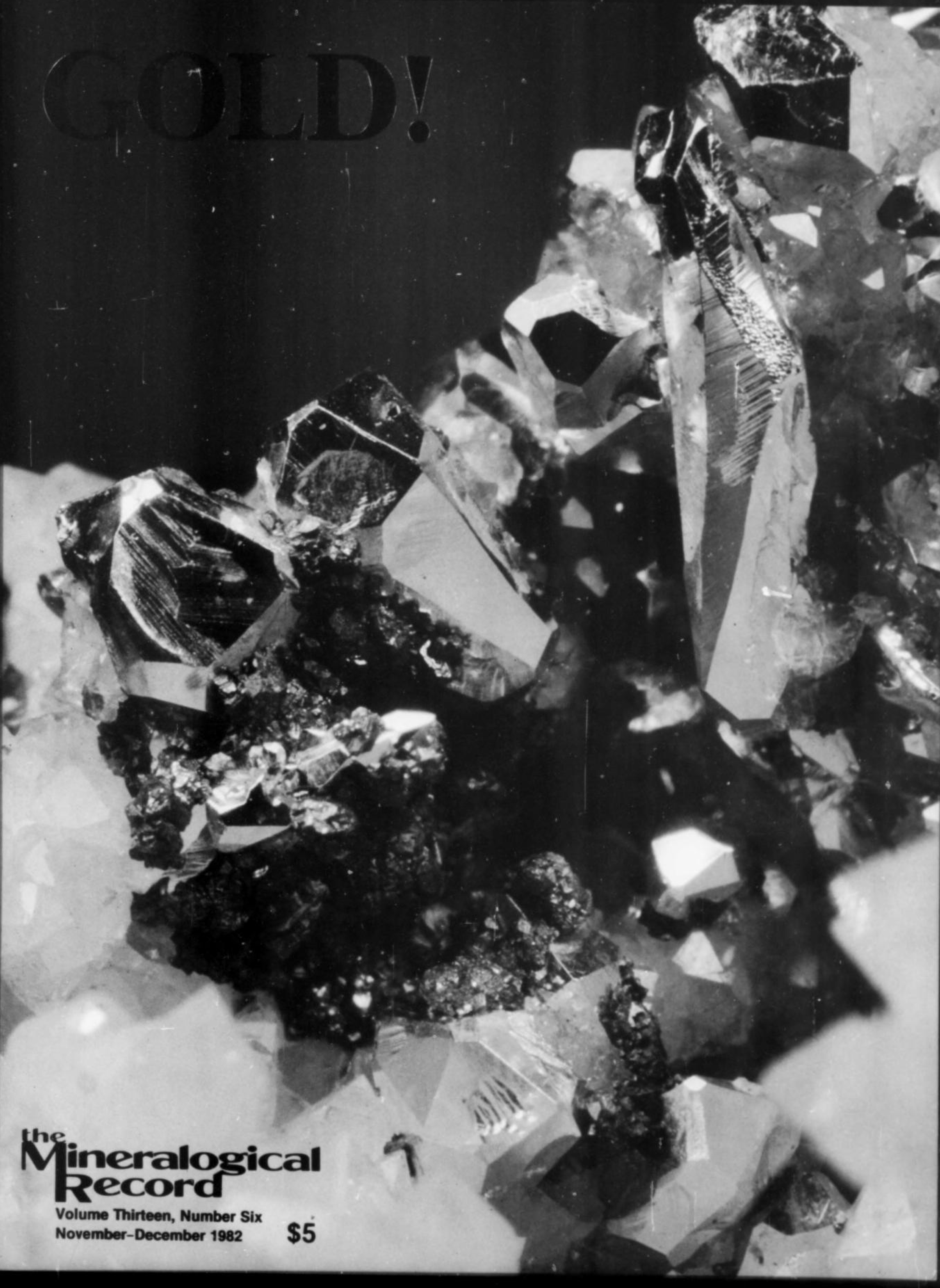
GOLD!
the Mineralogical Record
Volume Thirteen, Number Six
November–December 1982
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the Mineralogical Record

November–December 1982
Volume Thirteen, Number Six

GOLD!

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COVER: GOLD crystals on quartz, from Zlatna, Romania. The longest crystal measures 7 mm. University of Heidelberg collection; Olaf Medenbach photo. For more on Romanian gold see the article by Lieber in this issue.

notes from the EDITOR

A SPECIAL THANKS . . .

. . . To J. Richard and Roelle Harris of Calgary, Alberta, and to F. John Barlow of Appleton, Wisconsin, for particularly generous donations which made this issue possible. The *Mineralogical Record* is self-supporting only to the extent of publishing black and white issues; all color work must be paid for through donations. It is only with the help of special people like the Harrises, Randy Rothschild, John Barlow and others, that we can present minerals the way they were meant to be seen. When you try to imagine what the Arizona issues, the Tsumeb issue and this issue, to mention only a few, would have looked like in black and white you begin to see the true value of such contributions.

EXTRA COPIES of the GOLD ISSUE

Special offer: extra copies of the *Gold Issue* are available to bona fide dealers and subscribers at $3 per copy postpaid (note $5 cover price) for a limited time. This issue is probably destined to sell out quickly, so we suggest you place your order as soon as possible.

SLIDE COMPETITION

Yes, there will be a *Mineralogical Record Slide Competition* at the coming Tucson Show in February!

RULES

1. Anyone can enter, whether professional or amateur. In the last few years we have not observed a noticeable difference in quality between the professionals and the amateurs. This is no doubt due to the fact that good mineral photography requires a lot of practice taking *mineral* photos. Shooting scenery hardly helps at all. Therefore the professional has little advantage. The only restriction we are adding is that you *must be a subscriber to the Record.* We will verify this before prizes are awarded.

2. You must mark the following *on each* slide:
   a. Mineral name
   b. Mineral location
   c. Your name and mailing address

3. Maximum of two entries per person.

4. All entries *must* be 35 mm slides in *cardboard* mounts.

5. Photos must be of minerals (not fluorescing).

6. The entrant must be the sole owner of copyright for the entered slides, and by entering grants the *Mineralogical Record* permission to publish the photo(s) at no charge.

7. Entries *must* be received by Monday, February 7, 1983. **Entries will not be accepted at the show . . . you must mail them.**

8. Entries should be mailed to **Slide Competition, c/o Wendell E. Wilson, 4631 Paseo Tubutama, Tucson, Arizona 85715.**

9. No return envelope is required; all entered slides will be returned.

10. ENTRY FEE: This year there is a sort of entry fee: you must include a 5 x 7-inch glossy or semi-glossy print of each entered slide. The prints will be assembled into an album which will be auctioned off on Saturday night. In the white margin of the print bottom you should write the name of the mineral, its location, and your name.

PRIZES				
	First prize:	$100	Fourth prize:	$ 50
	Second prize:	$ 75	Fifth prize:	$ 25
	Third prize:	$ 50		

PROCEDURE

Twenty semi-finalist slides will be selected from those received. Selection will be based on composition, artistic quality, faithfulness in representing the mineral, and freedom from technical flaws. These twenty photos will be shown to show-goers, who will vote to determine the winners.

FIRST ANNUAL TENNIS TOURNEY!

Hey, you can't think about minerals *all* the time, can you? . . . Well, even if you can, you shouldn't. So why not enter the *First Annual Mineralogical Record Tucson Tennis Open?* You'll need a break from the hectic Tucson Show, and what better way to spend it than making new friends and playing tennis with your mineralogical soul-brothers (and soul-sisters)? Besides, you will get a super MRTTO T-shirt upon entering, which will be the envy of the show. *And* you can come to the cocktail party afterwards. Purpose: mostly just to have fun. If we pass break-even on the funds, so much the better. See you there?

Date: February 7 and 8, 1983.

Place: Sheraton Pueblo Inn courts.

Categories: Men's and Women's singles, doubles, mixed.

For registration information contact:

Gale Thomssen
P.O. Box 1656
Carson City, NV 89702
702-883-2598

Registration deadline: January 1, 1983 . . . no registration during show week in Tucson.

Trophies will be awarded Saturday night at the show.

NOTICES

Died, Catherine (Susie) Davis, 72, (*Davis Minerals,* Tucson), of pneumonia and congestive heart failure. During her 30 years in the mineral business, Susie handled thousands of outstanding specimens which found their way into museums and private collections around the world. Her large personal collection of fine Mexican and Southwestern specimens, carefully set aside one-by-one over the years, was acquired by the Smithsonian in 1972.

Susie was born, the daughter of a miner, at Johnson Camp, Arizona Territory, in 1909. Shortly thereafter her family moved to Tombstone, where her father often took her with him to the mines; from these early experiences her interest in mining and minerals began to grow. In 1929 she moved to the mining town of Bisbee and opened a flower shop. It was here she met and married Brooks Davis. They moved back to Tombstone where Brooks became superintendent of mines for the Tombstone Development Company, and was elected Mayor of Tombstone in 1936. In 1942 they moved to Tucson. Susie opened a leather shop, and she and Brooks became part owners of the Old Yuma mine nearby. After a few years her strong love of minerals won out, and *Davis Minerals* was opened in the early 1950's. Brooks passed away in 1974, but Susie remained in the wholesale mineral business until her death. Her local interest was the Arizona-Sonora Desert Museum, and she regularly added specimens to the museum's collection.

Died, Curt Van Scriver, 26 (Golden States Minerals), in an auto accident while traveling from Tucson to Phoenix. A freeway pile-up of eleven cars and four tractor-trailer rigs was caused by a sudden dust storm.

As the son of Brad and Nancy Van Scriver (*Van Scriver Minerals*) and grandson of Beth Gordon (*Beth Gordon Minerals*), Curt was a third-generation mineral dealer. He accumulated many fine specimens in his personal collection, traveled the world as part of his business, and was well known for his mining ventures in Mexico (particularly the San Francisco mine in Sonora). Many extraordinary specimens passed through his hands to fortunate curators and collectors; and yet he was happy to share his time and enthusiasm with even those whom he knew could not afford such pieces. His cheerful, good-hearted nature and his love of minerals were endearing to all who knew him. W.D.P., W.E.W.

Collecting Gold Mining Memorabilia

by **Wendell E. Wilson**
P.O. Box 35565
Tucson, Arizona 85740

and **Ron Bentley**
309 Irvin Drive
Midland, Texas 79701

When collecting fever strikes, it is sometimes not limited to mineral specimens alone. The romance and history that surround the winning of such minerals as gold from the earth will lead susceptible collectors inevitably into the realm of mining memorabilia.

INTRODUCTION

Those of us who have what is termed the "collector instinct" are vulnerable to becoming interested in an ever-widening range of fascinating acquisitions, and must guard constantly against such temptations. Undoubtedly a large proportion of mineral collectors (perhaps *all* of them?) already collect other things, or have done so in the past, or would do so in the future if they could afford it.

The most tempting areas of expansion for the mineral collector are those fields closely associated with minerals in some way, especially mining, mineralogical research, and related books. After all, most people reading this already have a hefty collection of the *Mineralogical Record* stashed away. And in times when mineral funds are low, the collector can console himself through the acquisition of items in less expensive fields of collecting. For example, a respectable *collection* of miners' lamps or mining antiques can cost less in total than a *single* mineral specimen! On the other hand, well-funded collectors may wish to round out their decorating with a wider variety of collectibles. Rare mining and mineral books, original art, or exceptional related antiques can cost huge sums of money and represent a worthy challenge for anyone.

The particularly strong sense of romance and adventure which surrounds the mining of gold has induced many collectors to expand in that area. Perhaps the most difficult aspect is distinguishing between *gold* mining memorabilia and similar items related to the mining of other metals and materials. One can pursue provenance and authenticity with dogged relentlessness and zeal; or one can decide to not worry too much about the problem . . . if a *copper-*

mining item somehow sneaks in, no matter. In either case it will be a satisfying, challenging and fascinating road to travel. But remember: anything worth money can be reproduced and faked. Reasonable efforts at self-education are the responsibility of every collector, and will help him avoid being stung by fakes.

Listed below are the general categories into which most gold mining memorabilia fall, and a short discussion of each. But don't feel limited by these. There are always new areas and unrecognized treasures to be found.

The advertisements shown here were taken from various turn-of-the-century publications; a date has been added to each for reference.

Prospecting Equipment

The well-equipped gold prospector of the nineteenth century used a wide variety of items, virtually all of which are now desirable as collectibles. Old photos commonly show men leading mules heavily loaded down with picks, shovels, pans for panning, canteens and cooking utensils. Probably also included were pocket-size scales for weighing gold, and perhaps even a portable chemical analysis kit. A compass and a hand lens rounded out the prospector's gear. A few rare prospectors even carried commercially made divining rods designed to find gold.

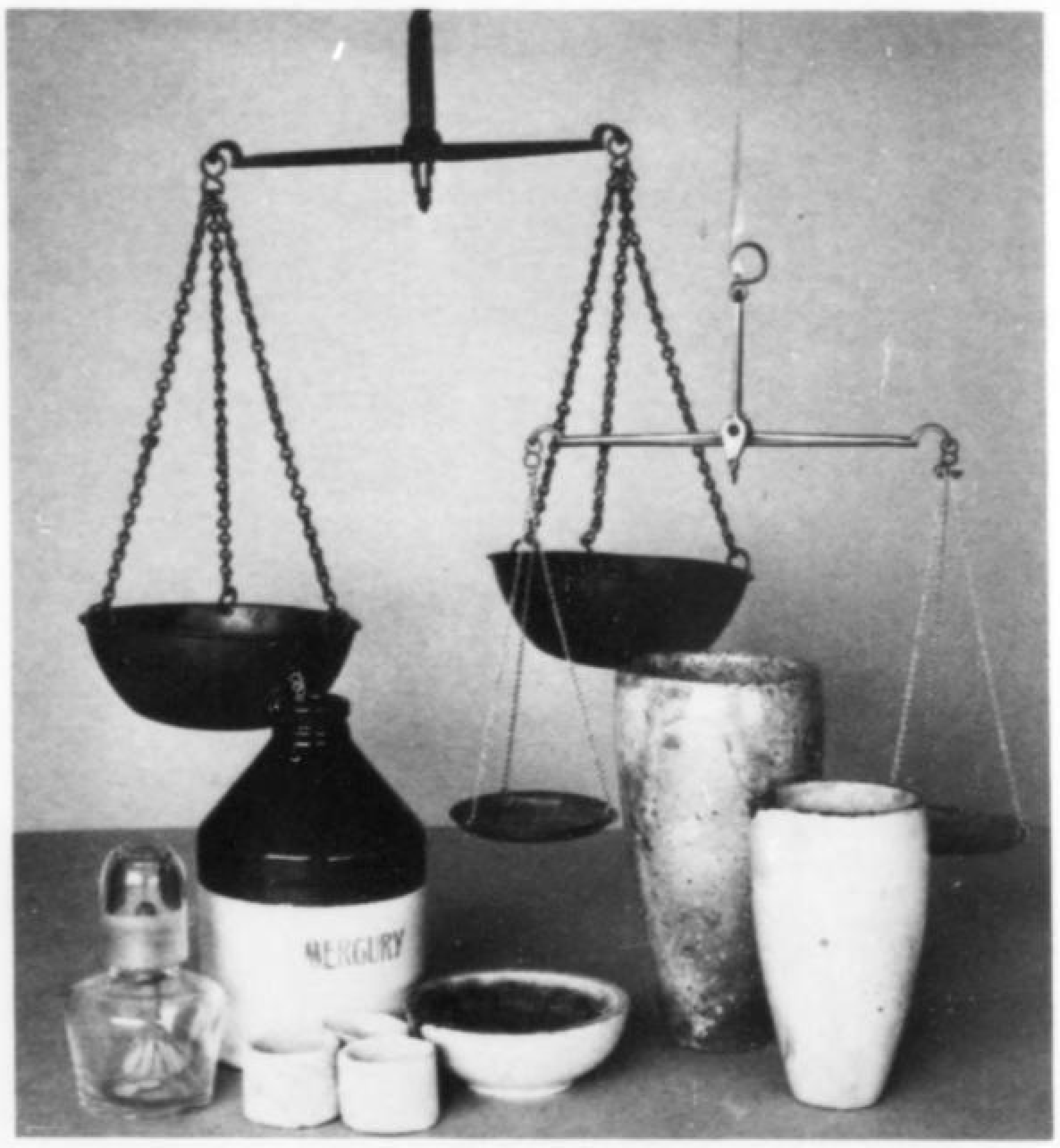


Figure 1. **Balance scales for weighing gold; clay crucibles and cupels used in assaying; assayer's alcohol lamp; empty mercury flask (mercury was used to collect fine gold by amalgamation).**

Except as noted, all photographed items are from the collection of Wendell Wilson.

Assaying Equipment

Once a promising occurrence had been found, the prospector commonly took samples to an assayer in order to determine just how rich his ore was . . . if indeed it even contained gold. These days, entire assay offices have been reconstructed in museums such as the Arizona Historical Society in Tucson, and no item is too small to be uninteresting. Assayers used larger, table-model scales which are enthusiastically hunted by today's collectors. Reagent bottles, mercury flasks, mortars and pestles of all sizes, assay crucibles, office signs and even assay ovens are collected.

Mining Equipment

Placer mining on a scale larger than one-man panning generally involved the construction of sluices, rockers and other devices designed to concentrate the gold. Though collectible, such items have only rarely survived and are almost impossible to authenticate. Underground mining required a far wider range of tools, gadgets and supplies. Picks, sledge hammers and hand-drill steel bars were used first, and later came the power drills which, though large, are still sought as collectibles. Blasting equipment and supplies include fuse, powder and dynamite boxes, blasting cap tins, cap crimping and fuse cutting pliers, and plunger-type detonators. Mine bells and the bell signal sign that accompanied them (giving the bell code for signaling the elevator operator) are particularly desirable items.

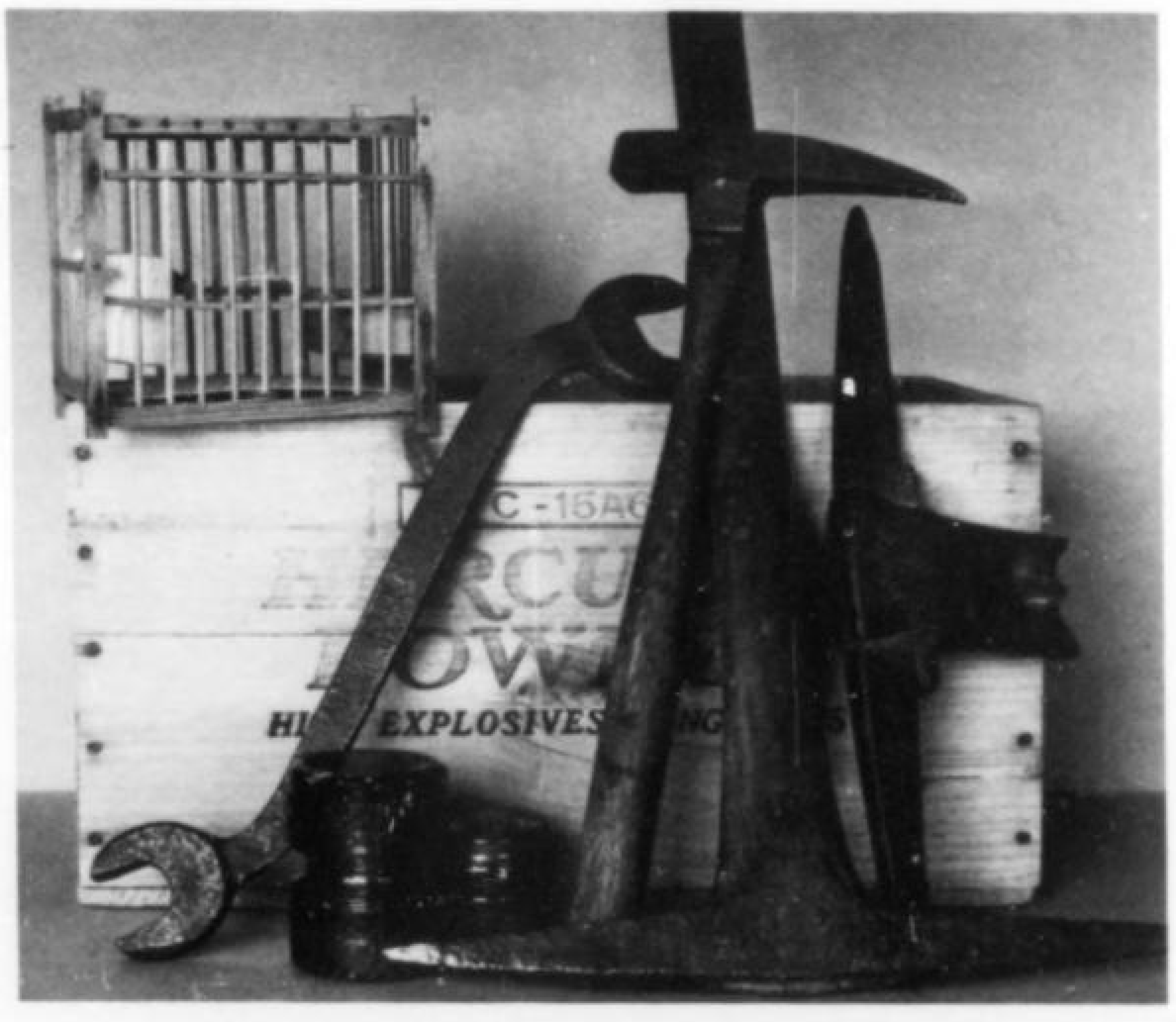


Figure 2. (left to right) **Miner's canary cage (canaries were used for gas testing); heavy spanner for adjusting pneumatic rock drills (marked "COPPER QUEEN," used in Bisbee, Arizona); glass insulators for underground wiring (left one, green, is marked "JEFFREY MINE INSULATOR"; right one, purple, is marked "CALIFORNIA"); geologist's rock hammer, miner's picks, and (behind) Hercules powder box.**

Figure 3. **Blasting paraphernalia *(left to right):* electric blasting wire; brass fuse cutter-crimper (Don Olson collection); rectangular blasting cap tins; hand sledge and hand steel for drilling blast holes; round blasting cap tin; dynamite tubes (with wooden dowels inside); and (behind) Atlas powder box.**

Even the heavy equipment such as steam engines, headframes, elevators, and especially ore cars and buckets are being hauled off for display in a mining museum or a collector's back yard. Supply wagons, ore wagons, mucking machines, electric mine train engines and specialty cars are all of value. For many years preceding the advent of power equipment underground, mules were used to pull ore cars; there existed numerous types of mule equipment including collars, harnesses, and even lamps worn on the mule's forehead. Fire-fighting and rescue equipment are also collected.

Milling Equipment

A sizeable mining operation eventually justified the construction of a mill on the site in order to process the ore into bullion. Prac-

THE GENUINE AMERICAN BRANDS.

1898

GOLD AND SILVER MEDAL

BLASTING CAPS.

STRONGEST and BEST MADE.

Manufactured by

THE METALLIC CAP MFG. CO.,

271 Broadway, NEW YORK, N. Y., U. S. A.

Electric Blasting Apparatus. . . .

VICTOR ELECTRIC PLATINUM FUSES.

Superior to all others for exploding any make of dynamite or blasting powder. Each fuse folded separately and packed in neat paper boxes of 50 each. All tested and warranted. Single and double strength, with any length of wires.

BLASTING MACHINES.

The strongest and most powerful machines ever made for Electric Blasting. They are especially adapted for submarine blasting, large railroad quarrying, and mining works.

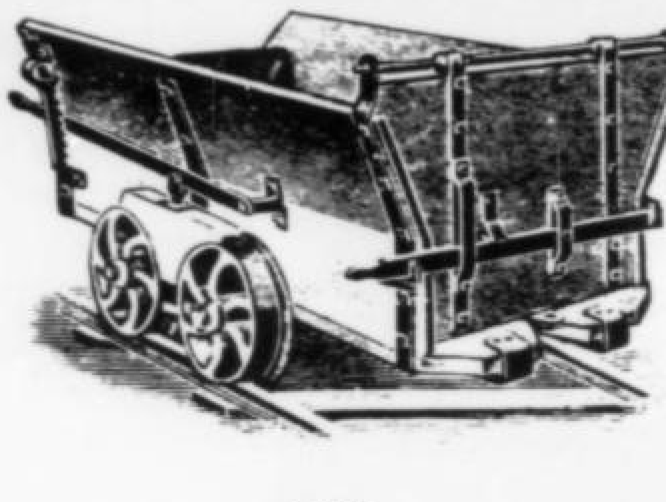
VICTOR BLASTING MACHINE.

Fires 5 to 8 holes; weighs only 15 pounds, adapted for prospecting, stump blasting, well sinking, etc.

Leading and Connecting Wire, Battery Testers, Insulating Tape, Blasting Caps, Etc.

SEND FOR CATALOGUE.
1898

MANUFACTURED ONLY BY **JAMES MACBETH & CO., 128 Maiden Lane, New York City.**



1898

THE NILES MINE AND MILL SUPPLY CO.,

Niles, Ohio, U. S. A.

TIPPLES, SCREENS, LARRIES, MINE CARS, WHEELS, CAGES.

Plans and Estimates by Competent Engineer.

Figure 4. **Miners' caps: hard rubber and leather cap with candleholder attached; soft canvas cap with "Sunshine" lamp attached; and (behind) Hercules powder box.**

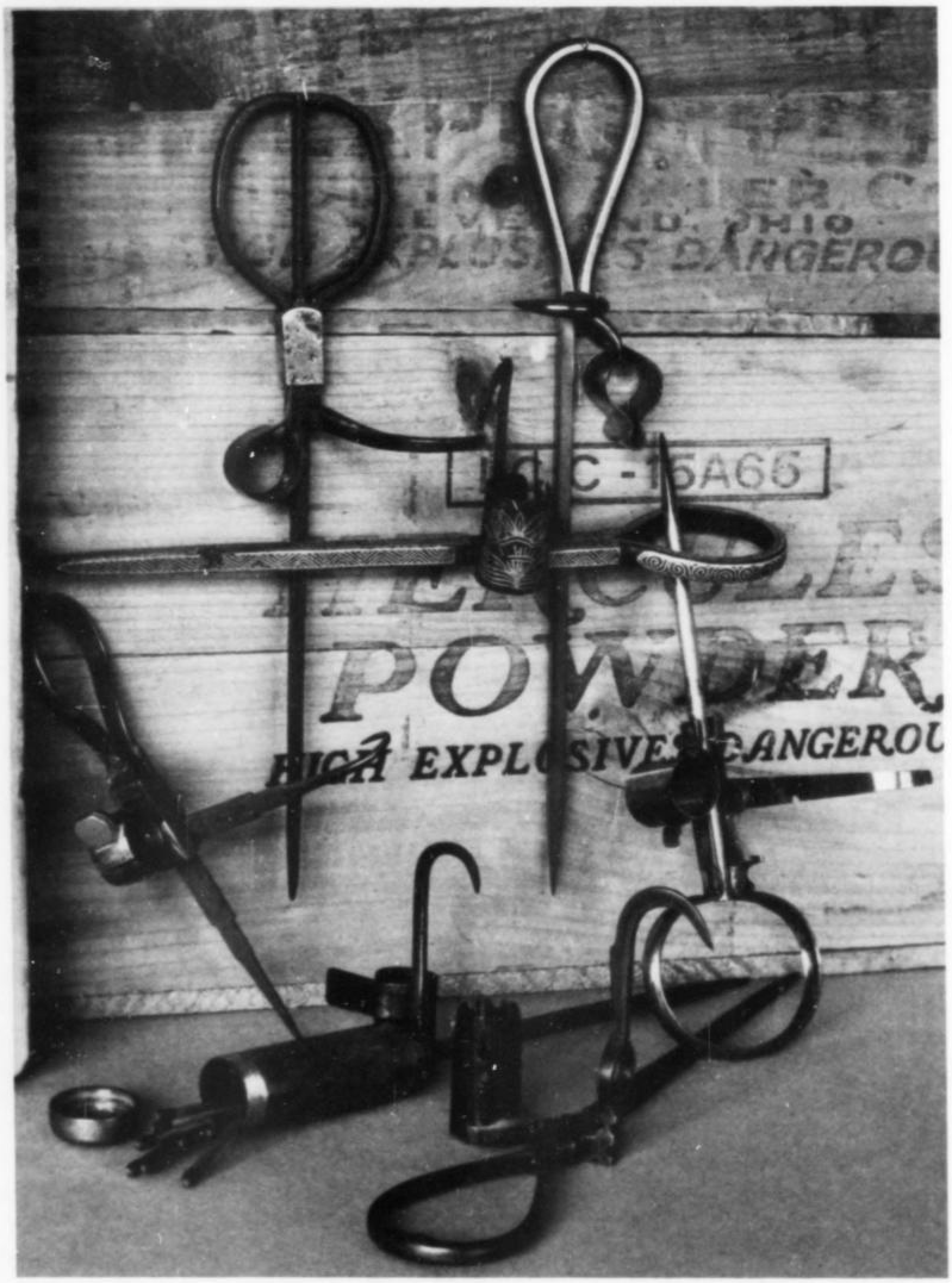


Figure 5. **Miners' candleholders: *(top left)* steel candleholder with cast brass collar; *(top right)* copper-plated Varney candleholder salesman's sample; *(center)* silver-inlaid steel candleholder dated 1910; *(left)* patented folding candleholder; *(bottom left)* Lindahl candleholder with brass match-safe handle and old matches; *(bottom right)* fancy steel candleholder, Ted Bobrink collection; *(right)* unique folding candlestick from the Cripple Creek, Colorado, area, Ken and Betty Roberts collection.**

tically everything in an old mine mill has value today. Most are large items such as rock crushers, stamp mills, amalgamating tables, slag cars and even waterwheels. Ingot molds are among the few conveniently small milling collectibles.

Blacksmith Equipment

Sizeable mines also employed a blacksmith to keep drills sharp and for the manufacture or repair of whatever miscellaneous mining equipment was required. Blacksmith tools, anvils and charcoal pots are usually considered mining collectibles if they can be reliably traced to a specific mine.

Lighting

As everyone must know by now, the collecting of mine lighting is among the most popular areas of mining memorabilia. Perhaps the most common such device in the American West was the candleholder, of which there are literally hundreds of different types and styles. Dozens of candleholder designs were patented, and many one-of-a-kind examples exist as tributes to the metalworking skill of early blacksmiths. Exotic examples such as folding models or models with intricate designs or silver inlays quickly bring several hundred dollars on today's market, and make fascinating display items. The boxes in which mine candles were shipped, and even the

Figure 6. **Rare carbide cap lamps:** ***(top row, left to right):*** **Ever-Ready, Wolf, Grier Brothers, Pathfinder.** ***(bottom row, left to right):*** **Gem, Hansen Force Feed, Zar, Lu-mi-num.**

Figure 7. **Miscellaneous lamp types** ***(top row, left to right):*** **safety lamps, Hughes Brothers superintendent's Davy lamp; J. Davis & Sons Ashworth-Hepplewhite-Gray safety lamp in brass; American Safety Lamp & Mine Supply Company lamp with sight-indicator for reading methane concentration; Hughes Brothers Clanny lamp; aluminum "baby Wolf" safety lamp.** ***(bottom row, left to right):*** **German frog lamp dated 1878 and made by W. Bülbring; United Mine Workers of America oil-wick cap lamp; French lenticular lamp with rooster stopper; Trethaway oil-wick cap lamp; frog lamp made by Henry Boker.**

old tallow candles themselves are nice pieces to have as well.

Carbide cap lamps were also used in gold mining, and there exists an enthusiastic fraternity of specialists in such lamps. Over 50 brand names are known; the most common by far are Justrite, Auto-Lite and Guy's Dropper. Some brands are extremely rare, with only one or two examples known to exist, and others are of such fascinating shape or construction as to make them particularly desirable. Names such as Maumee Duplex, Hansen Dry-Lite, Ever-Ready, Funk Brothers, Pathfinder, Squarelite, What Cheer, and Abercrombie & Fitch cause great excitement. Carbide cans, spare lamp parts and miners' hats are associated collectibles.

The other types of mine lighting such as Sunshine lamps, oil-wick lamps, safety lamps, and European-style lamps are less collected as gold mining items, though many were undoubtedly used as such. Some mines were even so advanced as to use electric lighting and telephones underground; the glass insulators for stringing wire, and the old mine telephones are found in a number of collections. Surveyors used special lamps of various types, both oil-burning and carbide-fueled, and these are extremely rare today.

Instruments

Mine surveying instruments such as the theodolite, the transit and the large surveying compass are elegant and expensive antiques. These finely crafted devices, made of brass and lenses with innumerable intricate and delicate parts, are revered along with antique microscopes and goniometers as among the finest of mining collectibles.

Photographs

There are major historical museums today devoted in large part

Figure 8. **Paper collectibles *(left to right):* original catalog of the gold collection of Georges de la Bouglise (1911) (to be sold at the next *Record* auction, donated by Harvard University); postcard scenes from the famous Cripple Creek district in Colorado (Ron Bentley collection); old stock certificate from the Alaska United Gold Mining Company; mining scenes illustrated in *Harper's Weekly* on April 24, 1869; books on gold mining.**

to the collecting and preserving of antique photographs. Scenes which are identified as to location are best, and underground scenes of mining are among the more difficult to acquire. This is easy to understand when one considers the bulky and delicate equipment used by photographers around the turn of the century.

Early photographs such as daguerreotypes (invented in 1839) are particularly valuable because there was no negative or print in the modern sense . . . the exposed plate became the one and only finished picture itself. *Original* prints from glass-plate negatives are also quite valuable, depending on scene, documentation and preservation. Modern prints from old negatives are worth very little.

Stock Certificates

The collecting of stock certificates (cancelled or representing defunct companies) is a thriving specialty these days. Certificates are valued primarily for attractive or spectacular artwork and the presence of interesting engravings of mining scenes. Stocks from California gold mining regions are eagerly sought; rarity and condition are factors in determining their value. Sometimes the signature of a historically famous person on the certificate boosts its value even further.

Other Paper

The collecting of paper items in general is increasing as people search for enjoyable specialties where prices are still relatively low. Items such as claim papers, assay reports, mining equipment purchase orders, mine supply catalogs, company-printed money and advertising items are all attracting attention. Among the more historically valuable paper items are the diaries of miners in famous mining areas, and their letters home telling about their success or failure in the gold fields.

Coins and Bars

During the gold rushes there was a currency problem: more gold was being mined than there was paper money and government coinage to give in exchange for it. This caused difficulty for merchants and miners alike, because they had to use the raw gold nuggets and dust, of unknown purity in many cases, as currency. Beer, liquor and other essentials were often bought and paid for with a pinch or a handful of gold dust. Accordingly, it was common practice for storeowners to hire clerks and bartenders by the size of their

Figure 9. **Gold bar, about 10 ounces, from the Harquahala gold mine in Maricopa County, Arizona; Smithsonian specimen.**

hands! To the rescue came private minting companies who, during the height of a rush, would smelt, assay and render into coins and bars the gold which miners brought them. Commonly such pieces have the weight, fineness and coining company stamped into them. Gold bars marked with the names of famous mines (having on-site equipment for smelting and casting) are also among the most loved of gold mining collectibles. Unfortunately the prices of such items are usually far beyond the reach of the average collector; values of $5000 to $50,000 are not uncommon for "private gold," and at least one coin (an 1851 Augustus Humbert) sold for half a million dollars in 1980.

General Collectibles

A huge number of items more or less closely related to gold mining are finding a home in collections. Souvenir bottles showing

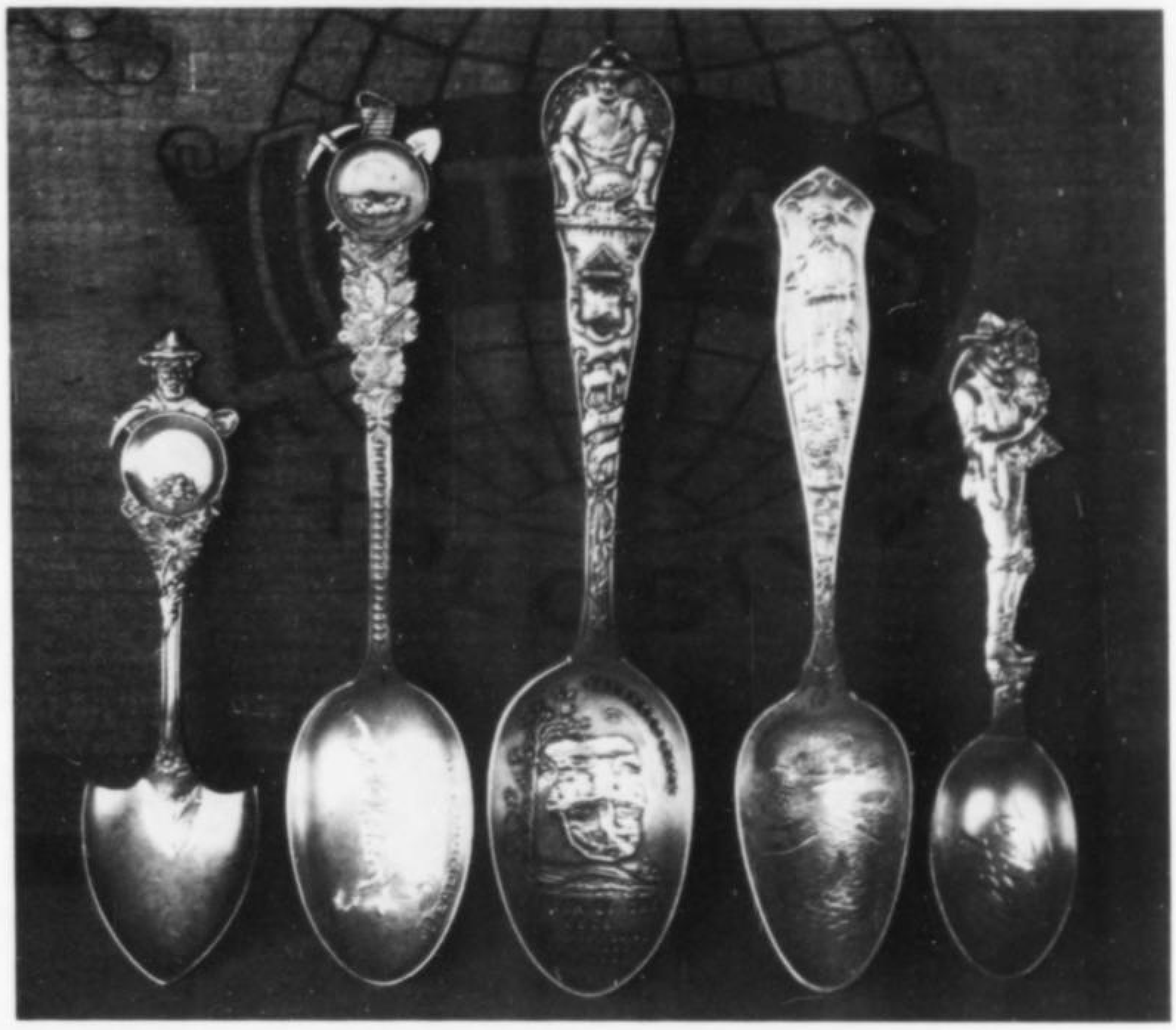


Figure 10. **Commemorative silver spoons with a mining theme *(left to right):* shovel-shaped spoon dated 1915; spoon marked "Deadwood S.D." and showing a miner's shovel, pick, bucket and gold pan with nugget; spoon from Colorado showing a prospector panning for gold; spoon marked "El Dorado 49" and "Sutter's M." showing gold miner; spoon marked "Lead S.D." and showing a miner. Earl Bentley collection.**

Figure 11. **Mining tokens and medals backed by a stock certificate from the Plymouth Consolidated Gold Mining Company. Ron Bentley collection.**

mining scenes, old whiskey and medicine bottles dug up at ghost town sites, and old tobacco tins found underground are gaining favor. Commemorative silver spoons sometimes depict miners and mining equipment. Saloon paraphernalia is a collecting domain unto itself, and includes gambling equipment, saloon paintings of exotic nudes, and even complete bars and back-bars. Mining companies sometimes issued small brass tokens redeemable at the company store for blasting caps, powder and other items. Miners' lunch buckets are a recognized item of mining memorabilia. And authentic leather pouches or "pokes" for holding gold are prized in a number of important collections.

Mining Art

The collecting of original mining art, whether old or recently done, is among the most expensive and challenging areas of collecting. Mining scenes are a legitimate part of Western Art, along with the better-known depictions of cowboys and savage Indians. Unfortunately, mining would come and go rapidly, and would commonly take place underground where the light was bad. Most artists found it far more convenient to set up their easel on the open prairies or the sunny mountainsides, rather than the raucous and sometimes dangerous mining camps and mines. Nevertheless a wide range of fine art was produced, from published engravings to large oil paintings. Most collectors will find that at least the published engravings, from old periodicals such as *Harper's* and *Frank Leslie's Illustrated Newspaper,* are within their budget. Artwork depicting actual specimens must usually be commissioned from working artists, though such paintings make fine additions to any mineral room. Paintings depicting mining scenes and still lifes of mining equipment can also be commissioned, and prices will depend upon the quality of detail and skill, and also the professional stature of the artist.

Books and Publications

A worthy project for the wealthiest of collectors would be the building of a gold-oriented library . . . and there are enough different books and publications known to fill a great deal of shelf space. But even the collector on a modest budget can indulge in some very interesting reading. Of the hundreds of titles that have been published, only a few are listed here in the bibliography.

Field Collecting for Mining Memorabilia

Yes, it is possible to collect your own memorabilia in the field, in

Figure 12. **"Miners and Puddlers Long Cut Smoking Tobacco" can, Ken and Betty Roberts collection.**

virtually the same manner as mineral collecting in the field. Collectors generally do some library research first to pinpoint likely targets. Mines most liable to contain untouched collectibles are those which are *not* known mineral specimen localities frequented by mineral collectors. Also, remember that items left in the mine will not date to much earlier than the closing of the mine, so even if a mine has a long and early history, it will not contain much if it was worked up to recent times. Mines in more inaccessible areas are less likely to have been picked over by hikers, backpackers and exploring mineral collectors.

Of course, problems with obtaining permission are identical to those for mineral collectors. But a mine which was closed in the late 1800's and never reopened may well have reverted to state or federal land. Many treasures for the collector still exist underground if he is willing to take the necessary trouble and brave the dangers of abandoned mines. More and more collectors are doing so these days. It is not uncommon to hear of old mines being stripped to the bare rock of equipment, headframes, ore cars, even mining timbers for displays! Care and common sense in the dangerous underground environment will distinguish the true collector from the vandal or the accidental fatality.

ACKNOWLEDGMENTS

We would like to thank Ted Bobrink, Don Olson, Ken and Betty Roberts and Earl Bentley for the loan of items to photograph. The listing of books on gold and gold mining is taken from a more comprehensive, unpublished work by Arthur E. Smith of Houston, entitled *Books on Mining History, a Bibliography* (1981).

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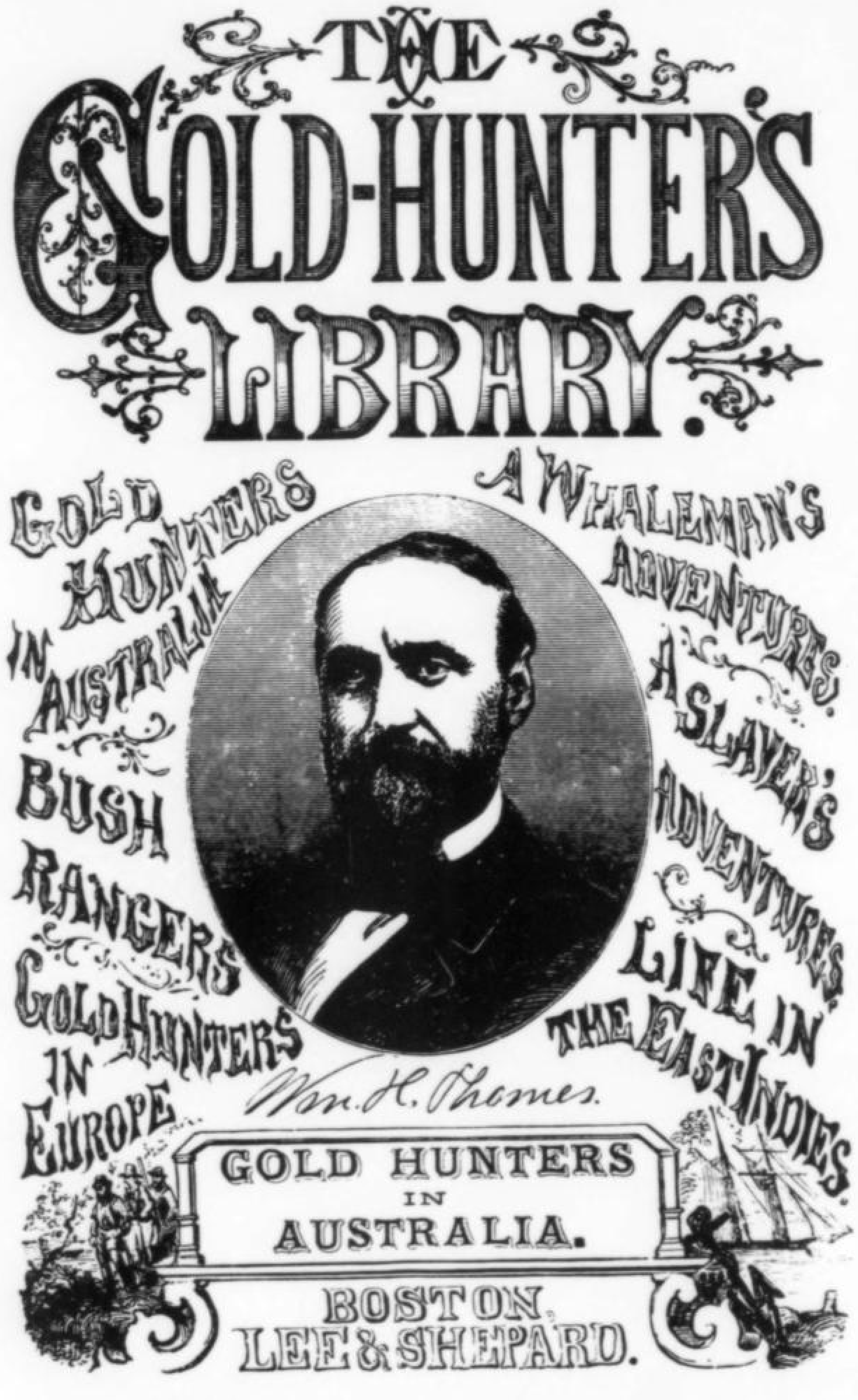

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AKEN, D. (1968) *Pioneers of the Black Hills:* Gordon's Stockade Party of 1874. Frontier Book Company, Fort Davis, Texas, 151 p., illustrated.

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Nova Scotian Gold

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"Not to be technical about it, the gold of Nova Scotia lies in thin spidery threads of quartz wandering through the deep mass of bedrock and creeping to the surface here and there. Where two veins meet or cross there may be a rich pocket of gold nuggets and dust, plain to be seen if the junction happens in the bed of a shallow stream."

Footsteps on old floors – The Lost Gold of Kejimikujik
by Thomas H. Raddall (1968)

INTRODUCTION

Many of the men who flocked to California after the discovery of gold there in 1848 were Nova Scotian seafarers and adventurers. Some remained in California. Others headed for Australia in 1851, and from there to New Zealand in 1858. A few may have returned to North America in time to join the tail end of the rush which began in 1857 to the "Cariboo" gold fields of south-central British Columbia. Such was the circuit of events which led to the exploitation of some of the world's great alluvial gold fields prior to the Klondyke rush in 1896.

The quest for gold in Nova Scotia by early French explorers in the mid-1600's is reflected by names of prominent geographic features like Cap d'Or and Bras d'Or. However, it was not until 1860 that John Pulsiver and his Indian guide located substantial amounts of auriferous quartz boulders about 15 miles from the coast, near Tangiers on the eastern shore near Halifax (Fig. 1). Since that year the mining of gold in Nova Scotia has continued intermittently up to the present. However, only a small portion has been won from alluvial workings. Most of the gold has been recovered from favorable structures in the so-called "Meguma group" of metasedimentary rocks.

OCCURRENCE OF GOLD IN THE MEGUMA

The Meguma group is a tremendously thick sequence of metasedimentary rocks prominent in the southwestern half of Nova Scotia. Slate of the Halifax formation is the dominant rock type of the upper Meguma, whereas quartzites (meta-sandstones) characterize the underlying Goldenville formation. Altogether, cross sections in excess of about 40,000 feet have been measured (Prest, 1915) and on the basis of sparse graptolite fauna a Cambro-Ordovician age is assigned to the rocks. Regional metamorphism in the Meguma ranges from greenschist to almandine amphibolite facies, modified locally by contact metamorphism due to intrusions of Devonian granite. Taylor and Schiller (1966) report that the gold-quartz veins are confined to the areas of greenschist facies metamorphism. However, other workers (e.g. Douglas, 1948) have suggested that the granite in some districts is responsible for helping localize the gold on the grounds that anticlinal fold limbs nearest granite are usually more abundantly metallized.

The major east-northeast trending anticlines and synclines, which have deformed the Meguma metasediments (Fig. 2), in turn, have minor cross folds superimposed upon them. However, it was early established by Dr. Eugène Rodolphe Faribault (Fig. 3) that the gold-bearing veins bear little relationship to the minor folds, being instead related mainly to the east-northeast trending series of major folds. He further determined that most of the gold quartz veins occur in slate beds in the Goldenville series; that many gold districts are located on anticlinal domes, and that interbedded veins are richer at, and near intersections with, "angulars" (branching veins) and in rolls or minor folds (Faribault, 1899).

The name Faribault is, for good reason, intimately associated with Nova Scotian gold. In his Autobiography and Bibliography (Faribault, 1944) he includes among his maps ". . . surveyed in the field and prepared for publication . . ." a total of: 47 geological maps and sections of the gold mining region on a scale of 1 inch to 1 mile, and 42 detailed geological plans with structural sections on a scale of 250 ft. and of 500 ft. to 1 inch (see also Johnston, 1961). The locations of the areas mapped are included in the index map (see Fig. 4 and Table 1) prepared by Gregory (1975).

Faribault's work has withstood the tests of time, for modern mapping methods have modified little of either topographic details or geological features shown on his maps. He was the first to

Figure 1. **Auriferous quartz; "Nigger" lead, Tangier, Halifax County. Height of specimen, 4 inches. Gold occurs as a coarse mesh in milky quartz between two slaty layers; one folded slaty layer dips towards viewer. Arsenopyrite crystals are present on the reverse side of the specimen. Possibly it was the discovery of specimens like this by John Pulsiver that started Nova Scotia's gold rush in 1860. Specimen is housed at the Geological Survey of Canada, Ottawa. Photo by Dan Maruska, G.S.C., Ottawa.**

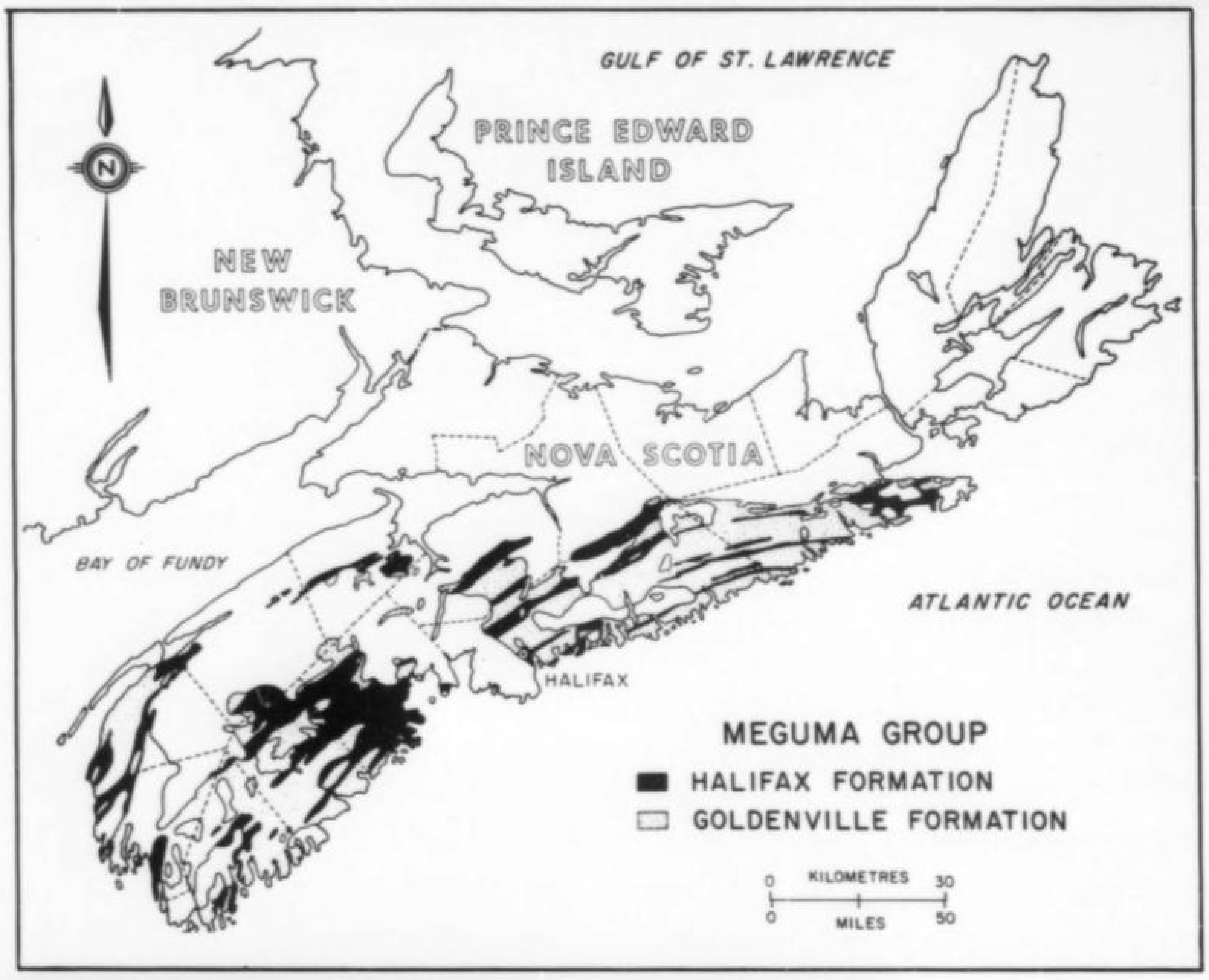


Figure 2. **Map showing the extent of the Meguma metasediments in Nova Scotia and the pattern in which they are folded. Pattern of Goldenville quartzite (stippled) indicates anticlinal axes; black areas are Halifax formation slate (modified after Cooke, 1973).**

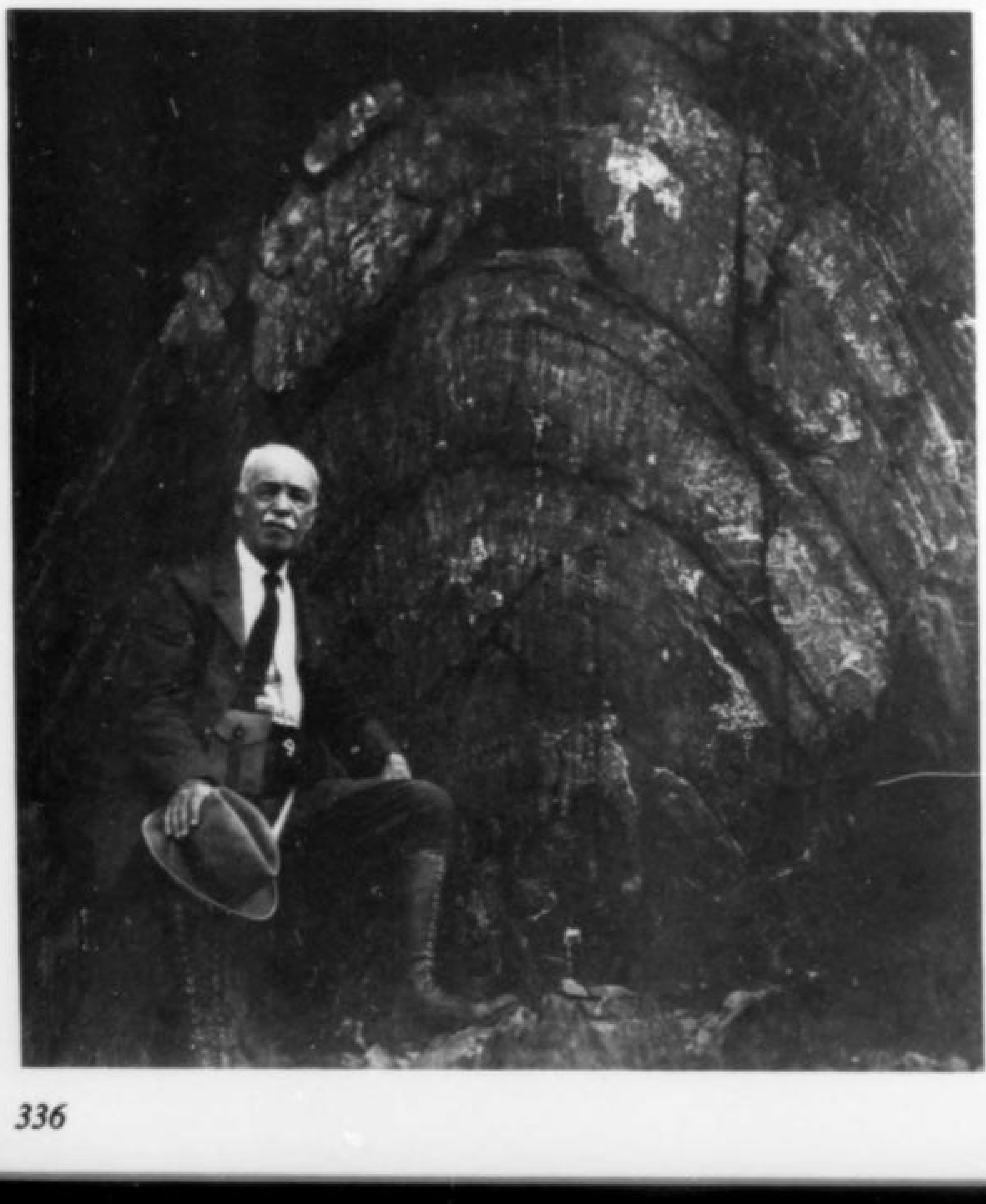


Figure 3. **Photograph of Dr. Eugène Rodolphe Faribault (1860 to 1953), geologist with the Geological Survey of Canada responsible for monumental studies on Nova Scotian gold. The photograph was taken at Bear River, Nova Scotia, in September of 1925. The anticline is on the east side of the river, below Bear River village. Dike of diabase (dark band at right) conformable on the north limb, but intersecting the strata on the south limb (out of photo) at a low angle. Geological Survey of Canada photograph 68906.**

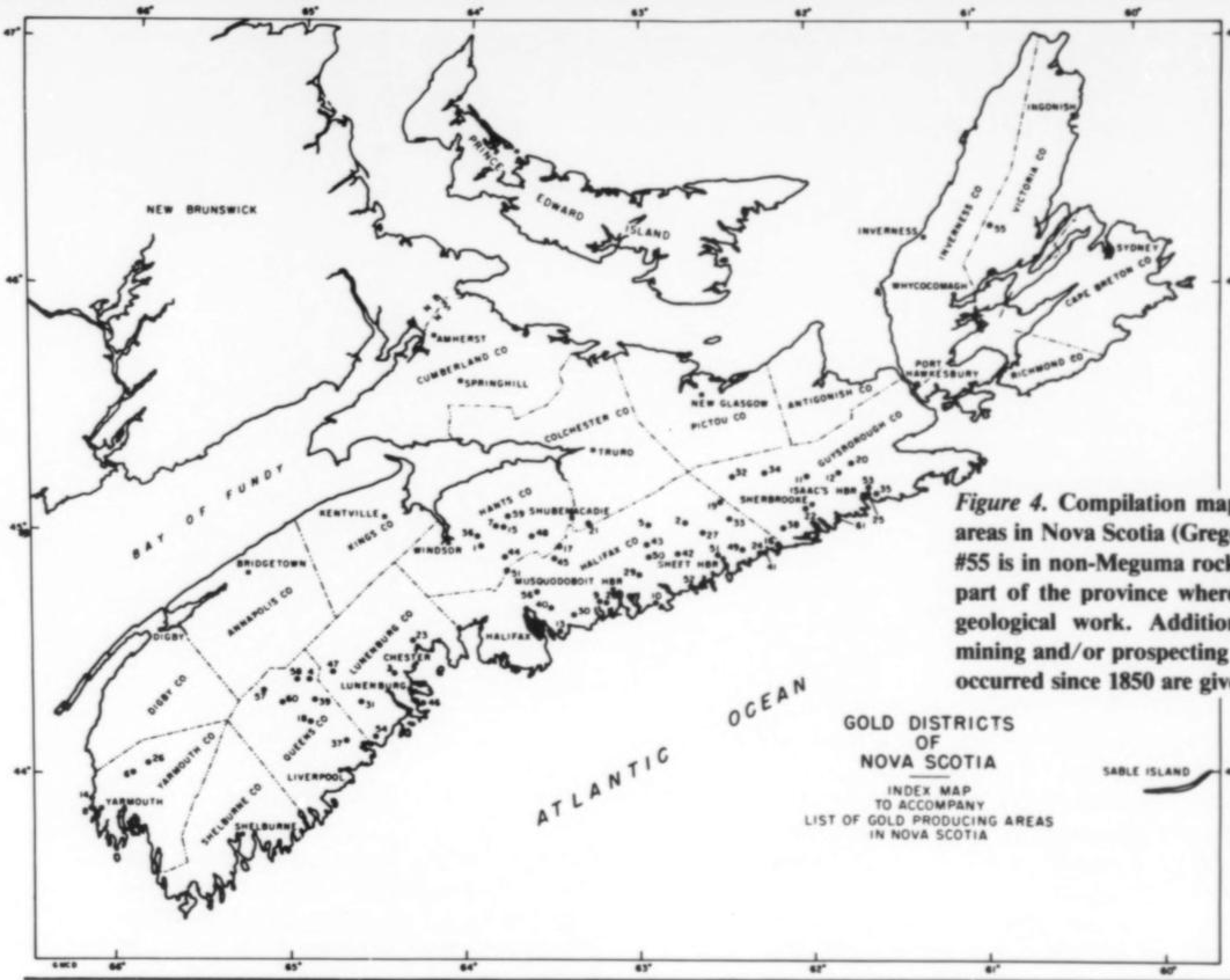


Figure 4. Compilation map of gold producing areas in Nova Scotia (Gregory, 1975). Location #55 is in non-Meguma rocks in Cape Breton, a part of the province where Faribault did little geological work. Additional localities where mining and/or prospecting activity for gold has occurred since 1850 are given by Graves (1976).

Table 1. List of gold producing areas in Nova Scotia (modified after Gregory, 1975). Additional localities where gold mining or prospecting have occurred since 1850 are given by Graves (1976).

No.	Gold Area	County	Yield of ounces 1862-1974
1	Ardoise	Hants	7
2	Beaver Dam	Halifax	966
3	Blockhouse	Lunenburg	3,588
4	Brookfield	Queens	43,041
5	Caribou	Halifax	91,381
6	Carleton	Yarmouth	190
7	Central Rawdon	Hants	6,744
8	Chegoggan	Yarmouth	–
9	Chezzetcook	Halifax	7
10	Clam Harbour	Halifax	53
11	Cochrane Hill	Guysborough	1,192
12	Country Harbour	Guysborough	9,959
13	Cow Bay	Halifax	1,242
14	Cranberry Head	Yarmouth	118
15	East Rawdon	Hants	13,494
16	Ecum Secum	Halifax	1,275
17	Elmsdale	Halifax-Hants	1
18	Fifteen Mile Brook	Queens	880
19	Fifteen Mile Stream	Halifax	19,740
20	Forest Hill	Guysborough	25,102
21	Gays River	Colchester	2,137
22	Goldenville	Guysborough	210,152
23	Gold River	Lunenburg	7,751
24	Harrigan Cove	Halifax	7,946
25	Isaac Harbour	Guysborough	39,654
26	Kemptville	Yarmouth	1,851
27	Killag	Halifax	3,504
28	Lake Catcha	Halifax	17,951
29	Lake Charlotte	Halifax	126
30	Lawrencetown	Halifax	867
31	Leipsigate	Lunenburg	12,083
32	Little Liscomb Lake	Guysborough	51
33	Lochaber	Halifax	2
34	Lower Caledonia	Guysborough	–
35	Lower Seal Harbour	Guysborough	34,295
36	McKay Settlement	Hants	13
37	Mill Village	Queens	909
38	Miller Lake	Guysborough	538
39	Molega (Malaga)	Queens	34,876
40	Montague	Halifax	68,139
41	Moosehead	Halifax	470
42	Mooseland	Halifax	3,865
43	Moose River	Halifax	25,984
44	Mount Uniacke	Hants	27,739
45	Oldham	Halifax	85,295
46	Ovens	Lunenburg	543
47	Pleasant River Barrens	Lunenburg	112
48	Renfrew	Hants	51,985
49	Salmon River	Halifax	41,049
50	Scraggy Lake (Gold Lake)	Halifax	38
51	South Uniacke	Hants-Halifax	20,762
52	Tangier	Halifax	26,022
53	Upper Seal Harbour	Guysborough	57,845
54	Voglers Cove	Lunenburg	43
55	Wagamatkook (Middle River)	Victoria	1,440
56	Waverley	Halifax	73,105
57	West Caledonia	Queens	2
58	Westfield	Queens	–
59	West Core	Hants	7,148
60	Whiteburn	Queens	11,890
61	Wine Harbour	Guysborough	42,726

recognize that many of the most productive gold veins of Nova Scotia take the shape of a saddle on the axes of anticlinal folds of interbedded quartzite and slate. He strongly promoted the concept of deep mining for he believed that other hidden saddle reefs underlie those exposed in outcrop.

A landmark paper by Keppie (1976) presents a structural model that goes a long way towards successfully predicting regional occurrences of gold in dilation zones formed during folding. The success of this model is taken as strong evidence supporting Faribault's concept of a close association of the gold with the first and major phase of deformation of the Meguma. A regional compilation of gold and other metallic mineral occurrences in the province is an important new contribution by the same author (Keppie, 1979).*

On a local scale Faribault established three main structural forms in which Nova Scotian gold occurs: (1) Interbedded veins; (2) Cross (fissure) veins; and (3) Angulars (Faribault, 1913).

Interbedded veins are in many cases traceable over 1,000 feet along strike and possess distinguishing characteristics such as color, texture and distribution of sulfides. Ideally, the veins take the form of saddles thrown over the axial planes of folds. Interbedded veins developed as a result of the deformation of intimately interlayered competent and incompetent strata. Thus near the apex of the fold, or a dome as the case may be, the greatest potential for development of gold exists. Variations on this theme are many, all thoroughly documented by Faribault (*in* Malcolm, 1912). Thus in many gold districts auriferous veins occur only on one limb of the anticline, that being the one with the higher dip (generally the south limb). The Oldham district is unusual in that it is a symmetrical dome, wherein the veins form ellipses.

Crenulated structures are common (Fig. 5). In some instances where a vein is enlarged, for example at a corrugation (an exaggerated crenulation) a roll-type structure is developed which is commonly enriched in gold. Such a structure is highly individual and may give rise to rich ore shoots, the distribution of which is apparently never the same in any two gold districts (Malcolm, 1912).

Cross (fissure) veins. These characteristically trend parallel to, and dip toward the center of, the nearby folds. The Libbey and Leipsigate are among the largest cross veins of their type. Each produced considerable amounts of gold. The Libbey fissure vein of the Brookfield gold district averages 14 inches thick but characteristically swells to 150 inches where it intersects interbedded veins. It was worked over a length of 2000 feet and to a depth of 1000 feet. The Leipsigate vein in the gold district by the same name (see Table 1) varies from 12 inches to 15 inches wide (Faribault, 1904) and is believed to have a strike length of about 9000 feet.

Angulars (cross fractures). Branches from the main veins were called angulars, and their manner of distribution was the subject of very close attention by the miners. In particular the distribution of angulars on domal structures was believed closely dependent on local structures and on rock types.

GOLD PRODUCTION IN NOVA SCOTIA

In the words of Walter H. Prest (1915), "Nova Scotian gold has come from small mines and mills. The narrow rich paystreaks, easy to raise money for and cheap to work, have been the salvation of gold mining in Nova Scotia. This is the country of the small capitalist; but undoubtedly the profit on the capital invested has been as high as in any gold mining country in the world."

After the experiences of California and Australia, entrepreneurs were not lacking in Nova Scotia. During the 30 years or so follow-

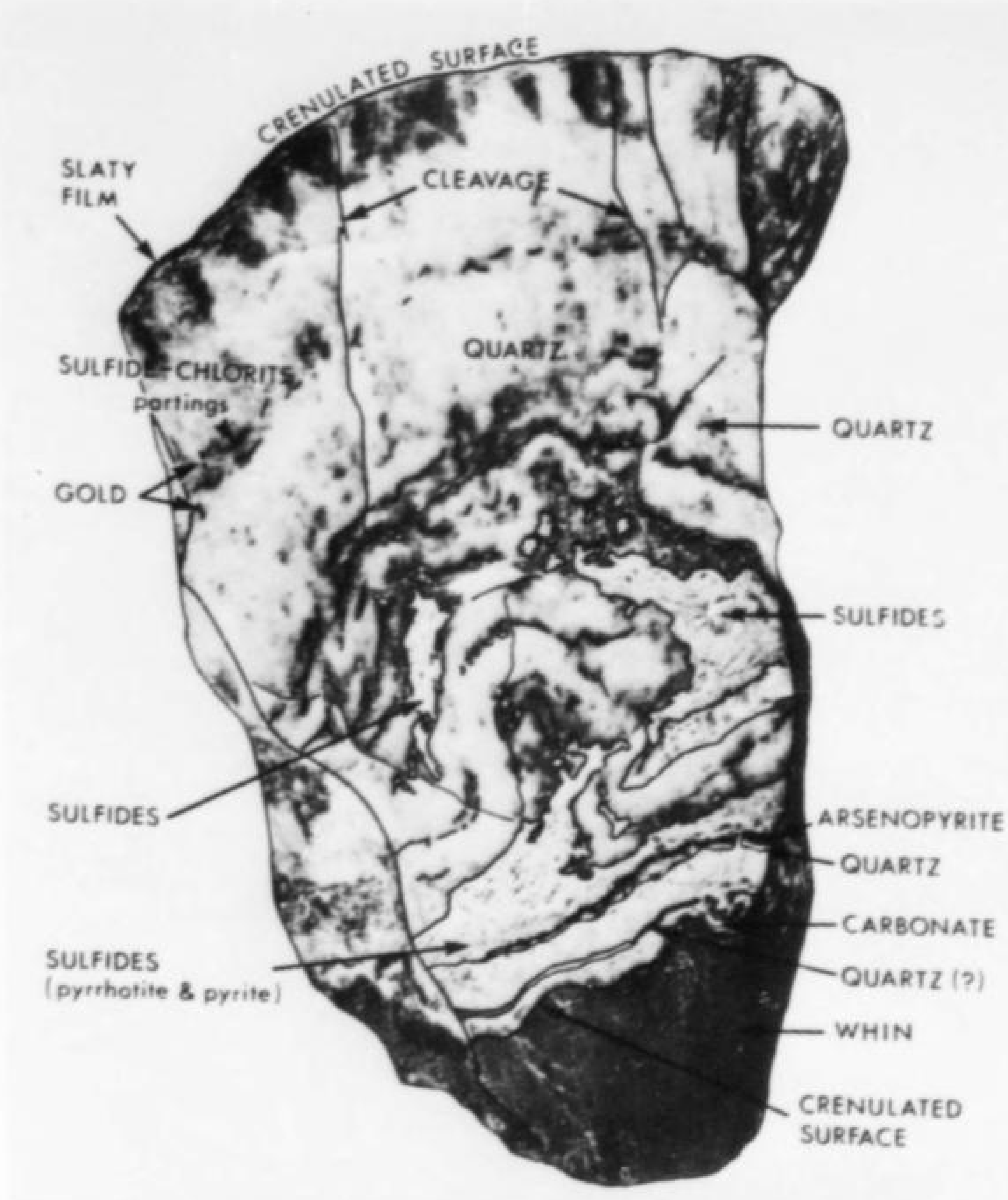


***Figure 5.* Sterling "barrel" vein, Acadia Gold Mines, Oldham, Halifax County, Nova Scotia. Specimen is 4 x 8 x 8 inches. Note crenulations (due to axial plane cleavage) at the top of the specimen around the circumference of the (partially dragged) fold. Gold is contained in cross fractures and as disseminated specks in the quartz, and as small specks and patches intergrown with the sulfides. Specimen G.S.C. 10329 housed in Geological Survey of Canada, Ottawa. Photo by Don Maruska.**

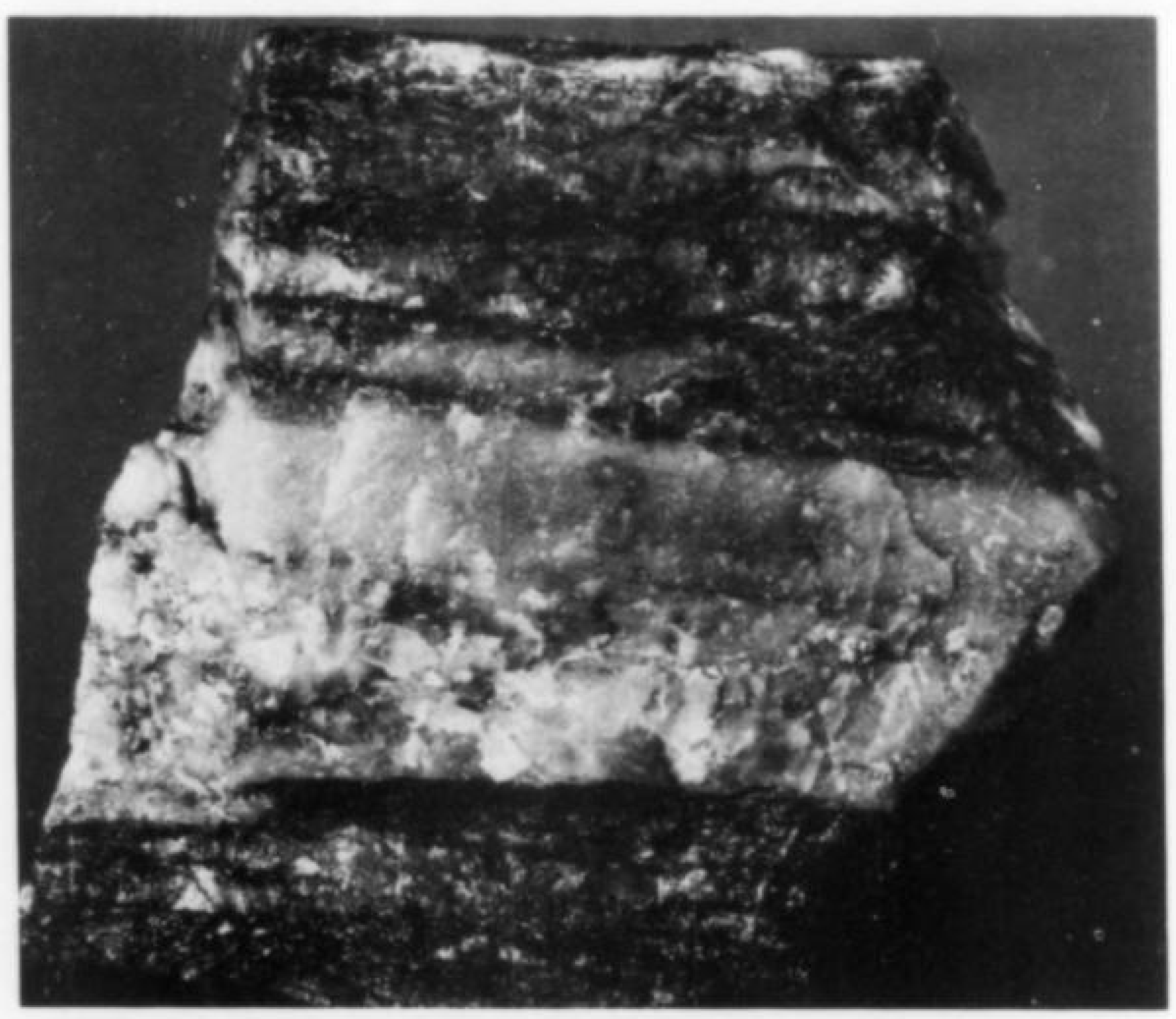


***Figure 6.* Gold from Baker's mine, Oldham, Halifax County, Nova Scotia; the specimen is 3 inches high and shows metasedimentary layering; a trace of iron pyrite occurs in the slaty layers and, to a lesser extent, in the quartz. The specimen is housed at the Geological Survey of Canada, Ottawa. Photo by Dan Maruska.**

* Mineral Occurrences Data (MOD) cards on file in Nova Scotia Department of Mines provides additional information on 102 gold occurrences in the province.

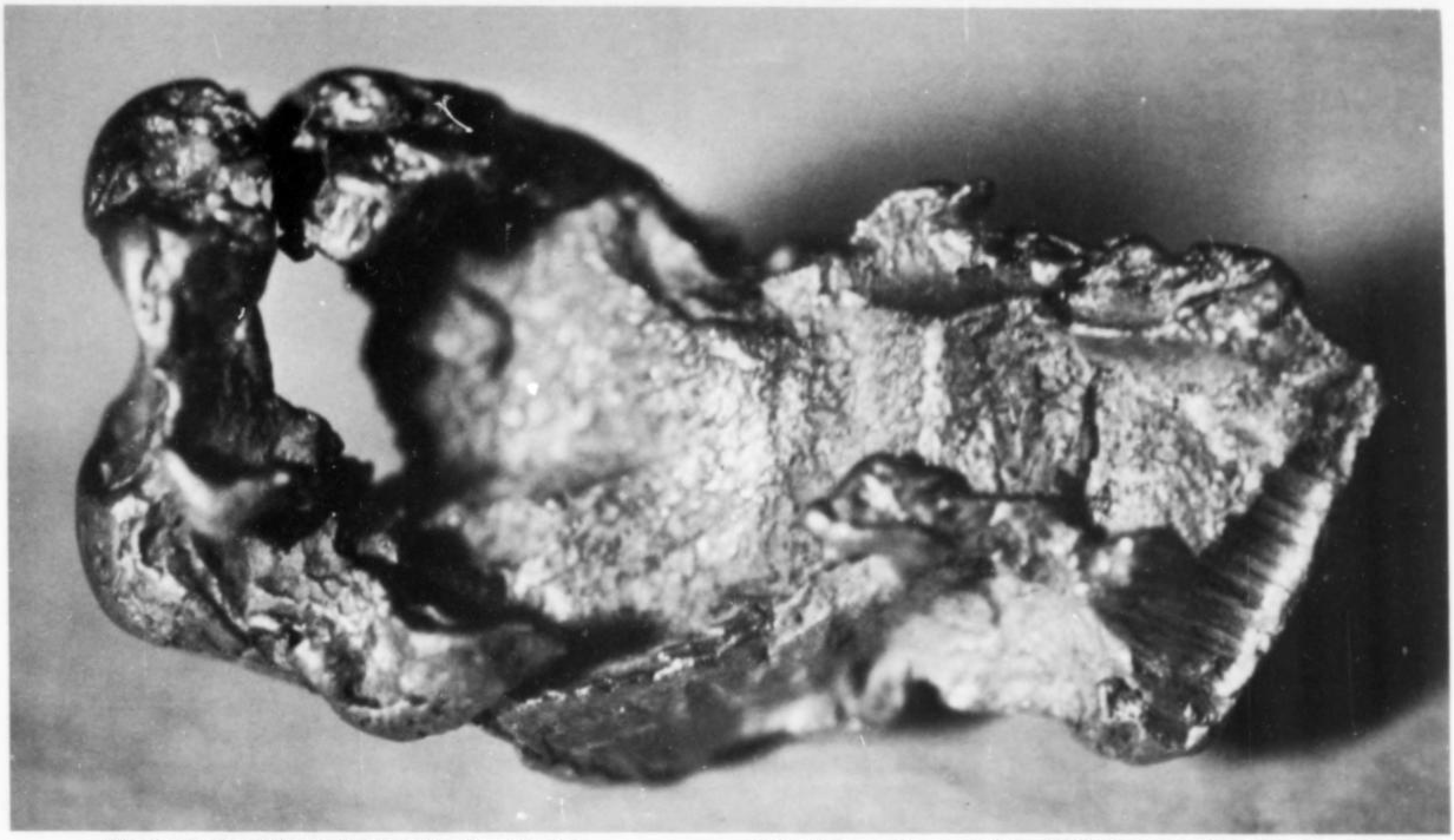


Figure 7. **Gold from the beach, Crook Cove, near Seal Harbour, southeast of Goldboro, Guysborough County, Nova Scotia. (Shown on Isaac's Harbour Map, Geological Survey of Canada Map #381 [E. R. Faribault]); the specimen is about ⅔ inch in diameter. F. Ebbutt Collection; specimen N.M. 35437 housed at the National Museum of Canada, Mineral Science Division, Ottawa. The black mineral is sphalerite. Specimen is probably from the "Donkin-John Bull" belt (Malcolm, 1929). Photo by D. J. Mossman.**

ing the initial strike, miners were hard at work sinking shafts and drifting on bedrock discoveries.

The high tenor of ore mined in the early days is of course due to the selective process of highgrading, and of working in confined spaces in order to recover "pockety" gold. And, like most old gold mining areas, the record for Nova Scotian gold is replete with mouth-watering numbers which describe rich finds. Thus, isolated pockets containing as much as 60 oz. of gold were reported, as for example, from the Hay lead at Oldham, while at the West Lake mine nearby one batch of 13 tons of ore yielded 234 oz. (Malcolm, 1912).

Most of these early mining operations would count as little more than holes in the ground in the present age of earth moving. However, there were notable exceptions. The Sterling "barrel" lead at Oldham was worked to a depth (on the average incline of about 36°) of over 1500 feet, with ore averaging (in 1909) 2.88 ounces of gold per ton (Malcolm, 1912). (The term "barrel" was used, as at Oldham and Waverley, to describe extreme development of crenulation structure.)

The substantial tonnages recovered and the accompanying grades pretty well confirm Faribault's conviction that the exposed Bendigo-type saddle reefs in Nova Scotia are part of a pattern repeated at increasing depths. Official returns from the mill of the Oldham Gold Company between the years 1885 through 1894 list 16,112 tons of ore yielding 22,967 oz. Au for an average grade of 1.4 oz./ton (Malcolm, 1912). (See Fig. 6.)

The above data are characteristic of the type of mining carried on. Government statistics of gold production in the province from 1862 to 1910 show that 2,080,403 tons were mined yielding 919,046

Figure 8. **West exposure of Ovens anticline, looking east. Auriferous white quartz veins are drag-folded towards the axis in the Halifax slates. Note the "cross vein" in the foreground which offsets the "interbedded" veins. G.S.C. photo #138501 by L. M. Cumming (Sept. 1953).**

oz. Au for an average grade of 0.45 oz./ton (Malcolm, 1912). More recently Boyle (1966) has given the figure of 0.35 oz. Au/ton as the average grade of deposits mined to date in Nova Scotia. This figure exceeds the traditional average grade of several large Canadian producers, (Kavanagh, 1980).

Placer operations never accounted for more than a very small portion of gold recovered in the province (Fig. 7). However, the discovery, in July 1861, of the yellow metal in beach gravels at "The Ovens" helped to get things going (Fig. 8). The Ovens, a small summer resort near the port of Lunenburg, was never a big producer. However up until about 20 years ago the then owner-proprietor, Oscar Young, continued to "rock for gold" in a small way, according to his good sense of time, and tide, and season (Fig. 9). Some of his rewards are to this day proudly displayed in the local museum at The Ovens.

A rather large-scale program began in 1962 to search for alluvial gold off the coast of Nova Scotia. However, despite a subsequent optimistic report (Libby, 1969) of 42 million cubic yards of "pay dirt" concentrated in two areas, one offshore The Ovens, and the other offshore Isaacs Harbour, little serious follow-up work has been done.

GOLD AND ASSOCIATED MINERALS

A paragenetic study of the ore minerals in Nova Scotian gold mines (Harrison, 1938) indicated a three-stage sequence: (1) arsenopyrite-pyrite, (2) quartz; (3) sulfides, including galena. More recent work by Graves (1976) shows that the auriferous veins exhibit a constant mineralogy, dominantly quartz, secondly carbonate with minor amounts of arsenopyrite, pyrite, pyrrhotite and host rock fragments. Chalcopyrite, galena, sphalerite, feldspar, rutile, scheelite and gold are trace minerals.

Various workers have commented on the constant occurrence of arsenopyrite with Nova Scotian gold. In certain camps it is conspicuous (Fig. 10). Arsenopyrite, pyrrhotite and pyrite are all commonly observed in the Meguma group, particularly in slate of the Halifax formation. The three minerals are conspicuous in many ores, *e.g.* Montague (Figs. 11 and 12) and Mt. Uniacke (Figs. 13 and 14), and are usually accompanied by chalcopyrite, galena and sphalerite.

Graves (1976) renewed speculation that arsenopyrite (and pyrite) played a key role, through solid solution effects, in concentrating gold in the (mesothermal) quartz veins. Something similar may have occurred in the country rock also for, according to Boyle (1966), in the Meguma slate and quartzite, the pyrite averages 0.15 ppm Au and 1.2 ppm Ag, and arsenopyrite averages 2.0 ppm Au and 0.5 ppm Ag. Gold reportedly tends to "follow" arsenic and be concentrated in arsenopyrite (*ibid.*).

According to Boyle (1966) most Nova Scotian gold occurs as a native gold-silver alloy, a fact that Faribault and his peers doubtless would not have argued although they too were well aware that a portion of the gold is tied up in sulfide. Boyle (*ibid.*) reports that the Au/Ag ratio in the deposits varies a great deal, but falls in the range 4:1 to 20:1. Substitution of base for precious metal in this alloy also appears likely, for distinct color differences including, for example, a reddish tint to some of the Oldham (Sterling "barrel" vein) specimens is also detectable among gold samples from different districts. A total of 0.39 percent Cu is reported by Faribault (*in* Malcolm, 1912) for gold from Waverley.

Crystalline gold is known from very few localities in Nova Scotia. Marsh (1861) reported three isolated crystals of gold from Tangier, the largest being about ⅓ inch in diameter . . . "a rhombic dodecahedron with its edges slightly beveled . . . its faces are marked with delicate striae, several of them unusually brilliant. The other two were octahedrons, with dull and somewhat rounded faces. One of these was flattened and also much elongated. The smallest crystal was about two lines in length and quite perfect." According to Malcolm (1912) numerous crystals were also found at Harrigan Cove, a few of which were purchased for the Victoria Memorial Museum, Ottawa (see Fig. 15).

Figure 9. Photograph from an old postcard (ca. 1940) showing Mr. Oscar Young "cradling" for gold at the Ovens Natural Park. A tourist attraction now for many years, the park takes its name from several "blow holes" in cliffs (background) partly excavated by ocean wave action, and partly by former mining activities. At most no more than several thousand ounces of gold have ever been recovered from "The Ovens."

Figure 10. An arsenopyrite crystal 1¼ inches in diameter in "whin" (Goldenville meta-sandstone) from near the Montague mine, Waverley, Halifax County, Nova Scotia. The specimen was collected by R. Thorpe, Geological Survey of Canada. Photo by Dan Maruska, G.S.C., Ottawa.

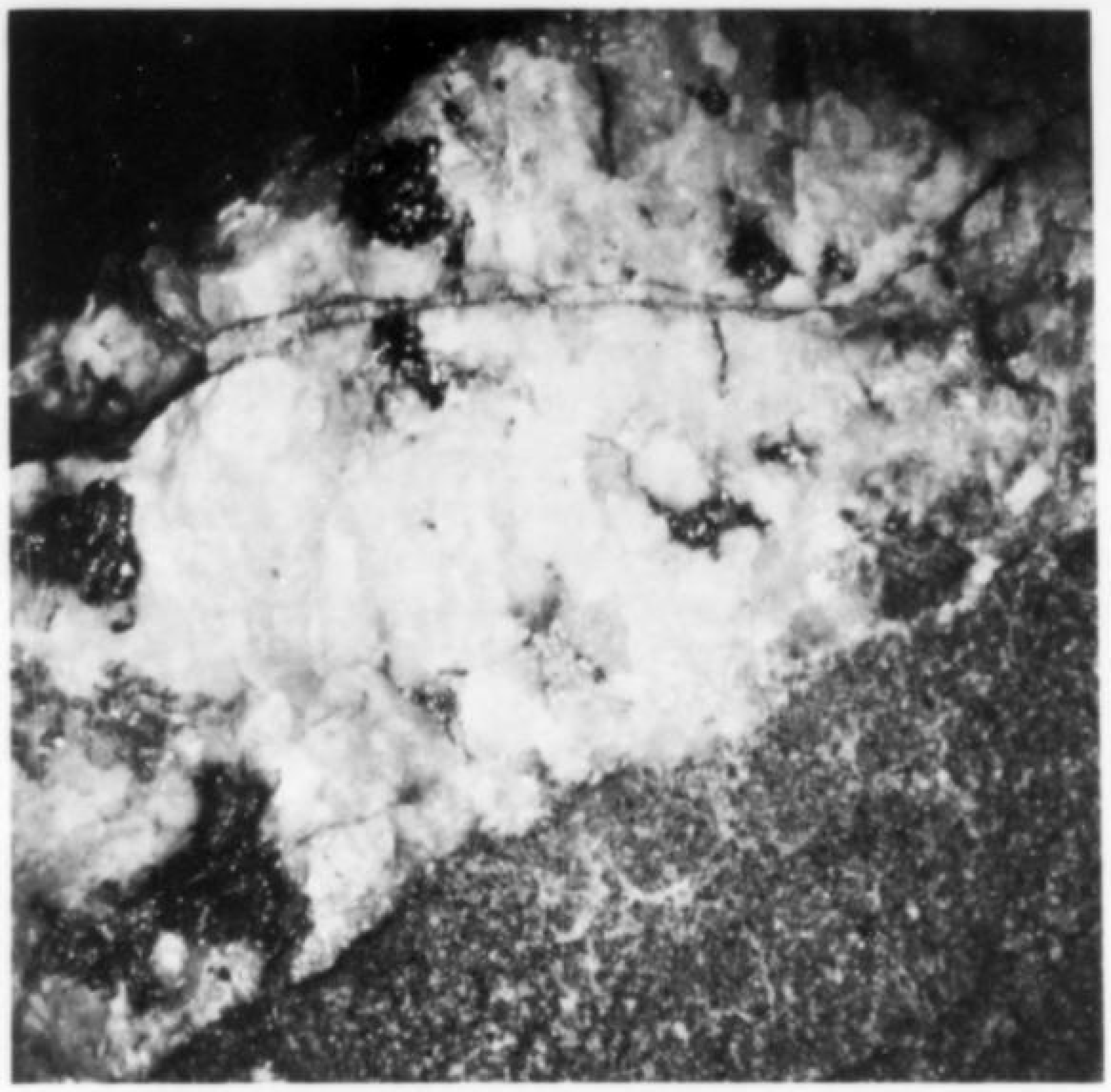


Figure 11. **Gold ore from Montague mine, Halifax County, Nova Scotia; host rock to the gold-bearing (plus iron sulfides, arsenopyrite and sphalerite) quartz vein (3⅛ inches wide) is meta-sandstone characteristic of the Goldenville series "quartzite." Dilation zones commonly develop in proximity to this competent rock type where it occurs as narrow beds near base of the Halifax formation (slate). Specimen N.M. 30871 housed at the National Museum, Mineral Sciences Division, Ottawa. Photo by D. J. Mossman.**

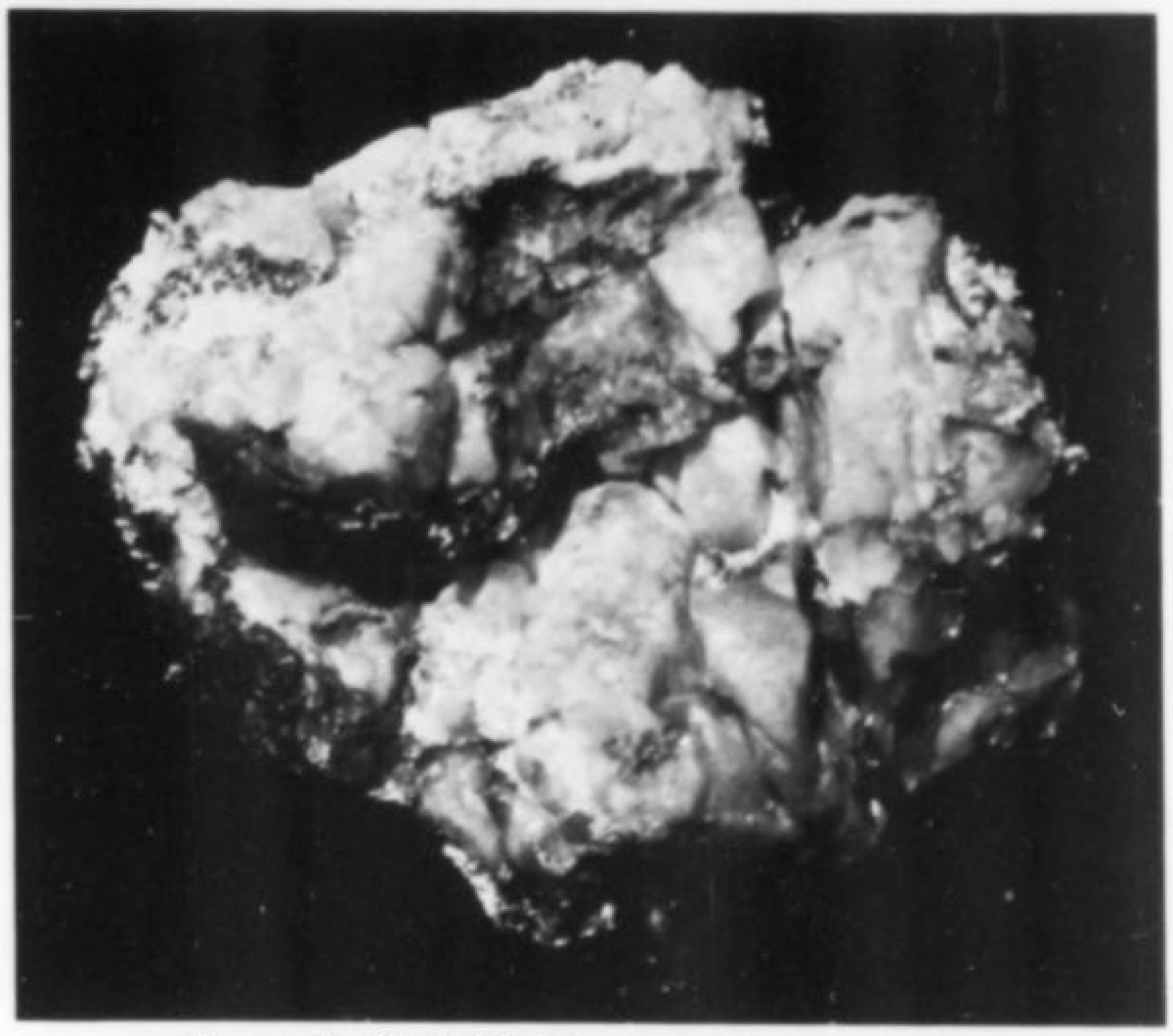


Figure 12. **Gold (23.90 ounces Troy – see also Table 2) in quartz with minor arsenopyrite; the specimen measures 2⅓ x 2¾ x 3¾ inches. Although the specimen is labelled "Montague," it may in fact be from the Goldenville district. (R. G. Grantham, pers. comm., 1980). Specimen number 118-a, housed in the Nova Scotia Department of Mines. Photo by D. J. Mossman.**

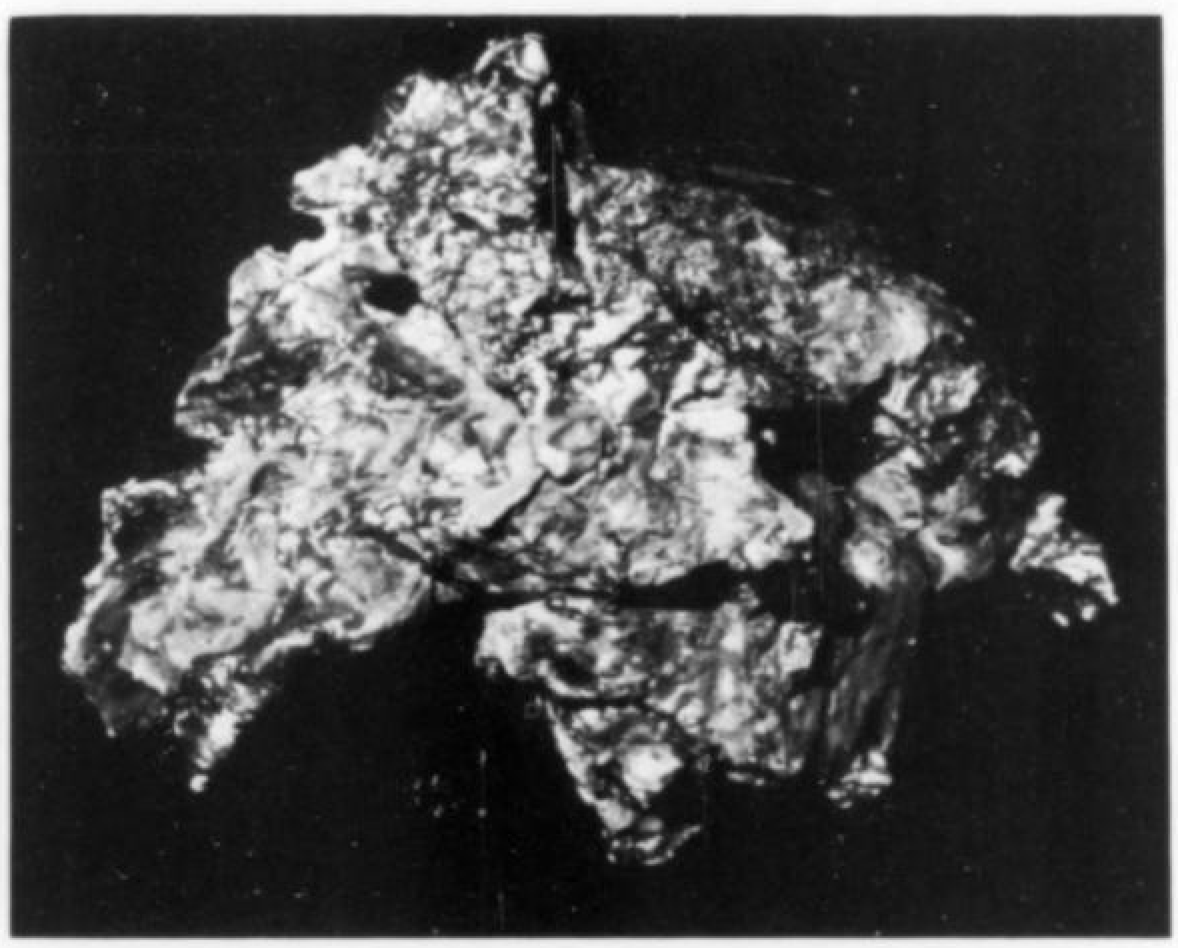


Figure 13. **A full-size cast of a specimen of native gold made from the original (ca. 54.86 oz. Troy) which was taken from the Borden lead, Mt. Uniake district, Hants County. Size: 2½ x 4 x 5 inches. Original catalog number was 2319. Present number: 978GM 127.1. Housed in the Nova Scotia Museum (see Fig. 14). Photo D. J. Mossman.**

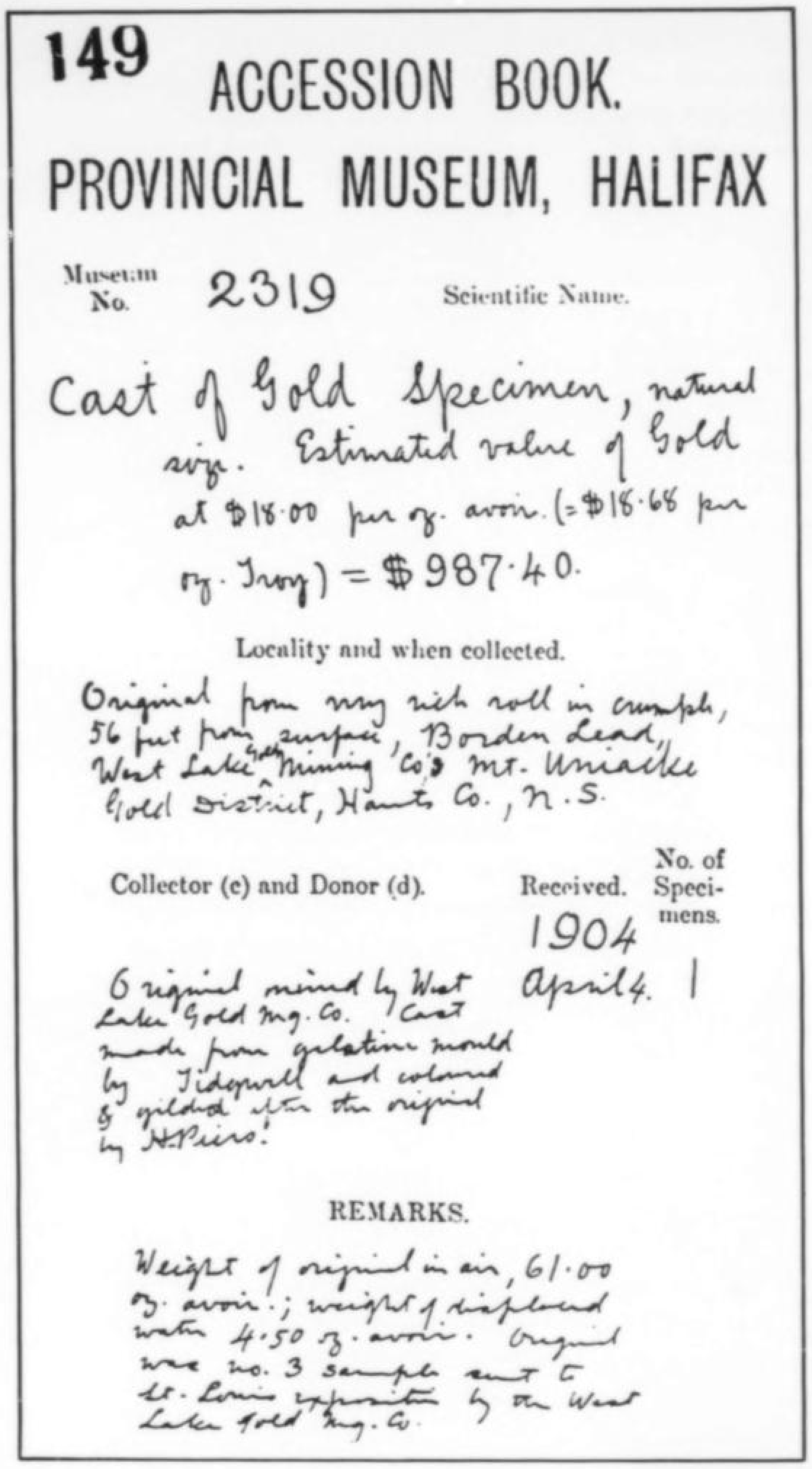
Crystals of gold are also present in stibnite ore from West Gore, Hants County (sample #118 housed in the Nova Scotia Museum); these crystals are up to $1/10$ inch in diameter.

In addition, gold crystals occur in two specimens (of highly dubious locality) housed in the Nova Scotia Department of Mines in Halifax. The first specimen (both unidentified), 17.7 oz. Troy, contains several $3/32$ inch (modified) octahedrons of gold and a beautiful dendritic spray of crystals ⅖ x ⅗ inch. The second specimen, 6.9 oz. Troy, contains several octahedrons and one elongate cluster of gold crystals nearly ⅕ inch on edge.

In addition to the collection of Nova Scotian gold samples at the National Museum of Canada (Ottawa), the Geological Survey of Canada (Ottawa), the Nova Scotia Department of Mines and the Nova Scotia Museum, an interesting collection belonging to the Nova Scotia Department of Mines is presently housed (with the exceptions noted) at the College of Cape Breton, Sydney, Nova Scotia (Table 2). Most of these specimens, among them #118-a, were retrieved in 1968 for safekeeping by Mr. H. R. Oldale of the College of Cape Breton, from the Isle Royal Hotel in Sydney where they had been kept in an open display case after closure of the Nova Scotia Department of Mines office in Sydney in the mid-1950's! Data on these particular samples are given in Table 2; the method of calculating weight of gold in these samples is outlined, courtesy of Mr. Oldale, in the appendix to this paper.

Industry and government alike are showing renewed interest in gold mining in the province. There are, however, surprisingly few, if any, of the old claims left open at present. For example, interest has recently been shown in testing the feasibility of large scale open-pit mining at the Cochrane Hill property 10 miles north of the picturesque tourist town of Sherbrooke, east of Halifax. Cochrane Hill gold district, one of the oldest in the province, is hosted in high-grade metamorphic rocks noted for coarse, crystalline, black biotite, staurolite and violet-blue andalusite, the latter mineral being hosted in vein quartz (R. Thorpe, personal communication).

Legends of great gold finds are commonplace at most gold camps throughout the world. Nova Scotian gold is certainly no exception. For example, the legend of lost gold at Kejimikujik has been the cause of speculation on the part of many people, Faribault



149 ACCESSION BOOK.

PROVINCIAL MUSEUM, HALIFAX

Museum No. 2319 Scientific Name.

Cast of Gold Specimen, natural size. Estimated value of Gold at $18.00 per oz. avoir. (= $18.68 per oz. Troy) = $987.40.

Locality and when collected.

Original from very rich roll in crumple, 56 feet from surface, Borden Lead, West Lake Gold Mining Co's Mt. Uniacke Gold district, Hants Co., N.S.

Collector (c) and Donor (d).	Received.	No. of Specimens.
Original mined by West Lake Gold Mg. Co. Cast made from gelatine mould by Tidswell and coloured & gilded after the original by H. Piers.	1904 April 4.	1

REMARKS.

Weight of original in air, 61.00 oz. avoir.; weight of displaced water 4.50 oz. avoir. Original was no. 3 sample sent to St. Louis exposition by the West Lake Gold Mg. Co.

Figure 14. **Photograph of an entry in the Provincial Museum's Accession Book (April 4, 1904) of specimen 2319 by Rev. Dr. David Honeyman, first curator of the Nova Scotia Museum. Honeyman estimated the weight of gold in the specimen as 54.86 ounces Troy. Harry Piers, successor to Honeyman, colored and gilded the model (see Fig. 13). The original specimen was most likely part of the prize-winning collection of Nova Scotian minerals which Faribault organized for various international exhibitions. Subsequent to having been exhibited, this particular specimen was probably processed for its gold content (R. G. Grantham, pers. comm., 1980).**

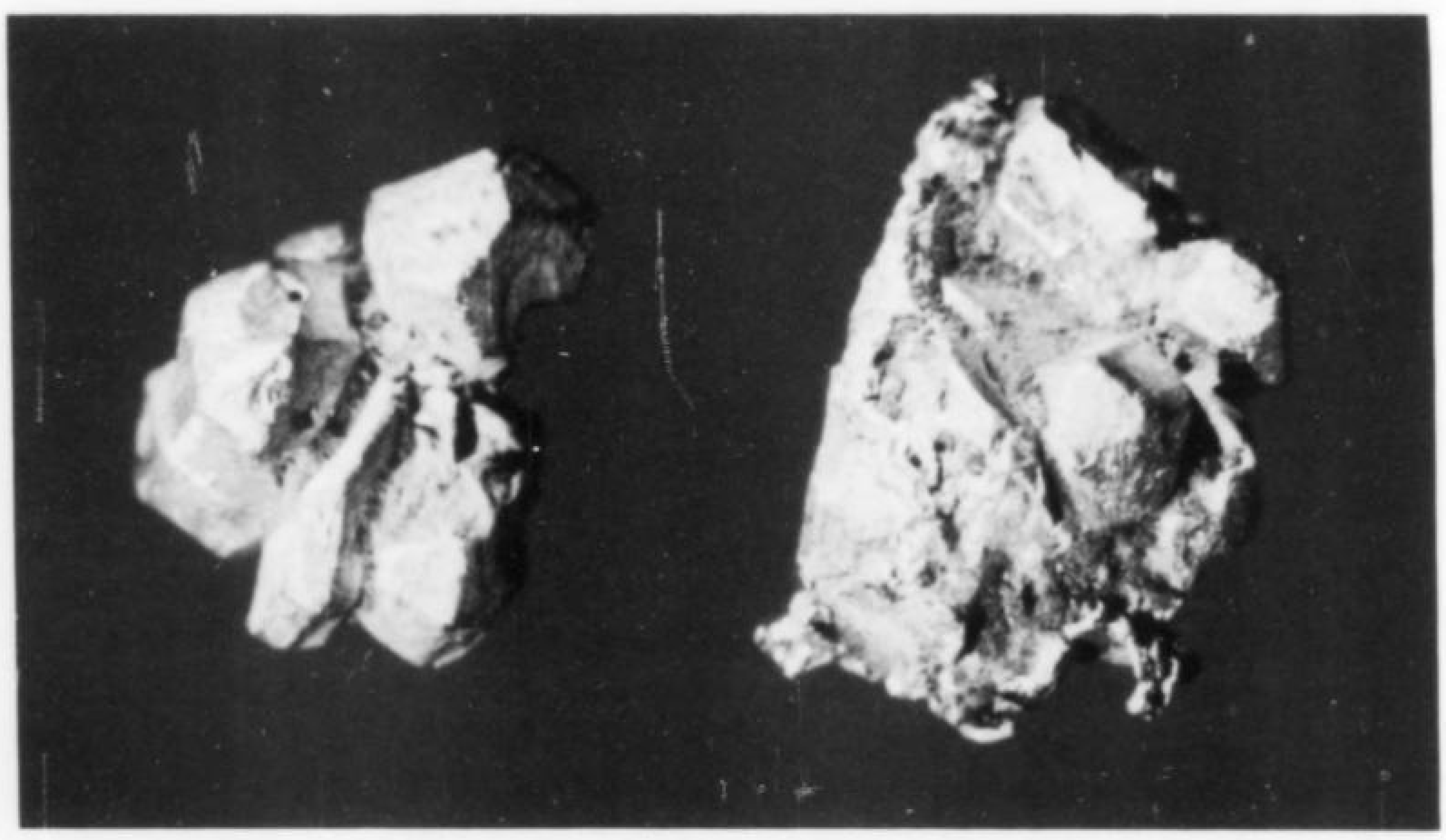


Figure 15. **Crystalline gold from Archibald gold mines, Harrigan Cove, Halifax County, Nova Scotia. The largest crystal is ⅓ inch in diameter; octahedrons are slightly distorted. Each specimen is about ⅔ inch wide. The specimens are housed at the Geological Survey of Canada, Ottawa. Photo by Dan Maruska, G.S.C. These specimens were probably taken from the MacDonal lead and were reportedly recovered "at the outcropping" (Faribault *in* Malcolm, 1912).**

included. The central figure in the legend is an Indian named Jim Charles who, about 1879, achieved sudden wealth by selling gold from his secret mine.

The area in question, near the West Caledonia gold district, is now a national park. Faribault worked on the Kejimikujik Lake sheet in 1914 and also after his retirement in 1933, and it was one of his last maps to be published. In fact, publication was delayed until a young geologist by the name of J. Tuzo Wilson was hired to complete the assignment in 1936 in order to ensure that Faribault's efforts would be preserved (Faribault *et al.*, 1938).

During his career Faribault doubtless saw some very pretty gold specimens, for he covered a lot of ground, and his visits to operating mines were frequent. Equally certain is the sad fact that many of those specimens, which would likely rank high in historical value, are as irretrievably lost as those of Jim Charles.

ACKNOWLEDGMENTS

I am grateful to the Natural Sciences and Engineering Research Council of Canada, and to the University of Saskatchewan for contributing financial assistance towards this project. A large part of the work was completed at the Economic Geology Division of the Geological Survey of Canada, which institution treated me as a welcome guest during my sabbatical in 1978-1979.

It is with pleasure that I acknowledge the help of the following people: L. M. Cumming, geologist, who in light of his own extensive research on the subject, together with a few true tales of mystery, stimulated me to complete the assignment; R. I. Thorpe, geologist, with an intimate knowledge of many Nova Scotian gold districts, gave freely of advice and information; R. W. Boyle, geochemist, authority on gold, for helpful discussions and exciting tales of Molega gold; Dan Maruska, photographer, for his enthusiasm and expertise on the job. The above people are all of the Geological Survey of Canada, Ottawa.

Others to whom a special vote of thanks is owed include: Director of Mineral Resources of the Nova Scotia Department of Mines, J. A. Garnett, for permission to photograph several specimens housed in the department at Halifax, Nova Scotia; R. G. Grantham,

Table 2. **Data on some Nova Scotian gold specimens compiled and recalculated (October 22, 1980) by H. R. Oldale, College of Cape Breton, Nova Scotia. Specific gravity of quartz and slate = 2.65; sulfides (arsenopyrite) = 6.0. See appendix for method of calculation. Value of bullion content is shown here on the basis of $420.00/oz. Troy. Samples presently housed in Faculty of Mineral Technology, College of Cape Breton, except for 118-a, 133-b, 119-b and 103, which are housed at the Nova Scotia Department of Mines, Halifax.**

Sample Number	Location and description	Weight in Air (grams)	Weight in Water (grams)	Loss of Weight in Water	S.G. (calc.)	Est. Volume Sulfides and Arseno-pyrite	Est. S.G. (gangue)	Weight of gold (oz. Troy)	Value gold $420/oz.
102	**Goldboro** – Gold in banded quartz and slate, trace of arsenopyrite.	874.5	560.0	314.5	2.78	Trace	2.65	1.57	$ 659.00
103	**Goldenville** – Gold in quartz. Some slate, trace galena.	768.7	482.4	286.3	2.68	Trace	2.65	0.33	$ 139.00
105	**Moose River** – Gold in quartz with wisps and fragments of slate, minor arsenopyrite.	529.3	351.8	177.5	3.16	‹1%	2.70	3.13	$ 1315.00
106	**Caribou** – Gold in quartz with thin bands of slate.	328.0	209.6	118.4	2.77	Trace	2.65	0.55	$ 231.00
113	**Tangier** – Gold in quartz with wispy slate, minor blebs arsenopyrite.	581.3	366.5	214.8	2.71	«1%	2.68	0.25	$ 105.00
114	**Brookfield** – Gold in quartz, some slate, trace arsenopyrite.	624.8	417.3	207.5	3.01	Trace	2.65	2.88	$ 1210.00
118-a	**Montague** – Gold in quartz, some arsenopyrite.	1,179.3	989.5	190.3	6.21	5%	2.95	23.90	$10,038.00
118-b	**Montague** – Gold in banded quartz and slate with accessory arsenopyrite.	777.4	537.3	240.1	3.24	‹1%	2.70	4.99	$ 2096.00
119-a	**Gold River** – Gold in quartz and wispy slate, trace of arsenopyrite.	499.5	346.9	152.6	3.27	Trace	2.65	3.65	$ 1533.00
119-b	**Gold River** – Gold in quartz with wispy slate, minor arsenopyrite.	340.4	242.2	98.2	3.47	1%	2.75	2.82	$ 1184.00
120	**Waverly** – Gold in quartz. Wisps of slate.	146.8	102.6	44.2	3.32	1%	2.75	0.97	$ 407.00
133-a	**Mt. Uniacke** – Gold in quartz with banded wisps of slate, minor arsenopyrite.	775.6	617.4	158.2	4.90	‹1%	2.70	13.40	$ 5628.00
133-b	**Mt. Uniacke** – Gold in quartz with slate and some arsenopyrite.	1,316.0	948.7	367.3	3.58	3-4%	2.90	9.61	$ 4036.00
133-c	**Mt. Uniacke** – Gold in quartz with thin slaty bands, minor arsenopyrite.	1,285.4	876.8	408.6	3.15	‹1%	2.70	7.08	$ 2974.00

Curator of the Nova Scotia Museum, Halifax, upon whom I came to rely for competent, willing assistance at various stages of the study; H. R. Oldale of the Faculty of Mineral Technology, College of Cape Breton, Sydney, Nova Scotia, introduced me to a fine old collection of Nova Scotia gold and polished the occasion with some interesting anecdotes (he has kindly contributed the appendix to this paper); J. M. Bingley, Regional Geologist, Nova Scotia Department of Mines, Stellarton, provided a wealth of background information; the staff of the National Museum of Canada, Mineral Science Division, made available the Museum's collection for study, while Hal Stacey with his weather eye for specimens of historical interest provided like service at the Geological Survey of Canada.

APPENDIX

Method of calculating weight of gold in some Nova Scotian gold-bearing samples:

$$Wg = Vg \times \frac{17.47\ (19.2 - z)}{453.6} \quad (1)$$

where Wg = weight of gold in Troy ounces
17.47 = conversion factor to Troy ounces (0.91) multiplied by specific gravity of gold (19.3)
Z = specific gravity of gangue
Vg = volume of gold
453.6 = grams/pound

To calculate volume of gold (Vg)

$$Vg = \frac{x(y - z)}{19.2 - z} \quad (2)$$

where x = loss of weight in water (weight in air − weight in water)
y = specific gravity of sample (weight in air ÷ loss of weight in water)
z = specific gravity of gangue

Further, (1) simplifies to:

$$Wg = \frac{x(y - z) \times 17.47}{453.6} = x(y - z)\ 0.0385$$

or by using reciprocal of the constant 0.0385

$$Wg = \frac{x(y - z)}{25.97} \quad (3)$$

Note: a slight discrepancy may appear between (3) and (1) due to rounding in calculating the constant.

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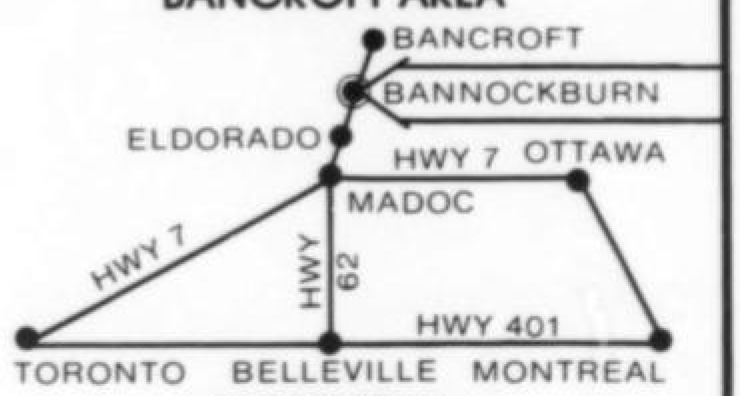
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NOW
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the Colorado Quartz Mine

Mariposa County, California: a Modern Source of Crystalized Gold

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INTRODUCTION

Following the Gold Rush of 1848–49, the Mother Lode region of California quickly became known throughout the world as a producer of finely crystallized gold. In 1850, Francis Alger of Boston published the first description of California gold crystals. They were well formed octahedrons up to ⅝ inch on an edge with somewhat cavernous faces. No locality was recorded. In 1885, William P. Blake published one of the most detailed studies of gold morphology to date. Much of his paper is devoted to California gold. These and subsequent descriptions of remarkable crystallized gold from California must certainly cause collectors to lament the conversion of most of this material to bullion.

Today, with renewed activity in California's Mother Lode region, more native gold is becoming available to collectors. Typically, this material is inferior to the crystallized specimens described in the early reports. One modern producer, however, stands out for its exceptionally fine crystallized gold. This is the Colorado Quartz mine of Mariposa County (Fig. 1). The first specimens from this mine appeared on the market in 1976 and their discovery was documented by Eidahl (1977). Since then, many more specimens have been recovered, including several that could be considered amongst the world's finest.

The historical and geological context of this mine, as provided in published mining reports, is notably ambiguous. The information provided here represents a careful distillation of historical accounts, geological and mining reports, early newspaper articles and personal communications.

Little attention has been given to gold morphology since the last century, except for a series of Russian papers. Because of the remarkable quality of the gold crystals recently recovered from the Colorado Quartz mine, and because of considerable collector interest in them, a detailed study of their morphology was undertaken. In both habit and quality, these gold crystals were found to be remarkably reminiscent of those described in the early publications.

Figure 1. **Location map of the Colorado Quartz mine.**

LOCATION

The Colorado Quartz mine is located in west-central Mariposa County about 5 miles north of the town of Mariposa and just south of Saxon Creek and the site of the old mining camp of Colorado (Fig. 1). It is near the center of Sec. 27, T4S R18E, M.D.M. The mine has been assigned to both the Whitlock and the Colorado mining districts (Clark, 1970).

The mine and surrounding area are not open to collectors and sightseeing is vigorously discouraged.

HISTORY

Little is known of the early history and production of the Colorado Quartz mine. We do know, however, that the area along Saxon Creek (then Sexton Creek) was worked extensively by Mexican (Sonoran) placer miners prior to the 1848 Treaty of Guadalupe, which transferred California from Mexico to the United States. With the signing of the treaty, forty-niners overwhelmed the area and pushed the Mexican miners out.

In 1852, Thomas Allsop, an English writer, made two visits to the placer mines on Saxon Creek surrounding the early mining camp of Colorado and noted that it was "a very rich spot" (Allsop, 1853). Early accounts suggest that Colorado was "a lively place as early as 1855, and had a post office from June 2, 1858 to March 26, 1860" (Gudde, 1975).

The first record that we have of the Colorado Quartz mine is the February 1, 1875, patent that was filed on the property in Stockton, California, by John A. Bataille, a merchant in the town of Colorado. The patent, located in what was then called the Mariposa Quartz mining district, consists of a 1250 by 400-foot parcel of land (roughly 11.5 acres) situated between Long Canyon Creek and Saxon Creek. The principal lode that Bataille was exploiting was the Colorado vein, a major structure (which will be discussed in the geology section of this paper). According to David Grimes, Sr., former owner of the property, Bataille sold the mine in 1885 to P. W. Judkins, Sr., C. H. Weston, and I. L. Dearborn of Mariposa. The property remained in the hands of these three families until 1974 when it was sold to Grimes.

The Mariposa Gazette (November 22, 1913) reported that "a ten stamp mill was recently erected on the property." Lowell (1916) reported that the Colorado Quartz mine property consisted of two unpatented claims in addition to the patented one already mentioned. The workings by 1914 included a 200-foot inclined shaft, an adit level 500 feet long, a 119-foot-long air raise, and a second raise 75 feet long. Also on the property were an assay office, change house, bunkhouse, office and storeroom.

In his report Lowell included a photograph of the mill. The remains of this mill are still in evidence, obviously situated on one of the adjoining unpatented claims, as were much of the workings which Lowell described. This mine is referred to in later reports simply as the Colorado mine.

The Colorado mine had temporarily ceased operation in 1918, possibly due to the war (Castello, 1921), and it appears as though the mine remained inactive until November of 1927 when it was leased to a syndicate called the Consolidated Gold Fields of Mariposa, Inc. More than 30 claims were under the control of this syndicate which was headed by Belle McCord Roberts, a prominent newspaper heiress from Long Beach, California. The syndicate reported $50,000 in production between 1927 and 1936. It is generally believed that this is a conservative estimate.

According to Grimes (personal communication) the syndicate lost their lease on the Colorado mine in 1936 and development of the mine was resumed by Perry Judkins, Jr. and John Vowel, heirs of the earlier owners. At the 190-foot level, they drove 180 feet of drifts and ran through two ore shoots. During mill development in 1937, an accident crippled Judkins and the Colorado mine was closed. The onset of World War II prevented any further development efforts. By the end of the war, the Colorado mine shaft had caved, reportedly leaving equipment and a great deal of highgrade ore underground. Bowen and Gray (1957) reported that by 1953 there were no buildings or equipment remaining on the property.

The modern period for the mine began in February, 1974, when David A. Grimes, Sr. purchased the Colorado Quartz mine patented claim and formed the Mariposa Mining Company. In September, 1974, Grimes started work on a shaft in a gulch about a quarter of a mile east of the Colorado mine in the hope of intersecting its old workings. Before reaching them, however, he intersected the old workings of an adjacent mine (the Artru) following a greenstone dike which has historically produced fine crystallized gold specimens. He put aside any further plans to redevelop the Colorado mine and began development of the new mine on the dike. Grimes hit his first pocket in the fall of 1974 and reportedly sold it for bullion value.

In March, 1975, Grimes sold the mine to Unlimited Minerals of Detroit, Michigan. They wasted little time in further development of the mine. A much larger shaft was started on the ridge just west of Grimes' original shaft. A headframe, hoist house and mill were constructed. However, because of inexperience and poor planning, operating funds soon dwindled and further development of the large shaft was abandoned.

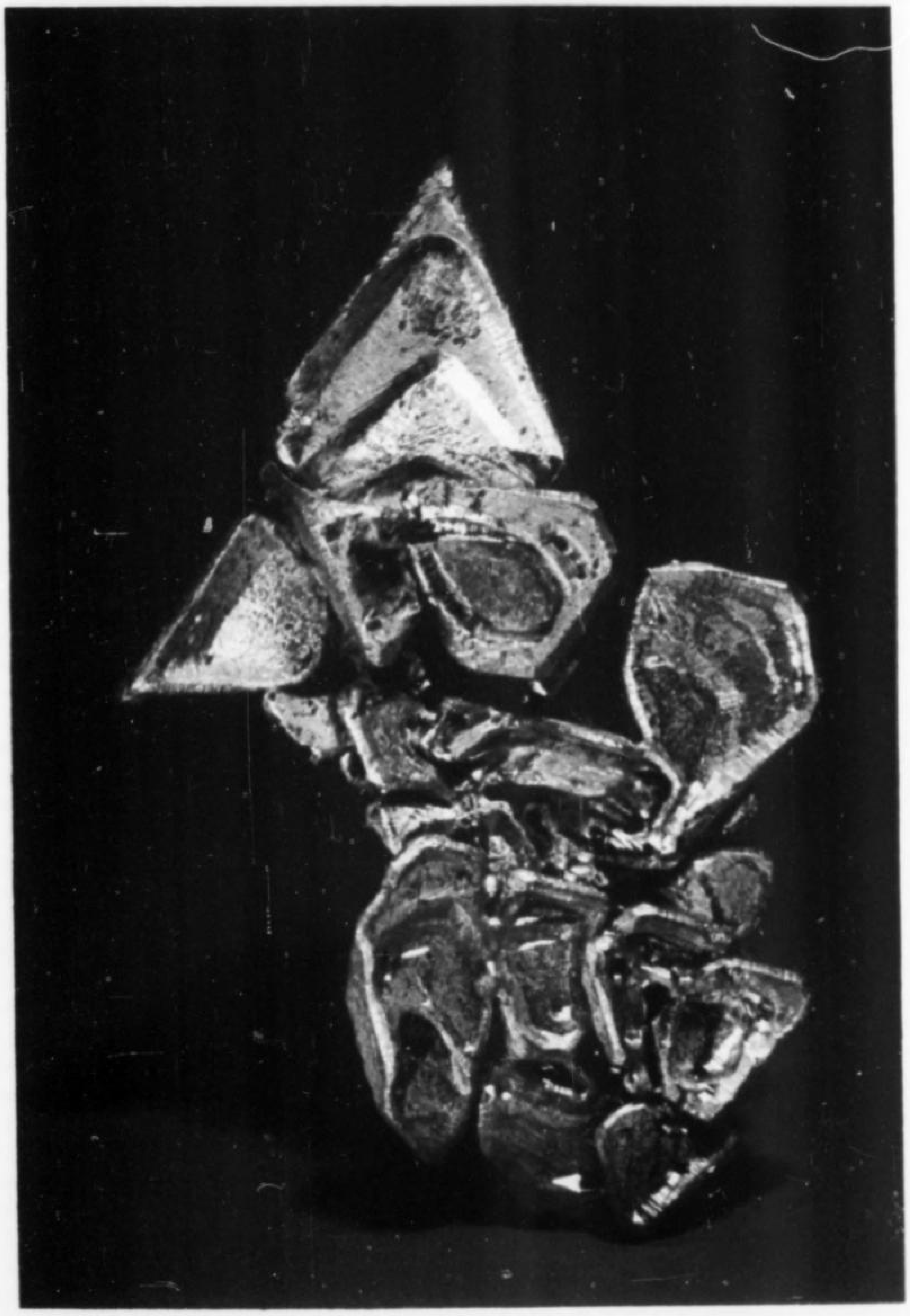
Returning to Grimes' workings, the miners soon encountered large quantities of crystalline gold. One report states that an estimated 350 pounds were recovered during the summer of 1976 (Cate, 1979). Much of this was apparently highgraded by the miners and found its way to European collectors. The gold reportedly was sold at slightly more than bullion prices.

Grimes, by the conditions of the sale, was entitled to a percentage of the gold. When this was not forthcoming, he began proceedings to regain ownership of the mine. By October of 1977, Grimes was successful and immediately renewed operation of the mine. A significant gold pocket was soon encountered; however, heavy

Photographs, unless otherwise noted, are by Anthony R. Kampf.

Figure 2. **Headframe and mine buildings of the current Colorado Quartz mine. Grimes' shaft is partially obscured by a tree in the left foreground. View is toward the west.**

Figure 3. **Gold crystals of flattened octahedral habit. Specimen is 1.2 inches tall. Leonard Bedale specimen.**



rains during the winter forced closure of the workings.

Grimes returned to the large shaft started by Unlimited Minerals. This he sank to a depth of 86 feet where he began drifting into the dike. More pockets of gold were forthcoming, encouraging development, and by the spring of 1979 about 300 feet of drifts paralleling the dike had been completed.

In June of 1979, Grimes sold the property to Colorado Gold, Inc. of Fallbrook, California. They are continuing development of the mine but, as of the time of this writing, have not encountered any significant gold pockets.

GEOLOGY

The famous "Mother Lode" of California is a roughly mile-wide, 120-mile-long system of subparallel gold-bearing quartz veins. The vein system extends along the western slopes of the Sierra Nevada from near Georgetown, in El Dorado County, southeasterly to Mormon Bar, about 4 miles south of the town of Mariposa. At Mormon Bar, the vein system has been obliterated by the massive granodiorites of the Sierra Nevada batholith (Knopf, 1929).

Flanking the Mother Lode system, on both the east and west, are additional interrelated gold-quartz veins referred to as the East gold belt and West gold belt respectively. The Colorado Quartz mine is situated on the western edge of the East gold belt of the Mother Lode. According to the classic study done by Ransome (1900), the veins of the East belt "tend to be preferentially located in rock with slaty cleavage and invariably dip northeastward at a flatter angle than the enclosing slaty rocks." It appears that the structurally weak section of the country rock, a function of the slaty cleavage, provided favorable channelways for the invading gold-bearing solutions and subsequent sites for ore deposition.

Most reports (e.g. Bowen and Gray, 1957) place the Colorado Quartz mine in the upper Paleozoic Calaveras formation. More recent work, however, has found the mine to be situated in rocks of younger age, probably late Jurassic (Bowen, 1963). The silty black slates surrounding the Colorado Quartz mine have been named the Briceburg formation by Bowen (1963). The Briceburg formation is probably equivalent to the Mariposa formation of Ransome (1900). Ransome reported that the Mariposa formation consists chiefly of very cleavable and homogeneous black "clay slates" with locally variable amounts of sandstone and conglomerate. These rocks form a remarkably persistent belt that generally traverses the district.

The slates have been intruded by various types of igneous rocks. Greenstone dikes are of particular interest here because they were locally mineralized during post-Jurassic folding. The current workings of the Colorado Quartz mine are exploiting a gray, propylitically altered greenstone dike which strikes approximately N70°W and dips 65-70° northeast. Crystalline gold occurs in red to black clay-filled pockets found where gently dipping quartz veins or stringers within the dike contact the Briceburg slate wall rock. The quartz stringers range in width from a fraction of a inch to several inches and sometimes contain pockets of well formed quartz crystals. The occurrence of gold is generally also related to the presence of later quartz "cutter" veins transecting both the dike and earlier quartz stringers. The local miners refer to these "cutter" veins as "feeders" because they believe them to have carried the gold from its deep-seated source.

The mineralogy of the quartz veins is simple. In addition to quartz and arborescent clusters of crystallized gold, the veins contain pyrite, galena, arsenopyrite, ankerite, calcite, and chlorite, as well as iron and manganese oxides. A chemical analysis of the gold was performed by the research lab of the Gemological Institute of America. The analysis showed 93.3 percent gold and 6.7 percent silver.

Cited in the literature are two other "pocket mines," the Artru (Lowell, 1916) and the Mockingbird (Preston, 1890; Bowen and Gray, 1957), that are situated on this greenstone dike within a quarter of a mile southeast of the Colorado Quartz mine. These mines are reported to have produced fine specimens of crystallized gold similar to that found in the Colorado Quartz mine.

In contrast, the Colorado mine and Bataille's original workings exploited a different structure, referred to as the Colorado vein. This vein consists chiefly of banded quartz carrying free gold and a little pyrite. It can be traced for several miles through the region, varying from 1 to 7 feet in width, with an average strike of N50°W and a dip of 60 to 80° northeast (Bowen and Gray, 1957). Where the Colorado vein crosses the Colorado Quartz mine patented claim it runs roughly parallel to and about 200 feet southwest of the aforementioned greenstone dike. The Colorado vein is not known for finely crystallized gold, but rather for nondescript high-grade gold ore.

GOLD MORPHOLOGY

William P. Blake (1885) made the following general remarks concerning gold crystals from California:

> The general habit of the gold crystals of California is octahedral and arborescent. . . . They are generally distorted by lengthening or by compression parallel to a face, or they are cavernous and only partly formed. Even the solid octahedra generally have depressed faces, often by a series of step-like planes, and again by a series of wire-like threads forming a skeleton framework, not quite filled out with gold. This structure gives the effect of raised edges so characteristic of the California crystals. . . . The most common form of distortion amongst the octahedral crystals of California is flattening parallel to two of the opposite faces of the octahedron . . . giving as a result a thin triangular or a six-sided plate . . .

These remarks and many of the illustrations appearing in Blake's report quite accurately depict much of the gold recently taken from the Colorado Quartz mine.

The flattened octahedral habit is best shown by a specimen mined in March, 1979 (Fig. 3). This specimen rivals in size and quality any of those of like habit mentioned in the early publications.

The typical arborescent form of the Colorado Quartz mine gold crystal aggregates is seen on a specimen mined in October, 1977 (Fig. 4). The larger crystals are generally flattened parallel to (111) and the prominent {111} faces are surrounded by raised edges. The arborescent aggregation consists of crystals elongated in the direction of the raised edges which branch to 60°, presumably due to twinning on (111), (Figs. 5 and 6).

The seemingly rounded surfaces of the gold crystals are seen under microscopic examination to consist of numerous faces. The relationship between these faces is best observed at the terminations of the elongated crystals or on small very perfect crystals sometimes projecting from the arborescent aggregates (Fig. 7). Measurements show the forms on the small crystals to be the hexoctahedron, *x*{1.10.18}, the octahedron, *o*{111}, and rarely the cube, *a*{001}, and a second hexoctahedron, *t*{124}.

The hexoctahedron consists of 48 faces which are observed as 24 paired faces differing in orientation by about 6 degrees. It is not an uncommon form on California gold crystals. E. S. Dana (1886), in first determining the proper indexing for this form, noted it to be present on gold crystals from numerous localities in California.

A remarkable specimen found in March of 1979* includes crystals up to 0.4 inch on an edge ranging from skeletal to solid octahedra (Fig. 8). The edges of each octahedron are modified by an oscillatory combination of two pairs of hexoctahedral faces simulating a striated dodecahedral face which upon careful examination is seen to be split into two halves along its length (Fig. 9). At each vertex of the octahedra the hexoctahedral faces meet to form a star-like array of four pairs of faces (Fig. 10). These crystals are identical in morphology to those described by Blake (1885) from the Princeton mine, about 3 miles southwest of the Colorado Quartz mine.

The hexoctahedral form is observed on virtually all recently mined gold specimens from the Colorado Quartz mine. On elongated crystals in arborescent aggregates such as those mentioned above, the oscillatory combination of hexoctahedral faces results in striations perpendicular to the crystal lengths (Fig. 5). On the surfaces of octahedral faces, the hexoctahedral faces form the edges of numerous small growth steps and the sides of deeper hexagonal pits (Figs. 8 and 9).

A recent study of gold crystallization by Petrovskaya (1971) relates morphology to the depth of formation:

> In the ores deposited at shallow depths, gold crystals are most complicated and variable in shape. . . . Variable conditions of crystallization near the earth's surface and significant admixtures of silver result in the development of inhomogeneous, often distorted forms of crystals: finely lamellar parallel to (111), ribbon-like, hair-like, and also dendrites. . . . Gold crystallized near the earth's surface is characterized by variable features of step-like reliefs, and on the whole they are thinner [than those steps formed at greater depths]; the heights of steps are within the range from 1.01 mm to 0.1 micron and less.

The morphology of the crystallized gold from the Colorado Quartz mine is clearly consistent with formation at shallow depth.

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* A photograph of this specimen (in its entirety) will appear in Peter Bancroft's forthcoming monograph on famous mineral localities. The owner is anonymous.

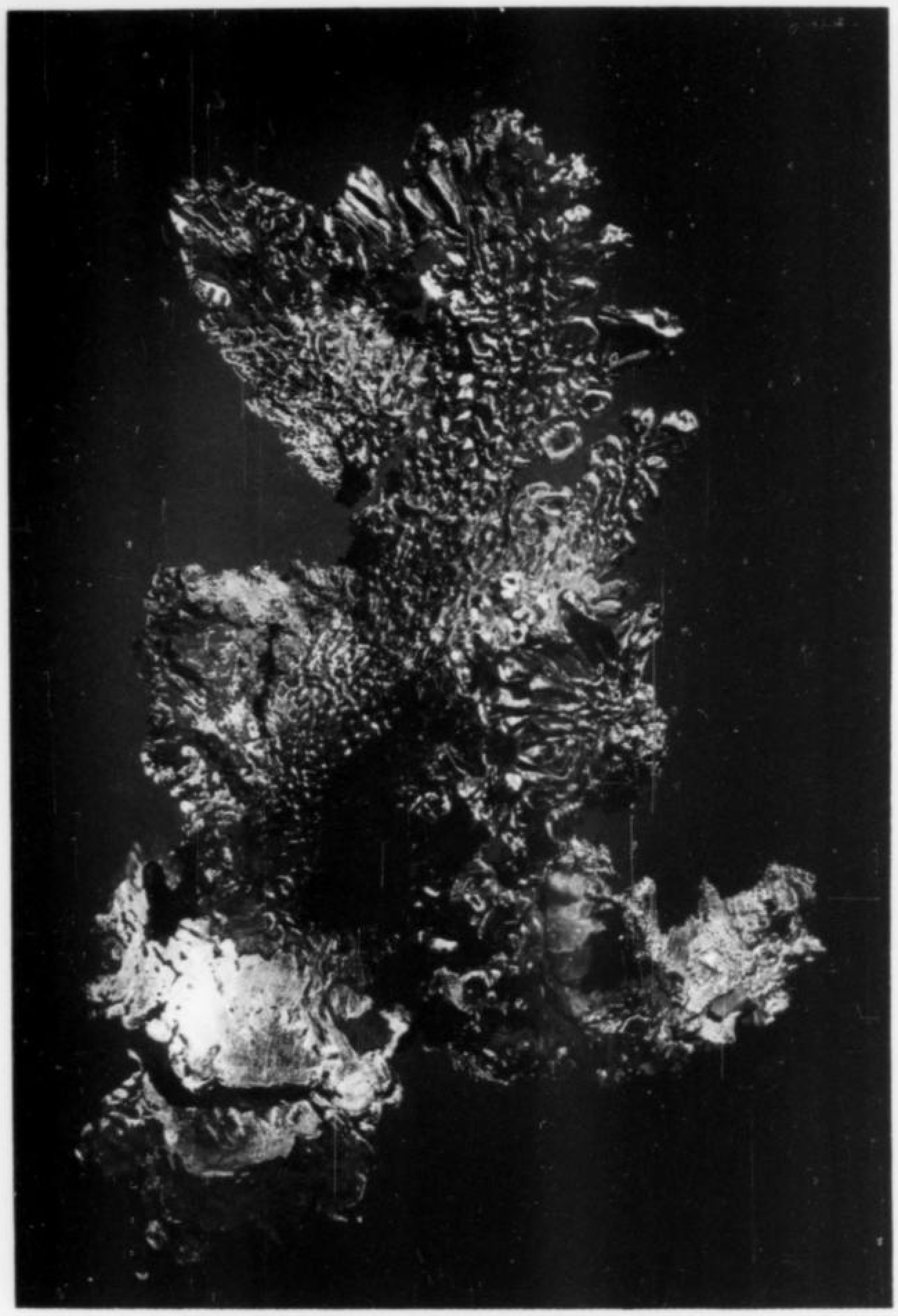

Figure 4. **Arborescent gold crystal aggregate, 4 inches tall. Giles W. Mead specimen. Photo by Larry Reynolds.**

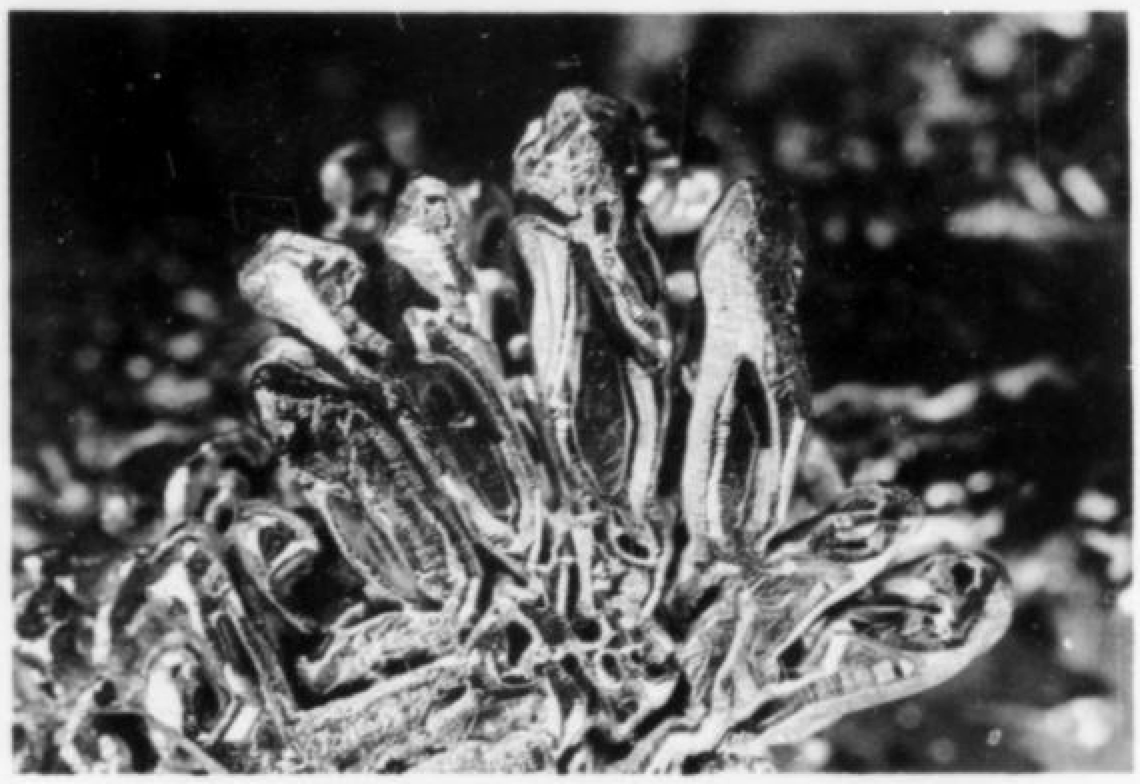

Figure 5. **Elongated gold crystals on specimen shown in Figure 4. Note the striations perpendicular to the lengths. The longest crystal is 0.5 inch.**

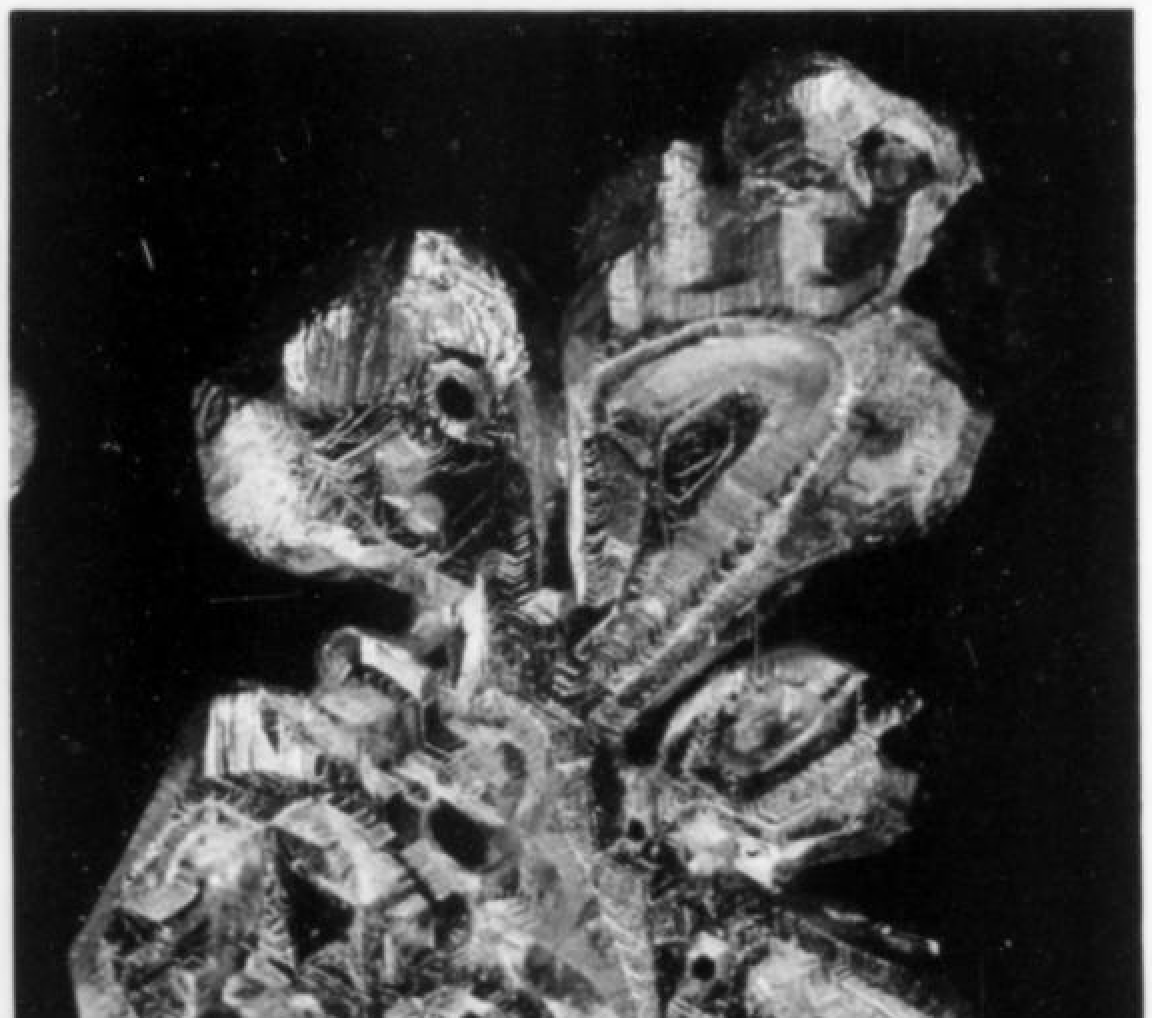

Figure 6. **Branching gold crystals on specimen shown in Figure 5. 0.3 inch across.**

Figure 7. **(a) Well-formed gold crystal (approximately 0.04 inches across) on specimen shown in Figure 5. (b) Crystal drawing showing** ***a*****{001},** ***o*****{111},** ***t*****{124}, and** ***x*****{1.10.18} forms.**

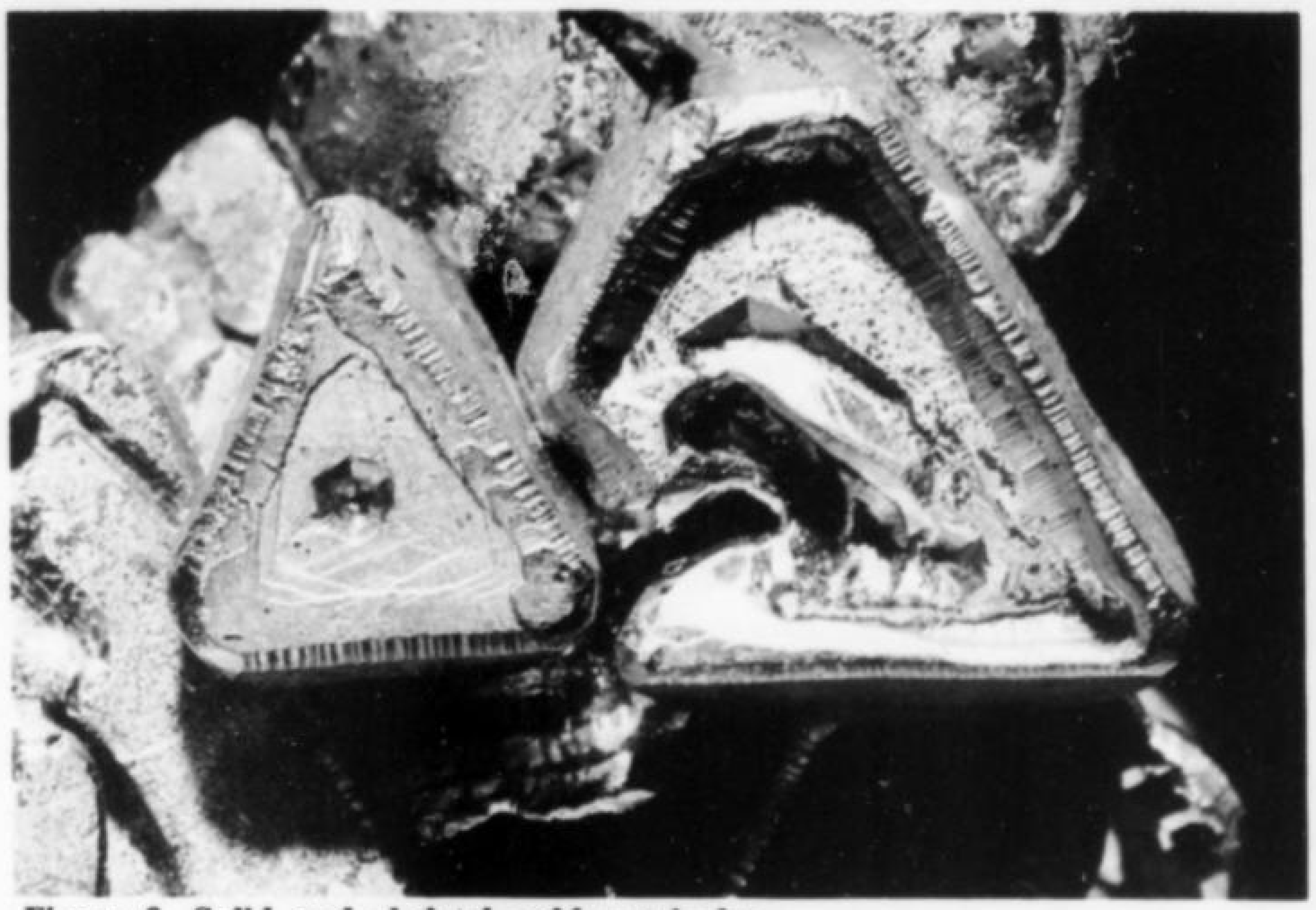

Figure 8. Solid and skeletal gold octahedra. Note the hexagonal pit and growth steps on the solid octahedron which is 0.16 inch on an edge.

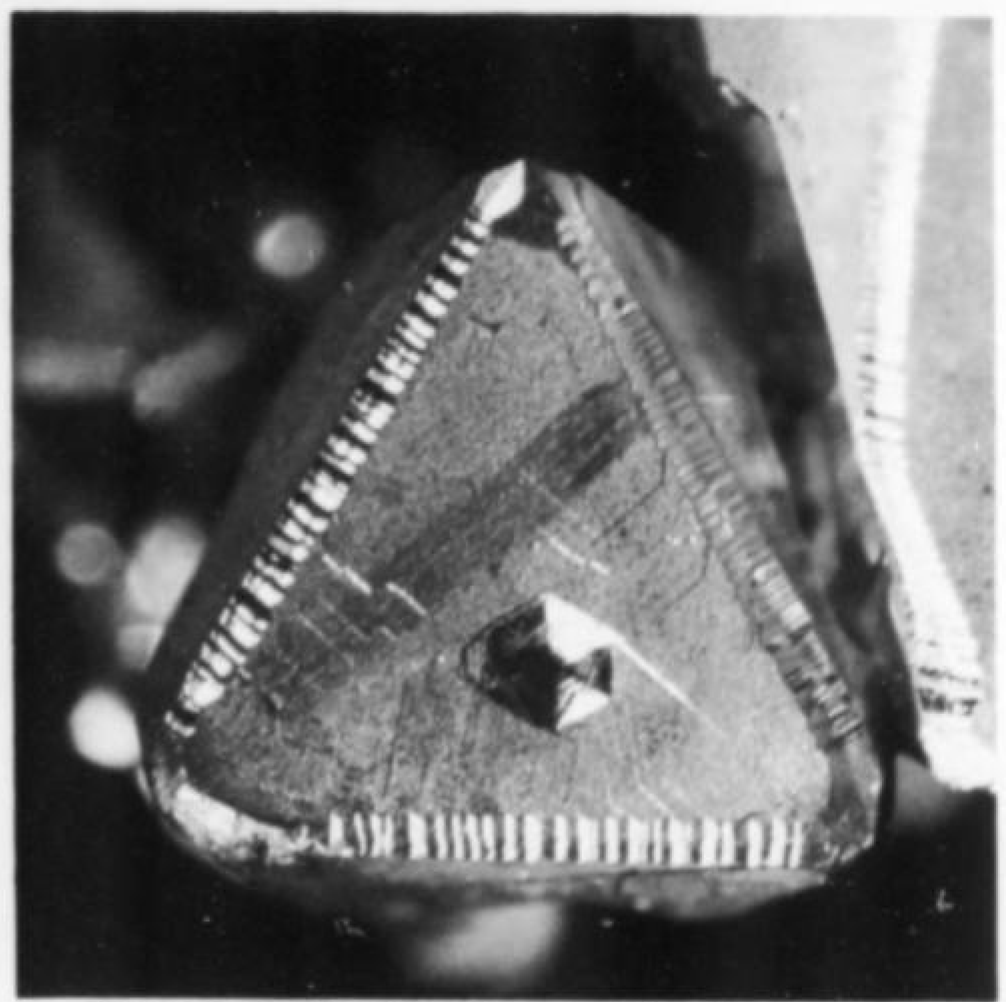

Figure 9. Gold octahedron modified by the hexoctahedron, *x*. The crystal is 0.12 inch on an edge.

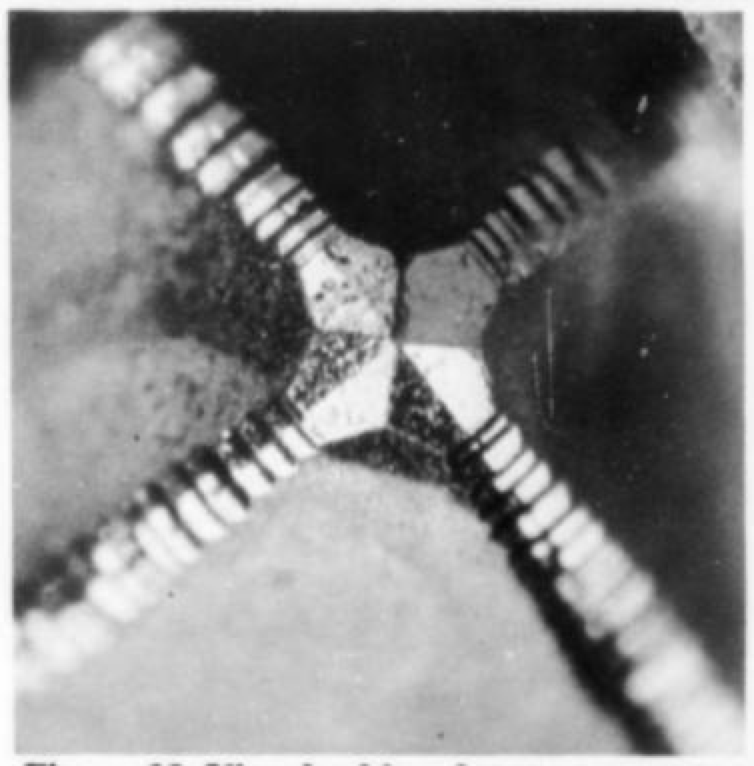

Figure 10. View looking down on a vertex of the octahedron shown in Figure 9.

Figure 11. Crystals of flattened, octahedral habit on quartz. Olaf Medenbach photo.

FUTURE PROSPECTS

To date, the only gold recovered from the current Colorado Quartz mine workings has been well crystallized. Judging from the reported production of the other mines which have exploited the same greenstone dike, future gold production from this mine will probably continue to be essentially crystalline in habit.

As with most pocket mines, production is likely to be sporadic; rich pockets are typically surrounded by a great expanse of barren rock. While certain signs are generally encountered near pockets, they are often ambiguous and unreliable, making the discovery of pockets more a matter of luck than skill.

For these reasons, a large scale mining operation exploiting the dike for bullion values would probably be uneconomical. However, the prospects for the future production of a limited number of finely crystallized gold specimens appear excellent.

ACKNOWLEDGMENTS

The authors wish to thank: Donald Chaput, Curator of History at the Los Angeles County Museum of Natural History, who took a serious interest in the history of the area and provided historical information far beyond the authors' original expectations; David Grimes, who graciously permitted access to the mine and provided considerable insight into its history and geology; Michael Gray, who freely provided the benefits of his research into the history and geology of the mine and his experience as one of its miners; D. Vincent Manson, Director of Research at the Gemological Institute of America, who performed the chemical analysis of the gold; and Alice Keller, who assisted in the editing of the manuscript.

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Harvard Gold

by **Carl A. Francis**
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The Harvard Mineralogical Museum, like most museums, is indebted to benefactors for its most prized possessions. Harvard's mineral collection was extraordinarily enriched by the bequest of the A.C. Burrage collection in 1948.

Albert Cameron Burrage (1859–1931), member of the Harvard class of 1883, was a financial magnate whose fortune was built through the promotion of copper mining companies. His avocations were horticulture and mineral collecting. Burrage enjoyed an international reputation for his growing of tropical orchids, and his mineral collection was world-class even by today's high standards. It contained about 5000 specimens – mostly hand-size or larger – and was broad in scope. Two special interests, however, are obvious. The larger azurite and malachite specimens from Bisbee, many of which were exhibited last February in Tucson, are an impressive suite, but the group of gold specimens is absolutely astonishing. Burrage described his interest in gold to Professor J. E. Wolff in a letter dated March 27, 1912.

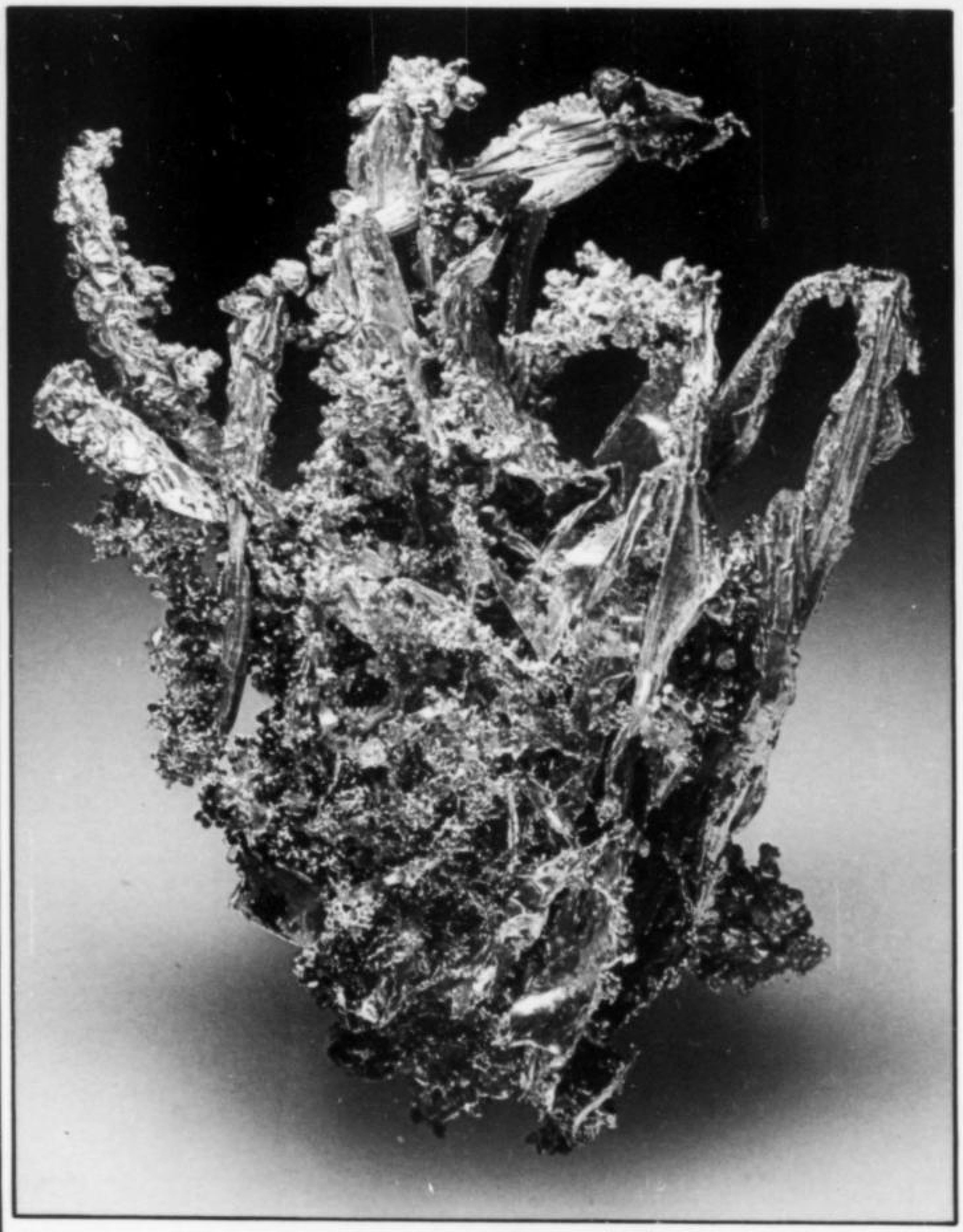
"The past two summers I have spent in Europe and have thus been able to see the fine collections of minerals at London, Paris, Vienna, Buda Pesth (sic), *etc., and the result is that I have become especially interested in gold specimens and during the past three years I have been paricularly on the lookout for gold specimens. During the past six months I have given considerable attention to the subject and have done my very best to get hold of crystallized gold.*

"In some ways I have been very fortunate and have succeeded in getting much more than I really expected to so soon. This is because I succeeded in obtaining two collections, one large and the other small, of two famous collectors, Georges de la Bouglise, the eminent consulting mining engineer of Paris, and Prof. W. P. Blake, formerly of California, Arizona and Connecticut. These men died over two years ago and the heirs in order to close up the estate were obliged to sell the collections. Prof. Blake's I bought at private sale from his sons, the executors. The Bouglise Collection I bought at public auction in Paris the 14th of last December."

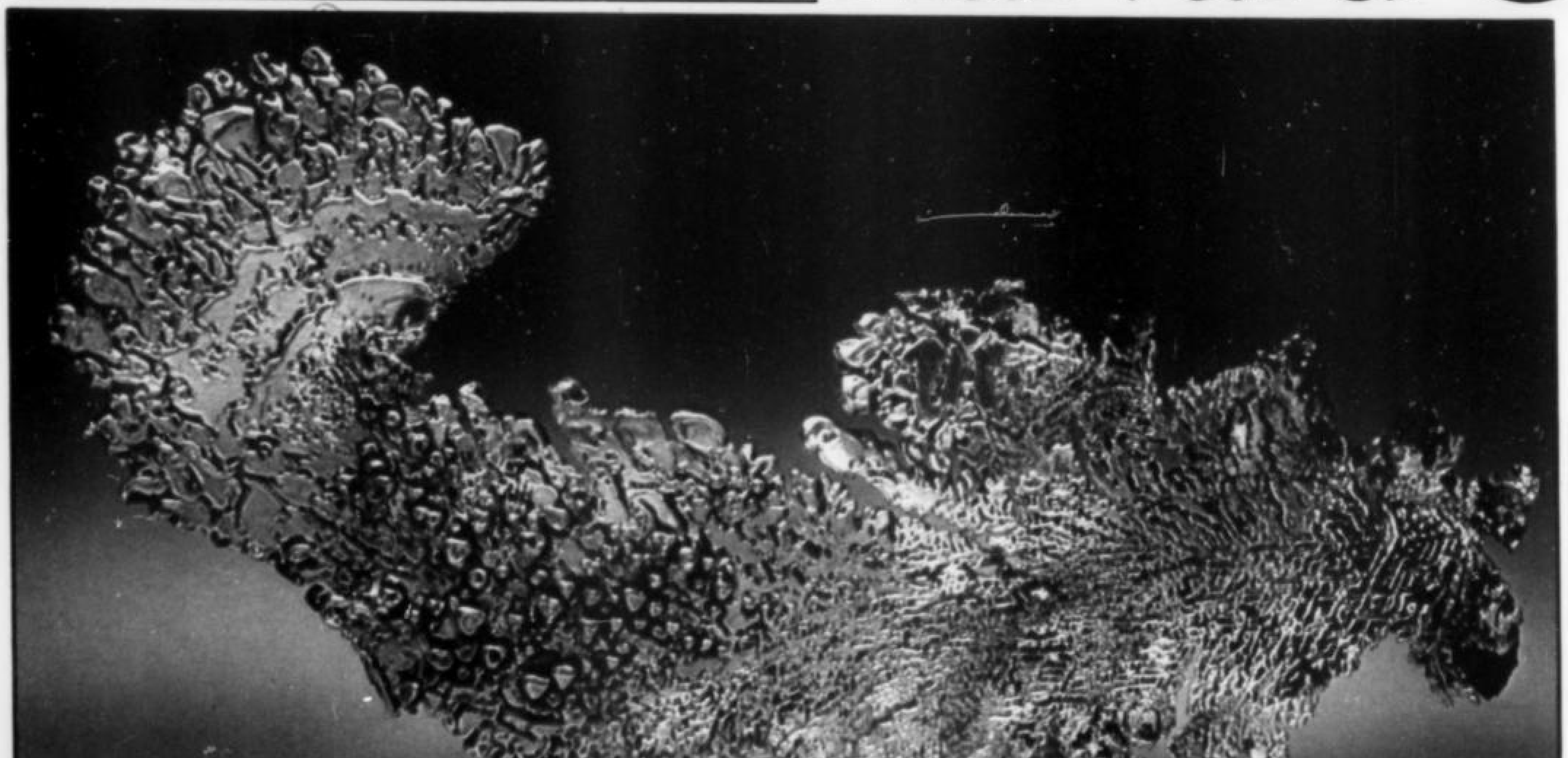
The Bouglise collection is composed of 526 numbered specimens, each of which is described in detail in the auction catalog prepared by Alexandre Stuer, the Parisian mineral dealer. The Blake collection was not documented but we have identified about a dozen Blake specimens by matching them to the illustrations in *"Gold Crystals from California,"* an article by Blake in the *Report of the Director of the Mint upon the Production of the Precious Metals in the United States during the Calendar Year 1884.* Burrage supplemented this nucleus with additional fine specimens as opportunity permitted.

At present the Harvard collection contains more than 1000 specimens of native gold which range in quality from the leanest of ores to the exquisitely crystallized specimens illustrated on the following two pages. Localities in 20 states and 40 foreign countries are represented so it is scarcely an exaggeration to say that no other species is so well represented in the Harvard collection except quartz!

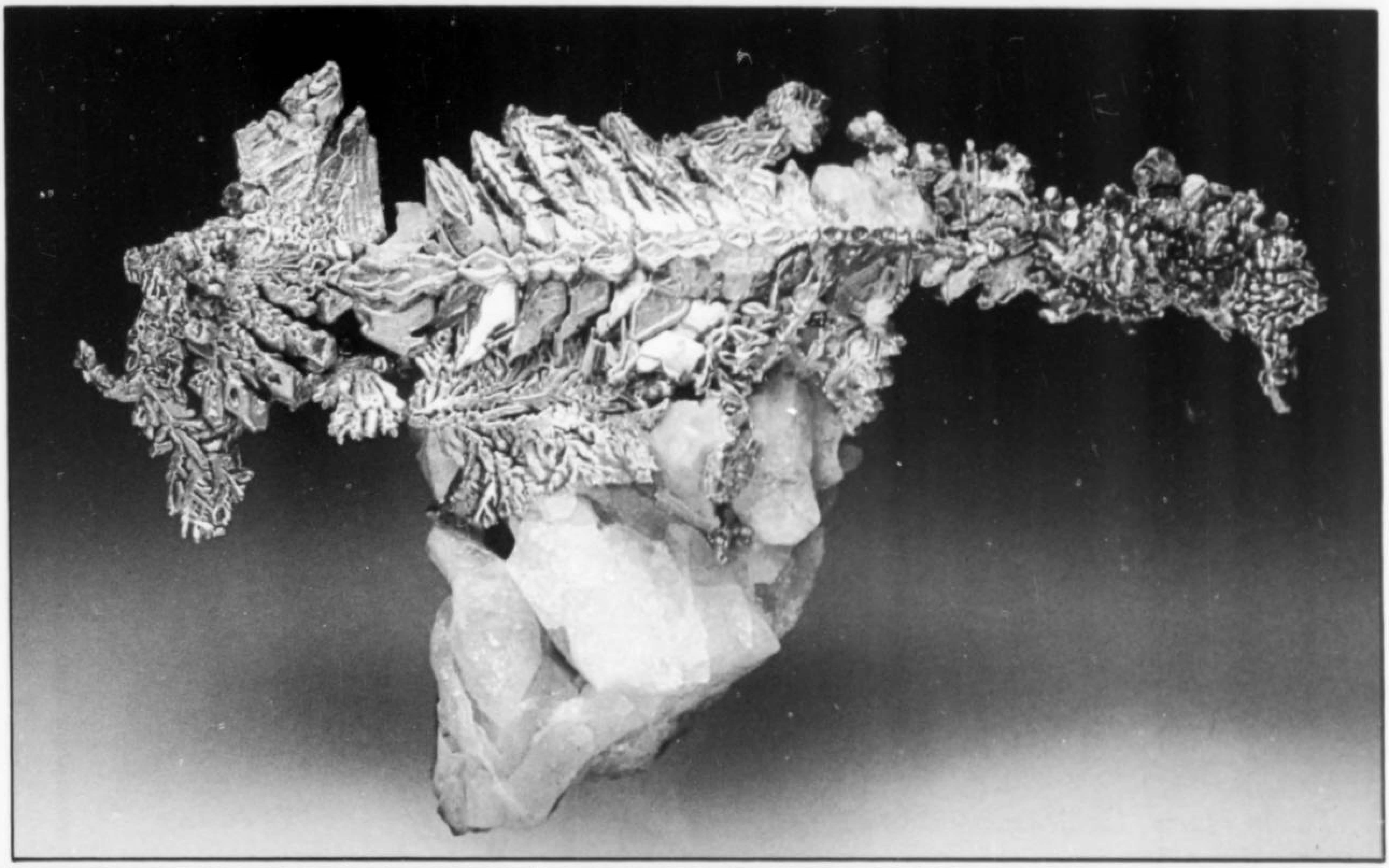
For more than 20 years the best of the Burrage golds were exhibited in the museum in a special Diebold safe but in the early 1970's, with the prices of specimens and gold skyrocketing, the security risk became too great and, reluctantly, Professor Frondel had them packed away in a bank vault. Thus the Harvard Mineralogical Museum is particularly grateful to our editor for providing this opportunity to share these beautiful and seldom seen specimens with such a wide audience.

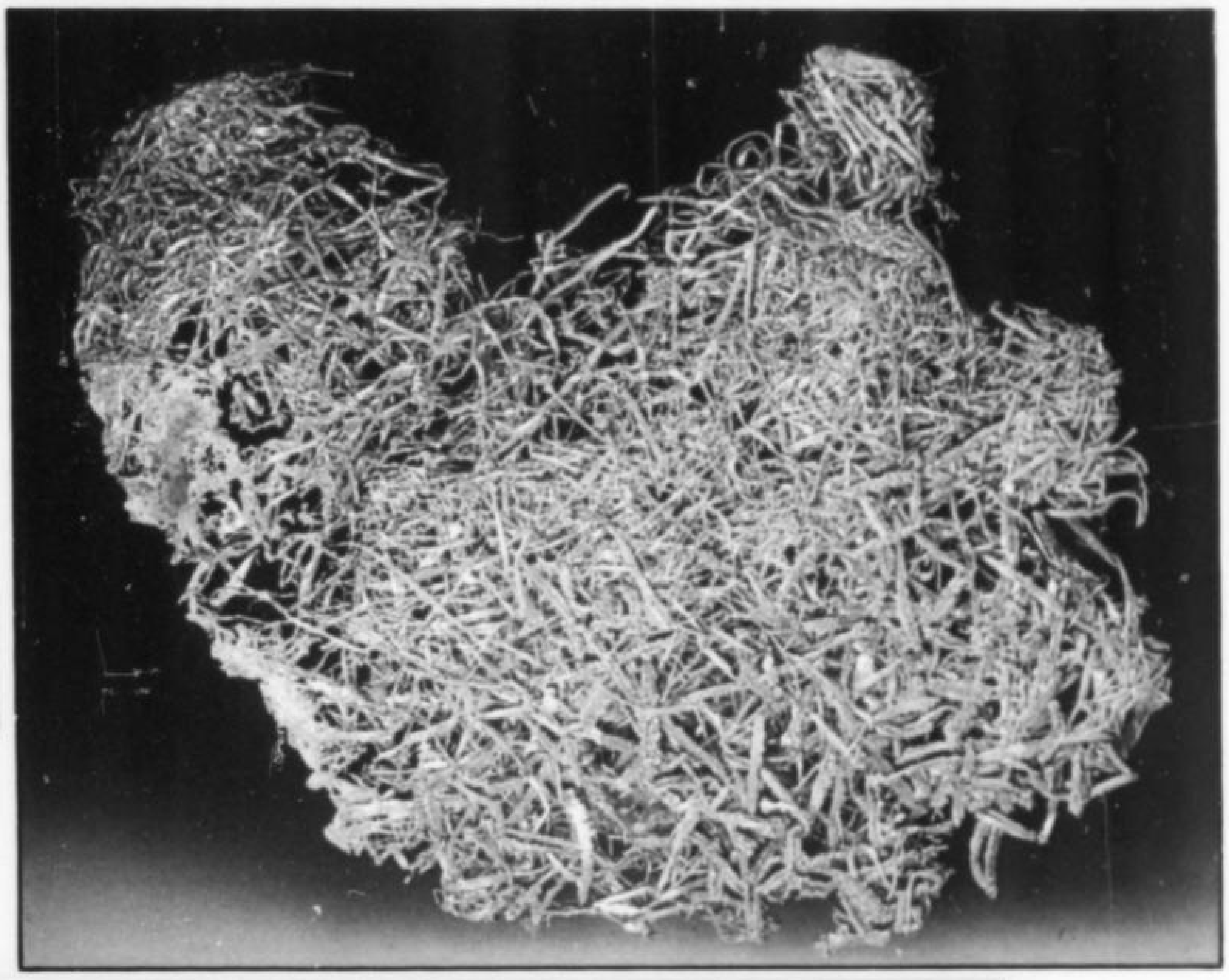


Harvard Gold

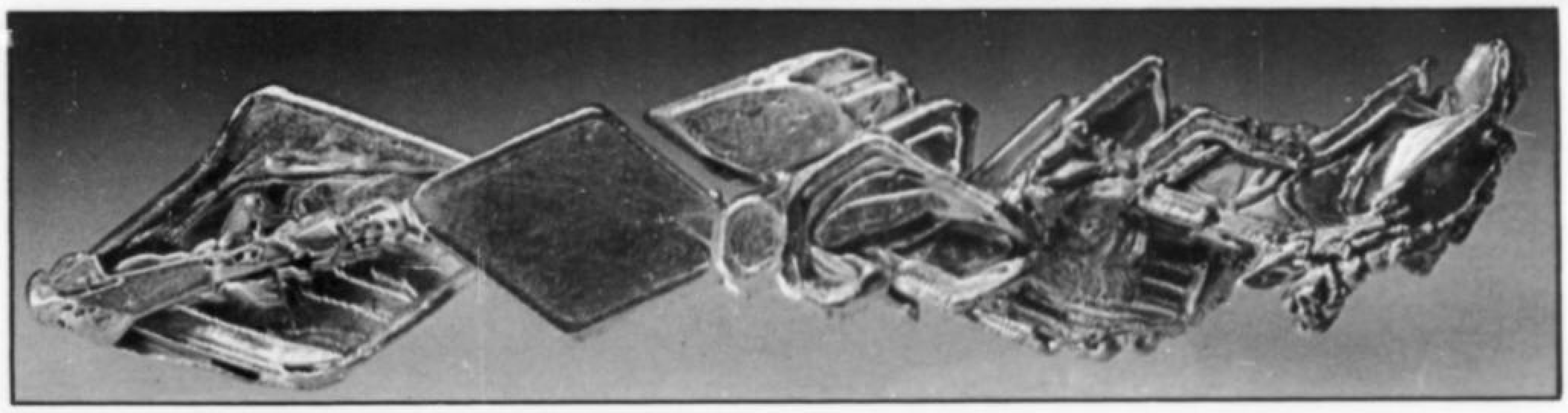


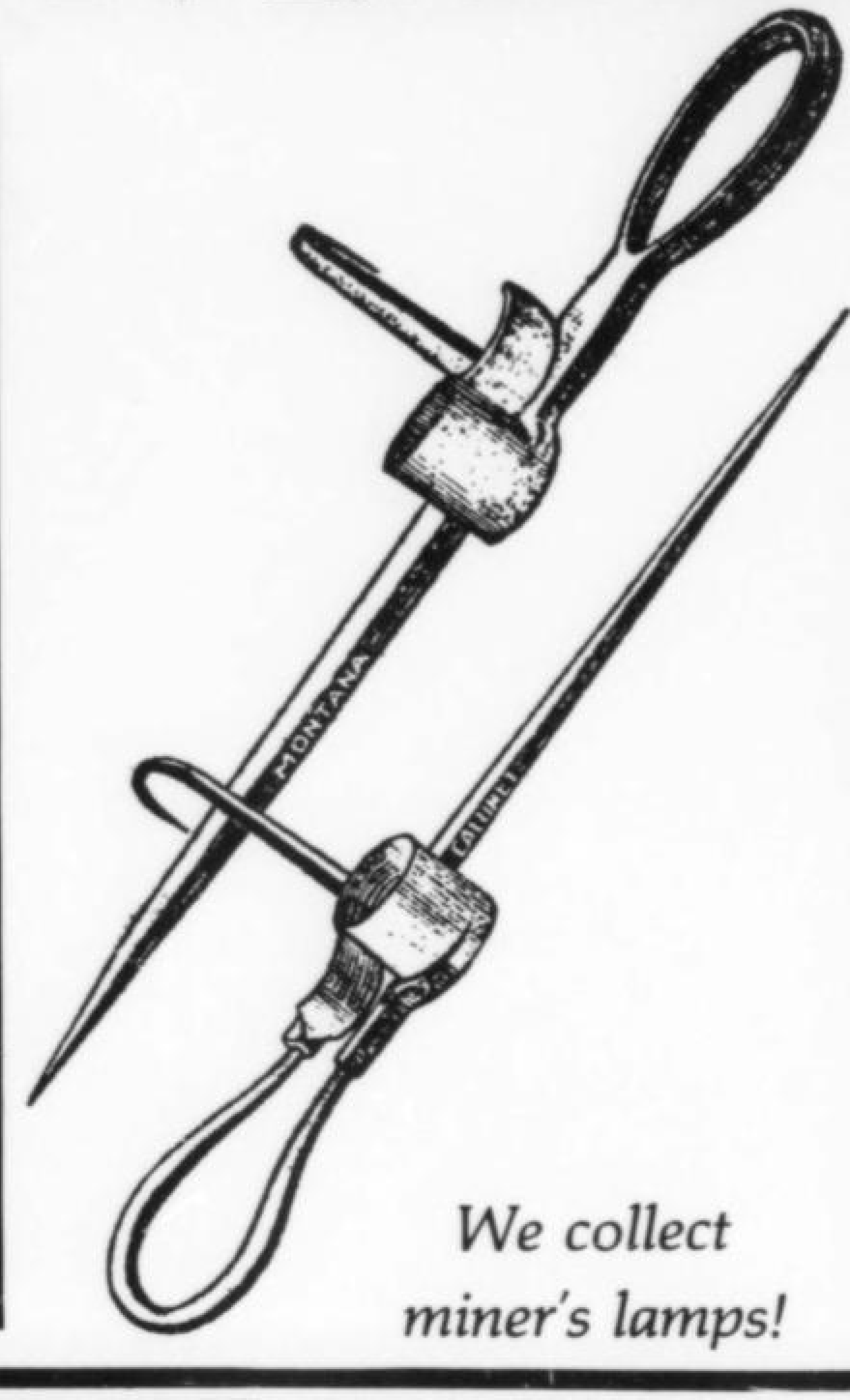
Clockwise from lower left:
1. **Alaska; 13.2 cm across.**
2. **Ground Hog mine, Gilman, Colorado; 11.7 cm.**
3. **Breckenridge, Colorado; 9.6 cm.**
4. **California(?); 7.5 cm.**
5. **Breckenridge, Colorado; 11 cm.**
6. **California; 6 cm.**
7. (left) **California; 4.2 cm.** *(right)* **Chihuahua, Mexico; 4 cm.**

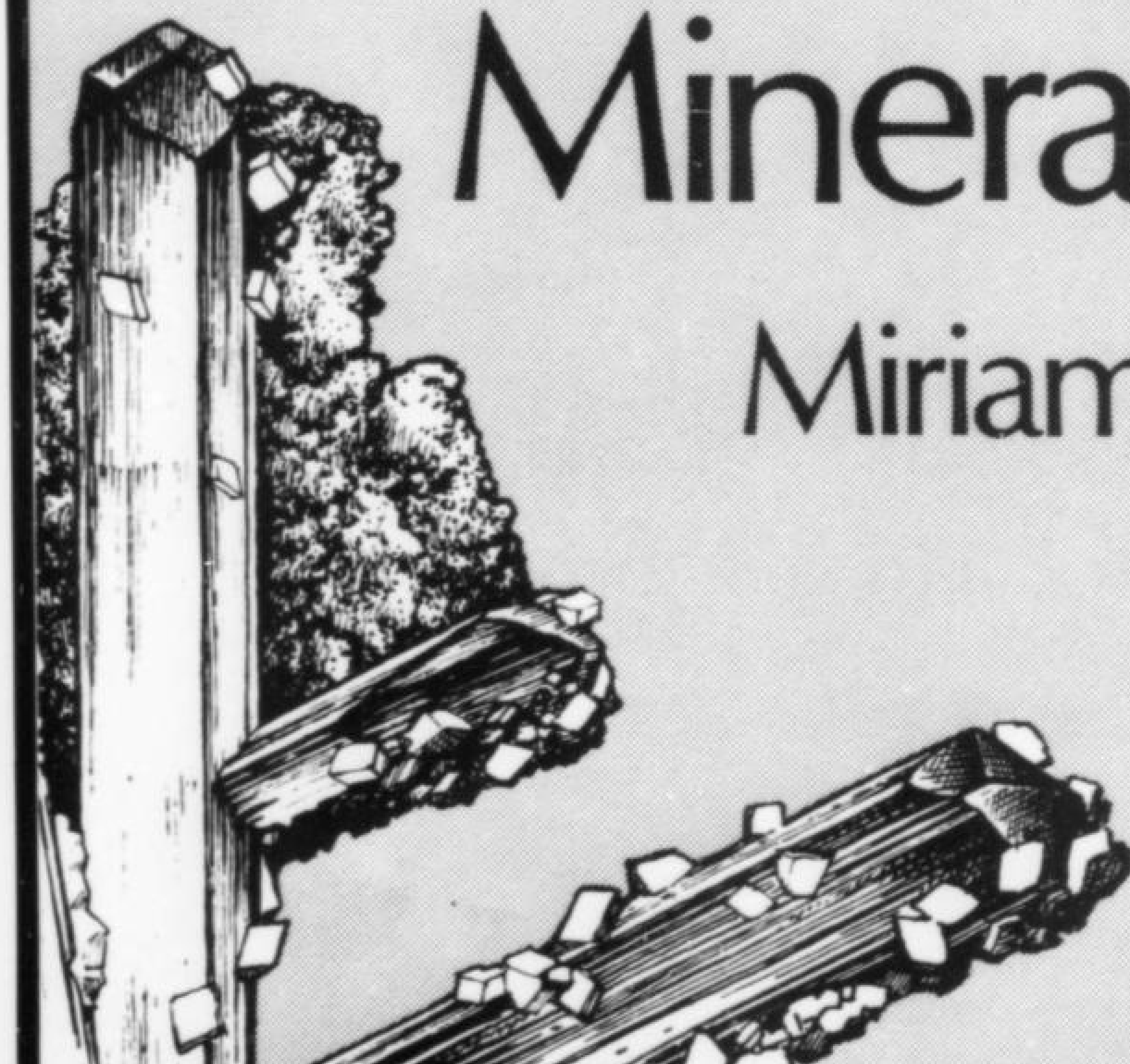




All photos by
Wendell E. Wilson.







European Gold

by **Werner Lieber**
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West Germany

Europe today (exclusive of the western Soviet Union) is poor in gold. Placer deposits have long since been exhausted, and only a few underground mines are still in operation. But it was not always so; mineral collections around the world, especially those in old museums, contain specimens that speak of a glorious past.

INTRODUCTION

In 1979 western Europe produced only about 1 percent of the world's gold output, or about 14.5 metric tons of gold. This may sound like a great deal of gold to the collector, but unfortunately almost the entire amount was the result of processing other ores (pyrite, chalcopyrite, arsenopyrite, etc.) in which gold is merely a microscopic or submicroscopic constituent. Visible gold has been found at relatively few locations in Europe, the most important of which are marked on Figure 5. Most of the locations shown are now abandoned.

The United States in 1979 produced about 28.5 metric tons, about twice as much as all of western Europe. For comparison, the gold production of individual countries in 1979 was: Spain, 4.8 tons; Yugoslavia, 4.3 tons; Sweden, 2.2 tons; France, 1.9 tons; Finland, 0.9 tons; West Germany, 0.1 tons; and the eastern European countries, 3.9 tons. One metric ton of gold would be a cube measuring about 37.3 cm (less than 15 inches) on an edge. (A metric ton equals 1000 kilograms, or about 2205 pounds.)

The brief histories of gold production presented here are keyed (superscript) to numbered locations shown on Figure 5.

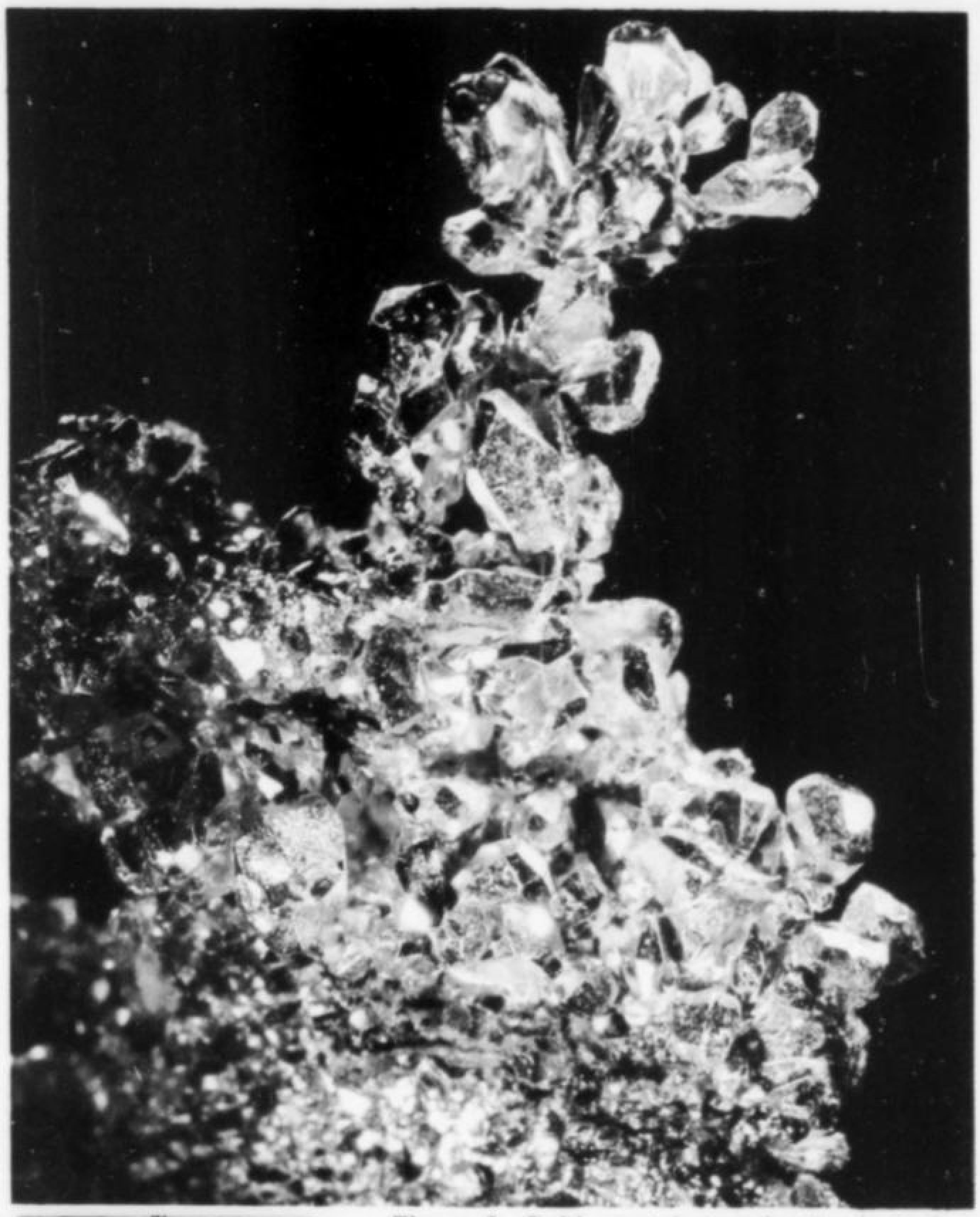
SCANDINAVIA

The famous silver mines at **Kongsberg,**[1] Norway, produced primarily native silver for more than 300 years; they closed in 1957. These mines, located about 80 km west-southwest of Oslo, did produce some specimens of electrum, the silver-rich variety of gold, as small blades and thin dendritic masses. Only a few collections in the world can count Kongsberg gold among their treasures.

Boliden[2] is a large ore deposit in the central Swedish province of Västerbotten, about 35 km from the east coast. Small percentages of gold have been recovered there, mostly from pyrite, arsenopyrite, pyrrhotite and chalcopyrite. The mine is closed now, but was an important source of gold.

Falun,[3] Sweden, is located about 250 km northwest of Stockholm. The sulfide ores of this old and famous deposit con-

Figure 1. **Crystalline leaf gold with herring-bone patterns from Roşia Montana (Verespatak), Romania. The gold is on a quartz matrix with white calcite crystals perched among the leaves. Size: 3 cm. (All photos by the author.)**



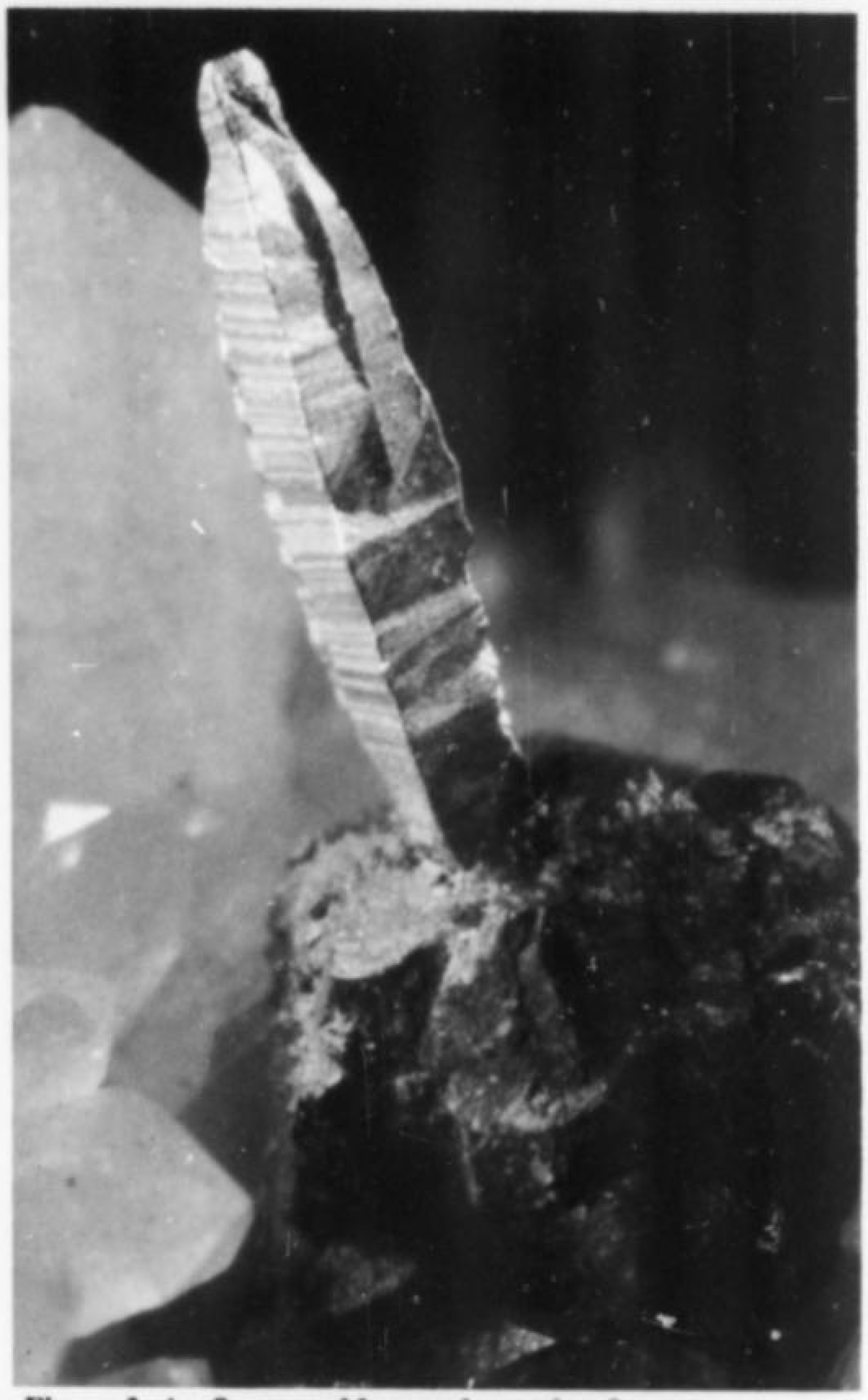


Figure 2. Gold crystals terminating a leaf or sheet of gold from Roşia Montana (Verespatak), Romania. Size of group: 5 mm.

Figure 3. An 8-mm gold crystal growing from a partially altered pyrite crystal on quartz, from Roşia Montana (Verespatak), Romania.

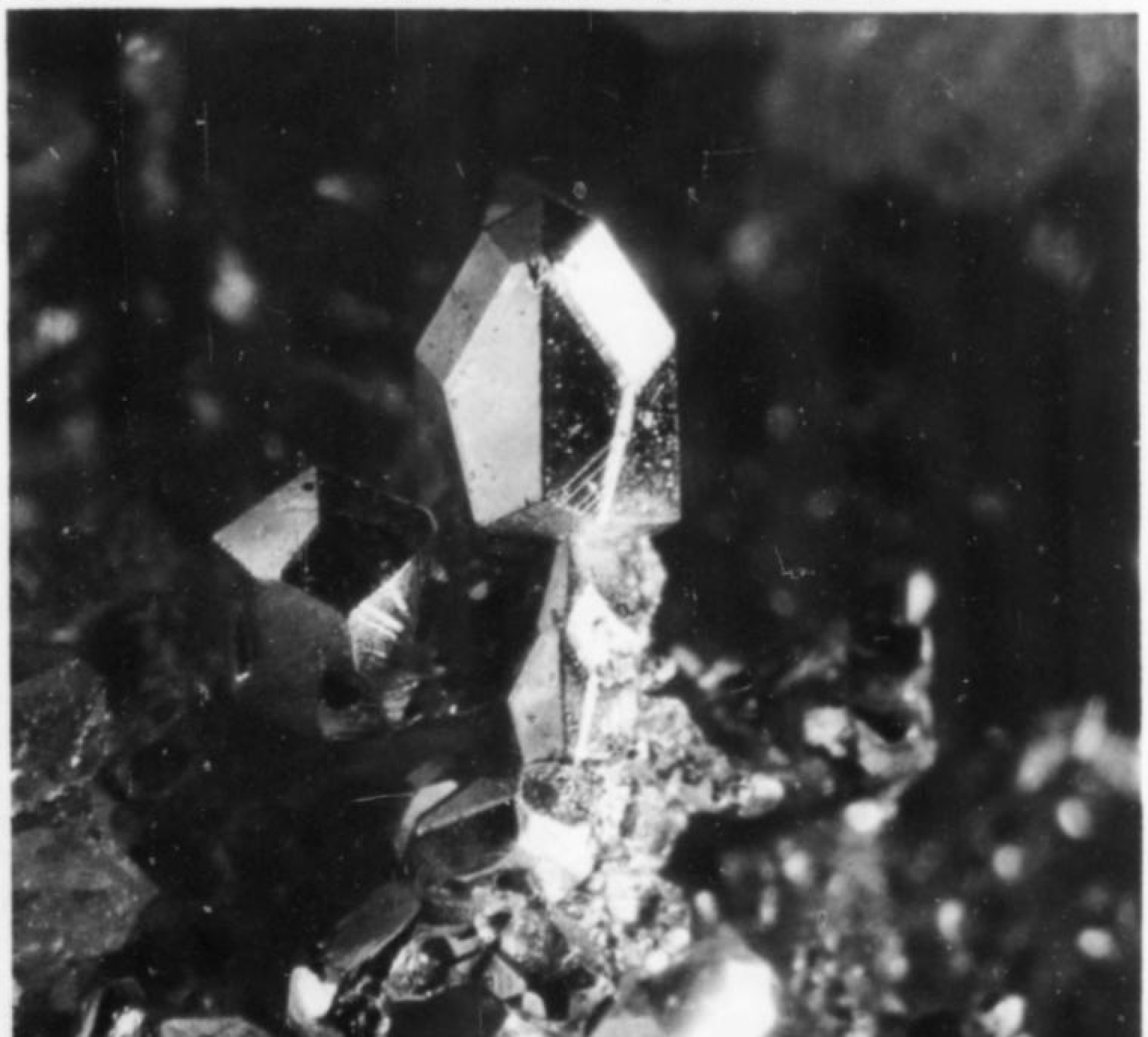


Figure 4. A sharp, twinned, 6-mm gold crystal on quartz from Roşia Montana (Verespatak), Romania.

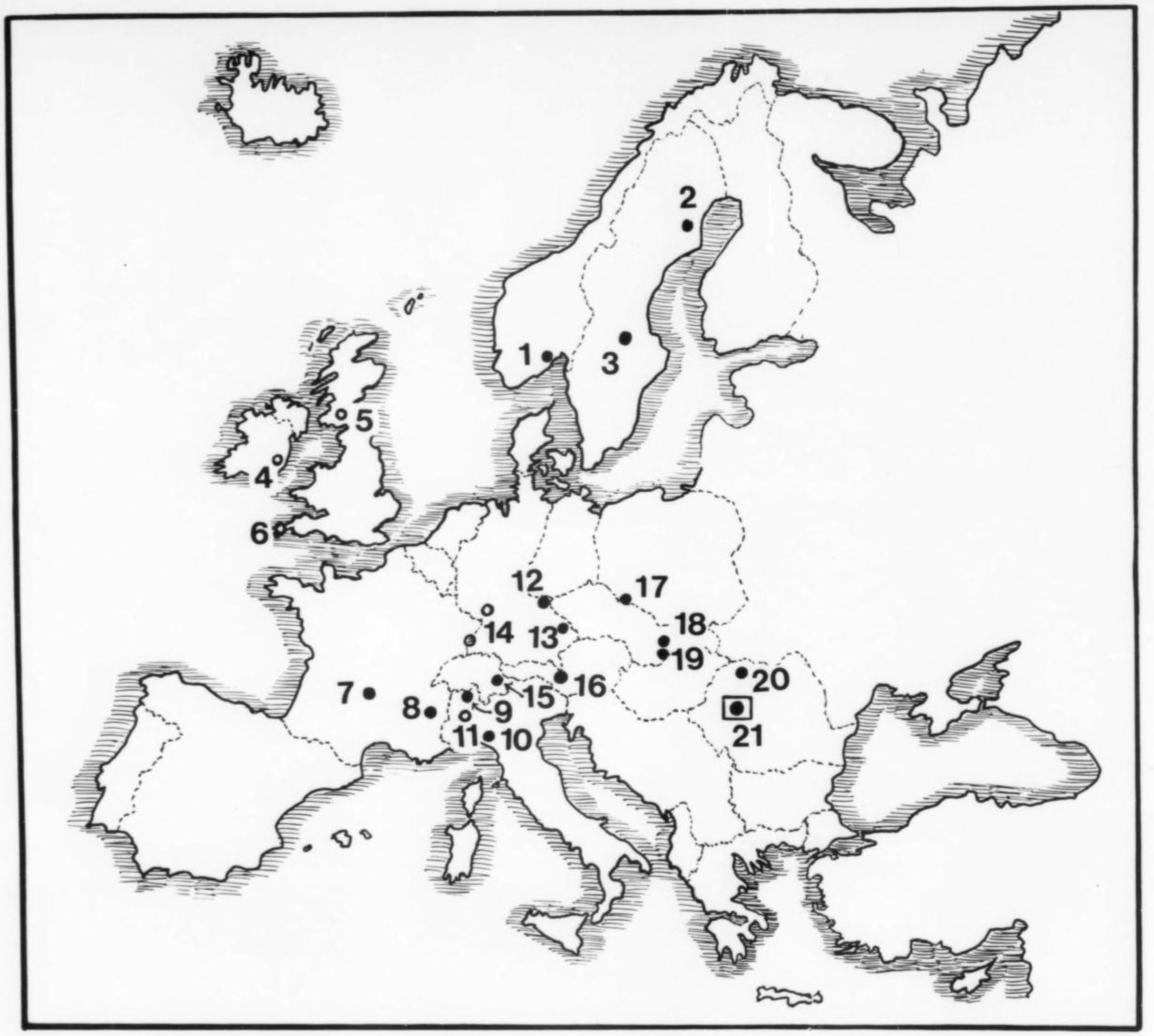


Figure 5. **Important gold deposits of Europe.**
1. Kongsberg, Norway
2. Boliden, Sweden
3. Falun, Sweden
4. Mt. Croghant, Ireland
5. Leadhills-Wanlockhead, Scotland
6. Redruth, Cornwall
7. Central Massif, France
8. Bourg d'Oisans, France
9. Monte Rosa, Italian Alps
10. Castiglione, Italy
11. Po River, Italy
12. Goldkronach, Fichtelgebirge, Germany
13. Bodenmais, Bavaria, Germany
14. Rhine River, Germany
15. Felsburg near Chur, Switzerland
16. Rauris, Hohe Tauern Mtns., Austria
17. Reichenstein, Silesia, Poland
18. Kremnitz, Czechoslovakia
19. Schemnitz, Czechoslovakia
20. Maramureş district, Romania
21. Transylvania, Romania

tained percentages of gold and, in rare cases, produced specimens of visible gold.

ENGLAND, SCOTLAND and IRELAND

Placer gold was once found about 60 km south of Dublin, in rivers at the base of the southern Wicklow Mountains and **Mt. Croghant.**[4]

The **Leadhills-Wanlockhead**[5] district of Scotland has produced metals for more than 400 years. Gold mining from placer deposits in streams in the area was quite profitable in the early years. During the 1500's, a team of 300 men working three summers extracted £100,000 in gold from the streams.

The area around **Redruth,**[6] in western Cornwall, also produced gold, as small grains incorporated into cassiterite nuggets.

FRANCE

There still exist a few small, hard-rock gold deposits in the **French Central Massif.**[7] They occur as plutonic-hypothermal veins of quartz with visible native gold; these deposits are very similar to gold veins of the California Mother Lode.

Much better known is the famous **La Gardette mine**[8] near the town of Bourg d'Oisans, Isére, in the French Alps. This mine, located about 60 km from Grenoble, is less known for its few gold specimens than for the Dauphiné-twin quartz crystals found there. The deposit consisted of a quartz vein about 1 meter thick containing galena and sphalerite with some native gold. The gold was found as small leaves and dendritic masses. The mine has long been abandoned.

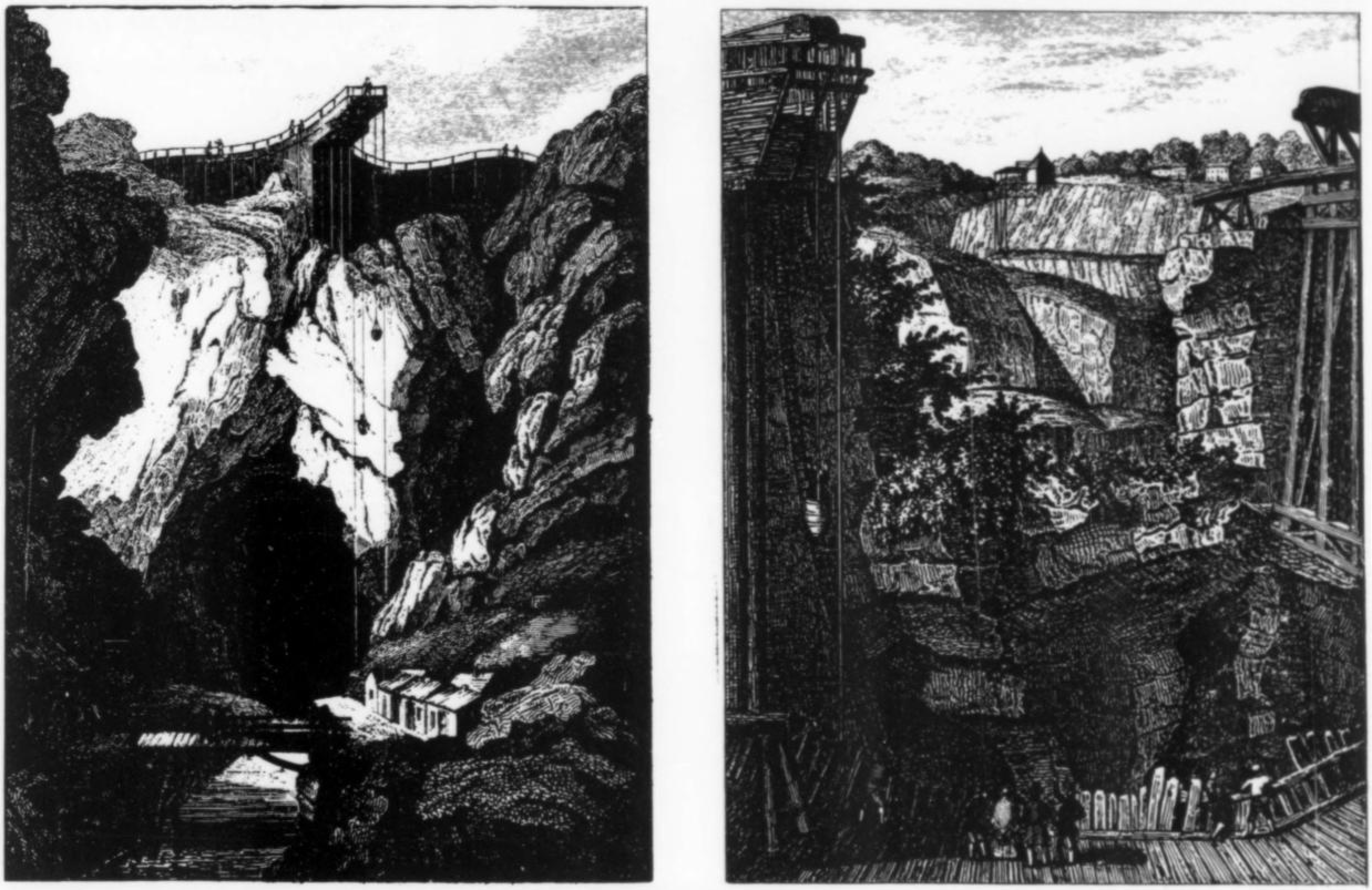


Figure 6. **Engravings showing the mine at Falun, Sweden, in the early 1800's.**

ITALY

Small lodes of gold have been worked in the southern parts of the **Monte Rosa,**[9] Italian Alps. At Val di Ayes, about 30 km south of the summit, a quartz vein was found which contained small amounts of gold and, on one lucky occasion, yielded a full kilogram (more than 2 pounds) of gold from a single pocket.

Another old gold mine is located in the upper Anzasca Valley, east of Monte Rosa near the village of Macugnaga. And lode gold was also found at the old Loreto copper mine near **Castiglione,**[10] about 60 km southeast of Genova, where it occurred as small dendritic masses in quartz.

Placer deposits have been mined along the **Po River**[11] near Torino (Turin), but relatively small amounts of gold were recovered.

GERMANY

Much investigative work has been done on the Brandholz deposit near **Goldkronach,**[12] Fichtelgebirge, about 15 km east of the town of Bayreuth. Several small quartz veins of the Mother Lode type containing arsenopyrite and argentiferous gold have been discovered, but remain unexploited due to economic factors.

The old and famous **Bodenmais**[13] deposit in eastern Bavaria, near the Czechoslovakian border, has been worked since the early Middle Ages. The ore there is pyrite containing small amounts of gold. The Rammelsberg deposit near the town of Goslar in the Harz Mountains also produced some gold, about 1 gram per ton of pyrite-galena-chalcopyrite-sphalerite ore. These are the sources of gold in Germany today . . . not of much interest to the collector.

Although now exhausted, the banks of the **Rhine River**[14] were a famous and fabulous source of placer gold for 2000 years. "Rhine-gold" played an important historical role in the Middle Ages, and the last panner did not give up until 1874. About 400 gold panners were registered on the Rhine in 1838. Prior to that, between 1804 and 1834, panners delivered almost 150 kg of gold to the nearby mint office at Karlsruhe, Baden. Beautiful coins made of Rhine gold are today among the most treasured prizes of coin collectors. These coins carried Latin inscriptions around the edge, such as *Sic fulgent Littora Rheni,* ("Thus shine the shores of the Rhine").

SWITZERLAND

Occasional minor occurrences of gold have been found in Switzerland over the years, but the most remarkable deposit is near **Felsberg,**[15] about 105 km southeast of Zurich in the Canton of Graubünden. At least six gold mines have been operated in this area, among them the Goldene Sonne mine ("Golden Sun"). Written records speak of gold mining going back to the 1500's. The deposit consists of several thin (10 to 20 cm) quartz veins with calcite and native gold in leaves and dendritic masses. The mines were operated intermittently, but in more recent times have not been profitable. Nevertheless, some specimens of native gold in quartz found their way to various private and public collections.

European Gold

continued on p. 369

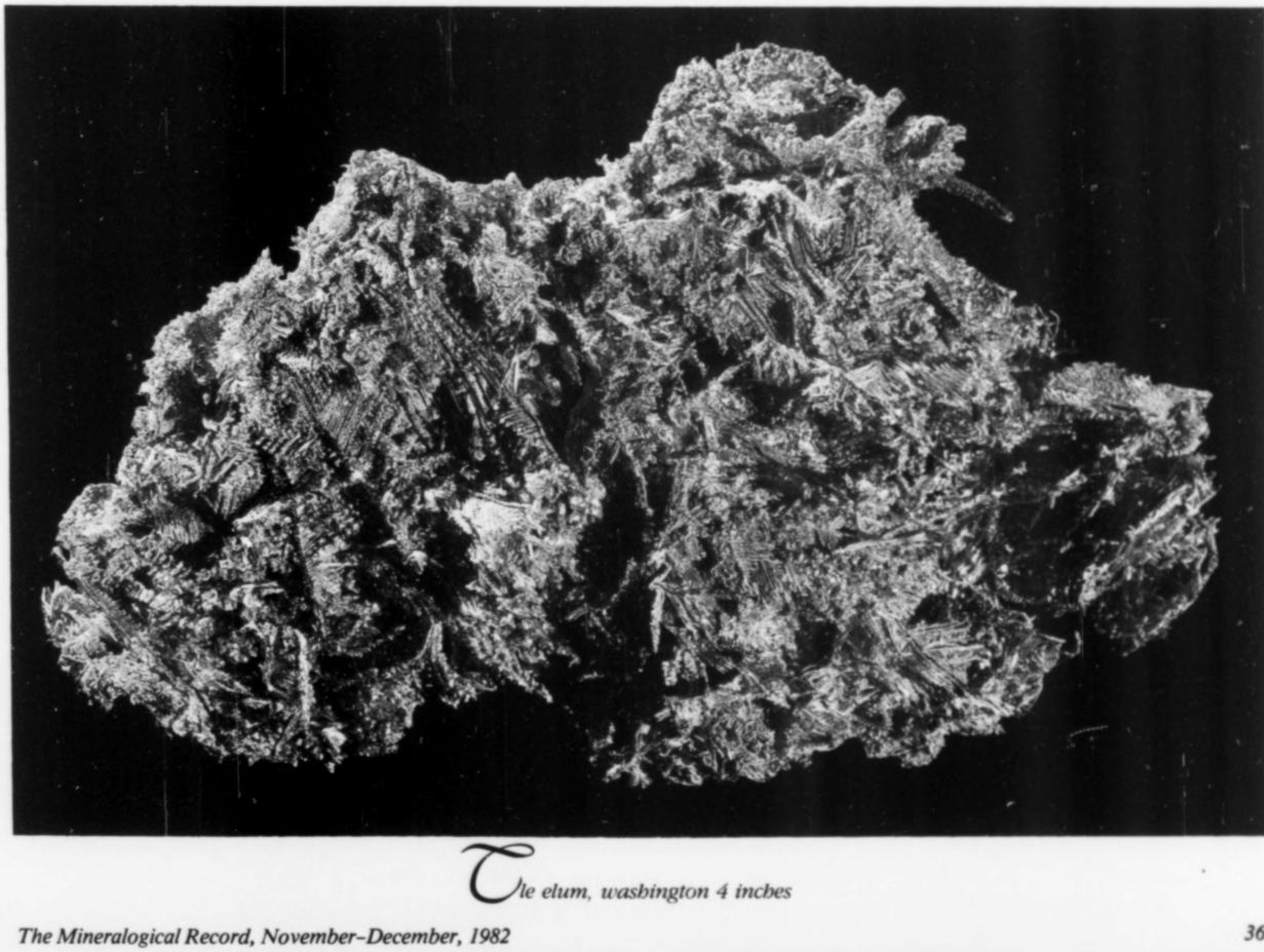
Figure 7. **The village of Roşia Montana (Verespatak), Romania, is seen here spread out below hills thickly covered by small gold workings and dumps (taken in 1965).**

Figure 8. **An 8-mm crystal of gold from Roşia Montana (Verespatak), Romania.**

Figure 9. **A gold crystal aggregate 1 cm in size, from Roşia Montana (Verespatak), Romania.**

Gold
from the F. John Barlow collection

Photos by E. Munroe Hjerstedt and Malcolm Hjerstedt
Munroe Studios, Neenah, Wisconsin

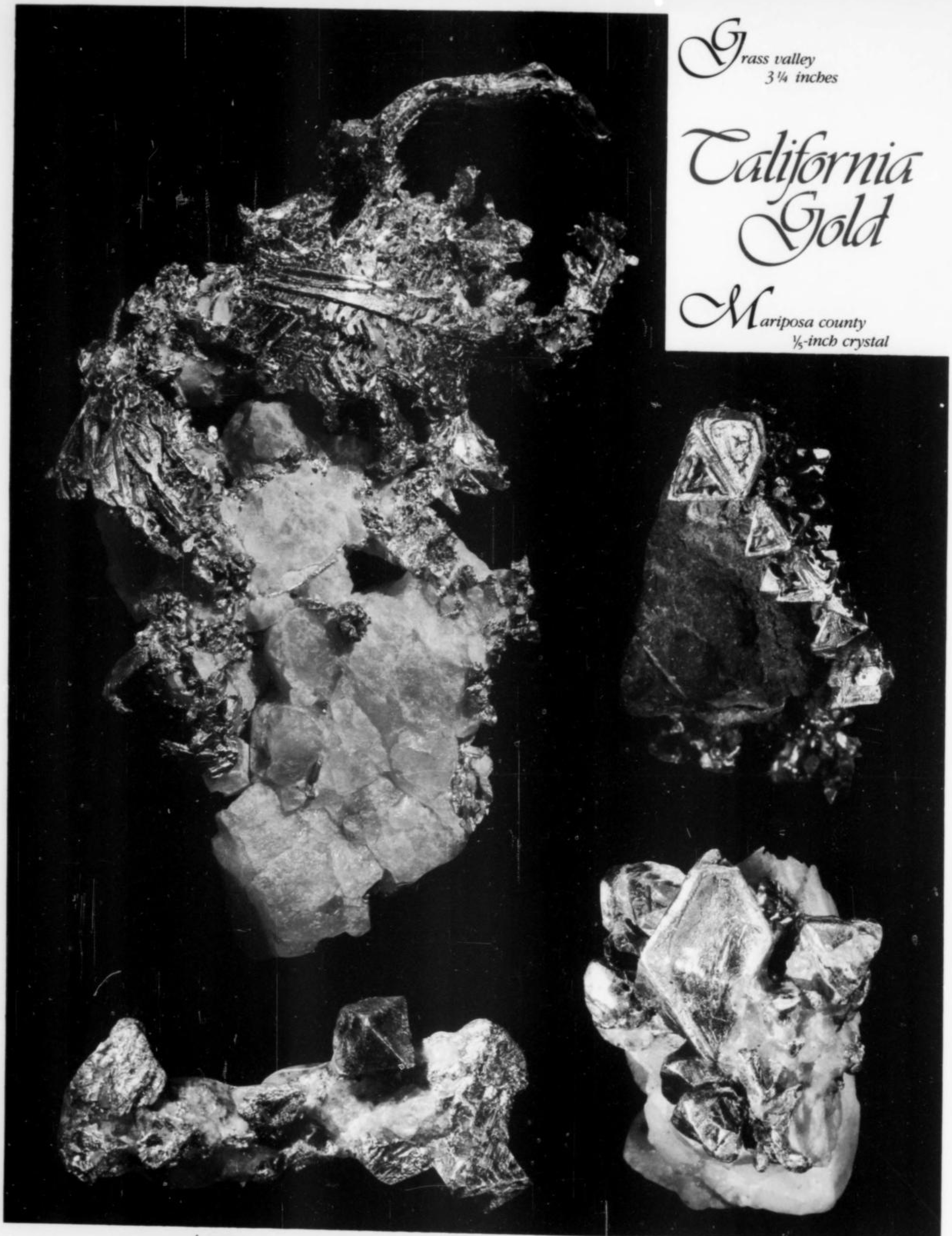


Tle elum, washington 4 inches

Grass valley
3¼ inches

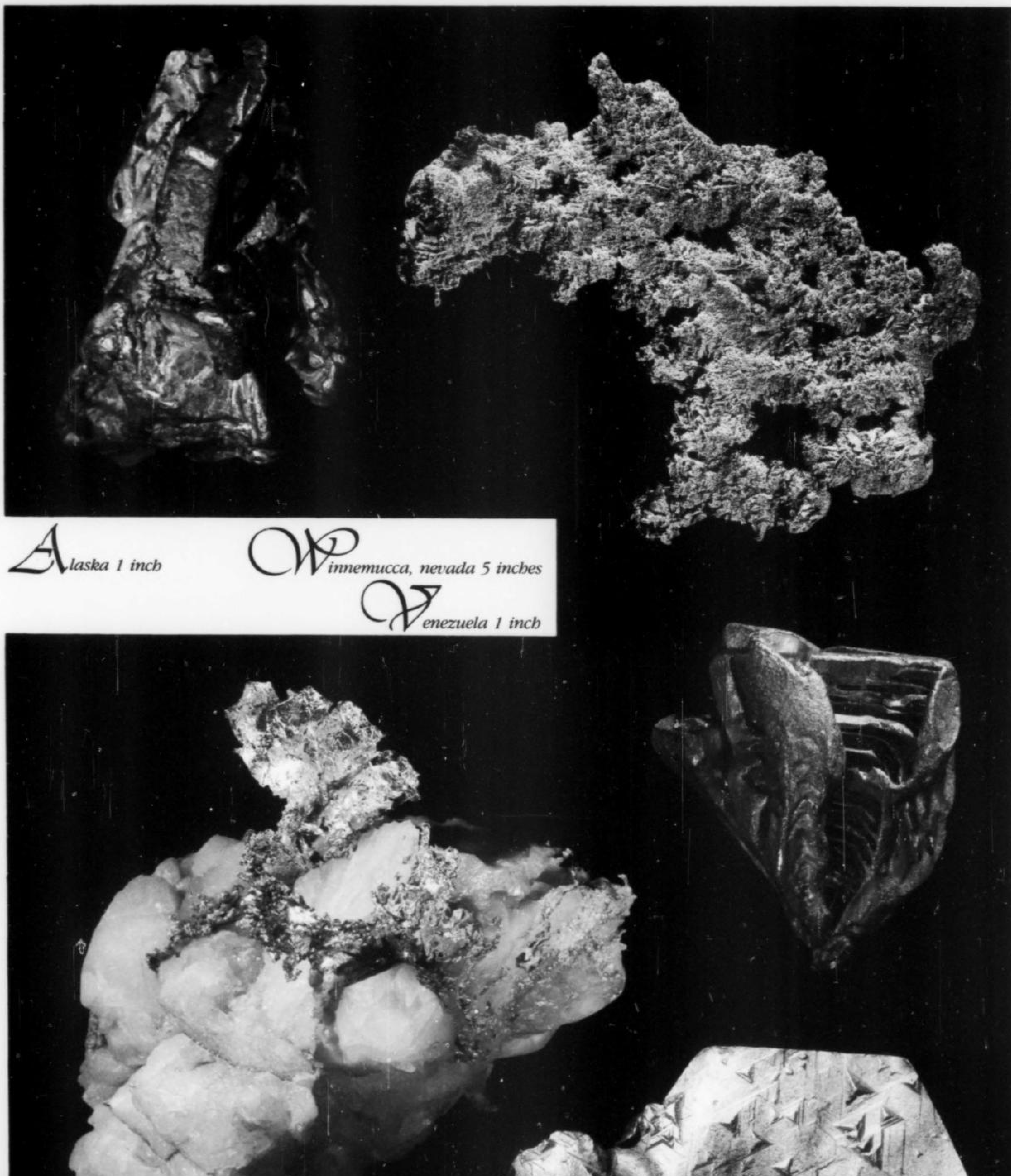
California Gold

Mariposa county
⅕-inch crystal



Placerville
¼-inch crystal

California
⅖-inch crystal



Alaska 1 inch *Winnemucca, nevada 5 inches* *Venezuela 1 inch*

Cle elum, washington 2½ inches *Colorado 1½ inches*

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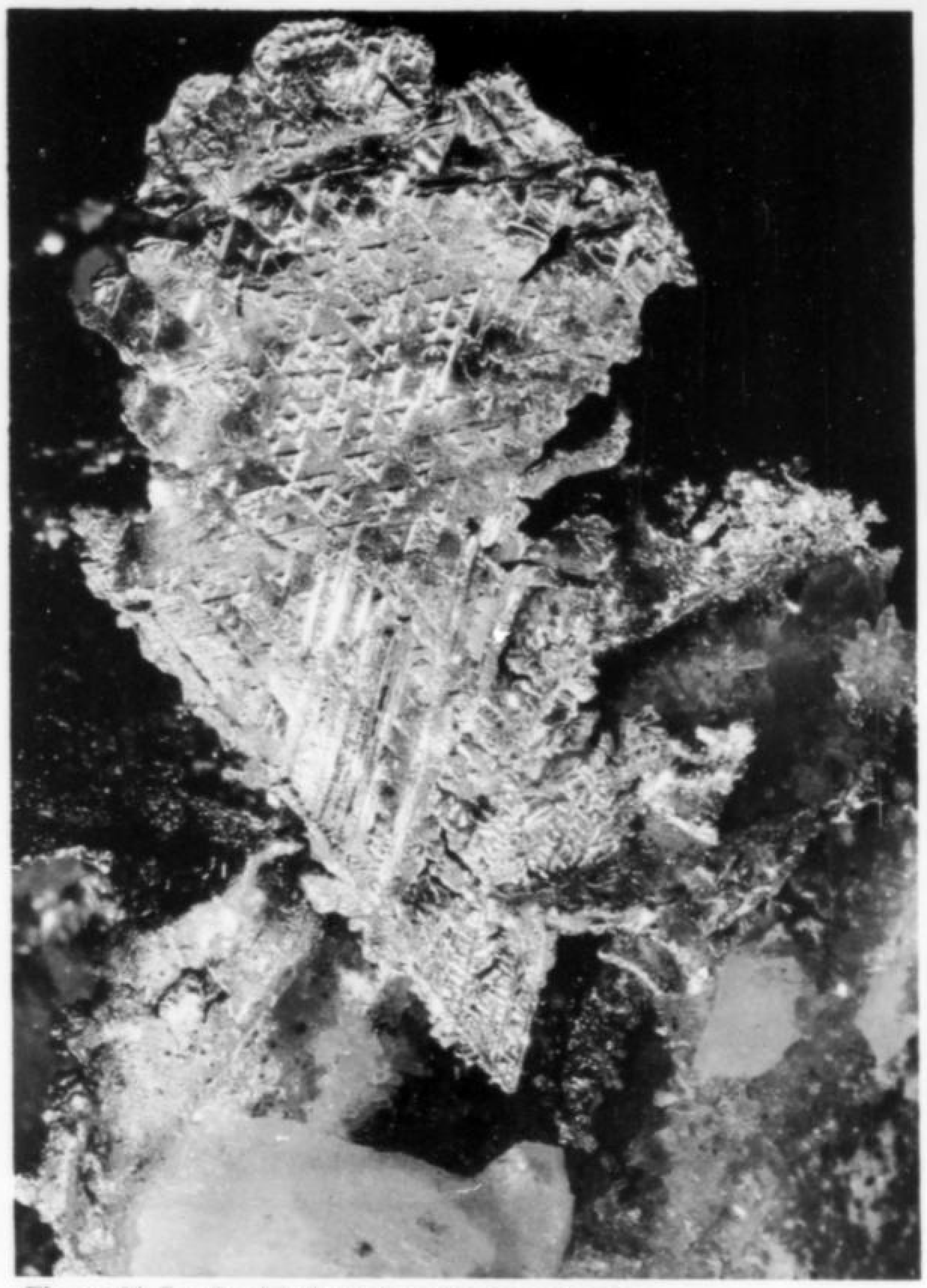
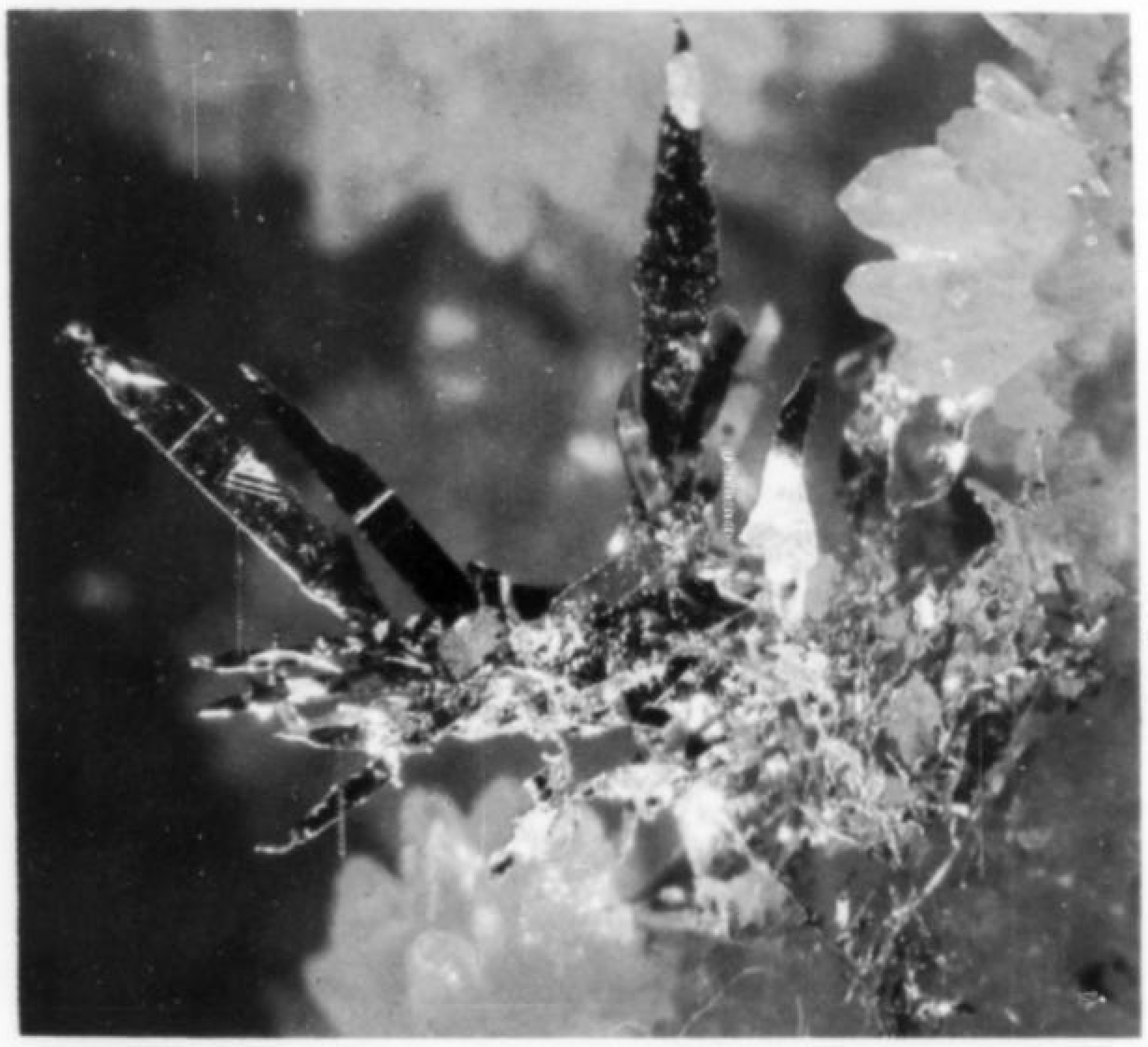


Figure 10. **Leaf gold about 1 cm in size, showing triangular markings, from Roşia Montana (Verespatak), Romania.**

Figure 11. **Dendritic gold sheets 1 cm in size, on quartz from Roşia Montana (Verespatak), Romania.**

Figure 12. **Thin gold blades to 5 mm, some with triangular markings, from the Musariu mine near Brad, Romania.**



AUSTRIA

Among the most prolific and successful of all European deposits is the **Tauern Mountains**[16] area in the eastern Austrian Alps. These deposits have been worked for perhaps 4000 years, first as placer deposits and later as underground workings, after the Mother Lode-type veins were found *in situ.*

The Tauern veins were worked by the Romans, but the first written documents date back "only" to 1346. Production was high during the years from 1300 to 1385, perhaps 50 kg of gold per year. Investigations have revealed a total of 130 km (80 miles!) of underground workings, mostly hand-chiseled without benefit of explosives. At an average content of 11 grams of gold per ton, about 2 million metric tons of ore were mined from early times up until the Middle Ages, yielding a total of about 22,000 kg of gold (22 tons).

Mining was always intermittent, and a heavy fall of snow during the decade of 1570 to 1580 caused nearby glaciers to descend and cover the mining installations (located between 2300 and 2500 meters above sea level). The first intensive efforts to reopen the

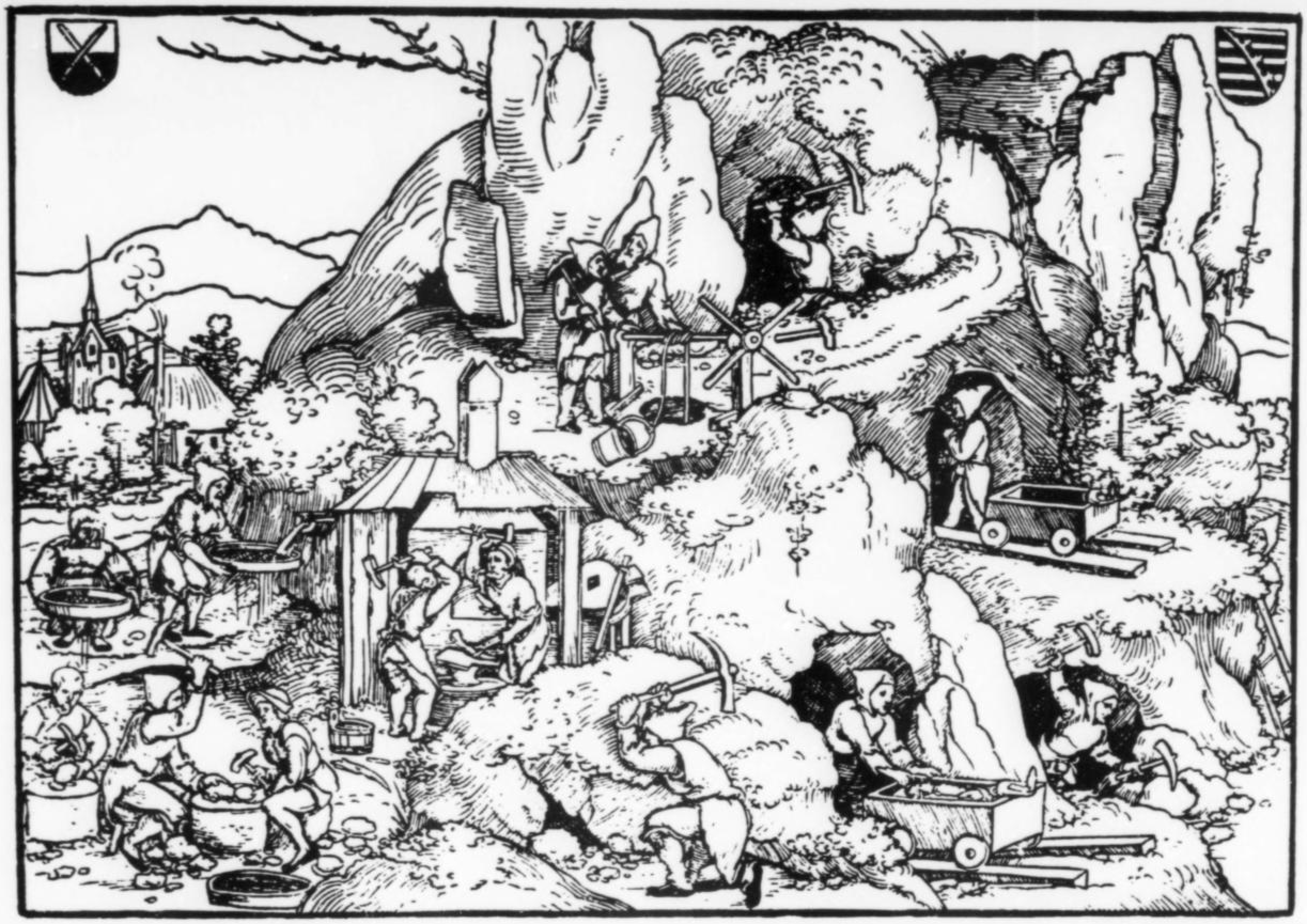


Figure 13. **This woodcut by Erhard Schön (1525) shows various aspects of gold mining in Saxony.**

mines took place following World War I. In 1924, 350 miners managed to remove 42 kg of native gold, along with 143 kg of silver, 72 tons of arsenic, 107 tons of sulfur and some lead.

The Tauern deposits are located between Mt. Sonnblick and Mt. Ankogel. The veins are several hundred meters long and are filled with quartz, carbonates and chlorite, containing ore minerals such as chalcopyrite, arsenopyrite, stibnite, pyrargyrite and gold. The gold is most commonly a microscopic constituent of pyrite and arsenopyrite, but many specimens of visible gold in leaves and grains to 1.5 cm have been found and now reside in museums.

The mining areas can be reached by car from the town of Zell am See, Salzburg, via Bruck and Taxenbach through the Rauris Valley to the beautifully situated village of Rauris, and from there by bus or four-wheel-drive up to Kolm-Saigurn. Other mining areas to the east can be reached by car through the next valley of Gastein up to Böckstein.

POLAND

Reichenstein [17] is an old mining area in Silesia. It produced arsenopyrite-loellingite arsenic ore for more than a thousand years, from which 20 to 30 grams of gold per ton were recovered.

CZECHOSLOVAKIA

There are several famous mineral locations in eastern Czechoslovakia, including **Kremnitz (Kremnica)** [18] and **Schemnitz (Banska Stiavnica).** [19] Subvolcanic epithermal dikes of the same type as those found in Nevada's Comstock Lode occur up to a few kilometers in length and up to 30 meters wide.

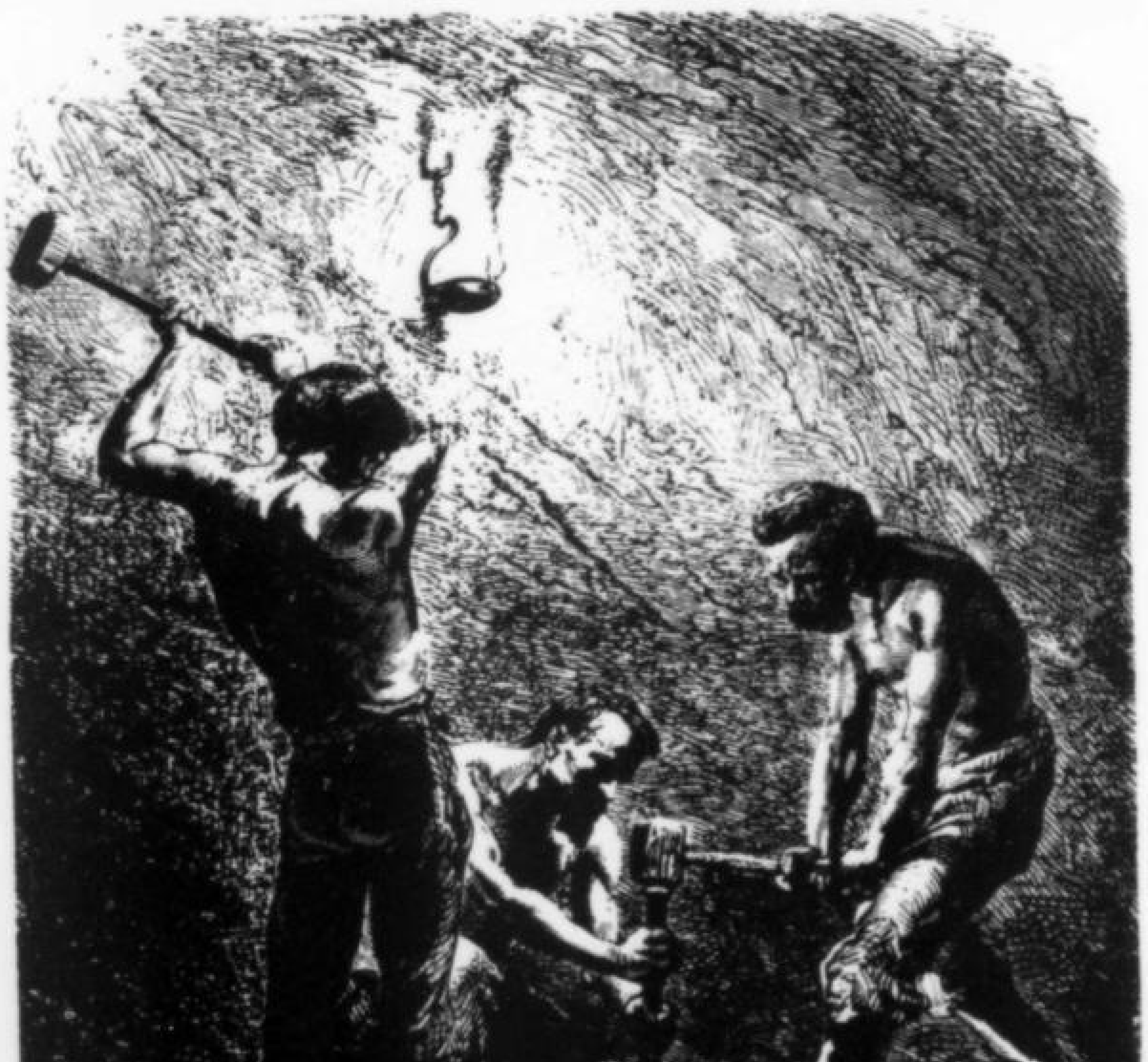


Figure 14. **Double-jack drilling in the Harz Mountains of Germany, about 1860.**

Kremnitz has produced many fine crystallized specimens of minerals such as sphalerite, galena, stibnite, tetrahedrite, pyrite, argentite, pyrargyrite, stephanite, quartz, calcite, siderite and rhodochrosite, in addition to leaf and dendritic gold. Visible gold is limited to only a few dikes, particularly those in the neighborhood of the Ferdinand shaft. There is little active mining in Kremnitz today, but a rise in the price of gold would encourage further activity.

The dikes at Schemnitz, 30 km south of Kremnitz, contain pyrite, galena, sphalerite, chalcopyrite, quartz, carbonates and, in some cases, amethystine quartz. Gold at Schemnitz is generally not visible, but some ore, for example that of the Grüner Gang dike, contains 8 to 10 grams of gold per ton, in addition to 100-120 grams of silver, 1-1.5 percent lead, 2-3 percent zinc and 0.5 percent copper.

Figure 15. **Miners working at the face of a mine in Freiberg Saxony, 1857.**

ROMANIA

The Czechoslovakian deposits of Kremnitz and Schemnitz are part of the Slovakian Mittelgebirge, a western spur of the Carpathian Mountains. The mountain range, with a total length of perhaps 800 km, extends from eastern Czechoslovakia to the southwest, then curves through the southwesternmost corner of the Soviet Union, passes through Romania (including the districts of Maramureş and Bukowina), turns south and finally west. This semicircular mountain chain encompasses the area known as Transylvania (formerly called Siebenbürgen).

The Carpathian Mountains were folded and uplifted during the Tertiary period some 50 million years ago. Volcanic activity then rose along the intensely fractured rocks as many volcanic pipes of andesite, dacite and rhyolite. These eruptive rocks form an almost complete ring along the inner base of the Carpathians. Later, faults and fracture systems developed subvolcanic epithermal mineralization. Economically important deposits of the system include Schemnitz/Kremnitz, the Matra Mountains in Hungary, the Maramureş district in Romania, and the Transylvania Mountains in central Romania. Not all are gold deposits. But the mines of Romania have produced some of Europe's finest mineral specimens, including all of the gold specimens shown in color in this article.

Three locations in the **Maramureş**[20] district of northwestern Romania have become famous among collectors the world over: Baia Mare, Baia Sprie and Cavnic. Visible gold has only rarely been found at these mines; it is typically disseminated through other minerals such as pyrite and chalcopyrite.

Baia Mare (former Hungarian name: **Nagybánya**) is the largest town in the district. Mines are located to the north and northwest of the town. Among the better known veins are the Kreuzberg dike and the Martin dike, containing (old analysis) 14 grams of gold and 40 grams of silver per ton. Fine specimens of bournonite, jamesonite, amethyst and calcite have been recovered.

About 10 km east of Baia Mare is the village of **Baia Sprie** (former Hungarian name: **Felsöbánya**), well known for beautiful specimens of stibnite, chalcopyrite, tetrahedrite, pyrite, galena, sphalerite, bournonite, jamesonite, and in rare cases also wolframite, barite, calcite and others. Average ore contained 2 grams of gold and 110 grams of silver per ton.

Between Baia Mare and Baia Sprie, a few kilometers to the

Figure 16. **Crystal forms of gold from Roşia Montana (Verespatak), Romania, from Goldschmidt (1918).**

Figure 17. **Dendritic and wire gold growth 6 mm tall, on quartz, from Roşia Montana (Verespatak), Romania.**

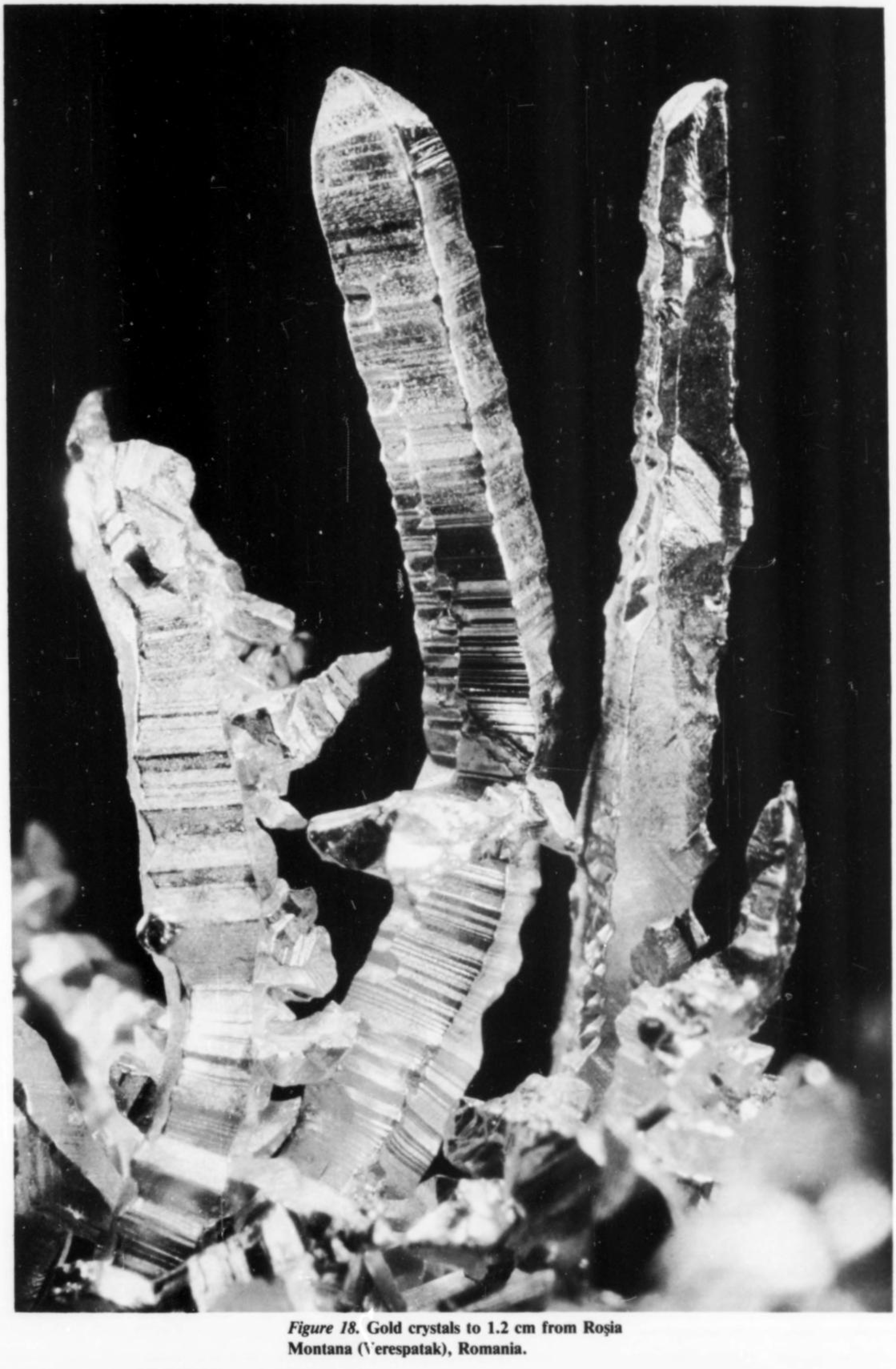


Figure 18. **Gold crystals to 1.2 cm from Roşia Montana (Verespatak), Romania.**

north, is the famous location of **Herja** (former Hungarian name: **Kisbánya**). In addition to galena and sphalerite, this mine also produces beautiful rosettes of short-prismatic, flattened and well-terminated stibnite, and roses of pyrrhotite crystals. Fine specimens of berthierite, semseyite, fizelyite and siderite have also been found. The gold in these ores is not visible.

Cavnic (former Hungarian name: **Kapnic**) is another famous locality, situated 10 km due east of Baia Sprie. Fine specimens include sphalerite, tetrahedrite, bournonite, chalcopyrite, rhodochrosite, calcite, amethyst and barite, in addition to some visible gold. The ore contains about 50 grams of gold per ton.

The most remarkable gold mining district in Romania and all of Europe is an area in western **Transylvania,**[21] about 30 by 50 km in size. Numerous dikes and dike systems having epithermal mineralization of the Comstock Lode type occur near volcanic pipes. The dikes are commonly under 400 m in length, scattered across an area lying between the **Arieş River** on the north and the **Mureş River** to the south. The earliest writings on this area are those of the Greek historian Herodotus (484–425? B.C.), who mentioned the gold jewelry worn by inhabitants along the Mureş River. The name of the river Arieş is probably derived from auries or aurum, which is gold. Waters draining the Roşia Montana deposits flow into the Arieş and have deposited placer gold.

In the western part of the district is the town of **Brad.** Mining has been carried on there for more than 2000 years, some of the earliest tunnels having been excavated by the Romans. Mining reached its height during the 18th century, and written documents date back to 1774. The miners were usually Romanian farmers, and the mine officials were typically Austrians, Germans and Hungarians. A mining school was founded in 1835 in Săcărâmb (Nagyág), and the official teaching language was German.

Famous mines are situated 5 to 8 km southwest of Brad. Their names are familiar to European collectors, names such as Valea-morii, Valea-arzului, Ruda-Barza, Brădişor and Musariu. Musariu in particular is famous for beautiful specimens of leaf gold and bladed gold crystals. The most remarkable find was made on November 6, 1891, when 55 kg (121 pounds) of gold were removed from a single pocket. Several grams to a few kilograms per pocket was the norm.

Brad has an interesting mineral museum, exhibiting some overwhelmingly beautiful gold specimens. One specimen is a mass of crystallized gold having the form of a snake. Another specimen has two 10-cm leaves of gold. The gold contains up to 30 percent silver; other habits include wires, blades and dendritic masses, and also rare crystals.

In the northern part of the area is the world-famous locality of **Roşia Montana** (former Hungarian name: **Verespatak**). This small village is located in a small valley about 35 km from Brad. The hills nearby show many small dumps. About 15 percent of the gold occurs as visible gold, and the other 85 percent is finely divided, microscopic or sub-microscopic gold which must be recovered by processing. However, that 15 percent has included many of the finest specimens of gold ever found in Europe, as the photographs presented here will attest.

Between Brad and Roşia Montana is the **Stanija** mine (former Hungarian name: **Sztanizsa**), which was known for specimens of altaite, petzite and calaverite but very little visible gold. The **Boteş** mine, 20 km east of Stanija, is famous for hessite and a small amount of native gold.

On the southern edge of the district is the village of **Săcărâmb** (former Hungarian name: **Nagyág**). The deposit here was discovered in 1748, and proved to contain no native gold. But fine specimens of beautifully crystallized gold tellurides such as sylvanite, nagyagite, petzite and calaverite have been found there, in addition to the more common ore minerals such as galena, tetrahedrite, bournonite, stibnite, alabandite, jamesonite and others.

On the northeast corner of the district is **Baia de Arieş** (former Hungarian name: **Offenbánya**), and to the east lies **Zlatna** (see cover photo). Mines in the surrounding area have produced fine specimens from time to time, though not in the abundance common to the other mines in the area.

Most of the mines in the above-mentioned areas are now abandoned, though a few still operate. Many specimens from Baia Mare and Baia Sprie have reached the mineral market in recent years, especially stibnite and associated minerals, but no new specimens of gold or gold-containing minerals have surfaced. Those collectors and museums fortunate enough to possess an old Transylvanian gold specimen will prize it highly.

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California Gold

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Though other mining regions of the world may have produced larger quantities of gold, California's "Mother Lode" has unquestionably produced the finest crystallized examples.

INTRODUCTION

Placer County

A vast number of locations in California have produced gold. Many of them are placer deposits containing only stream-worn nuggets and dust; because these are so numerous and of little interest to collectors, placer gold deposits will not be discussed. Of far greater appeal are the specimens removed from pockets in quartz veins where they formed. Undamaged by erosion, such gold is found in an array of beautiful forms, including leaves, wires and fine crystals.

Only a few of the California mines which have produced fine pocket gold are discussed here. Many other locations exist but suffer from incomplete documentation, a problem particularly common to gold occurrences. In many cases the locality data are deliberately withheld or inaccurately reported to conceal the exact location of a discovery. Other specimens, some collected more than a century ago, have passed through many hands and lost their locality information along the way. Still other specimens, perhaps treasured for many decades by an old miner, are victims of the failing memory of their finder. Adding to the confusion are frequent mine name changes and the incorporation of several small mines into larger mines as time goes on.

Fortunately, mines like the Red Ledge and the Colorado Quartz mine (see the article in this issue) were carefully followed and discoveries there recorded by interested owners and collectors. Consequently these mines are today better known as producers of fine crystalline gold than other mines which may have yielded equally fine specimens.

HISTORY

Placer County

Certainly no other single event in the history of California has had such a profound impact on the early economic history of our nation as the discovery of gold on the American River in the winter of 1848. The enormous revenues from gold pouring out of California mines transformed the lackluster economy of the post-Mexican War era into a vibrant period of industrial expansion which later evolved into what is now known as the American Industrial Revolution. Additionally, the thousands of American and foreign fortune hunters who

Figure 1. **This exceptionally fine gold specimen was found in 1959 by Mr. Sam Tracy at the Red Ledge mine, Nevada County, California. The pocket from which it came was located just a few feet below the surface, and had been penetrated by tree roots; a piece of root is still imbedded in this specimen. The rest of the pocket was filled with dirt and other loose gold specimens. Size, 5½ x 6½ inches; Wayne and Dona Leicht collection; photo by Harold and Erica Van Pelt.**

flooded into the Pacific wilderness during the gold rush period most certainly expedited the early statehood of California and secured the area once and for all from the threat of Mexican reoccupation. The richness of the California gold fields was only exceeded by the cost of everything needed to work one's claim and provide for even the barest of necessities.

During the period between 1848 and 1858 over 25 million troy ounces of gold were mined from the rolling foothills of the Sierra Nevada Mountains, in a region roughly bounded on the north by Nevada County, on the south by Mariposa County, on the east by the crest of the range, and on the west by the San Joaquin Valley. The "Mother Lode," as it is called, instantly became the new El Dorado of the world. (It should be noted that the geological definition of the Mother Lode is much more precise than that indicated on most maps. A more detailed definition of the Mother Lode follows.)

The total gold production of California to date is estimated to be in excess of 100 million troy ounces. (This is over 4000 tons, and would make a cube of solid gold nearly 9 feet on an edge.) Peak production was almost 4 million troy ounces in 1852, less than four years after the initial discovery by John Marshall at Sutters Mill (the purported original nugget is in the Smithsonian Institution).

The early Argonauts* found that placer gold could be easily extracted from alluvial material using relatively primitive devices. However, within a short period of time the gold pans, rockers and sluices gave way to the more efficient methods of hydraulic mining, with devastating effects on the ecology of the area. As the rich

*A term used to describe early miners in California during the gold rush. The Greek gold seekers who voyaged to the Black Sea in search of the Golden Fleece, traveled with Jason on the ship *Argo,* hence Argonauts.

Figure 2. **This unusually large mass of crystallized gold was found in 1946 at the Eureka mine, Tuolumne County. It measures 6 x 13 inches and weighs 67 troy ounces (5½ pounds). Originally in the Crespi collection, now in the Smithsonian Institution; photo by Harold and Erica Van Pelt.**

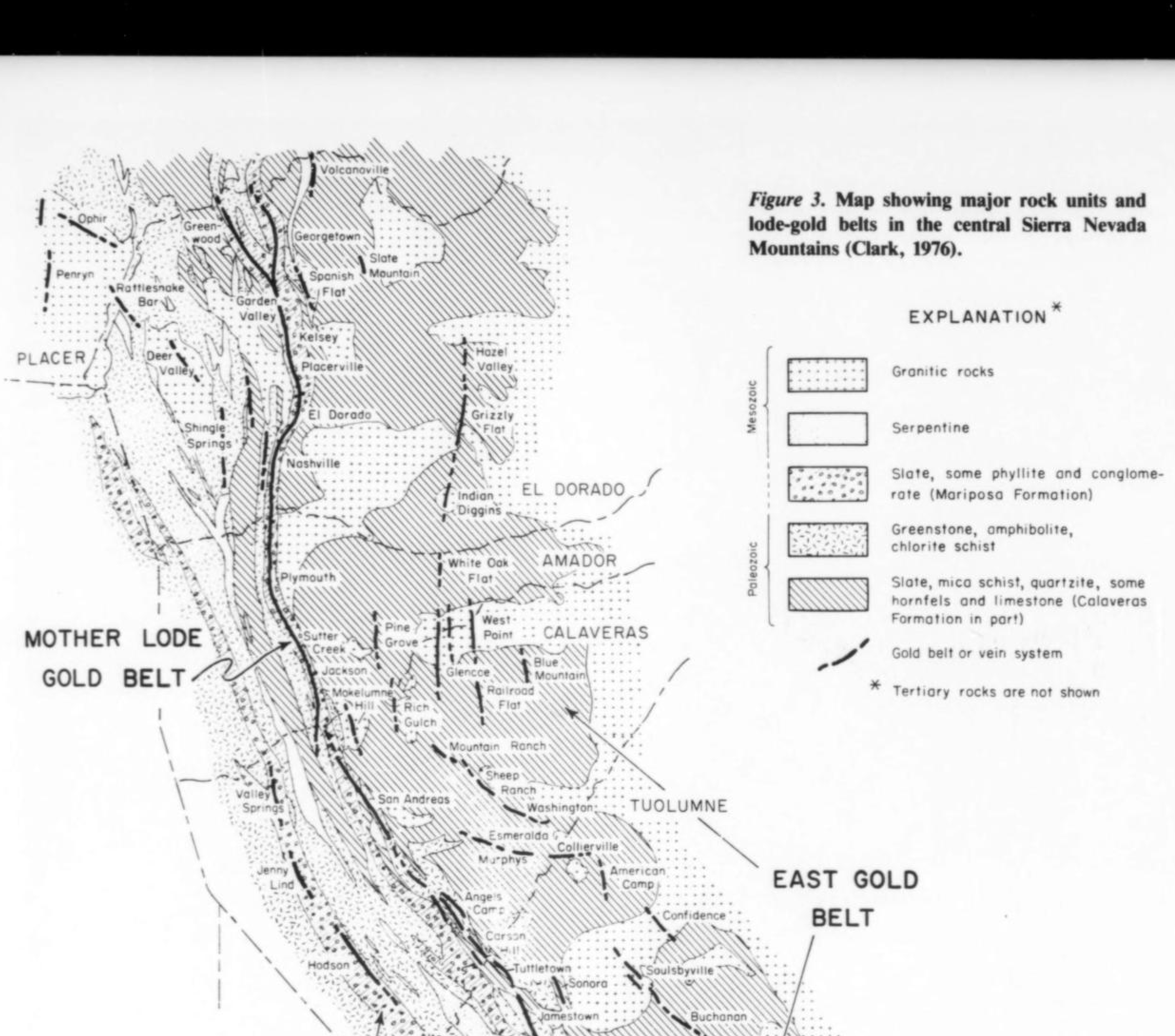


Figure 3. **Map showing major rock units and lode-gold belts in the central Sierra Nevada Mountains (Clark, 1976).**

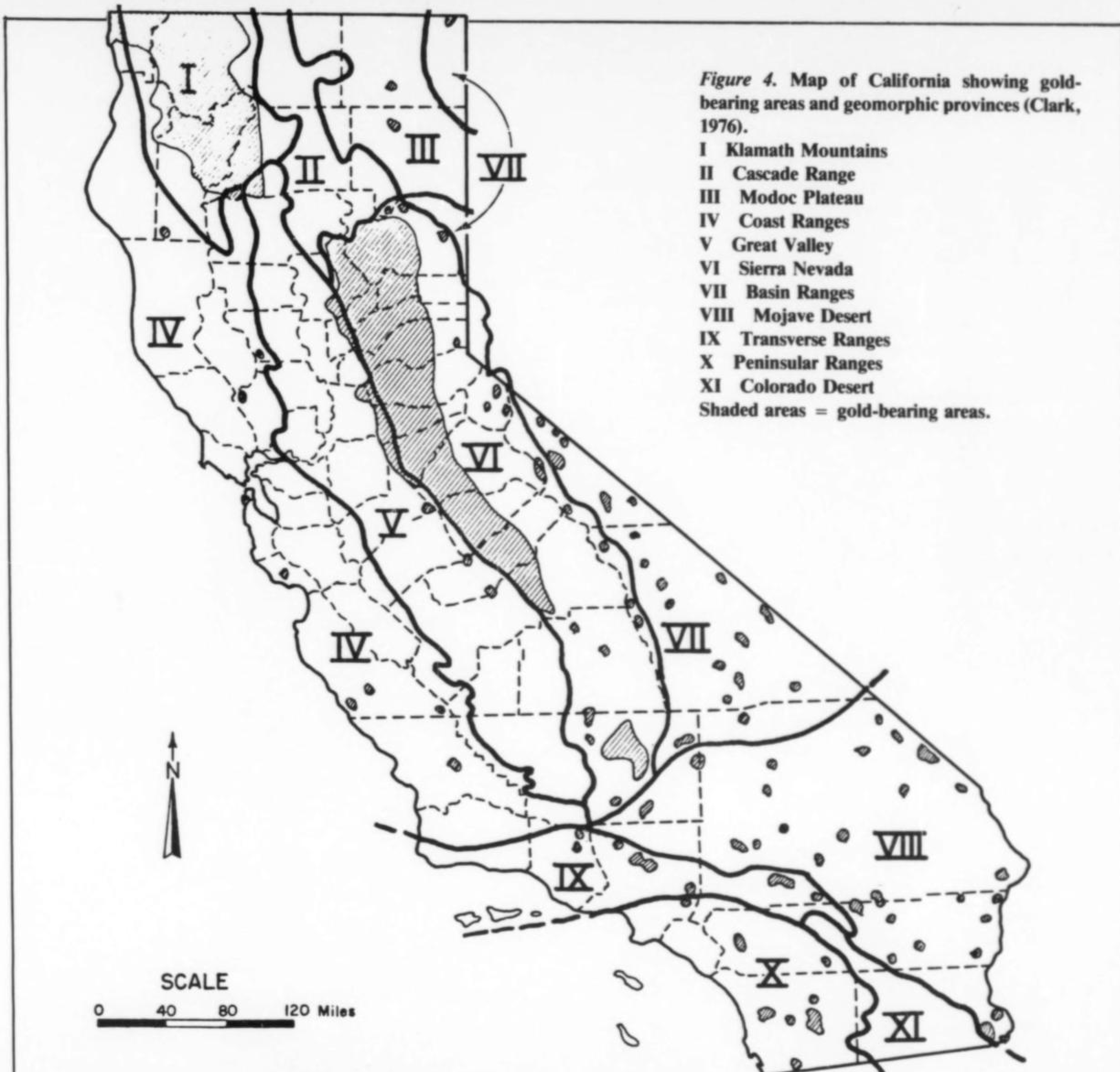


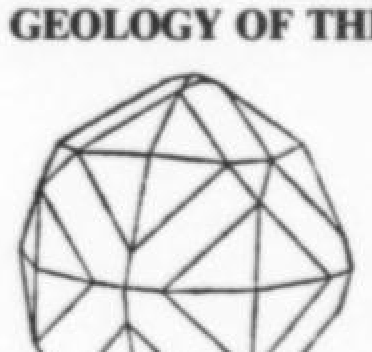
Figure 4. **Map of California showing gold-bearing areas and geomorphic provinces (Clark, 1976).**

I Klamath Mountains
II Cascade Range
III Modoc Plateau
IV Coast Ranges
V Great Valley
VI Sierra Nevada
VII Basin Ranges
VIII Mojave Desert
IX Transverse Ranges
X Peninsular Ranges
XI Colorado Desert
Shaded areas = gold-bearing areas.

placers of the Mother Lode began to diminish, some of the more enterprising miners turned their attention to mining the rich quartz veins in place. Most of the early lode mines were no more than extensions of placer or hydraulic mining operations where the miners continued to work upstream until the source of the gold was found. It quickly became apparent that the methods used to separate gold from alluvium in placer deposits were ineffective in lode mining. Small mining companies were formed to raise the capital needed to import the sophisticated mining equipment, personnel, and technology to operate these early lode mines. Much of the expertise necessary to operate the early underground mines came from the famous mining region of Cornwall, England.

No doubt these early lode mines produced many fine crystallized gold specimens. Early mining reports describe pockets of "jewelry gold" (a term usually used by the miners to describe crystallized gold) so large that chisels were used to cut the gold free from the rock. Unfortunately, few specimens from the early mining period were saved and those which remain are usually devoid of any indication of where they were found, most likely to protect " high-grader" collectors.

GEOLOGY OF THE MOTHER LODE



Tuolumne County

Considerable confusion exists as to the exact location and boundaries of the area of California known as the "Mother Lode." Clark (1976) defines the Mother Lode as a 120-mile long system of linked or en echelon gold-quartz veins and mineralized schist and greenstone that extends from the town of Mariposa, north and northwest to the northern part of El Dorado County. The Mother Lode is within a broader gold-bearing area known as the Sierra Nevada geomorphic province, which also includes the East belt and the West belt, as well as mining districts north of the Mother Lode.

The Sierra Nevada province is further broken down into over 200 mining districts which are defined as areas or zones of gold mineralization. These districts are not always well-defined and are commonly named after small towns which, because of their geographic locations, served as central supply points for the mines of the area. Hence, the gold districts of the Sierra Nevada province are often more important historically than geographically—nevertheless,

Figure 5. **Leaf gold from Tuolumne County, measuring 5 x 6½ inches. Originally part of the Crespi collection, now in the Smithsonian Institution; photo by Harold and Erica Van Pelt.**

Figure 6. **Brilliant, sharp octahedral crystals typical of those found at the Eureka mine, Tuolumne County. Size, 1 inch; Wayne and Dona Leicht collection; photo by Harold and Erica Van Pelt.**

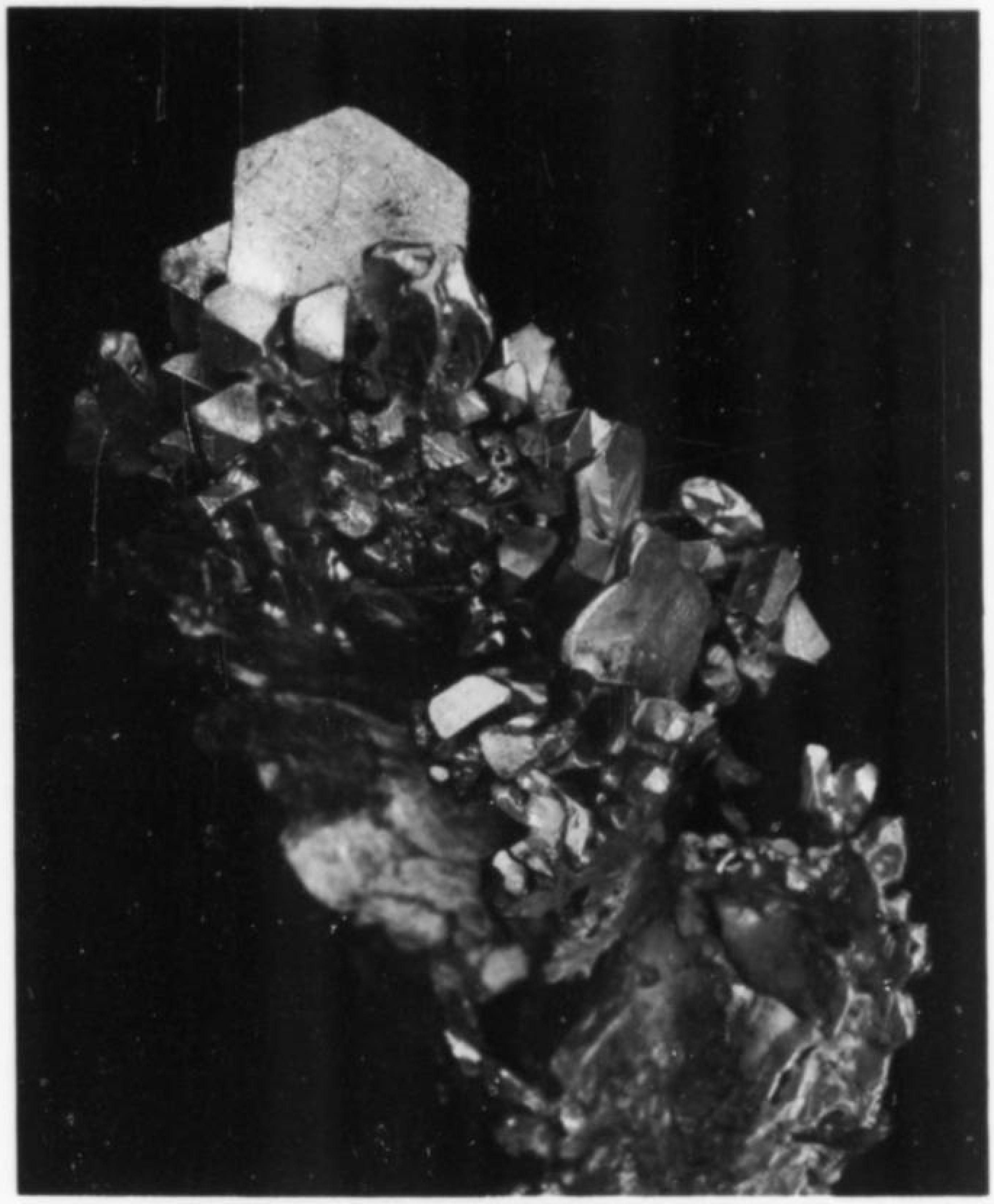
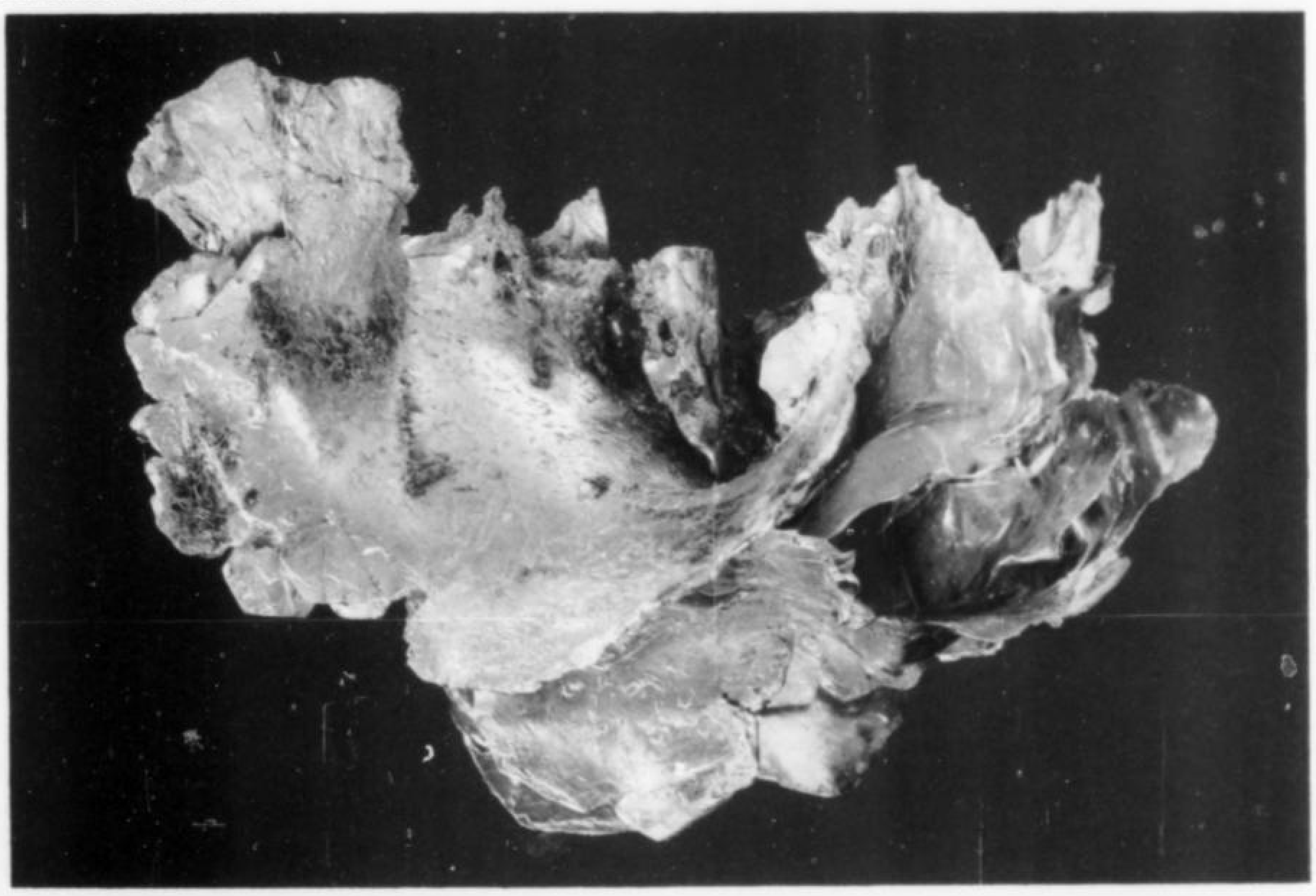


Figure 7. **Well-formed octahedral crystals of gold, one showing pseudohexagonal habit. Size, 1½ inch; Wayne and Dona Leicht collection; photo by Harold and Erica Van Pelt.**

Figure 8. **An unusual specimen of leaf gold from Tuolumne County, showing multiple curved leaves in the shape of a rose. Size, 2 x 2½ inches; Wayne and Dona Leicht collection; photo by Harold and Erica Van Pelt.**



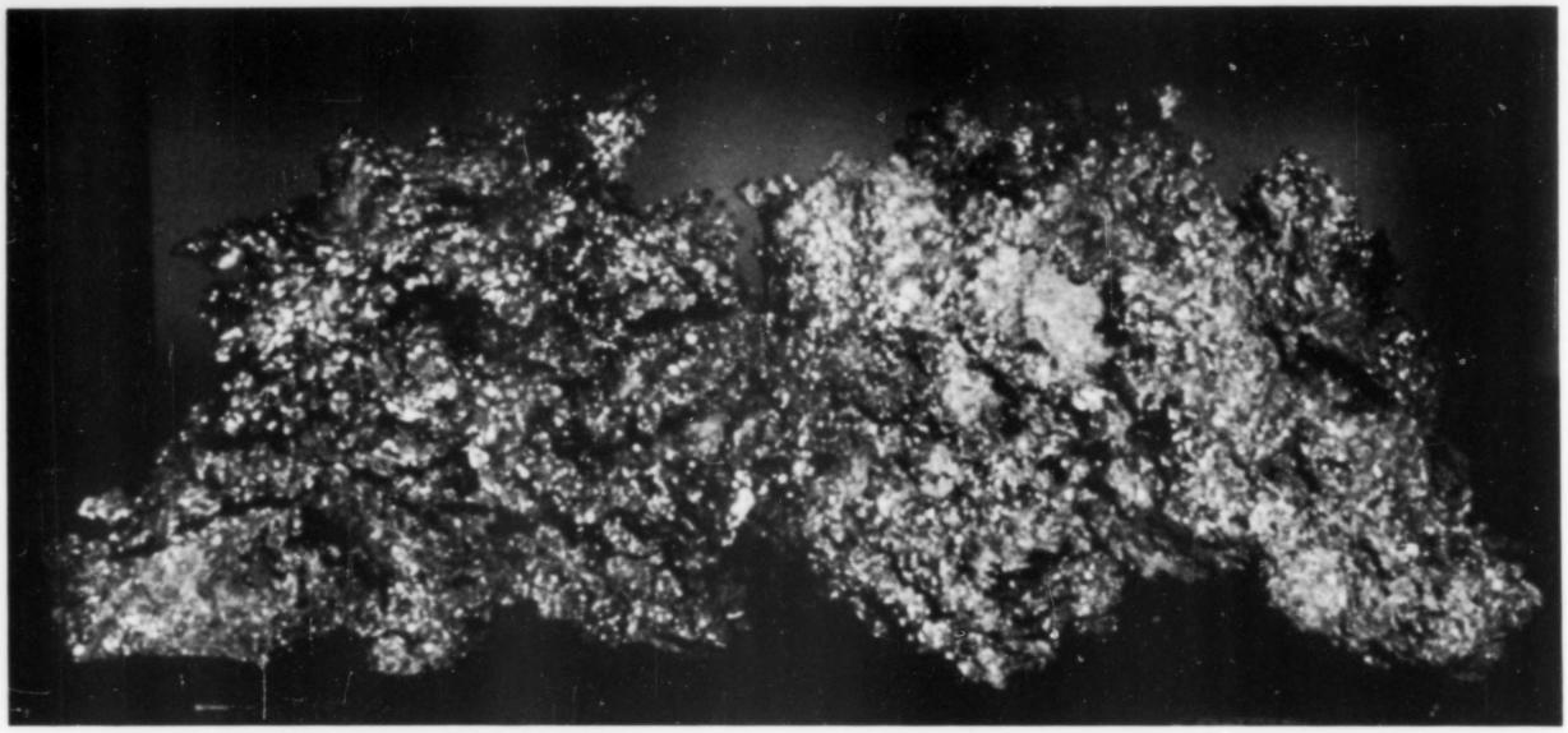
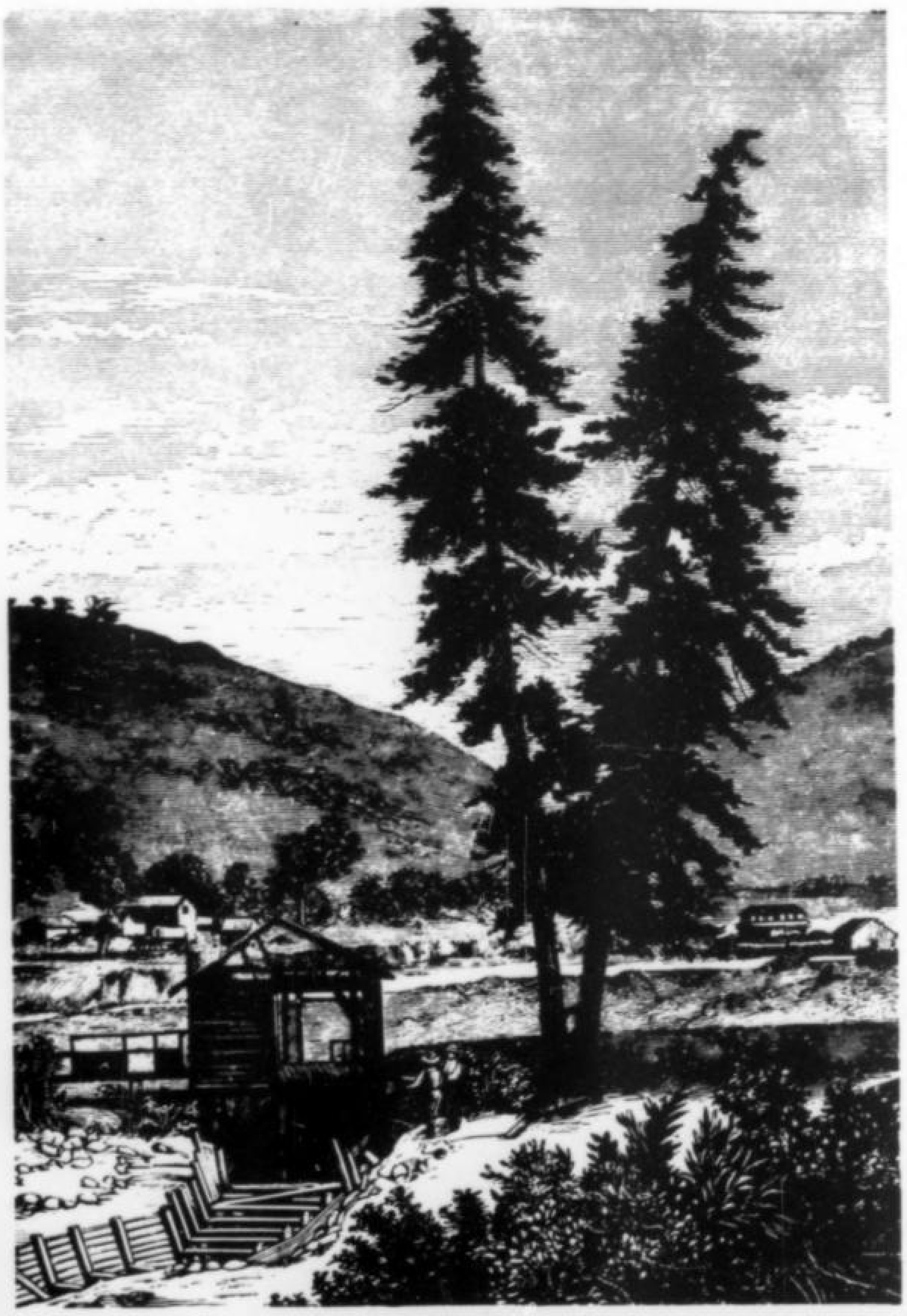


Figure 9. **The "Fricot Nugget," found in 1865 at the Grit mine, El Dorado County, California. This remarkable specimen of crystallized gold, one of the finest ever found in California, weighs 201 troy ounces (nearly 17 pounds). California Division of Mines and Geology collection, Ferry Building, San Francisco.**



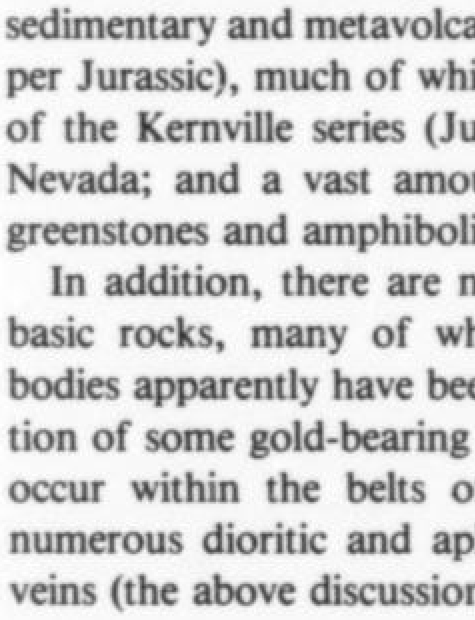
SUTTER'S MILL

they are useful and are often used by museums and collectors in labeling gold specimens.

The main mass of the Sierra Nevada is a huge batholith of granodiorite and related rocks that have intruded into metamorphic rocks of Paleozoic and Mesozoic age. The metamorphic rocks are confined largely to the western foothills and to the northern end of the range. They consist of a series of folded and faulted major rock units. The principle units are slate, phyllite, schist, quartzite, hornfels, and limestone of the Calaveras formation (Carboniferous to Permian); the Amador group (Middle and Upper Jurassic) of metasedimentary and metavolcanic rocks; the Mariposa formation (Upper Jurassic), much of which is slate; schist, phyllite and quartzite of the Kernville series (Jurassic or older) in the southern Sierra Nevada; and a vast amount of undifferentiated pre-Cretaceous greenstones and amphibolites.

In addition, there are numerous intrusions of basic and ultrabasic rocks, many of which are serpentinized. The serpentine bodies apparently have been structurally important in the localization of some gold-bearing deposits and typically are parallel to or occur within the belts of gold mineralization. There also are numerous dioritic and aplitic dikes associated with gold-bearing veins (the above discussion is largely from Clark, 1976).

HABITS OF CRYSTALLIZED GOLD



Mariposa County

Crystallized gold from California was reported as early as 1850, less than two years after Marshall's initial discovery of gold in the flume of a sawmill under construction near Coloma in El Dorado County. That year a few water-worn crystals of gold found their way to the east coast of the United States where they were described by Francis Alger of Boston in 1850. Alger described the crystals as rather large, unmodified octahedrons with slightly depressed centers, from an unspecified locality in California. Apparently because of their large size, there was some question as to whether these were true crystals of gold or pseudomorphs of gold after some other mineral. Alger indicated that he was "not disposed to ascribe any such forced and unnatural origin to these beautiful productions." Apart from a few vague references to "specimen gold" in various county and state reports, very little was written on the subject of crystallized gold until 1885. Buried in an obscure report from the Director of the Mint is a small but superb paper written by William P. Blake (1885) (after whom blakeite was named) while he was employed as a geologist for the California State Board of Agriculture. Blake described the various forms in which gold occurs in nature with the emphasis placed on California crystallized gold.

Almost every form of crystallized gold has been found in California. However, some forms, such as wire gold and gold in well-formed cubes, are relatively rare. By far, the most common crystal habit is the octahedron, either in the form of regular eight-sided dipyramidal crystals or in the more distorted leaf or plate form. Leaves and plates are almost always single or twinned octahedral crystals. Raised triangular faces can usually be observed on the surfaces of sheet gold though they may be microscopic. Leaves differ from plates only in thickness; leaves are thinner and tend to be more dendritic, especially at the edges, whereas plates are thicker and sometimes show sharp crystal faces along the outer edges.

Large gold specimens are commonly combinations of leaves, plates and individual crystals, sometimes distorted beyond easy visual orientation. Ideally, collectors want a specimen of gold to have some matrix either attached to it or preferably acting as a base of support for the gold itself. Unfortunately, many California gold specimens show little or no matrix. This is due in part to the fact that some of the finest crystallized gold formed in clay-lined quartz crystal pockets (the clay may or may not be present at the time the specimen is actually found). A case in point are the specimens of gold from the Red Ledge mine of Nevada County where much of the gold occurred loose in pockets.

THREE FAMOUS MINES

Red Ledge Mine

The most famous mine in California for crystallized gold is the Red Ledge mine, located in east-central Nevada County near the old mining town of Washington. Most of the gold from the Red Ledge is in the form of dendritic leaves, in itself not that different from other leaf gold; but the specimens are remarkable for their mirror-bright surfaces.

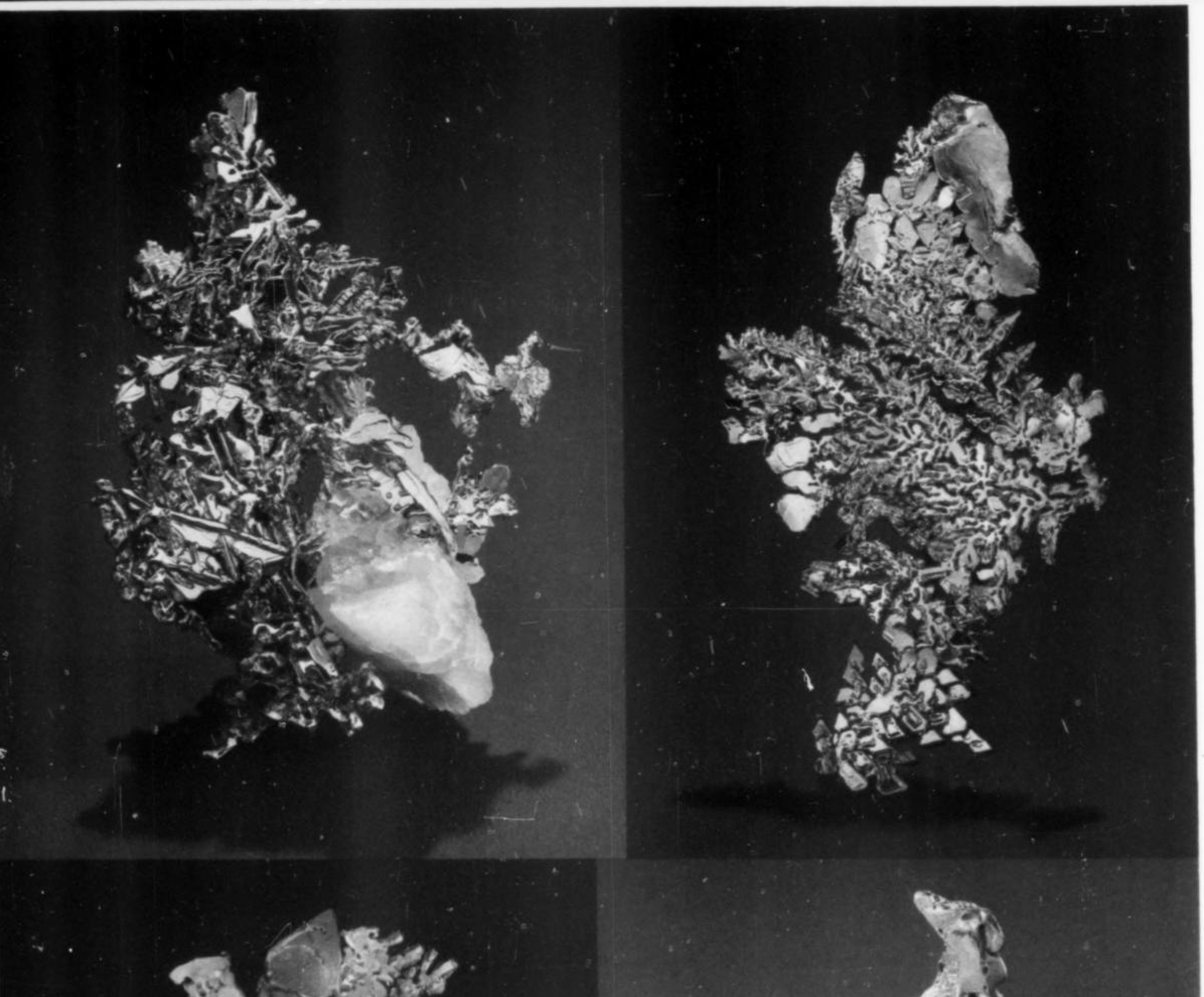
A latecomer to the mining scene in Nevada County, the Red Ledge was a shallow pocket mine situated on a series of small but rich quartz veins. Much of the gold was found loose in quartz vugs associated with albite and gemmy quartz crystals. Sulfides, except minor arsenopyrite, were rare in most of the mines in the Washington mining district. Very little is known about the output of the mine until 1952, when it was purchased by Mr. and Mrs. Sam P. Tracy, who worked the mine until Mr. Tracy's death in 1968. Obviously the mine did produce several fine specimens prior to 1952, as indicated by an exceedingly fine specimen reportedly mined in 1914 and now in the collection of the Cranbrook Institute of Sciences, Bloomfield Hills, Michigan.

Many of the specimens mined during the period in which the mine was owned by the Tracys were purchased by the late Charles Crespi, a banker in Angels Camp, Calaveras County, California. Mr. Crespi had been purchasing gold specimens from the Red Ledge mine as well as several other mines in the Mother Lode region for many years. At the time of his death in 1961 he had amassed what was probably the finest personal collection of crystallized gold in the world. Kristalle purchased a major portion of the Crespi collection in 1978; many of the finest specimens from this collection are now in the Smithsonian Institution.

The notoriety of the Red Ledge mine as a producer of fine gold specimens is due not only to the quality of the specimens but also to the fact that the mine was worked during a period when many collectors were actively seeking specimens. The locality "Red Ledge mine" was no doubt appended to many specimens of unknown or other origin. Consequently, there are probably more specimens inaccurately credited to the Red Ledge mine than any other gold mine in the world.

Other mines in the Mother Lode have produced specimens of similar quality and quantity but are not nearly as well known. The Eureka mine in Tuolumne County is a good example. It produced many important specimens but most of the output of the mine ended up in Mr. Crespi's collection (which until recently was seldom seen by the public). *(continued on page 386)*

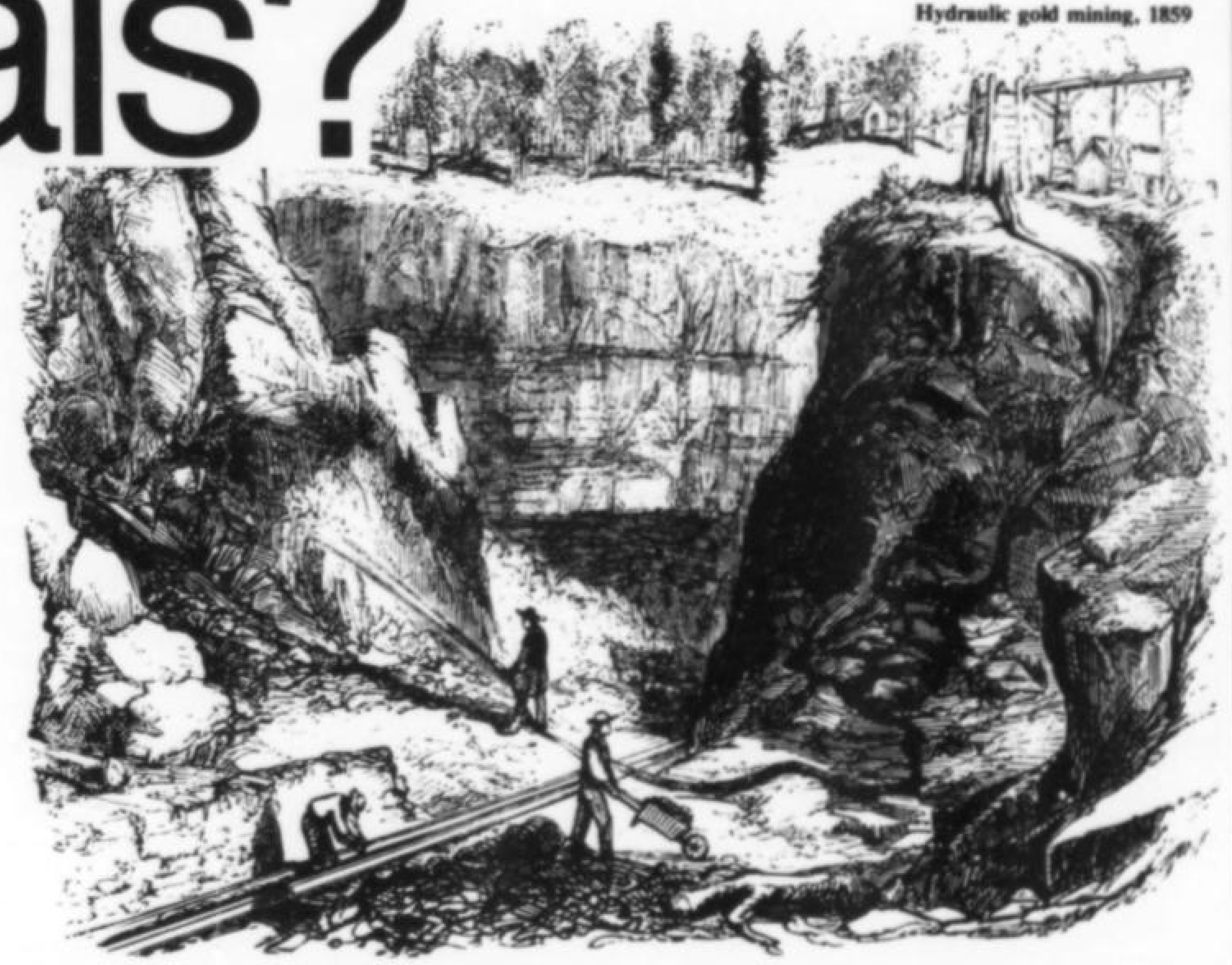
CRADLE ROCKING, ON THE STANISLAUS.



Recently collected gold specimens from the Michigan Bluff district, Placer County, California. Upper left: 1.4 inches. Upper right: 2.2 inches. Lower left: 1.4 inches. Lower right: 1.6 inches. Kristalle specimens; photos by Harold and Erica Van Pelt.

What's New in Minerals?

Hydraulic gold mining, 1859

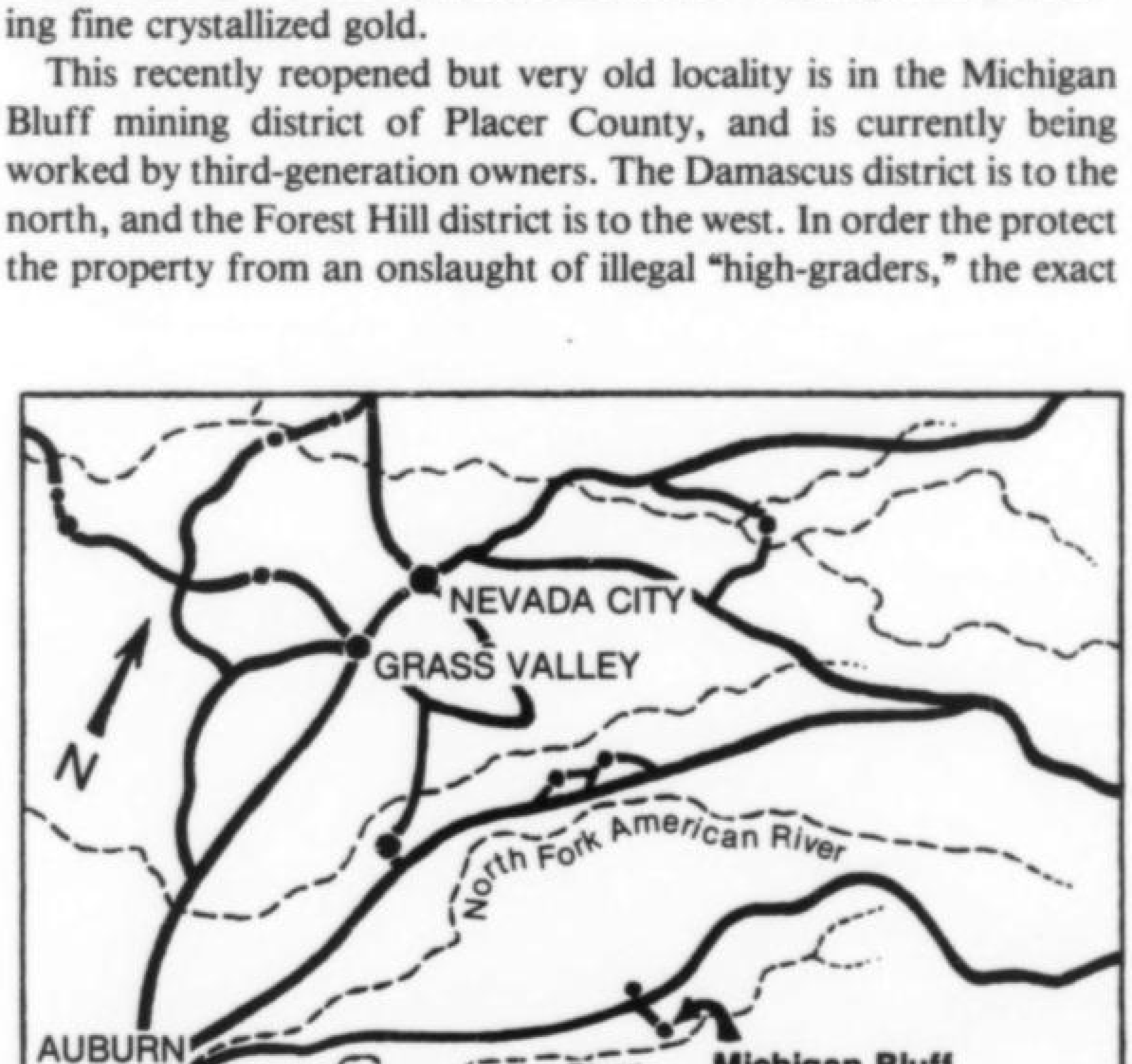


NEW GOLD FROM CALIFORNIA!

(Dona Leicht of Kristalle, *Laguna Beach, California, provided the following report and photos (facing page) for* What's New? *W.E.W.)*

Although much gold has come from the "Golden State," most of it has been found as stream-worn nuggets and dust rather than as beautifully crystallized "pocket gold." Of the few crystalline gold specimens that reach the market, most were collected long ago. Recent strikes have been rare, but in the late 1970's the Colorado Quartz mine produced some superb specimens (see the article in this issue). Now California can boast of another working mine producing fine crystallized gold.

This recently reopened but very old locality is in the Michigan Bluff mining district of Placer County, and is currently being worked by third-generation owners. The Damascus district is to the north, and the Forest Hill district is to the west. In order the protect the property from an onslaught of illegal "high-graders," the exact location is not given.



Hydraulic mining began at the placer deposits here in 1853, and the district produced an average of $100,000 in gold each month. Leland Stanford, a Governor of California and builder of the Central Pacific Railroad, operated a store in the district from 1853 to 1855. Activity declined during the 1870's, continuing intermittently through the 1930's. In 1960 a fire devastated the entire region.

The Michigan Bluff district has been producing fine specimens of gold as far back as the famous rush of 1849. Many such pieces are on exhibit in public displays across the country. In the early days, according to a family story, the grandfather sold a magnificent specimen for $20,000 (keep in mind that this took place when gold was valued at less than $20 an ounce, and specimen value was hardly recognized), but the piece was then melted down after a replica was made!

The deposit is a hard-rock operation, though most of the surrounding area is best known as a placer district. Several hundred feet of drifting have been accomplished, in places intersecting clay-filled pockets associated with milky quartz. Gold specimens occur suspended in this clay, unassociated with any sulfides.

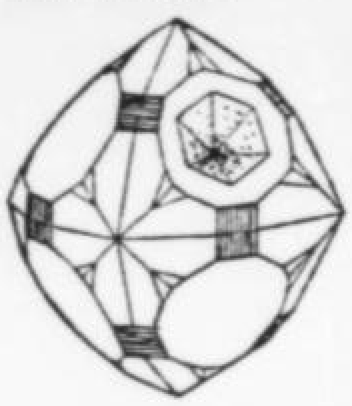
The gold ranges in habit from leafy to dendritic to octahedral. Some well-formed octahedrons measure up to ½ inch in size. All specimens have brilliantly lustrous surfaces. Much of the gold has been collected with quartz matrix attached but, as is typical of pocket gold, the finest crystals occur as "floaters" unattached to any matrix.

A full year of effort by the operators of the mine has yielded less than 100 specimens. Sizes range from thumbnail to miniature, and many are extremely esthetic, as one can see from the photos on the facing page. They are priced from $100 to several thousand dollars, depending on size and crystallization.

Kristalle acquired the entire year's output of crystalline gold from this locality. Due to the sporadic nature of the pocket distribution, and the operation of the mine on only a part-time basis, future production is expected to be very limited.

(continued from p. 379)

Eureka Mine



Tuolumne County

The Eureka mine (also known as the Harper Brothers' mine) is in the East belt of the Sierra Nevada province near the town of Big Oak Flat in Tuolumne County. The claim was first located in 1893 or 1894 in Grizzly Gulch by Edwin F. Harper and Charles F. Harper, who worked it intermittently until well into the 1940's. Like many of the small pocket mines of the area, the orebody consisted of a series of narrow quartz veins, up to 2 feet in width and 8 to 10 feet apart, in the Calaveras slate. Most of the specimens from the Eureka mine are rather thick plates of gold with octahedrons (some over ½ inch) attached to, or on, the surfaces of the plates.

Although the mine produced many fine specimens, it was not until 1949 that it came to the attention of the scientific community. Clarence A. Logan (1949) described a single crystallized gold specimen measuring 6 inches wide by 13 inches long and weighing 67 troy ounces. It was found in a bed of loose quartz crystals and talc, within a few feet of the surface. The specimen was displayed for a short period of time in Sonora and later acquired by Mr. Crespi. When the Crespi collection was dispersed this particular specimen was acquired by the Smithsonian Institution and is now on display there.

Grit Mine

El Dorado County

The Grit mine is located in the Greenwood district, north of the town of Georgetown in El Dorado County, in the northwest portion of the Mother Lode. The mine was formerly known as the Spanish Dry Diggins Seam mine, after the Spanish who first worked the area by carrying the gravel down to a nearby stream for washing. The Grit mine is a seam mine that was first worked by hydraulic mining; later the bottom of the pits were mined as lode mines. Most of the mines in the area are in the slates of the Mariposa formation and are associated with amphibolite schist and greenstones.

But for a single specimen, the Grit mine would have passed into obscurity as have thousands of other mines in the Mother Lode. In 1865 a mass of crystallized gold weighing 201.4 troy ounces was found in a shaft a few feet below the bottom of a hydraulic pit. The "Fricot Nugget," as it is called, is a cavernous mass of intergrown octahedral crystals up to ⅔ of an inch on a side. Although it is broken into two pieces, many people regard the Fricot Nugget as the finest specimen of large crystallized gold in existence. Other documented specimens from the Grit mine are rare. However, several mines in the immediate area, such as the Georgia Slide and

Table 1. **Some localities for crystallized gold in the California Mother Lode region.**

Amador County
- Amador Queen No. 2 mine (P)
- Central Eureka mine (C, M)
- Fremont mine (C)
- Keystone mine (P)
- Live Oak mine (P)

Butte County
- Flowery North mine (C)

Calaveras County
- Altaville Mining and Manufacturing Company's ledge (C)
- Bald Mtn., Browns flat (C)
- Belmont Osborn mine (P)
- Francis mine (C)
- Gwin mine (C)
- Hoosier mine (C)
- Jumper mine (C)
- Melones mine (C)
- Rich Gulch mine (C)
- Rio Vista mine (C)
- Sheep Ranch mine (P)
- Shore mine, Table Mtn. (S, P)
- Union mine (P)

Colusa County
- next to the Clyde mine (C)

El Dorado County
- Brust mine, Kelset dist. (C)
- Cedarberg mine (H)
- Davis mine (C)
- Garden Valley mine (C)
- Lukens Gold mine (C)
- Mameluke Hill mine (P)
- Mayflower mine (C)
- Stuckslager mine (C)
- Dry Gulch mine (C)
- Grit mine (C, M)

Inyo County
- Ida mine (M)

Madera County
- Gambetta mine (C)

Mariposa County
- Colorado Quartz mine (P)
- Diltz mine, Whitlock dist. (P)
- French mine (P)
- Hasloc mine (C)
- Mariposa Commercial and Mining Company mine (C)
- Martin & Walling mine (C)
- Princeton mine (H, M)

Nevada County
- Alcalde mine (C)
- Cadmus mine (C)
- Christmas Hill mine (C)
- Empire mine (H)
- Gold-Quartz mining Co. (C)
- Granite Hill vein (M)
- North Hill vein (M)
- Helvetia mine (M)
- Idaho-Maryland mine (C, H, P)
- Lafayette mine (M)
- Massachusetts lode (S)
- North Star mine (C, H, P)
- Pennsylvania mine (M)
- Red Ledge mine (C, S, H, L, P)
- Snow Summit mine (C)

Placer County
- Forest Hill mine (S, H, P)
- George Slide mine (P)
- Irish Creek mine (M)
- Michigan Bluffs dist. (P)

Plumas County
- Diadem Quartz mine (P)
- Independence mine (P)

Shasta County
- Banghart mine (P)
- Mammoth mine (P)
- Yankee John mine (C)

Sierra County
- Alaska mine (S, P)
- Four Hills mine (C)
- Iron Side mine (C)
- Oriental mine (L, P)
- Pride mine (C)
- Queen mine (P)
- Rainbow mine (C)
- Secret Canyon mine (P)
- Sierra mine (P, L, S, H)
- 16 to 1 mine (P)

Siskiyou County
- Burton mine (C)
- EDM mine (C)
- Flying Cloud mine (P)
- Happy Camp mine (C)
- Homestake mine (C)
- Independence mine (C)
- Quartz Valley mine (M)

Trinity County
- Bonanza mine (facing page)

Tuolumne County
- Alameda mine (C)
- Black Oak mine (C)
- Bonanza mine (C)
- Golden Rule mine (C, M, P)
- Harper Brothers or Eureka mine (S, P)
- Hidden Treasure mine (P)
- John Neale's mine (C)
- Lazar mine (C)
- Nigger Hill mine (C)

C – California Division of Mines and Geology Collection
H – Harvard Collection
L – Natural History Museum of Los Angeles County Collection
M – *Minerals of California*
P – Private Collection
S – Smithsonian Institution Collection

the French mine, have also produced some crystallized gold.

With the exception of the Colorato Quartz mine, there are few mines in the Mother Lode that have produced fine specimens in recent years. The number of deposits in the Mother Lode is staggering and it is virtually impossible for anyone to document specimens (if any were found) at each of the mines. Table 1 gives a list, by county, of some of the mines in the Mother Lode that have yielded crystallized gold.

ACKNOWLEDGMENTS

The gold crystal drawings from Tuolumne County are from Goldschmidt (1918) and were drawn by Dana in 1886. The other gold sketches are by Wendell Wilson.

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NOTE

For the past 12 years or so I have been gathering information on California gold mines and photographing specimens of gold from each location, with the purpose of eventually publishing a relatively complete directory of California crystallized gold occurrences. I would appreciate any such information that readers can offer, and would also be happy to share any of my own information on the subject.

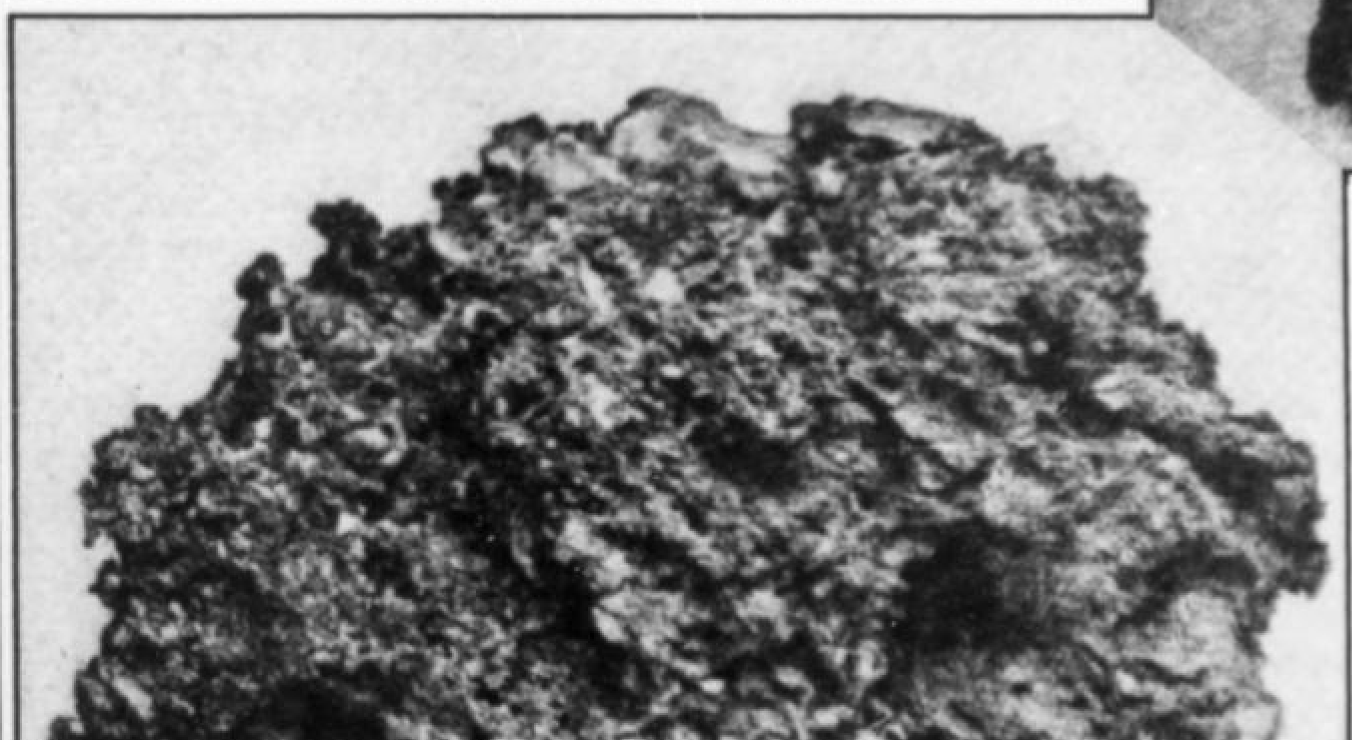
Remarkable Gold Specimens

(Reprinted from *The Mineral Collector,* May 1908, vol. 15, no. 3, p. 46; courtesy of Ron Bentley)

Our frontispiece this month represents two very remarkable gold specimens. The picture gives actual size of same. The largest weights 25 ounces and the other 14½ ounces. Very little matrix is attached and the gold is 95 per cent fine. Both are finely crystallized and the matrix is milky quartz. They are the finest specimens of native gold ever found in this country.

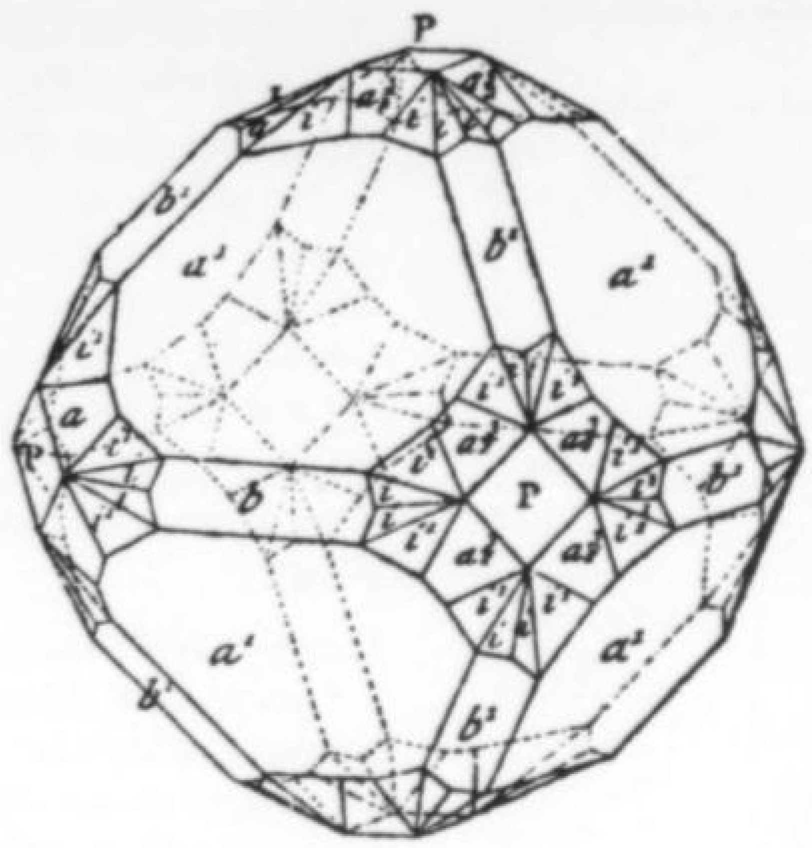
The history of their discovery is very interesting. They come from the Bonanza Mine, Trinity County, California. When they were sinking one of their perpendicular shafts they came in contact with a large mass of rock sticking out on one side, and instead of blasting this away, allowed it to protrude a little into the shaft. This in time proved a great annoyance and the engineer of the lift running up and down the shaft decided to try and get rid of it, so one day he took a sledge and chisel, and with the aid of one of the workmen, started to break it away.

He had not worked long when, to his astonishment, a large piece broke off and fell at his feet, and the sight that met his eyes made his head swim, as he had broken into a pocket that afterwards produced native gold to the amount of $55,000.



He immediately informed his boss, and the company was communicated with in regard to this wonderful pocket. Orders came to shut down the mine and the officers took the matter of removing the gold into their own hands. Shareholders and prominent mining men flocked from all over the country to see this remarkable pocket. The gold was later removed and the two specimens shown are the finest of the immense quantity of native gold taken from this pocket.

These specimens, together with another weighing 21 ounces, can be seen at the showrooms of Mr. A. H. Petereit.



the Gold-Containing Minerals: a Review

by **Wendell E. Wilson**
The Mineralogical Record
P.O. Box 35565
Tucson, Arizona 85740

Of the various gold-containing minerals, native gold, nagyagite, krennerite, petzite, calaverite and sylvanite are known to collectors as well-crystallized specimens. However, there are at least 14 other gold species, ten of which have been described as new minerals since 1950.

INTRODUCTION

The 20 species which contain gold as an essential constituent comprise an interesting group. Among the species, five of the six crystal systems are represented, and several of the minerals form complex crystals. All are metallic, soft ($H \leq 3$), heavy (density 5.6–19.3), and most are gray to white or yellow to brownish. Less than half show a cleavage, though that characteristic is as yet undetermined for seven of the species.

Gold, of course, occurs uncombined. But it also forms minerals in combination with 12 other elements, all of which are metals or semimetals except for sulfur. More than half of the known species contain tellurium. In addition, gold occurs as a non-essential constituent of a number of other species, making auriferous varieties.

Half of the gold-containing minerals have been described as new species since 1950; these include all of those *not* containing tellurium, except for maldonite and native gold. The mineralogy of a number of recently described species is poorly understood and awaits further work along with several potentially new gold minerals.

GOLD AND ITS VARIETIES

Gold (Au)

Knowledge of gold extends far back into prehistory. Its many names include *sol* (alchemical), *aurum* (Latin), *or* (French), *oro* (Spanish and Italian), *goud* (Danish), *gull* (Norwegian), and *guld* (Swedish). The name *gold* is probably of early Anglo-Saxon origin.

Gold crystals are most commonly of octahedral form, though seven other forms are known to occur individually or in combination, and an additional dozen or so are very rare or unconfirmed. Crystals are only rarely well-formed; more typically they are distorted, flattened or elongated in some way to yield branching aggregates and reticulated, dendritic, arborescent or filiform groups. Collectors generally divide gold specimens into six habit groups: (1) *crystal gold* (having relatively well-formed crystals), (2) *leaf gold* (flat sheets), (3) *wire gold* (curving wires), (4) *arborescent gold* (branching moss-like or tree-like groups), (5) *sponge gold,* and (6) *nugget gold.* These habits tend to grade into one another. For example, it is not uncommon for fine leaf gold to be rimmed or sprinkled with sharp, small crystals.

Though a common mineral widely distributed in all igneous rocks, significant concentrations of gold are more or less limited to veins of hydrothermal or related origin, and to placer deposits derived from these. Most vein gold is associated with quartz and pyrite, but a wide variety of other associations is known.

Small occurrences of gold are extremely numerous and widespread. A comprehensive listing would be beyond the scope of this paper. See the other articles in this issue for more locality informa-

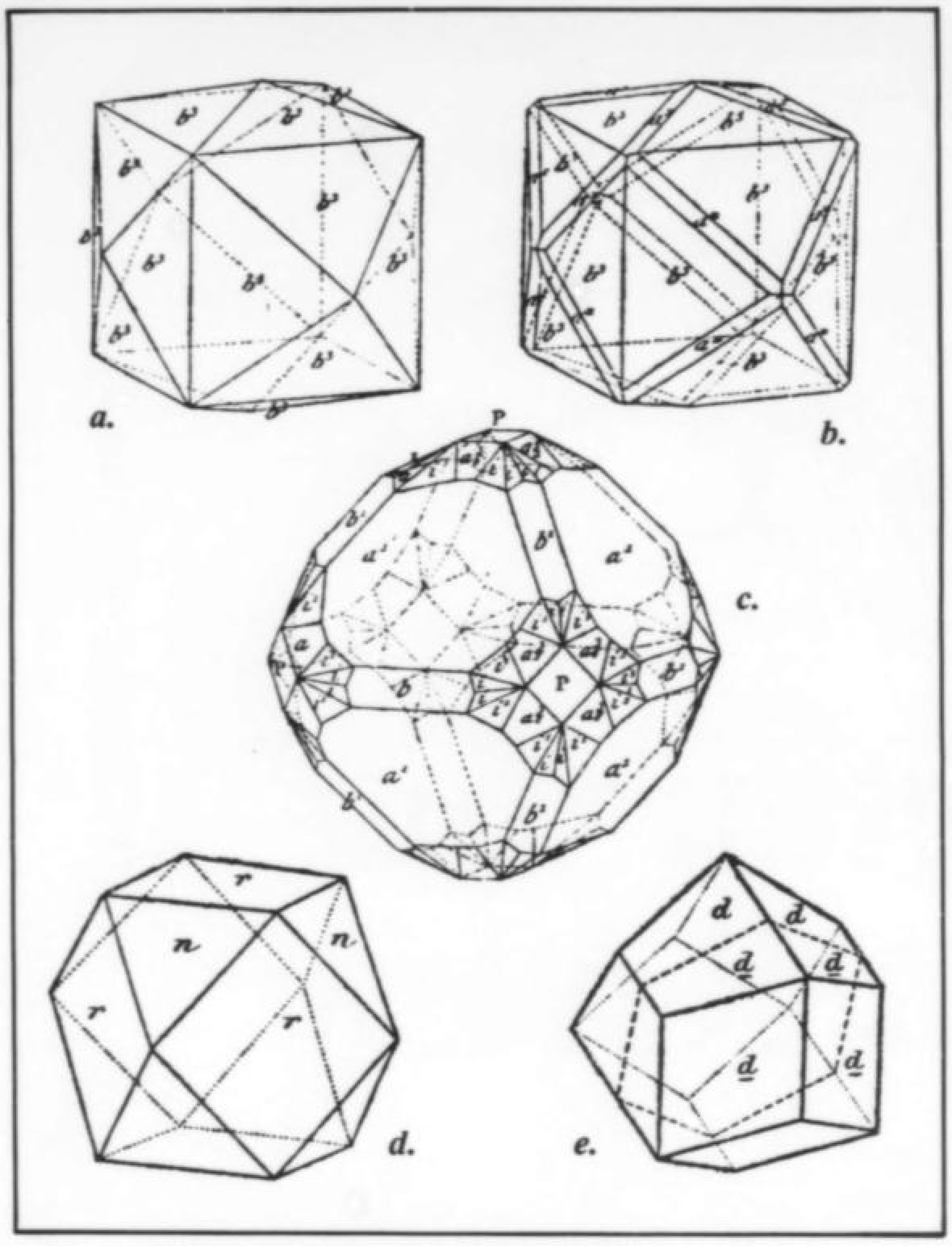


Figure 1. **Gold crystals from Brazil; a., b. Goias province; c., e. unspecified; d. Mato Grosso state. (Goldschmidt, 1918)**

tion, or consult some of the standard references.

Unless referenced, all information here and in the sections that follow (except the "Availability" section) was taken from Palache *et al.* (1944), Roberts *et al.* (1974) or Hey (1955). See these works for additional references. The best recent summary of information on gold, and the most comprehensive bibliography, are contained in the review by Boyle (1979).

Compositions here are given in weight percent unless otherwise noted.

Varieties of Gold

Argentiferous Gold (Au,Ag)

Most native gold contains some silver, ordinarily 5 to 15 percent. Sponge gold from Kalgoorlie, Australia, is among the purest and lowest in silver (99.91 percent Au). The term *argentiferous gold* should be reserved for specimens containing from 1 to 20 percent silver (see *electrum*). A complete series exists from pure gold to pure silver.

Aurobismuthinite $(Bi,Au,Ag_2)_5S_6$

Aurobismuthinite was reported in 1912 as lead-gray, massive, cleavable material from an unknown locality, containing 12.27 percent gold and 2.32 percent silver. Embrey and Fuller (1980) suggest that it may instead be a mixture of argentiferous gold and bismuthinite (Bi_2S_3).

Argentocuproaurite (Au,Cu,Ag,Rh,Pd)

Argentocuproaurite was described by Razin (1975) as a new mineral but relegated to cuprian argentiferous gold by Cabri (1977). It contains only small amounts, if any, of rhodium and palladium. Found as minute grains at the Talnakh copper deposit and at the nearby Noril'sk copper deposit, Soviet Union.

Argentiferous Gold-Amalgam (Au,Ag,Hg)

Samples of gold-amalgam from Colombia and Borneo have been shown to contain about 5 percent silver. The Colombian material is very malleable, whereas the Borneo specimens are brittle.

Bismuthian Gold (Au,Bi)

Though the reported solubility of bismuth in gold is less than 0.2 atomic percent in the artificial system, gold containing nearly 3 percent Bi was reported from the Schilowoissetsky mine, west of Kamenskij Zavod, Soviet Union. (Not to be confused with the mineral maldonite, Au_2Bi, containing 34.5 percent Bi.)

Cuprian Electrum (Au,Ag,Cu)

An analysis of electrum from West Africa yielded 4.27 percent copper.

Cuprian Gold (Au,Cu)

Cuprian gold is known from Borneo (containing over 5 percent copper) and from Mt. Karabasch in the Urals (over 20 percent copper); the Urals material, reported in 1914, is near the composition of the recently described tetraauricupride (ideally containing 24.4 weight percent copper). A copper-bearing gold has also been reported in association with the recently described gold-copper telluride bogdanovite (Spiridonov and Chvileva, 1979a).

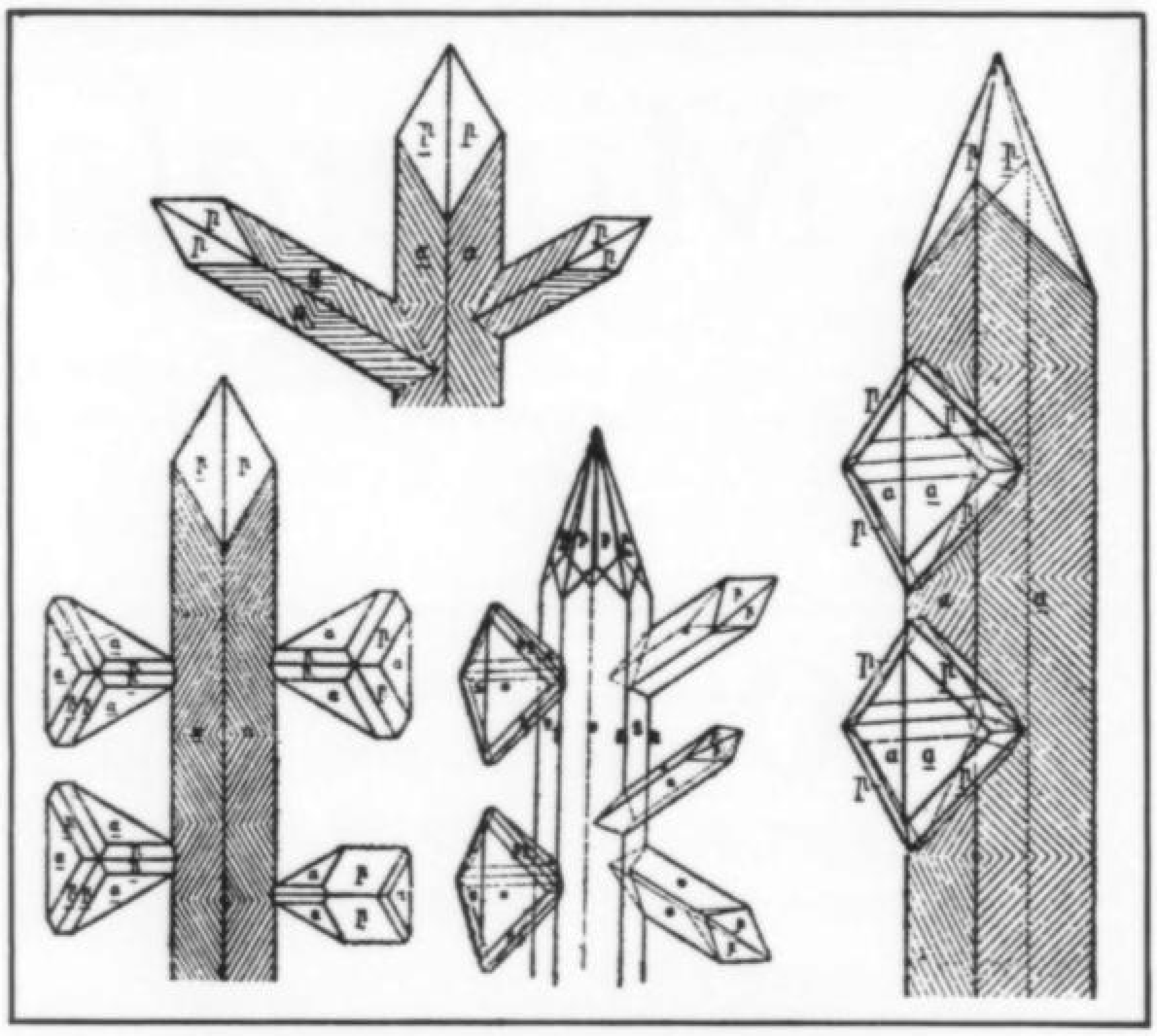


Figure 2. **Gold crystals from the Zdraholt mine, Barza, Hunedoara County, Romania. (Goldschmidt, 1918)**

Electrum (Au,Ag)

Nearly 2000 years ago it was suggested by Pliny that electrum should be defined as containing 20 percent silver; in practice today the range used is 20 to 50 percent silver. (Beyond 50 percent the mineral is auriferous silver.)

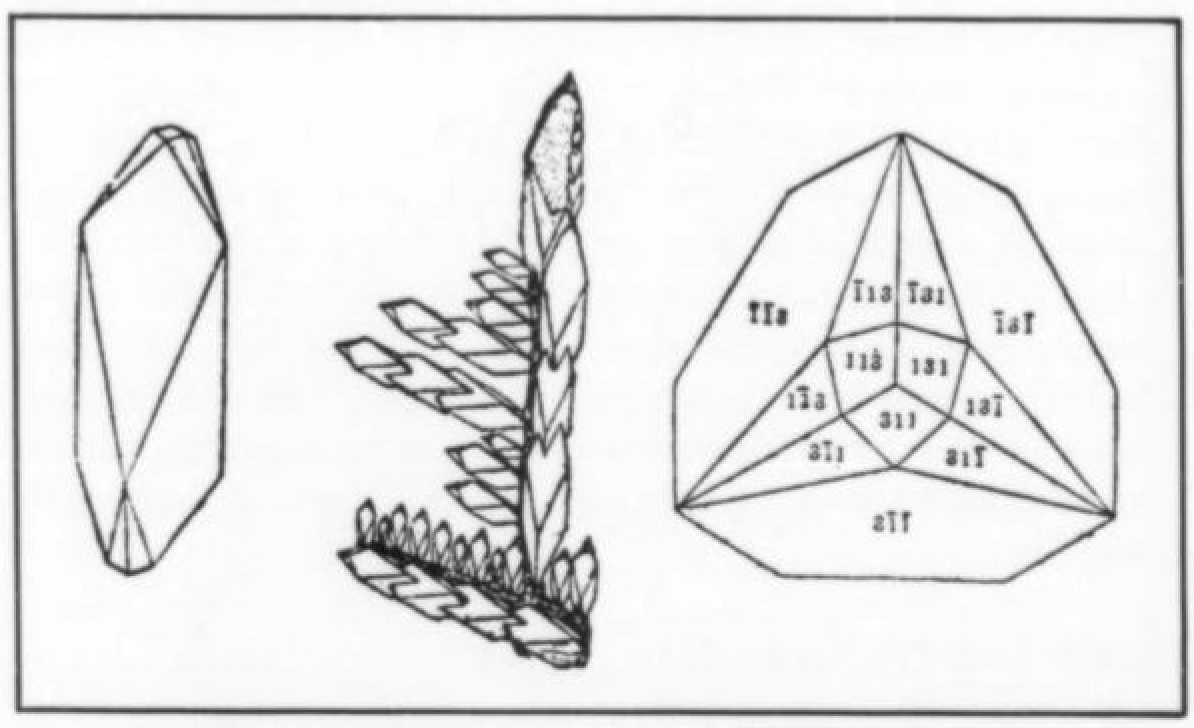


Figure 3. **Gold crystals from Oregon. (Goldschmidt, 1918)**

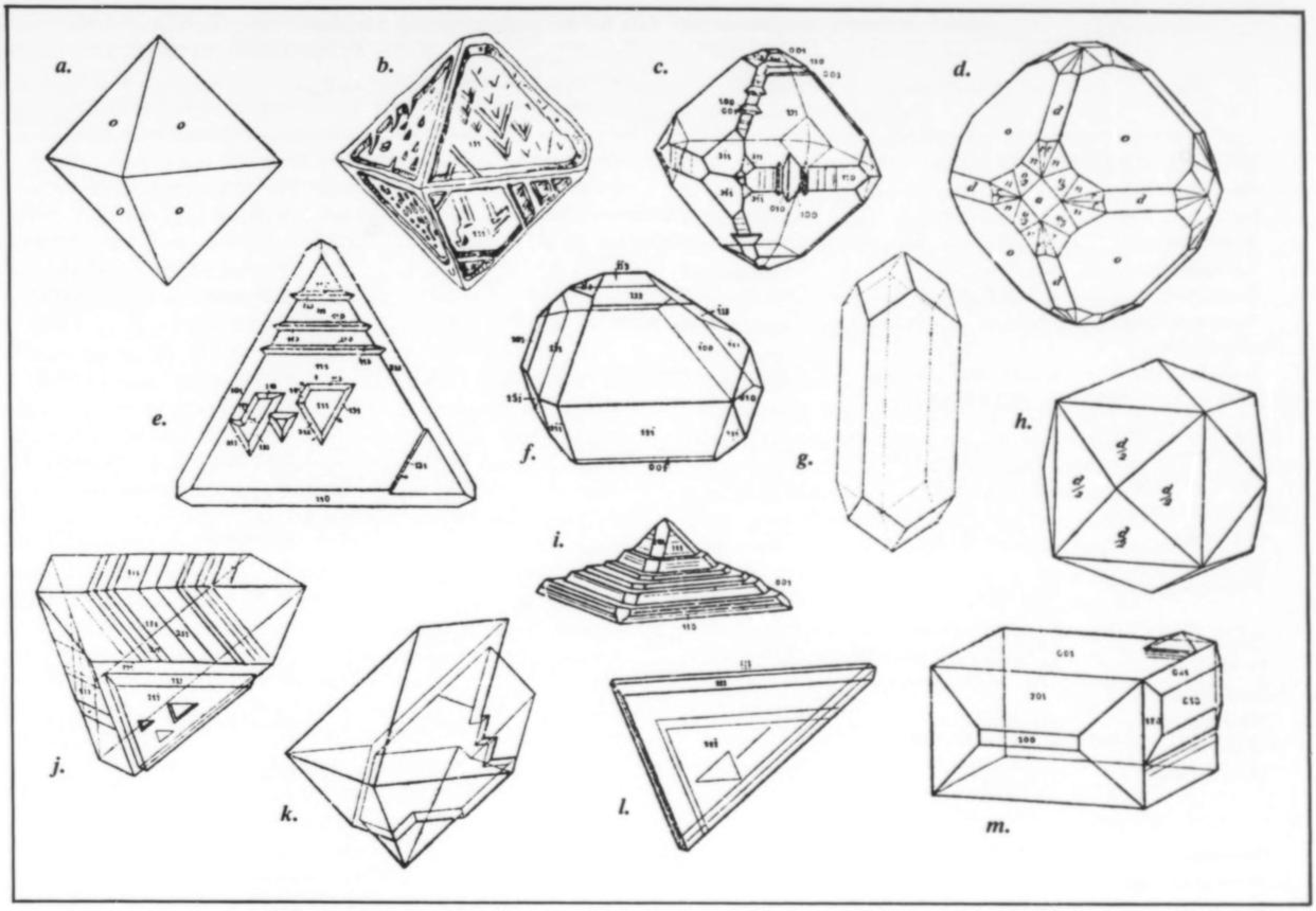


Figure 4. **Gold crystals from the central Ural Mountains, Soviet Union; a. Nizhniy Tagil, northwest of Sverdlovsk; b., c., e., f., i., j., l., m. Sysert, south of Sverdlovsk; d. Berezovskij, northeast of Sverdlovsk; g. Blagodatj Mountain, north of Sverdlovsk; h. Sverdlovsk (formerly Katharinenburg). (Goldschmidt, 1918)**

Gold-Amalgam (Au_2Hg_3?)

Some analyses correspond well with the above formula, suggesting that gold-amalgam may be a true species, the gold analog of moschellandsbergite (Ag_2Hg_3). However, other analyses have shown a range of compositions indicating a continuous series. Gold-amalgam occurs as metallic lumps of white or yellowish color, and is also known as a single, fine gray crystal in the Harvard collection.

Iridic Gold (Au,Ir)

Gold has been reported containing up to 30 percent iridium (compare auriferous osmiridium).

Platinum Gold (Au,Pt)

Gold containing up to 10 percent platinum has been reported, though gold and platinum are not completely miscible in the solid state.

Palladian Gold (Au,Pd) ("Porpezite")

A variety of gold from Porpez, Brazil, was reported in 1904 as containing 10 percent palladium; also from Jacutinga and Condonga, Brazil, carrying 5 to 6 percent Pd, and from Taquaril (sic), Minas Gerais, Brazil, containing 8.21 percent Pd. The town of Ouro Preto ("black gold"), Brazil, was named after the black palladian gold found abundantly nearby. Cabri and LaFlamme (1974) reported gold from the Stillwater Complex, Montana, containing up to 7.3 percent palladium. A complete Au-Pd series exists in the artificial system.

Rhodian Gold (Au,Rh) ("Rhodite")

Some gold specimens from Colombia and Mexico are reported to contain 34 to 43 percent rhodium. This is doubtful in view of experimental studies indicating that rhodium has a maximum solubility of 4.1 atomic percent in gold.

Others

Other elements reported in analyses of gold, always in amounts less than 1 percent, include Al, As, B, Ba, Be, Ca, Cd, Co, Cr, Fe, Ga, Ge, In, K, Li, Mg, Mn, Mo, Na, Ni, Pb, Sb, Sc, Se, Si, Sn, Sr, Te, Th, Ti, U, V, W, Zn, Zr and rare earth elements (Boyle, 1979).

SPECIES CONTAINING GOLD

Maldonite Au_2Bi

Maldonite is known only as massive, granular material and as thin coatings. It occurs in greisen-like zones or veins in granite, in association with scheelite and apatite.

Found at Nuggety Reef, Maldon, Victoria, Australia, and also at the nearby Eagle Hawk mine, Union Reef.

Named for the locality.

Auricupride Cu_3Au (syn. with Cuproauride)

Copper and gold form a continuous solid solution series in the synthetic system, but only above 410° C. Below that temperature solid state reactions occur resulting in miscibility gaps between phases centered around the compositions Cu_3Au, CuAu, and

Table 1. **Summary of mineralogical data for the gold-containing minerals.**

Name	Composition	System	Space Group	Mohs Hardness[1]	Density	Cleavage[2]	Color	Year Described
NATIVE ELEMENTS AND ALLOYS								
Gold Group								
Gold	Au	Cubic	*Fm3m*	2½-3	19.31	n	Yellow	?
Maldonite	Au_2Bi	Cubic	*Fd3m*	1½-2	15.70	{100}	white	1870
Auricupride	Cu_3Au_2	Cubic	?	3½	11.5	?	reddish yellow	1939
Rozhkovite	$(Cu,Pd)_3Au_2$	Orth.?	*Pmmm*	3½-4	14.37	1?	pale rose	1971
Tetraauricupride	CuAu	Tet.	*C4/mmm*	1.6	14.67	?	copper-red	1982
Platinum Group								
Zvyagintsevite	$(Pd,Pt,Au)_3(Pb,Sn)$	Cubic	*Pm3m*	4½	13.41	?	white	1966
SULFIDES, TELLURIDES, SELENIDES								
Algodonite Group								
Bogdanovite	$Au_5(Cu,Fe)_3(Te,Pb)_2$	Orth.	?	~4½	14.2	?	brownish	1979
Bessmertnovite	$Au_4Cu(Te,Pb)$	Orth.	?	5	16.3	?	?	1979
Dyscrasite Group								
Bilibinskite	$Au_3Cu_2PbTe_2$	Cubic?	?	5	?	n	brownish	1978
Argentite Group								
Uytenbogaardtite	Ag_3AuS_2	Tet.	$P4_122$ or $P4_1$	2	8.45	?	white	1978
Fischesserite	Ag_3AuSe_2	Cubic	*I432*	2	9.05	n	white	1971
Petzite	Ag_3AuTe_2	Cubic	$I4_132$	2½-3	8.74	{001}?	gray	1845
Galena Group								
Muthmannite	(Ag,Au)Te	Orth.?	?	2½	5.60	1	white-yellow	1911
Stibnite Group								
Montbrayite	$(Au,Sb)_2Te_3$	Tric.	$P\bar{1}$	2½	9.94	$\{1\bar{1}0\}$ $\{0\bar{1}1\}$ {111}	white-yellow	1945
Nagyagite	$Pb_5Au(Te,Sb)_4S_{5-8}$	Tet.?	$P\bar{4}$	1-1½	7.55	$\{0\bar{1}0\}$	gray	1845
Krennerite Group								
Aurostibite	$AuSb_2$	Cubic	*Pa3*	3	9.91	n	gray	1952
Krennerite	$(Au,Ag)Te_2$	Orth.	*Pma2*	2-3	8.86	{001}	white	1877
Calaverite	$AuTe_2$	Mon.	*C2/m or C2*	2½-3	9.31	n	white-yellow	1868
Sylvanite	$AgAuTe_4$	Mon.	*P2/C*	1½-2	8.17	{010}	white	1785
Kostovite	$CuAuTe_4$	Mon.	?	2-2½	?	1	gray-white	1961

[1] Hardness values originally given as Vickers hardness have been converted to Moh's hardness using the formula: $H_m = 0.7 \sqrt[3]{H_v}$.
[2] n = no cleavage observed, 1 = one cleavage observed.

$CuAu_3$ (Hansen and Anderko, 1958). This is reflected in nature. The material originally described by Lozhechkin (1939) as cuproauride, Cu_3Au_2, from the Karabash deposit, Soimon Valley, Urals, was probably closer in composition to Cu_3Au-Cu_5Au; so the ideal composition for auricupride is now considered to be Cu_3Au (Ramdohr, 1969). It is known from a number of other localities including hydrothermal veins in Victoria, Australia; the Kerr Addison mine in Ontario; Tankavaara, Finland; Mooihoek, Transvaal; and Insizwa, Japan (Ramdohr, 1969).

Ramdohr and Strunz (1978) mention four different "auricuprides" having the compositions Cu_3Au (Karabash), $CuAu_3$ (Victoria, Australia), tetrahedral CuAu (since described as the new mineral tetraauricupride), and Pd-bearing orthorhombic CuAu from the Talnakh deposit, Soviet Union (rozhkovite). Of these, only $CuAu_3$ remains to be described as a distinct species. A mineral approaching this composition ($CuAu_{2.6}$) was partially described by Oen and Kieft (1974) but not named. Novgorodova and Tsepin (1976) noted phases from Karabash having the compositions Cu_3Au (auricupride), CuAu, and $CuAu_4$.

Named for the composition.

Rozhkovite $(Cu,Pd)_3Au_2$ *or* (Au,Pd)Cu

Rozhkovite was first described as a new mineral, *palladian cuproauride,* $(Cu,Pd)_3Au_2$, by Razin *et al.* (1971). It was then later referred to as *rozhkovite* (Razin, 1975) with a footnote that the name was considered and recommended by the International Mineralogical Association in 1970, prior to the first description as palladian cuproauride. Unfortunately, comparisons to synthetic Cu_3Au_2 (non-existent) were in error and, depending upon how the other elements Pd, Rh, Ni, Bi and Ag are grouped, the analysis could be recalculated to give an ideal formula of (Au,Pd)Cu (Cabri, 1977), which, incidentally, is the formula approved by the IMA in 1970, and is more in keeping with the synthetic system. There also seems to be some doubt as to whether the mineral is orthorhombic or tetragonal. Single-crystal X-ray studies are needed to describe this species more completely.

Rozhkovite occurs in sulfide ores of the Talnakh copper deposit in the Soviet Union. These ores consist primarily of talnakhite, chalcopyrite and cubanite. It is commonly intergrown with gold alloys, native gold, zvyagintsevite, polarite, ferroplatinum, galena, sphalerite and sperrylite, and forms irregular grains up to 0.45 mm.

Named for professor I. S. Rozhkov, a Soviet researcher of gold and platinum deposits.

Tetraauricupride CuAu

Tetraauricupride was described recently (Keqiao *et al.*, 1982) as a new mineral from a platinum-bearing ultrabasic stock at Sardala, Manas County, Xinjiang autonomous region, China. It is associated with gold, silver, platinum group minerals, chalcopyrite, pyrite and pyrrhotite. Ramdohr and Strunz (1978) reported tetragonal CuAu from a hortonolite dunite in South Africa.

A comparison with rozhkovite shows dissimilarities in color (pale rose for rozhkovite, copper-red with a yellow tint for tetraauricupride), hardness (VHN_{20} of 205 vs. 294) and spectral reflectives. However, the X-ray data of rozhkovite and tetraauricupride are very similar.

Named for its structure and composition.

Zvyagintsevite $(Pd,Pt,Au)_3(Pb,Sn)$

Zvyagintsevite was independently described by Cabri and Traill (1966) and by Genkin *et al.* (1966). The composition varies from $(Pd,Au)_3Pb$ (Cabri) to $(Pd,Pt)_3(Pb,Sn)$ (Genkin). Consequently there appears to be doubt regarding which of the elements Au, Pt and Sn are essential, if any. Fleischer (1980a) gives the composite formula $(Pd,Pt,Au)_3(Pb,Sn)$, but perhaps the analyzed samples are all varieties of the composition Pd_3Pb. In any case, the material studied by Cabri and Traill contains 3.6 to 6.0 percent gold, and so the mineral is included here.

All samples, it appears, are from the Noril'sk group of deposits. These are mostly orebodies of the chalcopyrite-pentlandite-pyrrhotite type occurring on the western boundary of the Siberian plain. The material described by Cabri and Traill is found as minute, irregular grains and veinlets to 250 microns in size, intergrown with magnetite, chalcopyrite, auriferous silver, cubanite, valleriite and Pb(Bi,Pb) alloys. The material studied by Genkin *et al.* occurs with ferro-platinum and pentlandite as grains to 0.3 mm and as skeletal forms.

Named for Professor Orest Evgenevich Zvyagintsev, who did research on the geochemistry of the platinum minerals.

Bogdanovite $Au_5(Cu,Fe)_3(Te,Pb)_2$

Bogdanovite was described by Spiridonov and Chvileva (1979a) as a new intermetallide from Kazakhstan and the Soviet "Far East." It occurs only in the oxidized zone, and is associated with the gold minerals bessmertnovite and bilibinskite as well as native gold (including cuproan gold and plumbian-cuproan gold), sylvanite and krennerite. Varieties of bogdanovite rich in copper are associated with copper minerals, whereas those varieties rich in iron are associated with iron-containing supergene minerals. Individual grains of bogdanovite do not exceed 10 microns in size, although intergrowths and aggregates may reach 1 mm.

Named for Professor A. A. Bogdanov.

Bessmertnovite $Au_4Cu(Te,Pb)$

Bessmertnovite was described by Spiridonov and Chvileva (1979b) from the same occurrence as that for bogdanovite and bilibinskite (see above for associations), in the Soviet "Far East." The deposit, not named, is referred to as a volcanogenic gold-telluride deposit. Bessmertnovite occurs as elongated or irregular grains up to 0.05 mm in size.

Named for M. S. Bessmertnaya and V. V. Bessmertny, mineralogists and ore deposit researchers.

Bilibinskite $Au_3Cu_2PbTe_2$

Bilibinskite was described by Spiridonov *et al.* (1978) from the same deposits in Kazakhstan and the "Soviet Far East" as the gold minerals bogdanovite and bessmertnovite were described from the following year. The three minerals apparently occur in association, and only in the oxidized zone of the orebodies. Bilibinskite is the most abundant mineral of the ore suite, and commonly forms rims on native gold or replaces chalcopyrite, sylvanite and krennerite.

Named for Y. A. Bilibin, Soviet geologist.

Uytenbogaardtite Ag_3AuS_2

Uytenbogaardtite was described by Barton *et al.* (1978) as a new silver-gold sulfide from three different localities: the Comstock lode, Storey County, Nevada; Smeinogorski (Schlangenberg), Altai, Soviet Union; and Tambang Sawah, Benkoelen district, Sumatra. No information was given on the mineral's general appearance.

Named for Professor Willem Uytenbogaardt, ore microscopist and professor of geology at the Technical University of Delft, the Netherlands.

Liujinyinite $(Ag_3Au)S_2$

Liujinyinite was described by Zhen-jie *et al.* (1979) from three areas in China. At Guangdong it occurs in a migmatite as fissure-filling veinlets with pyrite and quartz, and as globular grains associated with electrum, galena and argentite in pyrite. At Anhui it occurs with electrum and pyrrhotite in a skarn-type disseminated copper deposit. And at Gansu it forms in close assocation with electrum in quartz-barite veins in a massive chalcopyrite-pyrite-tetrahedrite-galena deposit. Some samples are copper-bearing, from 1.2 to 4.8 percent, while others are copper-free. The mineral is fine-grained, in grains less than 2 mm in size.

The name is for the composition, in Chinese: *liu* = sulfur, *jin* = gold, *yin* = silver.

Fleischer (1980b) concluded from the data that the mineral is uytenbogaardtite. However, Mingxiu (1981) deduced from new X-ray powder data that uytenbogaardtite and liujinyinite are of different space groups, and are therefore polymorphs. Single-crystal data are needed to resolve the problem.

Fischesserite Ag_3AuSe_2

Fischesserite was the first known gold selenide when it was described by Johan *et al.* (1971). It is the selenium analog of petzite; the two are isostructural. Fischesserite occurs as xenomorphic grains in carbonate veins at Predborice, Bohemia, Czechoslovakia, and also in the Texas Gulf orebody, Timmins, Ontario (Boyle, 1979). Associations include naumannite (Ag_2Se), clausthalite (PbSe), hakite (a Cu-Hg-Ag-Sb selenide), permingeatite (Cu_3SbSe_4) and gold.

Named for Raymond Fischesser, director of the Ecole Natl. Superieure de Mines, Paris.

Petzite Ag_3AuTe_2

Petzite, the tellurium analog of fischesserite, occurs as massive material, finely granular to compact, and rarely as small crystals intergrown with hessite or gold. It occurs at a fairly large number of localities, generally in vein deposits with other tellurides, especially hessite. Localities include Botés and Nagyág (now Săcărâmb), Romania; on the Korogoch River, Transbaikalia; at the Hollinger mine, Timmins, Ontario; at Kalgoorlie, Western Australia; various mines in Colorado including those at Gold Hill and Sunshine; and at many locations in California including the Stanislaus and Melones mines in Calaveras County and the Golden Rule and other mines in Tuolumne County.

Named for W. Petz who first analyzed the mineral.

Antamokite

Antamokite was described in 1928 as a doubtful telluride of gold with some silver, from Antamok, Mountain Province, Philippines. It is probably identical with petzite.

Muthmannite (Ag,Au)Te

Muthmannite, described in 1911, occurs intimately associated

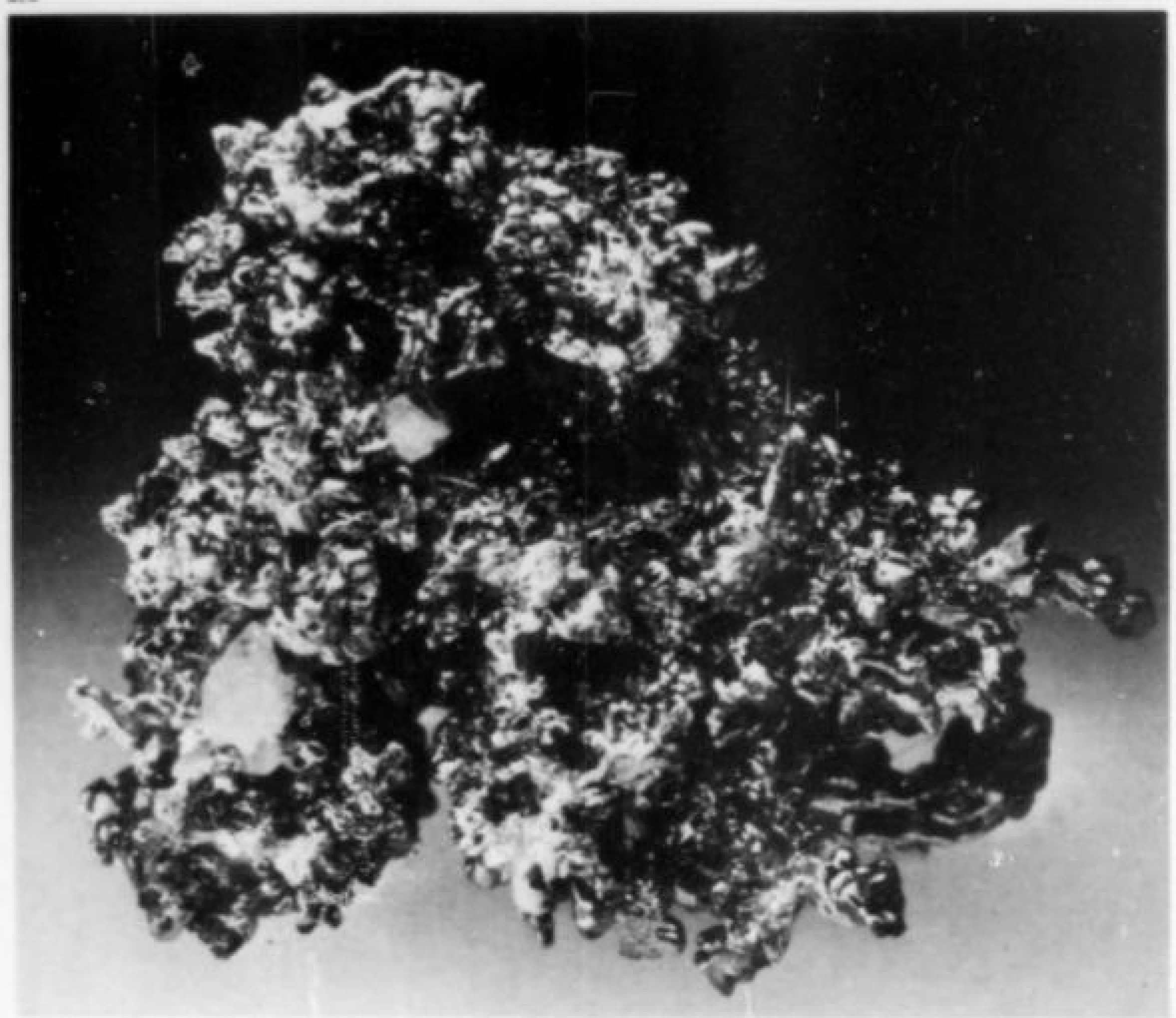


Figure 5. **Gold with gray petzite in a mutual intergrowth from Bald Mountain, near Sonoma, Tuolumne County, California. The specimen is 3 cm across; Harvard collection.**

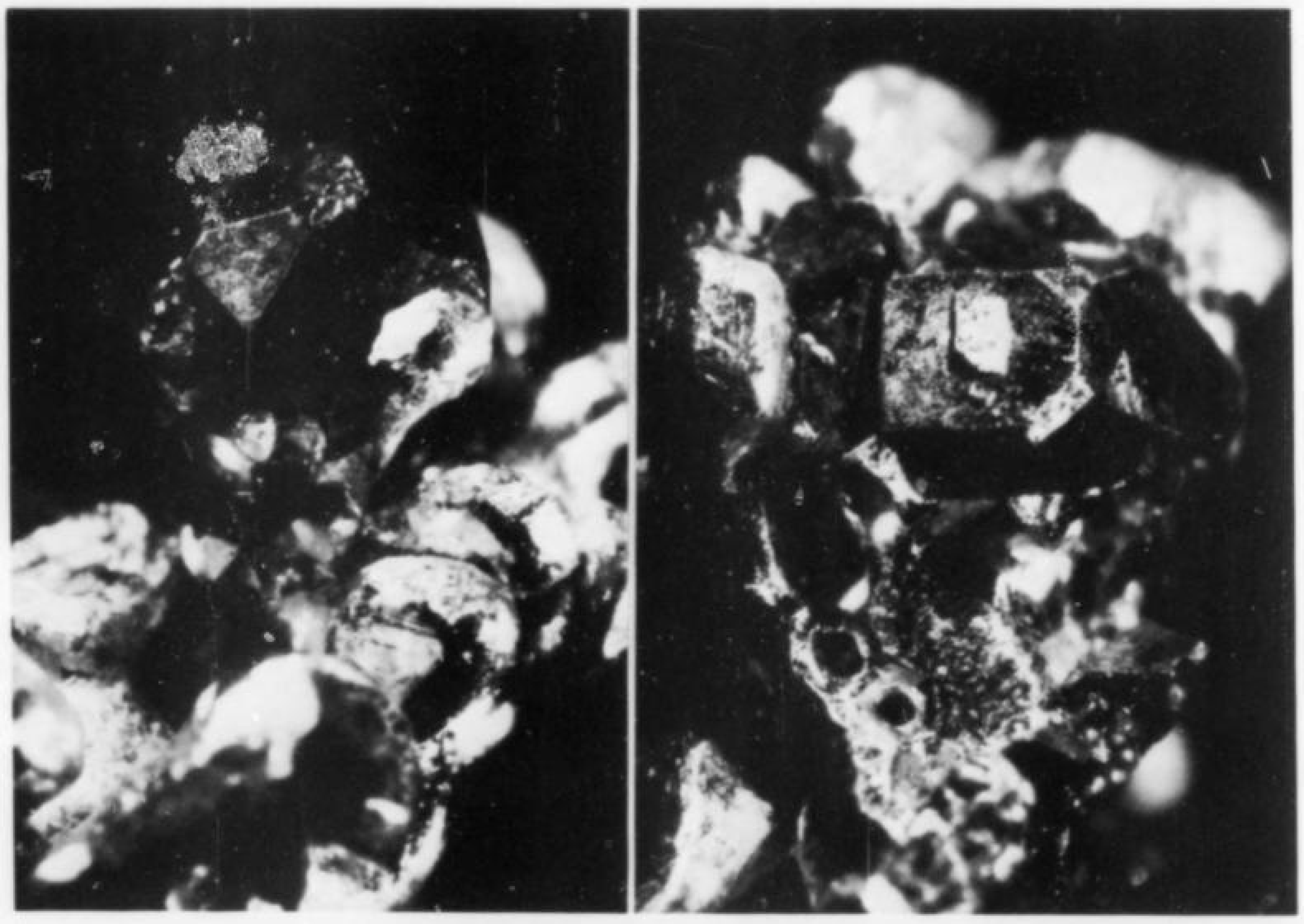


Figure 6. **Euhedral petzite crystals, very rare, from Bald Mountain, Tuolumne County, California. The crystals are about 1½ mm in size; specimen and photo: Julius Weber.**

with other tellurides, especially krennerite, at Nagyág, Transylvania, Romania. It forms tabular crystals elongated in one direction and having a good cleavage parallel to the zone of elongation. It has been suggested that muthmannite is actually an auriferous variety of empressite, AgTe.

Named for Dr. Wilhelm Muthmann, Professor of inorganic chemistry in the Technical High School of Munich.

Montbrayite $(Au,Sb)_2Te_3$ *or* Au_2Te_3

Montbrayite was first described by Peacock and Thompson (1945, 1946) as tin-white, triclinic, imbedded and interlocking crystals. This interesting occurrence consisted of a high-grade pocket or lens of almost solid gold tellurides measuring 1 x 2 meters and 2 to 5 cm in thickness, situated in a tension fracture at the Robb-Montbray mine, Montbray Township, Abitibi County, Quebec. Associations included coarse sponge and wire gold, tellurbismuth, altaite, petzite, melonite and sulfides. Masses of montbrayite exceeding 1 cm were noted.

Named for the locality.

Nagyagite $Pb_5Au(Te,Sb)_4S_{5-8}$

Nagyagite is widely known as thin, tabular crystals with striated faces, and also as granular, massive material. Crystals are foliated and flexible, and commonly bent. It occurs in hydrothermal vein deposits with gold, tellurides and carbonates. Pseudomorphs of chalcopyrite, bournonite and galena after nagyagite have been described.

Localities include the famous deposits at Nagyág and Offenbánya (now Baia de Arieş), Transylvania (where it occurs with proustite, altaite, arsenic and gold); Kalgoorlie, Western Australia; the Sylvia mine, Tararu Creek, New Zealand; the Tavua gold field on Viti Levu, Fiji Islands; the Rendaizi mine, Idu, Japan; Gold Hill in Boulder County, Colorado; the Huronian mine in Ontario; at many locations in California including mines in Trinity, Calaveras, and Shasta Counties; and the Kings Mountain mine, Gaston County, North Carolina.

Named for the type locality.

Aurostibite $AuSb_2$

Aurostibite, described by Graham and Kaiman (1951, 1952), is isostructural with pyrite. At the Chesterville mine, Larder Lake, Ontario, it occurs as minute grains with gold and freibergite in quartz. The occurrence at the Giant Yellowknife mine in Northwest Territories, Canada, is somewhat more interesting: "Among the

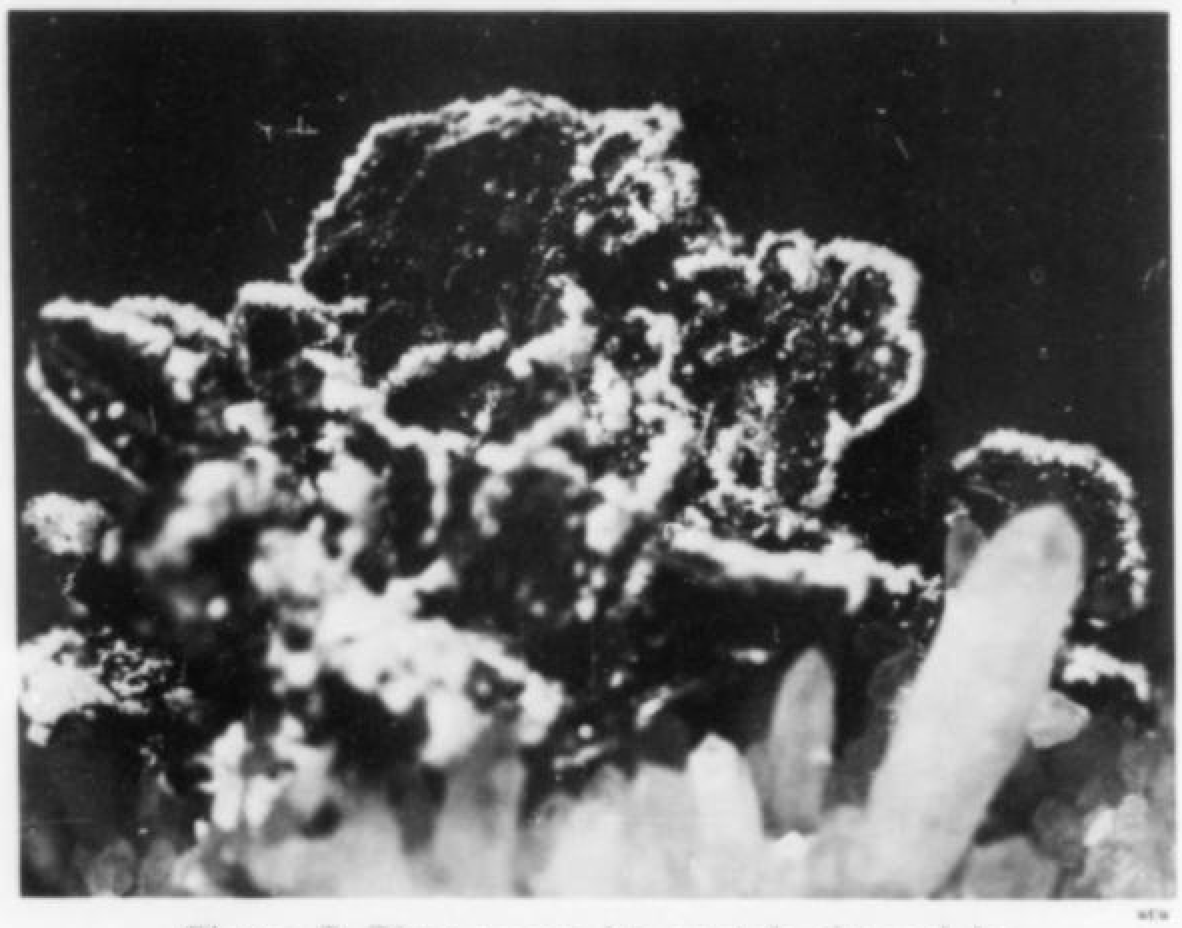


Figure 7. **Platy nagyagite crystals rimmed by white calcite, on quartz, from Nagyág (Sacărâmb), Transylvania, Romania. The specimen is 5.4 cm across. Philip Gregory collection.**

Figure 8. **Tabular nagyagite crystal about 1 mm in size, on quartz, from Nagyág, Romania. Specimen and photo: Julius Weber.**

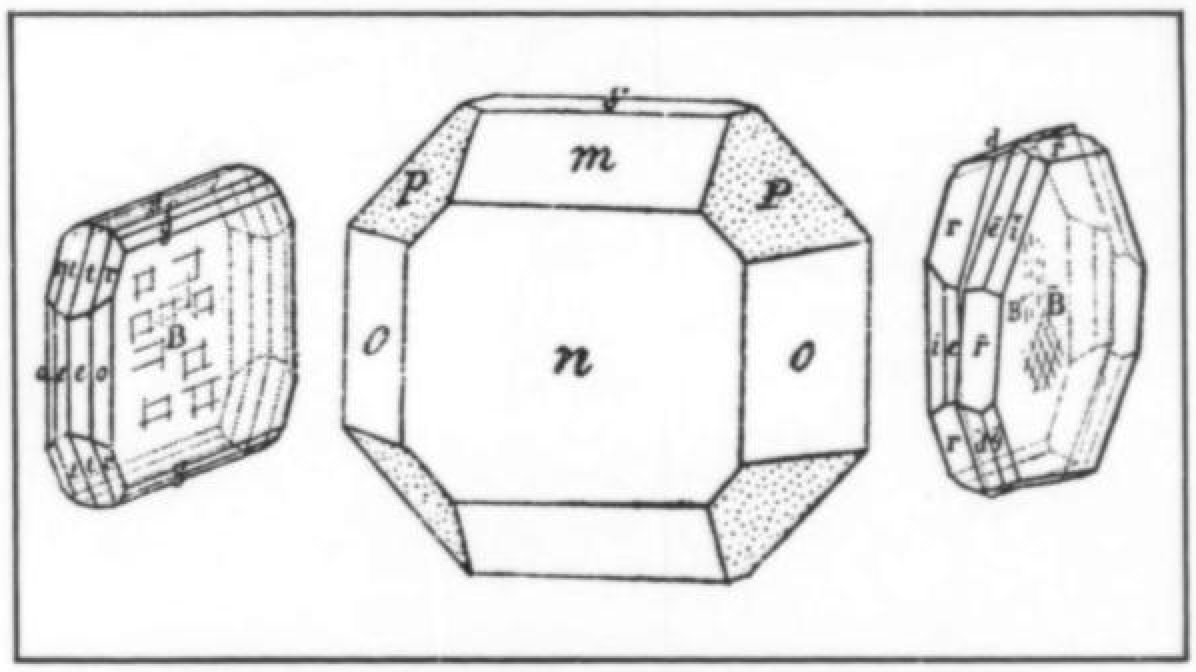


Figure 9. **Nagyagite crystals from Nagyág, Romania. (Goldschmidt, 1920)**

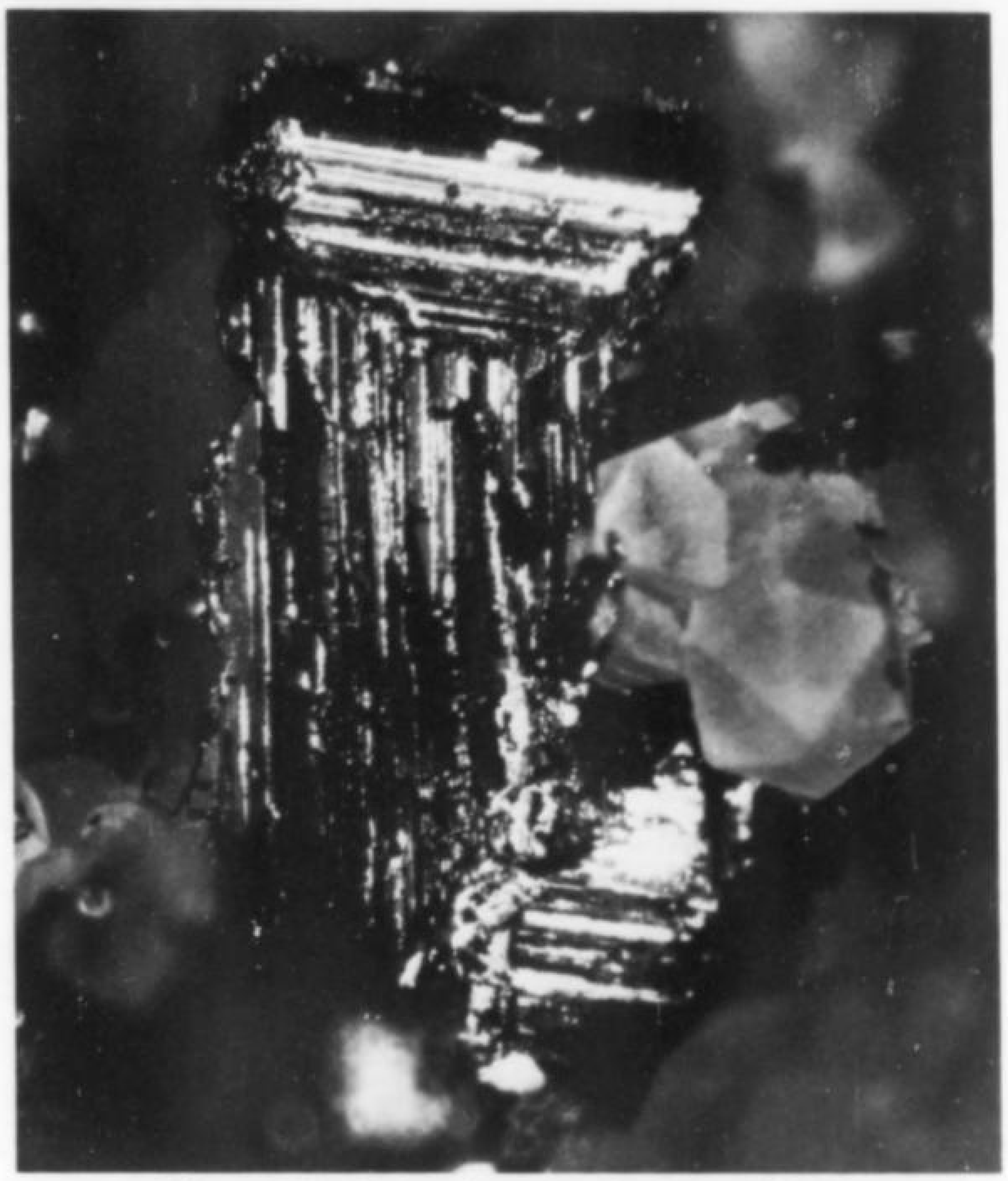


Figure 10. **Krennerite crystals from Cripple Creek, Colorado, measuring about ¾ mm. Specimen and photo: Julius Weber.**

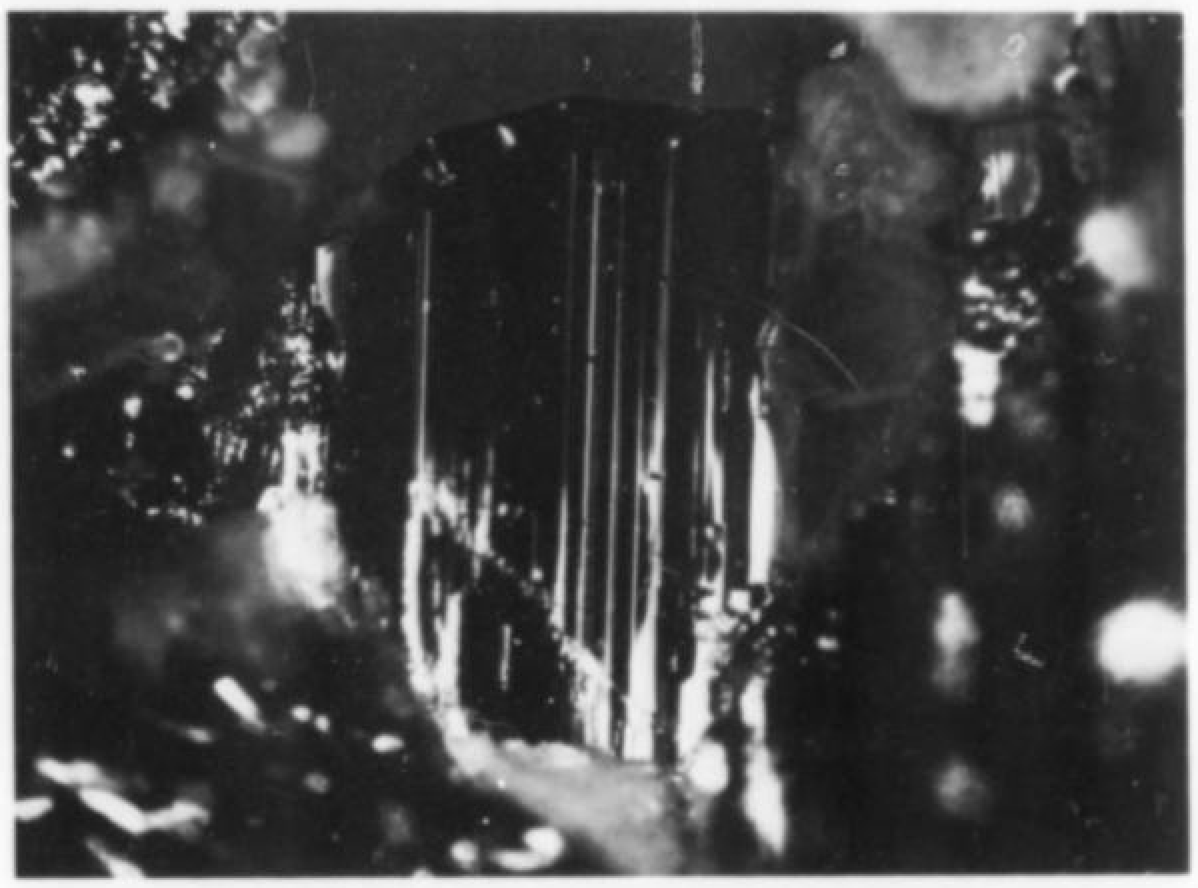


Figure 11. **Krennerite crystal about ¾ mm in size, from Cripple Creek, Colorado. Specimen and photo: Julius Weber.**

carbonate crystals in these vugs, scattered grains of hacky gold . . . to 1 or 2 mm occur accompanied by rounded iridescently tarnished separate grains of aurostibite up to 350 microns. . . . Certain of the gold grains appear to be thinly coated with tarnished, gray aurostibite," (Graham and Kaiman, 1952). Boyle (1979) reports additional occurrences at Krasna Hora and Milesov, Czechoslovakia; in the antimony veins of Costerfield, Victoria, Australia; at the Lone Hand and Jessie gold mines, Gwanda district, Rhodesia; at the Indarama gold-antimony mine, Sebakwe area, Que Que, Rhodesia; and in the Bestyube goldfield, northern Kazakhstan, Soviet Union.

Named for the composition.

Krennerite $(Au,Ag)Te_2$

Krennerite, described in 1877 and refined by Cabri (1965), occurs in fine crystals which are typically short, prismatic and striated. Dozens of forms are known. Krennerite is most commonly found in low-temperature veins, but has also been noted near the low-temperature limit of moderate and high-temperature veins. It is rarer than sylvanite and calaverite (see below) but occurs in the same type of environment, sometimes also in association with other tellurides. Silver commonly substitutes for some gold in the composition.

Localities include several mines in the Cripple Creek district, Teller County, Colorado; the Rouyn district, Montbray Township, Quebec; Nagyág, Transylvania, Romania; and at Kalgoorlie and Mulgabbie, Western Australia.

Named in honor of Joseph A. Krenner, Hungarian mineralogist (1839–1920).

Calaverite $AuTe_2$

Calaverite occurs in approximately the same environment as krennerite, as fine lath-like to bladed crystals and slender, striated prisms. It is also found as massive to granular material. Associations include gold, tellurides and various sulfides and sulfosalts.

Many localities have produced calaverite, including: Kalgoorlie and Mulgabbie, Western Australia; Antamok, Mountain Province, Philippines; various mines in Calaveras, El Dorado, Tuolumne and Siskiyou Counties, California; Costilla, La Plata, Montezuma, Boulder, Hinsdale and Teller (at Cripple Creek) Counties in Colorado; at the Kirkland Lake and Boston Creek areas of Ontario; and at other localities in Mexico, El Salvador, Romania and the Soviet Union.

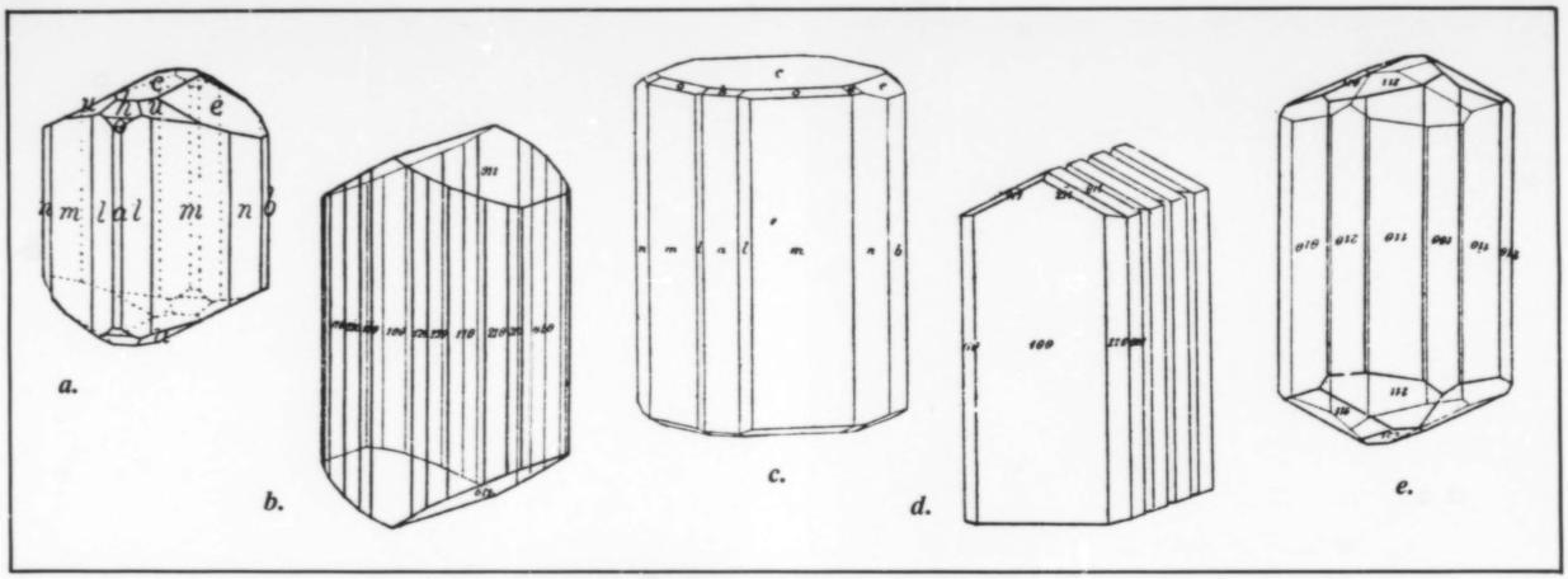


Figure 12. **Krennerite crystals; a. Cripple Creek, Colorado; b.-e. Nagyág, Romania. (Goldschmidt, 1918)**

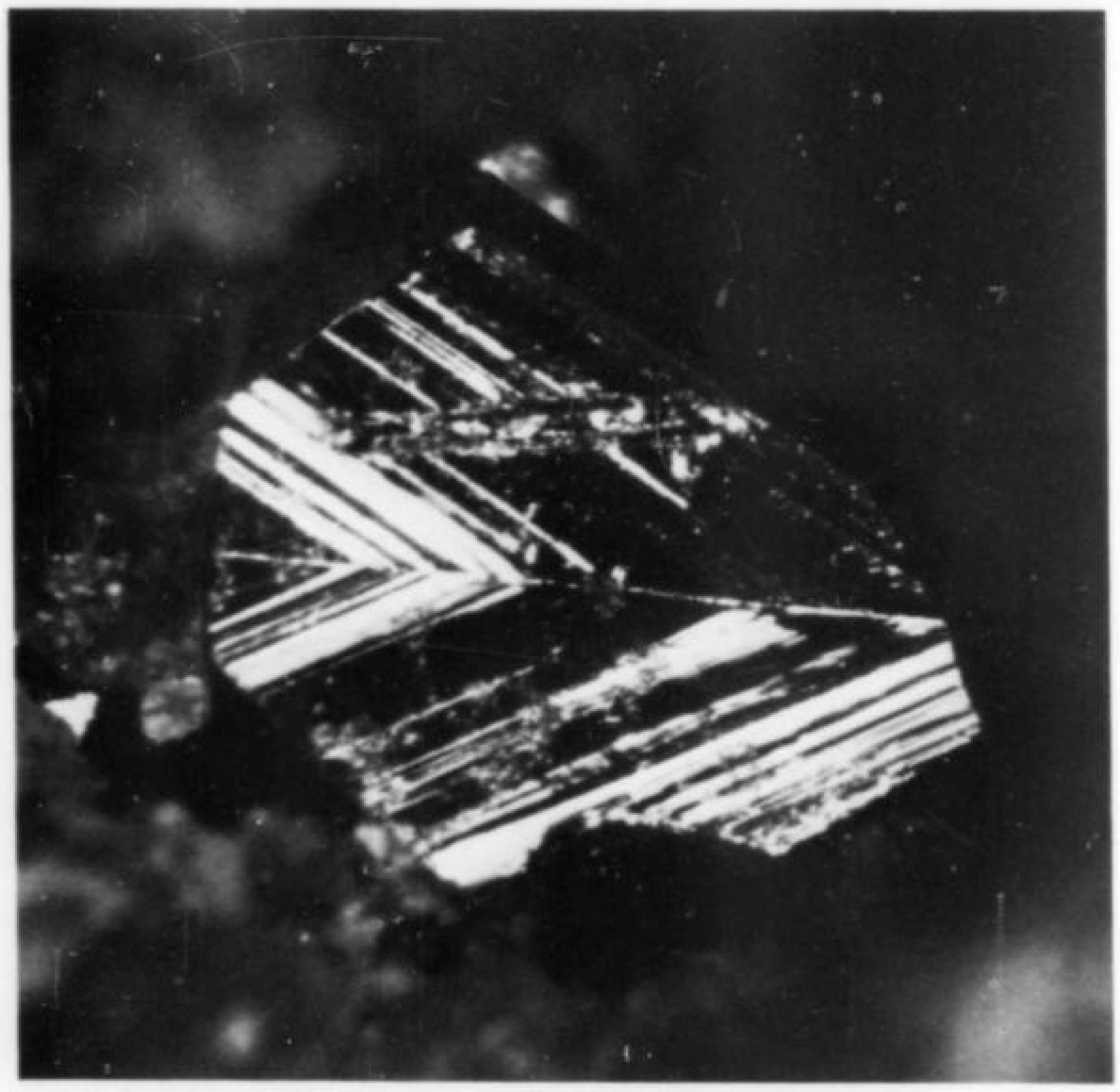


Figure 13. **Calaverite twinned crystal about ½ mm in size, from Cripple Creek, Colorado. Specimen and photo: Julius Weber.**

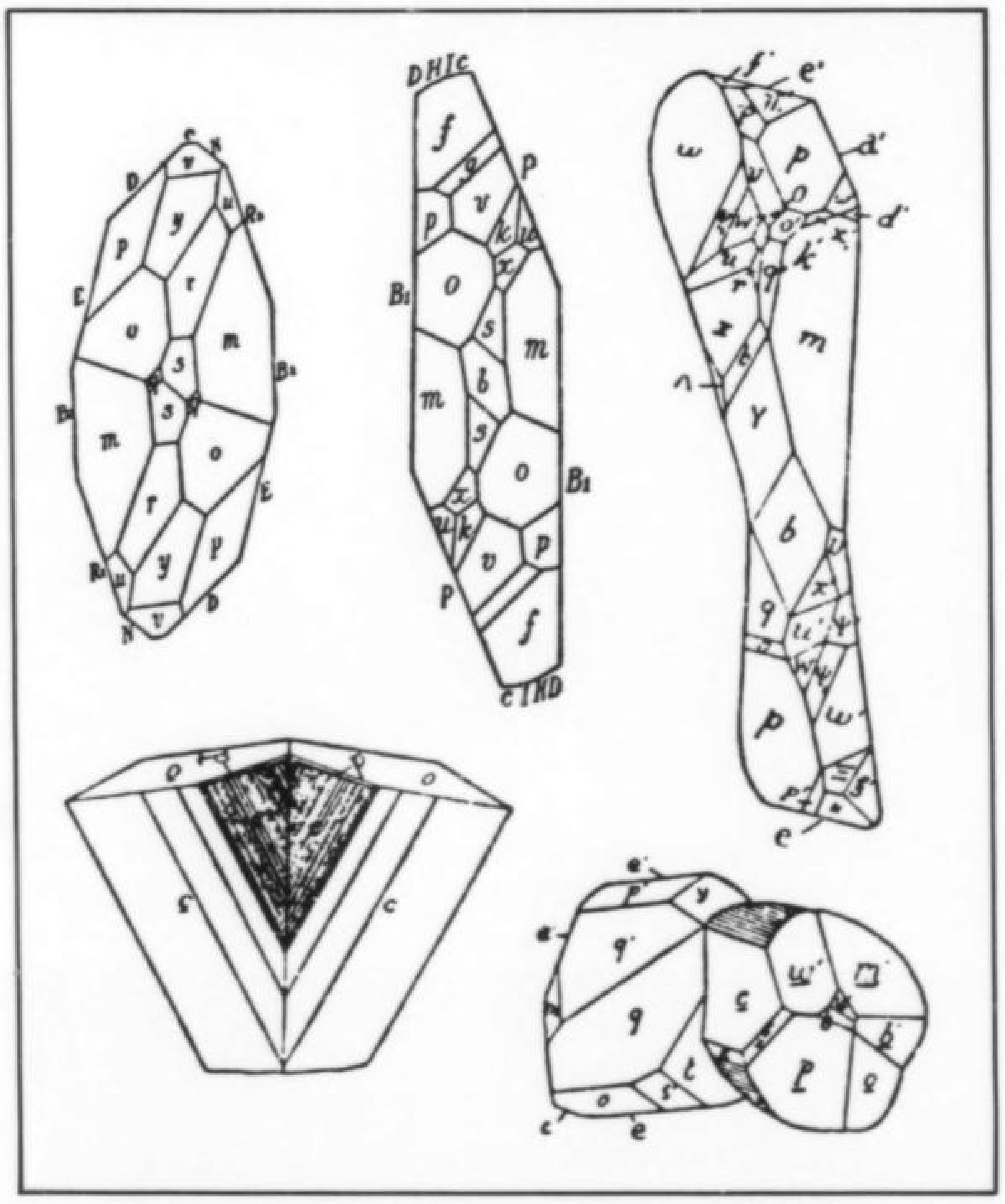


Figure 14. **Calaverite crystals from Cripple Creek, Colorado. (Goldschmidt, 1913)**

Named for the locality, the Stanislaus mine in Calaveras County, California.

Sylvanite $AgAuTe_4$

Sylvanite is also well-known in fine crystals of varied habit, usually thick tabular or short prismatic, but also bladed, columnar, skeletal and granular. Nearly 70 crystal forms are known. Sylvanite occurs in much the same environment as krennerite and calaverite, with which it is found; other associations include altaite and other tellurides.

Localities include Nagyág and Offenbánya in Transylvania, Romania; Koolgardie and Mulgabbie in Western Australia; Calaveras, Trinity, Yuba, Tuolumne and Siskiyou Counties in California; Cripple Creek and other areas in Colorado; the Cornucopia district and other areas in Oregon; the Woods and Dome mine, Porcupine, Ontario; and also at locations in Idaho, Montana, South Dakota and the Soviet Union.

Sylvanite has a long history of names, beginning in 1785 when it was called *weissgolderz* ("white gold ore"). It has also been called *or blanc d'Offenbánya* ("white gold of Offenbánya," 1790). *aurum graphicum* ("graphic gold," 1790), *schrifterz* ("writing-ore," 1798), *graphic tellurium* (1815), *sylvane* (1832), and finally sylvanite in 1835. Named for Transylvania, and also for sylvanium, an early name for tellurium.

Kostovite $AuCuTe_4$

Kostovite, the copper analog of sylvanite, was described by Terziev (1966) from the copper ores of Chelopech, Bulgaria. It forms mutual intergrowths with native tellurium, as small, polygonal grains to 0.05 mm in size. Other associations include gold, other tellurides, tennantite and chalcopyrite.

Named for Ivan Kostov, Bulgarian mineralogist.

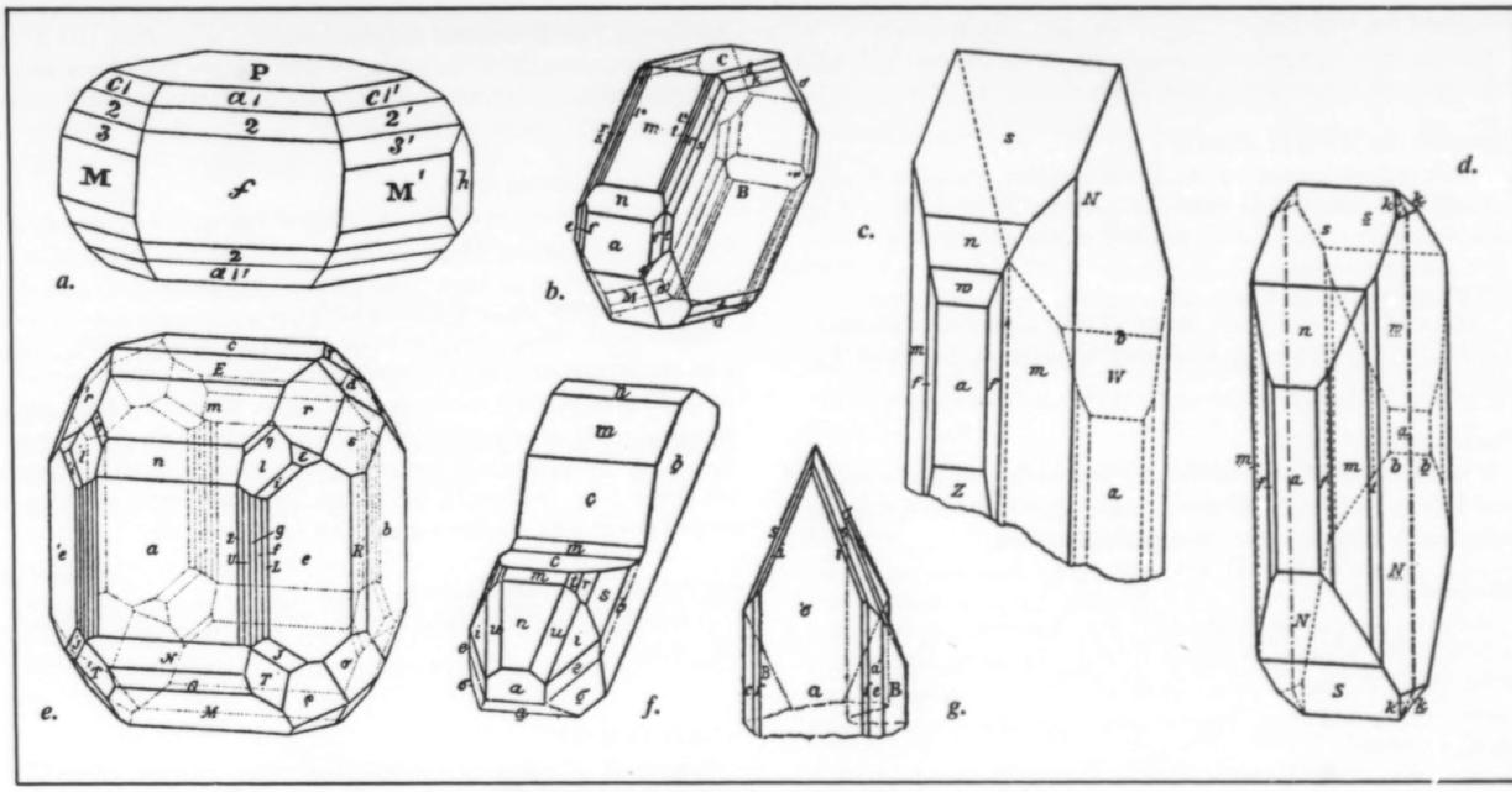


Figure 15. **Sylvanite crystals; a., b., g. Offenbánya (Baia de Arieş), Romania; c., d., f. Cripple Creek, Colorado; e. Nagyág, Romania. (Goldschmidt, 1922)**

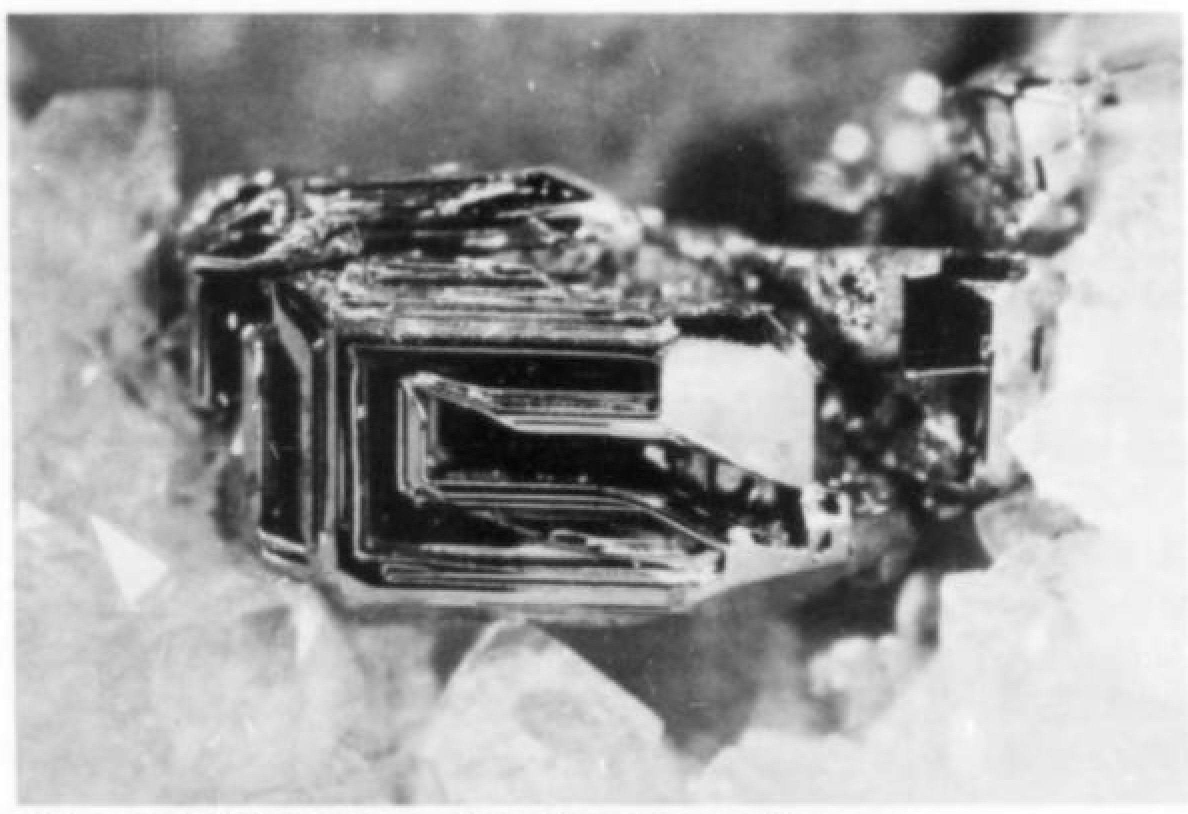


Figure 16. **Sylvanite crystal, about 6 mm, from Romania. Collection of the Mining Institute, University of Heidelberg; Olaf Medenbach photo.**

Figure 17. **Sylvanite crystals to 2 mm in size, on quartz from Nagyág, Romania. Werner Lieber photo.**

INCOMPLETELY DESCRIBED SPECIES

Aurobismuthinite $(Bi,Au,Ag_2)_5S_6$

Described in 1912 as a lead-gray, massive, cleavable mineral from an unknown locality. Embrey and Fuller (1980) suggest that it may be a mixture.

Bismuthaurite Au-Bi mineral

An unconfirmed bismuth-gold mineral was reported from Rutherford County, North Carolina in 1857. It may be maldonite.

Unnamed $Ag_{12}AuAsSe_3S_5$?

Occurs intergrown with electrum and rarely aguilarite at the Broken Hills gold mine, Hikuai, Coromandel, New Zealand (Moore, 1979).

Unnamed $Ag_{9.53}Au_{0.36}As_{1.38}Se_{1.0}S_{6.03}$?

Occurs as beaded or tabular grains at the Broken Hills gold mine, Hikuai, Coromandel, New Zealand (Moore, 1979).

Unnamed $Ag_8AuAsSeS_6$?

Occurs as pinkish-red, porous material at the Broken Hills gold mine, Hikuai, Coromandel, New Zealand (Moore, 1979).

Unnamed Au-Bi-Pb-Te mineral

A new mineral containing the above elements, found in Boulder County, Colorado, in the 1940's, is currently under study at Harvard University (Carl Francis, personal communication).

Unnamed Au_7Cu_2PbTe

Mentioned by Spiridonov *et al.* (1978) as a phase found in association with bilibinskite and other tellurides in the Soviet "Far East" and Kazakhstan.

Unnamed $AuTeO_4$ (?)

A "gold tellurate" was reported by Watanabe (1952) as a supergene mineral from the Daté mine, Hokkaido, Japan, derived by the oxidation of gold tellurides. Needs confirmation.

Unnamed $CuAu_3$

Material having approximately this composition has been reported from Victoria, Australia ($CuAu_3$, Ramdohr and Strunz, 1978); the Karabash deposit, Urals ($CuAu_4$, Novgorodova and Tsepin, 1976); and from Beni-Bousera, Morocco ($CuAu_{2.6}$, Oen and Kieft, 1974).

AURIFEROUS VARIETIES

A number of species in which gold is not an essential constituent have been reported as gold-containing varieties. Trace amounts of gold occur in many more minerals than those listed here (see Boyle, 1979), but the amount is generally far less than 1 percent and not sufficient to grant varietal status.

Auriferous Copper (Cu,Au)

Aurocuproite $Cu_{54}Au_{38}Pd_8$ and $Cu_{53}Au_{39}Pd_8$

Two grains having these compositions were described by Razin (1975) from the Talnakh copper deposit, Noril'sk, Soviet Union. The powder pattern of 8 lines was indexed as cubic, except for the weakest reflection at 1.070 Å; consequently Cabri (1977) prefers to await single-crystal work which might explain the weak reflection before accepting the mineral as a new species, calling it instead an auroan palladian copper. The above formulas can be recalculated to yield $(Cu,Pd)_{3.26}Au_2$ and $(Cu,Pd)_{3.12}Au_2$, close to the ideal rozhkovite composition of $(Cu,Pd)_3Au_2$. If the structure of aurocuproite is confirmed, it might be considered the cubic polymorph of the orthorhombic rozhkovite. This is also close to the cubic Cu_3Au_2 originally described by Lozhechkin (1939) as cuproauride.

Auriferous Gersdorffite (Ni,Au)AsS? ("Sommarugaite")

An auriferous gersdorffite was reported from Rezbánya (now Băiţa), Hungary in 1878.

Auriferous Hessite $(Ag,Au)_2Te$

It is suspected that a series exists between hessite (Ag_2Te) and petzite (Ag_3AuTe_2). A sample from Botés, Romania, contains 4.73 percent gold and a sample from the Red Cloud mine, Boulder County, Colorado, contains 13.09 percent gold. These equal Ag:Au atom ratios of 23:1 and 7:1 respectively, approaching the petzite ratio of 3:1. The crystals from Botés are highly modified.

Auriferous Osmiridium (Ir,Os,Au) ("Aurosmiridium")

Aurosmiridium was described in 1934 as the face-centered cubic phase of the osmiridium system, which is a solid solution series of gold, osmium and iridium. The brittle, silver-white material was found among the platinum residues of the Ural Mountains, U.S.S.R.

Auriferous Palladoarsenide $(Pd,Ag,Au)_2As$

Begizov *et al.* (1974) described the new mineral palladoarsenide from the Oktyabr deposit in the Talnakh field, noting that it contains 1.0 to 1.8 percent gold.

Auriferous Platinum (Pt,Au)

Boyle (1979) mentioned platinum containing up to 3 percent gold from a number of localities.

Auriferous Silver (Ag,Au) ("Küstelite")

Silver nearly always contains some gold, and the two metals form a continuous series. The term *auriferous silver* covers material with 10 to 50 percent gold; *electrum* covers 50 to 80 percent gold; and *argentian gold* covers material containing from 1 to 20 percent silver. The name *küstelite* was originally applied to material from the Ophir mine, in Nevada, which was found as silver-white bean-shaped grains with a specific gravity of 11.32 to 13.10.

Auriferous Tellurium (Te,Au)

A sample from the Ballarat district, Colorado, contains 3.4 percent gold.

AVAILABILITY

Specimens of many of the gold-containing species, especially those recently described from thin-section and electron microprobe studies, are generally unavailable to collectors and most museums. However, the mineral market has provided a number of others over the years, some of which can still be obtained.

Gold

Gold is perhaps the most widely available mineral of the group. Increases in the value of bullion gold in the last few years have caused renewed activity in former gold mining regions, especially California. Dealers in that state have worked hard to convince miners and mine owners that fine gold specimens in their natural state are worth far more than their bullion value. Consequently, many superb specimens in all sizes have come on the market in recent years (see the article by Leicht in this issue).

Gold from Europe (see the article by Lieber in this issue) is only occasionally available, although sometimes in fine specimens such as the 5 x 8-cm group of leaf gold from Nagyág sold by *Minerals Unlimited* in 1970. The electrum variety of gold, from Verespatak (now Roşia Montana), Romania, was available for a while in the 1960's, following the dispersal of the Farenhorst collection by Scott Williams; specimens in matrix measuring up to 5 x 5 cm were available for less than $50. Old collections brought to the market will occasionally contain vials of small flakes of platinum-gold from Colombia; apparently mineral dealer A. E. Foote had a supply of this. Foote's 1909 catalog also lists palladian gold ("porpezite") at $5 per vial. The locality specialist today could probably find on the market gold and gold varieties from 30 or 40 different localities worldwide.

Petzite

Petzite has been available from time to time, as blebs and patches in gold or in rock matrix – rarely in crystals. In the late 1950's specimens were mined from the Mayflower mine in Madison County, Montana, and more recently from the Cash mine, Gold Hill, Colorado, both as rich masses in quartz. Specimens have turned up in an old collection, from the Nancy mine and from the Rex Hill area, both in Boulder County, Colorado, the latter consisting of very rich petzite with hessite in quartz. Very rich masses with hessite, calaverite and gold in quartz were found in the Last Chance mine, Cornucopia, Baker County, Oregon, and are still available. Other petzite specimens have occasionally surfaced from the Mother Lode area of California. Scott Williams remembers an old gentleman walking into his shop one day and presenting a cigar box containing several pounds of rich, cleavable, bright petzite in native gold. He had saved them from a mine he worked in the early 1900's, in northern Trinity County, California; the specimens were immediately sold to a museum.

Nagyagite

Most major old collections coming on the market will have at least one fine nagyagite from Nagyág Transylvania. Specimens are almost always well-crystallized, some with native gold or rhodochrosite. Crystals sometimes exceed 1½ cm.

Aurostibite

In the late 1950's, small masses of aurostibite in quartz matrix to 5 cm were collected at Krasna, Yugoslavia, and reached the American market. The find was limited to about 15 specimens.

Krennerite

Mines at Cripple Creek, Colorado, especially the Ajax mine, have produced krennerite specimens over the years. Some specimens have relatively well-formed microcrystals in vugs in a volcanic rock.

Calaverite

Calaverite has long been available, but only from the Cripple Creek district, Colorado. Fine specimens with crystals up to 1 cm scattered on quartz were once found but are now scarce, most of the better ones having been collected in the late 1950's. According to Scott Williams, "Quite a lot of the material from the Cripple Creek mines was roasted first to show the gold (formed by the breakdown of calaverite), as the miners had difficulty selling the calaverite. No gullible tourist would buy 'pyrite' for gold, and that's exactly what the ore looked like. But roasted, it showed gold. Many old collections have several roasted calaverites, and one wonders how many spectacular specimens were destroyed in this manner."

Massive calaverite from Kalgoorlie, Western Australia, has occasionally been found, and there was reported to be a fine specimen of calaverite from Carson Hill, Calaveras County, California, in Old Bacon Hall (no longer standing) at the University of California, Riverside.

Sylvanite

Most old collections also have sylvanite specimens, generally from Cripple Creek. However, material has come to the market from Nagyág, Transylvania (small crystals on quartz), Boulder, Colorado (coarse crystal sections in seams) and the Fiji Islands (similar to Colorado specimens, microcrystals in volcanic rock). Gold pseudomorphs after sylvanite prisms (then called "rusty gold") have been found, and some Cripple Creek sylvanite occurs as sharply terminated microcrystals in vugs with pale purple fluorite crystals.

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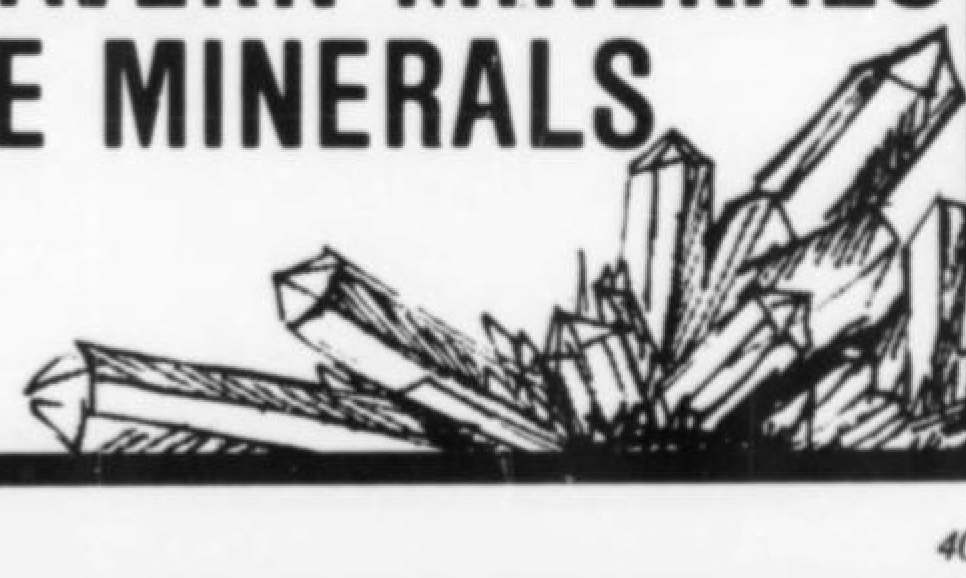

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