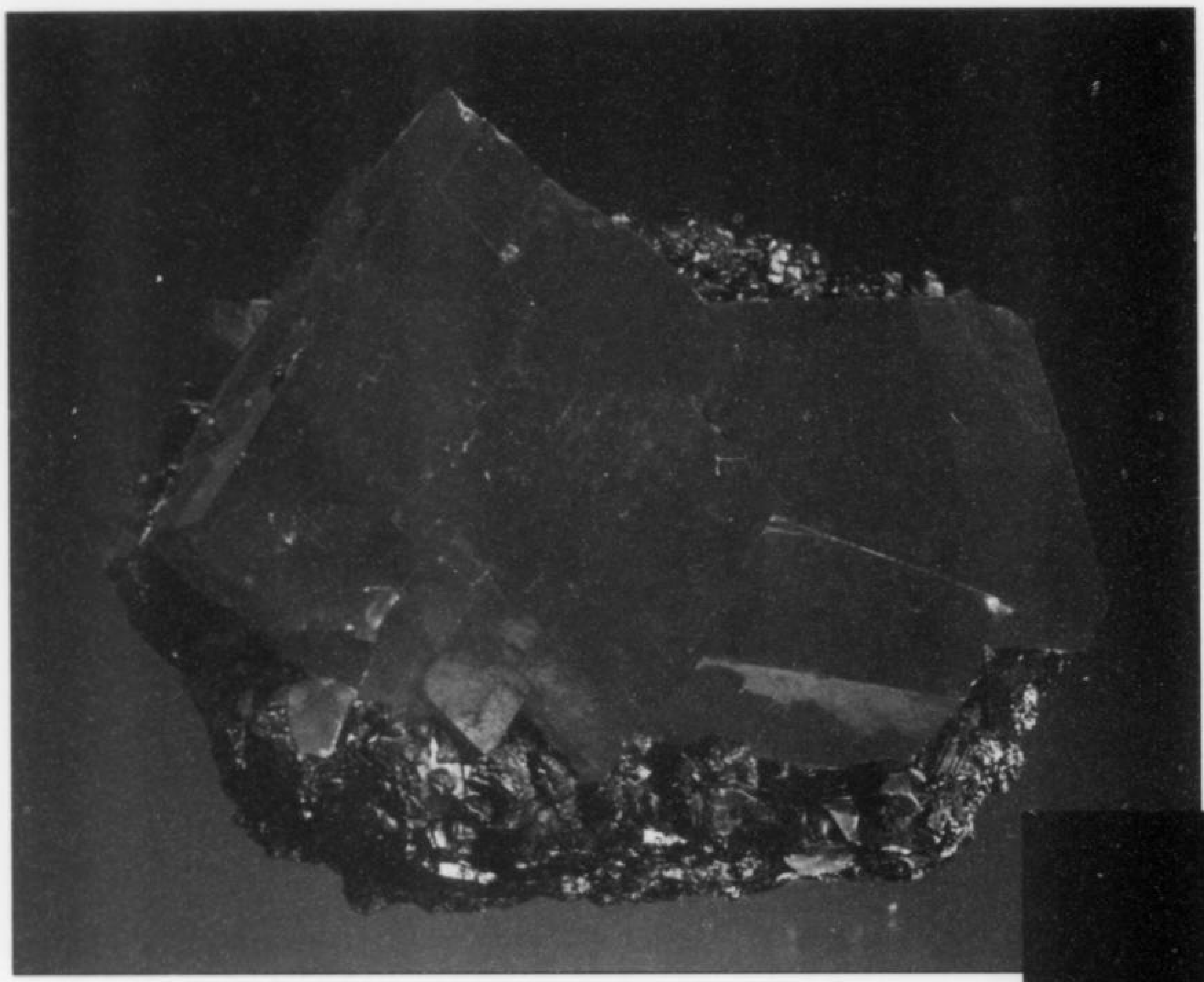


Figure 11. **Rhodochrosite and quartz, 9 cm, from the Sweet Home mine, Alma, Colorado. Jack Halpern collection; Jeff Scovil photo.**

Figure 12. **Bixbyite crystal on matrix, 3.2 cm, from the Maynard claim, Thomas Range, Juab County, Utah. Jack Halpern collection; Jeff Scovil photo.**

there and in one case perhaps the most magnificent sliced pair of liddicoatites I have ever seen. At 3 x 7 inches each, they look more like butterfly wings than polished minerals. He is very proud of them, as he should be. One of his old Bisbee azurite slices shows wonderful centers full of malachite, about 2 x 3 inches.

So many things catch the eye in Jack's collection that it soon becomes overwhelming. A gemmy 1-inch brazilianite crystal perched in a cluster of "star" muscovite (ex Joe Freilich collection). Beautiful 1-inch Colombian emerald crystals with lustrous and well-formed calcite crystals. Two large and superb variscite slabs from Utah, showing unusually rich green color (from Walt Lidstrom). A very large, blocky cluster of malachite-coated cuprite crystals from Onganja, Namibia. A truly spectacular, deep pink, highly lustrous beryl crystal at least 7 inches tall—from Afghanistan. Numerous Sweet Home mine rhodochrosite specimens including some very large ones. A Pulsifer quarry purple apatite thumbnail that's to die for. A gorgeous orange grossular crystal from Asbestos, Quebec, perched delicately on matrix. A large and superb cluster of blue apatite crystals from Brazil. A pink Mashamba mine cobaltoan calcite crystal on malachite that was illustrated in the *Mineralogical Record.* A giant cluster of Yugoslavian wulfenite crystals. I could go on and on . . . a large and beautiful tanzanite, Kelly smithsonites, big Vera Cruz amethyst clusters, green Poona apophyllite, a really gorgeous cluster of Brazilian rose quartz crystals fanned out around a smoky quartz crystal. And so much more . . . golds, silvers, a giant skutterudite crystal, Indian zeolites, a beautiful Moroccan wulfenite. In reviewing this wealth of specimens one is also struck by the long time period of active acquisition. Many specimens are of kinds that are no longer available, but Jack bought them at a time when they were briefly prevalent on the market. This aspect alone gives tremendous depth to the collection.

After an hour I gave up trying to select my own favorites, and quickly pointed out to Jack some 20 pieces for him to set aside for Jeff Scovil to later photograph for this article, so that readers will not have to suffer with mere words.

CONCLUSION

Jack has come far since his first exposure to minerals so many years before. In the years since that fateful day at the California Academy of Sciences, Jack has suffered two life-threatening health crises, but has emerged stronger than ever.

I can still see Jack in front of me—excited, participating actively in life's experiences, loving his beautiful flower gardens and especially his fabulous mineral collection, enjoying the pleasure of entertaining visitors, reveling in his friendships, living in the moment and just enjoying being alive. He is one lucky man, indeed, and a lesson to us all on how to be happy. The mineral collecting hobby is very lucky to have him, as well!

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CRITERIA

for

SELECTING CRYSTALLIZED MINERAL SPECIMENS FOR A DISPLAY COLLECTION

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Every collection reflects the particular eye and mindset of its collector. In a sense it amounts to his or her mineral fingerprint. But despite these variations the tastes of experienced collectors tend to have certain basic tenets in common. Here are the ideal characteristics which I have found to be integral to many specimens in top-level display collections.

INTRODUCTION

Mineral collectors tend to be as different from each other as clouds in the sky. We do share some similar characteristics, but each of us is an individual. Though we all share the desire to possess a fine collection of minerals, we each have our own predilections, our own preferences, our own motivations. As a result, our mineral collections are each unique, reflecting the diverse tastes, personality traits and technical training each of us brings to the hobby. This is as it should be.

Every collection reflects the particular eye and mindset of its collector. In a sense it amounts to his or her mineral fingerprint, but despite these variations the tastes of experienced collectors nevertheless tend to have certain basic tenets in common. As one among you, I have been guided by certain ideals in gathering specimens for my collection, based on the characteristics which are integral to many specimens in top-level display collections. I aim to share these with you. You may or may not subscribe to these ideals yourself. However, choosing among the vast array of specimens offered for sale or trade can be a daunting task! The criteria listed below often direct the experienced collector's eye and hand in singling out a particularly worthy specimen from the many thousands (actually millions!) offered for sale, and may likewise be useful to you in making your own selections.

For a display of mineral specimens in one's home, different criteria may dominate over those which might apply to minerals stored in drawers, in boxes, in vaults or located on the backroom shelves of a museum where scientific study may be a paramount objective. For a home display, it seems to me that visual delight should be among the primary satisfactions to be experienced by both the collector and his guests, whether or not those guests are themselves "mineral people." Their response to the phenomenal world of crystallized minerals is a rewarding dividend that comes from displaying your selectively assembled minerals.

Following are my personal criteria for selecting specimens for a display collection. Many of them were discussed by Wendell Wilson (1990) in his essay on "Connoisseurship in minerals," and by Keith Proctor in his videotapes, *The Proctor Collection* (1988) and *The Buyers' Guide to Building a Fine Mineral Collection* (2002). The criteria are presented in no special order, and many of them overlap, but I hope the list will serve as the basis for a useful discussion.

CRITERIA

(1) Appealing overall form. A pleasing architectural shape is a major attribute of a fine display specimen. What is desired is an attractive conformation (or "composition") about the entire specimen as well as about the arrangement of the crystals it harbors. Keen-minded collector Steve Smale uses the term "Good Horizons" in referring to a specimen with a generally pleasing aesthetic form.

(2) Good crystal form. The shape of the crystals should be clearly revealed. They should be complete and undamaged, and ideally, they should be morphologically perfect.

(3) Clean, bright color. Clear, vivid colors carry appeal. I avoid muddy colors. I vitalize my display with glowing greens, beckoning blues, radiant reds, opulent oranges, wintry whites. Black minerals stand out much more clearly when they are interspersed among specimens exhibiting bright colors. Red usually elicits major interest, hence the great value attributed to Sweet Home mine and other rhodochrosite, ruby, red beryl and cinnabar. The purity and "cleanness" of the color are important factors, and the presence of a color rare or unusual for the mineral adds to the desirability.

Generally, the deeper the hue, the better. Pink fluorite has traditionally been in high demand, but when it is deep pink it is more desirable; if pale, it is less so. Strong color contrast between crystal(s) and matrix also contributes visual excitement—as when, for instance, green dioptase studs a white calcite matrix, or blue-green aquamarine couples with deep pink apatite, or the green of emerald rests against the white of calcite, or red rhodochrosite cohabits a matrix with purple fluorite.

(4) Luster. High luster delights the eye! I choose lustrous examples of a mineral rather than dull ones whenever that choice is possible. Brilliant luster is stunning in stibnite, cassiterite, quartz, vivianite and gold. A more satiny luster characterizes some benitoite, barite and rhodonite. The presence of lively luster rewards the viewer with visual stimulation, a quality often absent in dull-lustered crystals.

(5) Desired size. Generally, I prefer hand-size specimens, but many factors come into play here, such as cost and degree of acceptable damage. Also of significance is whether one prefers to collect specimens of various sizes or whether one specializes in one size category, e.g. thumbnails or miniatures. The smaller the specimen, the greater the chance for perfection; thus more perfection is demanded by those who collect the smaller sizes. Also, the space available for display may influence the size-preference of a collector: a greater number of smaller specimens than larger ones may be accommodated on a shelf.

Wendell Wilson once noted that most investment-grade specimens measure between one and six inches. The upper size limit has increased somewhat in recent years, but this is an observation of interest to all who are concerned with the resale of their collections, by themselves or by their heirs.

(6) Freedom from damage. Dings Deliver Demerits! Though sometimes I reluctantly accept some slight damage on a specimen, I have learned that the educated mineral buyer generally shuns specimens showing even minimal damage. The eventual dollar value of a specimen, when it is resold, will probably be markedly less if it carries any damage.

(7) Crystals on matrix. Just as appropriate framing adds aesthetic coherence to a fine painting, the presence of matrix adds visual appeal and value to a specimen. Additionally, the matrix often helps to pin down the geologic environment in which the mineral(s) crystallized, and it may help the experienced collector to confirm the locality of the specimen. It is basically for these reasons that crystals on matrix usually command higher prices than do comparable crystals which are no longer attached to the mother rock.

(8) Transparency. Certain minerals sometimes possess the elegant quality of gemmy transparency. To me, transparency implies purity; it leads the eye away from any distracting features. As transparency is relatively rare, crystals that exhibit it are much more costly, in general, than translucent or opaque crystals. And some gemmy crystals possess intrinsic value based on their potential value as faceted stones, independent of their value as collectible crystals.

(9) Durability. This characteristic permits a specimen to resist breakage. Durable specimens may resist careless handling, earthquakes and other hazards; it is well to keep this in mind when making your selections for a display collection, even though vulnerable specimens of crocoite, mesolite or others may be appealing.

(10) Being among the best of its kind. The prospective buyer would be well advised to learn the attributes of any mineral planned for acquisition, and to be aware of "the best it can do." If one carefully reviews the offerings at mineral shows, looks exhaustively through museum and private collections, and studies the extraordinarily fine photographs appearing in journals such as the *Mineralogical Record*, one will sharpen one's awareness of the elements of quality for each mineral species and occurrence. Make friends with fellow collectors. Arrange to see their collections. Make mental or even written notes. But be forewarned: high-quality minerals usually command high prices.

(11) Size ratio between crystals and matrix. A "comfortable" ratio is desired. It may be of interest to note that a large crystal on a small matrix seems somehow to be more acceptable than a tiny crystal on a large matrix. However, balance is best.

(12) Crystal relief. I prefer crystals which stand out boldly from the matrix over ones tending to merge with it or lie flat on it. With high-crystal-relief specimens, isolated crystals can be viewed individually, their edges not being concealed by edges of encroaching neighbors or by matrix material. The result is a greater opportunity to view the crystal in its entirety and to appreciate the awe-inspiring magic of crystal perfection and form.

(13) Rarity of the species. I collect a rare species for display only when the elusive specimen possesses what I perceive as eye-arresting geometry or great visual beauty. An example is the cumengite in my collection. It is small, but I find it geometrically amazing! My overriding objective is to bring delight to my mind and eye, and to reach out similarly to visiting viewers. Other collectors may be attracted to rarity for its own sake, even when this means sacrificing beauty. To each his own.

(14) Focal point. A "center of attention" on a specimen, when present, draws the eye and adds considerable interest, while the absence of a focal point sometimes relegates a specimen to the realm of the ordinary. A good center of attention usually takes the form of a particularly large, centrally located crystal.

(15) Classic localities. When superb minerals found long ago in a particular location have never been bettered in later finds, they are deemed "classics." They are highly prized and eminently collectable, and the locality which produced them achieves fame among collectors. The great "architectural" wire silvers from Kongsberg, Norway are a fine example. Acquiring classics is generally more costly, but it involves less risk to one's investment. The mentally agile collector, though, may be able to distinguish from today's mineral finds those specimens which bear the hallmarks of becoming tomorrow's classics. Be alert! Seek them out!

(16) Authenticity. Are the crystals natural, or were they manmade? Is the specimen a fake? Have crystals been glued onto a matrix or inserted into a matrix on which they did not grow? Is the locality appearing on the label a lie fabricated to mislead the prospective purchaser into thinking he is looking at a classic? I avoid such faked specimens. I do business with purveyors of established repute, and count on them to apprise me, to the best of their knowledge, of any authenticity problems. Careful inspection of a specimen is recommended.

(17) 360-degree viewability. Some perfection-seeking collectors (such as Marshall Sussman) emphasize the appeal of 360-degree viewability. They especially appreciate specimens which may be viewed to advantage from all angles. If the back portion of a specimen is broken away, or if a vital part is missing from the front, this is a major flaw.

(18) Recent finds—What to do? Are more specimens of a desirable, recently discovered mineral occurrence likely to be recovered in the future? If so, should I wait to examine more examples before making my choice? Or, since the finest examples often appear in the initial offering, and are rapidly snapped up, would delaying be unwise? A reliable crystal ball—oxymoron—is required to resolve this disturbing dilemma.

(19) Acceptable cost. Is the specimen fairly priced? Experience, foresight and comparison shopping are the preferred ways to know; however, the delay that shopping around entails may result in your losing a desirable specimen to a faster-acting, more decisive buyer. And sometimes, even though a particularly desirable specimen may be overpriced at the time, you may later regret not having bought it anyway. Everyone owns a few specimens for which they overpaid, and likewise a few for which they underpaid—it averages out. It is also true that if you moderately overpay for a truly fine specimen, the passage of time will soothe the sting. Anyway, the value of a superior specimen generally grows over time, and the initial overpayment eventually becomes unimportant. Conversely, however, a low-grade specimen never achieves high value, either in my esteem or in the marketplace. I strongly suggest that you acquire the best specimens that you can manage to find. Buy fewer and buy better!

Can I afford it? Does the specimen's cost match my available means? Self-control comes into play here. After experiencing acute financial discomfort from yielding to the allure of a large group of excellent specimens offered to me, but priced beyond my ready supply of funds, I now attempt self-discipline in the face of temptation. I have found that disciplined buying, though difficult, avoids later stress.

(20) Special characteristics. Distinctive factors such as fluorescence, twinning, phantoms, movable bubbles, or complete "floater" form may add to value and collectibility.

(21) Past owner labels. The presence of historic, authentic labels made by previous possessors of a specimen may increase its perceived worthiness. Conversely the absence of any previous labels for an old specimen may detract from its desirability. There is a certain glamour associated with a specimen's past connection to a famed person or institution, and there is a stimulation arising from knowing that consequential people or organizations have appreciated the specimen sufficiently to have taken possession of it. Any dealer deserving of respect will safeguard all early labels and pass them on to the new owners of specimens.

From dedicated collector Bill Smith, I learned to use a separate glassine envelope to preserve past owners' labels as well as my own, together with any other information of interest, for each specimen in my collection. The envelope permits the collector to organize in one place all documentation associated with a specific specimen. Such envelopes, in a variety of sizes, may be obtained inexpensively from stamp dealers. I mark the envelope with the same unique identifying number which I have marked on the specimen. This procedure has proven invaluable to me, and will likely be equally beneficial for you and for your heirs when your beloved collection is being readied to move on to new owners.

(22) Special needs. Your own special requirements point to other criteria. For example, does the specimen under consideration fit well in size, style or specialization with others you currently own? Displaying one thumbnail in a collection of cabinet-sized specimens may create physical disharmony. Does the specimen satisfy your personal collecting goals? For example, you may have almost enough twinned calcites to fill a display case devoted to this specialty, but need one or two more. Does the specimen under consideration fulfill your need?

(23) Specimen enhancement. Man manipulates minerals. His hand is capable of transforming an unprepossessing rock into an excellent mineral specimen. Performing such alchemy requires knowledge, experience, talent, a keen eye and a steady hand. In some cases, highly specialized equipment and state-of-the-art techniques and chemicals must also be employed to prepare fine and worthy specimens for display.

Very few specimens shown in the offerings of mineral dealers appear as they did when first taken from the earth. After cleaning, sometimes in itself an extensive process, many specimens have been chemically bathed to remove unwanted coatings which obscured crystal surfaces. Then they were trimmed, a procedure in which the trimmer's concept of an ideal shape for the specimen is realized. The result of these operations is to allow more collectors to possess a greater number of specimens with appearances approaching perfection. Bob Jones has observed that were it not for certain steps taken to repair tourmalines recently mined from the Pederneira mine in Brazil, few of these extraordinary crystals would ever have reached collectors; the talents and patience of many humans have been employed to reassemble components into the major specimens we see today.

Improving the appearance of specimens raises ethical issues for many collectors; some, in fact, view any "repair" as intolerable. It would be wise for each collector to open his or her mind to the complexity of the problem, remembering that many acknowledged masterpieces of art in museums and private collections worldwide have had their bruises mended over time, and have thereby become again accessible for appreciation. But it is precisely because collectors do differ in their tolerances of repair that any steps taken to restore wholeness to a damaged specimen should be declared clearly and openly, and the word "repaired" or "restored" should appear plainly on the label. If more space is needed to detail any major corrective steps taken, the dealer should prepare and staple to the label an accompanying card, the existence of which is noted on the label. The ethics of the dealer and the level of his honesty are plainly laid on the line in the area of openly acknowledging repair.

Marc Wilson of the Carnegie Museum of Natural History has written a stimulating treatise entitled "The Four R's of Mineral Specimen Enhancement," recently published in *Emeralds of the World: ExtraLapis English No. 2*. Here are Marc's four R's as I interpret them, in order of decreasing acceptability:

1. *Reinforcement.* Glue or polymer has been applied to a delicate but unbroken specimen (usually to the matrix) to increase stability and strength.

2. *Repair.* Glue has been used to reattach broken pieces.

3. *Restoration.* An artificial substance has been applied to replace a gap in the specimen. This approach is still controversial.

4. *Reconstruction.* Artificial material has been added to replace a partial termination of one or more crystals, in an effort to duplicate the presumed original appearance. All such treatments are highly questionable, even if clearly and honestly spelled out on the label.

If any sort of treatment is suspected and is not acknowledged on the label, I recommend that the customer question the dealer on the point. The overwhelming majority of dealers operates above board and with full honesty, and could not succeed, long-term, in the business otherwise.

I am personally grateful, however, for the technology which has been developed to reinforce, repair and restore crystallized minerals to a state permitting me to enjoy collecting them, and am indebted to such pioneers of mineral preparation as Bryan Lees of *The Collector's Edge*, whose skilled staff has developed highly advanced specimen-preparation techniques. Many others, such as Cal Graeber, are also adept in the science (and art) of specimen preparation. These people deserve our thanks for improving the world of the mineral collector.

(24) The "Wow" factor. Every once in a while, there appears upon one's horizon a specimen of overwhelming visual magnetism! It suffuses the collector with a sense of awe, and seems to challenge his belief that the earth could have conceived and gestated so magnificent a thing! If such a specimen comes your way and is within your reach, go for it!

These, then, are the criteria which come into play for me in selecting specimens for a display collection—the ways in which I say "yes!" to visual excitement. Thank you for granting me this privileged access to your own eye, and thus to your mind.

ACKNOWLEDGMENTS

I would like to thank Carolyn Manchester for lending her perceptive eye, and sharing her own finely honed sense of mineral aesthetics, in reviewing this essay. Thanks also to Thomas Moore and Wendell Wilson for editing the manuscript.

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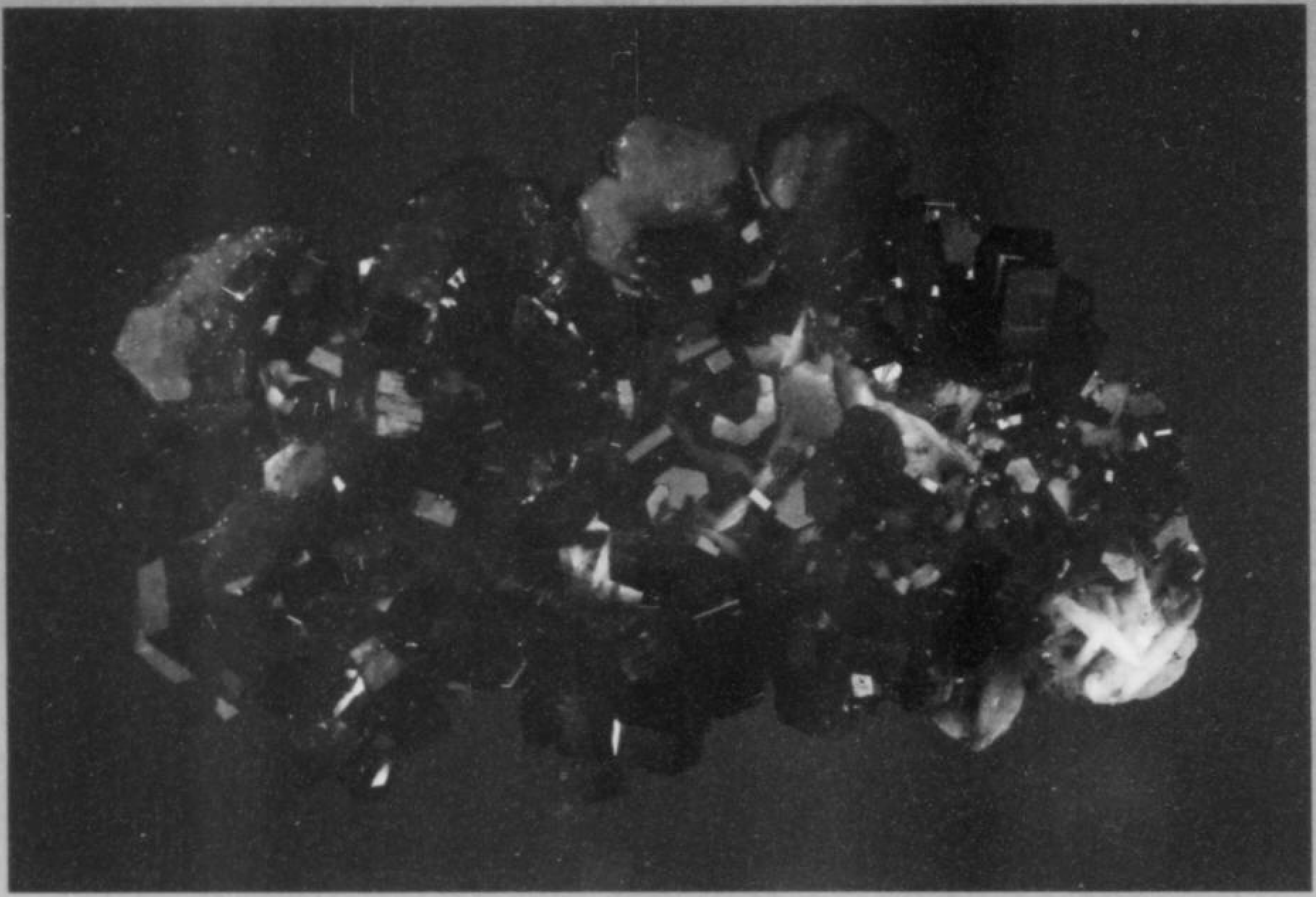
TOURMALINE on Quartz and Albite, 5.5 inches, from Minas Gerais, Brazil. From Collector's Edge (June 2000); Wayne Thompson to James Horner. Lyon Show Poster specimen; photo published in *Le Règne Minéral*

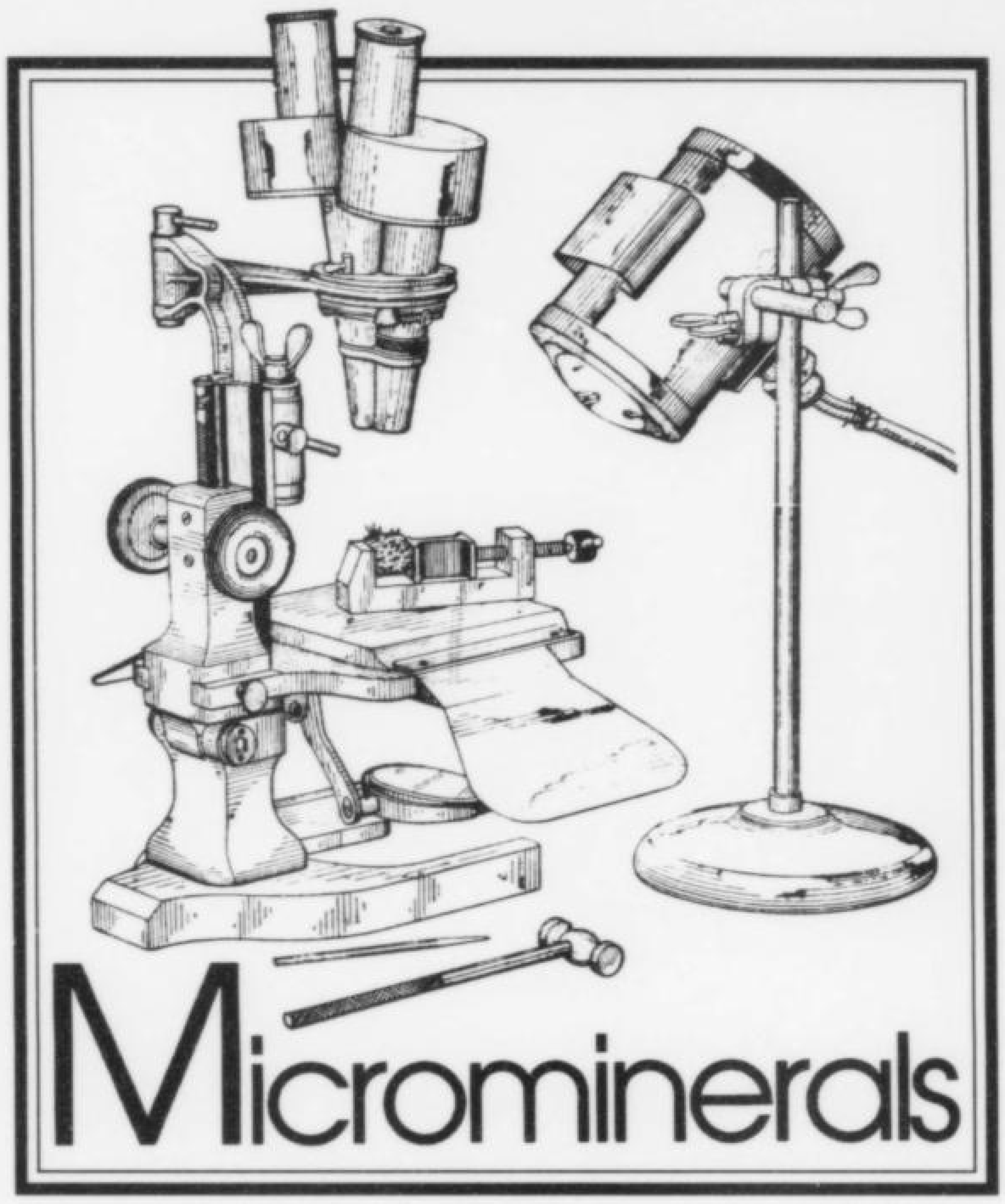
Clara and Steve Smale

COLLECTORS

PHOTO BY STEVE SMALE



VANADINITE, 10 CM, FROM MIBLADEN, MOROCCO. JEFF SCOVIL PHOTO.



Microminerals

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Reflections on reflections

All photomicrographers are aware of one major problem—specular reflections. Just as one lines up a particularly nice crystal under the microscope, there are annoying bright flashes from neighboring crystals or cleavage planes that interfere with the composition of the shot. Worse, they produce nasty overexposed spots that look as if they had been burned through the film. Dr. Peter Richards experienced that in another context—working with an optical goniometer—and thought up a solution. Here's what he suggests:

> I was trying to measure a calcite crystal on the goniometer, but it contained several segments that were not completely in line with each other, so they produced several sets of competing light signals that made taking internally consistent measurements difficult. I wanted to isolate one section of the crystal that was coherent. How to blunt the reflections from other areas? What I have done before is to use white-out, but this is pretty much a permanent treatment. I used a flour paste, dabbed it on with the end of a toothpick, and let it dry. Of course, it washed off easily later.

Now, that sounds like a great idea. I haven't had a chance to try it yet, but I certainly will next time I'm working with a clutch of glassy, reflective crystals. Obviously, one doesn't want to have a secondary crystal looking like a snowman, but it should be possible to dull the shine without causing obviously unnatural artifacts on the film.

Thinking in circles

Some folk think that micromount gatherings are solely for the purposes of trading, buying or getting more specimens from the freebie tables. It ain't so. One can learn a lot from micromount symposia. One of the things we learned from the *Paul Desautels Micromount Symposium*, held in Elkridge, Maryland in September, 2002, was that there's an art to making a circle.

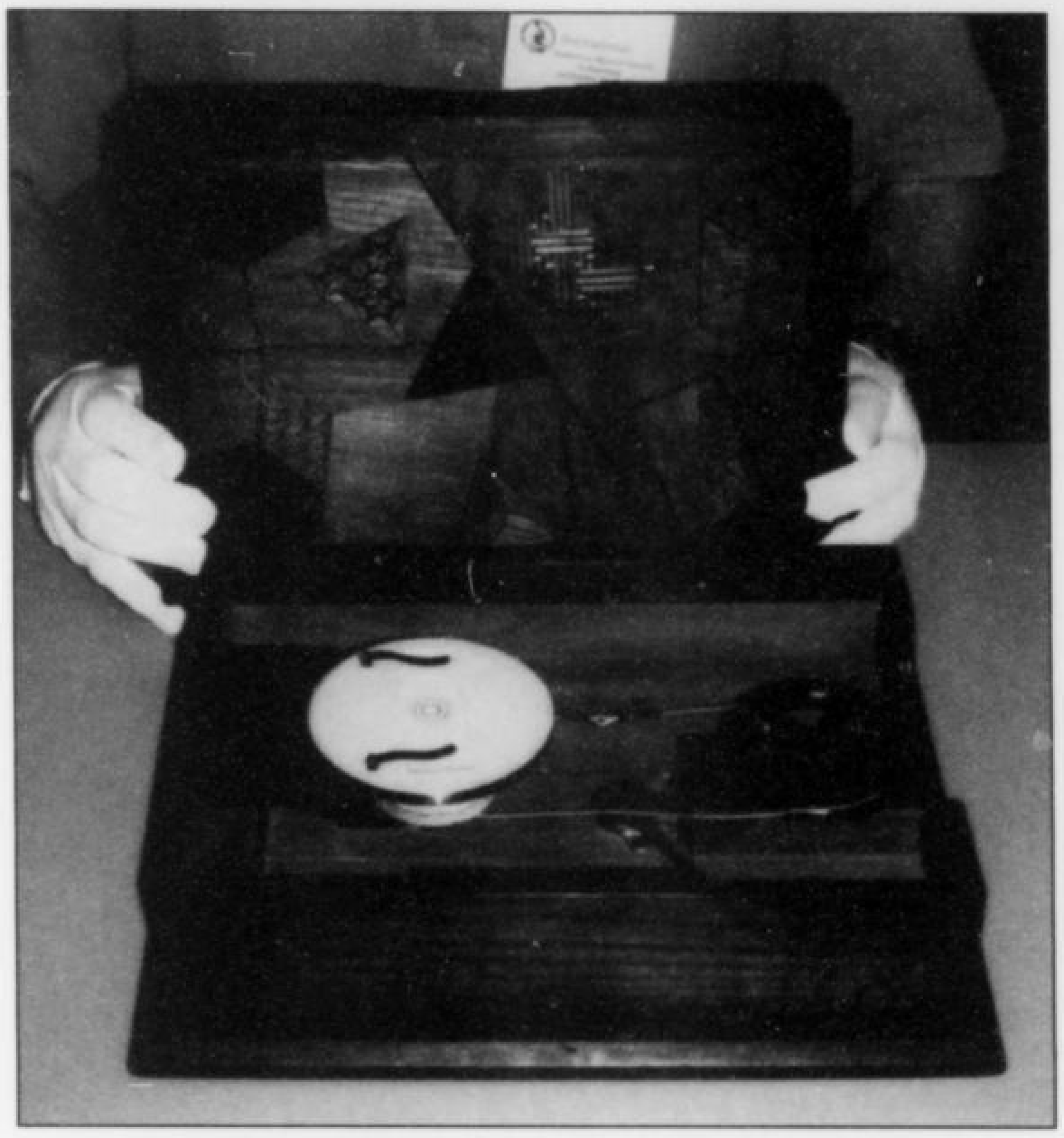


Figure 1. **Leidy Microscopical Society president Don Halterman holds the machine for making perfect circles on microscope slides. Photo: Willow Wight.**

"Why a circle?" one might ask. Well, early micromounts were made directly on standard microscope slides. A standard slide is a thin glass plate, one inch by three inches in size. The trick was to glue on a small ring (a piece of tubing) that would enclose the specimen. For really thin specimens, one could simply build up a heavy ring of adhesive that would support a cover glass. The difficult part was getting a nice, uniform circle of adhesive.

Someone thought about that, and produced a machine to do the job. In essence, the slide was centered upon a circular disk that was spun by a pulley system. A brush with a little glue, held to the spinning disk at a given distance from the center, produced a perfect circle as the disk turned. At least one such machine still exists, in the collection of the Leidy Microscopical Society. Don Halterman, current President of the Society, found it in rather worn condition, and polished it up for display. He brought it to the Micromount Symposium as an example of early work. Naturally, as an instrument of a bygone era, it was built and finished with beautiful craftsmanship—in fact, almost frivolous craftsmanship, with an intricately inlaid lid. Our current little jigs and pedestal holders pale in comparison.

Few, if any, micromounters use glass slides today. We have the advantage of better microscopes, more appropriate containers, and a host of other small conveniences. In many ways, our collections themselves are superior to those of the past, but in many ways also, we have lost the pride in care and craftsmanship that went before. It is becoming increasingly difficult to find a well made micromount.

The Hall you say!

The last time I mailed off to the Board of Directors of the Baltimore Mineral Society (BMS) the list of those micromounters nominated for election to the *Micromounters Hall of Fame* (the BMS is the host group for the Hall of Fame) it brought a couple of thoughts to mind. As the current coordinator for the Hall, I field a lot of questions about the nomination and election procedures. There is clearly a great deal of misunderstanding of the process, so it may be worthwhile to expand a little on the subject here.

Nomination

Anyone may nominate a micromounter for election to the Micromounters Hall of Fame. All nominations received are treated with the same consideration, no matter their source.

The only important factor in making a nomination is that it must be supported. One cannot say: "I nominate Charlie Brown," and leave it at that. The nomination must say: "I nominate Charlie Brown because he has done this, this, this, and that, and these are the dates, places, and times at which he did them."

Nominations should be sent directly to me as the coordinator, or to the president of the Baltimore Mineral Society.

Election Criteria

In making their decision, the members of the BMS Board assess the accomplishments of each nominee with respect to the following criteria:

(1) Assembly of a worthy and substantial micromount collection and arrangement for its preservation and accessibility for study and viewing by serious micromounters and mineralogists.

(2) Author of a regular micromount column in recognized mineral publication(s) over a period of 15 or more years.

(3) Founding and supporting micromount symposia continuing regularly (annually) for fifteen or more years.

(4) Photomicrography and building a library of micromount slides used regularly for education and pleasure of micromounters and others at micromount symposia, mineral shows, mineral club meetings and informal groups of micromounters over a period of fifteen or more years.

(5) Lectures, demonstrations, micromount slide programs and courses given on a more or less regular basis at micromount symposia, mineral shows, mineral club meetings and similar functions to educate and inform micromounters over a period of fifteen or more years.

(6) Founding a mineral club that has been recognized as a leader in promoting micromounting for twenty or more years.

(7) Regular contributions to the health and growth of micromounting, including instructing individuals and groups of micromounters over a period of twenty or more years that is comparable in significance to one of items (1) through (6) above.

Obviously, a candidate need not fulfill all of these criteria for election. If such were the case, there would be almost no members in the Hall of Fame. Most members are elected on their records of having accomplished an acceptable number of significant achievements related to the criteria over a period of at least fifteen years. Success in election is therefore based on two things: the quality of the nomination submission, and the interpretation by the BMS members of how closely the candidate's qualifications match the criteria. Clearly, one depends on the other.

It should be noted also that there is no criterion related to the *size* of the candidate's micromount collection. The terms are "worthy and substantial." In other words, a 1,000-mount collection that illustrated the complete suite of minerals from one locality, showing their habits and paragenetic relationships, may be much more significant than a random jumble of 10,000 mounts from all over the place.

Follow-up

The BMS Board members choose two candidates per year from those nominated. That does not, however, ensure their election. The names of the two chosen candidates are then circulated to the current members of the Hall of Fame, who are asked to vote upon their suitability. Once a candidate's name has passed this second screening, the election is considered final. The names are announced at the Paul Desautels Micromount Symposium in September, and the induction ceremony takes place at the same venue, one year later.

As of June, 2003, the Micromounters Hall of Fame had 46 members, of whom 22 are still living.

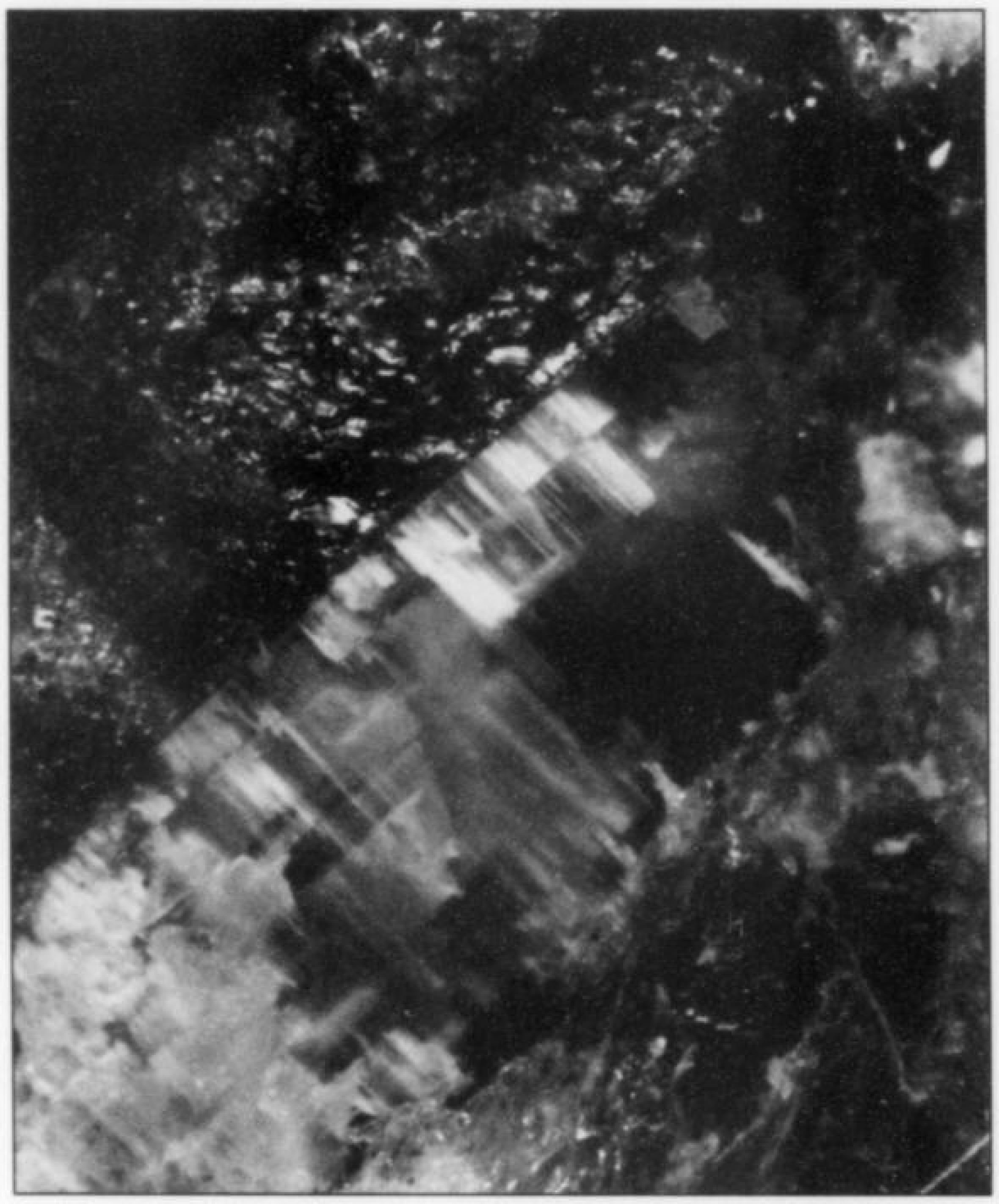


***Figure 2.* Interior of the broken quartz crystal (5 mm) from Mont Saint-Hilaire showing the fine quartz fibers oriented across the gap between the outer layers and the central core. [MQ 2410 and 2391]**

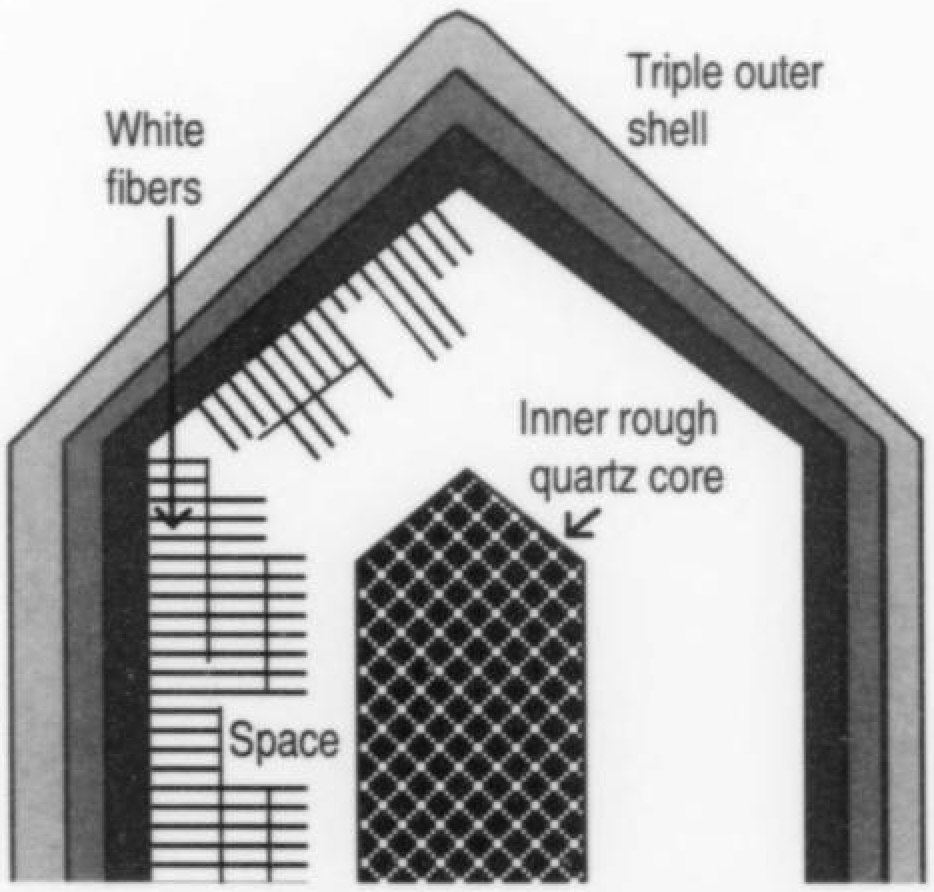


***Figure 3.* Schematic diagram of the broken half of the quartz crystal from Mont Saint-Hilaire, showing the gap between the core and the outer layers.**

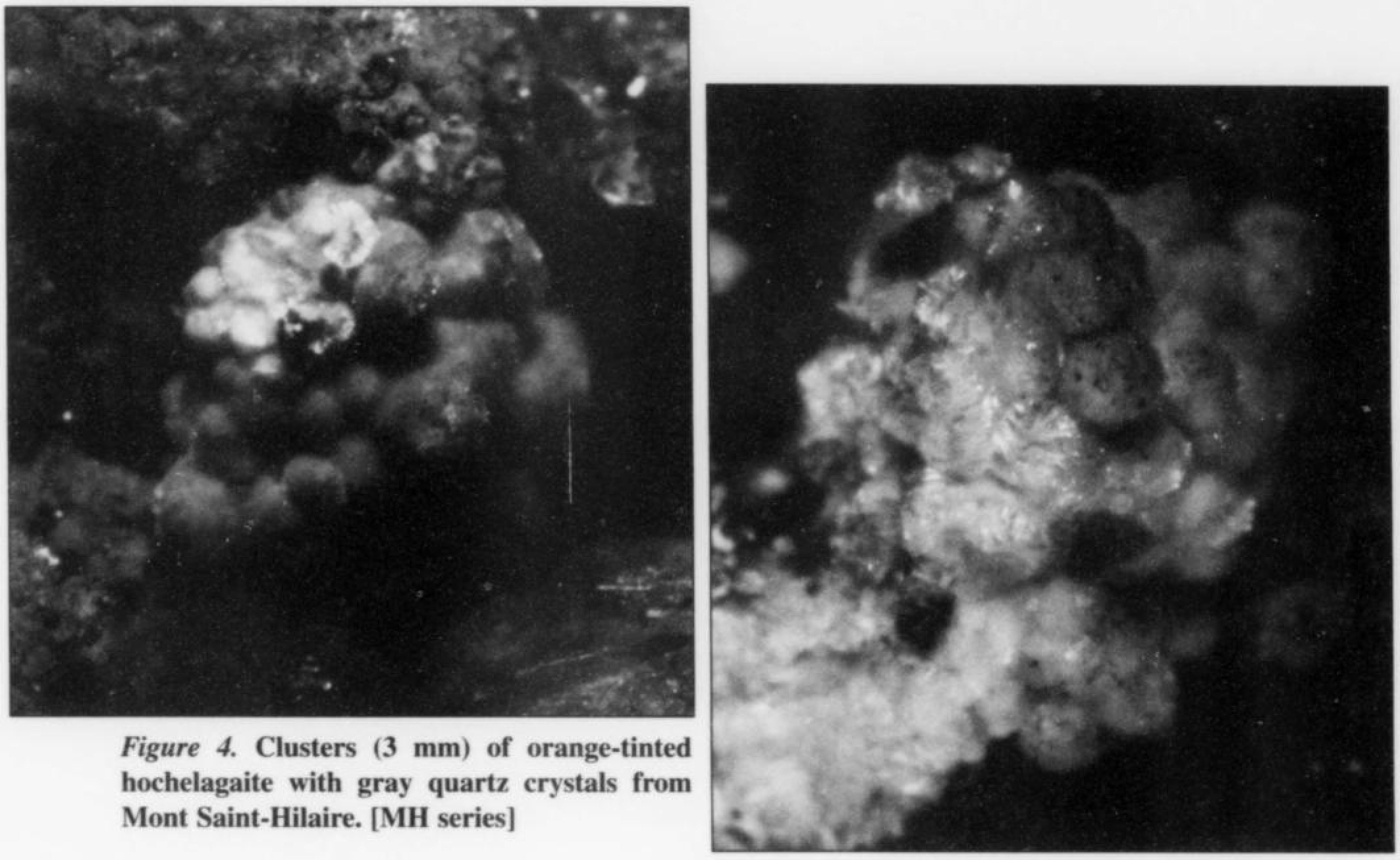


Figure 4. **Clusters (3 mm) of orange-tinted hochelagaite with gray quartz crystals from Mont Saint-Hilaire. [MH series]**

It's what's inside that counts

In my last column, I mused about the many habits of quartz at Mont Saint-Hilaire. Then, I was speaking of the outer appearance. Now, I have an inner problem.

In the quarry, in 2002, I picked up a chunk of rock that was basically a mixture of vuggy, brecciated feldspar and clusters of dull, gray quartz crystals, all more or less stained by decaying pyrite. In the crevices were clumps of orange balls. Under the microscope the clumps resolved themselves into nice, white, hochelagaite clusters, tinged orange by iron oxide. While breaking the rock apart to get at the hochelagaite, I noticed that one quartz crystal had split in two, neatly parallel to the "c" axis. The inside of each half turned out to be a real surprise.

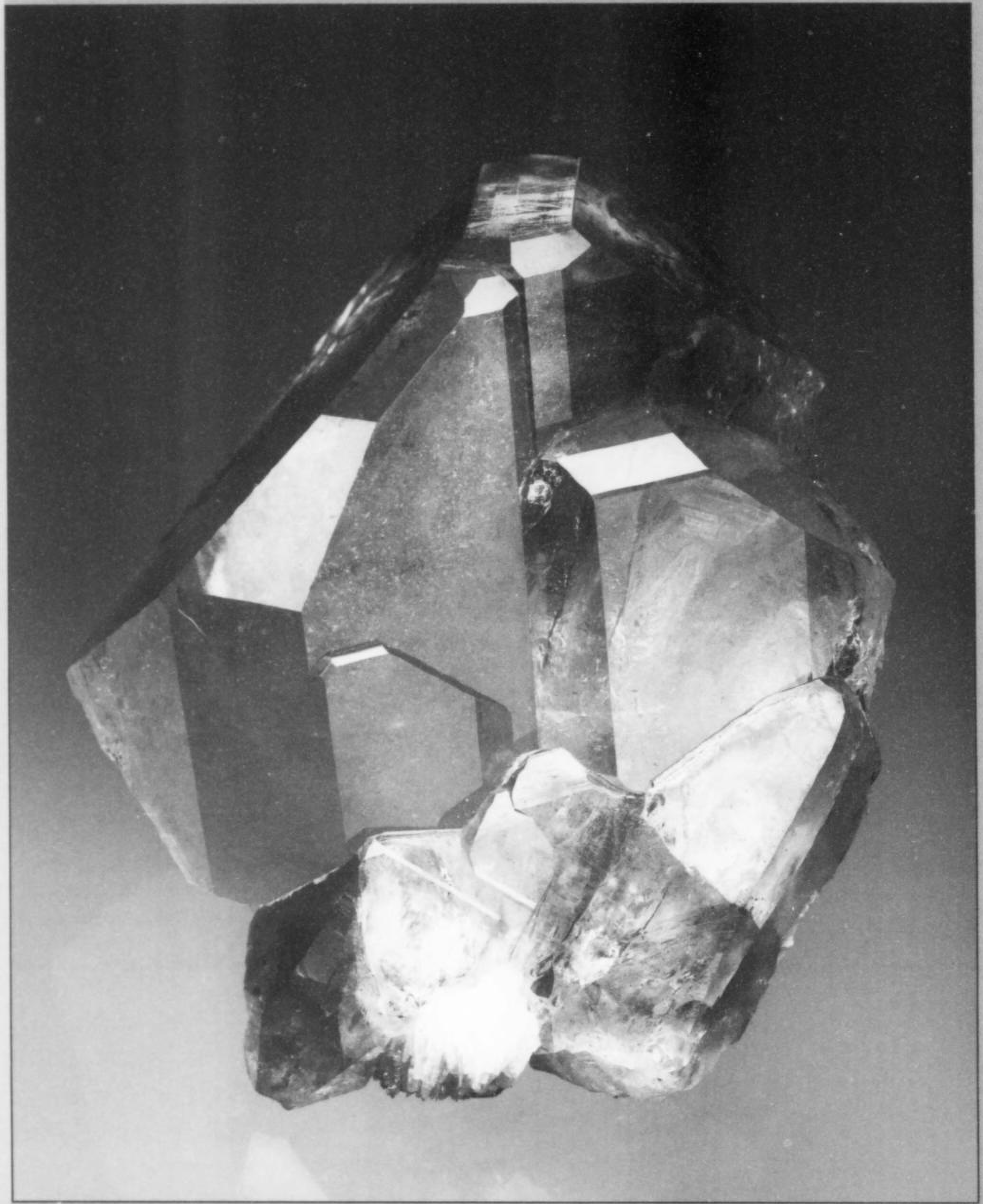
One half revealed an outer shell made up of three distinct layers, the inmost of which was black. That was followed by a space, then there was an inner crystal core. The surprise was that the space was occupied by an array of gorgeous, stiff white fibers, seemingly oriented at right angles to the black layer. At intervals, the fibers were cut by exquisitely thin plates (Figure 1).

The other half of the crystal had a few white fibers, but it was mostly empty space with more thin, platy shells of quartz (Figure 2).

Although no formal work has been done on the specimen, professional opinion has since determined that the fibers themselves are quartz, as are the very thin plates that cut them. Again, I emphasize the point that no matter how common a mineral may be it is always worth examining. One never knows what treasures may be revealed.

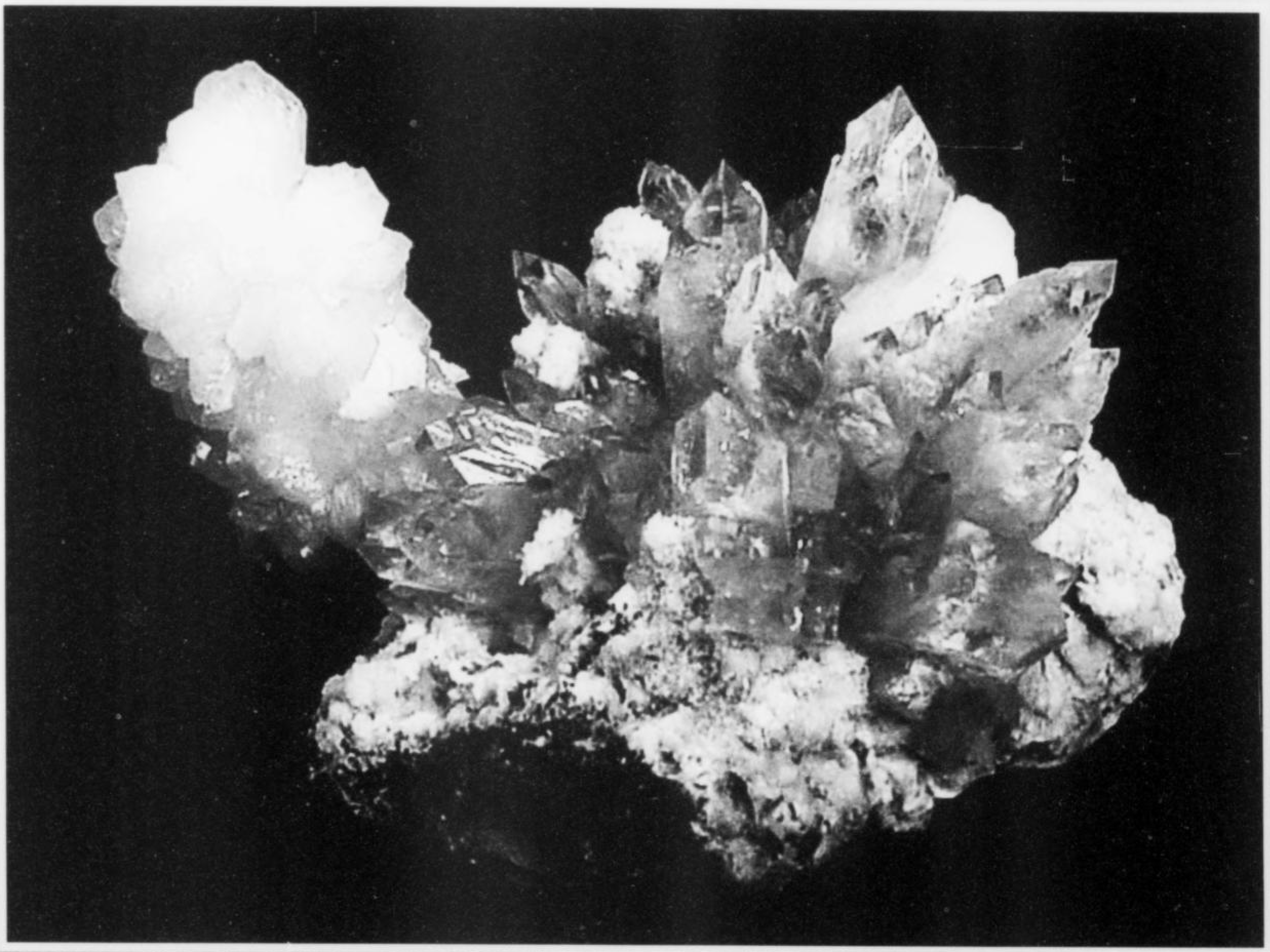
As for the hochelagaite, it was originally thought to be franconite, but as it refused to fluoresce under either longwave or shortwave ultraviolet light, it was subjected to both X-ray and EDS analysis at the Canadian Museum of Nature. It showed a little sodium, but a high calcium spike, confirming the identification of hochelagaite.

From the Steve Neely Collection



TOPAZ on Smoky Quartz, 3⅜ x 4 x 4½ inches (Topaz crystal 4 1/16 inch). Shigar Valley, Northern Areas, Pakistan. Herb Obodda (Feb. 1991); Keith Proctor (Jan. 2005); 1992 Pearl Trophy, Denver

Jeff Scovil Photo

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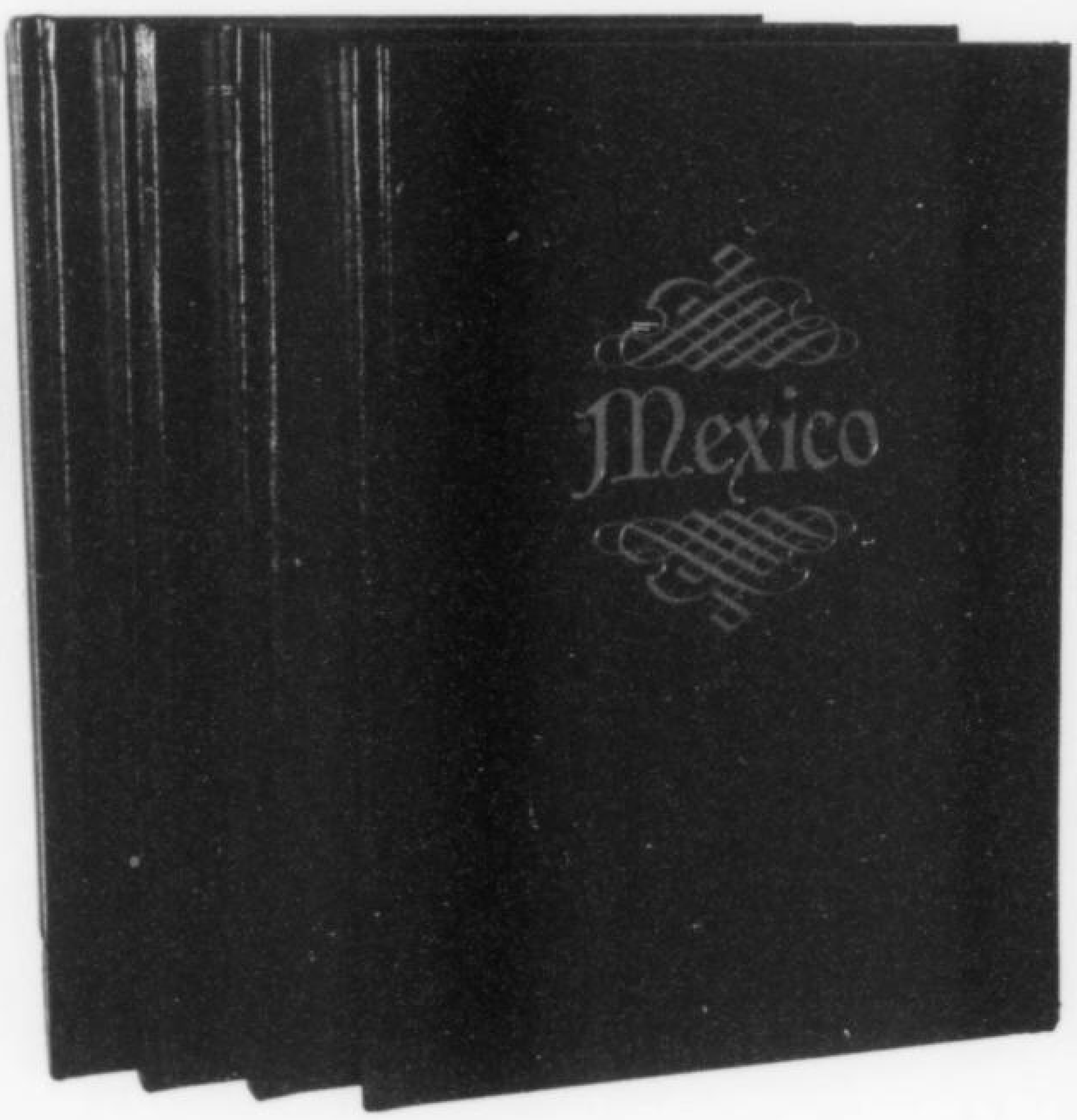
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Who We Are

The Friends of Mineralogy (FM), formed at Tucson, Arizona on February 13, 1970, operates on a national level and also through regional chapters. It is open to membership by all. FM's objectives are to promote, support, protect and expand the collection of mineral specimens and to further the recognition of the scientific, economic and aesthetic value of minerals and collecting mineral specimens.

FM has a long association with *The Mineralogical Record.* It helps produce locality indexes for specimen mineral localities published in *Rocks and Minerals,* and is co-sponsor, with the Tucson Gem & Mineral Society (TGMS) and the Mineralogical Society of America (MSA), of the annual Tucson Mineralogical Symposia. Among its activities it also sponsors awards for best articles each calendar year in *The Mineralogical Record*, *Rocks & Minerals* and *extraLapis English* and gives special recognition at the February Tucson Gem and Mineral Show for educational displays which help explain an aspect of mineralogy.

The Friends of Mineralogy is affiliated with the *American Geological Institute* and the *Mineralogical Society of America,* as well as with *Rocks & Minerals* and *the Mineralogical Record.* Both of these magazines provide FM space and publish news of its activities from time-to-time. FM in turn supports these magazines in various endeavors.

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ABSTRACTS

of the 26th Annual

TUCSON MINERALOGICAL SYMPOSIUM

CHINA!

PROGRAM SCHEDULE

Saturday, February 12, 2005

[10:00 am to 10:45]
The Development and Future Potential of China as a Supplier of Mineral Specimens
Rock H. Currier

[10:45 to 11:15]
Mineral and Stone Collecting in China
Guanghua Liu

[11:15 to 11:45]
Mineralogy of the Yaogangxian Tungsten Mine, Chenzhou Prefecture, Hunan, China
Berthold Ottens & Robert B. Cook

[11:45 to 12:15]
In Search of World-Class Specimens in China
Georg Gebhard

LUNCH BREAK

[13:30 to 14:00]
The Xuebaoding Beryl-Scheelite Vein Deposit, China
Berthold Ottens

[14:00 to 14:45]
A Mineral Excursion to China: 2004
Jeffrey A. Scovil

[14:45 to 15:30]
China's Underground Frontiers and Comparative Observations on Cave Mineral Deposits
Kevin Downey

The Development and Future Potential of China as a Supplier of Mineral Specimens

Rock H. Currier
13100 Spring Street
Baldwin Park, CA 91706

With the fall of the Iron Curtain, specimens began flooding out of former Soviet-bloc countries and China. While it has proven difficult to export specimens from Russia, China has taken to the export of mineral specimens with a passion that shows no signs of diminishing.

The initial supply of mineral specimens from China was centered around the various Chinese Geological Survey branch offices, especially in Hunan province. The supply increased as survey personnel quit their government jobs and began buying and selling specimens on their own, thus capitalizing on the greater financial opportunities afforded by dealing in minerals. Other miners and geologically trained individuals soon joined the fray and now China is one of the largest if not *the* largest supplier of mineral specimens in the world.

China has an appreciation of minerals and stones that goes back to dynastic times. In the Forbidden City in Peking, the emperor's private garden prominently features cave formations. In one part of the garden, there is a small hill with grottos built of cave formations as well as a display of beautiful river-sculpted rocks. Today, the Chinese continue to cherish cave formations and river rocks.

Although cave explorers in the United States and Europe are strictly prohibited from collecting in caves, the Chinese routinely strip them. Containers of cave formations and river rocks are regularly exported to the United States and are purchased predominantly by Chinese Americans.

Changsha, the capital of Hunan province, has become the center of China's mineral specimen trade. The quantity of Chinese specimens being exported to the West and the number of Westerners going there to buy specimens continue to increase, assuring China's future as a source of mineral specimens.

Mineral and Stone Collecting in China

Guanghua Liu
AAA Mineral International
Franzoesische Allee 24
72072 Tuebingen, Germany

The Chinese have not traditionally collected minerals in the Western sense. Rock and stone collecting, on the other hand, is quite popular and can be traced back to 200 BC when the royal families sought and preserved rare stones. Besides jade or other stone carvings, the Chinese collect stones and rocks that show uncommon shapes, colors and structures or that exhibit unusual properties. Unlike Western collectors, the Chinese are not particularly interested in the scientific significance of their collections or in crystal perfection. They instead focus on a stone's aesthetic/sculptural appeal and on odd configurations, as well as any suggestive shapes having potential links to legend, ancient events, famous people, religions or philosophies. The Chinese do not collect the stones themselves; rather they collect a physical representation of the ideas that the stones imply. Rock collecting in China is, therefore, regarded as a cultural endeavor.

Collectible stones are generally grouped into one of four categories: rare stones, imaging stones, ornamental stone and writing-room stone. The first three groups can include any attractive or strange looking stones or can be a piece of rock from a remote or historic location. A pebble or cobble with graphic veins or laminations that form a special Chinese character or an image of an animal, a historic figure, etc. would fit into these categories as would a piece of rock shaped like a Buddha.

Writing-room stones combine typical oriental culture with natural stones and the art of cutting. Writing-room stones include ink stones used to grind inks; paper stones used to press paper; pen stones used to hold pens; and chop seal stones used as signature stamps.

Shops selling collectible stones to the Chinese can be seen all over China, especially in big cities and in tourist spots. In the Chinese stone market, bigger is generally better and more expensive. In recent years, some Chinese have begun to take up Western-style mineral collecting, with more and more stone lovers expressing an interest in and passion for minerals, crystals and fossils.

Mineralogy of the Yaogangxian Tungsten Mine, Chenzhou Prefecture, Hunan, China

Berthold Ottens
Klingenbrunn-Bahnhof 24
94518, Spiegelau, Germany
&
Robert B. Cook
Department of Geology and Geography
Auburn University
Auburn, AL 36849

The Yaogangxian mine lies within the Nanling metallogenic belt of southern Hunan, China, an area long known as the world's richest tungsten province. The mine exploits a series of mineralized quartz veins and associated tungsten-rich skarns on Yaogangxian Mountain, located in the extreme southeastern part of Hunan Province approximately 50 kilometers southeast of the city of Chenzhou. In recent years the mine has become a prolific mineral specimen producer of considerable note.

At least 310 mineral species have been identified in tungsten deposits of the Nanling belt; these include diverse suites of tin, beryllium, silver, rare-earth, and base-metal minerals, in addition to those of tungsten. At Yaogangxian, 32 species, some of which occur in world-class specimens, are of particular interest to collectors. Fluorite in both purple and green crystals occurs in local abundance, often in association with well-developed, lustrous ferberite crystals. Arsenopyrite is an abundant accessory mineral and is common in groups of sharply developed crystals. Some of the world's finest and certainly largest bournonite crystals have been recovered. Ferberite, the dominant tungsten mineral of the vein systems, forms spectacular groups of somewhat tabular crystals, commonly with transparent quartz crystals. The locality is well known for the unusual bertrandite-rhodochrosite association, many specimens of which have reached the collector market. Other well-crystallized carbonates include calcite and manganoan calcite. Fine specimens containing sharply formed stannite and bornite crystals occur locally. Helvite, apatite, topaz and molybdenite are of only rare occurrence but are found occasionally in collectible specimens. Scheelite, tetrahedrite, cassiterite, pyrrhotite and fibrous sulfosalts including jamesonite and boulangerite are locally important and have been collected specifically for their specimen value.

In Search of World-Class Specimens in China

Georg Gebhard
Grossenseifen, Germany

Over the course of the centuries during which Westerners have been collecting minerals, distinctively twinned cinnabar was the only world-class mineral known from China. About 15 years ago, the world began to awaken to China's mineral potential as stunning specimens of realgar and orpiment, clusters of azurite and huge stibnite crystals up to 1 meter long arrived at international mineral shows.

Over the ensuing years, these specimens have been followed by more than 30 "best of species," including orange scheelite crystals to 20 cm, lustrous black cassiterite crystals to 15 cm, ferberite, arsenopyrite, fluorite of all colors, pyromorphite, mimetite, and rarities such as kermesite, helvite, stannite, kësterite and even common minerals such as calcite and quartz.

Although the number of Chinese mineral species on the market unimpressively numbers less than 50, the large perfect crystals (e.g. bournonite), the number of habits (e.g. calcite) and associations (e.g. garnet) have been striking. In a very short time, Chinese minerals have thus impacted mineral collecting and the mineral business as strongly as those from any other country.

Although there are countless mines throughout China, the poor knowledge of minerals by the indigenous Chinese, their even poorer knowledge of deposits of collectible minerals and how to mine them, the difficulty of the language and the poor infrastructure make locating mineral specimens near their source complicated, if not impossible. Mineral dealers in Changsha, the capital of Hunan province, who were previously professional geoscientists, are now the main suppliers of minerals.

These, however, are not China's only suppliers. Antique markets in tourist centers can also be important sources for new finds. Many fabulous specimens of kermesite, pyromorphite and mimetite were originally found in street markets and offered for sale by people who knew neither the mineral nor the locality. Although no new occurrences have surfaced over the last two years, in this huge country, new sensational finds are virtually guaranteed.

The Xuebaoding Beryl-Scheelite Vein Deposit, China

Berthold Ottens
Spiegelau, Germany

Located in Sichuan's Pingwu county, the Xuebaoding beryl-scheelite vein deposit (32°26′N, 104°31′E) is famous for producing superb scheelite, beryl and cassiterite specimens. Xuebaoding Mountain (5,588 meters) is one of the highest mountain peaks in southwestern Sichuan Province. Though regional geological research has been minimal, the deposit is inferred to be part of a regional metallogenic province of Au-Ag, Cu-Pb-Zn and W-Sn-Be.

Structurally, the Xuebaoding deposit is part of the sub-Pankouwan Dome, which lies north of Longmenshan, west of the Huyuagua fault and east of the Xuebaoding Dome of the western Yangtze Paraplatform. The orebody itself is part of a muscovite-rich quartz vein in arizonite.

Inclusion analyses suggest homogenization temperatures varied between 147° and 343° Celsius, low fluid salinity and a mineralization depth of between 160 and 280 meters. The deposit dates from the Yanshan epoch 187 million years ago.

The deposits are found at altitudes of nearly 4,500 meters. About 70 people are currently working the gravel for scheelite ore, and approximately 30 people are employing simple mining techniques to extract what they can from a small number of short underground mines.

In addition to the well-known minerals (such as orange scheelite, tabular beryl in various colors and black twinned cassiterite) produced at Xuebaoding, the deposit yields fine associated specimens of quartz, fluorite and feldspar. On occasion, interesting species such as euclase, apatite, topaz and kësterite with mushistonite have also been found.

A Mineral Excursion to China: 2004

Jeffrey A. Scovil
PO Box 7773
Phoenix, AZ 85011

At the Munich mineral show in 2003 Dr. Guanghua Liu told me of his plans to write a book on the minerals of the province of Hunan, China. He invited me to go with him on one of his research trips and of course I accepted. Dr. Liu was to gather more data on the mines, minerals and mining history of the province, while I would take photos of the mines and region.

I flew to Beijing on April 26th, 2004 where I met Dr. Liu and then together we flew to Changsha, Hunan. The typical day began by renting a car and driver, then driving out into the countryside over usually very bad roads through beautiful countryside to some mining area. At a number of mines we were able to go underground and see the workings as well as photograph ore zones and pockets *in situ*. Some of the better-known mines included Shimen, Xianghuapu, Yaogangxian, Leiping and Shuikoushan. After exploring the mines, local dealers were visited and specimens were bought. In Changsha the mineral dealers' street was visited as well, and we visited a mineral museum in Guiyang.

We visited 12 different mines gathering much useful data for the book, which should be published some time in 2005. It will be illustrated with a mix of mine photos by both Dr. Liu and myself, and with mineral specimen photos from my archives.

China's Underground Frontiers and Comparative Observations on Cave Mineral Deposits

Kevin Downey
Northampton, Massachusetts

The past decade has seen an unprecedented worldwide increase in exploration, major discoveries and new ideas about the development and alteration of minerals in natural cave environments. Caves represent perhaps the best opportunity we have to utilize a natural laboratory for the observation and detailed study of mineralization under many different conditions. Along with studies made of "normal" carbonate bedrock solution caves, work in hydrothermal, sulfuric, sulfidic, high CO_2, and even more exotic environments has resulted in some impressive new findings. In addition to investigations of Karst and cave environments, studies have been performed in hydrothermal environments under high sulfate, sulfide and carbonate activities. Very small differences in the conditions of deposition of minerals such as calcite/aragonite yield remarkably different habits, which also act as a useful way of evaluating paleo-environments. Cave studies have improved our understanding of micro-organic processes and influences on deposition and crystal development long thought to be entirely chemical in nature. While much remains to be done, the current state of knowledge is rapidly expanding. Chinese caves, in particular, include many examples of sulfide and sulfate deposits related to complex hydrothermal, acidic and biological mechanisms. Given that the majority of the world's limestone formations and karst topographies are in China, this country represents a very rich frontier.

It has also become clear that many caves worldwide preserve incredibly interesting data that may forever be compromised or lost if great care is not taken to preserve them. In this context the idea of mineralogical study "*in situ*" is stressed as the key to understanding the details of exactly how and why minerals crystallize and take various habits, as opposed to simply listing and describing them.

Aside from the obvious reasons for preservation of caves for their aesthetic values and for water quality, the potential for mineralogical studies is immense. Considering that development worldwide is fast altering and destroying many important caves, the current explorations in China represent a very time-sensitive opportunity.

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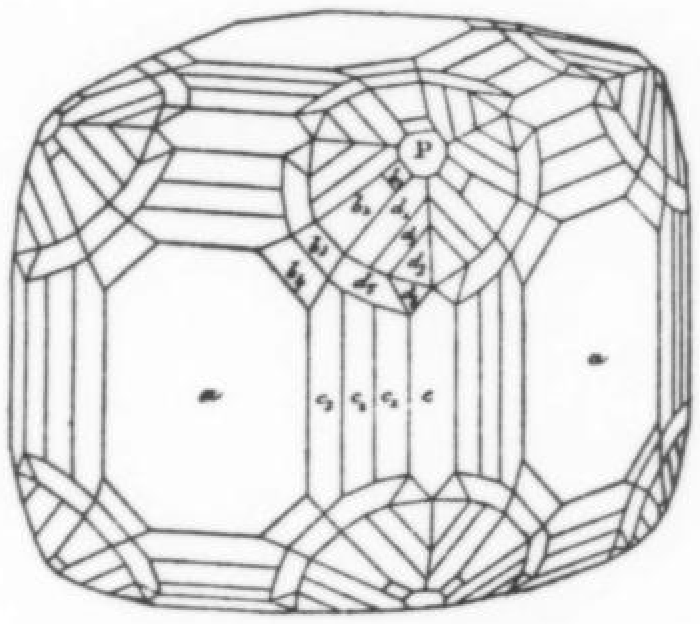

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Megakalsilite Hexagonal

$KAlSiO_4$

Locality: The Khibina alkaline massif, Kola Peninsula, Russia

Occurrence: In a large body of hyperagpaitic pegmatite in ijolite-urtite, near their contact with apatite-nepheline rocks. Associated minerals are: cancrinite, sodalite and natrite (all of which are intergrown with megakalsilite), K-feldspar, natrolite, pectolite, aegirine, nacaphite, vitusite, fluorcaphite, belovite, umbite, lemmleinite-K, lomonosovite, lovozerite, phlogopite, sphalerite and galena.

General appearance: A corroded, anhedral grain 2 to 3 mm across.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* fluoresces pale whitish green in ultraviolet light (240 to 400 nm). *Hardness:* 6. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* conchoidal. *Density:* 2.58 g/cm^3 (meas.), 2.62 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3$, *a* 18.104, *c* 8.467 Å, *V* 2403.3 Å^3, Z 24, *c:a* = 0.4677. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.18 (50) (141), 3.091 (100) (222), 2.612 (70) (060), 1.674 (50) (173), 1.585 (50) (282, 225), 1.516 (50) (145, 660), 1.240 (60) (4.10.1, 066, 583), 1.204 (50) (4.10.2, 285), 1.031 (50) (666, 228). ***Optical data:*** Uniaxial (–), ω 1.538, ε 1.531, nonpleochroic. ***Chemical analytical data:*** Means of thirty sets of electron microprobe data: Na_2O 0.02, K_2O 29.73, FeO 0.04, Al_2O_3 32.38, SiO_2 37.96, TiO_2 0.01, Total 100.14 wt.%. Empirical formula: $K_{1.00}Al_{1.00}Si_{1.00}O_{4.00}$. ***Relationship to other species:*** It is a polymorph of $KAlSiO_4$.

Name: For the relationship with kalsilite the most common form of $KAlSiO_4$ in nature; the prefix mega (from the Greek μεγας) alludes to the much higher unit cell volume of this mineral (2403 Å^3) compared to that of kalsilite (200 Å^3). ***Comments:*** IMA No. 2001-008.

KHOMYAKOV, A. P., NECHELYUSTOV, G. N., SOKOLOVA, E., BONACCORSI, E., MERLINO, S., and PASERO, M. (2002) Megakalsilite, a new polymorph of $KAlSiO_4$ from the Khibina massif, Kola Peninsula, Russia: Mineral description and crystal structure. *Canadian Mineralogist* **40**, 961–970.

Moëloite Orthorhombic

$Pb_6Sb_6S_{14}(S_3)$

Locality: The Ceragiola marble quarry, near the small town of Seravezza, in Versilia, at the southern rim of the Apuan Alps, province of Lucca, northern Tuscany, about 35 km north of Pisa, Italy. The Seravezza area is 20 km southwest of Carrara.

Occurrence: In small cavities within marble. Associated minerals are: sulfur, pyrite and enargite. In these cavities many other sulfosalts have been found: guettardite, robinsonite, zinkenite, boulangerite, semseyite, jordanite, tetrahedrite, sulvanite, colusite, famatinite and kësterite.

General appearance: Very thin, needle-like crystals (up to 0.1 x 0.1 x 5 mm) or as soft plumose aggregates of flexible thin fibers up to 5 mm long.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* grayish-black to brownish-red. *Streak:* brown. *Hardness:* could not be determined. *Tenacity:* flexible. *Cleavage:* not observed. *Fracture:* not given. *Density:* could not be measured, 5.87 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, $P2_122_1$, *a* 15.328, *b* 4.0400, *c* 23.054 Å, *V* 1427.6 Å^3, Z 2, *a:b:c* = 3.7941:1:5.7064. Morphology: no forms were identified, elongated on [010]. Twinning: none observed. ***X-ray powder diffraction data:*** 3.724 (55) (106), 3.427 (100) (403), 3.047 (85) (312), 2.844 (58) (503), 2.779 (70) (016), 2.753 (45) (116), 2.017 (80) (614), 1.733 (50) (0.1.12). ***Optical data:*** In reflected light: white, moderate anisotropism, nonpleochroic; rare red internal reflections in oil. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (40.0, 37.8; 26.6, 24.2 %) 470nm, (38.8, 36.5; 24.9, 22.8 %) 546nm, (38.6, 36.7; 23.4, 21.4 %) 589nm, (36.5, 34.7; 21.2, 20.1 %) 650nm. ***Chemical analytical data:*** Means of four sets of electron microprobe data: Pb 48.94, Sb 29.47, S 21.76, Total 101.17 wt.%. Empirical formula: $Pb_{6.02}Sb_{6.04}S_{16.94}$. ***Relationship to other species:*** None apparent, but it is the natural analogue of synthetic material.

Name: For Dr. Yves Moëlo (1949–), Institut des Matériaux de Nantes, France in recognition of his contributions to lead sulfosalt mineralogy. He also characterized the synthetic equivalent of this phase. ***Comments:*** IMA No. 1998-045.

ORLANDI, P., MEERSCHAUT, A., PALVADEAU, P., and MERLINO, S. (2002) Lead-antimony sulfosalts from Tuscany (Italy). V. Definition and crystal structure of moëloite, $Pb_6Sb_6S_{14}(S_3)$, a new mineral from the Ceragiola marble quarry. *European Journal of Mineralogy* **14**, 599–606.

Monazite-(Sm)

Monoclinic

$(Sm,Gd,Ce)PO_4$

Locality: Annie Claim #3 granitic pegmatite, 1.2 km northwest of Greer Lake, southeastern Manitoba, Canada (Lat. 50°21′12″ N, Long. 95°20′18″ W).

Occurrence: In a pegmatite. Associated minerals are: manganocolumbite, quartz, albite and lithian muscovite.

General appearance: Platy subhedral crystals up to 0.4 mm.

Physical, chemical and crystallographic properties: *Luster:* given as vitreous to slightly greasy, but the optical data indicate adamantine. *Diaphaneity:* translucent to transparent. *Color:* yellowish. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* could not be measured. *Tenacity:* brittle. *Cleavage:* one good direction. *Fracture:* uneven. *Density:* could not be measured, 5.51 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/n$, a 6.725, b 6.936, c 6.448 Å, β 104.02°, V 291.8 Å³, Z 4, $a:b:c$ = 0.9696:1:0.9296. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.191 (40) $(\bar{1}01)$, 4.647 (50) (011), 4.164 (80) $(\bar{1}11)$, 3.492 (40B) (111, 020), 3.264 (70) (200), 3.065 (100) (120), 2.857 (90) $(\bar{1}12, 012)$. ***Optical data:*** Biaxial (+), α 1.768, β 1.771, γ 1.818 (calc.), 2V(meas.) 29°, dispersion not mentioned; pleochroism not mentioned; X=b, Y ∧ a = 5_ in obtuse angle β, Z ∧ c = 9° in obtuse angle β. ***Chemical analytical data:*** Means of three sets of electron microprobe data: CaO 2.75, PbO 2.14, Y_2O_3 1.29, La_2O_3 2.10, Ce_2O_3 10.04, Pr_2O_3 1.58, Nd_2O_3 6.03, Sm_2O_3 13.02, Gd_2O_3 12.06, Tb_2O_3 1.14, Dy_2O_3 1.18, Yb_2O_3 0.02, Lu_2O_3 0.05, ZrO_2 0.71, ThO_2 16.27, UO_2 0.62, SiO_2 1.53, P_2O_5 27.48, Total 100.01 wt.%. Empirical formula: $(Sm_{0.18}Gd_{0.16}Th_{0.15}Ce_{0.15}Ca_{0.12}Nd_{0.09}La_{0.03}Y_{0.03}Pb_{0.02}Pr_{0.02}Tb_{0.02}Dy_{0.02}Zr_{0.01}U_{0.01})_{\Sigma 0.97}[(PO_4)_{0.94}(SiO_4)_{0.06}]_{\Sigma 1.00}$. ***Relationship to other species:*** It is the Sm-dominant member of the monazite series.

Name: For the relationship to the monazite series. ***Comments:*** IMA No. 2001-001.

MASAU, M., ČERNÝ, P., COOPER, M. A., CHAPMAN, R., and GRICE, J. D. (2002) Monazite-(Sm), a new member of the monazite group from the Annie Claim #3 granitic pegmatite, southeastern Manitoba. *Canadian Mineralogist* **2002**, 1649–1655.

Mottanaite-(Ce)

Monoclinic

$Ca_4(CeCa)AlBe_2(Si_4B_4O_{22})O_2$

Locality: Monte Cavalluccio, Sacrofano, north of Rome, Italy.

Occurrence: In miarolitic cavities in a feldspathoid-bearing alkali-syenitic ejectum from the "lower pyroclastic flow" of the Sabatini volcanic complex. The only associated mineral noted is britholite-(Ce) with which it is intergrown.

General appearance: Small (< 0.5 mm) tabular crystals.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent to transparent. *Color:* brown to pale brown. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* not given. *Tenacity:* brittle. *Cleavage:* absent. *Fracture:* conchoidal. *Density:* 3.61 g/cm³ (meas.), 3.88 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2/a$, a 19.032, b 4.746, c 10.248 Å, β 110.97°, V 864.3 Å³, Z 2, $a:b:c$ = 4.0101:1:2.1593. Morphology: {010}, tabular. Twinning: none observed. ***X-ray powder diffraction data:*** 3.452 (67) $(\bar{2}12)$, 3.243 (80) (410), 3.085 (85) $(\bar{4}12)$, 2.916 (86) (212), 2.854 (100) (411), 2.647 (84) (013), 2.646 (86) $(\bar{4}13)$, 2.635 (84) $(\bar{6}11)$. ***Optical data:*** Biaxial (–), α 1.680, β 1.694, γ 1.708, 2V(meas.) 90°, 2V(calc.) 89°; dispersion not given; nonpleochroic; orientation not given. ***Chemical analytical data:*** Means of two to four sets of electron microprobe data (light elements by SIMS): Li_2O 0.037, Na_2O 0.00, BeO 2.94, MgO 0.140, CaO 24.46, BaO 0.002, B_2O_3 13.85, Al_2O_3 2.53, Cr_2O_3 0.00, Mn_2O_3 0.00, Fe_2O_3 3.06, Y_2O_3 0.073, La_2O_3 7.42, Ce_2O_3 12.63, Pr_2O_3 1.103, Nd_2O_3 2.36, Sm_2O_3 0.137, Eu_2O_3 0.020, Gd_2O_3 0.094, Dy_2O_3 0.024, Er_2O_3 0.005, Yb_2O_3 0.002, SiO_2 23.85, TiO_2 0.560, ThO_2 4.01, UO_2 0.430, H_2O 0.390, F 1.00, sum 101.13, less O = F 0.42, Total 100.71 wt.%. Empirical formula: $Ca_{4.00}[(REE)_{1.47}Ca_{0.37}Th_{0.15}U_{0.02}]_{\Sigma 2.01}(Al_{0.50}Fe^{3+}_{0.38}Ti_{0.07}Mg_{0.03})_{\Sigma 0.98}(Be_{1.18}Li_{0.02})_{\Sigma 1.20}B_{3.99}Si_{3.98}O_{22.00}[O_{1.04}F_{0.53}(OH)_{0.43}]_{\Sigma 2.00}$. ***Relationship to other species:*** It is a member of the hellandite group.

Name: For Annibale Mottana (1940–), Professor of Mineralogy at the Università di Roma Tre, Italy. ***Comments:*** IMA No. 2000-020.

DELLA VENTURA, G., BONAZZI, P., OBERTI, R., and OTTOLONI, L. (2002) Ciprianiite and mottanaite-(Ce), two new minerals of the hellandite group from Latium (Italy). *American Mineralogist* **87**, 739–744. OBERTI, R., DELLA VENTURA, G., OTTOLONI, L., HAWTHORNE, F. C., and BONAZZI, P. (2002) Re-definition, nomenclature and crystal-chemistry of the hellandite group. *American Mineralogist* **87**, 745–752.

Niigataite

Monoclinic

$CaSrAl_3(Si_2O_7)(SiO_4)O(OH)$

Locality: Miyabana seashore, Ohmi Town, Itoigawa-Ohmi district, Niigata Prefecture, Japan.

Occurrence: In a prehnite boulder. Associated minerals are: prehnite, diaspore and chlorite. Minor constituents are: zircon, galena, cinnabar and strontian clinozoisite.

General appearance: Subhedral grains 0.5 mm across.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* pale gray with a yellowish green tint. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* VHN_{100} 642 to 907 kg/mm², 5 to 5½. *Tenacity:* brittle. *Cleavage:* perfect in one direction. *Fracture:* not given. *Density:* could not be measured, 3.64 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/m$, a 8.890, b 5.5878, c 10.211 Å, β 115.12°, V 459.3 Å³, Z 2, $a:b:c$ = 1.5910:1:1.8274. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.05 (23) $(10\bar{2})$, 3.22 (25) (201), 2.90 (100) $(11\bar{3})$, 2.79 (48) (020), 2.70 (26) (013), 2.60 (24) $(31\bar{1})$, 2.40 (21) $(31\bar{3})$, 2.11 (24) (221), .872 (21) $(22\bar{4})$, 1.397 (22) (040). ***Optical data:*** Complete data could not be determined due to scarcity of material, indices of refraction are between 1.67 and 1.725, violet anomalous interference color was observed. ***Chemical analytical data:*** Means of nine sets of electron microprobe data (with H_2O calculated to give 1 OH): MgO 0.07, CaO 14.09, MnO 0.22, SrO 14.75, Al_2O_3 24.86, Fe_2O_3 7.08, SiO_2 35.49, TiO_2 0.75, H_2O (1.77), Total (99.08) wt.%. Empirical formula: $Ca_{1.00}(Sr_{0.72}Ca_{0.28})_{\Sigma 1.00}(Al_{2.48}Fe_{0.45}Ti_{0.05}Mn_{0.02}Mg_{0.01})_{\Sigma 3.01}Si_{3.00}O_{12.00}(OH)_{1.00}$. ***Relationship to other species:*** It is a member of the epidote group; specifically, the strontium-dominant analogue of clinozoisite.

Name: For the locality. ***Comments:*** IMA No. 2001-055.

MIYAJIMA, H., MATSUBARA, S., MIYAWAKI, R., and HIROKAWA, K. (2003) Niigataite, $CaSrAl_3(Si_2O_7)(SiO_4)O(OH)$: Sr-analogue of clinozoisite, a new member of the epidote group from Itoigawa-Ohmi district, Niigata Prefecture, central Japan. *Journal of Mineralogical and Petrological Sciences* **98**, 118–129.

Nikischerite

Trigonal

$NaFe^{2+}_6Al_3(SO_4)_2(OH)_{18}\cdot 12H_2O$

Locality: Huanuni tin mine, about 50 km SE of Oruro City, Dalence Province, Oruro Department, Bolivia.

Occurrence: Nikischerite does not occur in the cassiterite-bearing veins themselves, but rather in a later, low-temperature paragenesis filling fault zones which cut across the cassiterite veins. Associated minerals are: pyrite, pyrrhotite, siderite and cronstedtite in a brownish clay matrix.

General appearance: Small micaceous plates (up to 4 mm) forming isolated radiating balls comprised of stacked plates and aggregates up to almost 1 cm across. A second occurrence, found in the early 1990's consists of dull, tabular aggregates on vivianite crystals.

Physical, chemical and crystallographic properties: *Luster:* dull to greasy. *Diaphaneity:* transparent to translucent. *Color:* Georgian green (RHS # 139B), darker at the edges of aggregates and approaches grayish white at the cores. *Streak:* pale grayish green. *Luminescence:* nonfluorescent. *Hardness:* 2. *Tenacity:* brittle. *Cleavage:* {001} perfect. *Fracture:* irregular. *Density:* 2.33 g/cm^3 (meas.), 2.34 g/cm^3 (calc.). ***Crystallography:*** Trigonal, $R\bar{3}$, *a* 9.352, *c* 33.08 Å, *V* 2505 Å^3, Z 3, *c:a* = 3.5372. Morphology: {001}. Twinning: none observed. ***X-ray powder diffraction data:*** 10.980 (100) (003), 5.539 (60) (006), 4.311 (20) (113), 3.674 (50) (009), 2.624 (25) (033), 2.425 (30) (036), 2.176 (20) (039), 1.932 (30) (0.3.12). ***Optical data:*** Uniaxial (−), ω 1.560, ε could not be determined, nonpleochroic. ***Chemical analytical data:*** Means of an unspecified number of sets of electron microprobe data (with H_2O calculated to give 42 H): Na_2O 2.43, FeO 43.59, Al_2O_3 14.35, SO_3 13.54, H_2O (35.06), Total (108.97) wt.%. Empirical formula: $Na_{0.85}Fe^{2+}_{6.55}$-$Al_{3.04}(SO_4)_{1.83}(OH)_{19.41}\cdot 11.30H_2O$. ***Relationship to other species:*** It is the Fe^{2+}-dominant analogue of shigaite, $NaMn^{2+}_6Al_3(SO_4)_2$-$(OH)_{18}\cdot 12H_2O$, and motukoreaite, $NaMg_6Al_3(SO_4)_2(OH)_{18}\cdot 12H_2O$.

Name: For Anthony (Tony) J. Nikischer (1949–), amateur mineralogist and mineral dealer of Peekskill, New York.

Comments: IMA No. 2001-039. Tony Nikischer kindly provided some of the data not given in the paper.

HUMINICKI, D. M. C. and HAWTHORNE, F. C. (2003) The crystal structure of nikischerite, $NaFe^{2+}_6Al_3(SO_4)_2(OH)_{18}(H_2O)_{12}$, a mineral of the shigaite group. *Canadian Mineralogist* **41**, 79–82. HUMINICKI, D. M. C., HAWTHORNE, F. C., GRICE, J. D., ROBERTS, A. R., and JAMBOR, J. L. (2003) Nikischerite, a new mineral from the Huanuni tin mine, Dalence Province, Oruro Department, Bolivia. *Mineralogical Record* **34**, 155–158.

Novgorodovaite

Monoclinic

$Ca_2(C_2O_4)Cl_2\cdot 2H_2O$

Locality: The Chelkar salt dome, west Kazakhstan.

Occurrence: In evaporite rock. Associated minerals are: anhydrite, gypsum, halite, bischofite, magnesite and hilgardite.

General appearance: aggregates (up to 3 cm) of grains (up to 7 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 2½. *Tenacity:* brittle. *Cleavage:* {100} and {010} medium. *Fracture:* uneven. *Density:* 2.38 g/cm^3 (meas.), 2.40 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *I2/m*, *a* 6.936, *b* 7.382, *c* 7.443 Å, β 94.3°, *V* 380.0 Å^3, Z 2, *a:b:c* = 0.9396:1:1.0083. Morphology: equant. Twinning: none observed. ***X-ray powder diffraction data:*** 5.062 (7) (110), 4.812 (5) (101), 4.323 (7) $(11\bar{1})$, 4.063 (7) (111), 3.644 (5) (020), 2.956 (8) $(21\bar{1})$, 2.917 (10) (112). ***Optical data:*** Biaxial (–), α 1.565, β 1.645, γ 1.725, 2V(meas.) 88°, 2V(calc.) 86°; dispersion not observed; Y = *b*, Z ∧ *c* = 40° (synthetic). ***Chemical analytical data:*** Analysis (Ca and Cl by electron microprobe, C and H by selective sorption of combustion products in oxygen, O by difference) gave: Ca 29.43, Cl 24.56, H 1.67,C 8.53,O (35.81), Total (100.00) wt.%. Empirical formula: $Ca_{1.83}(C_2O_4)_{1.77}Cl_{1.72}\cdot 2.06H_2O$. ***Relationship to other species:*** It is an oxalate.

Name: For Margarita Ivanovna Novgorodova (1938–) well known Russian mineralogist and director of the Fersman Mineralogical Museum of the Russian Academy of Sciences. ***Comments:*** IMA No. 2000-039. The crystal structure has been solved.

CHUKANOV, N. V., BELAKOVSKIY, D. I., RASTSVETAEVA, R. K., KARIMOVA, O. V., and ZADOV, A. E. (2001) Novgorodovaite $Ca_2(C_2O_4)Cl_2\cdot 2H_2O$, a new mineral. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **130(4)**, 32–35.

Paceite

Tetragonal

$CaCu(CH_3COO)_4\cdot 6H_2O$

Locality: The Potosi silver-lead-zinc deposit, 2 km northeast of Broken Hill, New South Wales, Australia (Lat. 31°56′ S, Long. 141°30′ E).

Occurrence: In gossan. Associated minerals are: goethite, hematite, quartz, linarite, malachite, azurite, cuprian smithsonite, cerussite and hoganite.

General appearance: Short, prismatic crystals (up to 1 mm across).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* deep sky blue. *Streak:* pale blue. *Luminescence:* nonfluorescent. *Hardness:* 1½. *Tenacity:* brittle. *Cleavage:* {100} and {110} perfect. *Fracture:* uneven. *Density:* 1.49 g/cm^3 (calc.). ***Crystallography:*** Tetragonal, *I4/m*, *a* 11.155, *c* 16.226 Å, *V* 2020.13 Å^3, Z 4, *c:a* = 1.4555. Morphology: {100}, {001} and {111}. Twinning: none observed. ***X-ray powder diffraction data:*** 9.297 (6) (101), 8.132 (8) (002), 7.896 (100) (110), 5.586 (15) (200), 3.530 (20) (310), 3.042 (3) (321), 2.497 (4) (420). ***Optical data:*** Uniaxial (+), ω 1.439, ε 1.482, pleochroism O = bluish with a grayish tint, E = pale bluish with a grayish tint, O ≥ E. See Comments. ***Chemical analytical data:*** Wet chemical analysis by AAS (Ca), CHN analyzer (C and H) and O by difference gave: C 21.25, H 5.3, Cu 14.1, Ca 9.0, O (50.35), Total (100.00) wt.%. Empirical formula: $Ca_{1.02}Cu_{1.00}(CH_3COO)_{4.00}\cdot 5.87H_2O$. ***Relationship to other species:*** It is an acetate.

Name: For Frank L. Pace (1948–) of Broken Hill, New South Wales, Australia, an ex-miner and well-known collector of Broken Hill minerals who drew the mineral to the attention of the describers. ***Comments:*** IMA No. 2001-030. Due to the very small amount of natural material, the optical properties were determined from synthetic crystals grown from aqueous solutions. Determination of the crystal structure was not attempted.

HIBBS, D. E., KOLITSCH, U., LEVERETT, P., SHARPE, J. L., and WILLIAMS, P. A. (2002) Hoganite and paceite, two new acetate minerals from the Potosi mine, Broken Hill, Australia. *Mineralogical Magazine* **66**, 459–464.

Paratsepinite-Ba Monoclinic

$(Ba,Na,K)_{2-x}(Ti,Nb)_2(Si_4O_{12})(OH,O)_2\cdot 4H_2O$

Locality: Lepkhe-Nelm Mt., Lovozero massif, Kola Peninsula, Russia.

Occurrence: A hydrothermal mineral in an alkaline pegmatite. Associated minerals are: microcline, aegirine, nepheline, magnesio-arfvedsonite, eudialyte, lorenzenite, lamprophyllite, catapleiite, titanite, vinogradovite, tundrite-(Ce), apatite, neptunite, tsepinite-Na, kuzmenkoite-Zn, korobitsynite.

General appearance: Long, prismatic crystals (up to 5 mm) in cavities and as aggregates.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* brown. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* 2.88 g/cm³ (meas.), 2.95 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 14.551, *b* 14.001, *c* 15.702 Å, β 117.58°, *V* 2835 Å³, Z 8, *a:b:c* = 1.0393:1:1.1215. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 7.11 (10) (020), 4.08 (8) (310), 3.95 (10) (202, 20$\bar{4}$), 3.24 (9) (400, 40$\bar{4}$), 3.11 (8) (042, 024), 2.403 (8) (60$\bar{2}$), 1.914 (9) (20$\bar{8}$), 1.634 (8) (75$\bar{5}$). ***Optical data:*** Biaxial (+), α 1.667, β 1.674, γ 1.770, 2V(meas.) 30°, 2V(calc.) 32°; dispersion not observed; pleochroism not observed; $X < c$, $Y = b$, $Z \wedge a = 28°$ in obtuse angle β. ***Chemical analytical data:*** Means of five sets of electron microprobe data (H_2O by TGA): Na_2O 1.80, K_2O 1.69, CaO 0.51, MnO 1.25, SrO 1.96, BaO 11.02, Al_2O_3 0.22, SiO_2 38.86, TiO_2 17.73, Nb_2O_5 11.60, H_2O 12.85, Total 99.50 wt.%. Empirical formula: $(Ba_{0.46}Na_{0.37}K_{0.23}Sr_{0.12}Mn_{0.11}Ca_{0.06})_{\Sigma 1.35}$-$(Ti_{1.41}Nb_{0.55})_{\Sigma 1.96}(Si_{4.10}Al_{0.03})_{\Sigma 4.13}O_{12.39}[(OH)_{1.80}O_{0.20}]_{\Sigma 2.00}\cdot 3.62H_2O$. ***Relationship to other species:*** It is a member of the labuntsovite group with Ba-dominant and the *c*-parameter twice that of tsepinite-Na.

Name: For the relationship to tsepinite-Na. ***Comments:*** IMA No. 2002-006.

CHUKANOV, N. V., PEKOV, I. V., ZADOV, A. E., ROZENBERG, K. A., RASTSVETAEVA, R. K., KRIVOVICHEV, S. V., and LEVITSKAYA, L. A. (2003) New minerals tsepinite-K $(K,Ba,Na)_2(Ti,Nb)_2(Si_4O_{12})(OH,O)_2\cdot 3H_2O$ and paratsepinite-Ba $(Ba,Na,K)_{2-x}(Ti,Nb)_2(Si_4O_{12})(OH,O)_2\cdot 4H_2O$ and their relationship with other labuntsovite group minerals. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **132**, 38–51.

Paravinogradovite Triclinic

$Na_2Ti_3Fe^{3+}(Si_2O_6)_2(Si_3AlO_{10})(OH)_4\cdot H_2O$

Locality: Mount Kukisvumchorr, Khibina alkaline massif, Kola Peninsula, Russia.

Occurrence: In miarolitic cavities in a nepheline-feldspar pegmatite. Associated minerals are: albite, carbonate-fluorapatite, ancylite-(Ce), natrolite, aegirine, a glauconite-like mineral, nordstrandite, anatase, fluorite, galena, cerussite and vinogradovite.

General appearance: Fan-shaped aggregates of columnar and acicular crystals up to 1.0 cm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* colorless to white. *Streak:* white. *Luminescence:* fluoresces weak yellow-green under 240–400 nm radiation. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* {001} perfect and {010} indistinct. *Fracture:* splintery. *Density:* 2.77 g/cm³ (meas.), 2.74 g/cm³ (calc.). ***Crystallography:*** Triclinic, *P*1, *a* 5.246, *b* 8.734, *c* 12.968 Å, α 70.32°, β 79.01°, γ 89.90°, *V* 547.65 Å³, Z 1, *a:b:c* = 0.6006:1:1.4848. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 11.9 (58) (001), 5.98 (35) (002), 5.88 (65) (0$\bar{1}$1, 012), 4.35 (38) (1$\bar{2}$1, 102), 3.182 (100) (0$\bar{1}$3, 014), 3.085 (29) (123), 2.735 (21) (1$\bar{2}$2, 030). ***Optical data:*** Biaxial (−), α 1.707, β 1.741, γ 1.755, 2V(meas.) 64°, 2V(calc.) 64°; dispersion $r > v$; nonpleochroic; $X \wedge a = 30°$, $Z \approx b$. ***Chemical analytical data:*** Means of eighteen sets of electron microprobe data (BeO calculated by stoichiometry, H_2O by Penfield method): Na_2O 7.77, K_2O 0.87, MgO 0.13, BeO 0.76, Al_2O_3 6.12, Fe_2O_3 4.11, SiO_2 43.54, TiO_2 29.59, Nb_2O_5 0.50, H_2O 6.23, Total 99.62 wt.%. Empirical formula: $(Na_{2.28}K_{0.17})_{\Sigma 2.45}(Ti_{3.37}Fe_{0.47}Nb_{0.03}Mg_{0.03})_{\Sigma 3.90}(Si_{6.59}Al_{1.09}$-$Be_{0.28})_{\Sigma 7.96}O_{22.00}(OH)_{3.74}\cdot 1.27H_2O$. ***Relationship to other species:*** It is chemically and structurally related to vinogradovite.

Name: For the relationship to vinogradovite. ***Comments:*** IMA No. 2002-033.

KHOMYAKOV, A. P., KULIKOVA, I. E., SOKOLOVA, E., HAWTHORNE, F. C., and KARTASHOV, P. M. (2003) Paravinogradovite, $(Na,\square)_2[(Ti^{4+},Fe^{3+})_4\{Si_2O_6\}_2\{Si_3AlO_{10}\}(OH)_4]H_2O$, a new mineral species from the Khibina alkaline massif, Kola Peninsula, Russia: description and crystal structure. *Canadian Mineralogist* **41**, 989–1002.

Percleveite-(Ce) Tetragonal

$(Ce,La,Nd)_2Si_2O_7$

Locality: The Bastnäs Fe-Cu-REE deposit, Skinnskatteberg, Västmanland, Sweden (Lat. 59°51′ N, Long. 15°35′ E).

Occurrence: Known from a single old specimen in the Swedish Museum of Natural History. Associated minerals are: cerite-(Ce), bastnäsite-(Ce), magnetite, chalcopyrite and a clinoamphibole close to the borderline between actinolite and tremolite. Rarer associates are: allanite-(Ce), törnebohmite-(Ce), scheelite and quartz.

General appearance: Anhedral grains (up to 0.5 mm) across in aggregates several mm wide.

Physical, chemical and crystallographic properties: *Luster:* greasy to resinous. *Diaphaneity:* transparent in thin section. *Color:* yellowish gray to white. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* about 6. *Tenacity:* not given but probably brittle. *Cleavage:* 001} imperfect. *Fracture:* not given. *Density:* could not be measured, 5.20 g/cm³ (calc.). ***Crystallography:*** Tetragonal, $P4_1$, *a* 6.7805, *c* 24.689 Å, *V* 1135.1 Å³, Z 8, *c:a* = 3.6412. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.271 (31) (202), 3.135 (27) (203), 3.121 (24) (116), 3.084 (100) (008), 3.011 (18) (211), 2.846 (22) (213), 2.034 (19) (219). ***Optical data:*** Uniaxial (+), ω 1.840, ε 1.846, nonpleochroic. ***Chemical analytical data:*** Means of four sets of electron microprobe data: MgO 0.00, CaO 0.10, Al_2O_3 0.00, Fe_2O_3 0.01, Y_2O_3 2.93, La_2O_3 14.66, Ce_2O_3 31.36, Pr_2O_3 3.41, Nd_2O_3 12.97, Sm_2O_3 2.69, Gd_2O_3 2.26, Dy_2O_3 0.53, Ho_2O_3 0.07, Er_2O_3 0.21, Yb_2O_3 0.04, SiO_2 26.55, Total 97.79 wt.%. Empirical formula: $(Ce_{0.87}La_{0.41}Nd_{0.35}Y_{0.12}Pr_{0.09}Sm_{0.07}Gd_{0.06}Dy_{0.01}Ca_{0.01})_{\Sigma 1.99}Si_{2.01}O_{7.00}$. ***Relationship to other species:*** None apparent.

Name: For Per Theodor Cleve (1840–1905) a professor of chemistry at Uppsala University and the discoverer of the elements holmium and thulium. "Cleveite" a REE-bearing variety of uraninite was named for him by Nordenskiöld in 1878. ***Comments:*** IMA No. 2002-023.

HOLTSTAM, D., NORRESTAM, R., and ANDERSSON, U. B. (2003) Percleveite-(Ce)—a new lanthanide disilicate mineral from Bastnäs, Skinnskatteberg, Sweden. *European Journal of Mineralogy* **15**, 725–731.

Potassic chloropargasite — Monoclinic

$(K,Na)Ca_2(Fe^{2+},Mg)_4Al(Si_6Al_2O_{22})(Cl,OH)_2$

Locality: Elgoras Mt., Sal'nye Tundry, Kola Peninsula, Russia.

Occurrence: In the granulite complex of the massif. Associated minerals are: chlorapatite, almandine, diopside, enstatite, chlorian biotite, potassic pargasite, marialite and plagioclase.

General appearance: Grains up to 0.5 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* opaque. *Color:* black. *Streak:* olive green. *Luminescence:* nonfluorescent. *Hardness:* 5½. *Tenacity:* brittle. *Cleavage:* {110} perfect. *Fracture:* uneven. *Density:* 3.29 g/cm³ (meas.), 3.36 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 9.843, *b* 18.130, *c* 5.362 Å, β 105.5°, *V* 922.1 Å³, Z 2, *a:b:c* = 0.5429:1:0.2958. Morphology: no forms were mentioned, habit equant. Twinning: none observed. ***X-ray powder diffraction data:*** 8.42 (8) (110), 3.116 (3) (310), 2.951 (3) ($\bar{1}$51, 221), 2.714 (10) (151), 2.562 (7) (241), 1.444 (3) ($\bar{5}$33). See COMMENTS. ***Optical data:*** Biaxial (–), α 1.675, β 1.687, γ 1.690, 2V(meas.) 65°, 2V(calc.) 53°; dispersion r > < v, strong, moderate, weak; pleochroism X = light gray, Y = gray, Z = dark green, X < Y < Z; Y = *b*. ***Chemical analytical data:*** Means of unstated sets of electron microprobe data: Na_2O 1.22, K_2O 3.03, MgO 9.08, CaO 11.41, FeO 16.63, Al_2O_3 15.05, SiO_2 38.71, TiO_2 0.26, H_2O 0.84, Cl 4.33, sum 100.56, less O = Cl 0.98, Total 99.58 wt.%. Empirical formula: $K_{0.60}Na_{0.37}Ca_{1.91}(Fe_{2.17}Mg_{2.11}Al_{0.82}Ti_{0.03})_{\Sigma 5.13}(Si_{6.05}Al_{1.95}O_{21.98})[Cl_{1.15}(OH)_{0.87}]_{\Sigma 2.02}$. See COMMENTS. ***Relationship to other species:*** It is a member of the amphibole group, calcic subgroup.

Name: For the composition within the amphibole classification. ***Comments:*** IMA No. 2001-036. The paper gives the formula with Mg > Fe, but the calculations show that the atomic proportion of Fe is slightly higher than that of Mg; the formula given here shows Fe > Mg. The strongest lines of the X-ray powder diffraction data given in the paper's abstract are quite different from those given in Table 2 of the paper. The former match those given in the IMA proposal and are presented here.

CHUKANOV, N. V., KONILOV, A. N., ZADOV, A. E., BELAKOVSKIY, D. I., and PEKOV, I. V. (2002) The new amphibole potassic chloropargasite $(K,Na)Ca_2(Mg,Fe^{2+})_4Al(Si_6Al_2O_{22})(Cl,OH)_2$ and conditions of its formation in the granulite complex of Sal'nye Tundry massif (Kola Peninsula). *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **131(2)**, 58–62.

Potassicleakeite — Monoclinic

$KNa_2Mg_2Fe^{3+}_2LiSi_8O_{22}(OH)_2$

Locality: Tanohata mine, Iwate Prefecture, Japan.

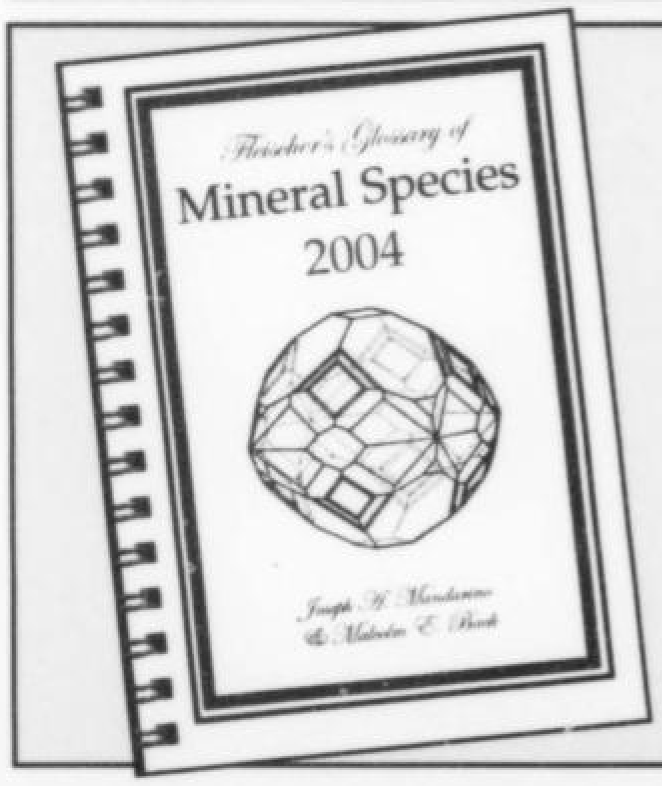
Occurrence: In pegmatite-like veinlets in a manganese ore deposit. Associated minerals are: quartz, K-feldspar, vanadium-dominant mangan-neptunite, suzukiite, roscoelite and sérandite.

General appearance: Prismatic crystals (up to 2 mm long and 0.2 mm wide).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* reddish brown. *Streak:* pale brownish yellow. *Luminescence:* not mentioned. *Hardness:* VHN_{100} 425 to 572 kg/mm², Mohs about 5. *Tenacity:* brittle. *Cleavage:* {110} perfect. *Fracture:* uneven. *Density:* not measured, 3.18 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 9.922, *b* 17.987, *c* 5.286 Å, β 104.07°, *V* 915.1 Å³, Z 2, *a:b:c* = 0.5516:1:0.2939. Morphology: no forms were mentioned; elongated on [001]. Twinning: none mentioned. ***X-ray powder diffraction data:*** 8.48 (67) (110), 4.50 (89) (040), 3.40 (46) (131), 3.28 (45) (240), 3.16 (72) (310, 201), 2.83 (49) (330), 2.74 (44) ($\bar{3}$31), 2.71 (41) (151), 2.53 (100) ($\bar{2}$02). ***Optical data:*** Biaxial (+), α 1.672, β 1.680, γ 1.692, 2V not measured, 2V(calc.) 79°; dispersion not given; pleochroism distinct, X = yellowish brown, Y = pale brown, Z = reddish brown; X ∧ *c* = 35 to 40° in obtuse angle β, Y ∧ *a* = 21 to 26° in acute angle β, Z = *b*. ***Chemical analytical data:*** Means of six sets of electron microprobe data and three sets of LAM-ICP-MS data (H_2O calculated to give 2 OH): Li_2O 1.20, Na_2O 8.73, K_2O 3.10, MgO 7.23, CaO 0.13, MnO 7.81, Al_2O_3 0.44, V_2O_3 5.52, Fe_2O_3 9.45, SiO_2 55.34, TiO_2 0.29, H_2O (2.08), Total (101.32) wt.%. Empirical formula: $(K_{0.57}Na_{0.46})_{\Sigma 1.03}(Na_{1.98}Ca_{0.02})_{\Sigma 2.00}(Mg_{1.29}Mn_{0.65})_{\Sigma 1.94}(Fe^{3+}_{1.02}V_{0.64}Mg_{0.26}Al_{0.05}Ti_{0.03})_{\Sigma 2.00}(Li_{0.70}Mn_{0.30})_{\Sigma 1.00}(Si_{7.98}Al_{0.02})_{\Sigma 8.00}O_{22.00}(OH)_{2.00}$. ***Relationship to other species:*** It is a member of the amphibole group, specifically the sodic subgroup, and it is the K-dominant analogue of leakeite, $NaNa_2Mg_2Fe^{3+}_2LiSi_8O_{22}(OH)_2$.

Name: For the relationship with leakeite. ***Comments:*** IMA No. 2001-049.

MATSUBARA, S., MIYAWAKI, R., KUROSAWA, M., and SUZUKI, Y. (2002) Potassicleakeite, a new amphibole from the Tanohata mine, Iwate Prefecture, Japan. *Journal of Mineralogical and Petrological Sciences* **97**, 177–184.



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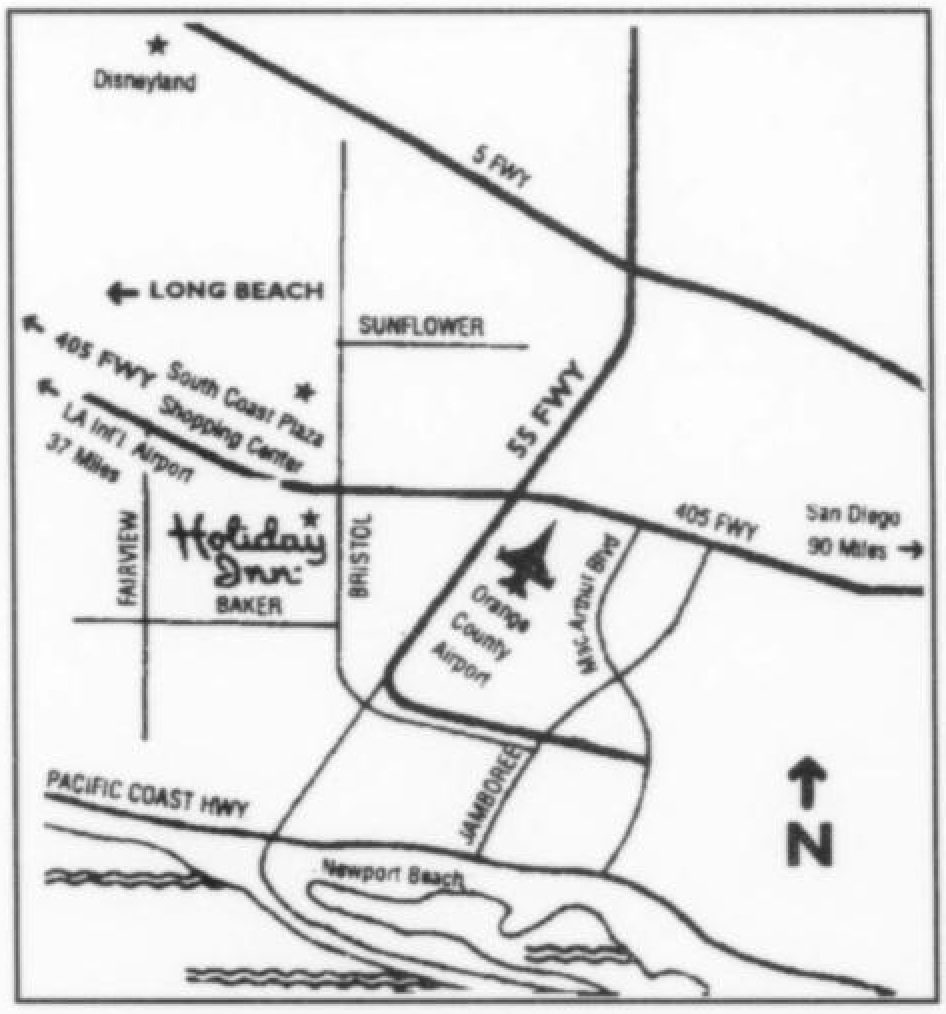

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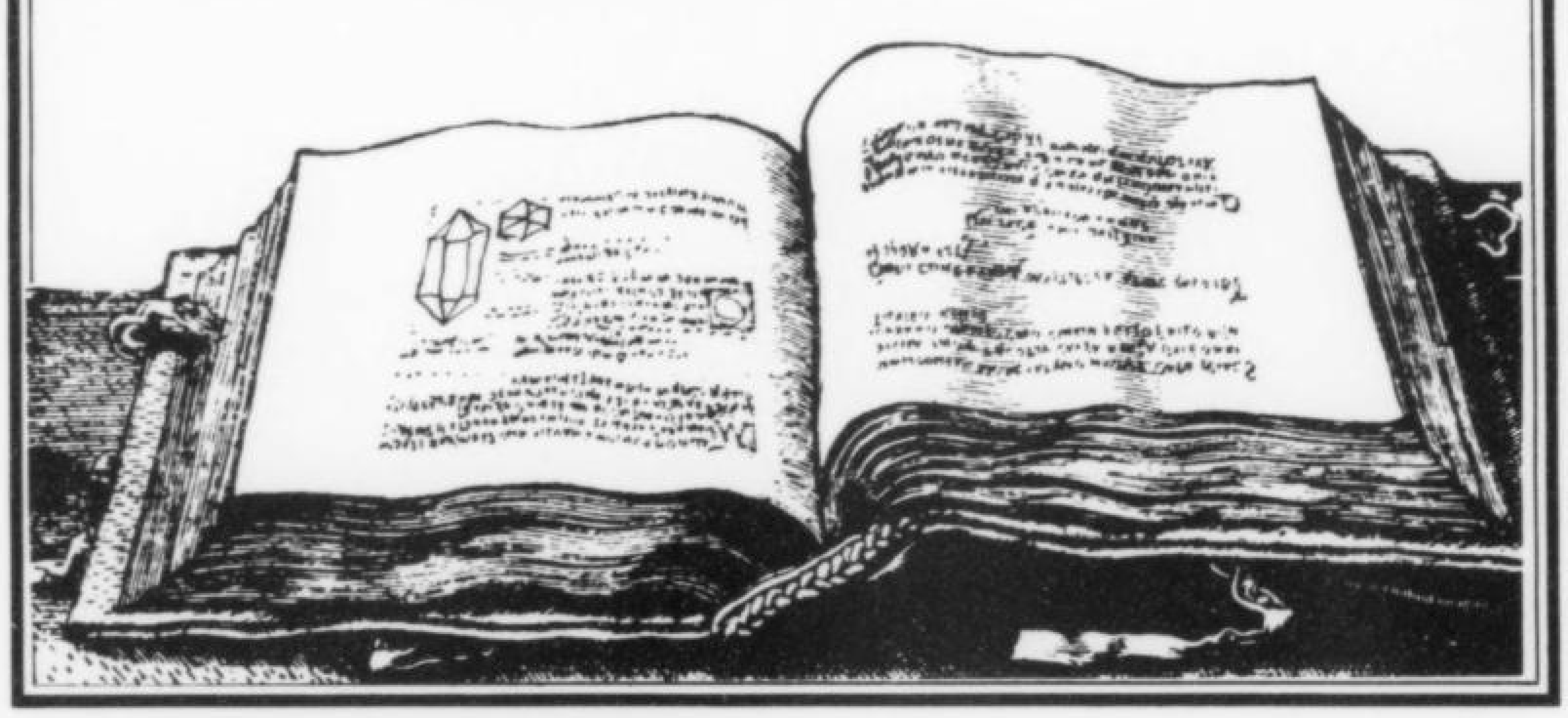
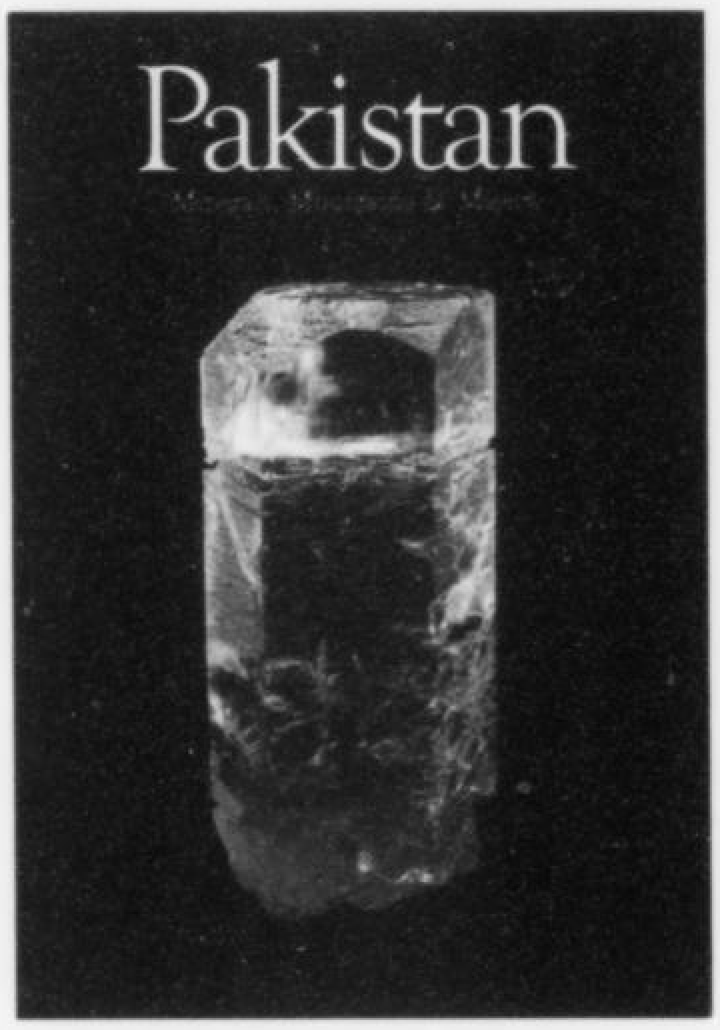
Book Reviews





Pakistan: Minerals, Mountains & Majesty

Edited by Giuseppe Agozzino, Dudley Blauwet, Miranda Jarnot, Shafiee Muhammad, Günther Neumeier, Gloria Staebler and Tom Wilson. Published (2004) by Lapis International, LLC, available from the Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740; e-mail order: minrec@aol.com. Stiff softcover, 8.25 x 11.7 inches, 96 pages. Price: $25.00 + $2.00 shipping in the U.S.

For the theme of their current bravura performance in the English *ExtraLapis* series, after two rich orchestral concerts on individual mineral species (Calcite and Gold), general editors Gloria Staebler and Günther Neumeier have put a whole mineral-rich country on the program: Pakistan now joins Madagascar (subject of *ExtraLapis English* No. 1) in getting the well-scored, many-keyed treatment which by now we've come to expect from this editorial team.

Actually, *Pakistan: Minerals, Mountains & Majesty* is the English version (more or less) of the German *ExtraLapis* No. 24, *Edle Steine vom Dach der Welt*, i.e. "precious stones from the roof of the world," and some of the mountainous landscapes shown in the color photographs here are gorgeous enough to divert the reader's attention for, oh, a second or two at a time from the mineral photographs. But indeed it seems to me that the photos of mineral specimens here set a new, even higher standard for *ExtraLapis* specimen photography. Most of the pictures are, as before, the work of Master Photographer Jeff Scovil, but perhaps one secret of their exceptional success is simply that their subjects are, almost always, absolutely top-quality mineral specimens, including not only predictables such as aquamarine, elbaite, quartz, topaz, epidote, etc., but also relative exotica like gem zoisite, pargasite, ilmenite, bastnäsite and parisite. Just to flip through the book and look at these pictures is a major aesthetic experience; and if the supernally water-clear aquamarine crystal shown on p. 42 (a Gene Meieran specimen) had only replaced the more deeply colored but etched and somewhat raggedy-looking crystal shown on the cover, all would be virtually perfect (in my estimation) in the photo-selection department.

Another virtue of this publication is that several detailed maps, full-page size or nearly so, of the mineral-producing areas are provided in appropriate places, and in the booklet's middle there sprawls a double-page map, after Ali (1995) and Blauwet *et al.* (1987), of the central part of the Northern Areas province. This map, with its ultrafine level of detail (one almost looks for symbols to indicate individual prospect pits or rock dumps) will minister helpfully to the curiosity of collectors puzzling over their labels' locality data. Like Brazil and Russia before it, and like China even as we speak, Pakistan is notorious for producing confusion about locality names, partly because of the many indigenous languages involved, partly because of dealers' secrecy, essentially as a function of the area's remoteness and its geographical, cultural and political complexity. This *ExtraLapis* will, of course, not eliminate the problem, but it should at least make it seem more tractable for the average collector, and the work's very existence might motivate dealers to increase their efforts to get good locality information to pass along to customers. Also noteworthy in this connection is that this English *ExtraLapis* reprints, as a separate chapter, the Blauwet-Smith-Smith index to localities in the Northern Areas of Pakistan which appeared in the May/June 1997 *Mineralogical Record*.

In the first three chapters we read three different kinds of histories of trading in Pakistani minerals. In one, student author Tyler Funk surveys the history of the Eurasian gem trade during the past several thousand years or so; as a bonus he shows us a photo of a beautiful aquamarine crystal obtained in India during World War II by Dick Gaines—among the earliest Pakistani mineral specimens (considered as such) known to have reached the west, and belonging now to Herb Obodda. Speaking of Herb, in another of these essays he looks informally back over his career as a mineral dealer, beginning in the early 1970's, in Pakistan and Afghanistan. In the book's third opening essay a leading Pakistani dealer, Qari Saeed-ur-Rehmann, speaks through interviewers about *his* career in the field, emphasizing the manifold ways in which "Obodda was my teacher."

There follows a short geological chapter in which Bernhard Grasemann and Erich Draganits recount how the Indian plate slammed, and is slamming, into the Asian one, raising the Himalayas, Karakorums and Hindu Kush and giving birth to some of the world's youngest pegmatite swarms. And then, for four chapters (with that amazingly detailed map in the middle), several authors tell us about, in the words of one title, "picking pegmatite pockets" along a long, winding road from Gilgit to Shengus, Stak Nala and Skardu, then north again via Shigar into the Braldu Valley, and finally to

Chumar Bakhoor . . . it is fun simply to write these words, and greater fun still to see them constellate on the map, while letting the likes of Shafiee Muhammad, Syed Kazmi, Dudley Blauwet and others take one there (on the page), to these Places Of Resonant Names.

The next four chapters are loosely about "gemstones," though of course the emphasis is on their natural crystal forms (the authors know their audience). Rubies, sapphires and green pargasites from Hunza; rubies from Azad Kashmir; pink topaz crystals from Katlang in the Mardan district, North West Frontier Province; emeralds from Swat; peridots from the Sapat Valley in Kohistan; and the remarkable, gemmy and pleochroic lazulite crystals which probably, although not certainly, come from Laila Camp in the Gilgit district . . . all these, and their places of origin too, are covered. In the book's final chapters, Shafiee Muhammad invites everyone to visit the Pakistani Gem and Mineral Show held each October in Peshawar; Vera M. Hammer and Andreas Weerth describe Alpine cleft minerals from Pakistan; Si and Ann Frazier explicate faden quartz; Andreas Weerth and Herb Obodda tell us about the rare-earth species of Zagi Mountain (*cf.* the *Mineralogical Record*, May/June 2004); and Dudley Blauwet and Bill and Carol Smith provide the Northern Areas locality index already mentioned.

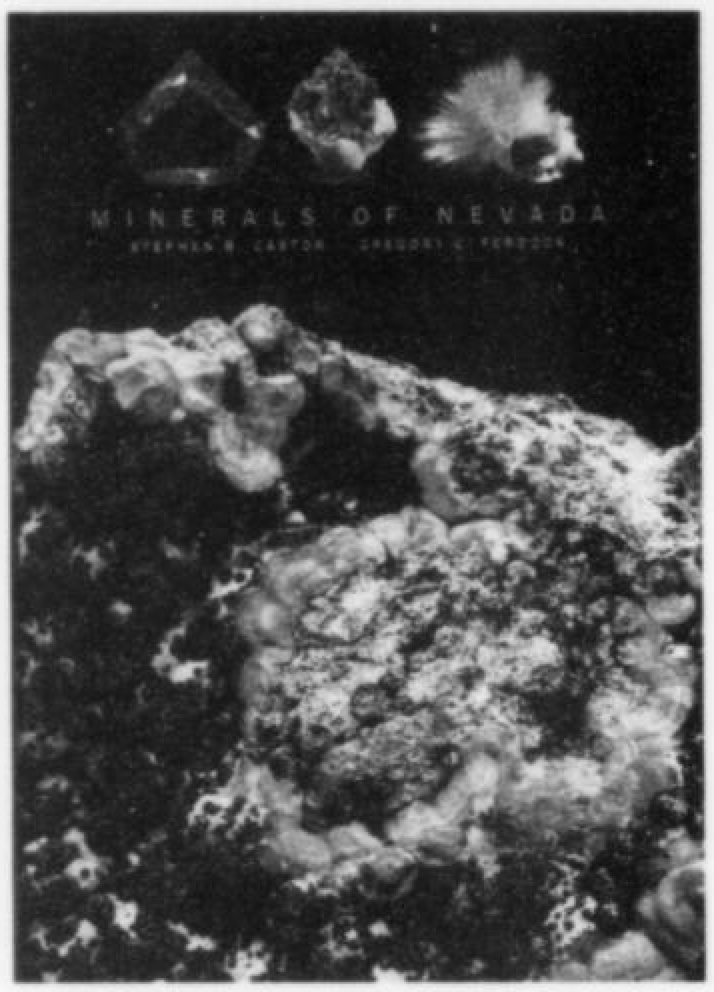
This fine, handsome work is the product of 16 contributing authors, two excellent translators (Günther Neumeier and Alfredo Petrov) and seven editors, and its communal "Literature Cited" list contains 65 titles. It has all the virtues of earlier English *ExtraLapis* productions, and not one of their faults that I can think of. It is the most beautiful and alluring "regional mineralogy" I have ever seen, and full of some of the most useful kinds of information for mineral collectors—and the price is right, too. Do you gather by now that I mean to recommend this book very highly? What part of "Wow!" do you not understand?

Thomas P. Moore

Minerals of Nevada

by Stephen B. Castor and Gregory C. Ferdock, published (2004) by the University of Nevada Press, Reno, Nevada 89557. Hardcover, 7 x 10.5 inches, 512 pages. Price: $75 plus shipping.

Any time a complete new state mineralogy is published, mineral collectors should rejoice, and their celebrations should be particularly jubilant when the work is the first ever prepared for that state. Now at last the mineralogy of the state of Nevada has been described in a major new work by Stephen B. Castor (a research scientist for the Nevada Bureau of Mines and Geology) and Gregory C. Ferdock (a Nevada mineral dealer).



Nevada is a large and mineral-rich state. Eighty-seven percent of all Nevada lands are federally managed and most land is open to public access. Consequently Nevada should be considered a real field-collector's state, as countless localities are still open to collecting.

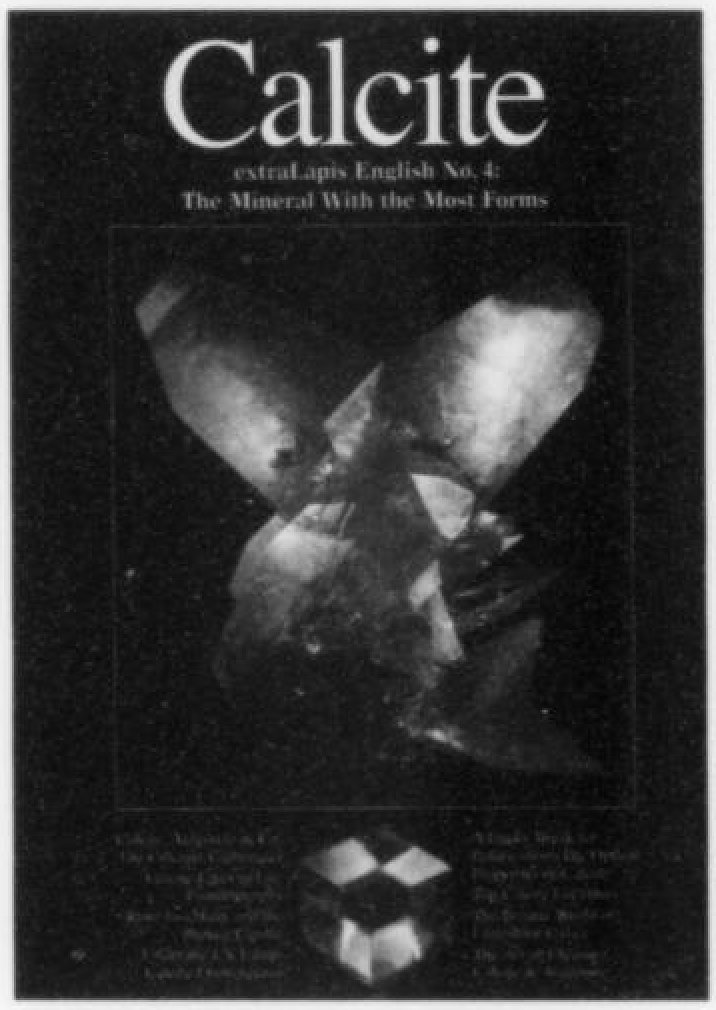
A brief introduction to Nevada geology is followed by a fairly detailed and well-organized summary of the state's mining history. The 37 mineral species for which Nevada is the type locality are tabulated, followed by sections describing Carlin-type gold deposits, Nevada precious-metal deposits in volcanic rocks, porphyry and contact metasomatic deposits, mercury deposits, Nevada's industrial minerals, Nevada's gemstone occurrences, Nevada meteorites, and the Goodsprings mining district. All of these sections provide interesting and pertinent background to a study of the state's mineralogy.

What comes next is rather unusual in such works: three personal collecting narratives written by collector/dealers Forrest Cureton, Martin Jensen and Scott Kleine. These essays provide a personal perspective on dozens of the state's most prolific localities and what they have produced over the years,

Then comes the main body of the work, a 342-page synoptic review of approximately 860 mineral species, described alphabetically, which have been reported or identified from Nevada. The localities for each species are discussed by county, and the work is rendered scholarly by detailed references keyed to a thorough 34-page bibliography.

Lest the gentle but uninformed reader wonder whether Nevada has actually produced any minerals worth looking at, a beautiful 32-page album of color specimen photography is also provided, containing photos by Jeff Scovil and others showing attractive and interesting Nevada minerals. This section and a folded state map of localities (in a map pocket at the back) round out what is a thoroughly competent and well-done state mineralogy, printed on good-quality paper, in clear and readable typography, and nicely bound in navy-blue cloth with an attractive dust jacket. The price is perfectly reasonable as well. This is a book which serious mineral collectors should add to their libraries.

Wendell E. Wilson



Calcite: The Mineral With the Most Forms

Edited by Terry Huizing, Miranda Jarnot, Günther Neumeier, R. Peter Richards and Gloria Staebler. Published (2003) by Lapis International LLC, available from the Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740; e-mail order: minrec@aol.com. Stiff softcover, 8.25 x 11.7 inches, 114 pages. Price: $24.00 + $2.00 shipping in the U.S.

It seems like only a few months ago that I took up the pleasant chore of reviewing *Emeralds of the World* and *Tourmaline*, respectively the second and third offerings in the series of English-language versions of *ExtraLapis* publications on popular mineralogical topics. And now we have a fourth publication, identical in form with the others and easily matching them in beauty, reader-friendliness and conscientious presentation. The editing and translating teams have differed slightly from issue to issue (appropriately, for the changing topics), but Günther Neumeier and Gloria Staebler are still the main organizers, and they have once again created a fine overview, this time, of calcite, "the mineral with the most forms."

Presumably the appearances of future English *ExtraLapis*es will retain their slight element of fun-surprise, as there's no predictable pattern to the topic choices. Some subsequent issues will be about whole mineral-rich countries or provinces (as in "Madagascar," the first of the series) while some will be about particular localities, others about gem varietals ("Emerald") or mineralogical groups ("Tourmaline") or single species ("Calcite").

Calcite opens with a glance at one of those arcane, exhaustive monographs that amateur naturalists of bygone centuries used to self-publish: an album of 1,000 interference figures generated by light polarized by passing through calcite, this the life's work of a German chocolate manufacturer of the 19th century, Hans Hauswaldt. The keynote for the volume is thereby sounded: it enjoys making little excursions to calcite-related subtopics, many of them historical, such that the progress of scientific understanding is shown. For example, there is an essay by Lydie Touret which presents in a cheerfully balanced way the seminal work of the celebrated French Abbot, René Just Haüy: no, he was not the first to seize on the intellectual concept of the unit cell, and yes, he plagiarized an idea or two and then tried to deny/minimize having done so, and no, he most certainly did *not* deliberately smash up his entire calcite collection just to make sure of the constancy of calcite cleavage, but yes, he was a tireless worker who was, if anyone was, the father of modern crystallography.

This Haüy essay belongs to a first group of chapters which are, in effect, basic primers in mineralogy, using calcite to illustrate most of the concepts. In these chapters we read of the relations between the rhombohedral and orthorhombic carbonates and between calcite and its orthorhombic polymorph, aragonite; of calcite crystal symmetry, and the concepts of axes, planes and centers of symmetry, and basic crystallographic forms; of pseudomorphism, and pseudomorphing of other species by and after calcite; of optical phenomena like double refraction and the polarization of light; and of fluorescence as a function of trace-element chemistry. The pristine computer-generated graphics and equally crisp, clear text in these chapters will make it a painless experience even for technically challenged readers to review what they know or don't know about such matters as birefringence, twinning, Miller indices, Snell's Law, and the relationship between cleavage and crystal structure. This part of the work concludes with a short chapter by Michael Gray on faceted calcites, which nicely sums up what has gone before by explaining why the gemcutter needs to know everything he can about optics and cleavage and crystals if he is to produce such gorgeous objects as the six huge faceted calcite gems pictured with the text.

Then comes the fun part: the necessarily, lusciously lengthy survey of major worldwide localities for calcite specimens. These chapters are, as we've come to expect, provided with many dazzling specimen photographs, most of them by the ever-reliable Jeff Scovil, but a good number by others, e.g. Terry Huizing, Steve Smale, Mick Cooper, Debra Wilson and Hartmut Meyer. Here, sticky decisions regarding coverage inevitably had to be made, and I can imagine devotees of Tsumeb, Santa Eulalia, the New Jersey traprocks, the Katanga mines, or cherished old sites like Bisbee, French Creek or Příbram objecting that "their" calcites have been slighted in the text and/or in the "photo gallery" which follows. But what can you do about the ubiquity of calcite? As the editors say, "with innumerable worldwide localities . . . it is literally impossible to cover them all in a single volume or even review all of the significant deposits." Anyway, some of the pictures show calcites from quite unfamiliar places: outstanding specimens often seem *more* outstanding when we see that the locality is, say, the Riber mine, Matlock, Derbyshire, England; Taff's Well, Cardiff, Wales; the Mershberger quarry, Columbus, Indiana; the Woodlawn quarry, McDowell County, North Carolina; or the Juchem quarry, Idar-Oberstein, Germany.

The major localities which rate their own, separate chapters are a sensible mix of old and new: various recent sources in China; the Deccan traprocks of India; Dal'negorsk, Russia; Cumbria, England; Andreasberg, Harz Mountains, Germany; Maramures, Romania; "the American heartland" (this one could have used subdivision); the Michigan Copper Country; and Irai, Rio Grande do Sul, Brazil.

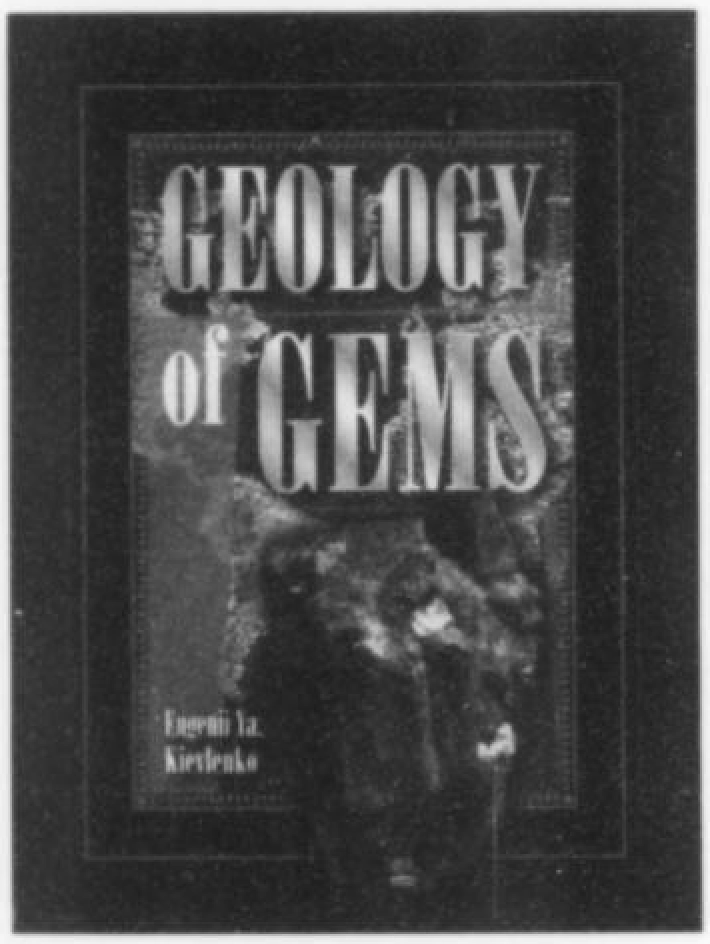
In the Chinese chapter the author, Dr. Guanghua Liu, provides for contemporary collectors what will seem like a cooling draught after long thirst: a large fold-out map of south-central China with about a dozen calcite-producing mines shown in red, and a generous text in which the geology and the recent collecting history of most of the mines are summarized. As a preliminary reference work on these localities, this chapter is invaluable: I suspect it is typical that, of the three Chinese calcites in my own collection, two of them came with locality attributions totally unlike the ones given here for what's obviously the material shown in the photos.

Following the chapters on localities, the work has chapters on calcite and aragonite crystallizations in limestone caves; techniques for cleaning calcite and aragonite; calcite as a fossilizing agent for sea urchins and other echinoderms; a bibliography with 68 titles; and the addresses of the 16 authors (and pictures of 12 of them). The limestone cave chapter, we are told on the inside front cover, is the work of Sarah Bronko, a senior at Westover School in Middlebury, Connecticut; similarly, one of the chapters in *Emeralds* was the work of Zak Swartz, a Connecticut high school junior. Not only is this endearing, it is most appropriate, as one of the purposes of the whole series is to encourage young mineral collectors (and possible future earth-scientists) to participate actively and to do creative research, functioning as honorary adults. Indeed the chapter on limestone caves is as well written and interesting (and as well-illustrated with photos) as the rest of the volume.

My only negative observation about *Calcite* is a slight one: its chapter organization seems needlessly loose, and its headings somewhat confusing. The typography of these headings, both in the table of contents and in the text, treats as "equals" a rather motley list of topics, some of which are properly main topics while others are informally conceived subtopics. Why, for instance, are there three "main" headings for "Setting the Standard for Beauty" and "A Feast for the Eyes" and "English Calcite: Cumberland Twins and More," all concerning English calcite but in no typographical way distinguished from "Cumbria: the Legendary Calcite Twins" or, for that matter, from "A Bountiful Harvest of Calcite From the American Heartland" and "Limestone Quarries of the Midwest?" The logical organization that I described as a virtue in the earlier works threatens here to turn into an oh-by-the-way approach, such that the ground is not always mapped out clearly for beginners. A related problem is over-indulgence in "informal," verging on merely cute, topic rubrics and comments in captions, which elevate cliches like "a feast for the eyes" to the status of categorical concepts. And there could be fewer captions like the one that calls the Sterling Hill mine an "Eldorado," or the one that says that a pictured (and quite remarkable) German specimen of manganite pseudomorphous after calcite is a "black ugly" which we ought to force ourselves to look at anyway. These gee-wow stylistic mannerisms faintly patronize the reader; they are habitual in some amateur-mineralogical publications, but should be tempered for an international readership.

This minor carping aside, any reviewer who wouldn't unequivocally recommend this lovely book to any and all readers would be a walking pseudomorph after good sense.

Thomas P. Moore



Geology of Gems

By Eugenii Ya. Kievlenko. English edition edited by Art Soregaroli. Published (2003) by Ocean Pictures Ltd. Hardcover, 8.25 x 11 inches, 432 pages, $98 from minbooks@online.ru or from Terry Huizing, 5341 Thrasher Dr., Cincinnati, OH 45247 (e-mail: tehuizing@fuse.net); ISBN 5-900395-25-1.

Evgenii Yakovlevich Kievlenko (1923–2000) was a distinguished exploration geologist and gemologist who, among other achievements in industry, furthered the economic development of several Russian deposits of piezoelectric quartz crystals and "Iceland spar" calcite. In the late 1960's, upon joining a Soviet government team charged with identifying and evaluating gemstone deposits in the U.S.S.R, he began compiling data for the work under review here. Although Kievlenko wrote in Russian, the first good news is that *Geology of Gems* is nearly free of the sort of linguistic cramp-ups which have often marred English translations of Russian texts in the past; we owe thanks for a job extremely well done to the six translators and no doubt numerous copyeditors. Compliments are due, too, to the seven expert photographers whose works appear in the beautiful "Photo Gallery" at the end of the book; to Irina Fashchevskaya, for her fine layout work; and to the chief editor for the Englishing project, Dr. Art Soregaroli. This book is a careful production, as sturdy in its erudition as in its physical packaging, and something of a breakthrough in its way of combining the two title-concepts, Geology and Gems.

This is to say that while most pretty books about gemstones are aimed at readers or browsers whose interests do not necessarily run to formal geology, this book's ideal reader is required to be geologically literate, since, to quote from the Foreword, "The main purpose . . . is to acquaint professional geologists with characteristic features of geological structure and geological settings of [gemstone deposits], thereby ensuring well-directed prospecting for such deposits." But even the reader who is not (as Kievlenko was) a professional prospector will find useful the book's wealth of geological data concerning many "hot" gem-crystal localities of today. Where have *you* seen, anywhere else, many thousands of words and dozens of geologic maps and line drawings in explication of places like Rangkul or Kukhi-lal, Tajikistan; Malkhane, Chita Oblast, Siberia; Volodarsk-Volyn', Ukraine; or Darai-Pech, Afghanistan? Of course the book also treats, as other books do, of the geology of Brazilian, African, North American etc. gem fields, but it is a virtually unique reference work on many a gem-crystal site in central Asia. Magisterial, dense, educational, *Geology of Gems* is capable, too, of bringing the science behind your specimen labels to life in a flash, like lightning over the steppes.

After a 24-page presentation of "General Data on Gems," 18 chapters examine individual gem-substances. Really, though, "decorative stones," not "gems," is the operative word, since, as the "General Data" chapter announces, the book covers not only gemstone minerals but also ornamental and carving materials, synthetic gems, and organics (amber—although not pearls). A table displays Kievlenko's classification of all these substances by their commercial *value*, showing the evolution of his value-based system from that of Kluge (1860). Kievlenko's three major divisions, in descending order of value, are "jewelry stones," "jewelry-industrial stones," and "industrial stones." The "jewelry stones," in turn, are ranked in four "orders": first (diamond, ruby, emerald, blue sapphire, alexandrite), second (demantoid, tsavorite, spinel, black opal, tanzanite), third (other-colored sapphires, rubellite, aquamarine, imperial topaz, white and fire opal) and fourth (other beryls, other tourmalines, other garnets, amethyst, citrine). "Jewelry-industrial" and "industrial" materials range down a scale from lazurite, jadeite and nephrite at the top, through charoite, rhodonite, jasper and petrified wood, to items like "aventurine quartzite," "ophicalcite (serpentine/calcite)" and "agalmatolite (pyrophyllite/talc)," although, perhaps mercifully, the last three which merit separate chapters in the parade of chapters to follow are malachite, chalcedony and rhodonite.

Two more interesting tables in "General Data on Gems" deserve mention. One shows average per-carat prices (in U.S. dollars, 1987–1992) of the gem materials; the other lists 28 "non-traditional gemstones," amblygonite to willemite, with generous mineralogical, optical and geological/genetic data. Surveying this latter table, one wishes (if one is a mineral collector) that certain gem materials of "non-traditional" type, listed here, had been awarded chapters of their own: benitoite, brazilianite, euclase, sinhalite, or even sphalerite might justly have claimed more text-space (we think, if we are mineral collectors) than chalcedony or amber, each of which gets a large chapter. Another surprise, and a disappointment, is that there is no chapter on diamond to head up the parade. The English Editor says in his Foreword that this is because diamonds always have "received special and isolated attention in Russia"; we may not quite understand this, but it means that we must settle in this book for just a few diamond-factoids (e.g. the retail price per carat, for a fine 3 to 5-carat diamond, tops out at $41,500).

On, anyway, to chapters #2 (corundum) through #19 (rhodonite), which treat individual "decorative stones." Here, as mentioned, Geology rules, and the text takes on a "reference" rather than a "general reading" style, with cascades of authoritative, well organized geological/genetic information for each gem mineral. A typical one of these chapters is organized in two parts: a general discussion of the gemstone in question, with data on crystallography, optical properties, inclusions, the history of its use as a gemstone, and whatever else is of interest; and a section on geological/genetic types of deposits, with appropriate subdivisions (common headings here include magmatic, pegmatitic, greisen, hydrothermal, contact-metasomatic, and placer). There is no attempt to furnish full data for *every* major deposit of each type for each major species; rather there is, as already mentioned, an emphasis on detailed presentations of the geology of ex-Soviet and central Asian occurrences. For topaz, for example, the subheading "pegmatitic deposits" sets up several pages on the Volodarsk-Volyn', Ukraine pegmatite, several more on the Ural and East Siberian pegmatites, almost a whole page for the Rangkul, Tajikistan pegmatite field, and just two pages giving about a paragraph each to many U.S. and Brazilian occurrences. Then there are similar treatments, in similar proportions, for "greisen" and "hydrothermal" and "placer" topaz occurrences, taking the reader from Schneckenstein to Teofilo Otoni. Typically, too, there is a sprawling table showing the geological/genetic classification of topaz deposits; two clear, uncluttered geological sketch-maps for the Ukraine occurrence (one for the pegmatite field, one for the eluvial placers); one sketch each for two of the Russian occurrences; and one sketch each for geological structures in Minas Gerais and the Thomas Range, Utah. Coverage of this sort seems continually to anticipate what Western readers, especially, will want most to know, both about *where* and *how* gem topaz crystals occur.

A final, summary chapter offers about 15 pages of generalization about geologic environments for gemstone species, with another big table and with sketch maps showing locations of major gemstone deposits on each continent. The "References" list that follows shows an amazing 902 titles—at least as many English, German and French (combined) titles as Russian.

Then comes our rich dessert: 30 full-color pages with uniformly fine photographs of all the book's subject-substances . . . and the ratio of crystal specimens to cut gems, slabs, carvings, etc. here is higher than you might expect. About half of the photos are by Russian photographers, and show specimens now in Russia, hence probably unfamiliar to most Western readers. Included among these images is a photo of the Grand Imperial crown of the Romanovs, topped by a 398.72-carat red spinel—the photo by Alexei Sverdlov. The other contributing photographers are Anatolii Akimov, Mikhail Bogomolov, Michael Leibov, Erica and Harold Van Pelt, Jeff Scovil and Wendell Wilson.

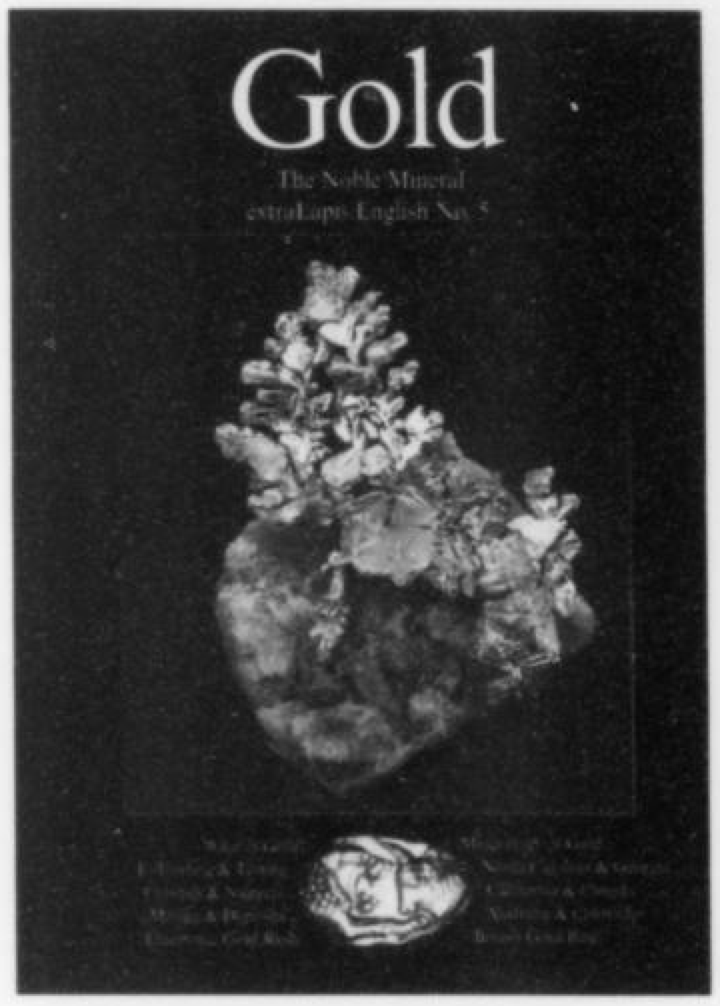
At the very end of the book are three pages of commercial ads for American dealers and one page for Russia's "Mineralogical Almanac," necessary, presumably, to help finance publication. What is unfortunately missing is a good, thorough index for the text.

Geology of Gems is a winner, a major work—and it can fit equally well in the Gem or Geology section of your reference library.

Thomas P. Moore

Gold: The Noble Mineral

Edited by Robert B. Cook, Edward R. Coogan, Dr. Günther Neumeier and Gloria Staebler. Published (2003) by Lapis International, LLC, available from the Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740; e-mail order: minrec@aol.com. Stiff softcover, 8.25 x 11.7 inches, 112 pages. Price: $25.00 + $2.00 shipping in the U.S.



The *ExtraLapis English No. 5* publication on Gold was one of the biggest sellers at the *Mineralogical Record* tables during the 2004 Tucson Show, keeping pace respectably even with Bob Jones' new book on the 50-year history of the Tucson Show and the 2004 edition of *Fleischer's Glossary of Mineral Species*. Yes, of course, this is partly because 2004 was the "Year of Gold" at Tucson, and partly because of the eternal mystique of "the noble mineral" itself, but surely the new book was popular also because the *ExtraLapis English* productions (which are really individual books rather than journal issues) have by this time acquired a mystique of their own, for their beauty, informativeness, and lively presentation.

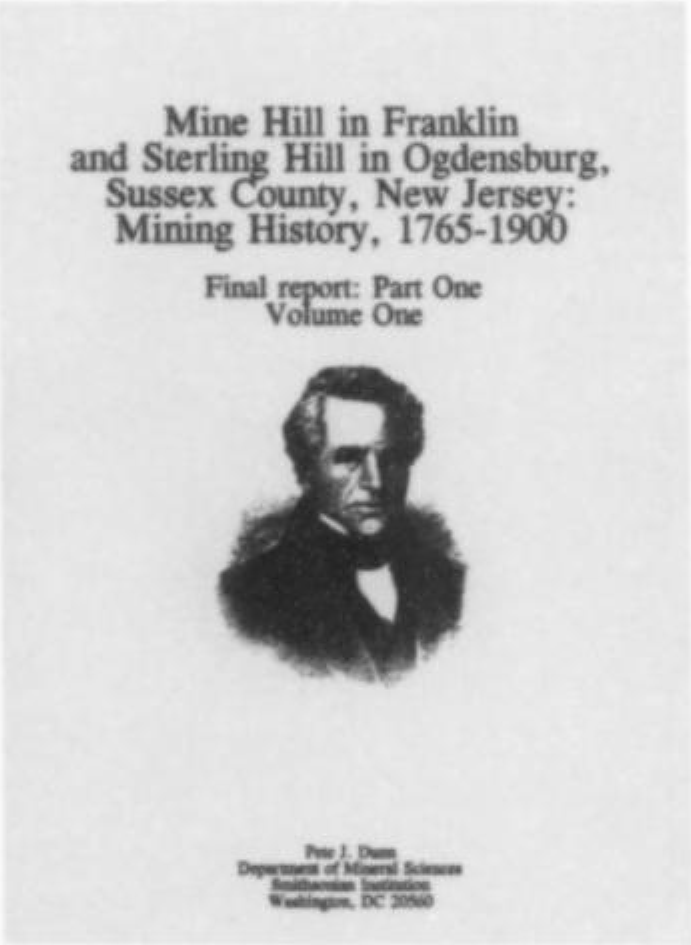
Indeed, each new *ExtraLapis English* seems to be more alluring than the previous one, and presents the reader with its own set of little surprises: the approach to topics remains flexible, almost playfully so, from book to book. A new set of authors and even of editors takes charge each time, and in this new book, sure enough, the author-list of the 19 chapters amounts to a roll call of gold experts of various kinds, and on the editing team Dr. Robert B. Cook (from academe) and Edward R. Coogan (gold prospector *extraordinaire*) join general-series editors Dr. Günther Neumeier and Gloria Staebler. The chapters are clearly conceived and straightforwardly titled: gone this time is the somewhat squishy organization and over-cute topic rubrics of which I complained in my review of *extraLapis English No. 4*, on Calcite. And yet the march of chapter-subtopics through the book retains the element of creative "surprise" when we encounter, say, a chapter (by Gary Mason) on "Gold Records," on the biggest/deepest/oldest/most valuable etc. gold-related phenomena, or a chapter (by Wayne Leicht) on aesthetic evaluation of gold specimens, or a chapter called "The British Gold Rush of 1854," which its author, Mick Cooper, knows perfectly well most readers will begin in a "*Really??* Never heard of *that* before . . ." spirit.

In fact, I don't want to list all the chapter titles in order, for fear of spoiling the eclectic fun, and will settle instead for an overview. We read of the history of man's fascination with gold, from times more ancient than Old Kingdom Egypt ("Gold and Man: Since the Dawn of Civilization," by Karl-Ludwig Weiner) to the contemporary period of gold prospecting with metal detectors ("The Great Electronic Gold Rush," by Edward R. Coogan and Robert B. Cook). The great gold rushes of history are limned, and, along the way, the geology and mining history of famous gold provinces ("Gold Fever in the Southeastern USA," by Chris Tacker; "California and All That Is Golden," by Wayne Leicht; "Australian Gold: Mega-Nuggets from Down Under," by Dermot Henry and Bill Birch; "The Rush for Gold Turns North to Canada and Alaska," by Mark Mauthner; "Farncomb Hill: Colorado's Finest Gold Specimens," by Ed Raines). Basic science gets done in chapters like "What is Gold?" by Karl-Ludwig Weiner; "Gold Deposits—an Overview," by Karen L. Webber, Rupert Hochleitner and Robert B. Cook; and "The Mineralogy of Gold—a Review," by Stefan Weiss (this last, which describes all known gold-essential mineral species, is an update to Wendell Wilson's similar listing back in the *Mineralogical Record*'s first Gold Issue in 1982). And finally there are "surprise" chapters on topics like gold pseudomorphs (Dave Ellis), gold mining and investment (Hans-Gert Bachmann), the testing of gold (Hans-Gert Bachmann), and the uses of gold in medicine (Jamie Spiller, a high school student, and clearly a very bright one, from Massachusetts).

Everywhere—not just in the "Gold Records" chapter but throughout the book—we hit gold factoids that fascinate. The total volume of all the gold ever mined is equivalent to a 19.6-meter cube, or the volume of a small apartment building. The famous "Dragon" gold specimen from the Colorado Quartz mine was first located by a metal detector. The largest known single mass of gold was a 3,000-ounce specimen found in 1872 in an Australian mine. India now has more gold (including jewelry gold) within its boundaries than does any other country. And do not neglect to ogle the Jeff Scovil photograph of Dave Bunk's amazing 3.5-cm crystal group of the rare gold/lead/antimony sulfo-telluride nagyagite from Sacaramb (formerly Nagyag), Romania.

Beautiful photographs and clear graphics, a stout binding and good, heavy, slick paper, and a general bibliography with about 100 titles, all help to complete the success of this effort. Errors of fact seem few, although a reviewer must carp at one photo caption (on p. 23) which places the Peabody Museum at Harvard (it is at Yale), and I hope that the copyeditors will bear in mind, for next time, the fact that the past tense of the verb *lead* is *led*, not *lead* (when *lead* rhymes with "head" it's a noun, denoting the metallic element); a few other mechanical glitches occur as well. But if by this time you have developed a craving to buy up new issues of *ExtraLapis English* as they appear, there is no reason now—less than ever—to kick the habit.

Thomas P. Moore



Mine Hill in Franklin
and Sterling Hill in Ogdensburg,
Sussex County, New Jersey:
Mining History, 1765-1900

Final report: Part One
Volume One

Pete J. Dunn
Department of Mineral Sciences
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Mine Hill in Franklin and Sterling Hill in Ogdensburg, Sussex County, New Jersey: Mining History, 1765–1900

By Pete J. Dunn. Published (2002) by Dr. Pete J. Dunn, 7821 Fort Hunt Rd., Alexandria, VA 22308, available only from the Franklin Mineral Museum, Evans Street, P.O. Box 54, Franklin, NJ 07416 (tel. 973-827-3481) or Sterling Hill Mining Museum, 30 Plant Street, Ogdensburg, NJ 07439 (tel. 973-209-7212). Softcover 8.5 x 11 inches, 1102 pages, seven volumes. Price: $15 per volume or $75 per set, plus postage.

Experienced mineral collectors everywhere (and not just in the northeastern United States, although the reflex is strongest there) have learned to hear the term "Franklin" as an instant evocation of American mining history, in all its complexity and adventurousness, from early colonial days to the mid-20th century. Of course, "Franklin" is also the world capital of fluorescent minerals, a geochemically unique ore deposit, and one of the world's greatest mineral localities, rivaled only by Långban, Sweden and perhaps two or three more recently developed places for total number of mineral species. But it is more to the point of Pete Dunn's giant historical work that "Franklin" (more properly, the Franklin and Sterling Hill mines, in Sussex County, New Jersey) is a microcosm of American metal mining, and it is a place where such enterprise was already old by the time that the very first reels of the Bisbee, Butte, Leadville, and other popular Western features were being eased into the projection machine of history. As for the actual mineralogy, Dunn has chosen in this exclusively historical work to do no more than hint from time to time at the specimen riches of Franklin and Sterling Hill, and at the culture of mineral collecting. There is another source for all of *that*: Dunn's other definitive work: *Franklin and Sterling Hill: the World's Most Magnificent Mineral Deposits* (1995) (those five volumes were reviewed here by Wendell Wilson in vol. 27, no. 3, p. 226).

Although mining at Franklin/Sterling Hill today is dead, what may not be dead for those of us who grew up in the northeast are memories of old, naive notions of "treasure" very nearby, which one somehow could and *had to* get at, perhaps on the very next field trip to the Buckwheat dump. Today's visitor might go in September or April to enjoy the thriving Franklin mineral shows, and there are still a few fine private collections to visit, but probably the best one might do to recover History is to take the excellent guided tour of a part of the Sterling Hill mine, where one will see a limb of the orebody which has been left in place, and experience a "rainbow room" of thrilling red and green fluorescence. Besides the tour, there is the Sterling Hill mining museum to look in on, and just down the road there is also the Franklin Mineral Museum, rich in old-time specimens. Indeed it is only in these two museums (and from them by mail order), in Ogdensburg and Franklin respectively, where one may buy copies of the work under review here, a seven-volume labor of love and of immense scholarship by Dr. Pete J. Dunn, the Smithsonian mineralogist who is without question the world's leading expert on Franklin and Sterling Hill and all that has transpired there.

Dunn's detailed account begins in the mid-18th century and ends in 1900, with only a brief final notice of the closing of the Franklin mine in 1954, and of the Sterling Hill mine in 1986. The History surveyed by the work is largely a history of contests for ownership of this or that claim, of complex litigation and general "politics," as hundreds of people and commercial interests (some of the free-lancers portrayed persuasively as the worst kinds of opportunists and scoundrels) vied for control and wealth. Some readers may be disappointed to see that the mineralogies of the orebodies, let alone the distinctive mineral specimens and *their* histories, are barely mentioned at all in the work. Nor are the geology or geochemistry of the deposits discussed, nor are there any illustrations in color in any of the seven volumes—although there is a very rich black-and-white offering of early photographs and drawings of landscapes and townscapes, schematic maps of mine layouts and workings, formal portraits of people, and many more sorts of images, all feeling quite satisfyingly antique, archaic and "archival." Much of the work is essentially a journalistic collage: considerable stretches of it offer almost back-to-back sidebar fragments of quotation from court testimonies, personal correspondence, diary entries, contracts, legal rulings, and commercial ads from various moments in the mines' legal and human histories. The sheer volume of primary source-material, most of it more than a century old, which Dunn has gathered together is quite amazing; about 120 pages, more than half of the final volume, are filled by Appendices listing relevant people and organizations (with thumbnail biographies for the people), plus an enormous general index. Dunn's own voice is heard chiefly as narrative summaries and commentaries which give an overview and provide a narrative line for what would otherwise seem, confusingly, an unchanneled stream of angry court cases, rapidly morphing mining strategies, wild administrative and commercial gambits, and general rambunctious capitalism. A century and a half of goings-on in the unquiet little mining camp on the Wallkill River, as well as in some ore-processing facilities in New Jersey and Pennsylvania and offices in New York, thus come to us in the form of thousands of details noble and mean, compelling and dull, from the times when the great zinc mines were giving up their riches (enriching, too, the science of mineralogy, as Dunn does not often say but trusts the reader to be continually aware).

Despite the work's preoccupation with legal and commercial history, there are many things to be learned here about the Franklin and Sterling Hill deposits themselves, and about the increasing efficiency with which they were exploited. Dunn takes note of the legends that the first people to try to make some use of the originally very prominent and very odd-looking outcrops of the deposits were aboriginal *Lenni*

Lenapes and/or 17th-century Dutch explorers. The latter may have mistaken the red zincite in the outcrops for cuprite: a Dutch document from 1669 mentions "copper" deposits along the Wallkill.

But it was iron, not zinc, which was first mined in these parts. As early as the mid-18th century, locals developed small mine pits on the Furnace Magnetite Bed, a deposit of high-grade magnetite ore which lies very close to the Franklin outcrop of franklinite/zincite ore and strikes parallel to it. Small iron-working furnaces ("Franklin furnaces") and "bloomeries" (simple forges) were flourishing in the region before and during the American Revolution; in fact, the iron-mining and iron-working industry around Franklin did not entirely shut down until about 1880. Of course, during this early time it was believed and hoped that the metallic black franklinite exposed so massively in the two great fishhook-shaped ore outcrops at Franklin and Sterling Hill could be profitably worked as iron ore. The first known attempt to mine and treat it as such was made at Sterling Hill by the man after whom this place (after a vowel shift) was named: William Alexander, Lord Stirling (1726–1783), a hero in the colonial cause during the Revolution.

In the first half of the 19th century, to the extent that Franklin and Sterling Hill were thought of as *zinc* mines, the most avidly sought of their ore species was the bright red zincite (ZnO) that was often found as large masses and lenses in black franklinite, particularly at Sterling Hill. An 8-ton mass of virtually pure zincite, 80% zinc metal by weight, was shipped at great cost to London in 1852, to be exhibited in the famed Crystal Palace of that year's World Exhibition (world's fair); the newly capitalized New Jersey Zinc Company won a medal for the enormous ore lump, beating out competing French and Belgian companies. In 1830 Dr. Samuel Fowler—the patriarch of the mines, if anyone was—and an associate had succeeded in making white zinc-based paint (utilizing zinc oxide obtained from zincite) and demonstrating its superiority to earlier lead-based paints. Fowler at around the same time admitted defeat in his assaults on the "franklinite problem," i.e. the great difficulty of smelting usable iron from the franklinite which constituted the bulk of the Franklin ores—but zinc was taken easily enough from the same ores, and now zinc had a major industrial use, and so the mines' economic importance was assured.

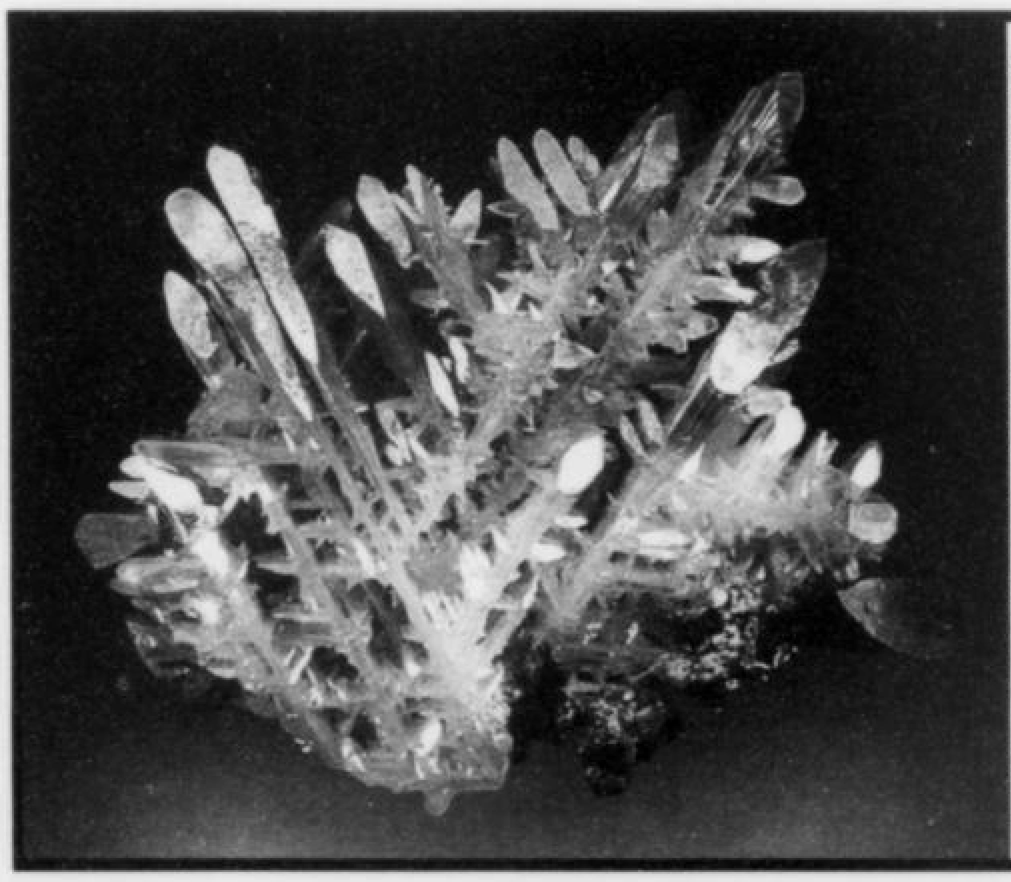
Within a few years of 1850 (the precise date is not known), the first major commercial ore cut, the Southwest Opening, was made on the Franklin orebody, at the sharp point of the curve of the fishhook-shaped outcrop. On one side of it, the Buckwheat and Taylor mines would later develop, and on the other limb of the outcrop the Weights and Measures opening and a few other crude excavations were already extant. But here, as well as at Sterling Hill, about 40 years of confused, byzantine, and often vicious legal battles ensued, impeding orderly development of the mines. In 1857 the first lawsuits of "The Great Franklinite Case" were filed, with five mining companies quarreling over mining rights, claim boundaries, and even the definition of "ore" and "ore mineral." The cultural tone was set for the next 40 years, while during this same period saner phenomena also flourished: eminent mineralogists came to study the Franklin and Sterling Hill mineral suites. The towns of Franklin and Ogdensburg grew, becoming more civilized and more prosperous. Willemite and hemimorphite came to be mined as ores (the lustrous white hemimorphite specimens known as "maggot ore" began to emerge around 1875 from the opencut Noble and Passaic workings at Sterling Hill). By 1880 the Buckwheat/Taylor mine on the south limb of the Franklin orebody had become, in itself, the greatest zinc mine in the world. Dunn shows some grand old photographs of its open cuts and of some entrances to the underground workings, and one especially impressive photo presenting an overhead view of a gigantic, laid-open, jet-black mass of franklinite/willemite ore.

The general legal settlement which Dunn calls the "Great Consolidation" of 1897 finally brought an end to the frenzied litigiousness and, through a complex series of buy-outs and mergers, gave birth to the present form of the New Jersey Zinc Company (which, of course, prospers today, and runs other mining colonies elsewhere).

Dunn's account ends, as mentioned, at the year 1900, the final textual portion of Volume Seven being given over to short, valedictory treatments of topics such as "Mining, men, and mineral collecting," "Sacred places and hallowed grounds," "Mine and feature names at Franklin and Sterling Hill," and "The early mineral collectors." Of these last-mentioned we would like, of course, more than the short, single paragraphs that we get about men like Francis Alger, Henry O. Fowler, Garrett Kemble, Dr. William Roepper, etc., and their collections. Frederick Canfield, who also has a paragraph here, may be looked up in the *Mineralogical Record*, vol. 21, no. 1, where there is an article devoted to him.

What the 1102 pages of these seven volumes give us is the most complete imaginable Franklin "story" as told from the viewpoint of the mining legal-historian and of the historian of settlement and cultural development in the bucolic landscape (yes, it was that, and in some ways it still is) of northern New Jersey. The best idea, of course, would be to buy this book in person in the museums at Franklin and Sterling Hill—and what mineral collector could justify passing up a trip like that?

Thomas P. Moore



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