COLLECTION.
WELLS, FARGO AND
Received of

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Mineralogical Record Volume 18, number 1, January–February 1987

Gold!

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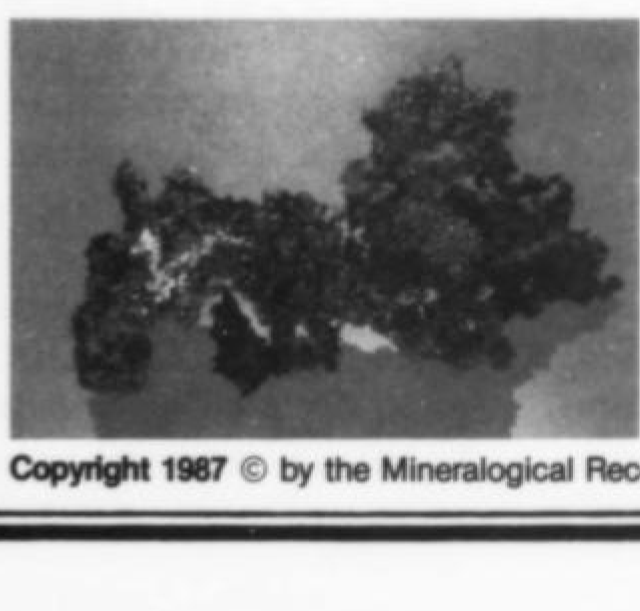
Recent Discoveries



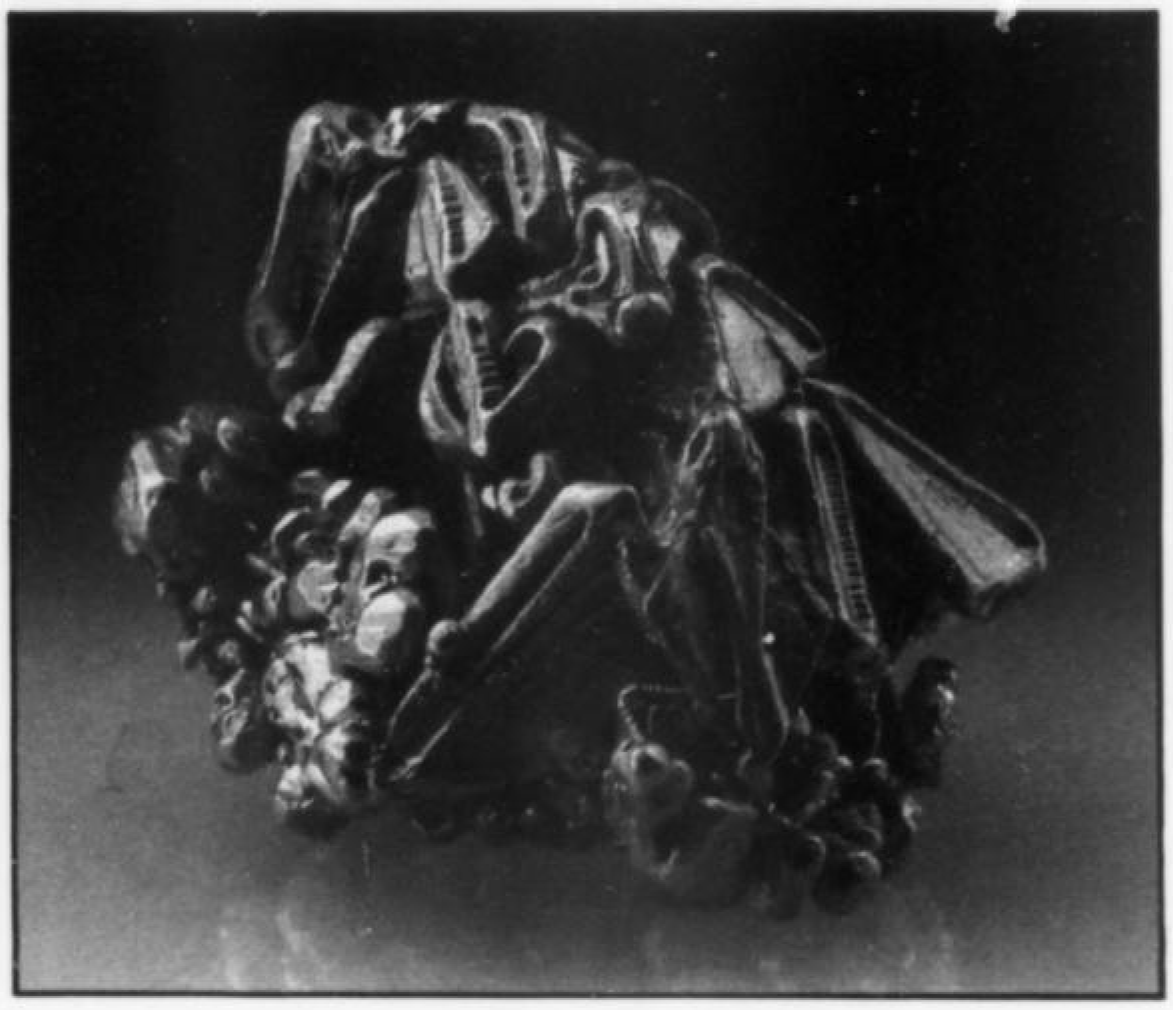
FRONT & BACK COVER: GOLD specimen known as the "Fricot Nugget," collected in 1865 at the Grit mine, El Dorado County, California, by Jules Fricot and donated to the California State mineral collection in his honor by his daughter Marie Fricot Berton in 1943. It measures 7 x 21 x 32 cm and weighs about 6 kg (13 pounds). Photo by James Patton. See the article on the California State collection beginning on page 81.

Gold Notes from the editor

COLLECTING GOLD

The very thought of collecting gold makes the blood warm up in one's veins. Most collectors, however, make the mistake of ruling it out as a specialty on the assumption that costs would undoubtedly be too high. The fact is that gold comes in all sizes and price ranges, and the budget need be no greater than for "ordinary" collecting. Of course, the actual price ceiling is somewhere out past the orbit of Neptune, but heavy prices are found on top-quality specimens of many different species these days, so what else is new? One must also be willing to make some concessions on size . . . pound for pound, gold specimens do cost more than calcite specimens. But size isn't everything. The important point is that gold is within almost everyone's reach.

Gold has some peculiar psychological effects working in its favor. There is something unutterably, inexpressibly special about the butter-yellow metal. Gold is easy to love. It is the one mineral species that everyone relates to. Just having it around, to admire and to heft occasionally, makes one feel somehow . . . better. Well it has that effect on many people, anyway, and mineral collectors with their acquisitive, materialistic streak are particularly vulnerable to its charms.



Gold from near Quartzsite, Arizona; 2.4 cm. University of Arizona collection.

Collecting gold is not like collecting wulfenite or quartz or even silver. On the subject of damage, for instance, far more is commonly tolerated than for any other species. A certain amount of stream tumbling, while not desirable, is nevertheless accepted for gold whereas it would destroy virtually all the value of a wulfenite or a quartz crystal. In fact, completely rounded, interestingly shaped nuggets retain a distinct specimen appeal and a price noticeably above bullion value. Collectors who cannot afford the lofty prices that large, razor-sharp, mirror-faced crystals bring can find major discounts and plenty of satisfaction with specimens of slight to heavy placer experience.

Gold as a collector species is relatively free of what is referred to in the art world as "inherent vice." It is oblivious to sudden changes in temperature or humidity, and is immune to light damage. Airborne acids and pollutants have no effect on it. If moderately mishandled it does not cleave or shatter; it tends to bend rather than break, and can often be bent *back* without suffering too much. Its only serious shortcoming is its softness.

We think of gold as a species having intrinsic value, and it does indeed. But for fine crystal specimens the relationship between bullion value (by weight, if melted down) and specimen value is often highly attenuated. In cases of small, superb crystallizations the bullion value may be a negligible fraction of the specimen value. After all, a full ounce of gold is about the size of a half dollar, and is worth only about $400. That much gold well-crystallized as several specimens nicely perched on matrixes could easily bring several thousand dollars. (That, of course, has led to numerous attempts at faking, so gold collectors must be appropriately cautious.)

Getting to know specimen values for gold is a major challenge to the collector. Knowing the pricing systems and structures for other species is of no help. Gold is a specimen commodity unto itself, with its own pricing scales and its own peculiar markets. Uninformed appraisals can be wildly inaccurate. Nevertheless, the empirical criteria are largely the same as for other species: size, esthetics, habits, luster, locality and so on. As for bullion values, it is best to put that our of your mind; for anything but average nuggets it is just not relevant.

Mineralogical value is a different consideration entirely. Most descriptive mineralogists would yawn at the prospect of studying gold; its mysteries have probably all been unravelled. On the other hand, great interest *does* lie in pieces having associated species. This is because most gold is relatively devoid of associations, and because related gold-containing species are often rare and exotic.

The only problem posed by gold's intrinsic value is its appeal to common thieves, who wouldn't know a diamond in the rough if they saw it, but who recognize gold. Museums and institution collections around the world have always had particular difficulty protecting their gold specimens from theft. Turn your back on such pieces for even a moment and they are gone. As a result, many historically important gold localities are today represented by very few surviving specimens or none at all. The older the discovery, the fewer the specimens that remain because the passage of time is always accompanied by opportunities for theft. For this reason, truly old specimens should be most carefully protected along with their invaluable provenance data.

Surprisingly, I have not heard of *private* collectors having any particular problem with gold specimen theft. But that may simply be because their own security procedures are better than those of some institutions, or that fewer people are allowed any kind of access. Furthermore, gold collectors are understandably disinclined to advertise their specialty to the local community of non-collectors. Discretion is implicit in successful gold collecting.

Acquisition of fine gold specimens must almost always be accomplished by purchase. Gold is generally not one of those species you can field collect as good crystalline specimens in abandoned mines. And it never has been; visible gold is never left behind by miners. Mineral dealers obtain most of their gold specimens from owners of operating mines and from old public and private collections. These sources are only rarely accessible to the average collector, so it pays to get to know some reliable, reputable dealers and inform them of your collecting goals and budget.

The number of possible localities from which the gold collector might hope to obtain specimens is truly immense. Practically every country in the world has at one time or another produced some gold. For many occurrences the habit is relatively distinctive, so that a collection of specimens can have a satisfying amount of variability and a reliable set of provenances. In other cases habit is not very indicative, and the collector must beware of mislabeling. But it happens that the trace element profile of gold is usually unique to each locality, like a fingerprint. Perhaps collectors a century from now will carry with them a computerized pocket-sized trace element analyzer which will tell in a moment the true locality for any specimen.

Fine gold specimens in all sizes are on the market today. A modest budget need not rule out gold collecting if the buyer is satisfied with thumbnail to micromount sizes. And even the largest specimens rarely reach the upper price range of the best gem species specimens.

Of one more thing the gold collector can be certain: visitors will be impressed. No matter who they are, collectors or not, gold will speak to them and give them pleasure. If you want a specialty in which you can share your joy most widely and most easily, gold is a sure winner.

GOLD-II

Back in 1982, as most readers know, we published our first special issue on gold (vol. 13, no. 6). Despite a relatively large press run of 10,000 copies it sold out within a few weeks.* People since then have continued to clamor for more copies, and have even suggested that we reprint it (we don't intend to). They have also asked for some coverage of gold localities not mentioned in *Gold-I* . . . Australia, Colorado and Appalachia, for example. It seems that we touched upon a unique mineralogical groundswell of interest in this particular species. In response, therefore, we present *Gold-II,* and hope it will provide equal enjoyment. With the exception of the 1977 Tsumeb book-issue, it is the thickest single issue we've ever published. Furthermore, it contains the greatest amount of color photography of any issue in our history (nearly a hundred specimens shown in full color), and has our first wrap-around cover photo! There will not be a *Gold-III,* however, even though we could probably find many more gold occurrences to cover. Enough is enough for a single species.

Almost every article in this issue was specifically solicited, and I want to thank our authors for the massive amount of effort expended on our behalf. Bill Birch, Curator at the Museum of Victoria, was given the formidable task of reviewing *all* of the major gold occurrences in Australia. The literature on Australian gold is enormous, but generally treats individual deposits and districts rather than the country as a whole. Gathering and boiling down all of these disparate data, locating and photographing the best specimens, and compiling it all into a single overview has, I think, resulted in giving an excellent perspective unavailable elsewhere in the literature.

For the article on Georgia and Alabama gold we went to Robert Cook, chairman of the Department of Geology at Auburn University and author of *Minerals of Georgia* (1978) and *Mineralogy of Alabama* (1982). I spent some enjoyable time on the telephone talking to various of our Georgia subscribers in an effort to track down more Georgia specimens; my thanks in particular to Jennings ("Beau") Gordon for loaning several from his personal collection, and to Sharon Johnson, Superintendent of the Dahlonega Courthouse Gold Museum, for providing information and photos.

The article on North Carolina gold is not intended to be as comprehensive as Cook's review of Georgia. It was inspired by several poor reproductions and short quotes I had seen, over the years, which originated in an early (1857) article in *Harper's New Monthly Magazine.* Out of curiosity I began searching for a set of *Harper's* so that I could read the whole article, and finally found one in the Huntington Library, San Marino, California. It makes such interesting reading, and the full set of illustrations is so appealing, that I thought *Mineralogical Record* readers would enjoy seeing a facsimile reprint for its historical interest. Leona Schonfeld at the Huntington arranged for a high-quality set of camera prints to be made from their original for our use. In the subsequent search for specimens, two fine North Carolina thumbnails were found at Harvard and graciously loaned for photography by curator Carl Francis. Gold specialist John Barlow of *Earth Resources* checked his vault and also came up with a fine specimen from one of the mines discussed in the *Harper's* article. John Dysart, Manager of the Reed Gold Mine State Historic Site, sent much additional information on the current status of this famous occurrence.

Mineral collectors do not normally associate Great Britain with fine crystalline gold, but an occurrence does exist there and has been yielding extraordinary specimens quite recently. Mineral dealer Simon Harrison and John Fuller of the British Museum (Natural History) researched the site (called "Hope's Nose") and turned up some interesting history.

Wayne Leicht (*Kristalle*) has spent years researching California localities for crystalline gold, nosing around in dusty museum drawers and old files all across the country. By now he must certainly be the leading expert on the subject, and for *Gold-II* he follows up his article in *Gold-I* with much additional information on old finds. In addition, four companion pieces also relate to California gold. Genne and Robert Allgood (mining geologists for the Sonora Mining Company, right in the Mother Lode Country) have provided a review of gold occurrences in Tuolumne County, Peter Bancroft provides a report on a new specimen mining operation under way near the famous Colorado Quartz mine, Dona Leicht writes on recent gold discoveries in California, and curator Jean DeMouthe at the California Academy of Sciences describes the gold specimens in the California State Mineral Collection.

Colorado gold is as spectacular as any, so we asked Ed Raines and Art Smith to prepare an article for this issue on Breckenridge. Specimens for photography were kindly made available by Carl Francis at Harvard, curator Jack Murphy at the Denver Museum of Natural History and Keith Proctor. Joe McGartor of the U.S. Geological Survey photo archives managed to locate one of Frederick Leslie Ransome's original 1911 glass-plate negatives of the Breckenridge area and had a new print made for us.

Finally, a What's New in Minerals? column is included which deals entirely with other gold discoveries made in recent years. My thanks once again to John Barlow for loaning specimens, Lawrence Conklin for providing information, and Terry Wallace, curator at the University of Arizona Mineral Museum, for making specimens available for photography.

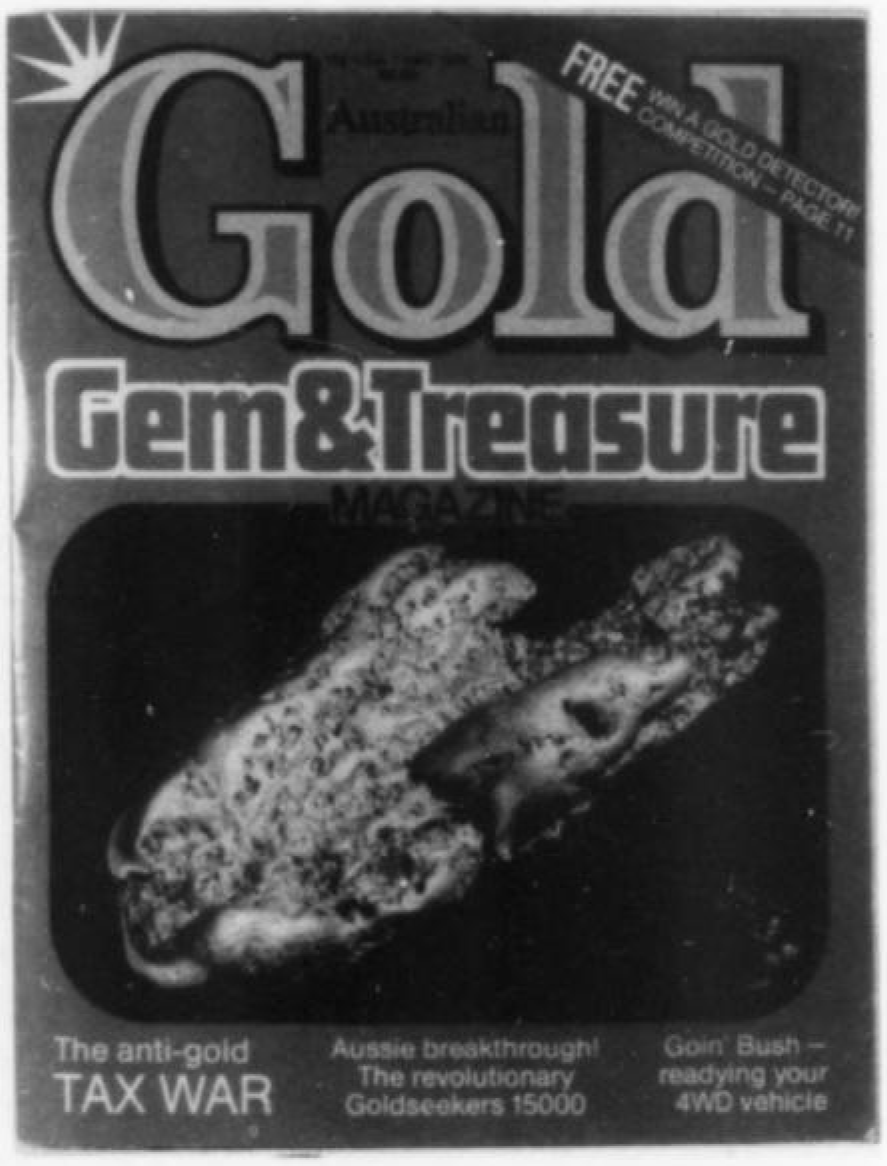
To these people and all the others who helped in one way or

* Incidentally, last January's special *Silver Issue* is now sold out too, save for a few scuffed copies.

another, our thanks. The publication of this special over-size issue was made possible by a grant from our long-time anonymous donor from Georgia. His faithful and generous support over the years has made all the difference for the *Mineralogical Record*; I hope that someday he will allow me to reveal his name so that he can be properly recognized for the tremendous contribution he has made to mineralogical literature.

EXTRA COPIES OF THIS ISSUE

Subscribers may purchase extra copies of this issue at a *25% discount* off the cover price, on prepaid orders of five copies or more. Why not put some away for use as business gifts, personal gifts, or just to keep? (Offer open to subscribers *only*; all orders will be checked. Standard discount on five copies or more is available to dealers with resale number.)



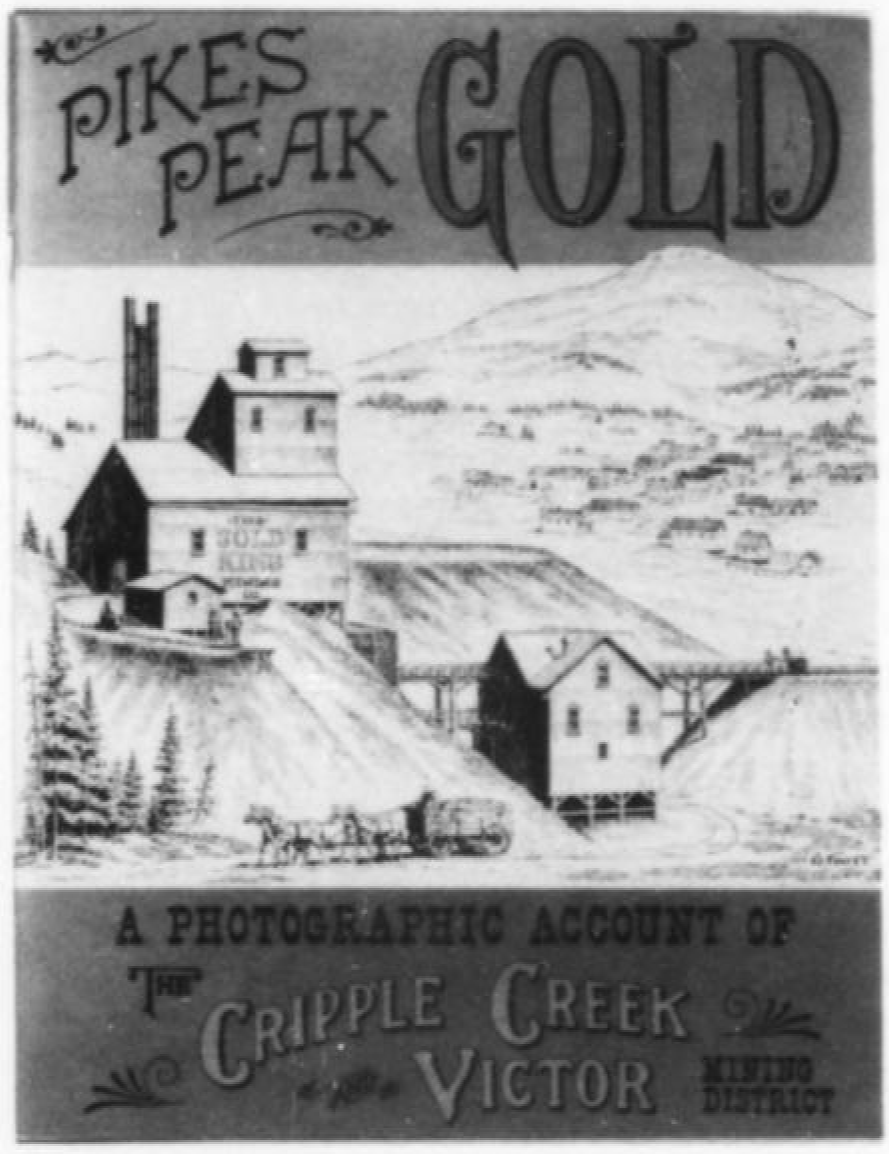
OTHER GOLD MAGAZINES

First it was called *Australian Gems & Crafts.* Then it became *Australian Gem & Treasure Hunter.* Now, under new management, Australia's only rockhounding magazine has been renamed *Australian Gold Gem & Treasure Magazine,* with gold being its principal subject. Volume 1, number 1, came out in May of 1986. Subscriptions are $30 Australian for one year (11 issues). The new publisher is Minelab Electronic Industries Limited (a manufacturer of metal detectors), P.O. Box 35, Stepney 5069, South Australia, Australia.

The most important gold-hunter's magazine in the U.S. has for many years been *Gold Prospector,* "the official publication of the Gold Prospectors Association of America." Published bimonthly and now in its twelfth year, *Gold Prospector* covers everything from panning and sluicing techniques to famous historical localities, field hazards, claim staking, mining news, new product testing, dowsing, dredging and detecting. Their June issue is 96 pages. A one-year membership in the GPAA for $25 includes a subscription ($8 additional outside of the U.S.). Send to Gold Prospector Magazine, P.O. Box 507, Bonsall, CA 92003.

FAMOUS NUGGET MODEL AVAILABLE

The biggest news in Australia in the last 109 years was the recent discovery of the "Hand of Faith" nugget (that's it on the cover of *Australian Gold Gem & Treasure Magazine*). Weighing in at an ample 876 troy ounces (60 pounds) and measuring 47 cm (18.5 inches), this piece ranks as one of the most spectacular gold specimens of all times. The original is currently on exhibit in a Nevada casino, but collectors and museums can now obtain a full-sized cast replica from *Australian Gold Gem & Treasure Magazine.* The weight has been trimmed to 4 kg of a durable plasticized casting compound. Over 50 of these replicas have already been sold in Australia alone. The price, including surface mail and insurance to the U.S., is $200 Australian. The replicas are manufactured upon order and require 12 weeks to finish, not counting shipping time.



NEW GOLD BOOKS

Pikes Peak Gold has recently been published by the Barbarossa Press. This book, in magazine format, is a collection of early photos taken in the Cripple Creek and Victor mining districts of Colorado. The collection was originally published in 1956 by Fred and Jo Mazzulla, under the title *The First Hundred Years; Cripple Creek and the Pikes Peak Region.* The new edition has a few photo substitutions, a new cover and title page plus a fold-out map at the back, but is otherwise identical. Many of the early photos shown were taken from the Mazzula's own private collection. Both authors are deceased now; their extensive photo archives were given to the Amon Carter Museum in Fort Worth, Texas. *Pikes Peak Gold* is available at $9 postpaid from the Mineralogical Record Book Department (P.O. Box 1656, Carson City, NV 89702).

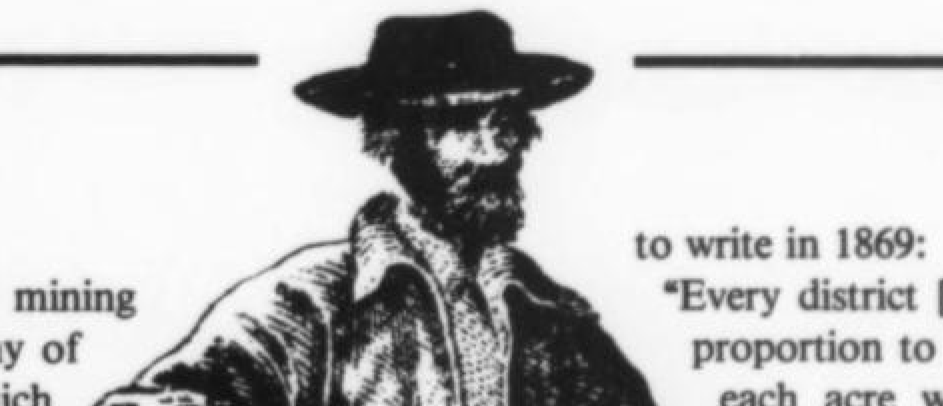
A new 54-page booklet on gold localities in Europe has recently been prepared by Dr. Wolfgang Homann and published (in German) by the Dortmund Museum of Natural History. Spain, Portugal, France, Belgium, East and West Germany, Austria, Switzerland, Italy, Poland, Czechoslovakia, Hungary, Yugoslavia, Romania, Bulgaria, Greece, Albania, Finland, Sweden, Norway, England, Caucasia (USSR) and Siberia (USSR) are all reviewed. The retail price is 14 DM (not including postage). Order (title: *Gold – Vorkommen und Gewinnung in Europa*) from Naturkundemuseums der Stadt Dortmund, Postfach 907, D-4600 Dortmund 1, West Germany.

Soon to be issued by Van Nostrand Reinhold is a new book entitled *Gold* by Robert W. Boyle of the Geological Survey of Canada. I haven't seen a copy yet, but Boyle's other works on gold have been thorough and professional so I assume that this new volume, at *624 pages,* will be his magnum opus. Price: $49.50, from the publisher.

W.E.W.

GOLD in AUSTRALIA

Australia has produced a stunning array of crystallized gold since the first lodes were opened in the 1850s. But it was placer gold in huge quantities that accounted for the main succession of gold rushes. In recent years, weekend prospectors armed with metal detectors have turned up a new bonanza of gold nuggets.



Bill Birch
Museum of Victoria
285 Russell Street
Melbourne, Victoria 3000
Australia

HISTORY

Early Discoveries

Australia's impressive history of metal mining began in the early 1840s, in the new colony of South Australia. It was copper, not gold, which excited a rush of immigrants, especially from Cornwall, and by 1850 South Australia was exporting more copper than wheat or wool. The interest in metals gradually extended to gold but there are, naturally enough, conflicting accounts and varying opinions on where the first gold was discovered on the Australian continent.

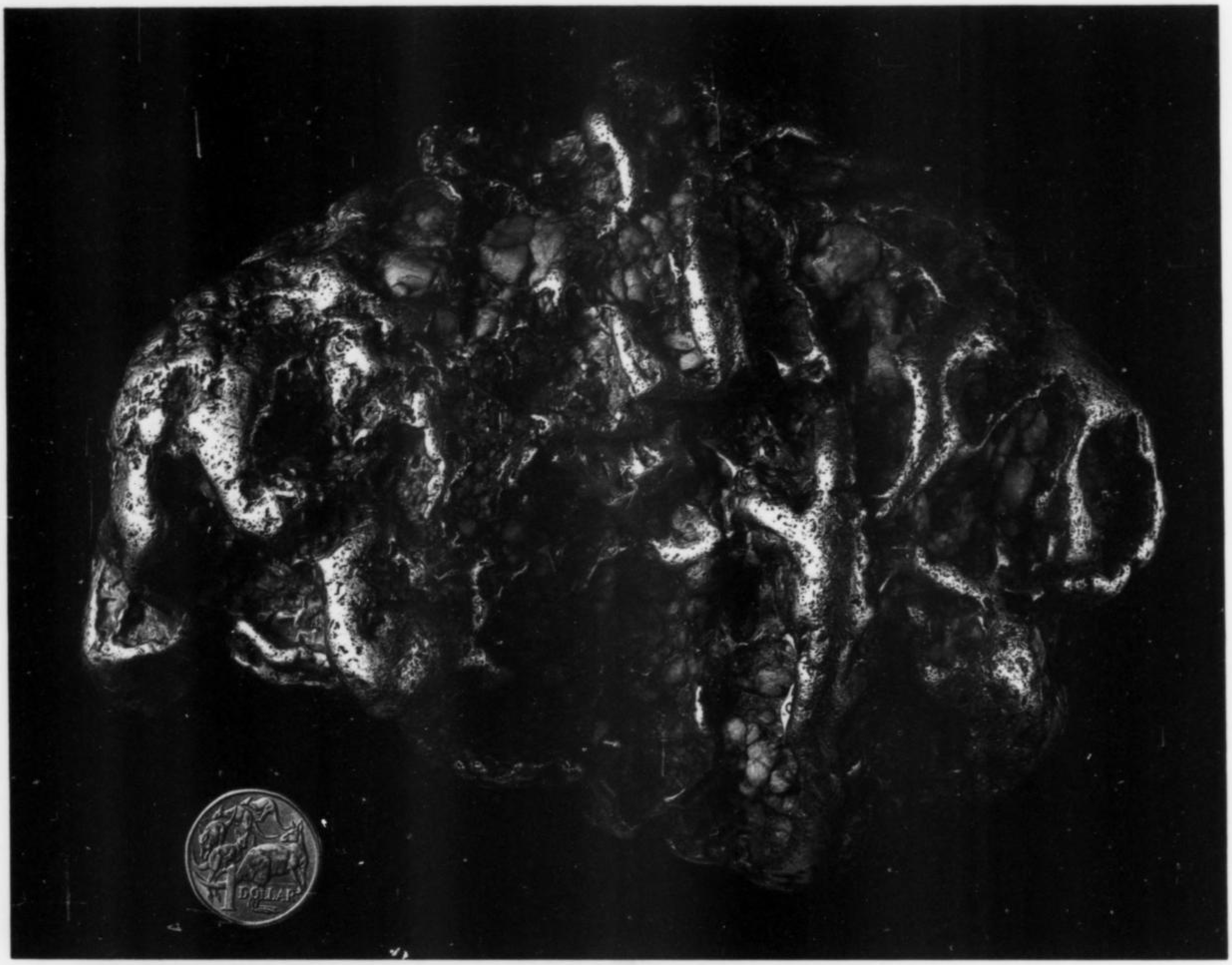
It could well be argued that the aboriginal tribes of central Victoria must have stumbled over gold nuggets prior to European settlement. There are instances of gold nuggets being found associated with old aboriginal camp sites, well away from auriferous reefs. The Watchem Nugget from near Maryborough (Dunn, 1929) and the Bunyip Nugget from near Bridgewater, east of Bendigo, may both have been carried to their recorded place of discovery by aboriginals. There is no evidence however that the aboriginal people attached any great economic or spiritual significance to the heavy yellow metal.

The first reliable record of the discovery of gold is a note in a field-book made by Assistant Surveyor James McBrien in 1823. He reported finding numerous grains of gold in soil near the Fish River, near Bathurst, in New South Wales. Throughout the 1840s, reports of further gold discoveries in New South Wales and inland from the Port Phillip district (eventually to become Victoria) were frequent, but generated little excitement. The prime interest of early settlers was still agricultural, as Robert Brough Smyth, Secretary for Mines in Victoria, was to write in 1869:

"Every district [in Port Phillip] was valued solely in proportion to the number of sheep or cattle which each acre would carry. Reefs of white quartz, standing 20 feet above the surrounding surface, every foot of which contained gold visible to the naked eye, excited neither curiosity nor enquiry; and the careless shepherd, whose earnings amounted to no more than ten or fifteen shillings a week, every day drew water from the creek beneath whose bed lay nuggets and grains of gold far exceeding the fee simple of the run on which he was a laborer."

In fact, so-called careless shepherds were finding gold and selling it on a small scale to Melbourne jewelers before the "official" discoveries were announced in 1851. However, the vast majority of the population could neither recognize gold, nor even begin to know where or how to mine it. And there was a further disincentive. According to English law, which operated in the colony, all gold and silver belonged to the Crown—there was no encouragement to the private miner. Historians have also suggested that Governor Gipps and the New South Wales authorities deliberately suppressed gold discoveries, even by reliable explorers such as Count Strzelecki in 1839 and the Reverend W. B. Clarke in the early 1840s, for fear of its effects on a convict-based society. Gipps is erroneously reported to have exclaimed, "Put it away, Mr Clarke, or we shall all have our throats cut," when shown a small piece of gold in 1844.

In the Port Phillip District the early landholders, or squatters, would have been reluc-



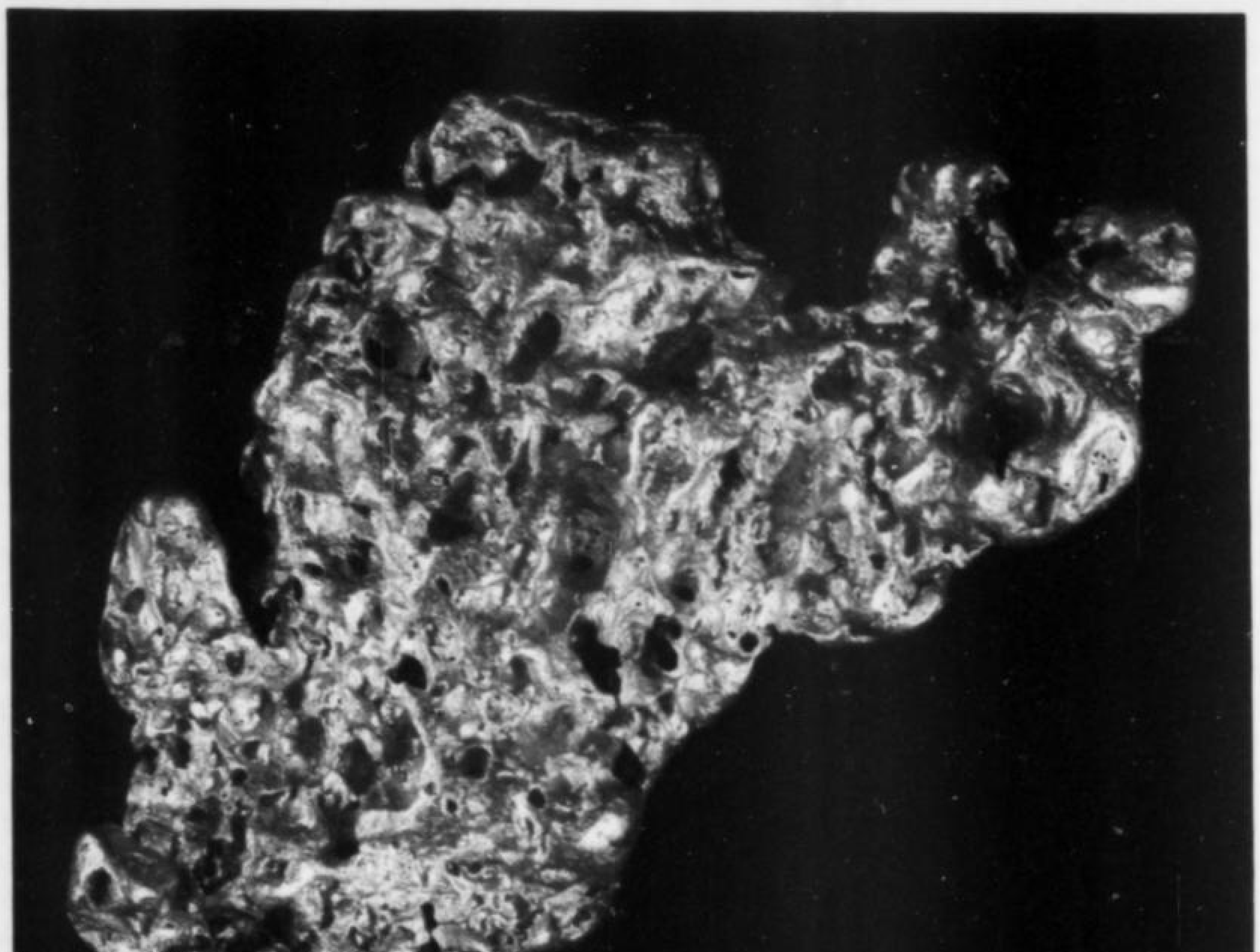


Figure 1 (above). **The Maitland Bar from Meroo Creek, near Hargraves, New South Wales (Geological and Mining Museum, Sydney, specimen 4818. Contains 313 ounces of gold, 8 x 17 x 22 cm). Photo by David Barnes.**

Figure 2 (left). **A 100-ounce nugget found using a metal detector at Jones Creek, near Dunolly, Victoria, in 1980.**

Figure 3 (facing page, top). **The "Hand of Faith" nugget, 845 ounces, detected at Kingower, Victoria, in 1980.**

Figure 4 (right). **Welcome Nugget tobacco poster. W. Wilson collection.**

Figure 5 (far right). **The Bunyip Nugget, weighing 50 ounces, was ploughed up near Bridgewater, west of Bendigo, Victoria, in 1971. Museum of Victoria specimen M34546; 11 cm high. Photo by Frank Coffa.**


WELCOME NUGGET
JACK! LOOK AT THIS
T.C. WILLIAMS CO.
MANUFACTURERS
VIRGINIA U.S.A.

Figure 6. **The site of the first "official" discovery of gold in Australia, Ophir, on Lewis Ponds Creek, near its junction with Summerhill Creek, Bathurst district, New South Wales (La Trobe collection, State Library of Victoria).**

tant to encourage gold mining ventures for fear of losing both their land and their laborers. The Port Phillip authorities may also have been too engrossed in the task of obtaining a political separation from the New South Wales administration to worry much about gold.

As noted Australian historian Geoffrey Blainey has pointed out of the early sporadic finds:

> It was not enough to find scattered nuggets of gold or to break gold from the jutting reefs. The treasure hunt had to become an industry and that required the discovery of large and rich deposits of gold.

Several developments brought the inevitability of such discoveries closer. Firstly, the convict population had begun to decline since transportation from England had ceased in 1840. Secondly, several poor seasons for the wool industry persuaded the New South Wales Governor that it was time to survey the Colony's mineral deposits and stimulate metal mining. The news of the Californian gold rush reached Australia early in 1849 and generated considerable excitement as well as an exodus of population to the American goldfields.

Onto this scene swaggered Edmund Hammond Hargraves, shrewd and confident following a stint in the Californian goldfields. On the 12th of February, 1851, he washed gold from Lewis Ponds Creek near its junction with Summerhill Creek near Bathurst. He then began a concerted campaign to publicize his find, aware that the more men he could attract to his "Ophir," the better chances there were of establishing both the richness of the field and his claims to any reward.

The rush to the Bathurst area that followed Hargraves' discovery was really the start of Australia's golden era of mining. It began a trail of discoveries, leading largely northwards along the eastern coastal ranges, which eventually filtered across the north of the continent and down into Western Australia, whose mines today yield nearly all of Australia's commercial gold.

The Alluvial Rushes, 1851–1879

The reaction from both the authorities and the public at large to Hargraves' find was immediate. From Sydney, Governor Fitz Roy (after whom Hargraves had named the richest point on Lewis Ponds Creek – Fitz Roy bar) sent the Government Geologist, Samuel Stutchbury, to report on the find and attempted to play down "the very great excitement which is engrossing and unhinging the minds of all classes of the community." Stutchbury however, confirmed the richness of the field and reported, on May 19, 1851:

> The number of persons engaged at work and about the diggings cannot be less than 400 and of all classes. . . . I have

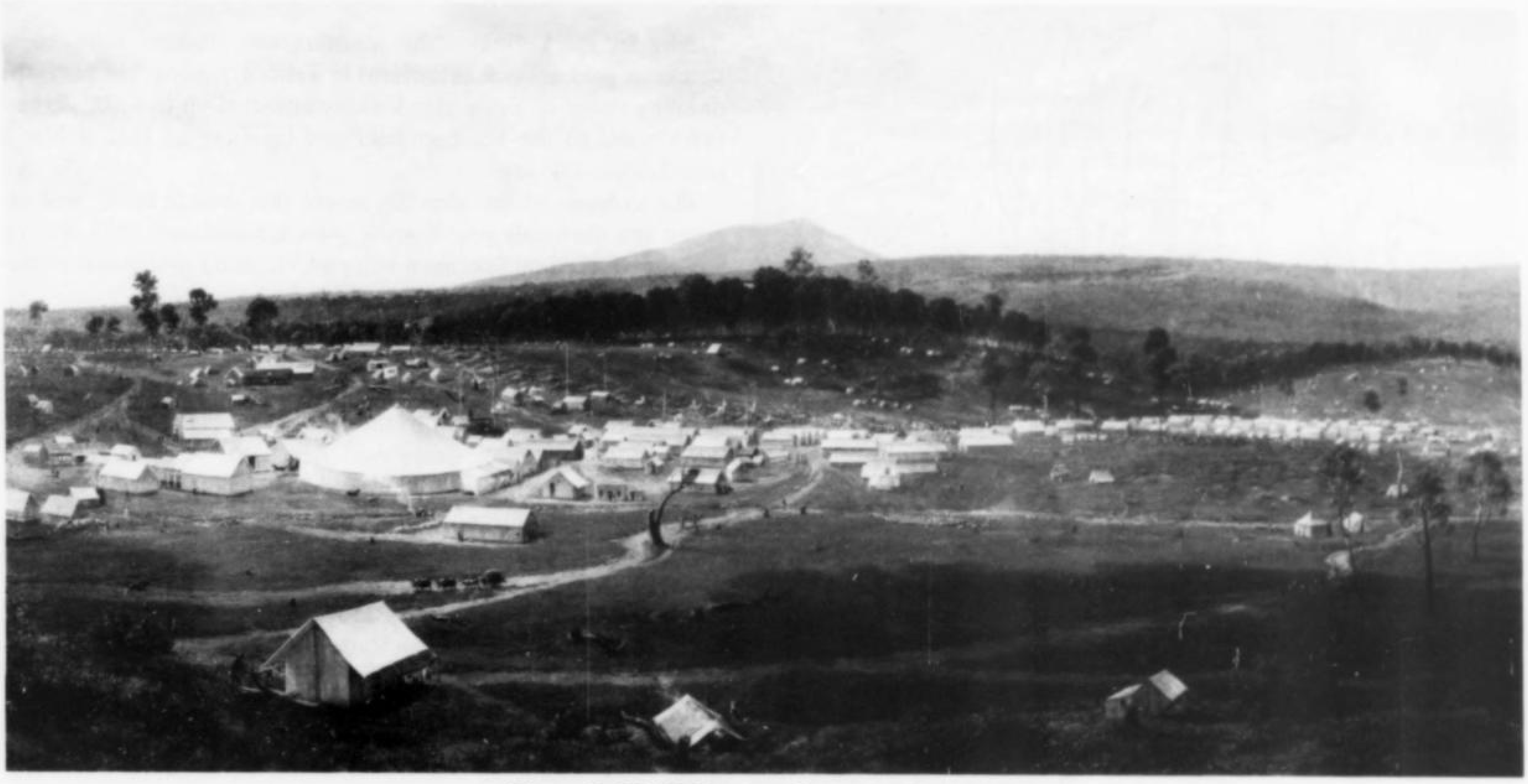


Figure 7. **Old Ballarat, as it was in the summer of 1893/4, from a painting by Eugene von Guerard (collection of the Ballarat Fine Art Gallery).**

no doubt of gold being found in greater or lesser quantities over a vast extent of country . . . .

Fitz Roy responded by proclaiming the Crown's right to all gold and that a license was required, at 30 shillings a month, for all those wanting to dig. Despite these attempts to dampen enthusiasm, between 1000 and 1500 men were working the field by early June. Contrary to the worst fears, the Ophir goldfields were peaceful and orderly, there was plenty of both workable ground and gold and the license fee was set at about the right level to avoid grievances. But several months after the initial rush, the gold was petering out and only a few hundred diggers remained. By July, a new rush had started to the northeast, on the Turon River, where gold was to be found for 30 km along the creek.

The sudden exodus of people from Melbourne to the Ophir and Turon diggings caused considerable concern amongst traders and small businessmen. In June a committee was established by a group of citizens which offered a reward of 200 Pounds to anyone who discovered a payable goldfield within 320 km of Melbourne. Louis Michel, owner of a city hotel suffering a loss of patronage in the first half of 1851, twice assembled a small party and unsuccessfully searched the Plenty Ranges, about 32 km east of Melbourne, from where small quantities of gold had been found during the 1840s. On their third attempt, they discovered a gold-bearing quartz reef and washed ten grains of gold from nearby Anderson's Creek. The rush to the area was small – probably only about 400 men worked the creek – and shortlived. In six months it was near-empty, only to be reborn in 1854.

Rich gold-bearing quartz veins had been found by local pastoralist William Campbell on the banks of Deep Creek, near Clunes, in March 1850. This was 16 km to the east of the reported discovery by a shepherd boy in the Pyrenees Ranges, in 1849, of 38 ounces of gold. The Clunes discovery was confirmed by a wandering eccentric German geologist/physician, Dr. Georg Bruhn, who spread the news during his travels. James Esmond, a timber cutter who had returned from San Francisco on the same ship as Hargraves, was quick to investigate the site. His claim (amongst many others) to have found the gold on June 29th, 1851, was eventually recognized by the Government Rewards Committee, more for the fact that, from his Californian experience, Esmond could demonstrate that the gold was payable and that he knew how to mine it.

On July 1, 1851, Victoria achieved its political separation and almost simultaneously the Anderson's Creek and Clunes discoveries were officially announced. Like Anderson's Creek, the rushes to Clunes were small, but within ten years the richest quartz-reef mine in Australia, the Port Phillip Company, was operating there.

The road to Clunes from Victoria's second port, Geelong, passed through the village of Buninyong and, 10 km to the north, Ballarat. Rumors of gold in the area during the 1840s prompted a Buninyong blacksmith to prospect the local gullies and in August 1851 he discovered alluvial gold in a gully in the ranges. Diggers rushed the area and it wasn't long before the rich fields at Ballarat were discovered. There was considerable discussion over who should be rewarded for the initial discovery but the claims of Thomas Hiscock (the Buninyong blacksmith) and several others, were eventually recognized.

Ballarat was probably the richest alluvial goldfield in the world at its peak, between 1852 and 1853. For a short period in 1852, the Ballarat field was eclipsed by that of Mt. Alexander, centered on the township of Castlemaine. The surface workings were incredibly rich over an area of at least 40 square km. By December 1851, the field was yielding 23,000 ounces weekly and had attracted 20,000 diggers.

Further north a chain of waterholes on Bendigo Creek was the site of the first goldwashings in the area, believed to be by two women, in October of 1851. The location quickly became known as Golden Point, and the nearby Golden Gully was soon rushed. By the end of March, 1852, gold was being found in all the great rich gullies to the northwest and Bendigo had become world famous. Sinkings in the valleys varied from 3 to 30 meters and fortunes were often made overnight. For example, in Peg Leg Gully in April 1852, two adjacent claims yielded 208 and 116 pounds weight of gold. In

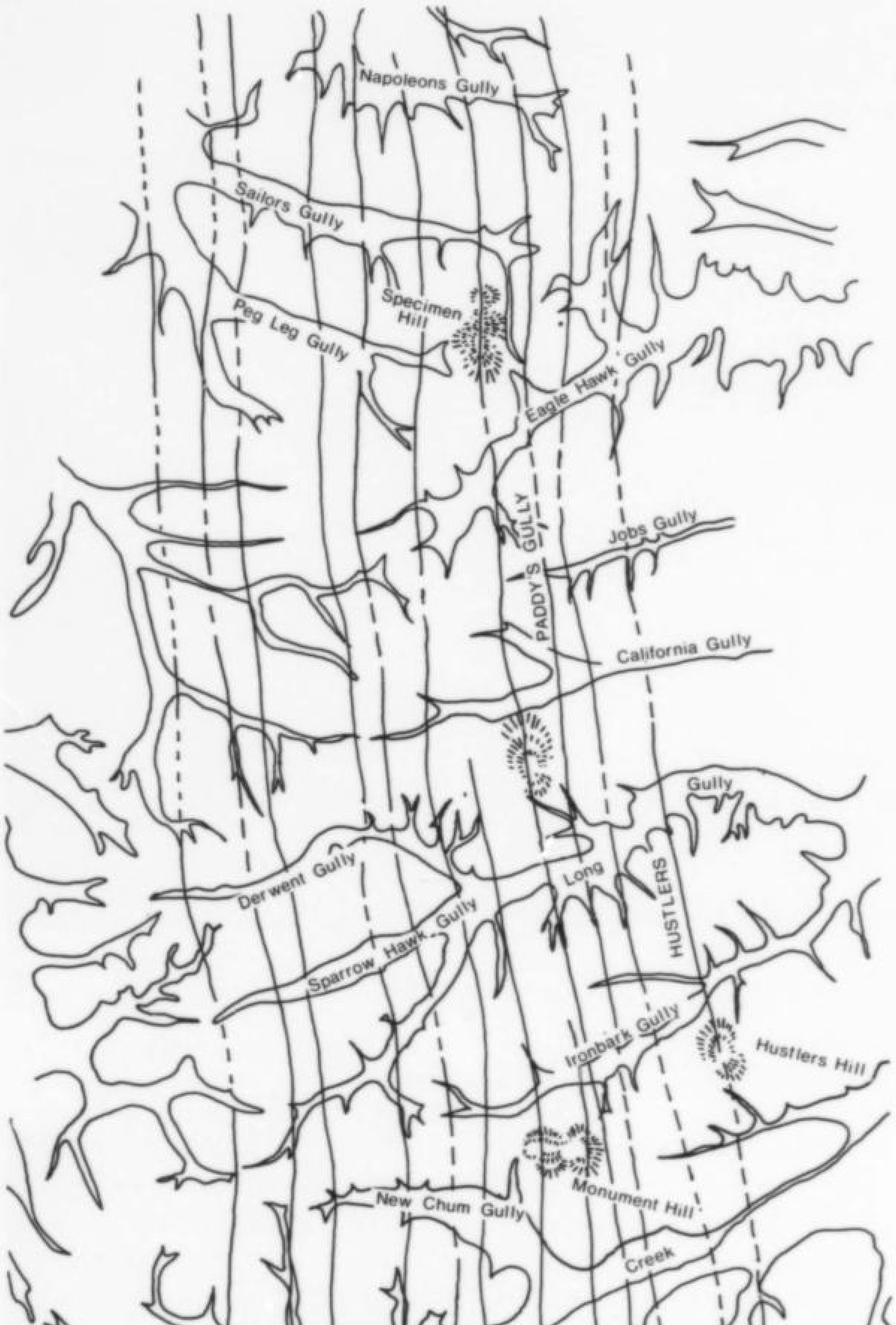


Figure 8. **Map of the "golden gullies" of Bendigo, Victoria, showing the site of the first washings at Golden Point. Also shown are the parallel anticlinal axes or lines along which the rich gold-bearing quartz reefs were later exploited. The present-day city of Bendigo covers most of the map area.**

nearby Ironbark Gully, "the washdirt was studded with coarse specks of gold as thick as currents in a rich dumpling." In May, the dazzling riches of Eagle Hawk Gully attracted up to 6,000 diggers every week to the Bendigo field and by June of 1852 it had a population of 40,000.

The richness of the alluvials meant that quartz reefs, well exposed and obviously gold-bearing, were ignored until 1853, when a reef was worked on Specimen Hill and Victoria's first quartz crushing battery was set up.

From Bendigo and Ballarat, diggers fanned out to discover rich fields at McIvor (Heathcote), Daylesford and Creswick. Smythesdale and Maryborough all opened up in 1853, as did the rich field at Maldon. In the second half of the 1850s, large rushes took place to the west of Victoria's established fields. St. Arnaud, Dunolly, Ararat and Stawell were discovered, as were the deep leads at Rutherglen and Chiltern. The rugged forested mountains to the east were also to yield their riches, at Beechworth, Jamieson and Walhalla.

By the late 1850s and early 1860s the great Victorian rushes, which had been far larger than those in New South Wales, had virtually ceased. The other southern States, South Australia and Tasmania had gold discoveries, but no great rushes. In fact, they suffered from an exodus of population to the Victorian and New South Wales fields. In Western Australia, Edward Hargraves was hired to report on that colony's gold prospects and delivered, in 1860, a very gloomy judgment.

From the late 1850s, the golden trail led northwards through important fields at Kiandra, in southern New South Wales, where some of the state's largest nuggets were found, then Young and Forbes, where 235,000 ounces of gold were hauled from deep leads in 1862, and the rich Rocky River field in the north. In the late 1860s, Gulgong with its deep leads was a stepping stone for diggers moving into Queensland in a northwards migration of over 1600 km.

The rush to Queensland had begun in 1858 when, as it turned out, misleading reports of rich gold in Bonnie Doon Creek, on Canoona Station, 55 km north of Rockhampton, lured up to 15,000 Victorian diggers. However, coastal shipowners ferrying men up and back were the main beneficiaries of that particular rush. Other smaller rushes took place, for example to Peak Downs in 1862, before the rich Gympie goldfield was discovered in 1867, followed by a rush to Charters Towers after rich gold-bearing quartz floaters were found below the main reef in 1872. The greatest alluvial rush in Queensland was to the Palmer River in 1873, attracting up to 25,000 people. On one of Australia's most isolated goldfields, life was harsh due to the tropical climate, illness, high costs and skirmishes with local aboriginals. Chinese miners outnumbered Europeans for much of that field's brief history.

The Chinese influence on Australian gold mining reached its peak following the discovery of gold in 1872 at Pine Creek, 160 km south of Darwin in the Northern Territory, during the building of the overland telegraph line between Adelaide and Darwin. The Adelaide share market boomed, but the price of isolation was high and most investors eventually lost money while miners lost their lives. Thousands of Chinese miners, for once encouraged by the authorities, controlled most of the output from the Northern Territory quartz reefs by the 1890s and outnumbered Europeans on the field by more than twenty to one.

Later Developments, 1880–1949

By the end of the 1870s, the great movement of diggers up the eastern edge of the continent, seeking easily won alluvial gold, had lost its momentum as the deposits were exhausted. But it was not the end of the golden discoveries. By now, reef mining, based on the capital and skills accumulated from alluvial mining, was well

Figure 9. **Map showing the general counterclockwise pattern of major gold rushes (as distinct from initial reports) to the major Australian goldfields discovered in the nineteenth century.**

established in the southern goldfields. Bendigo, Ballarat, Clunes and Walhalla were famous for the richness of their reefs. In New South Wales, first Hill End, then Hillgrove, Lucknow and Cobar, all major quartz reef mines, kept the batteries in action during the 1870s and 1880s.

However, as quartz reef mining could never match alluvial deposits for richness and accessibility, a long slow decline in overall production began. In 1882 Queensland's bonanza deposit, Mount Morgan, was finally tapped after being ignored for 25 years and, as a major producer, set the scene for a resurgence in production, this time dominated by northern Australian mines.

The "golden trail" continued counterclockwise, through the Pine Creek "stepping-stone," and saw the Halls Creek goldfield, in the rugged, isolated Kimberley Ranges of northern Western Australia, being rushed in 1886 after initial discoveries in the region in 1882. Conditions there were extreme and for three years diggers fought the heat, fever, dysentery and food shortages. Although the overall yield was small, the fact that Western Australia had proved to have a goldfield (despite the earlier predictions of Hargraves) excited further prospecting. This time the trail led southwards.

Rich alluvial gold, including nuggets, was discovered in the Pilbara region in 1887 and within two years it was Western Australia's most important field. The rich reefs of Southern Cross in the Yilgarn district were found in 1888, followed soon after by the great Murchison goldfield, inland from Geraldton. This field was much more attractive – the climate was less severe, food cheaper and the water supply reasonable. Even so, as on most of the Western Australian fields, "dry blowing" and "specking" were standard prospecting methods. The alluvial gold at Cue and The Island, two of the Murchison's biggest deposits, was shallow and short-lived but, like the quartz reefs from which it was derived, incredibly rich.

The best was yet to be found, however. East of Southern Cross stretched a desert area which repelled early pastoralists and defied early explorers. Nevertheless, men headed east on the search for alluvial gold and in September, 1892, Arthur Bayley and William Ford camped near the present town of Coolgardie and saw gold glittering around them in the red dirt. About a month later, they hammered over 500 ounces from a nearby quartz reef. There was an immediate rush from Southern Cross and although summer temperatures were distressing, diggers fanned out looking for new deposits. When Paddy Hannan discovered the riches of Kalgoorlie in 1892, even the Coolgardie field was deserted. Several kilometers south a syndicate pegged claims in the name Great Boulder, eventually to become the famous "Golden Mile."

During the 1890s the Western Australian goldfields were gradually extended and their richness confirmed. Hundreds of companies were set up and the international market saw a boom in gold mining shares. Kalgoorlie's growth began to eclipse that of Coolgardie as its population increased dramatically, a large component coming from the colonies to the east. More exciting finds were made, including the deep lead of Kanowna in 1897.

By 1898, Kalgoorlie's gold production exceeded Charters Towers and it was Australia's leading field. The shafts on the Golden Mile went deeper in the greenstones and still the gold persisted. Although production has declined from the peak year of 1903, when Australia was the world's greatest gold producer, the Golden Mile is still the mainstay of Australia's gold mining industry.

During the early 1900s, Australian gold production began another long decline similar to that of the 1880s. While the big mines stayed prosperous, by 1910 pessimism gripped the industry. Charters Towers, Gympie, Bendigo and Ballarat had all passed their peak and were in decline by World War I. It appeared that most of the Australian gold deposits had been found and that new ideas, new exploration methods and new technology were needed. Higher wages and operating costs sliced away at profits on most goldfields during the 1920s, even in Kalgoorlie.

By 1930 the world depression had reached Australia and thousands of men took to the goldfields for their livelihood. The price of gold doubled in three years following depreciation of the Australian and British currency and suddenly Western Australia's goldfields were in revival, with thousands of small mines starting up. Even in Victoria, where gold mining had almost ceased, small mines began to operate again. In the Northern Territory, perhaps Australia's remotest goldfield, the Granites, nearly 650 km northwest of Alice Springs, attracted a small rush in 1932, but it lasted less than two years. Two valuable deposits, Tennant Creek in the Northern Territory and Cracow in central Queensland, were discovered in the 1930s. By 1939 and the start of World War II, gold production had increased nearly fourfold in the decade and was again of national importance. But World War II saw the beginning

Figure 10. **Miners engaged in overhand stoping, Wentworth Proprietary gold mine, Lucknow, New South Wales (circa 1890s).**

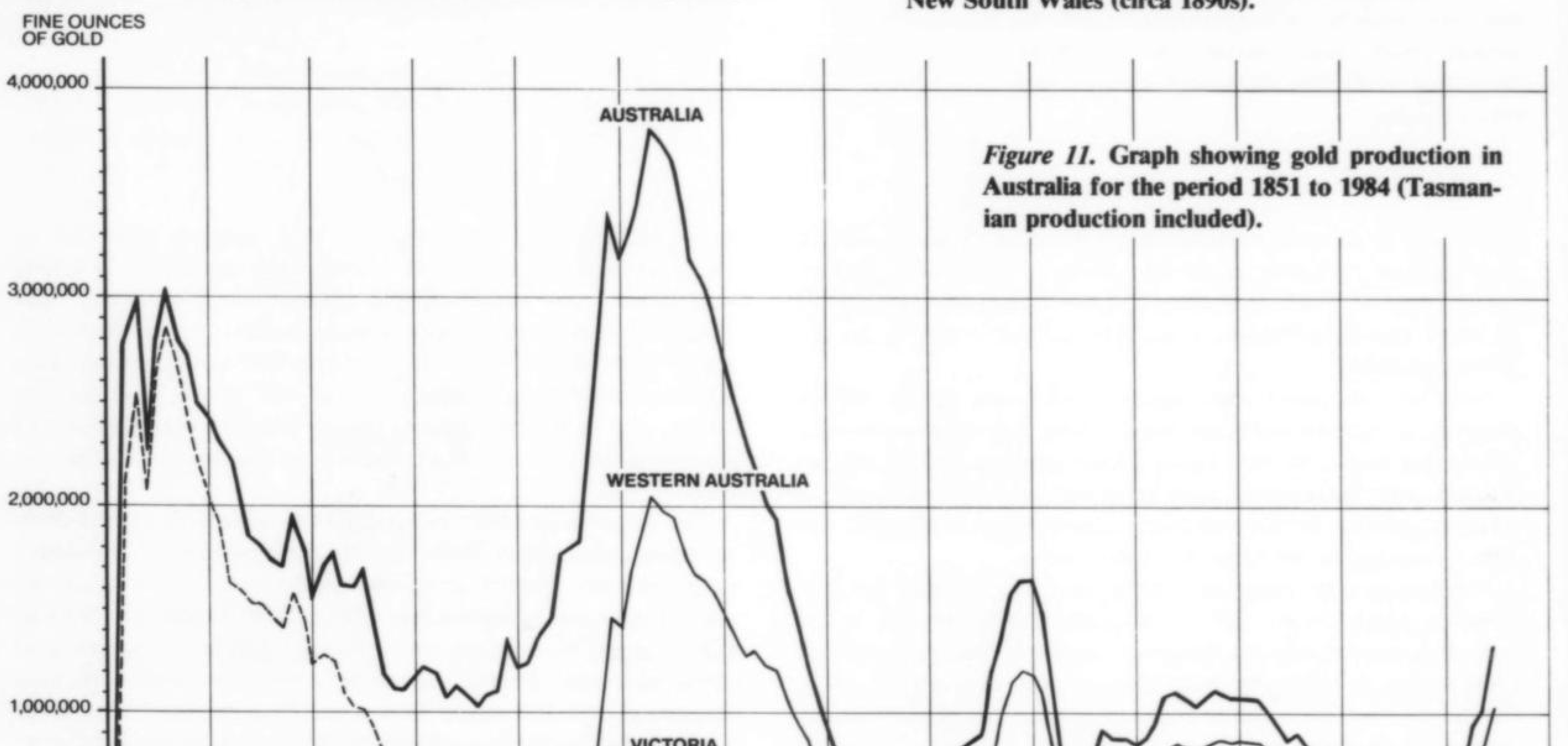


Figure 11. **Graph showing gold production in Australia for the period 1851 to 1984 (Tasmanian production included).**

of yet another decline lasting until the 1980s when production started to increase again as major new mines in Western Australia became operational.

While the 1900s could never match the gold fever generated by the discoveries of the 1850s and 1860s, the population could still be roused by exciting new finds. A new rush to the Tarnagulla field, in the Golden Triangle of central Victoria, followed the discovery of the Poseidon nuggets, the largest being 953 ounces, in 1906. The remarkable Golden Eagle nugget, of 1136 ounces, found south of Coolgardie in 1931, caused a new rush to the area and helped bolster the revival of the 1930s.

And then there was (or is?) the fabulous lost reef of enigmatic itinerant, Lewis Lasseter. Now one of Australia's folk heroes, Lasseter reported his rich find in Sydney in 1930. His plausible description of the reef and its location, in the remote Petermann Range near the unmarked borders of Western Australia, South Australia and the Northern Territory, persuaded a company to finance an expedition to rediscover and peg it. Lasseter left the expedition suddenly west of Alice Springs and was never seen alive again. In May 1931, his body was discovered in a shallow bush grave. Despite numerous, well-equipped expeditions, Lasseter's lost reef has never been rediscovered, if it existed at all other than in his imagination. But the legend lives on as perhaps the most intriguing and enduring of all Australia's goldfield sagas.

Recent Developments, 1950–1986

In 1953, Australian gold production topped 1 million ounces for the first time since 1942. However, profitability was such that the Australian Government introduced a gold subsidy in 1954 and, as if to signify the end of an era, the Central Deborah, the last operating mine at Bendigo, closed down in the same year. Victoria's gold production virtually ceased, mirroring the overall national decline which continued well into the 1960s. It seemed that gold had had its day and even the future for the Western Australian mines looked grim. In the late 1960s the discovery of large nickel deposits in the greenstones of Kambalda and elsewhere in Western Australia started another boom which enabled companies to make the change from the dwindling fortunes of gold to the promise of nickel. The town of Kalgoorlie survived as a result.

In the mid-1970s gold production reached its lowest level since the slump of the late 1920s, as several large producing mines such as Cracow in Queensland and Fimiston at Kalgoorlie closed down. On the 30th of January, 1976, the Reserve Bank of Australia ceased its long-held policy of purchasing all locally produced gold at an official fixed price. The Australian government also permitted private citizens to buy and sell gold for the first time. While the effects of these changes were not immediate, they did mean that when the world gold price spiral commenced in 1978, peaking in 1980, Australian gold miners could take advantage of the market forces.

The 1980s have seen a revival in exploration and production to something like the levels of the 1950s. Despite the closure of Mt. Morgan in 1981, after 99 years of operation, other deposits such as Telfer in the Pilbara goldfield of Western Australia, now Australia's largest producer, and major new mines commencing at Kambalda, Fimiston and Mt. Magnet, have more than compensated. In fact, the Western Australian goldfields are alive again, with many old prospects being investigated and reopened. Even in Victoria the A1 mine at Woods Point and the Magdala reefs at Stawell are back in production.

Not only have companies been involved in the renewed activity on the goldfields, but the small prospector and the weekend fossicker, armed with metal detectors, have found there is plenty of gold left in the surface deposits of Western Australia, especially on the old "specking patches" around Leonora, Cue and at Wiluna and Lake Way. Nuggets up to 9 kg (300 ounces) have been found near Kalgoorlie, although the biggest, the 419-ounce Yellow Rose of Texas "found" in 1980, is now known to have been manufactured from many smaller pieces of natural gold. Although remote desert goldfields such as Tibooburra in western New South Wales are ideal for detecting, small fortunes (and a few undisclosed large ones) have been made by this method in central Victoria, particularly in the nugget belt of the Golden Triangle. Old surface workings on the goldfields are now pockmarked with shovel holes, where detectors have signalled a potential bonanza. Nearly all have been dug in vain, but there have been many lucky strikes. One prospector detected two nuggets of 100 ounces and 60 ounces within half an hour and about 20 meters from each other at Jones Creek, near Dunolly, in 1980.

The sudden increase in availability of large gold nuggets weighing over 25 ounces from the Victorian goldfields in particular resulted in a drop in the specimen mark-up price over bullion value from around a factor of 5 to 2, the latter ratio persisting to the present day. Specimens showing crystalline form may be valued more on aesthetic appeal than on size and weight.

The most spectacular of the recent nuggets, the "Hand of Faith," was unearthed at Kingower in 1980. Weighing 845 ounces (27 kg), it is the largest nugget found in Victoria in nearly 80 years and ranks about twenty-fifth on the official list of the largest nuggets. It was quickly sold to the Golden Nugget Casino in Las Vegas, where it joined an earlier find, the 185-ounce Robins Nugget, found at Jones Creek in 1975. Nearly all of the large Victorian nuggets found recently have been sold overseas and it was only in 1985 that local interest and supporting funds from the State Bank enabled the "Pride of Australia" nugget, found north of Wedderburn in 1982, to remain in the State on public display. It is perhaps surprising, considering the richness of Victoria as a nugget producer, that none had previously been retained as a reminder of the fortune bestowed on the state by the gold occurrences.

LIFE ON THE EARLY GOLDFIELDS

The gold rushes dominated Australian life in the 1850s and had profound effects on the social, economic and political development of the country. While all colonial districts were affected directly or indirectly, the Victorian rushes brought about the most remarkable revolution. In early 1851, Victoria had a population of about 77,000 and a mainly pastoral economy. In 1852, it received 95,000 new arrivals and by 1854 the population had quadrupled. In Oc-

Figure 12. **Dry blowing for gold on Hannan's goldfield, Western Australia (from Price, 1895).**

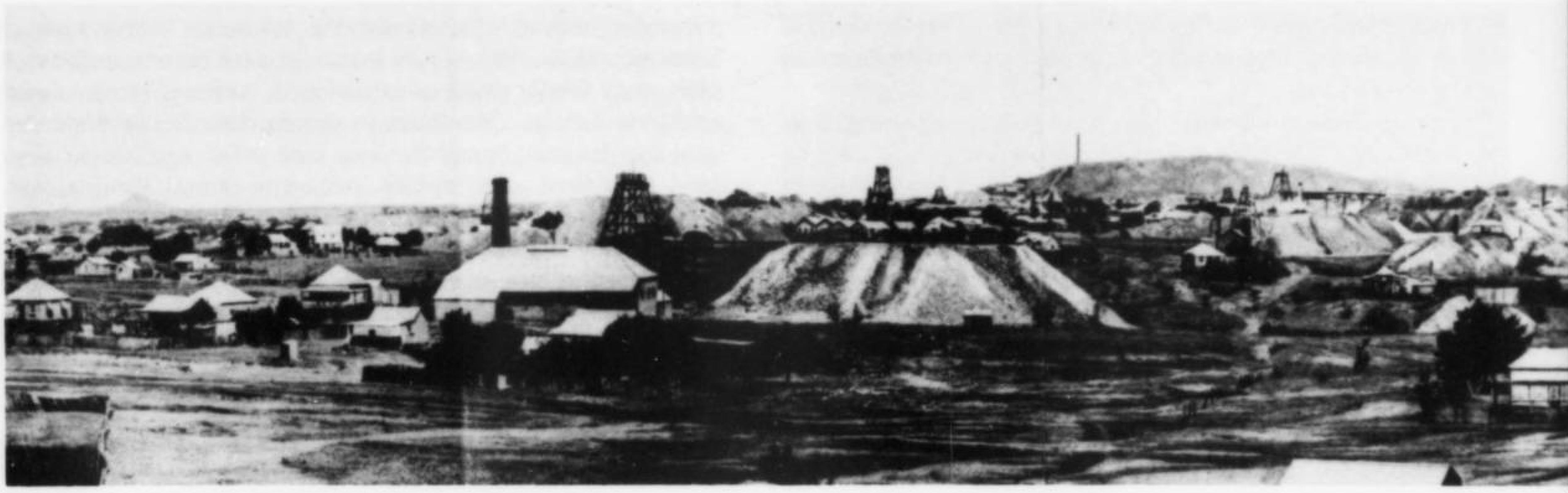


Figure 13. **Panorama showing the surface workings on the Charters Towers goldfield, circa 1900.**

tober, 1851, as people left Melbourne for the first New South Wales goldfields, Governor LaTrobe had complained that "cottages are deserted, houses to let, business is at a standstill." Yet within a year there were no empty houses in Melbourne and hostels and canvas towns could not cope with the population. Rents and food prices soared till thousands of new comers were practically at poverty level.

The 1840s in Europe had been a decade of revolution and deprivation and the magnetism of gold and a new life across the world, first in California in 1849, then in Australia in 1851, caused a mass migration. For several years, more people left Britain bound for Australia than for the United States – half a million people migrated south in the ten years from 1851 to 1861.

By late 1851 the first gold seekers from overseas, attracted originally by news of the Bathurst finds, left their ships at Melbourne and headed for the Victorian goldfields. In a single month in 1853, 69 ships arrived in the port of Melbourne, which soon became another San Francisco. Many migrants never got beyond Melbourne, but instead found a niche catering for the demands of other new arrivals.

The early rushes usually occurred in unmapped, remote country. Rough bush tracks were the only means of access, along which passed a continuous stream of heavily laden wagons and carts piled high with provisions and mining equipment, often escorted by groups of armed men. A contemporary writer, observing the road to Bathurst from Sydney, concluded:

> [The travellers] must have thrown all they possessed into the adventure, for most of their equipments were quite new – good stout horses, harnesses fresh out of the saddlers hands, gay-colored woollen shirts and comforters and Californian sombreros of every hue and shape.

If the scene on the road to the goldfields was a vivid jumble of images, there was just as dramatic a change in Sydney and Melbourne, where the question on everyone's lips was "Are you going to the diggings?" Shopkeepers changed their wares overnight to display goldfield essentials such as clothing and mining tools. The newspapers became filled with advertisements for all manner of items and services – tents, quicksilver, biscuits, guns, etc. Even identification information was offered, as the following announcement indicates:

> To Gold Diggers. The undersigned will give information on any unknown substance found at the Diggings in the process of washing, free of any charge whatsoever. [Signed] . . . Practical Chemist.

The long trek to the diggings, both in Victoria and New South Wales, took two or three days; there were no comfortable inns along the way, although sly-grog shanties and canvas rest homes soon appeared along the main routes. In wet weather roads became impassable bogs and in the height of summer, dustbowls. There were no bridges or punts, so that wagons and drays had to be dragged across fords – often a slow and sometimes a perilous exercise. Some forested areas became the haunts of bushrangers, whose targets ranged from lone travelers to the official gold escorts.

Once at the goldfield each party had to obtain their licenses from the local gold commissioner, then stake out their lease on any unclaimed ground. "New chums" needed to learn not only what gold looked like, but also how to recover it using the various techniques available.

The "rushed" country was usually pockmarked with shafts, sinkings and dumps. Where shafts went deeper, ventilation sails were erected over each windlass. Two members of each party on the claim, usually 2.7 to 3.1 meters square, worked the shaft, while the others loaded the washdirt into barrows or sacks and carried it to the creek for washing in pans or cradles. During summer, creeks often dried up and diggers had to stockpile the washdirt or else cart it long distances to more permanent streams.

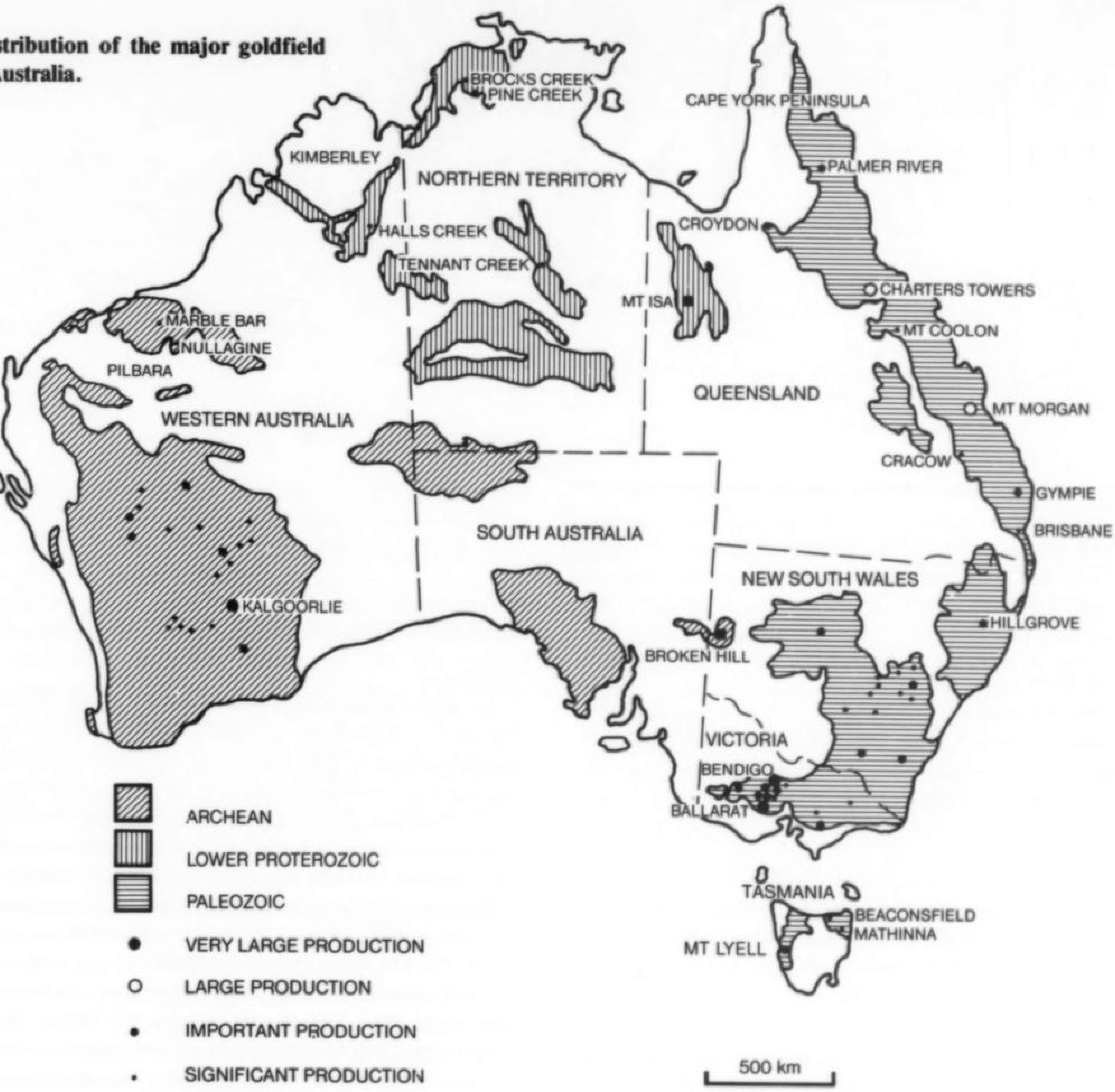
Scattered all round the diggings were tents and bark "lean-tos" and the main track through the field was lined with shops of all types. Even though these canvas towns were temporary, lasting only until the next rush, they housed up to 40,000 diggers. More permanent structures of timber and stone gradually appeared on larger fields and became fledgling townships such as Ballarat and Bendigo.

Life on the diggings is well documented in a rich legacy of goldfield literature and art. It was colorful, simple and hard. Food was essentially meat (mainly mutton), damper (a kind of bread) and tea, supplemented by vegetables when these were available. There were everpresent hazards arising from overcrowding, such as illness and accidents like cave-ins and drownings. In summer, flies, bushfires and lack of water made life uncomfortable. But the goldfields were surprisingly well-ordered, considering the lack of adequate police protection and the itinerant and cosmopolitan nature of the work force. There was a universal recognition of the sabbath as a rest day and the prohibition of spirts may have quelled some drunkenness, but encouraged the establishment of illicit outlets.

The small size of the claims meant that thousands of men could maintain the hope of making their fortunes. And if their claim proved barren, they could quickly move on to the next rush. However, as the number of diggers continued to grow and the richest alluvial deposits began to run out, unrest grew.

The chief cause of trouble on the fields, both in Victoria and New South Wales, was the licensing system which led, in 1854, to the armed rebellion at Ballarat; diggers fought police and troopers

Figure 14. **Distribution of the major goldfield provinces in Australia.**



from within a crude enclosure known as the Eureka Stockade. The casualties, although only about 30, caused shockwaves throughout the colonies and, as a result, the system was altered to allow for an annual miner's right at a reduced fee, a compensating tax on all gold mined, adult male franchise and other concessions.

Another cause of friction was the entry of Chinese miners in large numbers on many fields from 1853. The Chinese were not considered as permanent settlers, and much of their gold was sent back to their families or masters. On the diggings, they were highly industrious, often content to rework old shafts and tailings. They lived frugally and kept to themselves. As a result, they aroused unfair suspicion and were accused of all manner of vices. Race riots occurred on a number of fields, the most serious being at Buckland and Bendigo in the 1850s and at Clunes in 1873. New South Wales experienced similar disturbances at Lambing Flats in 1860–1861 and at Young. These led eventually to restrictions on Chinese immigration, but not before Chinese miners made significant contributions to the opening up of the northern Australian goldfields

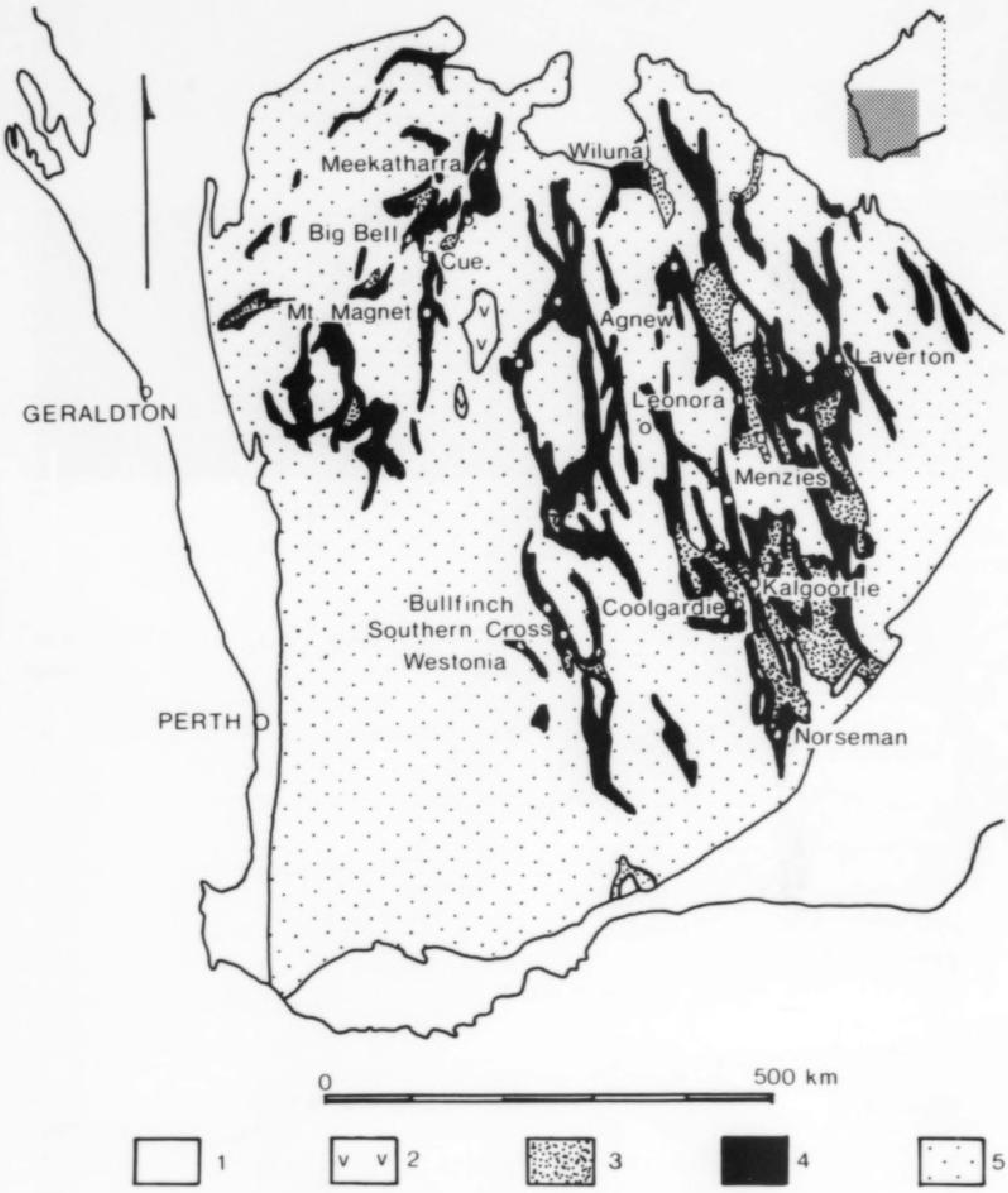


Figure 15. **Simplified geological map showing the major gold deposits of the Archean Yilgarn Block, Western Australia. 1. Post-Archean rocks; 2. Mafic intrusive complex; 3. Sedimentary sequences; 4. Volcanic rocks (greenstone belts); 5. Granitic rocks and metasediments (after Gee, 1975).**

such as Palmer River and Pine Creek.

Although representative government had been granted to the colony of New South Wales in 1850, before the official discovery of gold, the nature of the great influx of population in the 1850s (predominantly male and with a strong streak of independence) overturned a penal and pastoral society and guaranteed a democratic base. The wealth created by gold, although unevenly distributed, refuelled the pastoral industry. Gold mining established the need for supportive manufacturing industries, particularly when underground mining on quartz reefs began. Mines inland needed population bases and transport such as improved road and railway systems. More remote centers, such as the Queensland fields, saw the establishment of ports like Rockhampton, Cairns and Cooktown. The major cities boomed and country gold towns like Ballarat and Bendigo prospered and became permanent. Australian society as a whole became more individualistic, optimistic, speculative and egalitarian.

The effects were felt worldwide. Australian and California gold helped revive a depressed British economy and world commerce in general. The legacy of the early gold rushes went far beyond the value of the gold produced and as a result could never be squandered.

The above historical information was distilled from a large number of publications too numerous to cite without seriously disrupting the text; however these are all listed in the bibliography.

DISTRIBUTION OF GOLD IN AUSTRALIA

General

In nearly all the major Australian goldfields, detrital deposits of Tertiary to Recent age provided the most easily-won and richest concentrations of gold. However, since the 1860s the bulk of production has come from quartz reefs in Precambrian and Paleozoic rocks in various geologically and mineralogically defined provinces. The distribution of mineralization is not uniform and large areas of Precambrian rocks in central Australia are virtually barren.

Beginning in the west of the continent, a metalliferous province in which gold dominates extends for over 700 km north-south and is over 500 km wide. The province coincides with the Yilgarn Block, one of two large Archean cratons forming the Western Australian shield area. The Yilgarn and the smaller Pilbara Block consist of "greenstone belts" composed of ultramafic, mafic and felsic volcanic rocks and intrusions, banded iron formations ("jaspilites") and sediments which have been intruded by granitic rocks. The greenstone belts occur mostly as partly dismembered synclinal keels, elongated roughly north-northwest, between granitic intrusions (Gee, 1975).

All the major Western Australian goldfields such as East Coolgardie (including the important mines along the Golden Mile between Kalgoorlie and Boulder); Murchison (including the mining center of Mt. Magnet); Mt. Margaret (Laverton and Leonora); East Murchison (Wiluna) and Dundas (Norseman) are on the Yilgarn Block. The Pilbara Block, incorporating the Pilbara Gold-

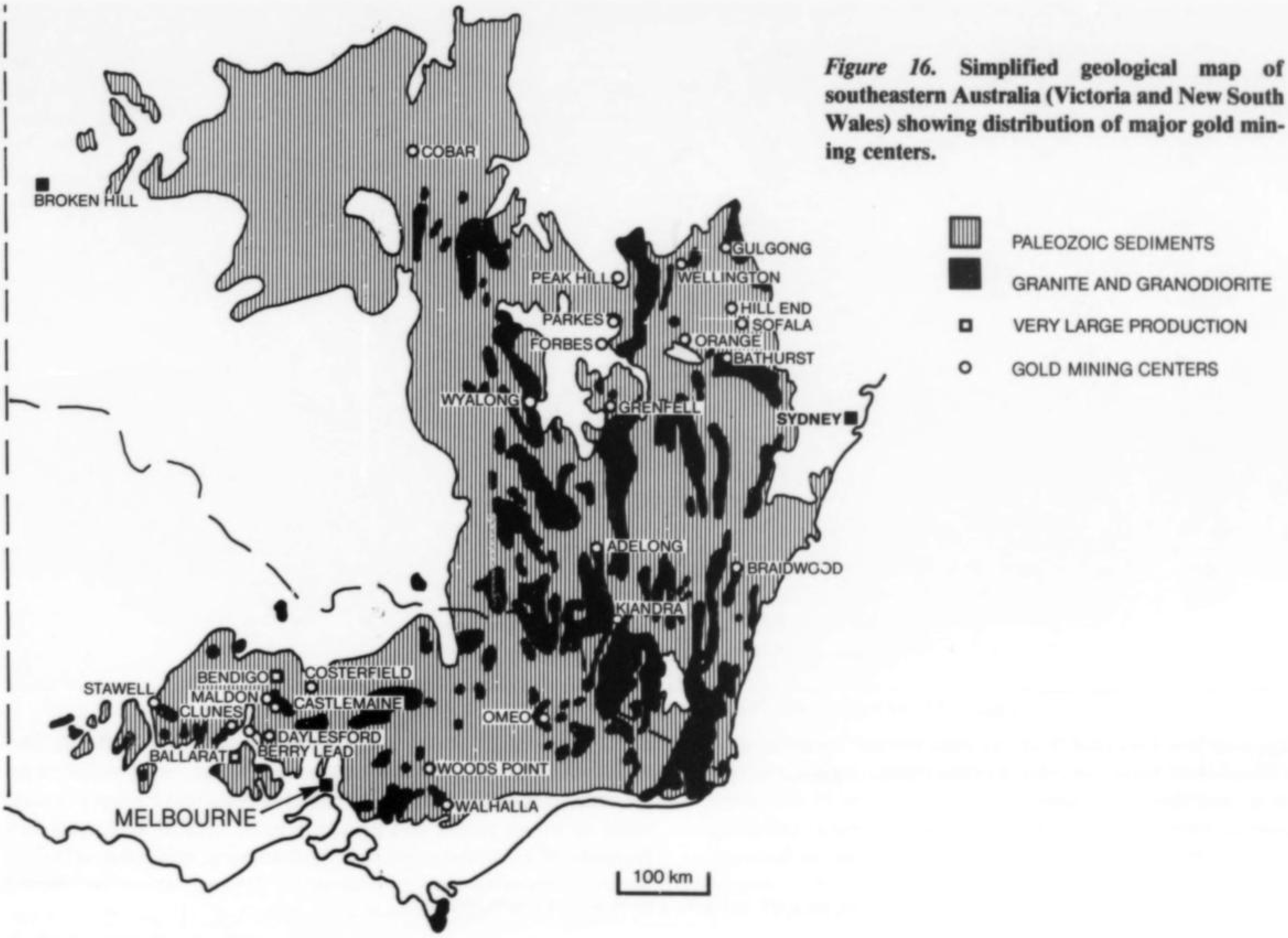


Figure 16. **Simplified geological map of southeastern Australia (Victoria and New South Wales) showing distribution of major gold mining centers.**

field, is not as richly mineralized, although the recently opened Telfer mine is now Australia's most productive mine. In northern Australia the Kimberley and Pine Creek goldfields are in Proterozoic rocks, mainly metasediments.

These old deposits in the relatively stable shield region contrast with mineralization in the Paleozoic sediments of the Tasman Geosyncline, extending almost continuously along the eastern margin of the continent from Queensland to Tasmania. This metallogenic province includes the major central Victorian deposits of Ballarat and Bendigo, the important copper-gold deposits at Cobar in New South Wales and Mt. Lyell in Tasmania and the Mount Morgan, Gympie and Charters Towers goldfields in Queensland.

Primary Deposits

The primary gold deposits in the eastern Australian goldfields of the Tasman Geosyncline can be classified into four main types (Murray, 1975; Golding and Wilson, 1981).

1. **Quartz reefs** in marine sediments which have been folded and metamorphosed to varying degrees. Examples are the Cambrian-Devonian slate-sandstone belt of central and west-central Victoria and the Permian sediments at Gympie.

2. **Disseminated or massive sulfide deposits** in either volcanic or sedimentary sequences. Examples are Mount Morgan in Queensland and Cobar in New South Wales, respectively.

3. **Fissure veins within granitic rocks,** for example, Charters Towers in Queensland.

4. **Fissure veins in mixed sequences,** mostly volcanic and especially near intrusive contacts. These are numerous but not economically significant.

In the older Precambrian goldfields of Western Australia the principal lodes are within cross-cutting shear and shatter zones in the host rocks, which are generally altered mafic volcanic rocks, tholeiitic doleritic intrusions and minor cherts, tuffs and black shales. Quartz reefs in shears and fractures are the dominant source of gold, but stockworks are also very important locally, for example at Mount Charlotte on the Kalgoorlie field. Intrusive, albite-rich felsic rocks are commonly associated with gold mineralization.

Many deposits are also hosted by jaspilites, which are widespread and of both Archean and Proterozoic age. These rocks consist of layers representing original chemical deposition, of alternating lamellae containing quartz, iron oxides, iron silicates and carbonates. The gold orebodies, although small and shortlived, contributed significantly to the total Western Australia gold production. They occur most often as quartz reefs, but fault lodes and enrichment zones are also found (McLeod, 1965).

Quartz Reef Deposits in Eastern Australia

Quartz reefs were extremely abundant in the Victorian goldfields and it has been estimated that between 6000 and 7000 were auriferous (Bowen and Whiting, 1975). The reefs ranged from paper-thin films to masses exceeding 30 meters or so in thickness. The quartz could be massive and white, laminated, cavernous or "mullocky" when it contained fragments of country rock. Rich gold was generally associated with the thinner reefs; the very thick quartz "blows" tended to be barren. In all quartz reefs containing gold, distribution is irregular, with rich patches localized in shoots, the shapes of which depend on the type of reef.

The abundance of auriferous quartz reefs in Victoria and New South Wales enables them to be classified according to their structural characteristics:

Concordant reefs: These are conformable with the enclosing strata. The best known are the saddle and inverted saddle reefs of the Bendigo and Castlemaine fields in Victoria (Thomas, 1953) and

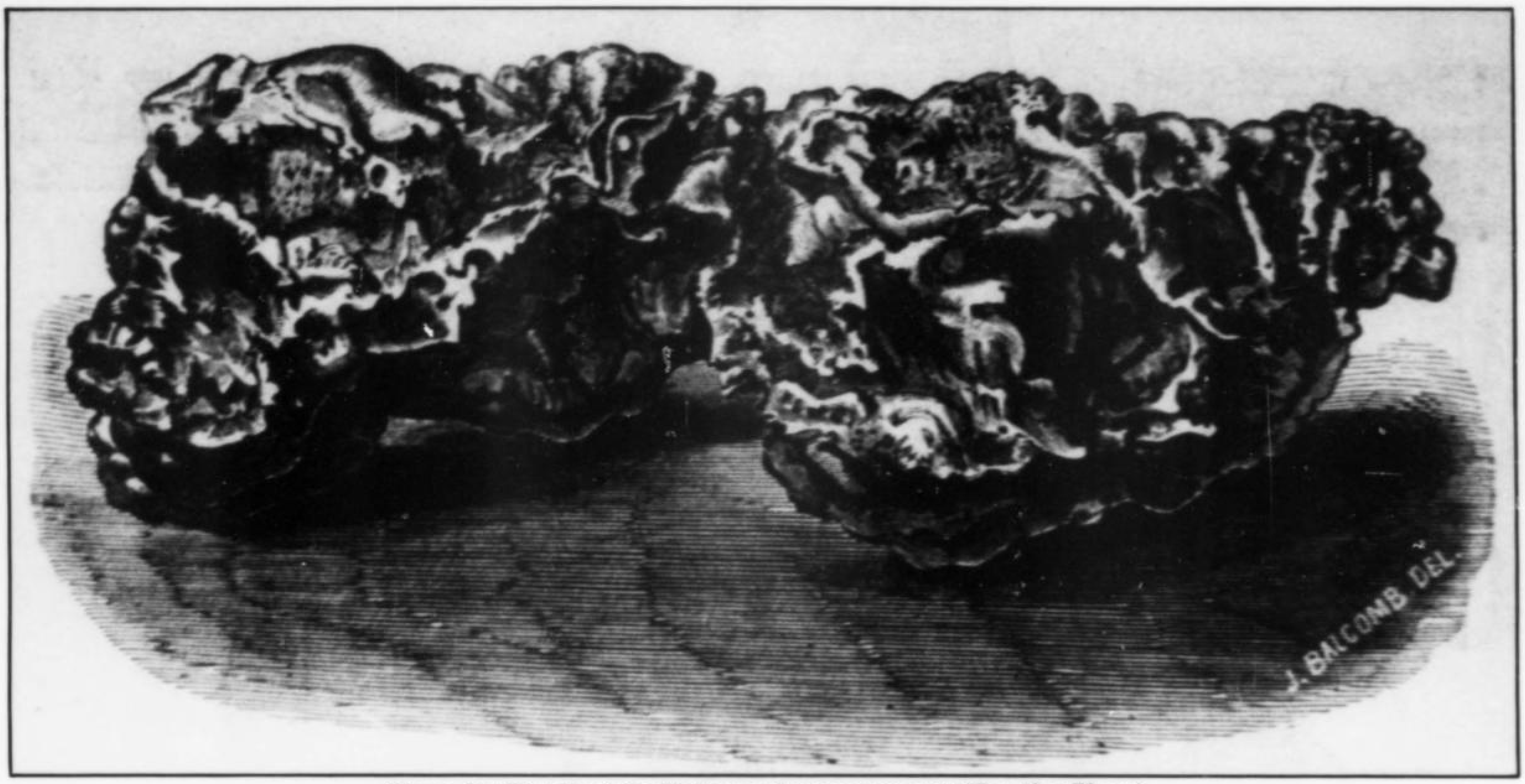


Figure 17. **SKetch of the Welcome Stranger nugget (17 x 40 x 70 cm).**

the Hargraves and Hill End fields in New South Wales (Kenny, 1924). These reefs form where two strike faults intersect at the hinge of an anticline or syncline.

Discordant reefs: These are of a number of types, including reefs in strike faults, and were particularly important at Ballarat, Castlemaine and Maldon. When traced laterally or vertically into folded bedrock, strike fault reefs could change into bedded reefs. Another important reef type consisted of relatively flat-lying quartz veins on thrust planes and tension breaks, such as at Stawell and Daylesford. Gold values were irregular but were highest when the

Table 1. **Largest gold nuggets found in Australia, by state.**

State	Locality	Nugget Name	Date of discovery	Gross weight (ounces)
New South Wales	Burrandong	Burrandong	1838	1,286
Victoria	Moliagul (Dunolly)	Welcome Stranger	1869	2,520*
	Bakery Hill (Ballarat)	Welcome	1858	2,217*
	Kingower	Blanche Barkly	1857	1,743
	Rheola (Dunolly)	Precious	1871	1,717*
	Canadian Gully (Ballarat)	Canadian	1853	1,319
	Canadian Gully (Ballarat)	Lady Hotham	1854	1,177
	Canadian Gully (Ballarat)	Sarah Sands	1853	1,117
	Rheola	Viscount Canterbury	1870	1,114
	Maryborough	Maryborough	1855	1,034
	Canadian Gully (Ballarat)	–	1853	1,011
	Old Golden Point (Fryer's Cr.)	Heron	1855	1,008
	Tarnagulla	Poseidon	1906	953
	Kangderaar	Viscountess Canterbury	1870	912
Queensland	Gympie	Curtis	1867	975*
	Sailor's Gully (Gympie)	–	1889	804
	Chinaman's Flat (Cloncurry)	–	1895	336
South Australia	Onkaparinga	–	1890	48
	Teetulpa	–	1887	29
Western Australia	Larkinville	The Golden Eagle	1931	1,135
	Londonderry	Big Ben	1894	850
	Wealth of Nations (Coolgardie)	–	1894	800
Tasmania	Rocky River	–	1883	243
	Rocky River	–	1883	143

*Net weights were as follows: Welcome Stranger, 2284 ounces; Welcome, 2195 ounces; Precious, 1621 ounces; Curtis, 906 ounces. The Holtermann nugget and the Kerr Hundredweight have been omitted from the table because technically speaking they were not nuggets but masses of gold *in situ* in reefs.

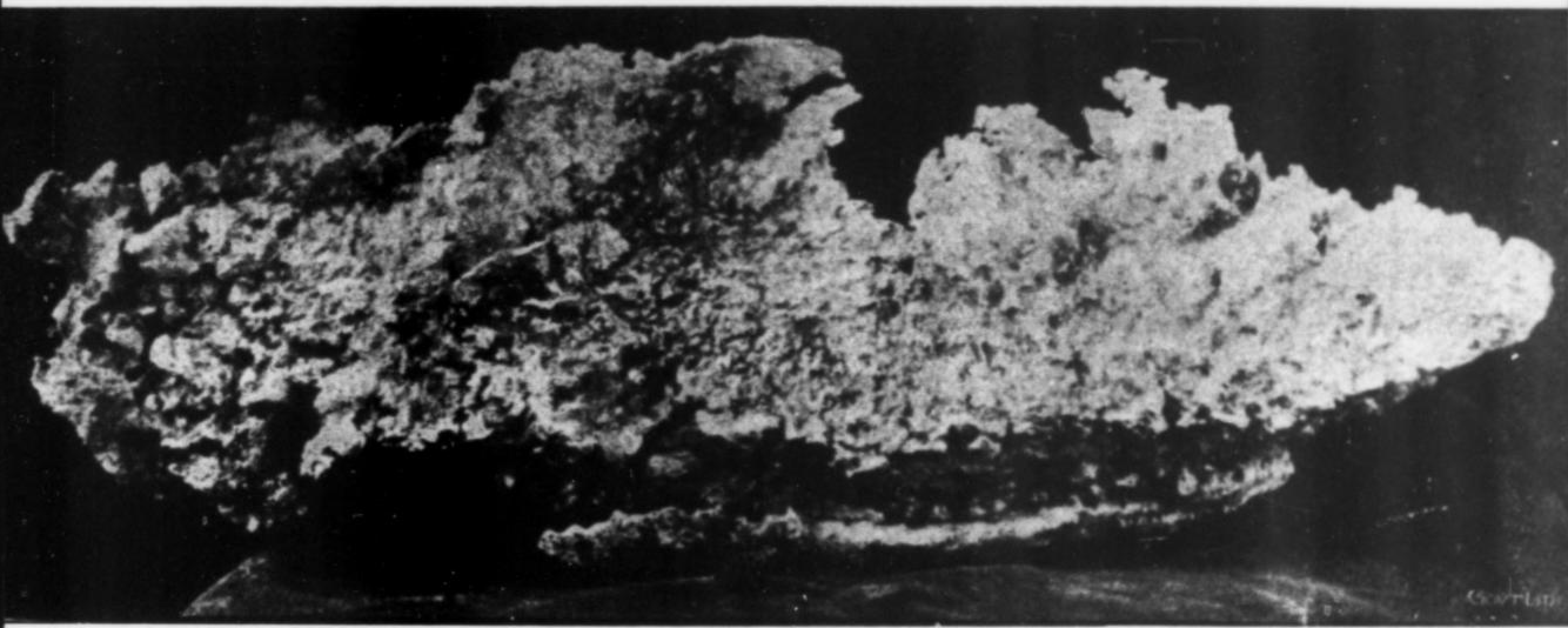


Figure 18. **Large slug of gold weighing 215 ounces found associated with a favorable bed at Kurnalpi, Northeast Coolgardie goldfield, Western Australia, in 1912.**

reefs cut favorable beds. Spurs are groups of quartz veins in irregular fractures, uneven in thickness and scattered throughout the strata, often in breccia zones and as stockworks. Gold values are erratic but often rich.

Reefs and veins associated with igneous rocks: These are of various types, such as reefs along dike walls, or cross-cutting or as spurs. They are of particular importance in the gold mines of Walhalla and Woods Point.

Secondary Enrichment

Early miners observed that, in many Victorian reefs, gold values were richest and gold was coarsest close to the surface. Pessimism that it was not worth mining to deeper levels was fueled by advice from contemporary geological expert Sir Roderick Murchison, based on his observations of gold mines in the Urals. For a period the debate raged, but time has shown that there were sufficient numbers of deep quartz mines in Victoria, where rich shoots in bedded reefs and strike faults were worked to depths of over 1000 meters, to dispel such a general theory.

It is likely that secondary or supergene enrichment occurred in some reef systems. Dunn (1929) considered much of the coarse gold in cracked and fissured quartz in the upper parts of reefs to be secondary in origin, having been redeposited by solutions responsible for dissolving sulfides from the lode quartz. Many sulfide-rich reefs were capped by an iron-oxide–rich zone containing gold which was probably secondary in origin. This is especially well-documented in reef systems hosted by jaspilites in Western Australia.

Indicators

In many Victorian goldfields in the early 1870s the discovery of rich nuggetty gold attached to quartz led miners to certain belts of strata where such specimens were abundant. These favorable beds were called "indicators" and were generally less than 1 cm thick, consisting of carbonaceous slate, pyrite or a thin quartz film. The first found and best known, "The Indicator" at Ballarat, could be traced for 5 km on the surface and to a depth of nearly 400 meters.

The indicators themselves usually did not carry gold, but large masses of gold were often found in or very close to quartz veins where they intersected indicators. These rich patches of gold, encountered when underground mining began, provided evidence for the origin of the large alluvial nuggets in the indicator country.

Similar indicators occur in the Hargraves goldfield in New South Wales. The first large mass of gold, christened "Kerr's Hundredweight," was found by an aboriginal in the outcrop of a quartz reef near Hargraves in July, 1851, and excited a rush to the area. A report at the time stated:

> Out of this [largest] piece, 60 pounds of pure gold was taken. Before separation, it was beautifully encased in quartz. Not being able to move them conveniently, Dr. Kerr broke the pieces into small fragments and herein committed a very grave error – as specimens the glittering blocks would have been invaluable.

Possibly the largest mass of gold ever recovered from a quartz reef was the Holterman Nugget, found in the Hill End goldfield in 1872. It weight about 630 pounds and probably contained around 200 pounds weight of gold prior to its being crushed and amalgamated. The first and largest nugget or slug found in a quartz lode in Victoria was the Lady Don, 606 ounces, from Ballarat in 1866. Other similar masses between 300 and 400 ounces occurred in a number of mines in the Ballarat East, Bendigo and other fields.

Indicators or favorable beds have now been widely recognized on Australian goldfields. At Gympie in Queensland, rich gold occurred where quartz veins intersected particular horizons characterized by carbonaceous shale beds. In a number of Western Australian mines, thinly laminated, highly ferruginous bands in jasper or sheared greenstone acted as favorable beds when cut by quartz veins.

Secondary Deposits

The Victorian and New South Wales goldfields show the widest variety of detrital gold deposits. Broadly speaking, they range from eluvial deposits largely *in situ,* through hillwash deposits to alluvial deposits in Tertiary to Recent stream gravels, sands and clays. Alluvial "gullies," broad sediment-filled valleys of often non-perennial streams, were a feature of most Victorian goldfields. Reactivated stream activity gave rise to terrace deposits in many areas.

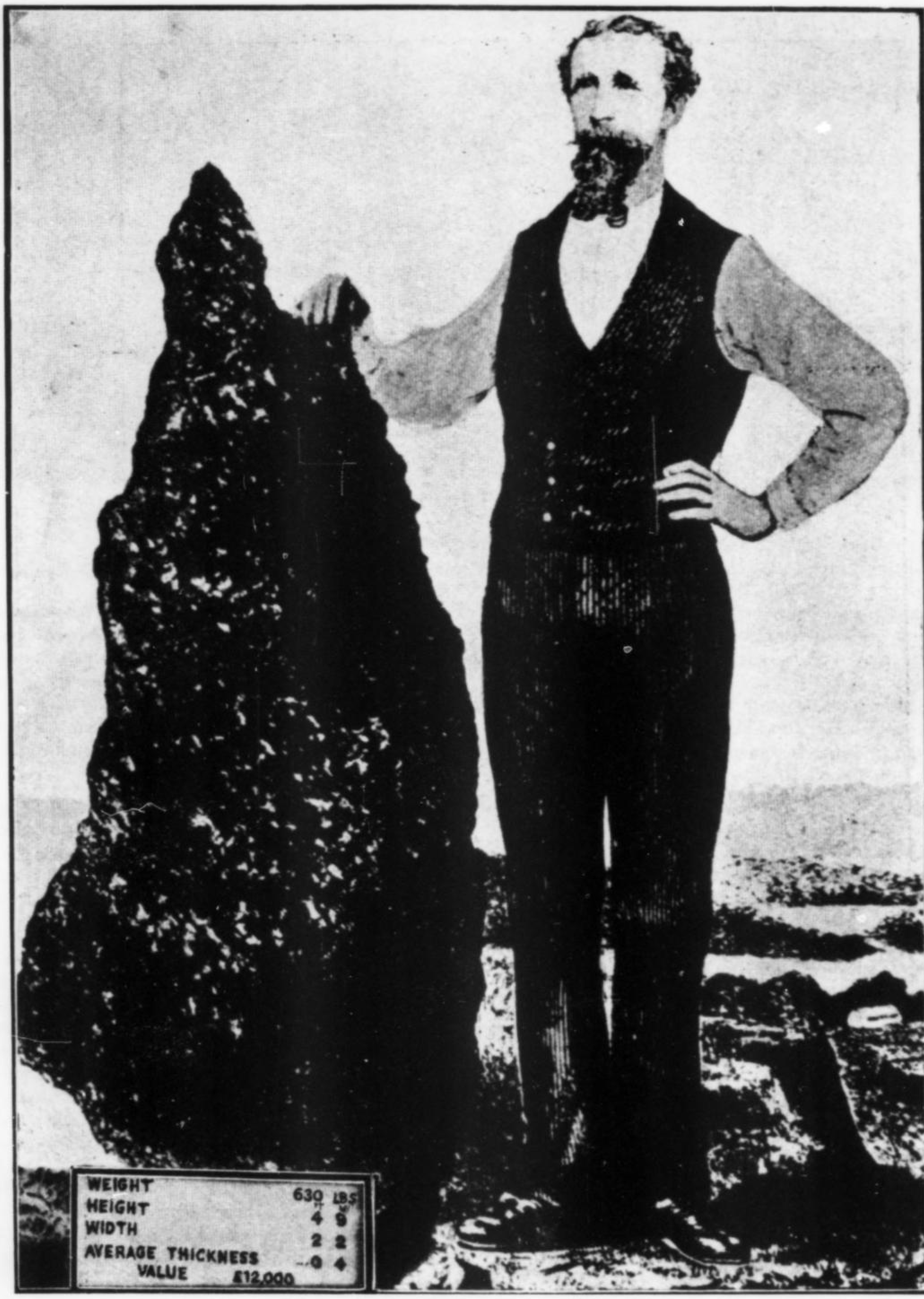


Figure 19. **The "Holterman nugget" found in Beyer and Holterman's claim, Hill End, New South Wales, in 1872.**

By contrast, alluvial gold deposits are less common in Western Australia due to the arid climate and flat terrain. Much of the rich surface gold represents concentration by wind and rain action close to the quartz reefs. Perhaps the richest area was around Cue, in the Murchison Goldfield, where the well known "specking grounds" were best developed.

Very thick alluvial deposits containing fine gold in loosely consolidated sediments were mined by hydraulic sluicing and dredging in both New South Wales and Victoria. While beach deposits were also mined they were of minor economic importance.

Leads

Auriferous gravels buried to depths of less than 30 meters were known as shallow leads. Deep leads, usually of Pliocene age, were important in Victoria (Hunter, 1909), for example at Ballarat, where 2,015,000 ounces of gold were won; Berry, north of Creswick (1,515,000 ounces) and Chiltern/Rutherglen (715,000 ounces) and to a lesser extent on the New South Wales goldfields, such as at Gulgong. A rich lead system was exploited at Kanowna, Western Australia. In Victoria deep leads were frequently formed by burial of stream valleys by widespread Tertiary basalt flows.

Deposits in the leads ranged from conglomerates containing huge boulders and well rounded pebbles, to coarse and fine sand, bound together by clays. Plant remains were common. Fine grains of well rounded gold were distributed throughout the thickness, but were more plentiful close to the base and in "gutters" on the bedrock. Gold was sometimes found concentrated in gravel bands well above the base and these layers were known as false bottoms. Rich nuggetty gold could be found in patches at various levels in the leads, but usually on the bedrock.

Gold was unevenly distributed along the usually sinuous course of the lead, but values generally became poorer with increasing distance from the head of the lead. Values often changed however when branch leads joined the main lead.

GEOLOGICAL FEATURES OF SOME OF THE MAJOR AUSTRALIAN DEPOSITS

The general characteristics of quartz reef deposits have been outlined. These and the other types of deposits found in eastern Australia are best illustrated by examining the geological features of a few of the better known Australian fields.

Ballarat

A number of features made Ballarat a unique goldfield. The early discovered shallow alluvial deposits were extremely rich, as were the deep leads, buried up to 150 meters below five different basalt flows. The number and size of its nuggets (including the 2215 ounce Welcome Nugget) and the persistence of the indicator at whose intersection with quartz veins slugs of gold up to 400 or more ounces occurred, were also remarkable features. Lastly, there was the diversity of auriferous quartz reefs occurring within an area of only 6 by 8 km.

The Ballarat field can be subdivided into three *en echelon* belts. The Ballarat West–Sebastopol field lies beneath basalt flows and the quartz reefs were discovered during deep lead mining. A 1.5-km-wide strip of barren sediments separates Ballarat West from the Ballarat East or Indicator field, which is 400 meters wide and 6.4 km long. To the northeast is the Little Bendigo field.

In all fields, gold occurred in quartz reefs within faults in Lower Ordovician slates and sandstones, folded with north-south axial trends. The predominant faults are parallel to the strike of the bedrock, either coinciding with the dip, or crosscutting. The most important of the latter type were the so-called "leather jacket" reefs in the Ballarat East field. These were named for the leathery nature of the rock in the fault planes and recurred at roughly regular intervals at depth. Rich shoots, with coarse gold slugs, occurred at intersections with indicators but only where the beds were east dipping. In one 45-meter section, 15 nuggets between 25 and 100 ounces each were obtained.

The richest reef mines on the Ballarat fields were the Star of the East, Band of Hope and Albion Consols (520,000 ounces), the Victoria United (452,000 ounces) and Llanberris (450,000 ounces). By 1917, all the mines at Ballarat had closed.

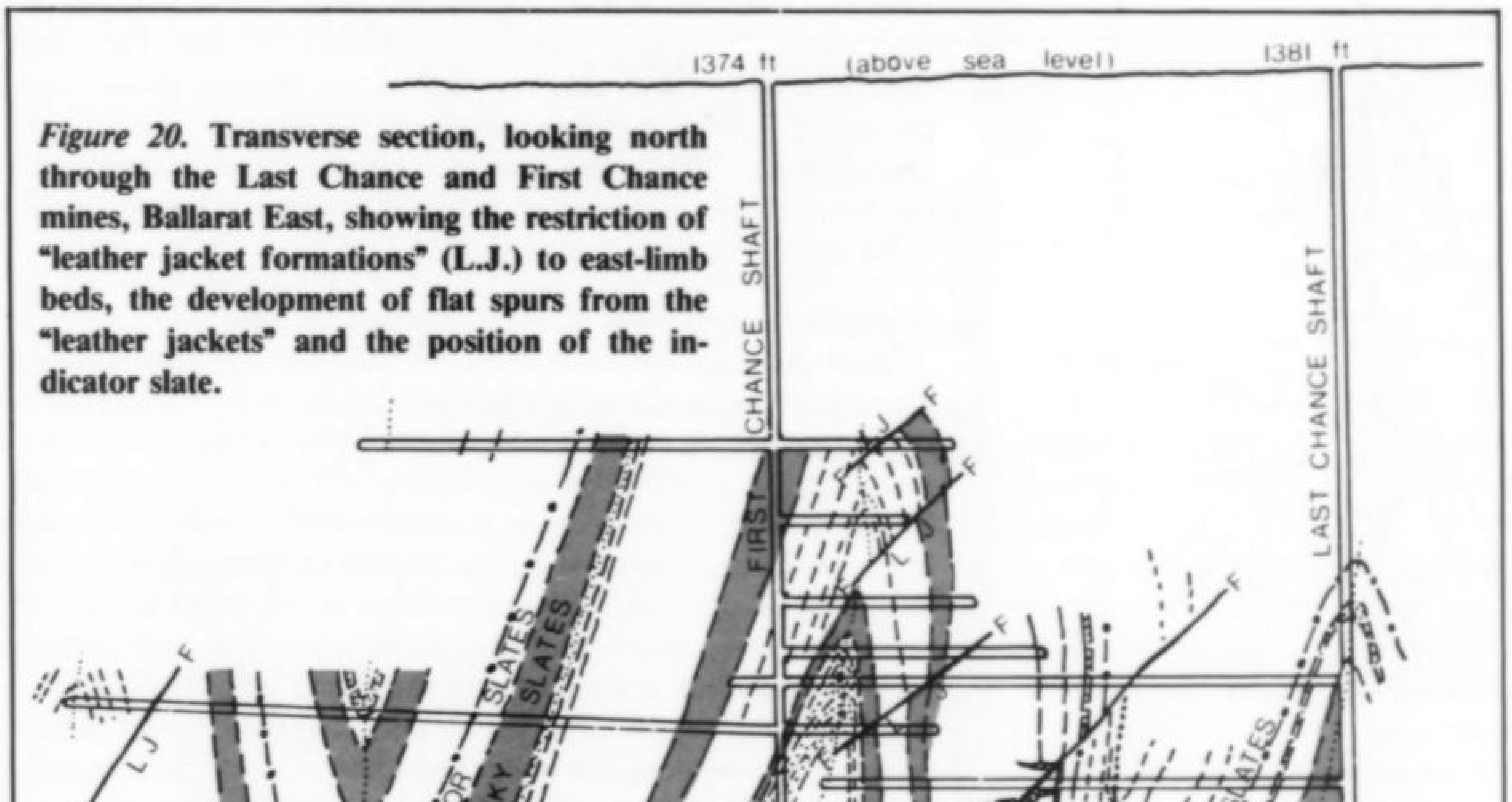


Figure 20. **Transverse section, looking north through the Last Chance and First Chance mines, Ballarat East, showing the restriction of "leather jacket formations" (L.J.) to east-limb beds, the development of flat spurs from the "leather jackets" and the position of the indicator slate.**

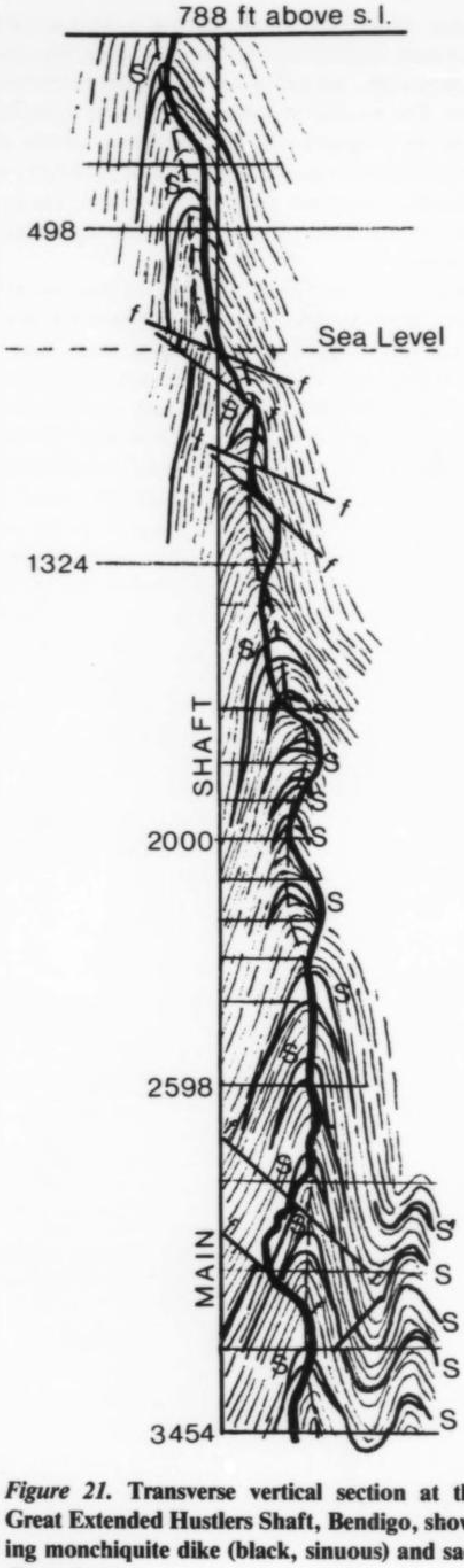


***Figure 21.* Transverse vertical section at the Great Extended Hustlers Shaft, Bendigo, showing monchiquite dike (black, sinuous) and saddle reefs (s).**

Bendigo

Bendigo shares with Ballarat the distinction of being, at one time, the richest goldfield with some of the deepest mines in the world. The goldfield covers an area of 5 by 24 km, elongated north-south, in closely folded Lower Ordovician sandstones and slates. More than 20 subparallel and persistent anticlines occur within the 5 km width. Most of the anticlines are mineralized, but six, the Nell Gwynne, New Chum, Sheepshead, Deborah, Garden Gully and Hustlers lines were the most productive. The deepest mines were on the New Chum line, with some of them reaching over 1400 meters.

The anticlines form part of a complex synclinorium. Individual folds are generally sharp with limbs dipping at 65–75°, but form and pitch may vary within and between folds. The most productive mines appear to be associated with domal structures on the anticlinal lines. Strike faults are numerous and usually bedded on limbs but cut across beds on the fold hinges (Thomas, 1953; Dunn, 1896).

Bendigo is famous for its bedded "saddle reefs," which occur along the axial lines of folds and may be repeated at irregular intervals to considerable depths. The form of these reefs vary but they are generally triangular in cross-section and asymetrical. Large lodes also occurred in faults in spurs and extending upwards from saddles.

A feature of the goldfield was the irregular and generally unpredictable distribution of rich gold in shoots. There is no clear evidence at Bendigo for the existence of favorable beds as at Ballarat.

The richest mine, the Garden Gully United, yielded over 444,000 ounces. Other significant mines were Johnsons Reef (328,000 ounces), Catherine Reef United (233,750 ounces) and Great Hustlers Extended (300,000 ounces). Mining at Bendigo ceased in the early 1950s.

Gympie

The Gympie goldfield, situated about 160 km north of Brisbane, occupied an area about 1.5 by 6 km and was one of the three major Queensland goldfields. Total production was around 3,425,500 ounces. After the initial rush for the alluvial gold, including nuggets, reefs were found in November 1868. These were rich at the surface but were soon abandoned as barren until later work showed that shoots occurred at depth.

The gold occurred in milky white quartz reefs occupying numerous parallel strike faults in a sequence of Permian sediments and volcanics over 650 meters thick. The strike faults dip at 60–80° west, while the country rocks dip uniformly 20° east. The richest concentrations of free gold occurred in flat-pitching shoots where the quartz reefs cut certain horizons of carbonaceous sediments including shales. There were four such horizons in the sequence and the deepest mine, the West of Scotland, reached 962 meters before underground working ceased in 1925.

Walhalla–Woods Point

Most of the gold deposits in the Walhalla–Woods Point goldfield were discovered in the early 1860s and mining in the remote mountainous country in east-central Victoria flourished until 1895. More than 60 mines were worked over an area 100 km long and generally less than about 5 km wide, in a synclinorium in Siluro-Devonian marine sediments intruded by the Middle Devonian Woods Point Dike Swarm. The dikes dip and strike with the sediments and are up to 5 km long. Diorites and lamprophyres are the most common rock types and are associated with the richest gold deposits.

In long narrow dikes, less than about 10 meters wide, quartz reefs occur in or along the walls or as segregations within the dikes. In short, wide dikes or "bulges" and pipe-like bodies, low-angle quartz reefs cross the dike or from wall to wall on faults, which zig-zag downwards forming "ladder vein" systems. Such lodes have been shown to recur to depths of over 600 meters in the A1 and Morning Star mines.

Cohen's Reef at Walhalla was traced at the surface for 5 km but only one major shoot was found. The orebody was closely associated with a thin diorite dike which the reef either cut or enclosed or else the two ran in contact. The reef was mined by the Long Tunnel mine which, with a yield of 1,285,300 ounces, was Victoria's richest single producer.

The A1 mine at Gaffney's Creek is the only large mine working, albeit discontinuously, to the present day. Total production from the field has been at least 2,400,000 ounces.

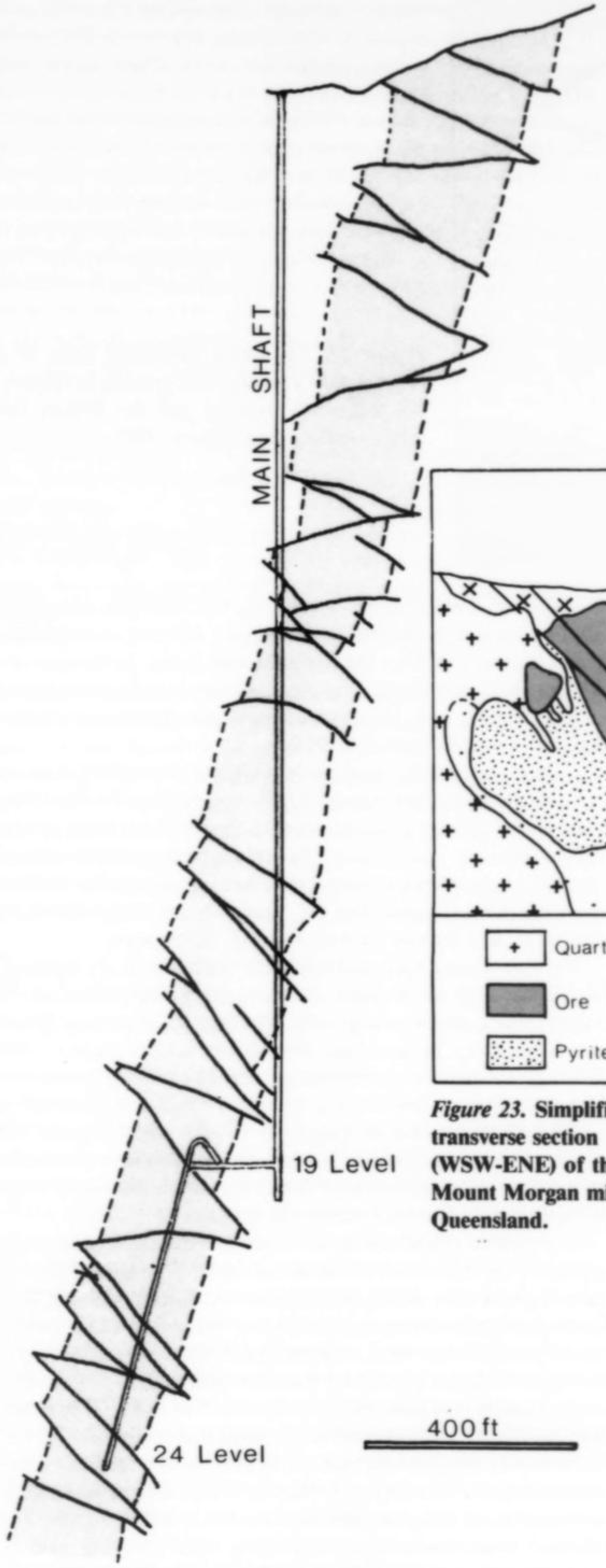


Figure 22. **Transverse section, looking north, through the Morning Star mine, Woods Point, Victoria, showing "ladder" quartz vein system in diorite dike.**

Charters Towers

The Charters Towners goldfield is an example of auriferous quartz reefs hosted by granitic rocks. It extends over an area of about 1500 square km in northern Queensland, but 90% of the gold was produced from mines within 3 km of the center of the city of Charters Towers.

The quartz reefs occur in a 1 by 5 km zone trending roughly northeast-southwest. All the important reefs are in the Ravenswood granodiorite complex, near its contact with mica schists and quartzites of the Charters Towers metamorphics. The reefs occur in two main shallow-dipping fault systems, one mainly north-south, the other east-west. Some lodes also occurred in altered granodiorite. The reefs had poor outcrops and were irregular and discontinuous underground. Many ore shoots did not reach the surface. The Brilliant mine worked to a depth of 960 meters, but in general gold values decreased noticeably with depth.

The central field closed down in the 1930s, but at one stage in 1889 it was Australia's largest producer, with some 320,000 ounces yielded. The overall production has exceeded 6,700,000 ounces.

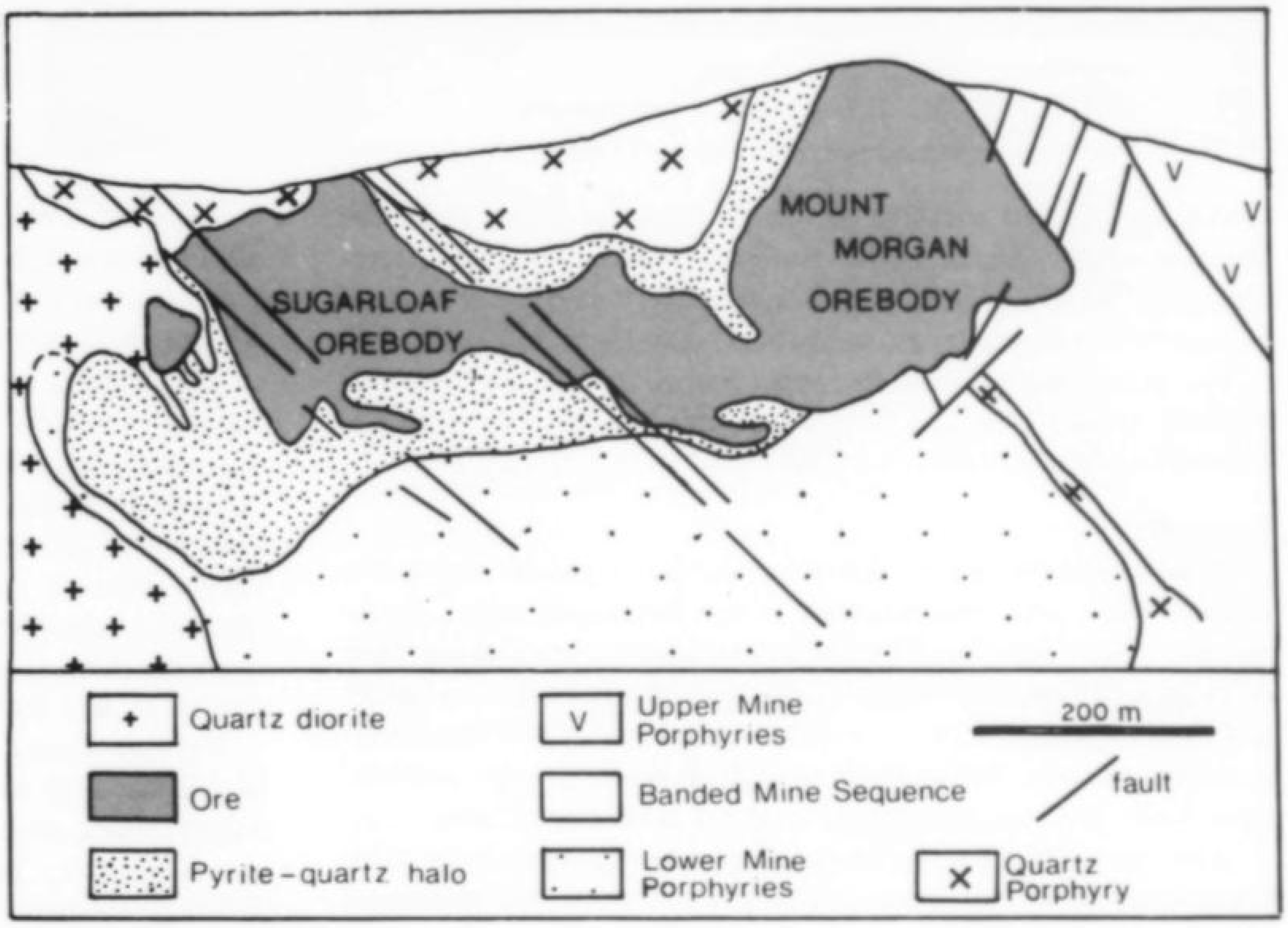


Figure 23. **Simplified transverse section (WSW-ENE) of the Mount Morgan mine, Queensland.**

Mt. Morgan

The Mt. Morgan orebody, 37 km south-southwest of Rockhampton, Queensland, was discovered in 1882. The upper levels were mined for gold until 1902, when copper ore was discovered at depth.

The orebody occurs in a sequence of felsic volcanic rocks forming a roof pendant within the Late Devonian Mount Morgan tonalite. The host rocks have been subdivided into three units and have been affected by several episodes of dike intrusions. The main mineralized structure is an arch or dome within the central unit.

The surface outcrop consisted of gold-bearing limonite and kaolin capping an oxidized zone containing fine gold in sintery quartz and kaolinite. Below the oxidized zone are zones of porous pyrite and quartz forming a halo and containing only a little chalcopyrite but with gold in well-defined, sometimes rich shoots. The main primary orebody consists of massive chalcopyrite, pyrite and gold with a distinctive breccia texture.

Total production from Mt. Morgan has been 7,620,000 ounces. The mine ceased operations in 1981 after 99 years. A large fire had brought production to a halt in 1925, but large-scale open-cut mining recommenced in 1932.

Cobar

The Cobar copper-gold deposit lies within a broad belt of mineralization in central New South Wales. It occurs in strongly

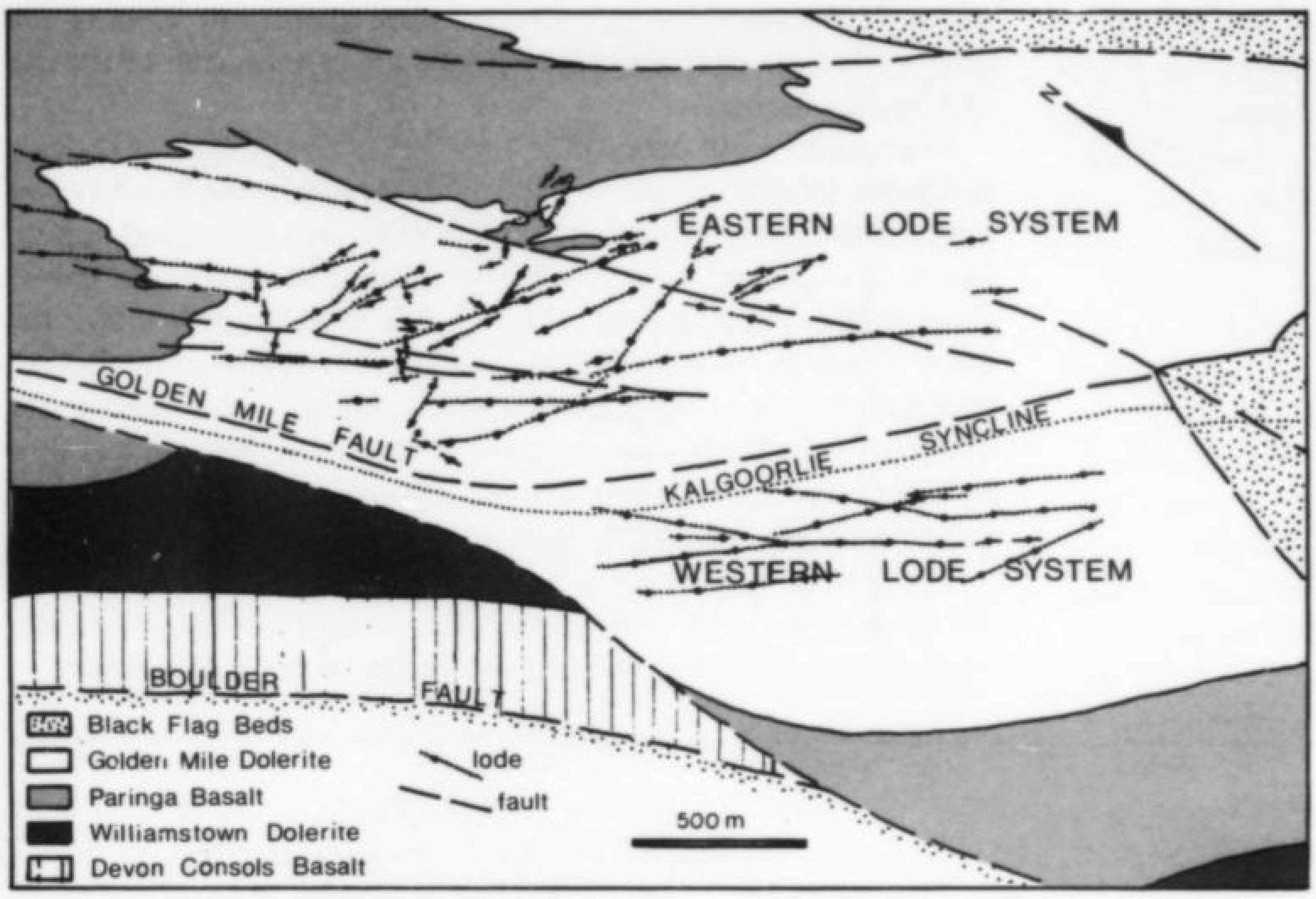


***Figure 24.* Simplified geological map of the Golden Mile showing lode systems in relation to the Kalgoorlie Syncline and the oblique faults (after Golding and Wilson, 1983).**

folded and faulted rocks to the east of a major strike fault, the Boundary Fault. The orebodies consist of replacement and disseminated sulfide ores occurring in strongly cleaved *en echelon* zones in Siluro-Devonian quartzites, sandstones, claystones and slates.

The richest mines, for both copper and gold, were the New Occidental, Great Cobar and New Cobar. Production of the field has exceeded 1,200,000 ounces of gold.

Kalgoorlie

In the Kalgoorlie area of Western Australia, especially within the Golden Mile, gold mineralization is best developed within stratigraphic quartz dolerite. The main host rock is the Golden Mile dolerite, a differentiated tholeiitic sill underlain by basalts and overlain by a sequence of tuffs, sediments and basalts. The Kalgoorlie sequence has been folded isoclinally, disrupted by strike and oblique faults and metamorphosed to upper greenschist facies.

More than 300 lodes consisting of narrow siliceous shears and fractures up to several kilometers long occur on the east and west-dipping limbs of the Kalgoorlie syncline, which are truncated by major strike faults. The main mineralization consists of gold, tellurides and pyrite in a siliceous chloritic host, formed by pervasive carbon dioxide metasomatism of the dolerite (Phillips, 1986). Low grade gold-quartz stockworks occur in the northern end of the field, for example at Mt. Charlotte.

The Golden Mile itself is about 5 km long and contains such famous mines as Lake View and Star, Great Boulder, North Kalgoorlie and Gold Mines of Kalgoorlie. Production from the Golden Mile has exceeded 32,500,000 ounces.

AGE AND ORIGIN OF AUSTRALIAN GOLD

The Tasman Geosynclinal gold deposits occur within a variety of host rocks and structural controls. Within Victoria the reef systems were for many years regarded as mainly Devonian and genetically related to various granitic intrusions of that age. However, there is no statistical correlation between the distribution of reefs and the proximity of intrusions. The variation in age of host rocks (Cambrian to Devonian sediments and late Middle Devonian dikes) and mineralization (Ordovician to early Upper Devonian) is now accepted. The Paleozoic sediments and metasediments hosting the auriferous quartz reefs contain insufficient gold to have been the source material (Glasson and Keays, 1978) and the gold is believed to be derived by remobilization from sediments and basic volcanics at the base of the Paleozoic sequence and emplaced by transportation as complexes in hydrothermal solutions through widespread fracture systems. Oxygen isotope studies (Golding and Wilson, 1981) have not been able to distinguish between a magmatic or metamorphic origin for the hydrothermal fluids. In the case of the Woods Point goldfields, where the reefs are closely associated with dikes, the gold may be magmatic in origin (Keays and Kirkland, 1972; Keays and Donnelly, 1984).

Oxygen isotope evidence for other important eastern Australian deposits (Golding and Wilson, 1981) suggests that the Mt. Morgan deposit is of volcanogenic origin, with the ore fluids being predominantly seawater. The Charters Towers reefs are probably of hydrothermal origin related to late-stage felsic intrusive rocks of Devonian age. The evidence for the probable late Permian Gympie deposit is, like that for central Victoria, ambiguous.

The gold-quartz reefs and wall-rock alteration in the Kalgoorlie-Norseman area in Western Australia have been dated at 2400 million years, much younger than the granitic intrusions into the greenstone belts (at least 2600 m.y., Turek and Compston, 1971). This suggests that the mineralization could be genetically associated with intrusion of mafic dikes 2420 m.y. ago. Geochemical and isotope studies on ore at Kalgoorlie (Golding and Wilson, 1983) suggest that mineralization formed by reaction between chloritic host rocks and hydrothermal fluids of metamorphic origin bringing precious metals from deeper crustal levels.

A common origin for most Western Australian deposits, irrespective of host rock or structural style, is suggested by widespread gold-Fe-As-sulfide associations and similar wallrock alteration, ore-element associations, high Au/base metal ratios and fluid inclusions (Groves, 1984). A general geological model for Archean lode gold deposits typical of Western Australia and other shield areas suggests that gold was first deposited in chemical sediments, then mobilized and redeposited in structural traps such as faults and shears in various host rocks both prior to and after the peak of metamorphism (Golding and Wilson, 1983). Deposition occurred at temperatures and pressures between 300 and 450°C and 0.8 to 2 kilobars, from low salinity, H_2O-CO_2 fluids carrying gold as a reduced sulfur complex (Groves, 1984; Ho *et al.*, 1984).

MINERALOGY

Gold

Primary Gold

The quartz reef systems in the Paleozoic and Precambrian host rocks have provided a spectacular variety of gold habits. The following examples represent a few of the more notable occurrences, based on specimens in museum collections.

Most gold in massive quartz reefs occurs as disseminated, irregular grains, scales, plates and veinlets ranging from microscopic dimensions up to compact, reticulated, spongy or hackly masses exemplified by the nuggets associated with indicators or by the coarse gold, possibly of secondary origin, found in near-surface environments. Often gold in quartz takes habits which lend themselves to descriptive terms such as wire gold and nail gold. In some mines, well formed modified octahedral and dodecahedral crystals were found enclosed completely in massive quartz.

The most beautiful crystals of gold occurred in cavities in quartz veins where they were free to develop perfect crystal faces. Possibly the best surviving specimen of Australian gold crystals is a group of sharp, branching, octahedral hopper crystals from Matlock, Victoria. A superb 23-ounce mass of crystals known as the La Trobe Nugget was found in the McIvor area in Victoria and purchased by the British Museum in 1858. Many other quartz reef mines in Victoria, New South Wales and other states have produced fine gold crystal groups.

Crystals were often found associated with indicators, for example at Wedderburn, Victoria. Gold crystals enclosed within quartz crystals were rare, but several Victorian mines yielded beautiful specimens.

Secondary Gold

So-called secondary gold occurred in many different forms. In the oxidized zones in some mines near Kalgoorlie dull yellow aggregates of fine, loosely adherent "mustard gold" of great purity occurred. Leaf or platy and paint-like forms occurred in near-surface quartz veins or their limonitic caps in many goldfields. Unusual examples of paint gold on serpentine or chrysotile were found at Gundagai, New South Wales. Other forms occurring in the oxidized zones included "plush gold" resembling the pile on velvet, moss gold and beautiful dendritic crystals of pale gold occurring in white clay.

Detrital Gold

Gold in detrital deposits may be classified by size, shape and degree of wear. In many cases the habit of the original primary gold crystallizations may still be discerned. The most comprehensive descriptions of the habits shown by alluvial gold in Australian fields were those of Dunn (1929).

In many Victorian goldfields a continuous sequence of auriferous deposits could be traced. In the hills were the primary gold-bearing quartz reefs. Immediately below them were slope deposits in which hackly or nuggetty gold, often attached to fragments of quartz, could be found by surfacing or loaming. Gold in these forms showed no evidence of abrasion. As the gold was traced into the auriferous gullies and creek deposits, then into shallow and finally deep leads, the grain size decreased and the degree of abrasion increased. The finer fractions were known as flour, fine or dust gold, with the finest fraction, slime gold, often obtained from washings in puddling machines. Scaly gold came in a range of grain sizes, while terms such as flaky, branny or seed gold were applied to particular less common forms. Small rolled cylinders referred to as cornet gold were found in alluvial deposits at Ballarat, Taradale and Creswick. Creswick also yielded spherical gold known as shot gold, derived from water worn crystals. Small water-worn single crystals and groups were common in alluvial deposits at Ballarat and Heathcote.

Nuggets

Of all the forms taken by gold, nuggets generated the greatest excitement and, at times, the most discussion. Although nuggets were found in virtually all Australian goldfields, those from Victoria were the biggest and the most abundant. The records are undoubtedly incomplete, but more than 1200 nuggets weighing over 20 ounces have been documented (Anonymous, 1912). The goldfields around Dunolly (with 126 over 50 ounces), Rheola (98) and Ballarat (38) yielded the greatest number.

Figure 25. **Unusual types of alluvial gold. Seed gold from the Goulburn River, Jamieson, Victoria (Museum of Victoria specimen M37980, largest piece 7 mm long); Cornet gold from Taradale, Victoria (Museum of Victoria specimen M37981) and shot gold from Creswick, Victoria (M37979).**

The largest of all, the Welcome Stranger nugget (2285 ounces), was uncovered on a bush track in Black Lead, Moliagul, in 1869. The second largest, the Welcome nugget (2218 ounces) was found in 1858 on Bakery Hill, Ballarat, in an alluvial gutter at a depth of 55 meters. Many other magnificent nuggets weighing close to 1000 ounces were found but virtually none survived intact. A number of smaller nuggets found their way to Europe as gifts for royalty. Models were made of many of the nuggets, mainly from sketches or photographs, but the resulting outlines are often distorted or much simplified.

The excitement generated by the discovery of the large gold nuggets in Victoria soon turned to a realization that they were not random in occurrence. While they varied in size and were not confined to any particular kind of washdirt or depth, they were almost always associated with quartz reefs in indicator country. This relatively narrow belt runs from Ballarat northwards through such fields as Dunolly, Moliagul and Tarnagulla to Wedderburn. Nuggets from particular goldfields sometimes show characteristic features. For example, many nuggets from Kingower, near Dunolly, ranging from less than 10 ounces up to the 845-ounce Hand of Faith nugget are characteristically flat and smoothed by abrasion.

While the Victorian alluvial nuggets were the most spectacular, large nuggets were discovered on many Australian goldfields. In Queensland the Curtis Nugget (975 ounces) and another of 804 ounces were found during early mining at Gympie. A 336-ounce nugget was found at Chinamans Flat, in the Cloncurry area in 1895. Of the New South Wales fields, Burrandong near Orange yielded the largest nugget (1286 ounces) in 1858. Kiandra was a prolific field with a 400-ounce nugget found in the Snowy River in 1860 and several others exceeding 100 ounces. One of the largest surviving nuggets, the Maitland Bar (350 ounces), was discovered near Hargraves in 1887.

In Western Australia the 1135-ounce Golden Eagle, found near Kalgoorlie in 1931, was the largest. In 1894 two large nuggets were found at Coolgardie and Londonderry (800 and 850 ounces respectively). In 1890, during early diggings on the Coongan River in the

Figure 26. **Dendritic gold crystals in white clay from Donnybrook, Western Australia (Museum of Victoria specimen M7327, 2 x 2.5 cm). Photo by Frank Coffa.**

Pilbara goldfield, the Little Hero nugget (338 ounces) was discovered. Nuggets were found on the Teetulpa goldfield in South Australia but were all less than 50 ounces. In Tasmania, the largest recorded nugget (243 ounces) came from the Rocky River in 1883.

The opinion that gold was found in far larger masses in the alluvial deposits than in nearby reefs, not only in Victoria, but also in the New South Wales and Western Australian fields (Woodward, 1894), led to early theories that nuggets grew by deposition of gold from solution and by accretion of smaller particles in the leads (Selwyn and Ulrich, 1866). One early theory even went so far as to accredit roots with the power to draw gold from solution, in order to explain nuggets found entangled in tree roots.

Accretionary theories of nugget growth were advanced by some observers who believed there were subtle differences in fineness between gold in nuggets and that in reefs. However, studies by Liversidge (1897) on Western Australian nuggets showed they were crystalline with no evidence for concentric or accretionary growth. Dunn (1929) suggested that the large nuggetty patches found near the surface in quartz reefs in both Victorian and Western Australian deposits could be explained by secondary enrichment.

There is certainly evidence for mobilization of gold in solution, both in surface enrichment zones in many Western Australian lodes and in deep leads. The famous deep lead at Kanowna, Western Australia, contains perfect small gold crystals growing on manganese oxide coating kaolin. Shale pebbles from a number of Victorian leads have been found with small flattened nuclei of gold on cleavage planes. However, it is now generally accepted that the large eluvial and alluvial nuggets found in Australian gold fields were derived directly from quartz reefs.

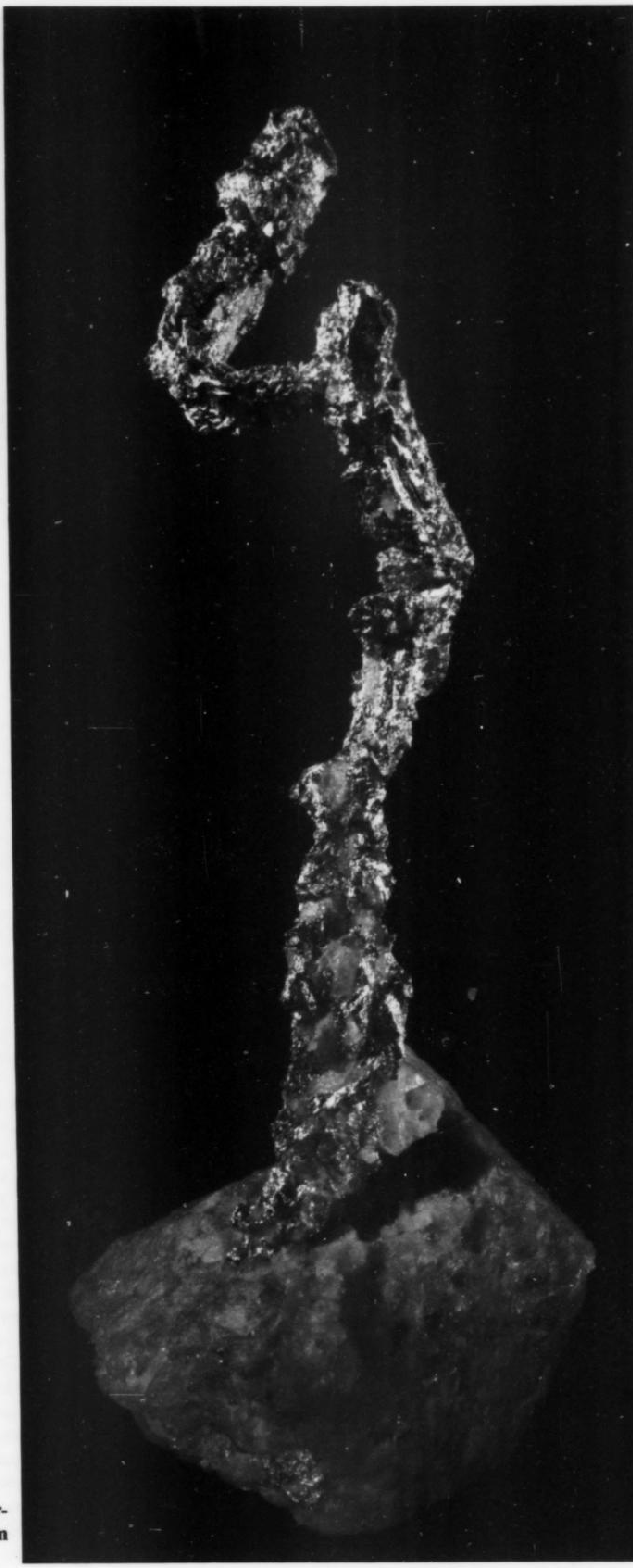


Figure 27. **Wire gold, Golden Crown mine, Yarrambat, Victoria (collection of B. Shelton, 8 cm high). Photo by Frank Coffa.**

Figure 28. "Mustard" gold, Kalgoorlie, Western Australia (Museum of Victoria specimen M35351; patch is 3 cm across). Photo by Frank Coffa.

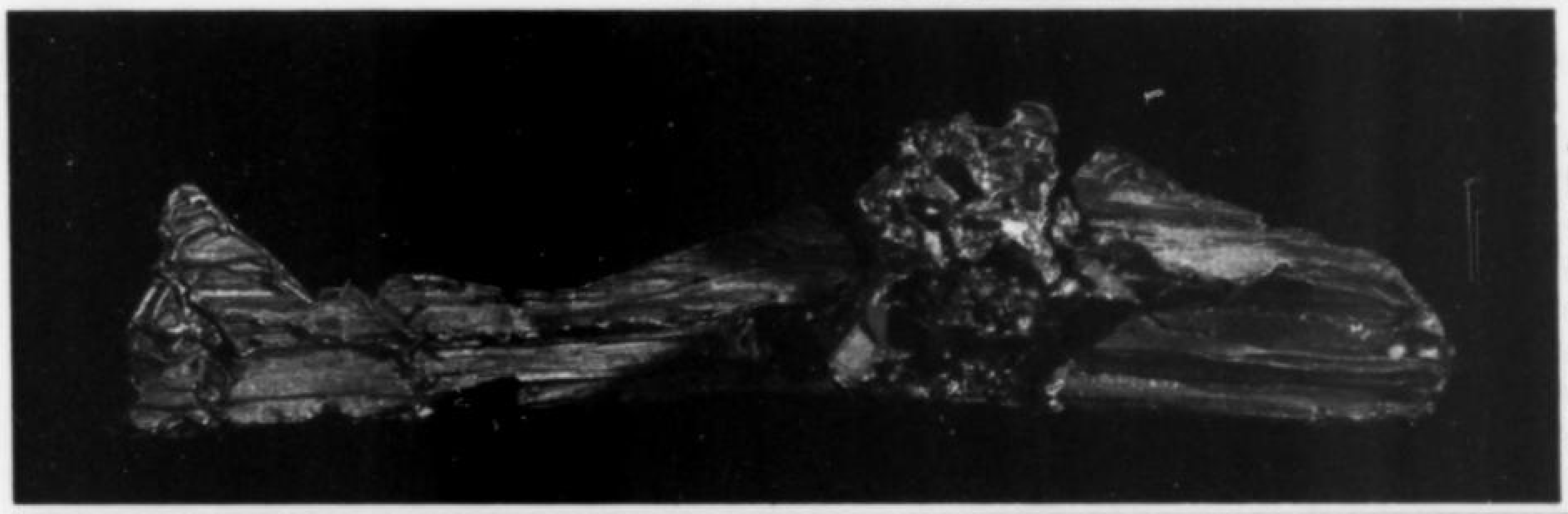


Figure 29. Thin gold crystal group, 2.5 cm long, from the Angepina goldfield, South Australia (collection of C. Johnston).

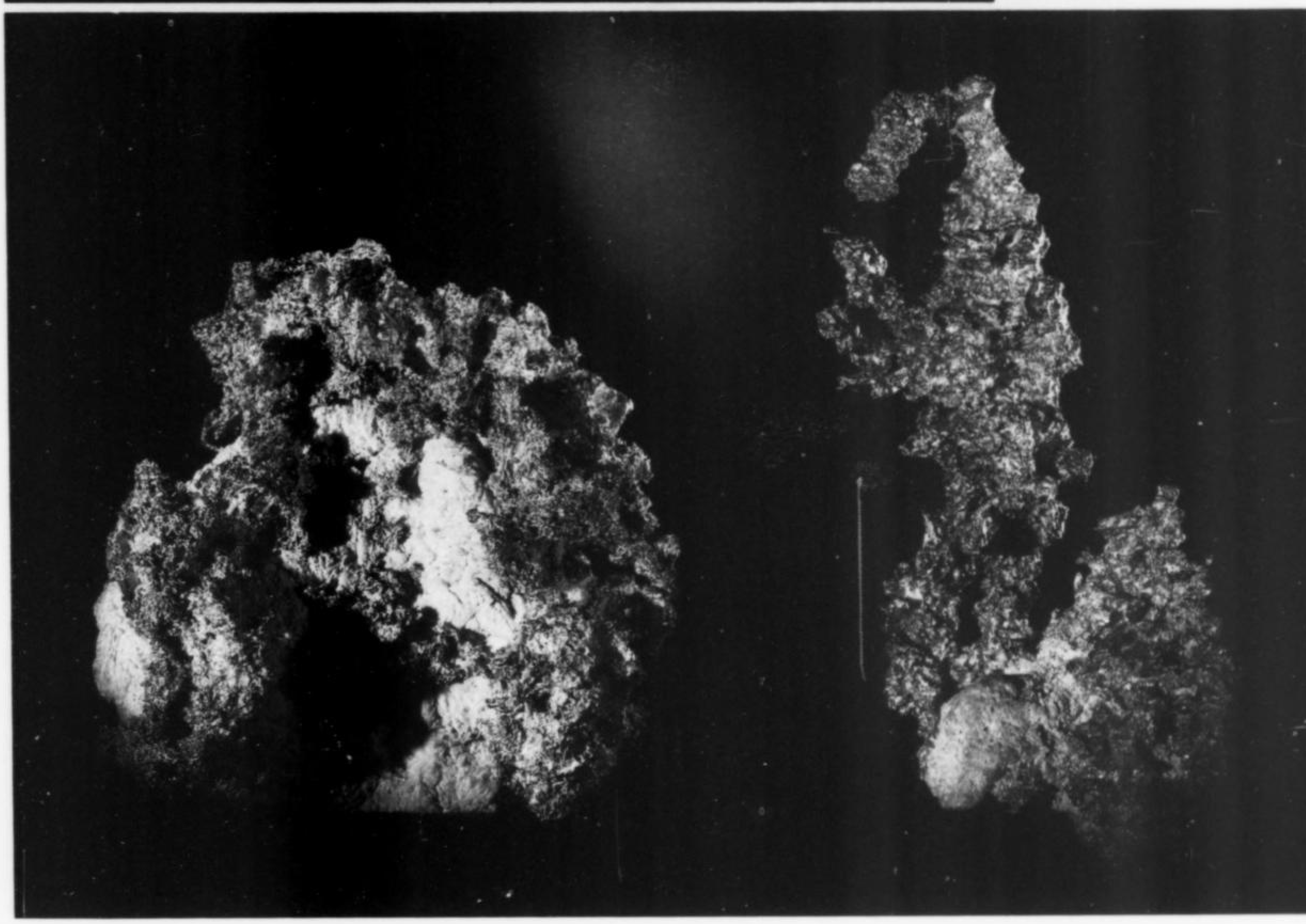


Figure 30. Coarse gold, etched from quartz, from Wehla, Victoria (left 4 x 5 x 6 cm, Museum of Victoria specimen M35844) and Golden Crown mine, Yarrambat, Victoria (right, 7 cm high, Museum of Victoria specimen M27001). Photo by Frank Coffa.

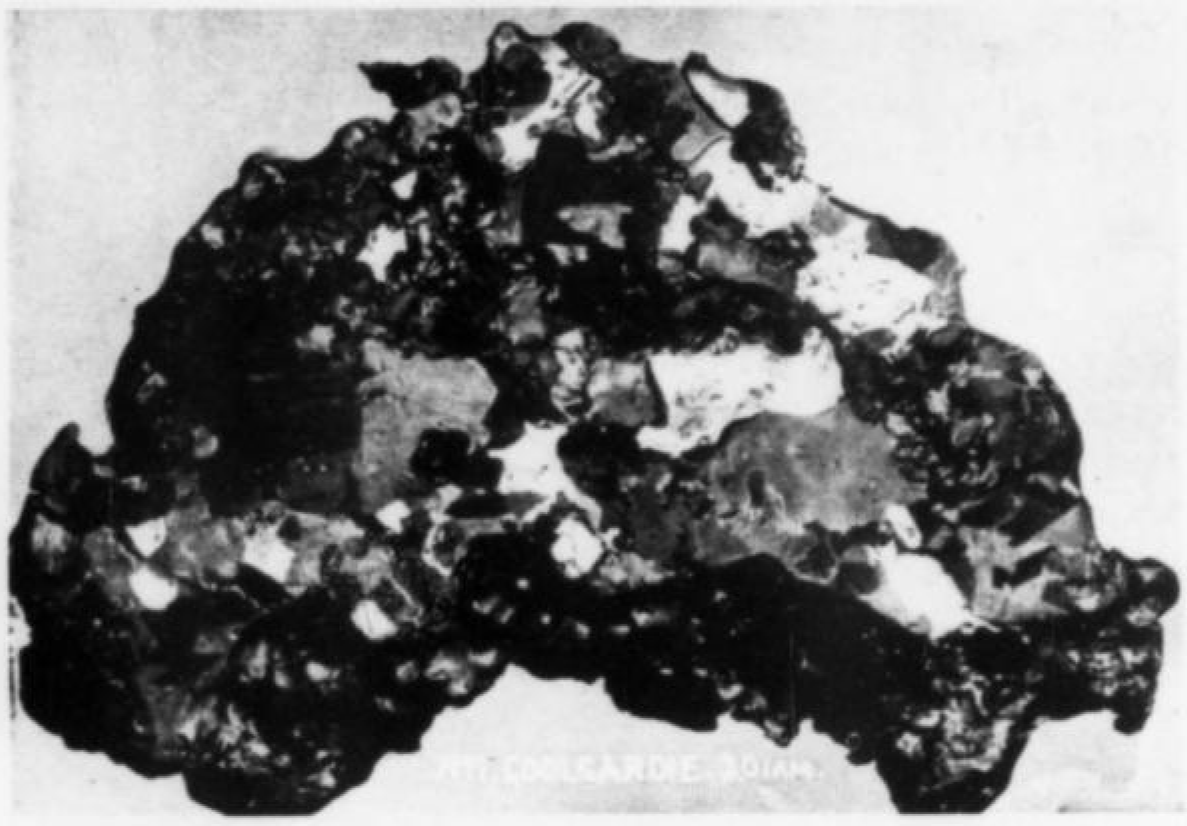


Figure 31. **Etched and polished section of a 4-cm gold nugget from Coolgardie, Western Australia, showing crystalline interior (from Liversidge, 1894, plate 4).**

large eluvial and alluvial nuggets found in Australian gold fields were derived directly from quartz reefs.

Composition

Early assays soon revealed the high purity of Victorian and New South Wales alluvial and reef gold. Victorian gold, including the large nuggets, had an average fineness of 960 (or close to 23 carats), New South Wales gold 935 (22.4 cts) and Queensland gold (excluding the Palmer River gold) about 870 (21 cts) (Liversidge, 1888; Smyth, 1869). Western Australian gold generally ranges from 850 to 950 in fineness.

Small variations in composition were noted both within and between the major goldfields in each state, in part possibly explained by analytical error. The supposed subtle difference between the compositions of alluvial gold and the nearby reef gold was based on an unreasonable comparison, since the alluvial gold represented erosion from now-removed vertical extensions of existing reefs. Even so, the suggestion was made (Dunn, 1929) that gold fineness was upgraded in alluvial deposits by removal of silver etc, in solutions.

Silver was the main element alloyed with gold. In a number of important fields, e.g., St. Arnaud and several reef systems in northeastern Victoria, high silver contents were encountered, lowering gold fineness to 650–700. In many Western Australian gold mines and in a number of major deposits in eastern Australia (e.g., Mt. Morgan) there are pronounced oxidized zones in which gold of fineness exceeding 990 occurs. For example, gold in the upper levels of the telluride-bearing mines at Kalgoorlie has a fineness of 999, possibly the purest native gold known. This degree of purity is almost certainly due to secondary enrichment, which has been favored by prolonged periods of chemical rather than mechanical weathering, during the formation of the Western Australian Shield.

Associated Species

On a broad scale, the minerals associated with gold in Australian deposits can be divided into four main groups.

1. Minerals containing elements alloyed with gold (e.g., tellurides of gold and other metals, maldonite).
2. Sulfosalts such as bournonite and tetrahedrite.
3. Sulfides such as pyrite, arsenopyrite, pyrrhotite, galena, sphalerite, chalcopyrite, etc.
4. Gangue minerals such as quartz, carbonates and silicates.

Mineralogy may vary quite widely, even within a particular field, so that it is not always possible to characterize an entire goldfield purely in mineralogical terms. For example, the full range of Victorian auriferous reefs has been classified according to their mineralogical associations, such as reefs with pyrite/arsenopyrite, galena/sphalerite/pyrite, pyrrhotite/arsenopyrite, stibnite, etc. (Hart, 1905), but there are considerable assemblage overlaps.

Tellurides etc.

The gold-telluride association reaches possibly its most spectacular development in the world in the ores of the Golden Mile at Kalgoorlie. Tellurides were first reported by A. G. Holroyd in 1896 and by the early 1900s, calaverite, coloradoite, petzite, sylvanite, krennerite and hessite had been recorded. "Kalgoorlite" and "coolgardite" were identified as mixtures. Since then, altaite, melonite, weissite and nagyagite have been added to the list (Stillwell, 1953), while rare grains of the selenide minerals umangite, berzelianite and eucairite were reported by Baker (1958).

Many of the tellurides are rare or sparsely distributed and microscopic in size; calaverite and coloradoite are the two most abundant species. The tellurides occur as veinlets in tension gashes and as interstitial patches, generally less than 1 cm across, in the gangue, which is usually mainly quartz, chlorite and carbonate. Free gold is often associated. Pyrite, chalcopyrite, galena and other sulfides and sulfosalts are often present. The gold-bearing tellurides are decomposed in the oxidized zone with the liberation of free "mustard" gold (Stillwell, 1953). It is perhaps surprising that there are no confirmed reports of tellurates and tellurites in the oxidized zone.

Tellurides have been reported from other Western Australian mines but they are of limited distribution. There are also reports of tellurides from Mount Morgan in Queensland and in several mines in New South Wales (Pittman, 1901). A suite of silver selenide minerals has recently been described from the Wolumla goldfield in New South Wales (Glaser, 1985).

Of the other gold-bearing minerals, the best known and rarest is maldonite, the bismuth-gold alloy first described from the Nuggety Reef on the Maldon Goldfield in Victoria by Ulrich (1870). Maldonite, which is easily confused with bismuth, occurs as rapidly tarnishing patches up to several millimeters across in quartz and is associated with bismuth, gold, bismuthinite and joseite. The Maldon reef systems yielded a very wide range of other minerals (Haupt, 1980).

Aurostibite, $AuSb_2$, has been recorded from important stibnite-gold bearing quartz veins at Costerfield, Victoria.

Sulfosalts

Sulfosalts such as bournonite, tetrahedrite and boulangerite are not abundant, nor do they form exceptional crystals in Australian goldfields. In the Walhalla–Woods Point belt in Victoria, bournonite crystals up to 1 cm long, accompanied by gold, have been found with quartz crystals from the A1 Mine. Sulfosalt assemblages including tetrahedrite and bournonite occur at Glen Wills and Steiglitz in Victoria. Silver sulfosalts such as pyrargyrite, miargyrite and owyheeite occur with argentian gold at Mt. Wills (Birch, 1981).

A notable occurrence of rare sulfosalts is in the Tennant Creek mines in the Northern Territory, where gold is associated with bismuth minerals such as pekoite, junoite and bismuthinite in a matrix of magnetite (Mumme, 1975; Mumme and Watts, 1976).

Sulfides

Sulphides are ubiquitous associates of gold mineralization in both the Western Australian Archean rocks and the eastern Australian province. The most abundant is pyrite, with arsenopyrite, pyrrhotite, galena, sphalerite and stibnite also locally abundant. Perhaps the finest crystallized sulfide mineral occurring with gold in Australia is the stibnite from the antimony-gold mines at Hillgrove, New South Wales. At the Lucknow mines near Orange, native antimony accompanied gold and arsenopyrite. In general, the gold-quartz reefs in central Victoria are sulfide poor.

Disseminated sulfide-rich orebodies such as those at Mount Morgan and Cobar show varying proportions of pyrite-pyrrhotite-chalcopyrite-gold mineralization.

Gangue Minerals

Quartz is the most prolific gangue mineral, hosting most of the major gold deposits. Fine quartz crystals were encountered in many mines but perhaps, ironically, because they were so abundant, few exceptional specimens seem to have survived undamaged. Perhaps the best known crystals came from mines at Fryerstown near Castlemaine, Matlock in Victoria, and Hillgrove in New South Wales. Fine albite crystals were discovered in the reefs at Bendigo and on the Woods Point field.

Calcite formed the host at several deposits, for example at Lucknow, New South Wales, and at Gympie, Queensland. Ankerite occurs both as massive veins and well-formed crystals in the Bendigo quartz reefs, and dolomite crystals accompany quartz on the Woods Point field. Other gangue minerals such as chlorite, clays, hematite and limonite are frequently associated with gold, particularly in zones of alteration or secondary mineralization.

In reefs where sulfides are present in significant proportions and an oxidized zone has developed, gold may be found with a variety of secondary minerals. Pyromorphite, mimetite, scorodite, pharmacosiderite and members of the beudantite group occur in the quartz reefs at St. Arnaud and Clunes, Victoria, and in a number of New South Wales gold mines. Perhaps the most unusual association is gold with crocoite, as dull, deep-red cyrstals up to 1 cm long, from the Happy Jack mine, Comet Vale, Western Australia.

In general, species associated with Australian gold specimens are too lacking in both consistent aesthetic appeal and abundance to have created a collector's market in their own right. Rare species are also difficult to obtain, as most mines are now inoperative and many dumps have been removed.

THE FUTURE FOR AUSTRALIAN GOLD

In the past five years, gold production in Australia has trebled, and within the next two years, at least 50 new gold mines are expected to become operational. With annual production exceeding 100 tonnes, Australia will leap into second or third place on the list of non-communist gold producing countries, vying with the USA, Canada and Brazil. Gold will be the nation's third largest mineral export after coal and iron.

The high price of gold (around A$700 per ounce as of this writing) combined with the massive devaluation of the Australian dollar, means that producers are now assured of their best returns for years. This has led to the current mini-boom in exploration and production, particularly in former mining areas in Western Australia and Victoria. Cheaper mining methods, especially open cut, and more efficient refining processes which allow, for example, the working of old dumps and slime deposits, have made many previously marginal or uneconomic prospects more attractive.

While production will be dominated by very large mines such as the copper-uranium-gold operation at Roxby Downs in South Australia, there is room for small companies and even individual prospectors to play a significant role. For example, small companies plan to reopen mines on the Bendigo, Ballarat and Maldon goldfields in Victoria and the weekend prospector, armed with metal detector or portable dredge, still has the chance to make a good living from the old alluvial fields in central Victoria.

There is only one cloud on the horizon as far as gold producers are concerned. Historically, profits derived from gold mining have not been subject to tax in Australia since 1924 and there is a suggestion that, in the near future, the Government may decide to eliminate this anomaly. Such a move would undoubtedly render many smaller deposits marginal or uneconomic, as well as affecting a number of the larger mines such as Fimiston, which are currently operating profitably. Whatever happens, the future of gold mining in Australia, while never likely to approach the heady times of the 1850s, looks secure.

For the collector, gold specimens ranging from crystals to large nuggets will still be available. Metal detectors will continue to be the main method of discovery and, with improvements in technology, will tap deeper levels in the alluvial deposits. Although the veil of secrecy which surrounds many finds makes the overall market difficult to assess, some discoveries still receive the publicity needed to keep the small prospector and weekend fossicker working the old deposits. Gold fever is as contagious as ever. The largest and most valuable specimens will still be sold overseas, simply because Australia does not have the individual wealthy collectors or institutions needed to retain them. Catering to another facet of the collectors market, the Western Australian government is soon to mint four gold coins, featuring famous Australian gold nuggets.

So in all respects, the end of the golden trail around Australia is not yet in sight.

ACKNOWLEDGMENTS

This article merely scratches the surface of a vast body of information—writings, illustrations, photographs—on gold in Australia. Yet this did not make the task any easier and without significant contributions from many individuals I would not have been able to complete it to my satisfaction.

Special mention should be made of Frank Coffa's photography. He was ably supported by Rodney Start, David Barnes and Kate Lowe. I am grateful to the Ballarat Fine Art Gallery and the State Library of Victoria (SLV) for permission to reproduce several early works of art. Cathie Leslie, from the La Trobe Picture Collection, SLV, was of great assistance in the selection of historical photographs and sketches. Sandra Lucey and Sue Grieve prepared a number of the diagrams. Lastly my thanks to Dermot Henry, who provided all around support, encouragement and assistance, particularly with the word processing of the manuscript.

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Figure 32. **Group of octahedral gold crystals from Canadian Lead, Home Rule, New South Wales (Australian Museum specimen D10118, 2 cm across, 19.6 g). Photo by Kate Lowe.**

Figure 33. **Gold crystals in quartz from the Zoroastrian gold mine, Bardoc, Western Australia (Museum of Victoria specimen M35320, 5.5 cm high). Photo by Frank Coffa.**

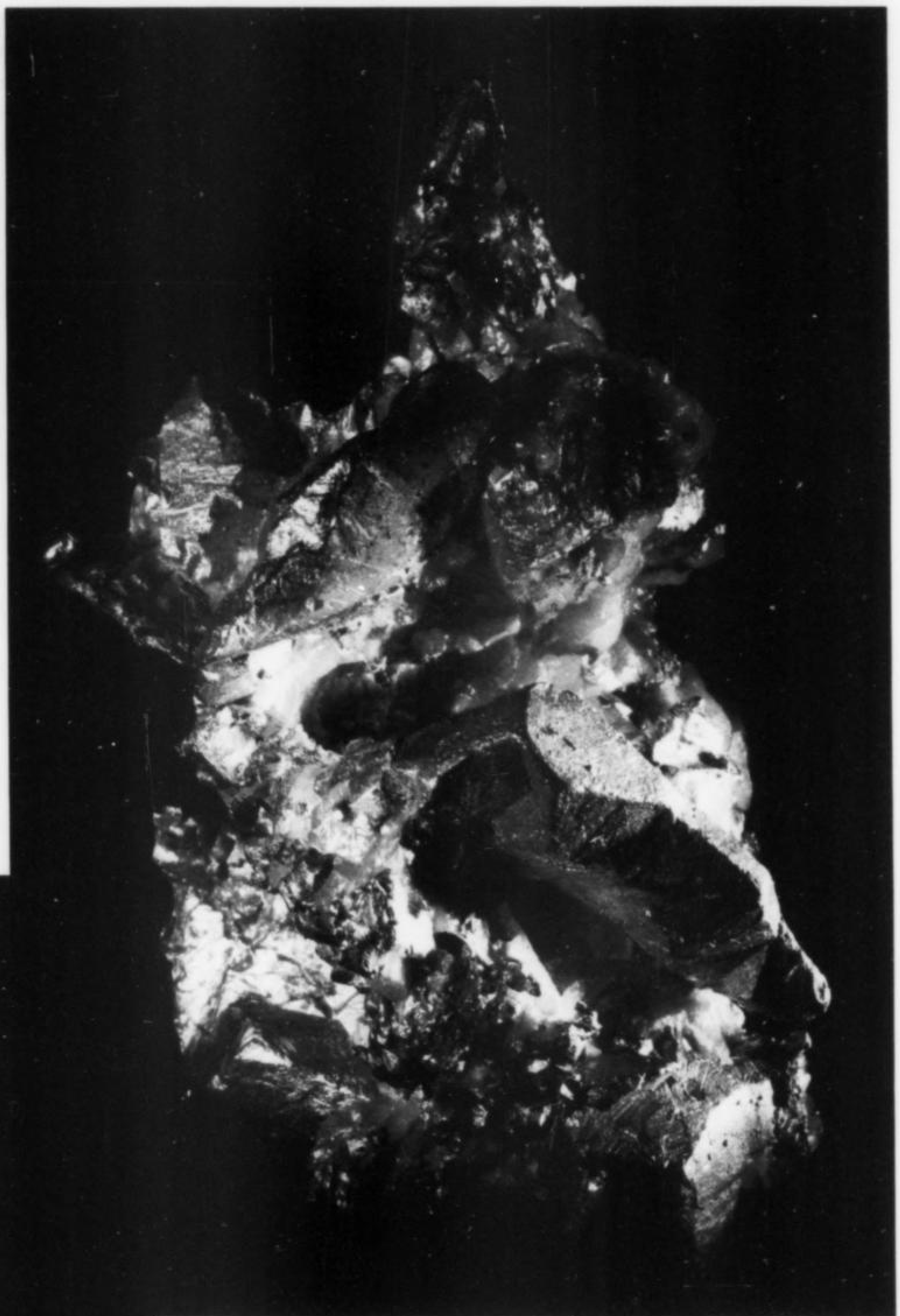

Figure 34. **Slightly abraded group of gold crystals from Chinese Gardens, Robertson's Gully, Wedderburn, Victoria. Specimen is 2 x 3.5 cm. Collection of B. Shelton. Photo by Frank Coffa.**

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Figure 35. **Group of gold crystals from Castlemaine, Victoria (Museum of Victoria specimen M36774, 3 cm across). Photo by Frank Coffa.**

Figure 36. **Group of gold crystals from Nundle, New South Wales (Geological and Mining Museum, Sydney, specimen 4831, 5.6 cm). Photo by David Barnes.**

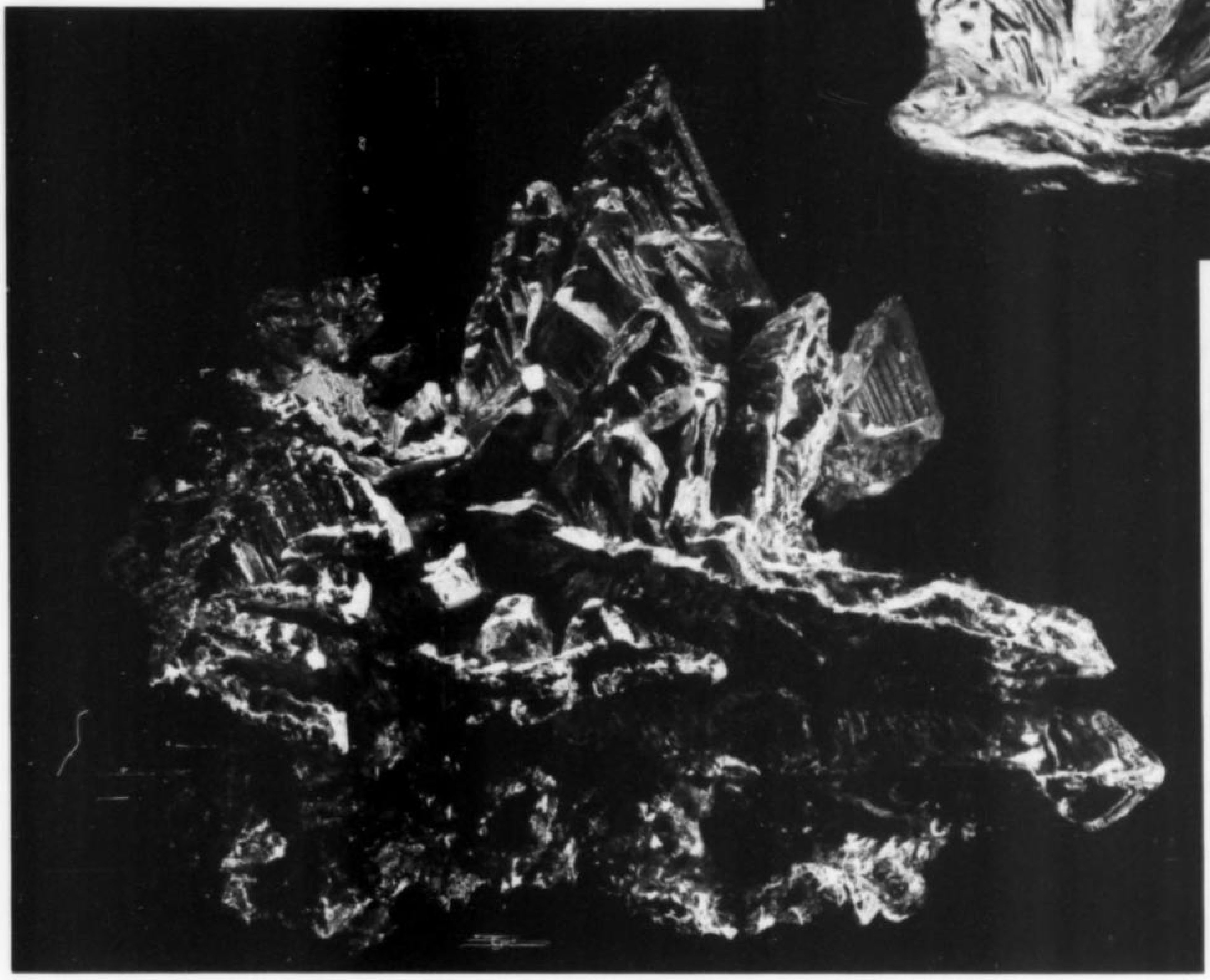

Figure 37. **Group of gold crystals from Matlock, Victoria (Museum of Victoria specimen M37982, 4 x 5.5 cm). Photo by Frank Coffa.**

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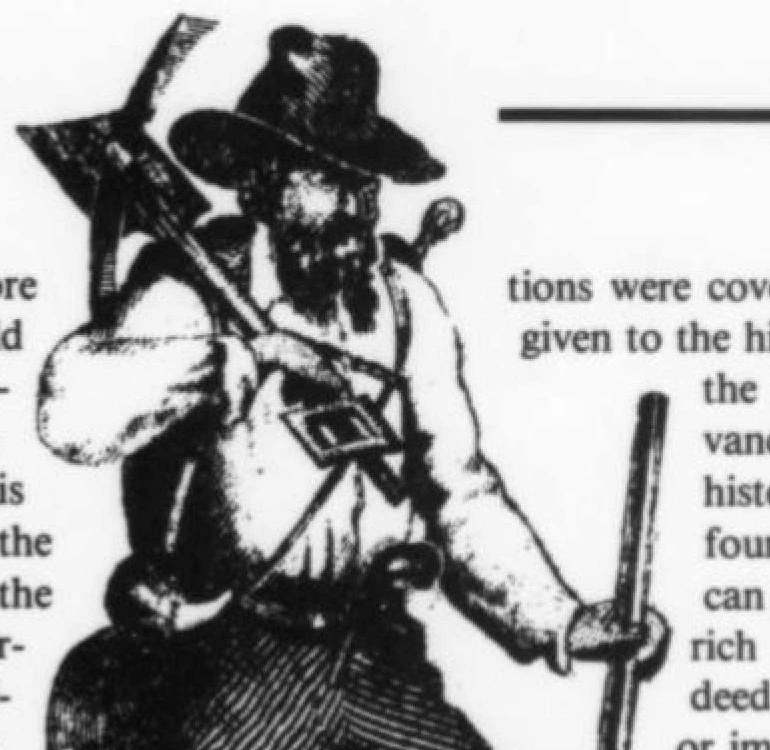
the history of crystallized

GOLD in CALIFORNIA

California's Mother Lode region is among the most famous gold mining areas in the world. Since gold was discovered there on the American River in 1848, well over a hundred lode mines have yield many extraordinarily beautiful specimens of crystallized gold.



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INTRODUCTION

Next to the American civil war, probably more books have been written about the California gold rush period than any other period in American history. Cowan's *Bibliography of the History of California* lists thousands of entries dealing with this period; and, although a standard reference on the subject, Cowan is by no means complete in listing the books, magazines and articles written on this colorful era. Hubert Howe Bancroft, in his epic 39-volume work on the history of the West, devotes three of the seven volumes on California to the gold rush period alone, highlighting the people, places and events which shaped the history of not only California but the history of the adjacent states of Arizona, Oregon, Washington, Utah and Nevada. No less than 200 books have been written about the man who has been given credit for having started the California Gold Rush, James Marshall.

The development of the state of California is so closely linked to the discovery of gold on the American River in the winter of 1848 that it is virtually impossible to assess what the state would be like today without those millions of dollars in revenue pumped into the Western economy. Men like Levi Strauss, Clement Studebaker, Charles Crocker and Leland Stanford, to name a few, got their start in the gold camps of early California. Although only a small percentage of mines in California have produced crystallized gold, the Mother Lode region of California has the distinction of having produced what are arguably the finest gold specimens in the world.

In the first *Gold Issue* of the *Mineralogical Record* (vol. 13, no. 6) many of the important California specimen gold localities and collections were covered in detail. Though some attention was given to the historical aspect of gold localities, it was not the primary thrust of that issue. As most advanced mineral collectors have discovered, the history of where a specimen was found, who found it and what was happening at the time, can add a new dimension to a collection and enrich one's overall enjoyment of collecting. Indeed, a relatively poor specimen with interesting or important historical data can easily be just as desirable in its own way as a fine specimen with little or no historical importance. However, one must always remember that the freshly mined specimens of today may become the classic specimens of tomorrow. Thus, even though it may not seem important at the time, it is nevertheless critical that specimens, gold or otherwise, be labeled with complete and accurate data.

Collectors who are perceptive enough to recognize which specimens today will become the classics of tomorrow have a rare gift indeed. If, for example, the miners at the famous silver mines of Kongsberg, Norway, had known how sought after the specimens from their area would be today, more specimens would no doubt have been saved. Similarly, had the early gold miners in California known how highly valued crystallized gold would be among collectors today, there would probably have been more fine golds preserved.

DIFFICULTIES IN VERIFYING INFORMATION

Like today's miners, the miners of past years also had difficulty in differentiating

Figure 1. **Arborescent to octahedral gold from the Michigan Bluff district, Placer County; 8.3 cm. Wayne and Dona Leicht collection; photo by Harold and Erica Van Pelt.**

matrix to beautiful, free-standing leaves of crystallized gold similar to those found at the Red Ledge mine in Nevada County, California. Gold specimens described as having flat faces and planes may have been just lumps of gold with impressions of other crystals such as calcite or quartz, or they may have been true crystallized gold.

Generally speaking the descriptive errors in early literature were not deliberate, and as such are not as frustrating as trying to determine which mine a deliberately mislabeled specimen came from. To illustrate: If Miner Joe works at the XYZ mine and breaks into a pocket of crystallized gold which just happens to fall into his lunch bucket, Miner Joe certainly does not tell the mine owner, the refiner or the collector to whom he sells the specimens that the gold came from the XYZ mine; instead he will attribute it to another mine, probably not even in the same county or state. This was the case some years ago when a shift boss was convicted of "high-grading" crystallized gold from a mine in Sierra County. He sold the specimens with the indication that they came from a mine in another county in which he had an interest. Sometimes, even when the correct locality information is initially known, it is subsequently lost on older specimens as the specimen is handed down from one collector to another.

Another frustrating problem is the renaming of a mine or the consolidation of many small mines into one larger mine. For example, the original 16 to 1 mine in Sierra County was not known to have produce well crystallized gold specimens; however, the 16 to 1 mine today is a consolidation of the old Tightner, Orphir, Red Star, Twenty One, South Fork, Osceola and Rainbow mines. Both the Rainbow and the Red Star have produced fine, chunky, well crystallized gold commonly associated with clear quartz crystals. There is a chance that the consolidated 16 to 1 mine will produce some new specimen gold since it is currently in operation once again (see *What's New in Gold?* elsewhere in this issue). The renaming of a mine presents some other obvious problems. For example, the

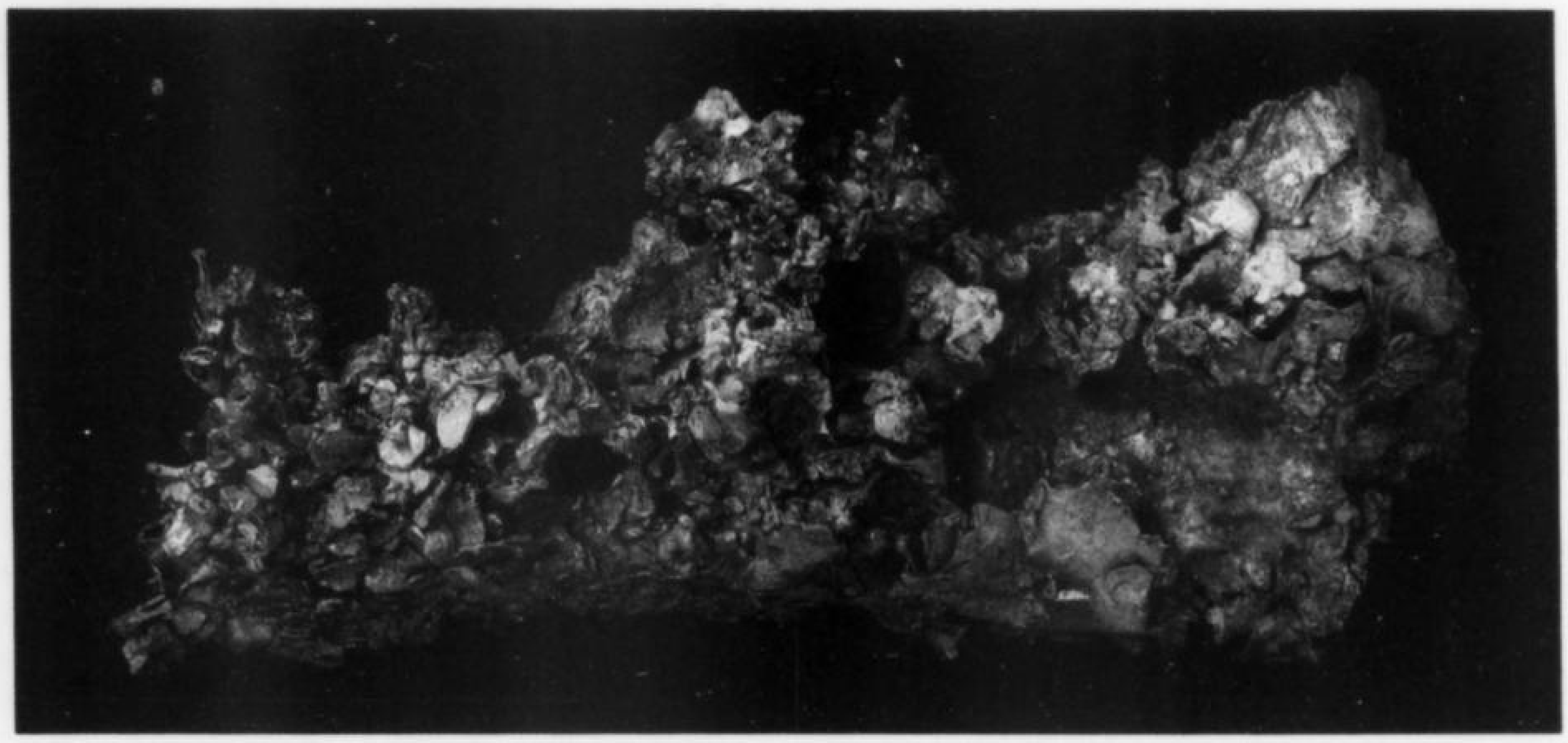


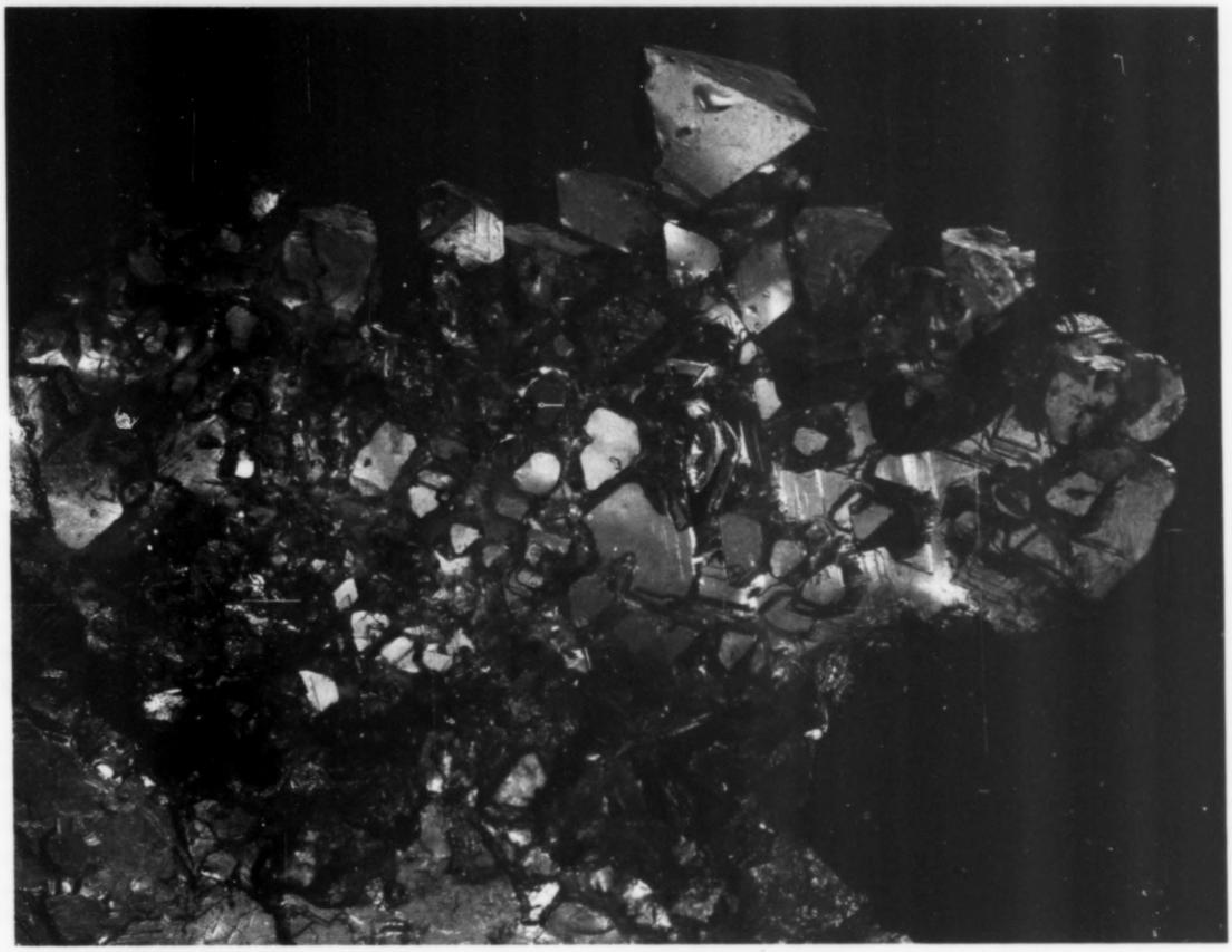
Figure 2. **Leaves and octahedral crystals from the Coe mine, Nevada County; 12 cm. Wayne and Dona Leicht collection; photo by B. C. Space.**

blobs of gold in quartz from true crystals of gold. Most of the people who made an attempt to document early gold finds had little scientific training in any of the natural sciences. Therefore, in surveying the literature it is useful to understand some of the terminology commonly used by these untrained writers. Although there are many exceptions, "specimen gold" usually refers to free gold in matrix (usually quartz), not necessarily crystallized. "Jewelry gold" usually refers to gold in solid white quartz which, even as early as 1850, was being polished and fashioned into jewelry. Often the terms specimen gold and jewelry gold were used interchangably but, to add to the confusion, the early miners sometimes wrote of specimen gold in reference to crystallized gold, and used the term "jewelry pocket" to describe crystallized gold pockets. "Ribbon gold" can mean anything from uncrystallized seams of gold in

Harper Brothers mine in Tuolumne County produced some of the finest gold specimens ever found in California in the 1940s but it appears on early claim maps as the Grizzly and/or Eureka claim. Either the Harper Brothers acquired these claims and operated them under their own name or they simply chose not to use the name filed with the mining district or County. Inadequate information associated with a specimen also creates problems. The Harvard University gold collection has at least two fine leaf gold specimens with raised triangular octahedron faces. These specimens are simply labeled "Alaska," and were thought to be from the state of Alaska even though very little crystallized gold has been found in that State. These are more likely from the Alaska mine, Sierra County, California, because no other comparable specimen can be found from any mine in Alaska, and the gold is almost identical to

Figure 3. **Bright leaves and equally bright wire (very rare) from the Magenta mine, Nevada County; 7.6 cm. Wayne and Dona Leicht collection; photo by B. C. Space.**

Figure 4. **Octahedrons of gold covering a gold leaf, 3.8 cm, from the Eureka & Grizzly mine (Harper Brothers mine). Wayne and Dona Leicht collection; photo by Harold and Erica Van Pelt.**



specimens found at the Alaska mine and represented in several other institutional collections. Other problems in locality labeling are mine names without the county or state indicated. Is a specimen simply labeled Nevada mine, California, from the Nevada mine, Nevada County, or from the Nevada mine, Sierra County? There is a Red Ledge mine in both Nevada County and Sierra County and a Bald Mountain (famous for specimen gold) in at least three counties.

In spite of the aforementioned problems, the verification of the locality data can be done with a fairly high degree of certainty if one can correlate several pieces of information from different sources without any one piece appearing out of place. For example, if you

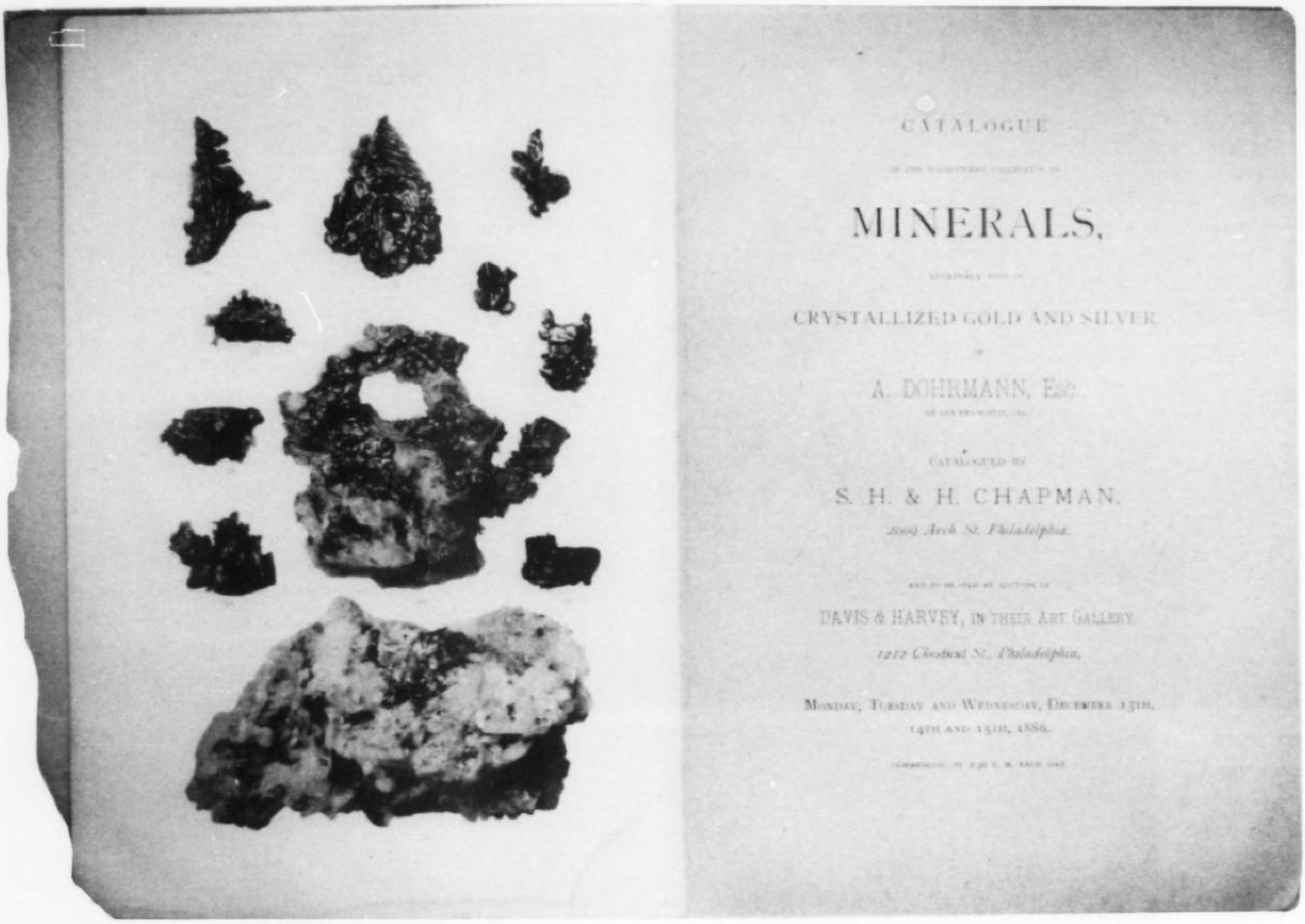


Figure 5. **Title page and frontispiece (showing gold specimens) from the 1886 Dohrmann collection auction catalog. Richard Hauck collection; photo by Ron Bentley.**

have a specimen of bright, shiny leaf gold labeled Red Ledge mine, Nevada County, California, it is most likely labeled correctly. However, if the specimen has large, chunky, octahedral crystals, is dull or has a low gold content it is most likely mislabeled because almost all the gold from the Red Ledge mine is leafy, bright and has a high purity.

SOURCES OF DATA – THE EARLY LITERATURE

Unquestionably the first reference to crystallized gold from California appeared in the *American Journal of Science and Arts,* Second Series, Volume 10, 1850. In an article written by Francis Alger of Boston, Massachusetts, entitled "Crystallized gold from California," octahedral crystals of gold recently brought from California by Mr. George E. Tyler of Boston and Mr. H. B. Platt of New York are described. Alger's paper was read, in part, before the Boston Society of Natural History in April, 1850, a little over two years after the initial discovery of gold on the American River at Coloma. This does not seem remarkable until one remembers that the trip to and from California from the East Coast could take anywhere from three months to a year depending upon which route the traveler chose.

Alger characterizes the crystals as both simple and modified, slightly disfigured by attrition (waterworn) and of great size. All three crystals illustrated in his report were hoppered octahedrons with prominent ridges at the edges and depressed central faces. Alger indicates that these must have weathered out of some soft matrix, probably not quartz. He also touches briefly on the old argument that crystals of gold are pseudomorphs of gold after iron pyrite but he goes on to state that he does not subscribe to this theory, and believed that these are true crystals of gold and not pseudomorphs. Apparently Platt, the collector who provided Alger with the gold described in his paper, resided in San Francisco for two years during the height of the gold rush. During that period he accumulated a fine collection of crystallized gold described as having a "great variety of ramified, arborescent, dendritic and other imitative forms, here and there showing crystalline faces, all of them being sometimes most fantastically joined together in the same specimen." In accumulating the collection Mr. Platt indicated that he examined more than four million dollars in gold (this would be equivalent to about 250,000 troy ounces of gold at $16 per troy ounce) to find the few specimens he had in his collection. Platt's specimens no doubt comprised the first organized collection of California specimen gold.

For the next 35 years little was written about crystallized gold from California, even though mining reports from the Mother Lode appeared almost daily in newspapers throughout the world. The lack of recorded data is even more surprising in light of the fact that during this period Professors Silliman and Shepard of Yale both visited the area. The oversight is unfortunate, because this was probably the most productive period for crystallized gold in California. Due to the lack of scientific recognition of the importance of crystallized gold, and to the absence of local collectors, few specimens were saved beyond the occasional "curiosities" put aside by miners.

A few early reports written by William Blake in *The American Journal of Science and Arts* are an exception. He describes not only individual gold specimens but indicates the specific mines which produced them. Mention of mines producing crystallized gold also appears in a series of annual government reports from 1867 to 1876 written by J. Ross Browne, James W. Taylor and R. W. Raymond (under various titles including *Mineral Resources of the States and Territories West of the Rocky Mountains* and, in later years, simply *Mineral Resources of the United States).* These reports contain a wealth of information on mining in the West; the earlier reports were dominated by mining activities in California. The reports contain some of the first good locality data on crystallized gold to be published. The following mines are indicated as having produced crystallized gold:

Irish Creek, Placer County (1867):
Arborescent-octahedral masses
Deidesheimer claim, Placer County (1867):
Flatten and distorted octahedrons
Mameluke Hill, El Dorado County (1867):
Ragged crystalline masses
Spanish Dry Diggins, El Dorado County (1867):
Large dendritic crystal masses
Whiskey Hill mine, Tuolumne County (1867):
Flatten distorted octahedrons
Princeton mine, Mariposa County (1867):
Brilliant octahedrons in bunches
Doctor Hill, Calavaras County (1867):
Spongy crystals up to ¼ inch
Rocky Bar, Nevada County (1868):
Beautiful crystallized masses
Scadden Flat, Nevada County (1868):
Beautiful crystallized masses

Recently an old (1886) auction catalog of the mineral collection belonging to Mr. A. Dohrmann, Esq., of San Francisco, California has come to light. Dohrmann's collection had a relatively large suite of golds from California but, unlike other auction catalogs of that period, this one has photographs of most of the important specimens and a listing with relatively good locality data. From that catalog two new localities can now be added to the list. They are:

Seaton mine, Amador County:
Elongated crystals on matrix
Byrd's Valley, Placer County:
Granular crystals on matrix

Several specimens in the Dohrmann catalog are now part of the Harvard gold collection, as well as other private collections. One specimen which was pictured in Bancroft's *Gem & Crystal Treasures* as having come from the Red Ledge mine is listed in the catalog as having come from the Grit mine, Spanish Dry Diggins, El Dorado County, California.* The specimen was listed in this auction catalog at least 25 years before the famous Red Ledge mine was located!

Other rich sources of information are the various reports of the California Division of Mines and Geology on the minerals of the gold producing counties, the U.S. Department of Interior Reports on the *Mineral Resources of California,* and the *U.S. Geological Survey Bulletins, Professional Papers,* and *Folios.* The information from these as well as other reports, magazines, books and personal communications are summarized in Table 1 with the appropriate references.

MUSEUMS AND PRIVATE COLLECTIONS

Even in our oldest museums it is difficult to trace many specimens beyond the turn of the century. The Harvard gold collection, lavishly illustrated in the first Gold Issue and considered to be one the most important gold collections in the world, is somewhat lacking in exact locality data on many specimens. The foundations for that collection were the Burrage and Bouglise collections, both of which had rather vague data on many specimens. The gold collection at Yale, New Haven, Connecticut, though small, yielded some reliable information regarding early gold localities in California. Many of the specimens had small paper labels with the mine name and acquisition date permanently affixed to the specimen. From that collection the following mines were added to the list of crystallized gold localities:

Rocky Bar mine, (No County) (Specimen 37-1):
Bright leaf in quartz
Whiskey Hill, Tuolumne County:
Bright leaf in quartz
Grave Yard Hill, Tuolumne County (Specimen P-40):
Thick leaf with octahedrons

Of course the Yale collection has many other interesting specimens with locality data from mines which were previously known to have produced crystallized gold. One remarkable specimen is pictured in Figure 5. At first it appears to be a large octahedron of gold attached to a stem of platy gold. But when the specimen is

* Ed. note: this specimen is pictured at upper left in the *Pala International* ad, outside back cover of the first Gold Issue (vol. 13, no. 6). Another Dohrmann specimen, also identified in his catalog as coming from the Grit mine, is in the Harvard collection and is shown in Figure 7 (left), p. 357, in the first Gold Issue; it had been identified in Harvard records only as "California."

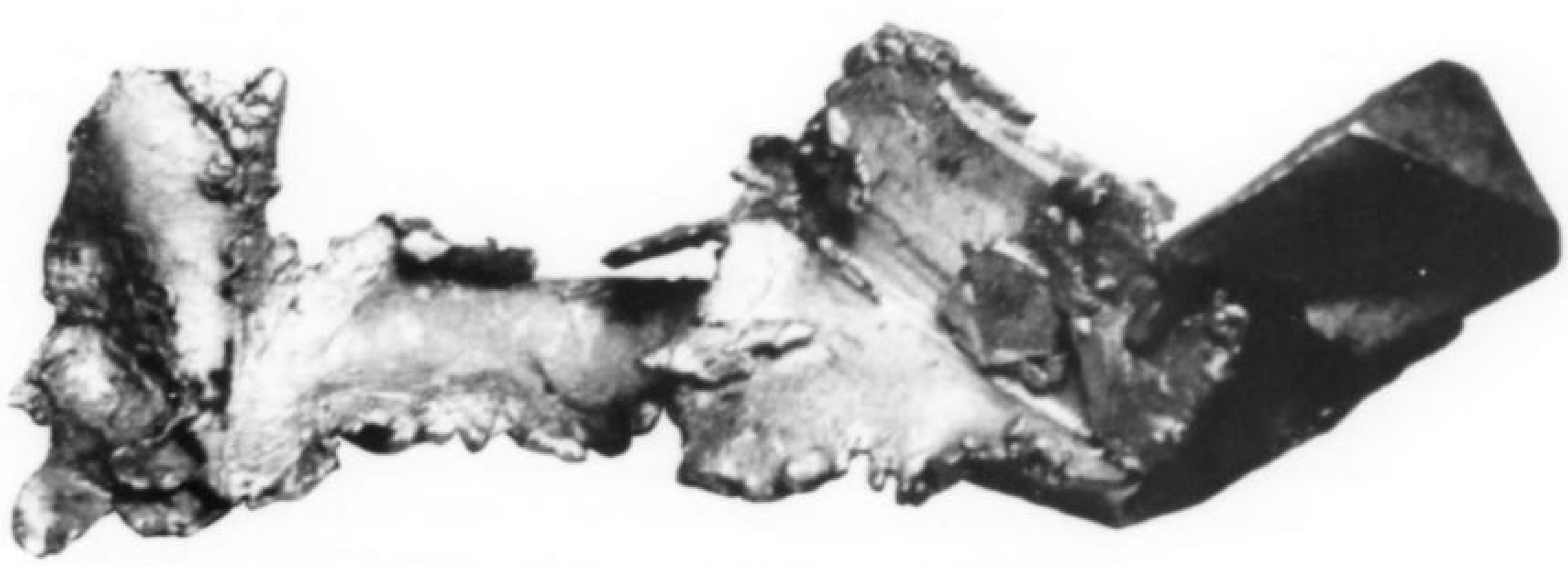


Figure 6. **Hollow octahedron with leaves, 6.4 cm, from Grave Yard Hill, Tuolumne County. Yale University collection; photo by Robert Jones.**

***Table 1.* Mines known to have produced crystallized gold in California.**

Mine	County	Type of Au	Reference	Collection
16 to 1 (Consolidated)	Sierra	Distorted octahedra with quartz crystals	111	lP
Alameda	Tuolumne	–		C
Alaska	Sierra	Leaves with small surface octahedrons	29	S,P,H?
Alcalde	Nevada	–		C
Altaville Mining & Mfg	Calaveras	Bright leaves on quartz		C
Amador Queen #2	Amador	Semi-crystallized with arsenopyrite	17	P
Argo	Mariposa?	Ribbon gold with pyrite	15	
Artru	Mariposa	Leaves & octahedrons	24,6,16	P
Bald Mtn., Browns Flat	Calaveras	Bright leaves with quartz		C
Bananza	Tuolumne	–		C
Banghart	Shasta	–		P
Belmont Osborn	Calaveras	–		P
Big Sandy (James Marshall)	El Dorado	–	10	
Black Oak	Tuolumne	Leaves with quartz		C
Bonanza	Trinity	Large semi-crystalline masses	1	
Brust (Kelset Dist.)	El Dorado	–		C
Burton	Siskiyou	Leaves with quartz		C
Cadmus	Nevada	–		C
Cedarberg	El Dorado	Foliated & platy	28	H
Central Eureka	Amador	–		C
Christmas	Nevada	Leaves in quartz		C
Clyde (next too)	Colusa	–		C
Coe	Nevada	Small octahedrons and stout leaves	12	P
Colorado Quartz	Mariposa	Octahedrons up to 1.9 cm	16,6,24	P,L
Davis	El Dorado	Leaves		C
DeMarie & Garbe	Placer	Bright leaves & octahedrons with quartz	7	
Diadem Quartz	Plumas	–		P
Diedesheimer	Placer	Waterworn large octahedrons	5,8	H
Diltz	Mariposa	Dull, distorted octahedrons & cubes	12,15	P
Doctor Hill	Calaveras	Spongiform with octahedrons	8	
Dry Gulch	El Dorado	Skeletal crystals		C
EDM	Siskiyou	Leaf gold in calcite		C
Empire-Star	Nevada	Small leaves & octahedrons (usually dull)		H,S
Eureka & Grizzly[1]	Tuolumne	Bright leaves & octahedrons w/quartz crystals	22,26,20	S,P
Flowery North	Butte	Octahedrons on quartz		C
Flying Cloud	Siskiyou	–		P
Ford Mine (Ladies Cyn.)	Placer	Bright dendritic	21	P
Forest Hill	El Dorado	Twinned crystals & octahedrons (some worn)	26,28,5	S,H,P
Four Hills	Sierra	–		C
Francis	Calaveras	–		C
Fremont	Amador	–		C
French	Mariposa	Leaves & distorted octahedrons		P
Gambetta	Madera	–		C
Garden Valley	El Dorado	–		C
George Hill[2]	Placer	Heavy plate w/raised octahedrons	7	L
Georgia Slide	Placer	Dull, distorted octahedrons	10,17	P,L
German Ridge	Calaveras	Rough leaves	14	P
Gold Crown	Sierra	–	Pers. Comm.	P
Gold Hill	Nevada	Large plates	5,8	P
Gold-Quartz	Nevada	–		C
Golden Rule	Tuolumne	Leaves and wire in quartz	26	C,P,Y
Golden Sheaf	Placer	Leaves & sharp octahedrons	Comp. Rept.	
Granite Hill (Vein)	Nevada	Bright leaves with quartz crystals	26,20	
Grave Yard Hill	Tuolumne	Thick leaves with octahedrons		Y
Grit	El Dorado	Large masses with many octahedrons	23,26,21,12	C,H
Gwin	Calaveras	Arborescent masses of crystals	27	C
Ham & Birney	Tuolumne?	Crystallized on quartz	7	
Happy Camp	Siskiyou	–		C
Harper Brothers[1]	Tuolumne	Bright leaves & octahedrons	22,26,20	S,P
Helvetia	Nevada	Plates & angular masses w/quartz	26,5	
Hidden Treasure	Tuolumne	Leaves with quartz	22	P
Homestake	Siskiyou	Leaves & octahedrons on quartz		C

Hoosier	Calaveras	Small octahedrons		C
Hosloc	Mariposa	–		C
Ida	Inyo	–	26	
Idaho-Maryland[3]	Nevada	Chunky, distorted octahedrons		C,H,P
Independence	Siskiyou	Leaves on quartz		C
Independence	Plumas	–		P
Irish Creek	Placer	Arborescent & platy	5,26,8	Y
Iron Side	Sierra	–		C
Jackass Hill	Tuolumne	Large dendritic leaves	14,22	P
John Neale's	Tuolumne	–		C
Jumper	Tuolumne	–	22	C
Keystone	Amador	–		P
Lafayette	Nevada	Plates & angular masses w/quartz	26,5	
Lazar	Tuolumne	Leaves & octahedrons	22	C
Live Oak	Amador	–		P
Lukens Gold	El Dorado	–		C
Mad Canyon	Placer	Foliated & tabular crystals	21	
Magenta	Nevada	Bright leaves and wires on quartz	12	P
Mameluke Hill	El Dorado	Dendritic	8	P
Mammoth	Shasta	–		P
Mariposa Commercial	Mariposa	–		C
Martin & Walling	Mariposa	–		C
Massachusetts (Hill)[3]	Nevada	Distorted octahedrons	8	S
Mayflower	El Dorado	Dendritic, bright leaves		C
Melones	Calaveras	Small crystals with tellurides		C
Michigan Bluff (district)	Placer	Bright octahedrons & leaves	19,26	P,L
Mockingbird	Mariposa	Leaves & octahedrons	6,24	P
Mokelumne Hill	Calavaras	Flatten, distorted octahedrons	25	P,C
Nigger Hill, (Nigger, Negro)	Tuolumne	Bright leaves & octahedrons w/quartz crystals	22,15	C
North Gold Hill	Nevada	Leaves with quartz crystals	20,26	
North Hill	Nevada	–		
North Star[3]	Nevada	Blocky, distorted crystals	8	C,H,P
Oriental	Sierra	Bright leaves with small octahedrons	11	L,P
Our Chance	Mariposa	Crystals in arborescent forms	15	
Pennsylvania[3]	Nevada	Wire gold on pyrite crystals	26	
Pride	Sierra	–		C
Princeton	Mariposa	Bright octahedrons on quartz	13,26,8	H,Y
Quartz Hill	Siskiyou	Leaves on quartz	7	
Queen	Sierra	Leaves with surface octahedrons w/quartz		P
Rainbow[4]	Sierra	Bright distorted octahedrons		C,P
Red Ledge	Nevada	Bright leaves & flatten octahedrons	12,26	C,H,P,S
Red Star[4]	Sierra	Distorted octahedrons	Priv. Comm.	P
Rich Gulch	Calaveras	–		C
Rio Vista	Calaveras	–		C
Rocky Bar	Nevada	Bright leaves in quartz	8	Y
Scadden Flat	Nevada	Crystalline masses	8	
Secret Canyon	Sierra	Small octahedrons		P
Sheep Ranch	Calaveras	Small crystals in gray quartz	7	P
Shepard	El Dorado	Foliated leaves	8	
Shore	Tuolumne	Large, bright leaves with octahedrons	15	S,P
Siedesheimes	Placer	Waterworn large octahedrons		H
Sierra	Sierra	–		P,L,S,H
Snow Summit	Nevada	–		C
Specimen (Byrd's Valley)	Placer	Leaves & octahedrons	21	
Stuckslager	El Dorado	–		C
Sugarman	Tuolumne	Leaves with quartz crystals	12,22	
Union	Calaveras	Small, dull, crystalline masses	17	P
Whiskey Hill (Harvard)	Tuolumne	Bright leaves in quartz	8	Y
Yankee John	Shasta	–		C

[1] Harper Brothers, Eureka & Grizzly names apply to the same mine.

[2] Probable locality of the "Golden Bear" nugget.

[3] Consolidated into the Empire-Star.

[4] Merged with the 16 to 1 (Consolidated).

[5] Collections studied: (C) California Division of Mines collection; (H) Harvard Mineralogical Museum collection; (L) Natural History Museum of Los Angeles County collection; (P) Private collections; (S) Smithsonian institution collection; (Y) Yale University collection.

turned over one finds that the crystal is a completely hollow shell with a wall thickness of about 1 mm. Again, all the locality data from both the Harvard and Yale collections are included in Table 1.

One of the most important sources of locality information has been the California Division of Mines Collection, some of which, with the exception of the famous Fricot "Nugget" (cover of this issue), is now on display in Mariposa, California. (A more complete description of that collection can be found in Jean DeMouthe's article elsewhere in this issue). The locality data on all the crystallized gold from that collection, as well as the collections of the Smithsonian Institution, Washington, DC and the American Museum of Natural History in New York are also included in Table 1.

Ironically, the older museums of Europe have provided very little information on California gold localities. More often than not a fine California gold will be labeled "Mother Lode," "Grass Valley," or simply "California."

Various private and company collections have been important sources of locality information. Unfortunately, for security reasons, many private collectors are reluctant to show their collection or to even let it be known that they collect gold. However, there are still old miners, mine owners and the descendants of same which will sell an occasional specimen with good, credible locality data. This is the case of the two specimens illustrated in Figures 2 and 3. Both of these specimens came from a family in the Mother Lode region which had a small but impressive collection of gold specimens.

REACTIVATION OF THE OLD MINES

Occasionally, as in the case of the Colorado Quartz mine in Mariposa County (Keller and Kampf, 1982) and the Michigan Bluff district in Placer County (D. Leicht, 1982), an old mine which has been known to have produced crystallized gold is reworked. The mines currently in operation and producing crystallized gold are discussed under "What's New in Gold" (page 90).

ACKNOWLEDGMENTS

I wish to thank Robert Jones and Ronald Bentley for their help in photographing various specimens and manuscripts; Richard Hauck, who brought the Dohrmann auction catalog to my attention and allowed me to reproduce it in detail; the curatorial staff at the Harvard Mineralogical Museum—Dr. Carl Francis and William Metropolis; and Ellen W. Faller, Peabody Museum of Natural History, Yale University, who graciously allowed me to examine both the specimens and the old records. Special thanks to Jean DeMouthe, California Academy of Sciences, San Francisco, for permitting me to examine the famous Fricot "Nugget" as well as other specimens in the collection. Thanks also to the late Eleanor Learned who, while at the California Division of Mines, San Francisco, provided me with information about the old mines in California from the Division's library. And of course to my wife, Dona, for putting up with me and the mess in my office.

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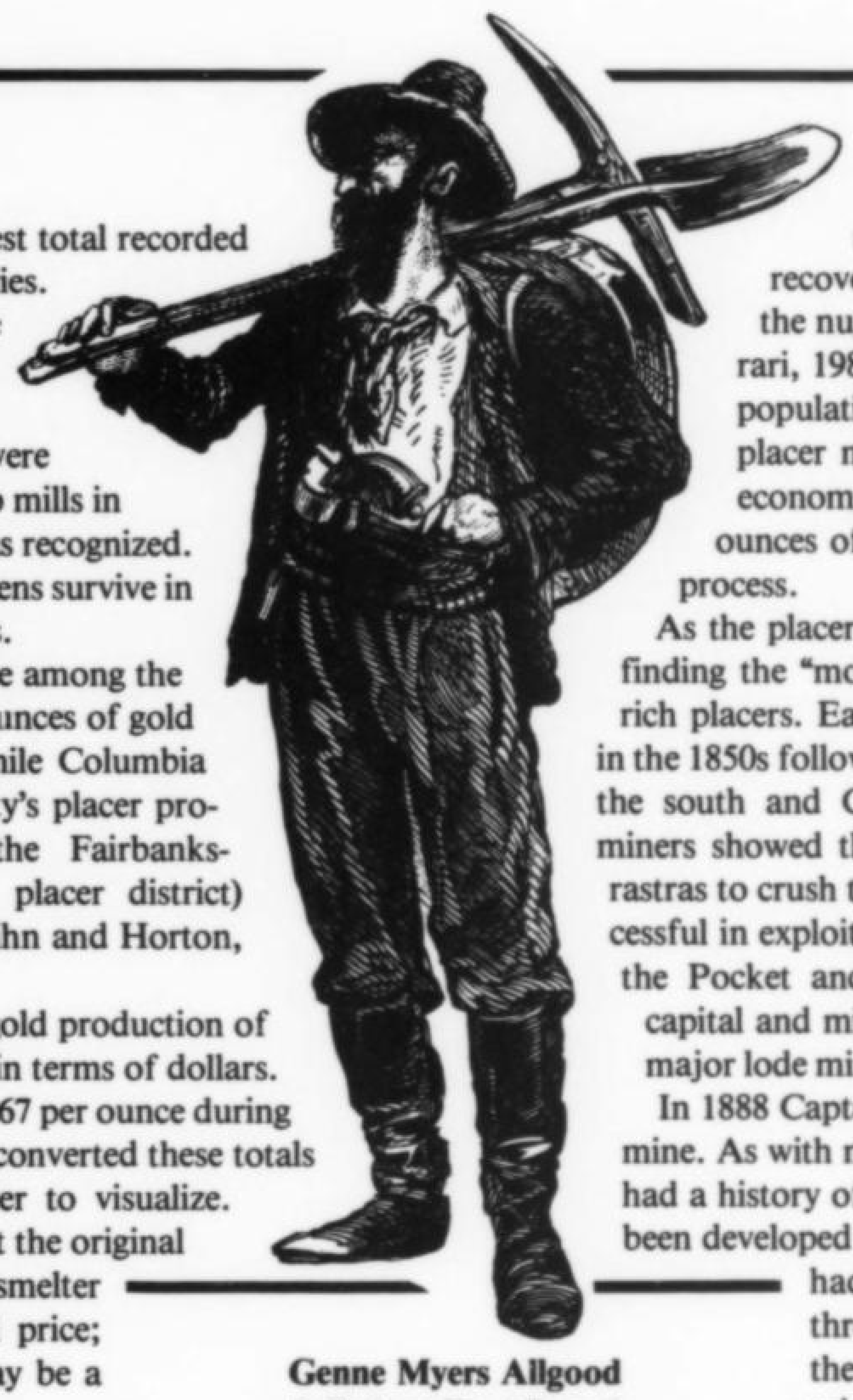
Gold Occurrences in

TUOLUMNE COUNTY

California

"The truth, however, in this instance, is more startling than rumor. The amount shipped was $189,000, and the weight (of gold) 820 pounds, taken out by two parties inside of a week."

Weekly Independent
Sonora, California, 1879



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INTRODUCTION

Tuolumne County has the third largest total recorded gold production of all California countries. Furthermore, it has produced some magnificent specimen gold from its famous pocket district. Unfortunately, many crystallized specimens were crushed in mortars, arrastras and stamp mills in the years before their aesthetic value was recognized. However, a number of beautiful specimens survive in major museums and private collections.

Tuolumne County's placer fields were among the richest in the world. Over 2.6 million ounces of gold were produced from the one-square-mile Columbia Basin alone. In fact, Tuolumne County's placer production is greater than that of the Fairbanks-Richardson district (Alaska's richest placer district) which was of comparable acreage (Julihn and Horton, 1940).

Contemporary reports typically list gold production of the various mines, claims and districts in terms of dollars. Because the gold price was fixed at $20.67 per ounce during most of the productive years, we have converted these totals to troy ounces because they are easier to visualize. However, it should be remembered that the original figures were probably based in part on smelter receipts, and smelters never paid full price; therefore the ounce figures quoted may be a little low.

HISTORY

The history of gold mining in Tuolumne County began in the summer of 1848 when the Wood's party discovered placer gold in a tributary of the Tuolumne River. Wood's Creek, as the stream came to be known, was so rich in gold that the first prospectors recovered 30 to 50 ounces per day just by prying the nuggets from the exposed stream bed (DeFerrari, 1982b). As news spread of the rich strike, the population of the county swelled with gold-seeking placer miners. Placer mining dominated the local economy from 1850 to 1870, producing 7.5 million ounces of gold, and some very large nuggets in the process.

As the placer fields became depleted, interest turned to finding the "mother lode," the quartz vein sources of the rich placers. Early attempts at quartz mining commenced in the 1850s following rich discoveries in Mariposa County to the south and Calaveras County to the north. Mexican miners showed the gringos how to construct primitive arrastras to crush the rich ore. Those early attempts were successful in exploiting many of the small, high-grade lodes in the Pocket and Mother Lode Belts. However, lack of capital and mining expertise delayed the development of major lode mines in the Mother Lode Belt until the 1890s.

In 1888 Captain William Nevills purchased the Rawhide mine. As with many mines in Tuolumne County, the mine had a history of sporadic small, rich strikes but had never been developed in an efficient, productive manner. Nevills had faith in his mining judgment and spent three years exploring the mineral potential of the property. Convinced of the value of the mine, Nevills sought capital to properly develop the property. In the first year the Rawhide mine yielded 3900 ounces of gold. The mine continued to show its worth as development proceeded; and, in 1894 several large chunks of Rawhide ore (weighing 1600 pounds and assaying 1258 ounces gold per ton) were exhibited at the San Francisco Fair. The mine produced a total of 290,000 ounces of gold before its closure in 1908 (DeFerrari, 1982a).

The success of the Rawhide mine renewed interest in Tuolumne County lode mines, and the publicity of the rich Rawhide ore brought much-needed capital into the county. A number of mines were developed and successfully operated into the early teens, some reaching a depth of over 600 meters. This was the golden period (1890 to 1915) of hard rock mining in Tuolumne County, and the recorded gold production of all the hard rock mines reached 2.7 million ounces.

The scarcity of supplies and labor during World War I effected the closure of most of the lode mines in Tuolumne County. Due to post-war increases in labor costs, the mines remained inactive until the Great Depression, when many jobless people tried their hands

Figure 1. **Gold, Tuolumne County; 4 cm. Harvard Mineralogical Museum collection.**

Figure 2. **Gold, Tuolumne County; 3.8 cm. Wayne and Dona Leicht collection.**

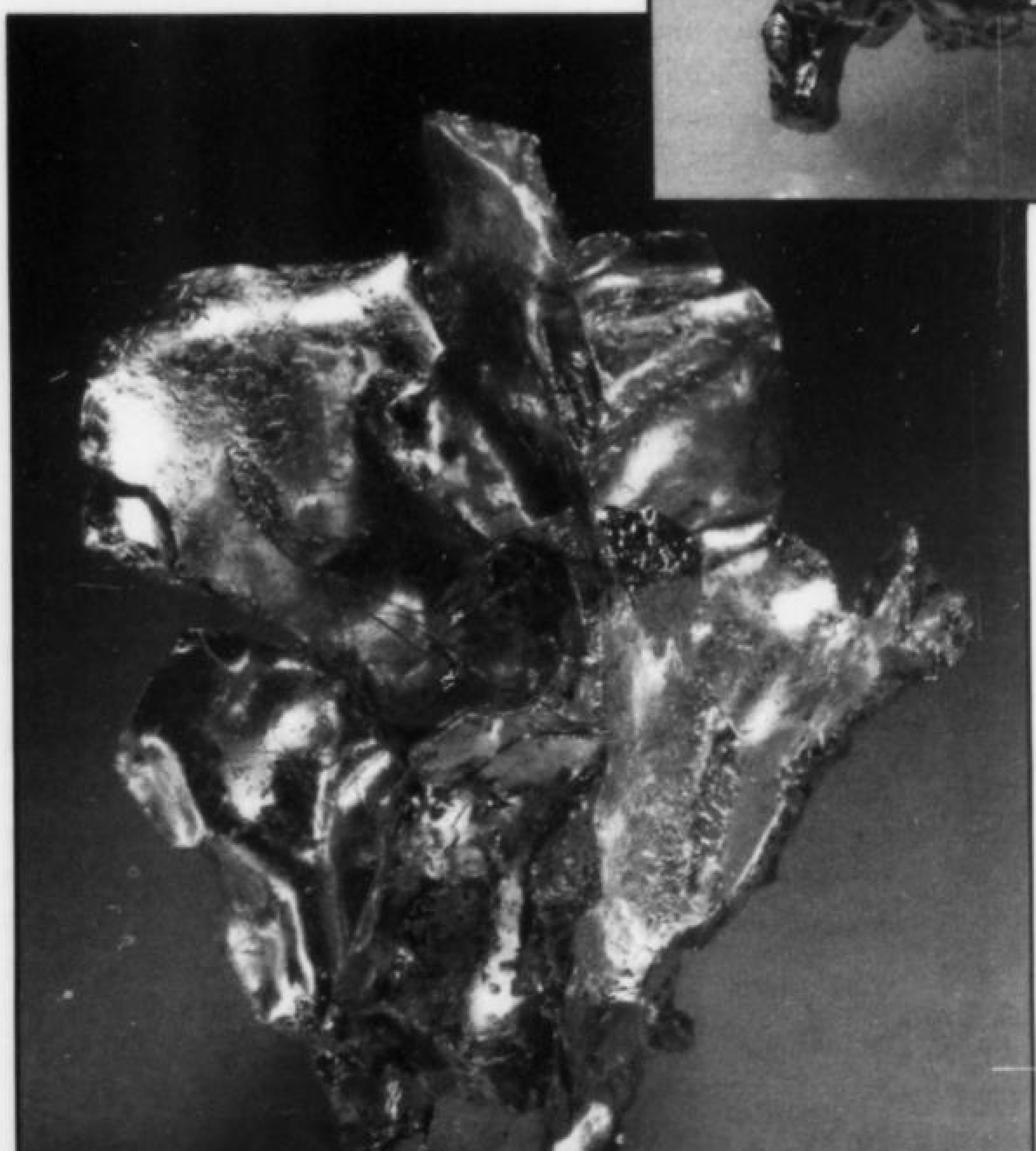


Figure 3. **Gold, Groveland (probably the Sullivan mine), Tuolumne County; 5.1 cm. Keith Proctor collection.**

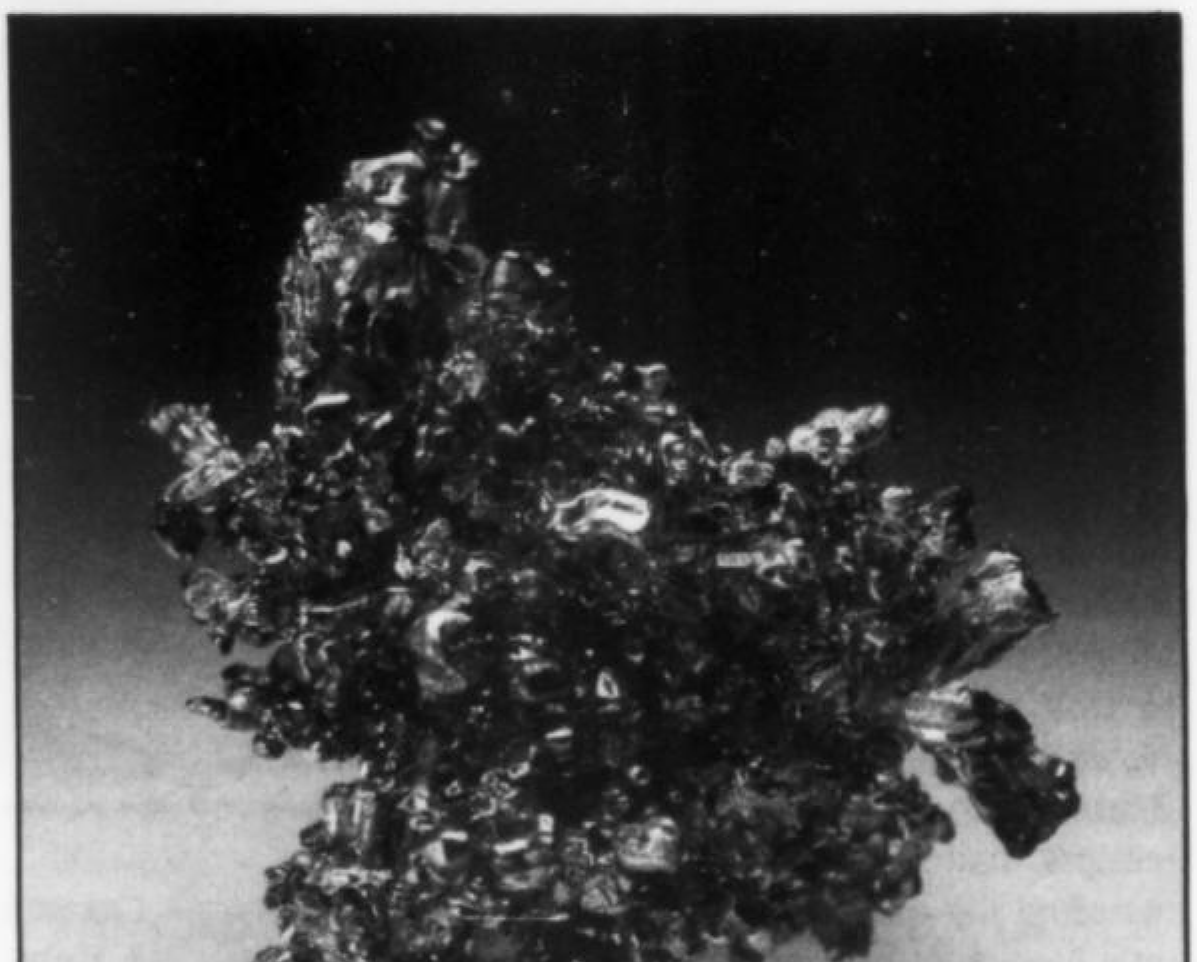


Figure 4. **Gold with petzite, Bald Mountain near Sonora, Tuolumne County; 3 cm. Harvard Mineralogical Museum collection.**

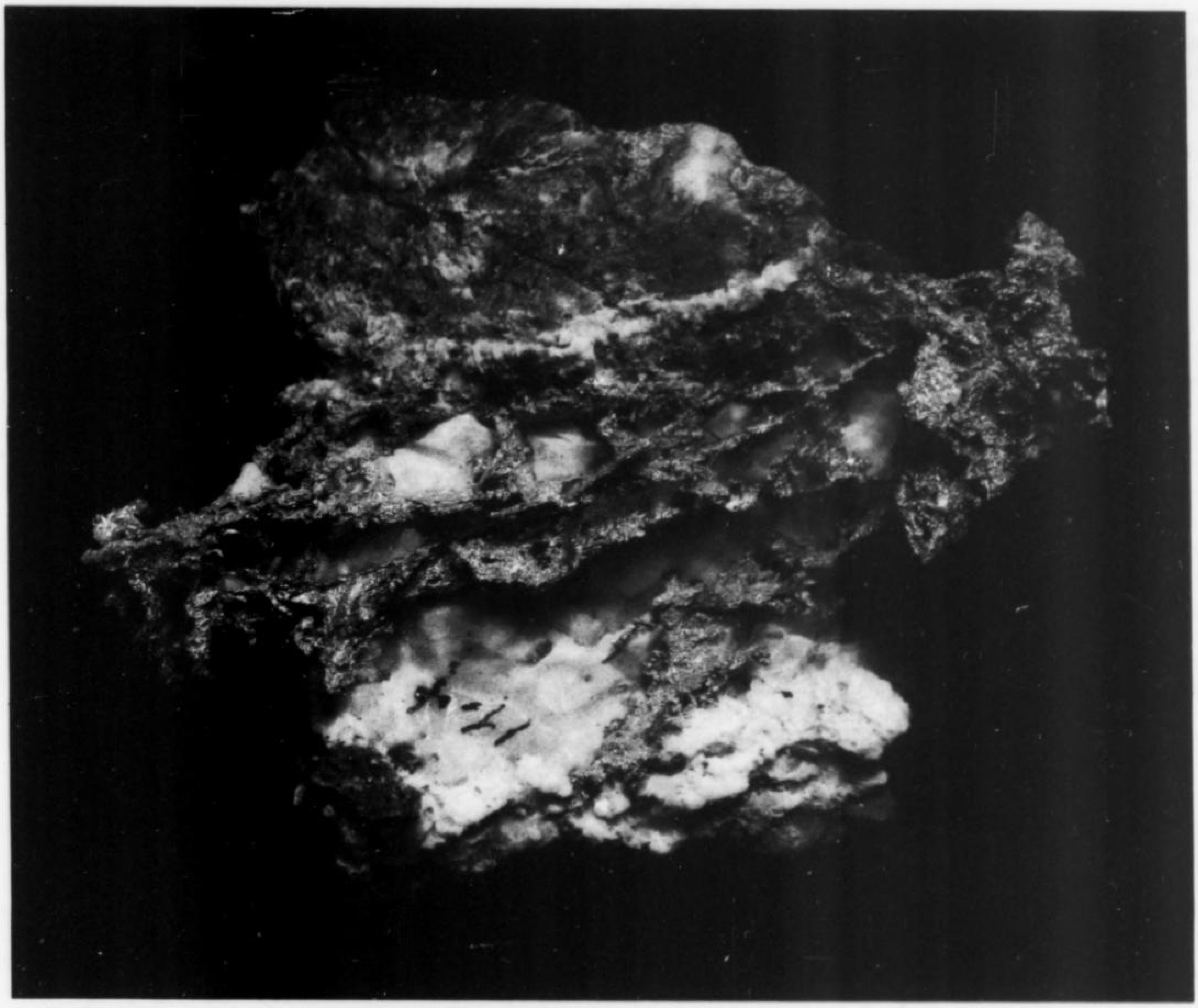


Figure 5. **Gold in quartz vein, Gillis mine, Tuolumne County; 10.6 cm. Tuolumne County collection; photo by John Pradenas.**

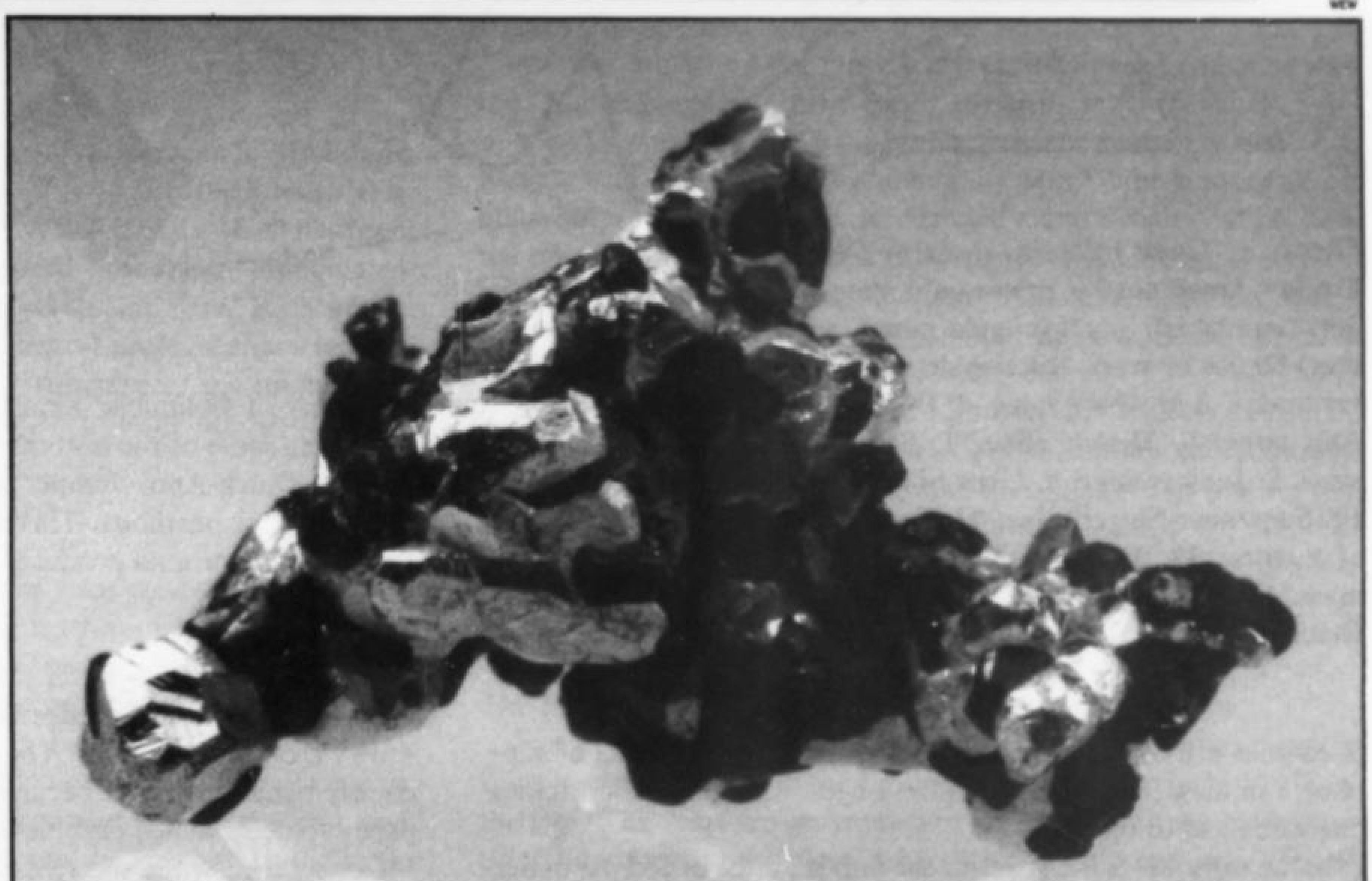


Figure 6. **Gold with altaite, Hidden Treasure mine, Tuolumne County; 1 cm. R. Allgood collection.**

at small-scale placer and lode mining. The legislated increase in the price of gold from $20.67 to $35.00 per ounce in 1934 sparked renewed investment in exploration and valuation of mining properties along the gold belts. Renovation and development work commenced at several mines, including the Harvard, Rawhide and Eagle-Shawmut among others. Virtually all of the mines came to a standstill in 1942 under Federal Order L208, which prohibited non-essential industries during World War II. Only the Eagle-Shawmut remained in operation, supplying needed pyritic flux to the base metal smelter at Selby, California. The post-war period saw the

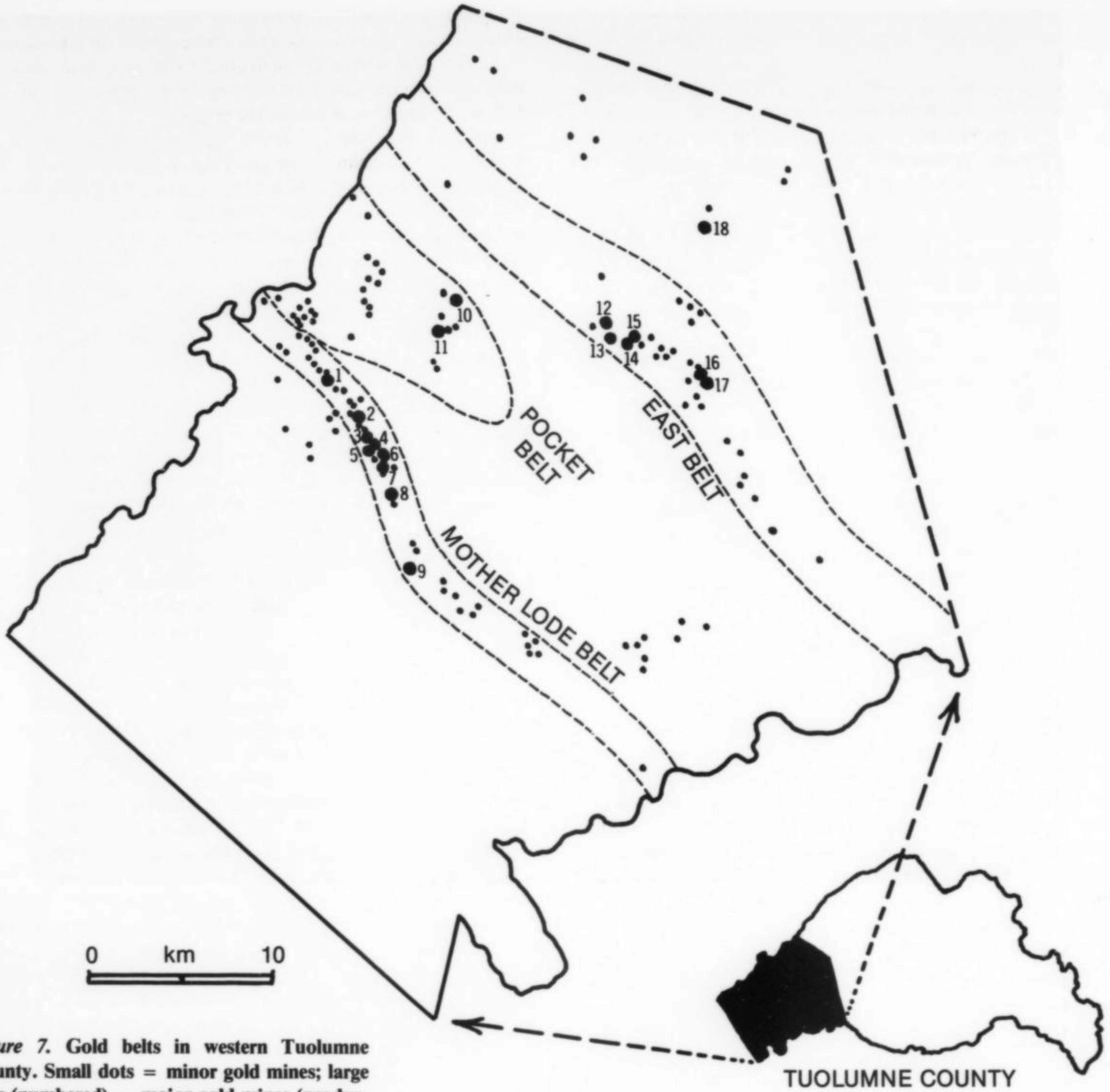


Figure 7. **Gold belts in western Tuolumne County. Small dots = minor gold mines; large dots (numbered) = major gold mines (production › 50,000 ounces). 1. Rawhide mine. 2. Harvard mine. 3. Sweeney mine. 4. Dutch mine. 5. App mine. 6. Heslep mine. 7. Santa Ysabel mine. 8. Jumper mine. 9. Eagle-Shawmut mine. 10. Sugarman-Nigger mine. 11. Bonanza mine at Sonora. 12. Draper mine. 13. Black Oak mine. 14. Gilson mine. 15. Soulsby mine. 16. Grizzly mine. 17. South United mine.**

fixed gold price increasingly countered by the higher costs of supplies, mining equipment and wages, making the mines uneconomical to operate.

In the early 1970s the government-imposd price of $35 per ounce was finally lifted and gold was allowed to seek its natural market value. Again, interest was stirred in the gold belts of Tuolumne County. At present, many of the Pocket Belt mines are being explored by small groups of independent miners seeking elusive pockets of beautiful crystalline gold. One such mine, the Hidden Treasure, is being mined for specimen gold and telluride minerals. Tours are offered to the public through Matalot Gulch Mining Company of Columbia. Similarly, Sonora Mining Corporation is reopening some of the historic Mother Lode mines (Harvard, Crystalline, Dutch-App, Jumper and Rawhide) using modern large-scale open pit methods. This activity will again make Tuolumne County a major gold producer in California.

GEOLOGY

Tuolumne County lies in the Sierra Nevada geologic province, and stretches from the edge of California's central valley to the snowy crest of the Sierras. The geology of the western third of the county (where the gold occurrences are located) consists of complexly folded, faulted and metamorphosed rocks of Paleozoic and Mesozoic age, while the remainder of the county consists of the great Sierra Nevada batholith. Most of the gold mineralization occurs in association with quartz veins injected into the metamorphic belt.

The Paleozoic rocks in the county consist of predominantly clastic sedimentary rocks with minor quantities of limestone-dolostone which have been dynamically metamorphosed and, in some cases, strongly altered by the batholithic intrusion. These rocks are preserved in the metamorphic belt directly west of the Sierra Nevada batholith, and as isolated roof pendants within the batholith.

The Mesozoic rocks in Tuolumne County lie in a metamorphic belt west of the Paleozoic rocks. These two rock groups are separated by the Melones fault zone, a major crustal suture that developed during Jurassic time. Mesozoic rocks consist mainly of metavolcanic and metagraywacke rocks which were probably deposited in a marine environment.

A series of mafic to ultramafic plutons intruded into the metamorphic belt during Jurassic time along the major fault zones. Most of these bodies are more or less altered to serpentinite, and are believed to represent portions of oceanic crust emplaced during tectonic collision.

The Sierra Nevada batholith formed over an extended period of time, beginning as early as 200 million years ago and ending some 80–90 m.y. ago. The composition of the intrusions varied with time and ranged from quartz monzonite to grandodiorite to quartz diorite.

It has long been held that the great batholithic system was responsible for the gold-quartz veins of the Sierra Nevada. Whether the batholith was the source of the gold or whether the gold was derived from the surrounding rocks is still a hotly contested question. In either case the batholith provided the heat necessary to circulate the hot waters which formed the abundant gold-quartz veins in the folded metamorphic rocks.

In Tertiary time two main geologic processes were occurring – erosion and vulcanism. The gold deposits were already present, and emplacement of the batholith coincided with the uplift of the ancient Sierra Nevada mountains. Erosion immediately began tearing down the mountains, exposing, removing and reconcentrating the gold in the rivers and streams. Erosion was followed by vulcanism which laid down vast sheets of volcanic debris, covering and preserving the older river channels and their placer gold deposits. After the volcanic activity ceased, erosion continued into recent times, continuing to create rich new placer deposits in the active stream channels.

THE MINES

Gold was produced from three distinct gold belts in Tuolumne County; the Mother Lode Belt, the East Belt, and the Pocket Belt. There is also a West Belt of massive sulfide deposits which has been exploited for copper, but has produced only minor amounts of gold, and does not warrrant further discussion here. Each of the three productive gold belts has a distinctive geologic character and will be discussed separately. Table 1 summarizes the major hard rock mines in the County showing their total production and periods of operation.

The Mother Lode Belt

The historic Mother Lode system of veins runs the width of the county from 3.2 km northwest of Tuttletown to 11.2 km southeast of Moccasin, a distance of 35 km. The vein is characteristically white quartz that, in places, juts 6 meters above the hill crests and may be as much as 15 meters thick. In Tuolumne County the veins generally follow the trace of the Melones fault, with Paleozoic rocks (Calaveras formation) in the hanging wall to the east and Mesozoic rocks (Mariposa formation) in the footwall to the west. Near several of the larger quartz mines, lenses of serpentinized ultramafic rock are interposed between the vein and the Mariposa formation to the west.

Ore grades in the Mother Lode Belt were generally low to moderate (0.13 to 0.18 ounces/ton) and had an average fineness of 808 (Benjamin, 1899). Usually, ore was not free milling. Sulfide minerals, predominately pyrite, had to be concentrated and either shipped to the smelter at Selby or leached on site using cyanide or chlorination. In general, ore shoots were steeply raking against the quartz vein and fairly uniform in grade to the maximum depths that they were worked (about 600 meters). Total production from the Mother Lode Belt was nearly $32 million.

The Harvard mine is fairly typical of the Mother Lode Belt mines. The first claim staked on Whiskey Hill was a placer claim, because the weathered soils yeilded abundant free gold. When the soils were removed, the early prospectors found that the rock also carried gold. However, they needed a way to liberate the gold from the rock. The richest rock could be ground in arrastras at a profit. In the early 1850s, large glory holes were excavated to remove pockets reported to carry about 22 ounces per ton (Julihn and Horton 1940). These rich zones were exhausted early, and in the 1860s the ore only averaged about 0.22 ounces per ton (Logan, 1934).

It was 1899 before large-scale, efficient mining methods were employed at the Harvard mine on Whiskey Hill. Operations continued until 1916 when they reached a total depth of 569 meters and a total production of more than 100,000 ounces of gold. The miners removed the ore from seven ore shoots which averaged 62 meters along strike and 2 meters in thickness. The average grade of ore removed during this main period of production was 0.13 ounces per ton (Logan, 1934).

Although the Harvard was mainly a low-grade producer, evidence indicates that coarse gold was found at Whiskey Hill. The Wood's Creek nugget, a 68-kg (150-pound) mass of quartz and gold containing 35 kg of gold, was found near where Wood's Creek intersects the Mother Lode outcrop on Whiskey Hill.

Adjacent to the Harvard mine to the north lay the Little Gem claim. This claim had been prospected by an audit in 1867, but had been abandoned. In 1876 a miner named Harris surveyed the adit length and the vein outcrop on the hillside above. He calculated that the adit should intersect the vein in only 5 more meters. He was wrong. In the first drill round (about 1 meter) he uncovered a vein of white quartz seamed with gold. Harris reportedly removed 387 ounces of gold in "picture rock" in ten days, and nearly 10,000 ounces over the next ten years (DeFerrari, 1982).

Another important but much less typical Mother Lode mine was the Jumper-Golden Rule. Until 1895, these two mines were operated separately. The geology of the two mines is very similar; a hangingwall of ankeritized amphibolite schist and a footwall of quartz diorite. The quartz vein intruded along a diabase dike, and the dike is heavily mineralized (Logan, 1934). Small, parallel cross veinlets of calcite which cut the quartz vein contained most of the ore (Thom, 1909). The gold was commonly coarse, beautifully crystalline, and frequently associated with petzite.

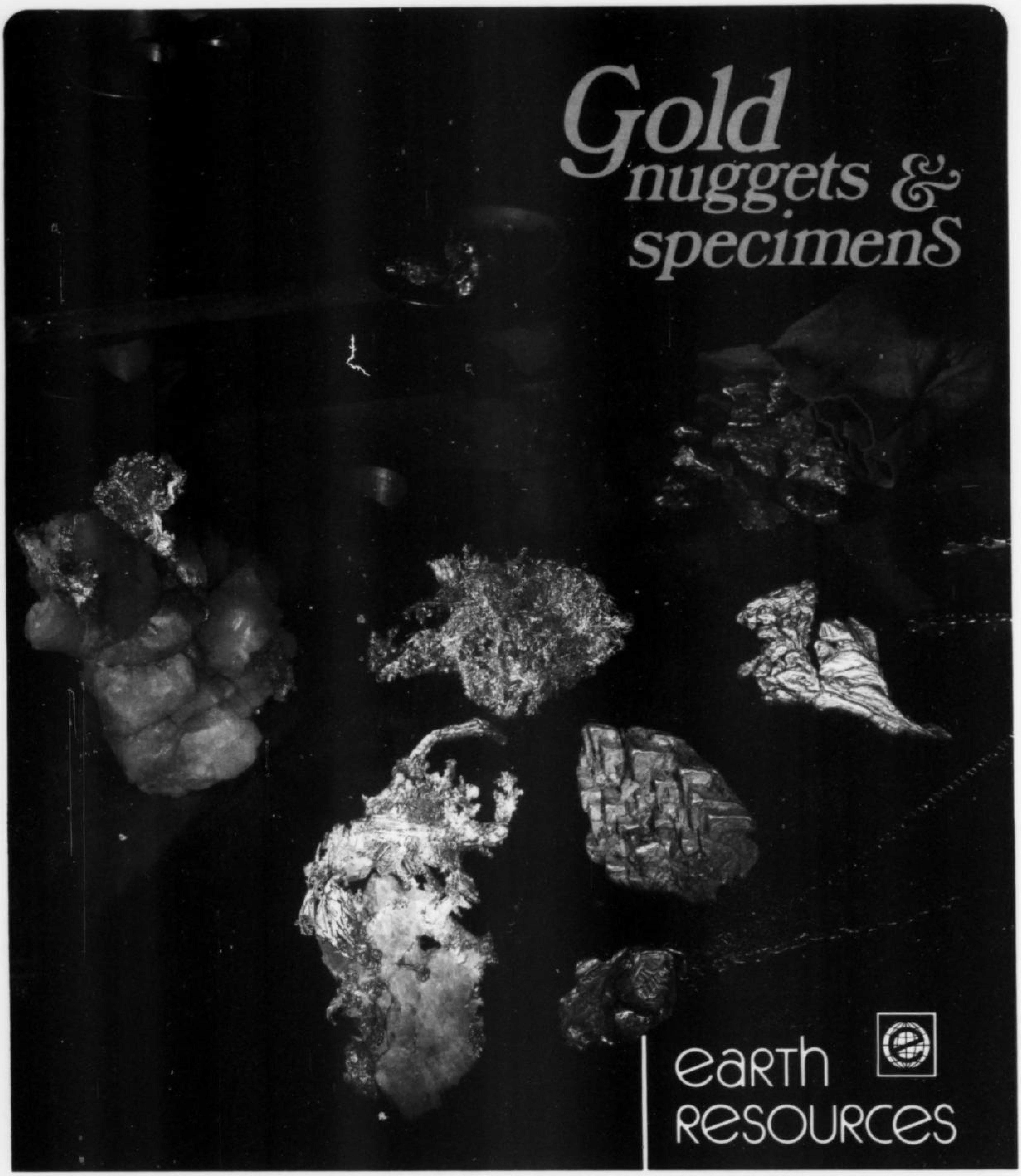
Besides having rich pockets, the Jumper-Golden Rule had sufficient quantities of lower grade ore to sustain continuous operations from 1896 to 1914. Average grades ran in the 0.25 ounce/ton range; however, one documented pocket contained 145 ounces. Some of this ore contained 0.5 ounces of gold per *pound* of rock (Logan, 1934).

The East Belt

The East Belt is composed of a series of discontinuous quartz veins, roughly parallel to the Mother Lode vein, and lying 16 km to the east. The veins are generally narrow (30-60 cm), are composed of ribbon quartz, and transect Mesozoic granite and granodiorite or Paleozoic Calaveras formation rocks.

The ore usually occurred at contacts of differing rock types or at dike intersections, and was higher grade (averaging 0.75 ounces ton) than the Mother Lode deposits. However, the average fineness was slightly lower than Mother Lode Belt gold at 789 fine (Benjamin, 1899). Very few of these mines were exploited below a hun-

(continued on page 62)



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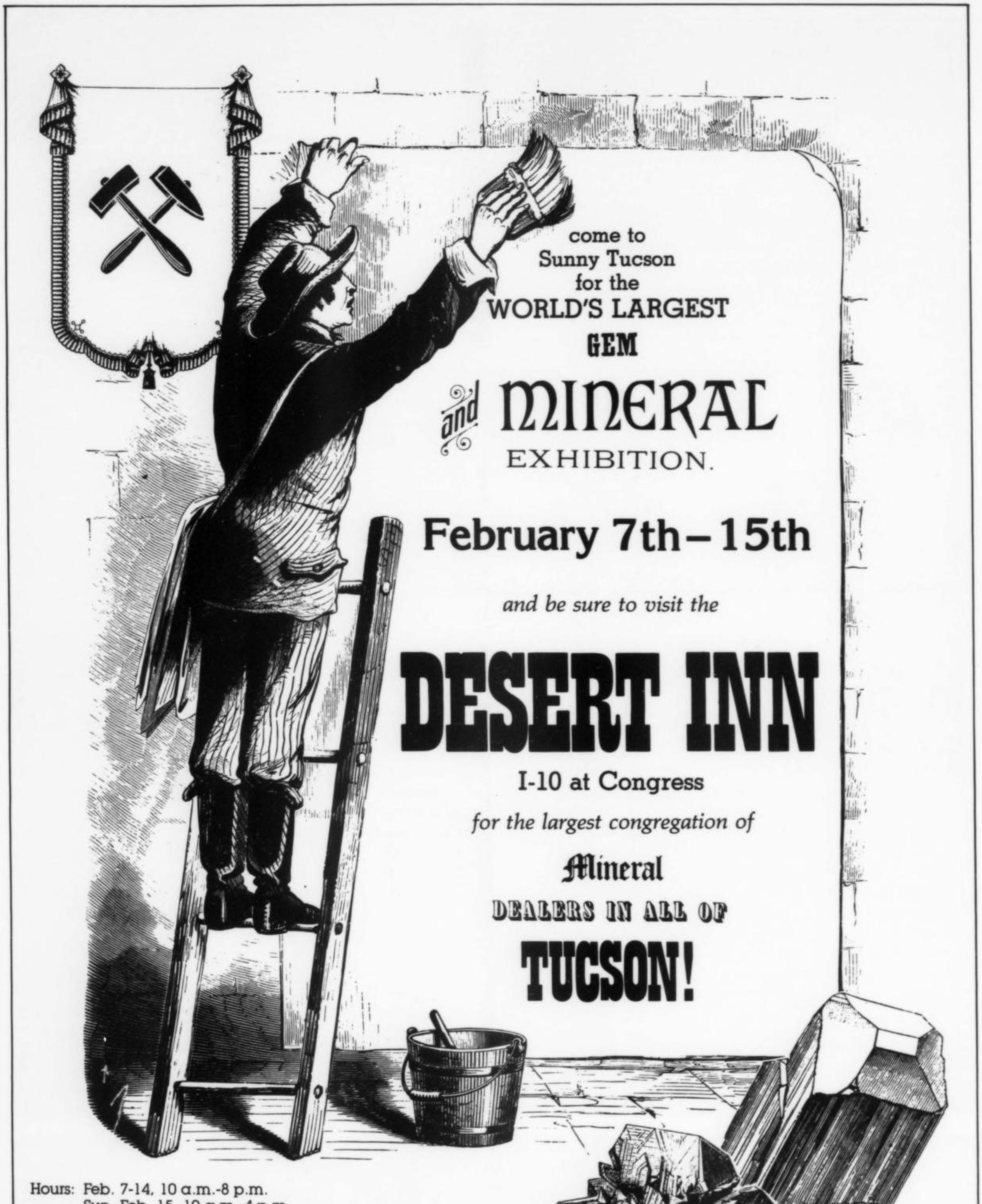
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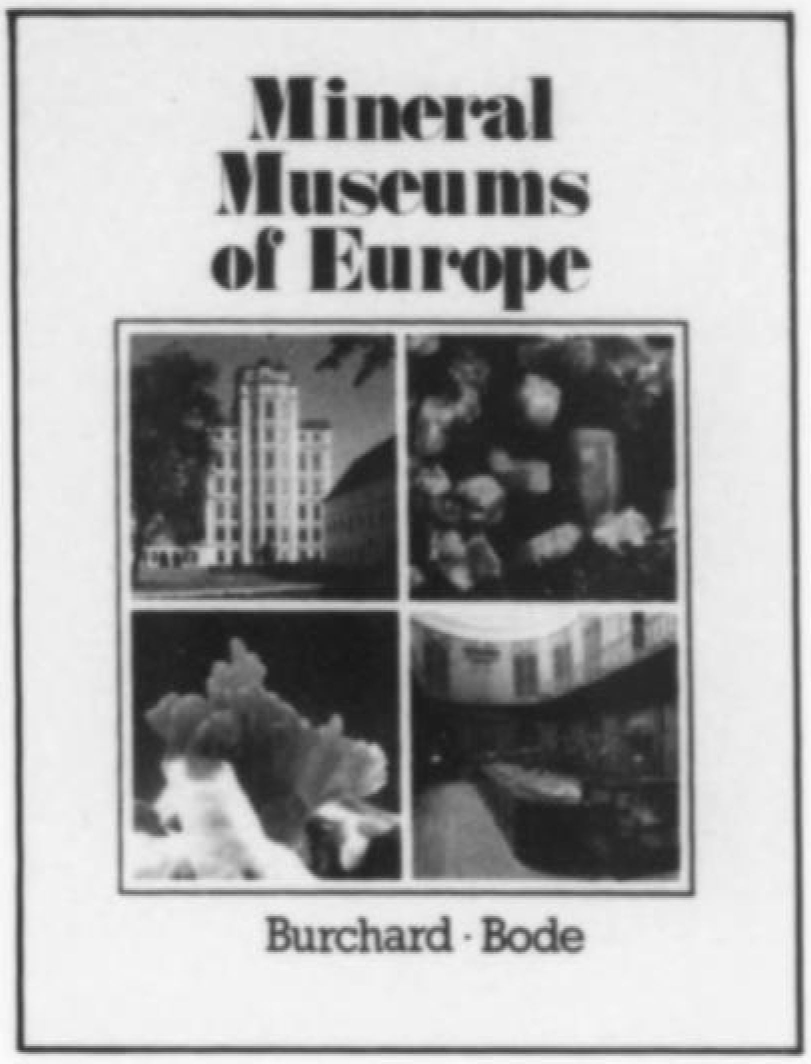

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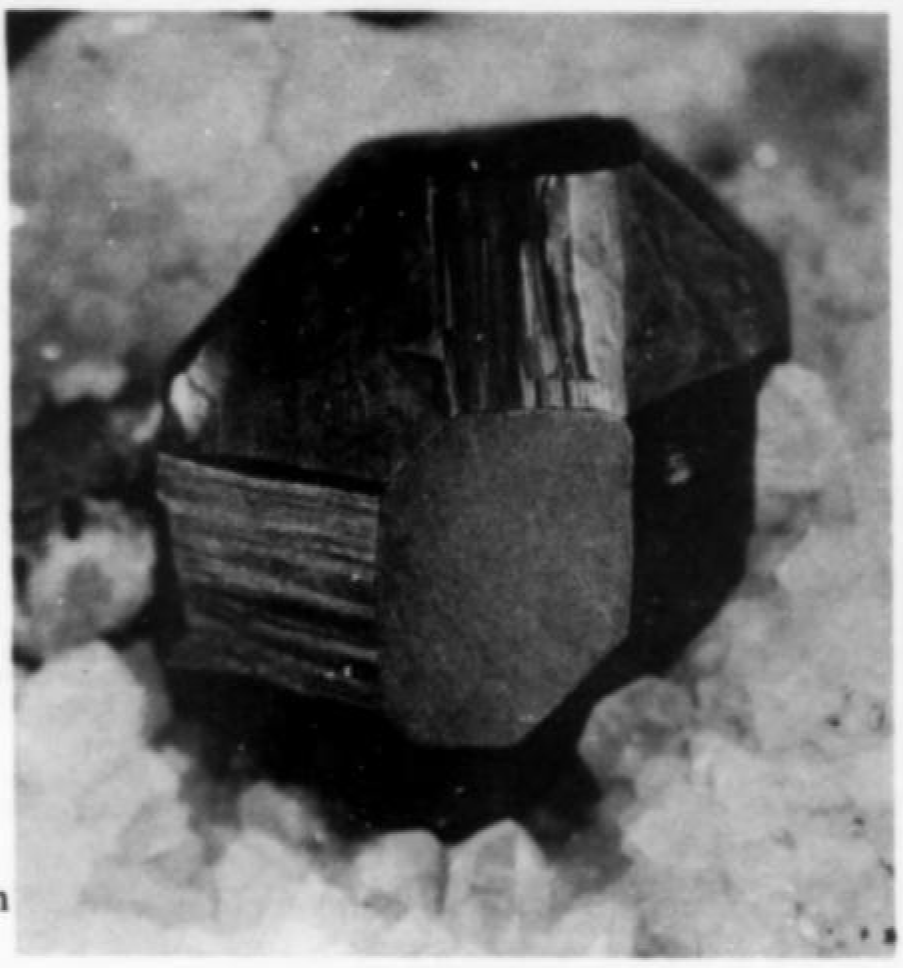

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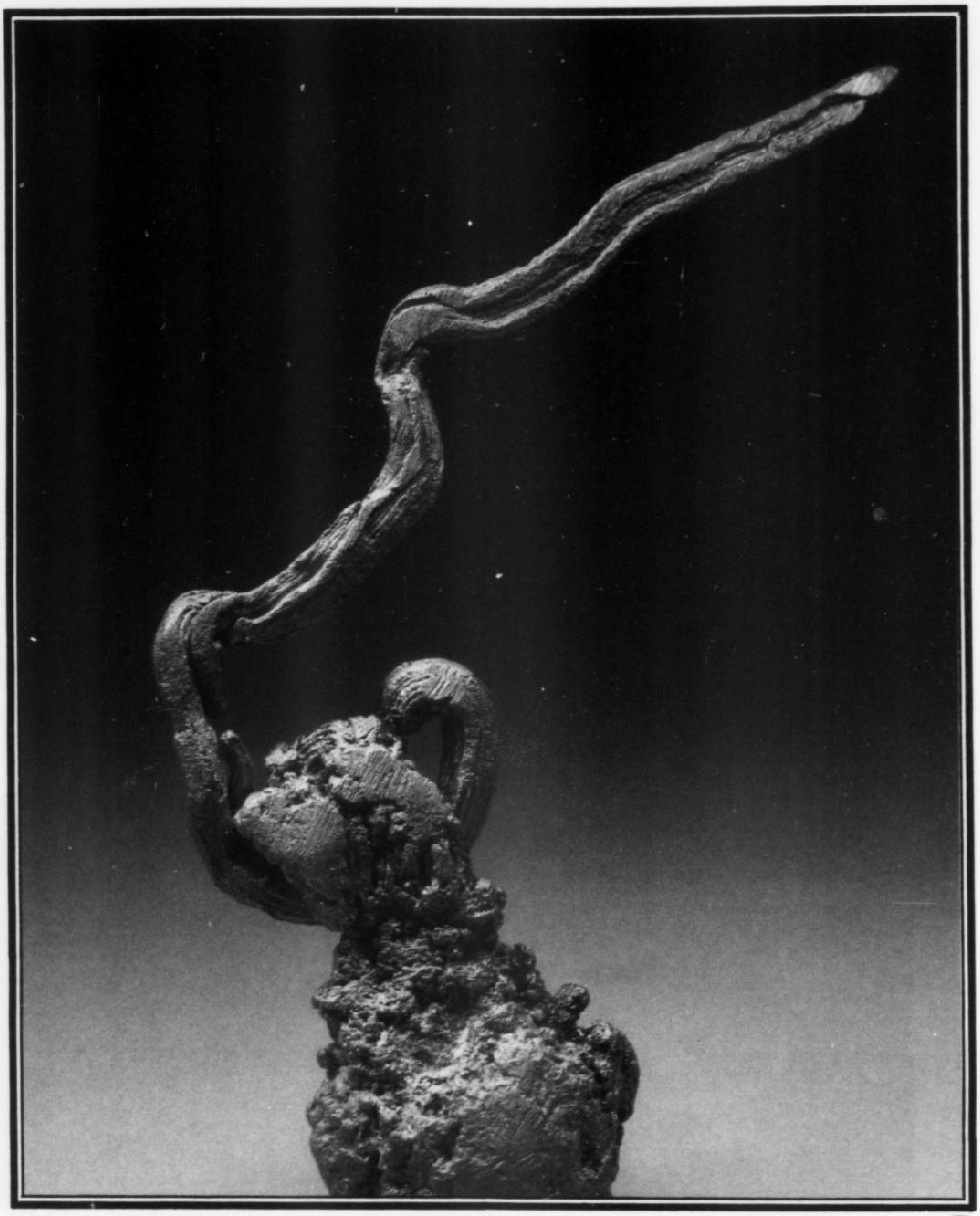

Gold
Aroroy dist.
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Masabe,
Philippines
9.2 cm

WEW

famous mineral localities:

BRECKENRIDGE

COLORADO

For 30 years following Harry Farncomb's discovery of the first gold lodes at Breckenridge in 1879, remarkable specimens of wire and leaf gold were pulled from the brown muck which filled the veins.

Ed Raines
9075 Gaylord
Houston, Texas 77024

Arthur E. Smith
9118 Concho Street
Houston, Texas 77036

INTRODUCTION

The Breckenridge mining district is located in Summit County, Colorado, a short distance northwest of the geographic center of the state. It lies on the east bank of the Blue River, a tributary of the Colorado River. Topographic coverage is provided on the following U.S.G.S. 7½-minute quadrangle maps: *Boreas Pass, Breckenridge, Frisco,* and *Keystone.* Located on the western slope of the Continental Divide, Breckenridge was considered to be a part of Utah Territory before Colorado Territory was created early in 1861. (The eastern slope was divided between Kansas, Nebraska and New Mexico Territories.)

The Blue River flows north along its rather narrow valley. To the west the Ten-mile Range rises abruptly, paralleling the river. A more gentle topography lies to the east, where several gulches with their attendant streams cut through the hills to join the Blue River. The two most important of these streams, French Creek and the Swan River and their tributaries, were hosts to much of Breckenridge's placer mining activities. The Blue River was also a major gold placer area.

HISTORY

Breckenridge history is highlighted by three distinct periods of gold mining. The first period began with the discovery of placer gold deposits along the Blue River in August of 1859. There are several versions of the story, but the most reliable is probably the version found in Frank Hall's *History of the State of Colorado* (1890). General George E. Spenser led a party of 29 men and one woman out of Denver, up the South Platte River, and into South Park in early August, 1859. After the party split, 14 continued on through South Park, over what is now Hoosier Pass, and into the Blue River Valley. This was the first group of white prospectors to cross over the Continental Divide to the Western Slope. Ruben J. Spalding, an experienced "forty-niner," was chosen to begin the prospecting effort. Spalding selected a bar on the Blue about 400 meters below the present site of Breckenridge. His first pan of dirt yielded 13 cents in gold and his second, 27 cents.

Claims were staked and more discoveries made. William H. Iliff's first pan yielded 2 dollar's worth. Spalding built the first cabin in the area, and General Spenser laid out a townsite. Two major construction projects soon dominated the party's efforts. The prospectors built a small log fort to provide protection from the supposedly hostile Ute Indians. The stockade was named Fort Mary B (also called Mabery, Meriby, and Maribeh) in honor of the party's only woman, Mary Bigelow. The Utes proved friendly toward the prospectors—there is no record of the fort ever being used as a defense against Indian attack.

The second project was the construction of a canal to rechannel the Blue River around the diggings, the idea being to placer mine the river bed. Upon completion of the canal, sluicing operations began, with Spalding's first day's work generating one-half ounce gold. Iliff's claim eventually netted him over 350 ounces. The miners continued operations into early winter before a lack of water shut down their sluices. Then they went prospecting to relieve the monotony of winter in the mountains.

The winter prospecting journeys were made

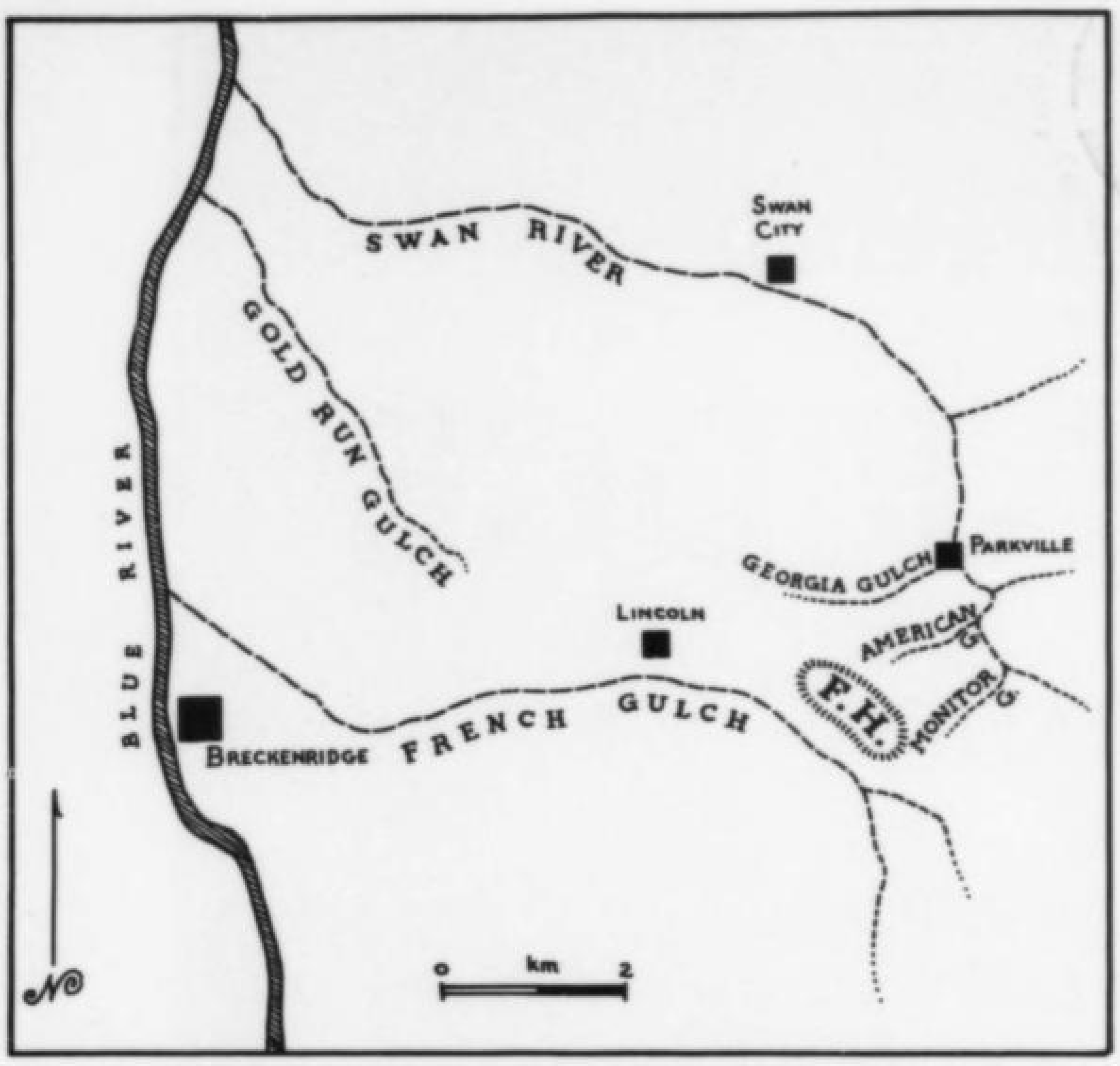

Figure 1. **Map of the Breckenridge Mining District, Summit County, Colorado (modified from Ransome, 1911); "F.H." is Farncomb Hill.**

possible by what the men called "snow shoes." These contraptions were really 2 to 3-meter-long boards more closely akin to skis than to the webbed-frame snowshoes with which we are familiar. The most successful trip carried a party 10 km down the Blue where a cabin was built and a townsite planned (to be called Eldorado West). The party fanned out to test the ground. Balce Weaver dug through 2.5 meters of snow and discovered Gold Run Diggings on a tributary of the Swan River, an area that proved to be one of Breckenridge's more productive regions.

The winter months also saw the community get a post office and a name. General Spenser chose the name Breck*in*ridge for Vice President John E. Breckinridge. He felt that Washington politicians would be inclined to expedite matters if the application for postal service was for a community named for an important political figure (Gilliland, 1980). Apparently he was right, for when the appointment came through on January 18, there were only 25 persons in the camp (Smith, *in* Fiester, 1973)! Spenser became the first postmaster.

News of the discoveries reached the outside world rather quickly. A party of 50 men from Tarryall donned "snowshoes" and crossed the Divide to investigate Gold Run Gulch. William A. Smith, one of the members of the Tarryall Party, began writing a series of letters that are today one of the more valuable sources for information on the fledgling camp (Fiester, 1973). He reports that a few men did well in spite of the winter, but that most prospecting was futile until warmer months arrived.

By May the rush was on. Parties traversed the divide by way of Boreas, Georgia and French Passes as well as Hoosier Pass. A Canadian named French Pete discovered gold in the Gulch which still bears his name. John D. Young's diary reports "color" in every hole but none in quantity enough to warrant staking a claim. His party crossed back over into South Park and traveled on to the diggings at California Gulch near present day Leadville (Young, 1969).

Daniel Ellis Conner (1963) reports the discovery of the "richest diggings ever found in this section of the Rocky Mountains" at Georgia Gulch. A Mr. Highfield had led a group of Georgia miners into the area in early June, 1860, and named the gulch for their home state. Conner goes on to report that it was common for three or four men to pool their energies and sluice 15 to 25 ounces per day. Gold was also discovered in American Gulch and Humbug Gulch (a small tributary of Georgia gulch).

Georgia Gulch and its neighbors soon became the busiest and most prosperous area of the district. At the mouth of Georgia Gulch the town of Parkville (also called Park City) was established which soon had a population of about 500 (Conner, 1970). By the time the first election was held later in the year the population had grown to 1800 voters. When Colorado Territory was established in February, 1861, Parkville came within 11 votes of being named the capital! It was named as the county seat for Summit County in November of that year (LaBaw, 1965).

The town grew by leaps and bounds as businesses were established and homes built. One of the more interesting enterprises was the private mint built by J. J. Conway in 1861. Conway coined $2.50, $5.00 and $10.00 gold pieces. While very few of these coins still exist today, they were an important catalyst to the easy flow of pioneer commerce in Summit County.

Women were very scarce in most of frontier Colorado and Parkville was no exception. Their appearance often touched off interesting events. A melodrama playing at a Parkville theater featured a kidnapping of the heroine by a villainous, thwarted lover. Just as the fair innocent was about to be carried off stage, a much besotted miner from the audience rushed the villain, intent on protecting the maiden's virtue. Pulling his gun he shouted, "No you don't, Mister! Just drop that gal or I'll blow the top of your head off!" An impromptu script rewrite saved the day and the show went on (Gilliland, 1980).

While Parkville grew and prospered, so too did Breckinridge. The outbreak of the Civil War in 1861 caused hard feelings and several incidents among the citizenry. Both southern and northern sympathizers departed to enlist in their respective armies. Apparently a majority of those who stayed on were Unionists because they were so scandalized at the traitorous actions of former Vice President and now Senator Breckinridge that they renamed the town! When word was received that the town's namesake had accepted a commission of General in the Confederate Army the townsfolk changed the name from Breck*in*ridge to Breck*en*ridge (Fiester, 1973). Not too drastic a change, but there were pressing local matters that needed attention.

Breckenridge citizens were really caught up in their rivalry with Parkville. The last county meeting had been held in Parkville during March, 1862. Some overly ambitious Breckenridge residents decided that there would not be another one, so they sneaked into the county offices under the cover of darkness and confiscated the official records. Breckenridge proclaimed itself county seat; it remains so to this day. Parkville, on the other hand, had been buried (literally!) under the dumps and tailings of hydraulic mining operations in Georgia Gulch during the 1880s (Gilliland, 1980).

Placer mining continued to boom throughout the district during 1862. Balce Weaver and his brother had left their discovery in Gold Run Gulch with 96 pounds of gold, the product of one season's work. Gold Run continued to produce excellent yields (Hollister, 1867). Diggings were established up the Swan River all the way to Georgia Gulch. Other areas in neighboring gulches also produced lesser amounts of gold.

Most of this early work followed a pattern. Discoveries were made and early claims worked by panning or using a rocker. Hand methods then gave way to the more elaborate and efficient methods of sluicing and later still to hydraulicking.

Hydraulic giants became quite popular as the most economical method to placer mine gold in the early days. Water was routed downhill through a series of ditches and flumes into a pipe with a nozzle. As the water "fell" downhill it built up pressure (called a hydraulic head) in the pipe and nozzle. The resulting stream of water had a force not unlike the modern fire hose. This stream was

Figure 2. **View from Farncomb Hill looking down the American Gulch placer workings; Continental Divide in the distance. Photo by F. L. Ransome (1911) courtesy of the U.S. Geological Survey.**

aimed at the hillsides which were eroded and washed down into a series of sluice boxes to trap the gold. It was much more efficient to wash the pay dirt down into the sluices than it was to hand shovel the dirt. It was also much more destructive to the environment.

Hydraulicking depended on two factors: plenty of water, and a sufficient slope for the water to be routed down in order to build pressure. Breckenridge had plenty of topographic relief, but parts of the district lacked an abundant water flow. Sometimes canals could be dug to bring in more water, but this wasn't always practical, especially for smaller claim operators. Another placer mining method offered a solution: "booming."

Booming (sometimes called hushing) calls for construction of a dam with a floodgate on a small creek above the ground to be "washed." Sluices are then constructed downstream in such a way that any water (and pay dirt) washed down will travel through them. When the reservoir behind the dam is full the floodgate is opened and the pay dirt is washed through the sluices in the ensuing flood of water (Boericke, 1936). Breckenridge was one of the few Colorado placer mining districts to utilize booming.

By the end of 1863 most of the rich placer deposits had played out and many of the district's miners drifted away. Only those operators who were able to work less rich ground on a large scale were able to stay in business. The first period of Breckenridge's gold mining history had come to a close. It is impossible to be truly certain of the district's production during these early days because no one kept complete records. Henderson (1926) reports $5,150,000 through 1867 (he is using a gold price of $20 per ounce). This translates into 257,500 ounces (over $100 million at $400 per ounce). Hollister (1867) reported 150,000 ounces for Georgia Gulch alone. This production certainly didn't place Breckenridge among the world's great gold camps, but future discoveries would (for reasons other than the amount of gold produced).

Attempts at lode mining had been made throughout the early days, but no significant discoveries were made until near the end of 1879. Harry (also called Henry) Farncomb had arrived in the district during the first rush of the 1860s. He moved to French Gulch where he operated small placer claims for nearly 20 years. Farncomb's prospecting efforts steadily carried him further and further upstream until he worked his way to the hill that now bears his name. This, he discovered, was the ultimate source of all of the gold in French Gulch.

Fossett (1880) reports Farncomb's production for 1878 to be $8,000 (about 400 ounces). Farncomb's approach to developing his discovery was unique. He *bought* land a few acres at a time instead of staking claims. Soon he owned a considerable portion of the southwest face of Farncomb Hill (this was the Wire Patch *placer,*

Figure 3. Gold crystal group, 7.8 cm wide, from Breckenridge. Harvard Mineralogical Museum collection.

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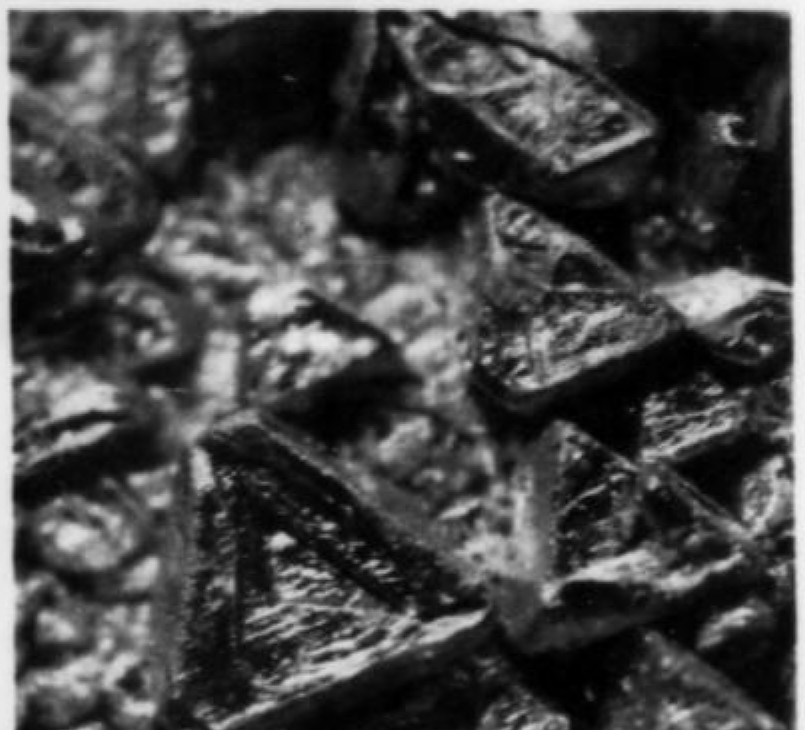

Figure 4. Octahedral gold crystals in parallel growth, Farncomb Hill. Photo by Bob Rozinski; collection of the Denver Museum of Natural History.

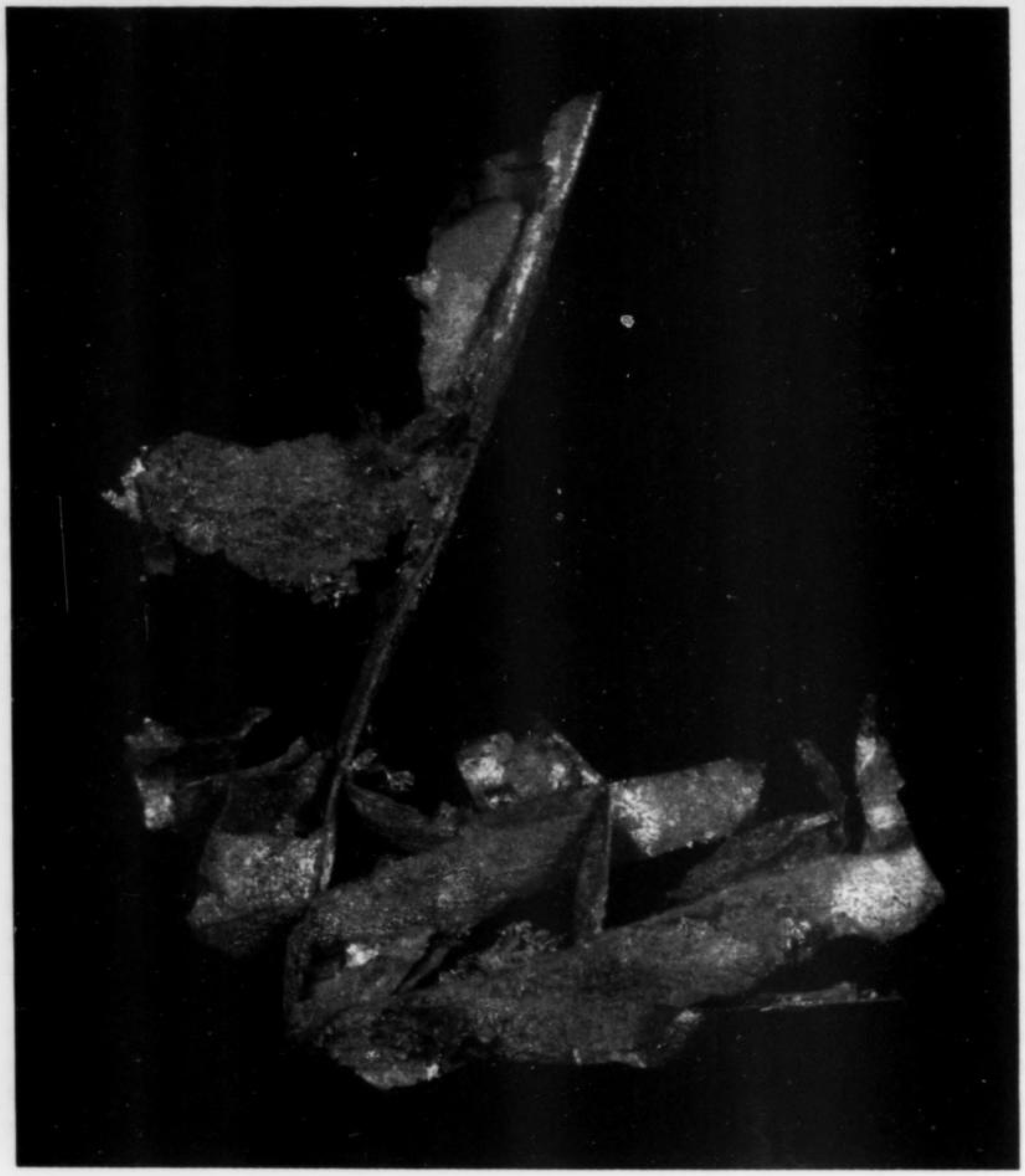

Figure 5. Composite of leaves showing orientation of intersecting calcite cleavage planes. In the authors' opinion this is the most exquisite Breckenridge gold specimen in existence. Specimen is 14.4 cm tall. From the Wapiti Mining Co. claims. Photo by Ed Raines; DMNH specimen #9537.

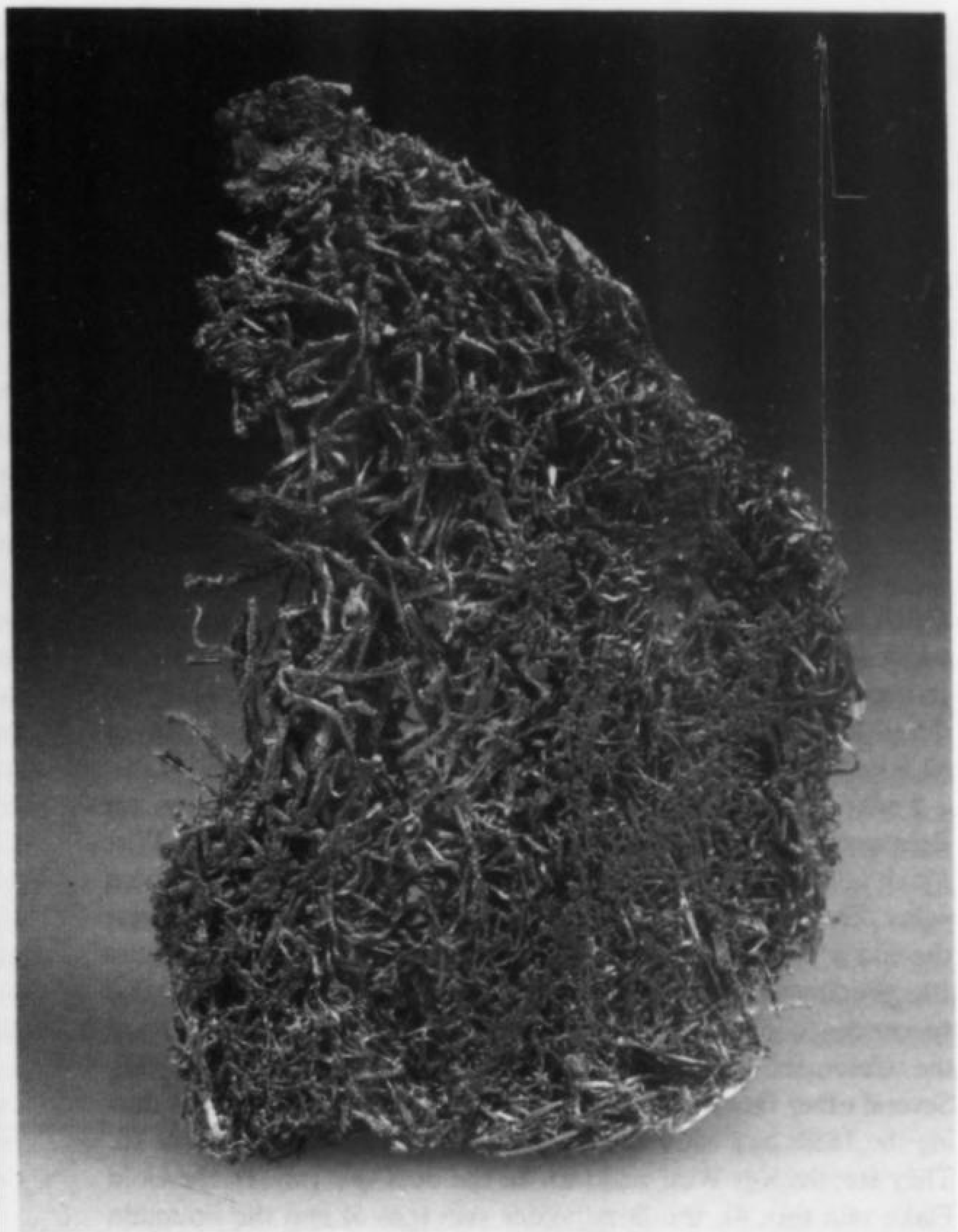

Figure 6. **Felted wire mass of "bird's nest" gold, 9.3 cm and 2 ounces in weight, from the Wire Patch mine. Keith Proctor specimen.**

Figure 7. **Composite of leaves showing orientation of intersecting calcite cleavage planes. Specimen is 15 cm across. From the Wapiti Mining Co. claims. Photo by Ed Raines; DMNH specimen #9534.**

Figure 8. **Gold crystal mass, 8.4 cm wide, from Breckenridge. Harvard Mineralogical Museum collection.**

not the Wire Patch *mine*). As Farncomb's placer operations produced more and more gold people began to take notice, especially since the gold was in the form of beautiful twisted wires and intricately joined leaves. Soon he had become one of Breckenridge's wealthiest citizens.

When he deposited a sackful of gold in a Denver bank all hell broke loose. Prospectors were enraged to discover that he *owned* most of the obviously rich ground. A group of Denver promoters joined together to attempt to take his land away since he had not *claimed* it in the normal way. The fight that ensued is now referred to as the Ten Years War. Before all was said and done, a bank went broke, a seven-hour gunbattle was fought up and down French Gulch by 40 men (three were killed and several more wounded), and a long legal battle erupted in which, as usual, only the lawyers came out ahead. In the meantime Farncomb had gone on to discover the Elephant orebody, which he incorporated into his Wire Patch mine (not the Wire Patch placer). Eventually the war ended when Farncomb sold his holdings to a neutral third party, and retired a wealthy man (Gilliland, 1980). The Wire Patch mine produced nearly $140,000 for Farncomb (that's 7,000 ounces or $2,800,000 at $400 per ounce) (Lovering and Goddard, 1950).

Farncomb's discoveries were only the beginning of Breckenridge's second period of gold mining. Neither the Wire Patch mine nor the Wire Patch placer were on actual gold-bearing veins. The first vein discovery, the Ontario mine, was made near the end of 1879 or in early 1880. The Ontario is shown on Figure 10. Specimens from this mine were the first Farncomb Hill specimens to win a blue ribbon at an exhibition. In this case it was the Colorado Industrial Exposition of 1881 (Gilliland, 1980). Several other famous veins that produced fabulous specimens during the 1880s and early 1890s are shown on the map of Figure 10. They are: the Key West vein (no. 2), the Boss vein (no. 3), the Gold Flake vein (no. 4), the Bondholder vein (no. 5) and the Fountain vein (no. 6).

It is extremely difficult to keep track of the various Farncomb Hill veins when reading about the area. Sometimes the veins were worked as individual mines by their owners. At other times they were worked by lessees who might either use the vein's name for their operation or might operate under an entirely different name. To further complicate matters most lessees operated more than one vein under their company's name. Through time a particular vein might be relinquished by one lessee who continued to operate other veins under his original company name. If that vein was then leased by another company (and it usually was) the situation could get very complicated. Many mining company records have not survived the years, making the situation even more difficult. Several examples of this problem will become obvious to the reader during the following discussion.

Farncomb Hill produced gold (and gold specimens) on a steady basis through the 1880s. Production decreased in the 1890s, but there was extensive mining done by a series of companies which controlled large blocks of claims on the northeastern flank of the hill. Col. A. J. Ware, one of the first men to operate a large group of Farncomb Hill veins under one company, put this block together in the late 1880s. Ware formed a partnership with Mason B. Carpenter and they expanded their holdings. The principal veins that were included in the Ware-Carpenter properties were the Gold Flake, Carpenter, Graton, Bondholder, West Bondholder (also called the Silver) and the Fountain. These veins comprised the so-called eastern group of veins (Ransome, 1911). Ware and Carpenter controlled a number of lesser veins for a total of twelve in all. They also controlled over 2000 acres of rich placer ground below the veins (Fiester, 1973). The partnership did little operating on its own. They instead preferred to lease all or part of their holdings. They retained a 25% royalty which was payable as "free gold" that was to be delivered directly to their office in Breckenridge on the very next day after being mined. Needless to say, Ware built an outstanding collection of gold specimens because of these unusual terms (Fiester, 1973).

In August of 1888 Ware and Carpenter sold their properties to the Victoria Company which was owned in part by three U.S. Senators: Hearst of California, Jones of Nevada, and Gorman of Maryland. The Victoria Company operated two mills in the area, and worked the properties until early 1894.

John F. Campion, a famous Leadville mining man and owner of the Ibex mine, bought out the Victoria Company early in 1894. He incorporated his holdings on February 26 and renamed the property (according to his custom, for a member of the deer family) the Wapiti Mining Company. He hired as manager Ben Stanley Revett, an English mining engineer, who was fast making a good name for himself in Colorado mining circles. Revett managed the property very successfully until 1897 when he turned the job over to Frank and Maurice Griffin of San Francisco. The Wapiti Mining Company's mines produced many fine specimens even though overall production declined during these years. Specimens from these mines won first place awards at both the 1893 World's Columbian Exposition in Chicago and the St. Louis World's Fair of 1904. Campion's own private collection was donated to the Denver Museum of Natural History where it may still be seen today (Gilliland, 1980). The mines also produced specimens for many other collections, for "more [gold] was probably sold as specimens and stolen by the miners than was ever shipped by the owners" (Lakes, 1911).

One of the most famous of all the Farncomb Hill discoveries came from the Gold Flake vein, one of the Ware/Victoria/Wapiti properties. On July 23, 1887, Tom Groves and Harry Lytton (lessees) removed over 243 ounces in gold from a pocket in the vein

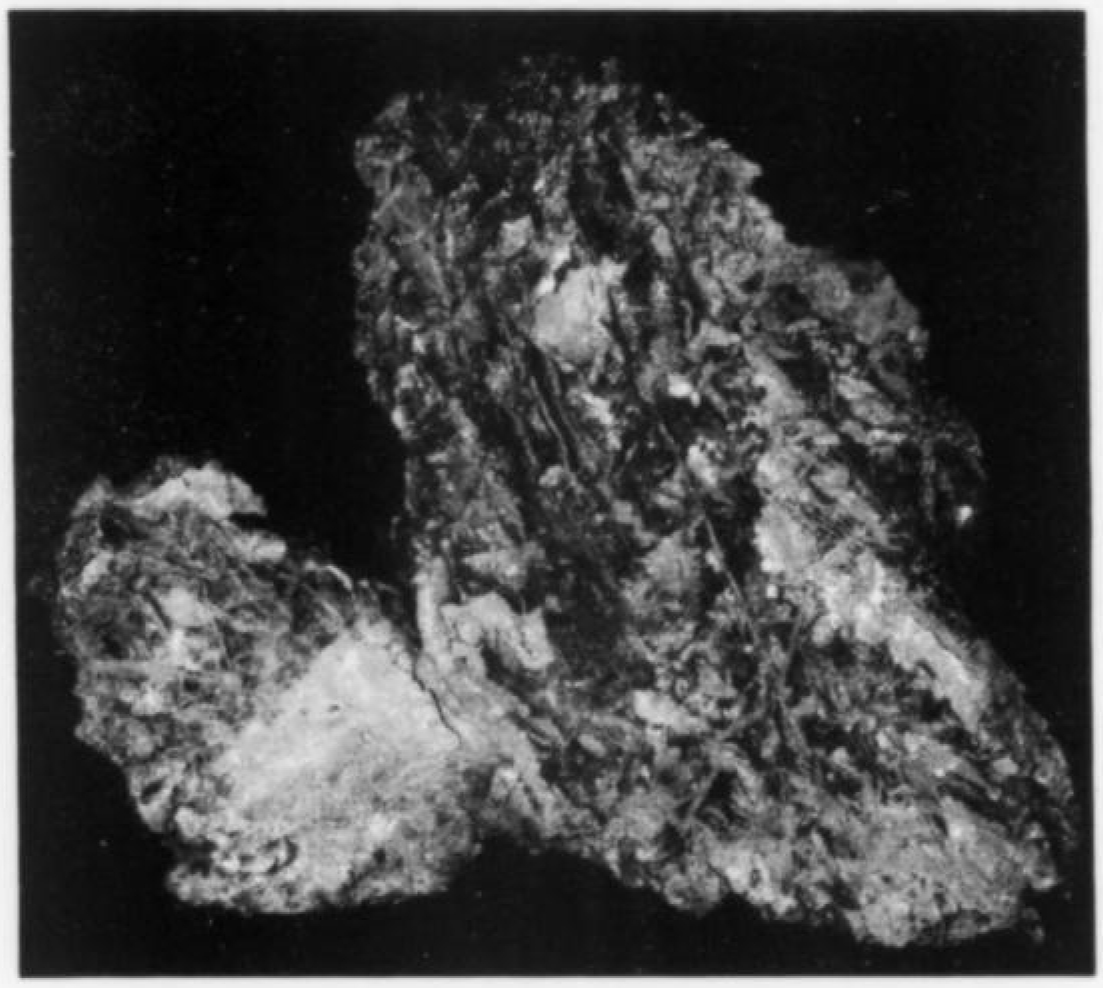

Figure 9. **The gold specimen known as "Tom's Baby," found in the Gold Flake vein by Tom Groves and Harry Lytton in 1887. It measures 21 cm and weighs 103 ounces, although an additional 33-ounce fragment has since been lost. "Tom's Baby" is one of the few (perhaps the only) significant Farncomb Hill gold specimens in which the original limonite-rich vein filling has been preserved intact instead of purposely dissolved away for display purposes. Bob Jones photo; collection of the Denver Museum of Natural History.**

(Breckenridge *Daily Journal,* 1887). One piece weighed 160 ounces when first extracted. Two pieces broke off, leaving a "nugget" of over 136 ounces. It was dubbed "Tom's Baby" because Groves often displayed it on a black satin pillow with the same (perhaps more?) enthusiasm usually reserved for one's firstborn. The specimen was the cornerstone of several award-winning exhibits, probably including the 1893 Chicago Fair exhibit (Fiester, 1973). Tom's Baby disappeared and was "lost" for nearly three-quarters of a century until it was rediscovered among some gold specimens in a storage vault at the United Bank of Denver. It was in two pieces (which have since been rejoined) with a weight of almost 103 ounces. The missing 33 ounces have never been recovered. Although there were other pieces in the vault, they did not fit onto the body of the main piece. (The 103-ounce specimen is now on display at the Denver Museum.) At present there is still almost as much mystery about Tom's Baby as there ever was (Murphy, 1975).

While the second phase of Breckenridge gold mining was winding down in the late 1890s, the third phase was beginning. Ben Stanley Revett had begun to dream of ways to extract the more deeply buried placer gold even while he still managed the Wapiti. Revett began a sampling program along the Swan River. After several experiments he began to use an oil well drilling rig to test the deep gravels. This was the first time that such a procedure had been used in mining operations. The new sampling methods were a huge success – they have been used in conjunction with every major placer operation in the district since that time. Revett then planned to import a new placer mining method from New Zealand: the dredge. Dredges offered several advantages over other placering methods: cost effectiveness, greatly reduced water requirements, and the ability to tap deeply buried gravels. It was these advantages that Revett intended using to exploit the gold-bearing gravels that had been delineated by his sampling program.

Dredges were usually constructed (from prefabricated parts) right where they were to operate. After a large depression was scooped out in the earth, the dredge was assembled in the depression. Upon flooding, the depression became a pond and the dredge floated. Operations were relatively simple. A series of buckets on a conveyor scooped up the gravel and carried it into the dredge where it was processed in a glorified sluicing operation. Conveyor belts carried the waste rock out and dumped it off the stern. The dredge would swing from one side of its pond to the other slowly advancing with each swing while filling in behind. Thus the pond and dredge gradually worked up the river valley leaving the waste rock as a continuous wormlike trail behind it.

Revett supervised construction of two small dredges on the Swan River in 1898, but they proved to be too lightweight to handle the huge boulders mixed in with the gravels of the district. After much planning Revett constructed another dredge, the *Reliance,* in French Gulch. It was a heavy-duty model that began a long career of profitable operations in 1905. It completed its first seven-month season with a $50,000 net profit. By 1908 the *Reliance* was operating through the winter months. Soon Revett had two other dredges operating, one on the Blue River and one on the Swan. After consolidation of several companies, these projects were operated by the Tonopah Placer Company for 15 years. One hundred, sixty-six thousand ounces of gold were produced. Production averaged 12.6 cents per cubic yard with costs averaging 9.3 cents per cubic yard.

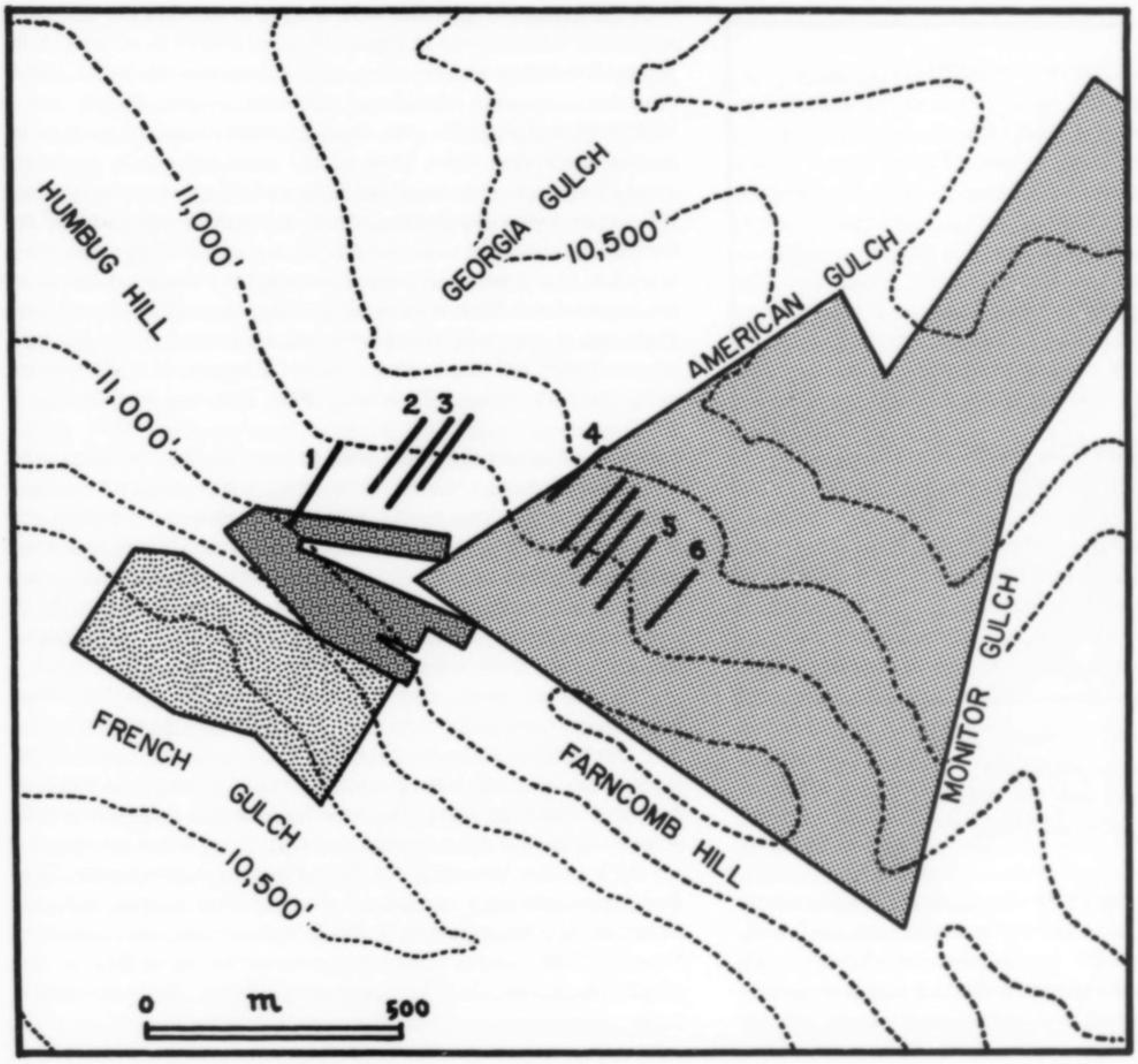

Figure 10. Sketch map of the Farncomb Hill area, showing major gold veins:
1. Ontario vein
2. Key West vein
3. Boss vein
4. Gold Flake vein
5. Bondholder vein
6. Fountain vein
Shaded area at left is the Wire Patch placer claim; at center is the Wire Patch mine claim group; and at right is the area covered by the various Ware-Carpenter, Victoria and Wapiti Mining Company claims (after Ransome, 1911).

Other companies followed Ben Stanley Revett's lead. Soon thundering, clanking monsters filled the gulches with an incredible din. Dredging operations continued in the district until 1939. Remains of two dredges can still be seen in French Gulch: Revett's original *Reliance* and a rival operator's *Reiling* dredge. Waste rock piles from the years of dredging seem to be everywhere.

GEOLOGY

The Breckenridge district, which is located within the Colorado Mineral Belt, is the site of a large volcanic and subvolcanic complex that formed as part of a very large volcanic field in the Southern Rocky Mountains. This field was active during late Eocene and Oligocene time. The Breckenridge volcanic episodes lasted for about seven million years during the early part of the Southern Rocky Mountain volcanic episodes (Pride and Robinson, 1978; Cocker, 1978).

The rocks exposed in the district are chiefly sedimentary. Most important, with respect to the gold deposits, are the Cretaceous shales. These shales were grouped together by both Ransome (1911) and Lovering (1934), but were divided into three separate formations by Lovering and Goddard (1950). From oldest to youngest they are: The Benton shale, the Niobrara formation, and the Pierre shale. The Pierre shale, which crops out in the Farncomb Hill area, is a dark olive to brown clay shale that has a maximum thickness of 770 meters. The shales are all cut by intrusive, subvolcanic rocks (mainly irregular stocks and sheets of porphyry) and volcanic breccias. Quaternary stream gravels and glacial deposits make up the balance of rocks exposed in the Farncomb Hill area (Lovering and Goddard, 1950; Pride and Robinson, 1978).

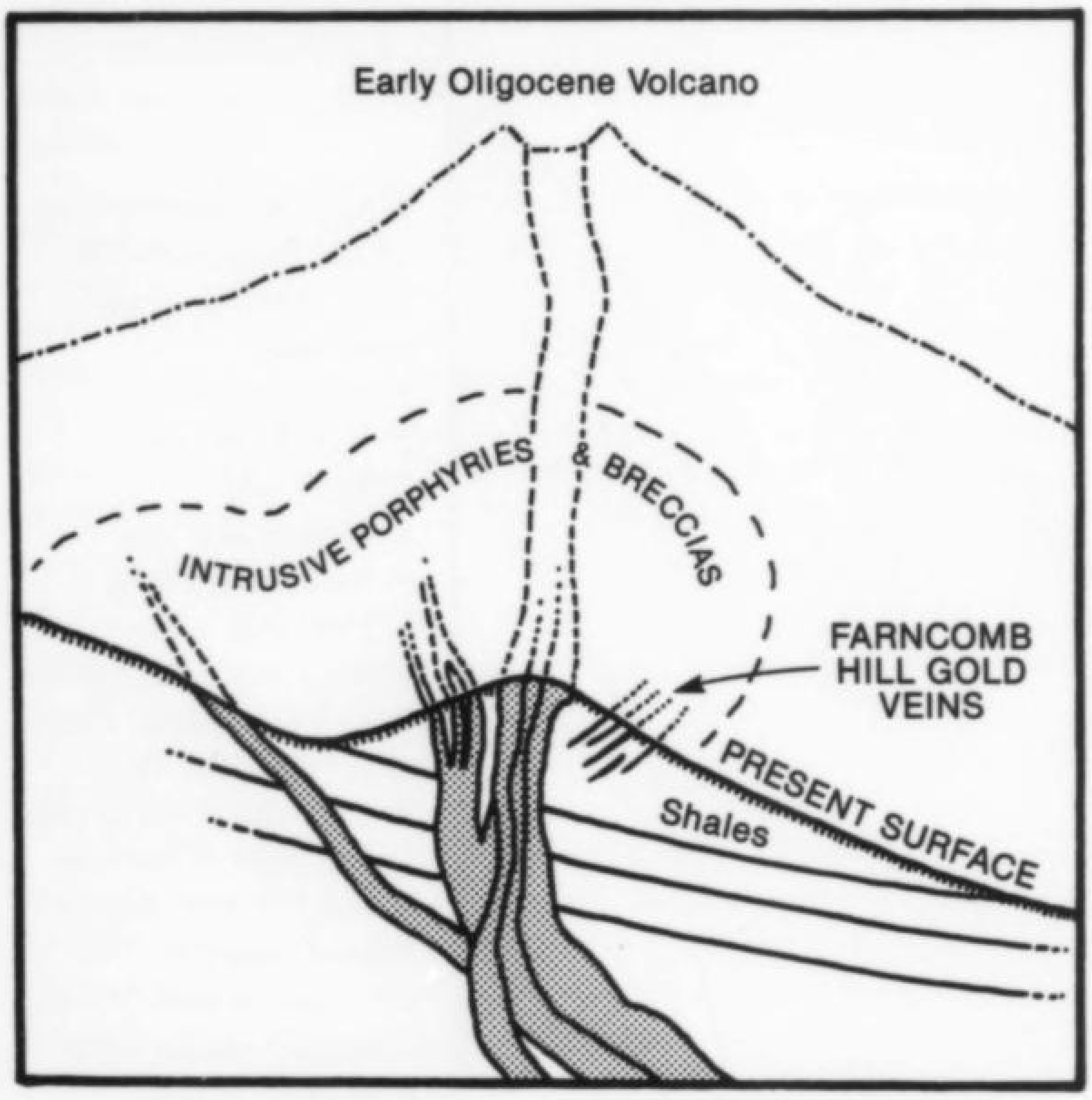

Figure 11. **Sketch geologic cross section (simplified) showing postulated volcano with subvolcanic complex near the Wire Patch mine (adapted from Cocker and Pride, 1979).**

The main structural feature of the district is the folding of the sedimentary rocks. In the Farncomb Hill area this regional folding left the shales dipping 5° to 25° to the northeast. There is little structural evidence of former volcanism. Surface and near-surface volcanic features have almost all been eroded away leaving only the subvolcanic complex of intrusive rocks. An idealized sketch of a postulated volcano showing its subvolcanic roots is illustrated in Figure 11. This particular drawing is modified from an illustration of a postulated volcano to the northwest of Farncomb Hill, but there is evidence that a similar complex erupted near the Wire Patch mine. The sketch shows an essentially symmetric volcanic/intrusive complex. In actuality the complex was probably quite asymmetric, with the vent farther to the west and the roots farther to the east (Cocker, 1978; Pride and Robinson, 1978; Cocker and Pride, 1979). There were several eruptive/intrusive events, each with its own characteristic rock suite, but these different units have all been shown as intrusive porphyries and breccias in order to simplify some rather complex geology. Hydrothermal alteration of both the eruptive/intrusive rocks and the Pierre shale is centered in the Wire Patch mine area. Geochemical analyses have shown maximum concentrations of lead, zinc, copper and gold in the Wire Patch mine area while molybdenum shows maximum concentration about 370 meters to the southeast (Pride and Robinson, 1978). Cocker (1978), Pride and Robinson (1978) and Cocker and Pride (1979) have all postulated that the intrusive complex is not only a subvolcanic complex, but also the upper portion of a porphyry copper-molybdenum system. Numerous studies of the upward and downward extensions of these systems indicate that their total vertical extension may be as great as 8 kilometers. Both precious and base metal vein systems are hypothesized to be emplaced in the upper portions of the porphyry system, below the volcanic eruptives but above the porphyry deposit itself (Sillitoe, 1973).

The Farncomb Hill Gold Deposit

The Farncomb Hill veins were unique in the district. The most important veins (shown in Figure 10) were limited to an area about 500 by 800 meters and lay oriented in a northeasterly trend. While the veins were quite regular and persistent, cutting directly across both shale and porphyry, they were extremely narrow, rarely more than a centimeter wide. Most of the veins die out at moderate depth. Only two veins, the Gold Flake and Silver, extend more than 150 meters below the surface. Small subparallel veins usually accompanied the main veins on one or both sides. The veins often branched into a series of stringers in porphyry while remaining intact in the shale. Numerous small bedding plane faults, both in the shale and at the shale/porphyry contacts, caused minor displacements. Rarely did displacement exceed 3 meters with the greatest being only 11 meters (Ransome, 1911; Lovering and Goddard, 1950).

Nearly all of the veins had been at least partially oxidized. The few unoxidized veins carried pyrite, chalcopyrite, sphalerite, galena and gold, with calcite as the main gangue mineral. Chalcopyrite and/or sphalerite were the chief sulfide minerals. Oxidation seemed to have removed almost all calcite and sphalerite, though some pyrite, chalcopyrite and galena was left. The chief component of the oxidized veins, however, was a spongy limonite which had to be dissolved away from the gold specimens.

Gold was not evenly dispersed throughout the veins, but rather was concentrated in pockets near the shale/porphyry contact or near the bedding plane faults. Most of the gold was found in the shale, although some was occasionally found in very thin sheets of porphyry within the shale. The famous pockets of gold were usually quite isolated and often remarkably rich. They consisted of a 1-3 cm thick section extending out 60 to 100 cm (or even more). They were composed of a continuous mass of wire and/or leaf gold embedded in a limonite matrix. Small pockets sometimes contained from 50 to 200 ounces while larger ones carried up to 2000 ounces of gold (Ransome, 1911; Lovering and Goddard, 1950; and anonymous, no date).

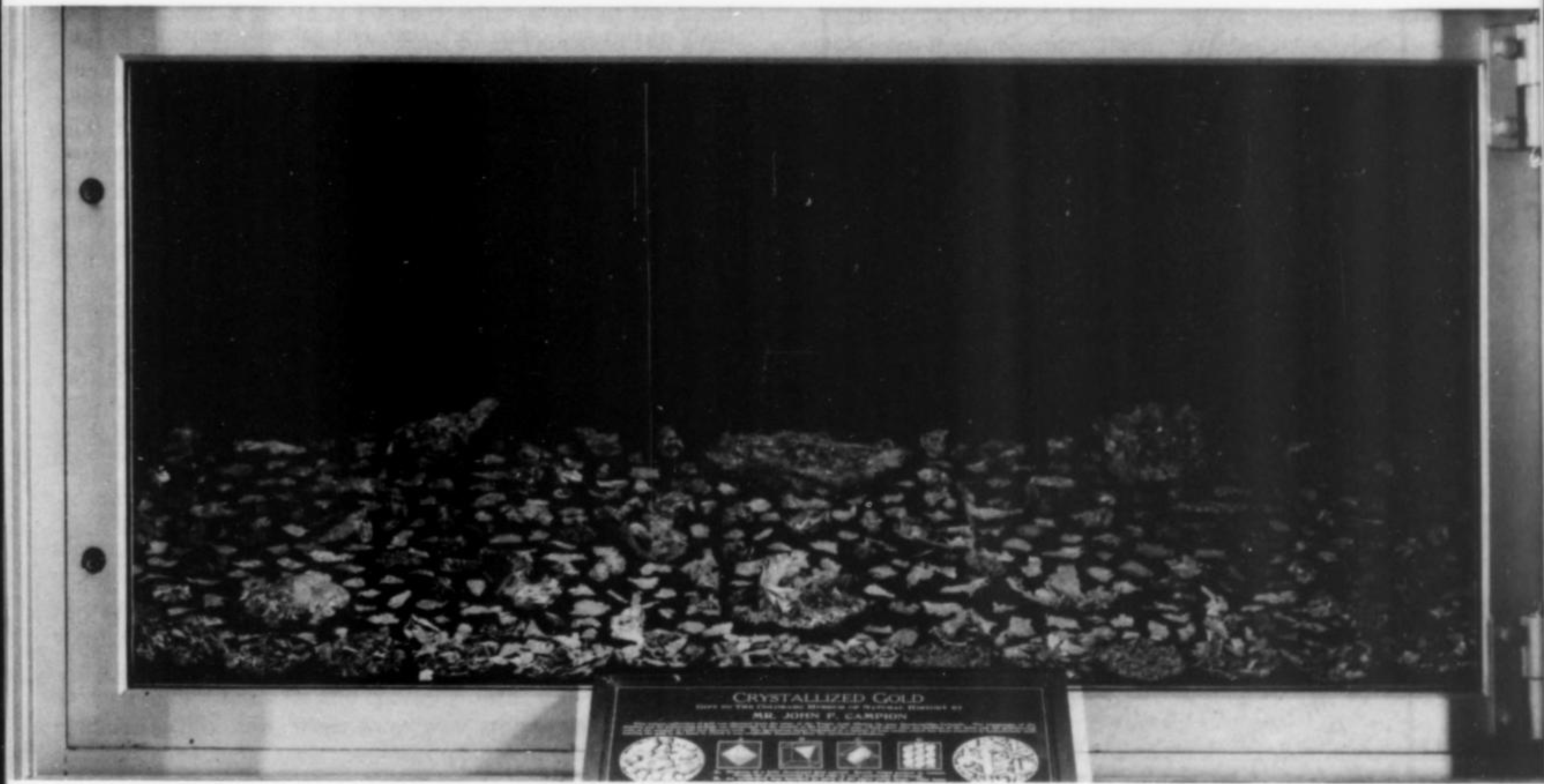

Figure 12. **The Campion Gold collection, as displayed prior to 1926 in the Denver Museum of Natural History (courtesy Denver Museum of Natural History).**

Orientation of the veins relative to the main Wire Patch mine intrusive complex was essentially perpendicular; there appeared to be no fault displacement from one side of a vein to the other. Their nearly parallel arrangement and regular, even width have already been noted. It seems apparent that the veins occupy the open spaces of a set of narrow tension joints. The bedding plane faults are probably a conjugate set of joints. The small movement along their plane was facilitated by the ease with which one bed could slide past the other. Jointing was most likely caused by either the stresses set up during the intrusions or the stresses created by the heating and cooling which accompanied intrusion.

Specimens from these fabulously rich pockets often display a unique habit: aggregates of oriented gold leaves intersecting at angles corresponding to the rhombohedral cleavage directions of calcite. This habit has often been cited as a primary argument in favor of a replacement origin for the Farncomb Hill gold pockets, but recent work has offered a second genetic theory. The new theory is based largely upon the work of Stanton (1964 and 1972) which emphasizes that coprecipitation textures are commonly derived from the different surface energies of two simultaneously crystallizing minerals. R. W. Thomssen (personal communication) feels that the preferrentially oriented leaf aggregates could have resulted from simultaneous crystallization of gold and calcite with the gold having been forced to precipitate along the rhombohedral crystallographic planes of the calcite. (It should, perhaps, be pointed out that coprecipitation does not of necessity rule out secondary replacement of vein material as the overall operative process responsible for the gold pockets.)

Other workers have taken a traditional approach, arguing a secondary origin for the deposit. Both Ransome (1911) and Lovering and Goddard (1950) point out the lack of even distribution of gold in the veins. They also recognize the irregular distribution of the pockets near bedding plane faults and at shale/porphyry contacts, Ransome (1911) goes on to emphasize the importance of the intersection of the veins with bedding plane faults or shale/porphyry contacts as places likely to have accumulated water which would trigger precipitation of gold. Ransome also discusses the relative insolubility of gold, even anticipating modern geochemical theory in emphasizing the possible importance of organic matter contributing to gold solution. The authors would add that because of gold's relative insolubility it is very likely to be precipitated quite rapidly from a saturated solution. Rapid precipitation would limit the area in which the gold was deposited. Also, if rapid precipitation did occur, skeletal and hopper crystals would be expected to form. These crystal habits are almost universal on Farncomb Hill vein specimens.

Ransome (1911) points out that the gold pockets were limited to the present oxidized zone, and theorizes that the pocket gold accumulated as a result of enrichment from hydrothermally deposited gold in the upper portions (now eroded away) of the veins. Whether or not this distribution is merely coincidental has yet to be determined; there is another ready source for the gold. Assays of both silicified and baked shale in contact with intrusions show a small amount of gold throughout the entire district. Shale samples from Farncomb Hill carry 0.01 to 0.05 ounces per ton. While gold leached from the low-grade, finely disseminated material and redeposited in rich pockets is not the same as a classic secondary enrichment from above, it still can be a replacement process. This scenario would call for gold replacement along calcite cleavage planes, followed in time by oxidation and removal of most of the calcite and primary sulfide minerals in the veins. (Calcite was the most important gangue mineral seen in the less thoroughly oxidized veins.) While recognizing the importance of Stanton's work (1964 and 1972) the authors feel that the orientation of one mineral along cleavage planes of another is most likely a replacement texture, as pointed out by Bastin (1950).

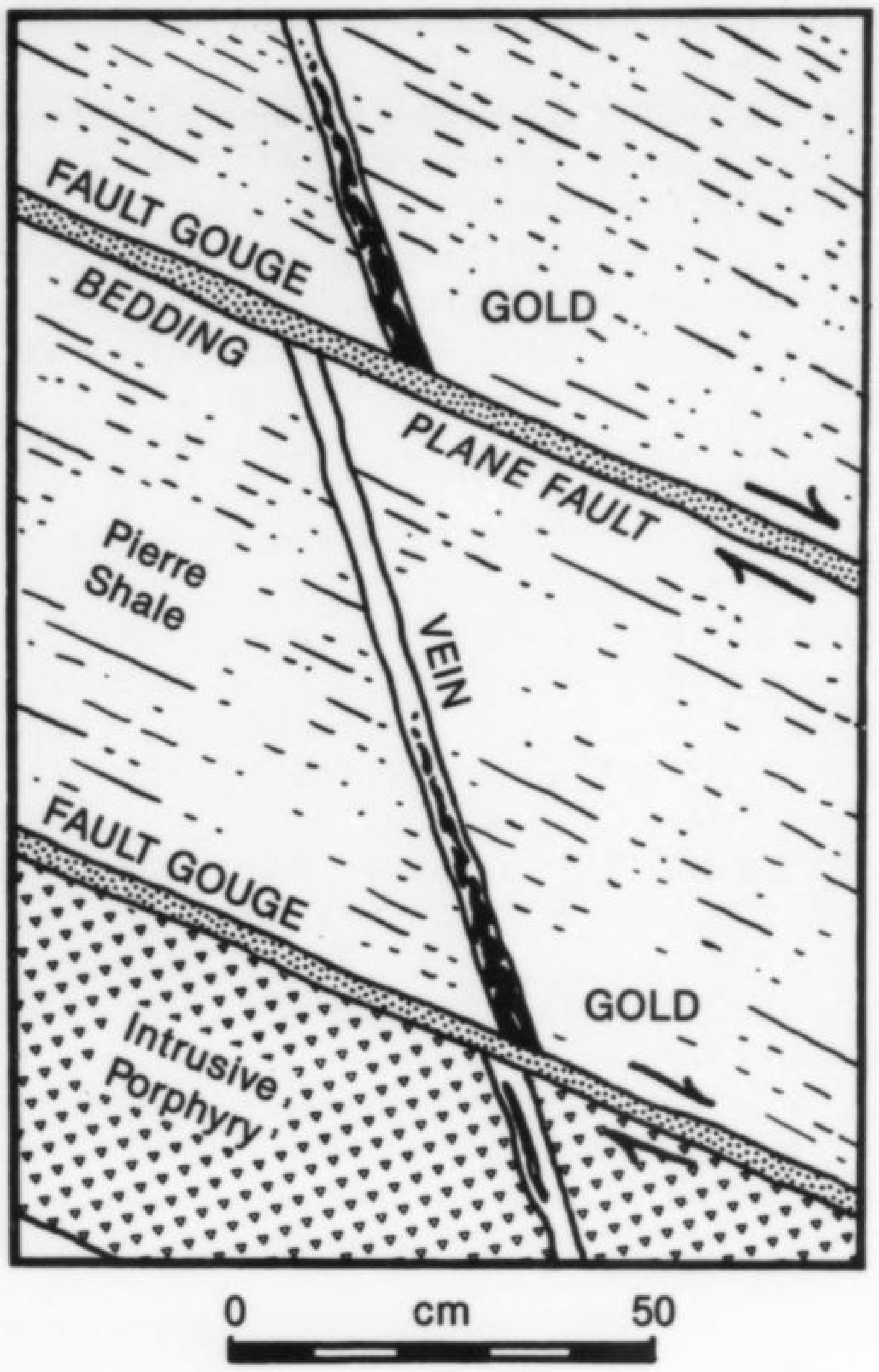

Figure 16. **A Farncomb Hill gold vein, showing gold pockets developed near bedding plane faults and shale/porphyry contact (from Ransome, 1911).**

Ramdohr (1980) states that while gold undoubtedly replaces and cements other minerals in many patterns, gold precipitates so easily that transportation in solution over long distances is unlikely. Gold is known to be dissolved by heavy concentrations of ferrisulfate, and as a chloride in the presence of manganese dioxide and sodium chloride, through sulfurous acid. Ransome (1911), however, pointed out that in an elevated and well-watered region like the Breckenridge district it would seem doubtful that much chloride existed in the waters to which the veins were exposed. This argument assumes a meteoric source for the dissolving waters in a classic secondary enrichment "from above" model. The authors, on the other hand, propose a convecting hydrothermal system which mingled meteoric solutions with magmatic components (salts, metals, sulfur and perhaps water) derived from the deeper intrusions.

Circulation through convection could have both deposited the gold in the country rock, and then leached it out again as the chemistry of the waters changed through time. The gold chloride-carrying solutions could then have rapidly precipitated their solutes when coming into contact with concentrations of meteoric water at the intersection of joints with bedding plane faults. As yet no one has pinned down the method of transport (or the source) for the gold. Speculation such as the above needs geochemical confirmation. Denver Museum of Natural History specimen no. 171 shows galena being replaced by quartz in the typical right-angled cross-hatched fashion. Gold is also left in the matrix and appears to partly replace the galena. No mine name is given but the specimen was part of the Campion Farncomb Hill collection. A lead isotope study of this and other Farncomb Hill galenas compared to lead isotopes of the country rock might prove illuminating. Strontium isotope comparisons of vein calcite with altered wall rock might prove whether alteration and primary mineralization occurred from the same hydrothermal solutions. Obviously the whole story on Farncomb Hill has yet to be written.

The Wire Patch Mine

The Wire Patch mine on the south side of Farncomb Hill is not classified as a vein deposit, although one small vein was encountered in the Elephant Tunnel. Most of the mining activity centered on two irregular orebodies occurring on opposite sides of a porphyry dike. The contact between shale and the dike is marked on both sides by breccia composed of porphyry including shale fragments. The ore consisted of pyrite, sphalerite and galena replacing porphyry and surrounding shale fragments in concentric overgrowths. Pyrite, sphalerite, galena and pale pink ankerite or rhodochrosite filled irregular fissures and spaces between rock fragments in the Elephant stope. Some of the porphyry in the Elephant stope was completely replaced by ore. Pyrite was the most abundant mineral while galena was rare (Lovering and Goddard, 1950). Native gold usually showed an arborescent or wire habit, as might be guessed from the name of the mine. Some leaf gold was also present.

FARNCOMB HILL GOLD

Fine Farncomb Hill gold specimens are among the most treasured and sought after specimens in the world. The good ones are relatively rare, but that is the case with all minerals. The scarcity is somewhat remarkable, however, when one considers how much Farncomb Hill gold is said to have been saved from the smelter and kept as specimen material. Apparently many of the oldtimers knew they had something special.

There are three principal habits of Farncomb Hill gold: leaf, wire, and spongy arborescent growths. Combinations and variations also exist in several forms. By far, the best place to study Farncomb Hill gold is at the Denver Museum of Natural History, which houses John F. Campion's gold collection. This collection is one of the truly great special collections in the mineral world. The variety, overall quality, method of display and esthetic appeal are remarkable. Campion's gold collection is thought to be primarily from his Waipiti Mining Company properties which, as we have already noted, included numerous claims on Farncomb Hill. Other institutions with outstanding Breckenridge gold specimens are Harvard and the American Museum of Natural History.

Leaf gold is far and away the most commonly seen habit for Farncomb Hill material. It also is perhaps the most esthetic of all the habits when observed as truly fine specimens. The leaves are almost invariably composed of distinct gold crystals. Most crystals are flattened octahedrons displaying a hopper or skeletal habit. The crystals are always arranged in parallel growth over most of the leaf surface. Crystal size varies from less than a millimeter to 1 cm (rare!) but most are from 1 to 2 mm. The leaves are usually 1 to 2 mm thick, and vary in length up to 15 cm on large and truly outstanding specimens. Many specimens consist of a single leaf but others are made up of many leaves. Some specimens show distinct variations in crystal size at different positions on the leaf. Most often the larger crystals occur toward the leaf edge. The leaves usually appear to be somewhat broad, but they can be quite narrow, especially when joined together in complex structures.

The most remarkable and esthetic of the leaf gold specimens are those with their leaves joining together in the same orientation as the planes of cleavage shown by calcite. It is these specimens which furnish one of the main points of evidence for the secondary nature of the Farncomb Hill gold vein pockets. An excellent example of this replacement is shown in Figure 5, which is one of the great Breckenridge pieces. Perhaps the finest of all Farncomb Hill gold specimens is shown in Figure 7. The leaves are oriented as calcite cleavage planes in a very esthetic pattern. The specimen is almost 15 cm tall!

Wire gold was the first habit seen at Farncomb Hill. The Wire Patch mine and Wire Patch placer were so named because of the profusion of wire gold at these locations. The Ontario mine was also well known for its wire gold. Most Farncomb Hill gold wires are not particularly long, 1.5 cm being common and 5 cm the exception. Most wires are approximately 1 mm in diameter, but the Denver Museum has several wires that are from 4 to 5 mm in diameter. Most of the larger wires exhibit lengthwise striations giving them a ribbed appearance. Also, some wires taper from one end to the other. Intergrown wire masses have been referred to as "bird's nest" gold.

Perhaps the least common habit shown by Breckenridge gold specimens is that of spongy arborescent growths. Most of these specimens were from the Wire Patch mine. These arborscent growths are rarely over 8 cm in any one direction, and are usually smaller. They apparently conform to their host vein's width, and are often quite flat on both sides.

All of the various habits are displayed in combinations with other habits. Wires with leaves and spongy growths with leaves are the most frequently seen, while wires with arborescent growths are rather rare. Multiple-habit specimens are much less common than single-habit specimens, yet multiple habits combine to form extremely esthetic specimens.

The variety of shapes in gold specimens is remarkable; and, like the clouds, they often remind us of familiar objects. Nicknames like "the Dragon," "the Jack Rabbit," "the Sailboat," and "Eternal Flames" seem perfectly appropriate for these exquisite pieces. When all is said and done, Farncomb Hill has furnished some of the finest and most interesting gold specimens in the world.

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Tuolumne County

(Continued from page 45)

dred meters. The ore was generally free milling and contained various sulfides including pyrite, pyrrhotite, chalcopyrite, galena and sphalerite. Mines in this belt produced a total of $19 million in gold (Julihn and Horton, 1940).

The Soulsby mine was the most productive East Belt mine in the county. The vein here follows the contact of diorite and quartzite of the Calaveras formation. Two parallel veins, averaging 60 cm in width and 12-25 meters apart, cropped out on the property. The veins were rich in pyrite, chalcopyrite, galena, sphalerite and free gold. These veins were followed to a maximum depth of 230 meters. Mineralization was erratic within the vein, but rich enough to average about 50,000 ounces for every 30 meters of depth mined (Julihn and Horton, 1940).

The Soulsby mine was discovered in 1858, and in the first 10 months produced 500 ounces. By the end of 1861, a total of 24,000 ounces had been produced. By 1868, production was fairly consistent at 480-580 ounces per month (Browne, 1868).

The Confidence mine, discovered in 1853, was another large East Belt producer. The Confidence vein cuts a granodiorite pluton and is accompanied by a chloritic dike. The ore zone was followed to a depth of almost 340 meters. In the early years after its discovery, concentrates were made from the highgrade sulfide ore and shipped to Swansea, Wales, for smelting (Julihn and Horton, 1940). During 1871, records indicate the Confidence mine was producing an average of 1400 ounces month (Raymond, 1874). During the latest operations from 1896 to 1912 the sulfide concentrate had a gold content averaging 8 ounces/ton (Tucker 1915).

The Pocket Belt

The Pocket Belt lies between the Mother Lode and East Belts, and stretches from the Stanislaus River to Sonora. The veins are very narrow, composed of quartz and calcite, and have varying strikes. These veins cut across both the Paleozoic Calaveras formation and Mesozoic granitic intrusions. The controlling factors of pocket deposition are complex and difficult to interpret. This general lack of continuity makes successful pocket mining highly speculative.

The gold occurred as rich pockets of very pure gold (averaging 909 fine), commonly crystalline and sometimes associated with tellurides. One mine in this belt produced the purest gold ever recorded at the San Francisco mint. The San Guiseppe mine consistently produced gold averaging between 982 and 987 fine. However, one 90-ton shipment of ore ran 998 fine (Benjamin, 1899). This is truly remarkable purity to have formed under natural conditions.

Despite the large number of mines in this district, only the Bonanza and Sugarman-Nigger produced more than $1 million in gold. Although no average grade figures are available for this district, it is reported that pockets at the Bonanza mine usually ranged between 1000 and 2400 ounces per pocket. The total production of the Pocket Belt was $5.5 million (Julihn and Horton, 1940).

The largest and most predictable mine in the Pocket Belt was the Bonanza mine. It was discovered in 1851 and mined for some years in shallow surface workings. In the early 1870s a partnership bought the claim and sank a 460-meter shaft. Pockets containing 50-250 ounces were regularly found at the intersection of three well-defined structures. As these intersections were often open voids, the gold was usually found as beautifully formed crystals. The largest pocket discovered was found in 1879 and yielded 14,400 ounces (nearly a thousand pounds) of gold. The Bonanza pockets lie in a diorite dike containing narrow quartz veins. The dike lies between a footwall of limestone and a hanging wall of mica schist (Julihn and Horton, 1940).

The only other Pocket Belt group to produce a major quantity of gold was the Sugarman-Nigger group. The Sugarman vein cuts across the Calaveras formation slates, schists and limestones. The gold pockets formed where the vein intersects the slates. The mine was worked from surface diggings prior to 1870, and produced a total of 9700 ounces. In 1875 a tunnel was driven along the vein into the ore shoots and 10,900 ounces were removed. A tunnel driven along the vein from the Nigger claim exposed 5800 ounces of gold. Water became a problem in the mine and work was abandoned for many years. In 1928 a company was organized to develop the deeper ore. They recovered 3100 ounces in 18 months but the workings flooded and the project was abandoned. In 1930 another company attempted to mine the Sugarman-Nigger group, and recovered 1700 ounces before flooding again terminated operations (Julihn and Horton, 1940).

Records of the early rich pockets are sketchy at best. Many discoveries went unreported and others were grossly exaggerated. Some claims which never had significant gold production yielded a few spectacular pockets. The Bald Mountain claim produced a 1450 ounce pocket, and in 1851 the Ford claim produced a 1900 ounce pocket. In comparatively recent times, the Lazar mine produced a 240 ounce pocket in 1934 and a 630 ounce pocket in 1935. (Logan, 1949).

Placer Mines

By far the majority of the gold produced in Tuolumne County, $155 million, came from the placer mines. The richest placer districts were those areas which drained the Pocket Belt. Some nuggets of exceptional size were found in Tuolumne County (see Table 2). Many nuggets, several pounds in weight, were found in the Columbia-Sonora area in the heart of the Pocket Belt. In fact, the Pocket Belt probably contributed two-thirds of all the placer gold found in Tuolumne County (Julihn and Horton, 1940). These placers consequently produced a very pure grade of gold, as high as 950 fine (Benjamin, 1899).

Some of the placer camps contained some exceptionally rich

***Table 1.* Major gold lode mines of Tuolumne County (production exceeding) $1 million).**

Mine	*Belt*	*Production*[1]	*Principal Years*
Eagle-Shawmut	Mother Lode	› 358	1896–1923, 1936–47
App-Heslep	Mother Lode	› 314	1895–1912, 1914–18 1935–42
Rawhide	Mother Lode	290	1894–1907
Soulsby	East	266	1856–1911[2]
Jumper	Mother Lode	242	18951919
Confidence	East	206	1866–?, 1896–1912
Black Oak	East	169	1879–1917[2]
Dutch-Sweeney	Mother Lode	› 145	1893–1906, 09–15, 19–20, 35–42
Harvard	Mother Lode	97–145	1899–1916
South United	East	82	› 1914[2]
Bonanza	Pocket	73	1878–1880
Grizzly	East	73	› 1914
Santa Ysabel	Mother Lode	73	1897–1900, 1903–07
Gilson	East	60	› 1914[2]
Draper	East	48	› 1914, 1915–16
Sugarman-Nigger	Pocket	48	1870–1915[2], 1928–34

[1] In thousands of troy ounces.
[2] Probaby not continuous.

ground. Knapp's Ranch, east of Columbia, lay within the limestone belt where the deeply weathered crevices held abundant placer gold. A five-acre parcel of this ground produced an average of 1900 ounces per acre. In one summer, one claim 154 meters square yielded 12,000 ounces. One exceptionally rich 15 meter square claim yielded 4800 ounces, which averages almost 2 ounces per square foot (Browne, 1868).

Ninety-five percent of all the placer gold came from recent placer gravels. However, some minor production of gold was recovered from the Tertiary channel of the Cataract River. This river is preserved today by volcanic agglomerates capped by a latite flow, and forms the sinuous topographic feature known as Table Mountain. A few miners were successful in tunneling beneath the volcanic cap and locating the auriferous gravels. Exposed Tertiary gravel beds near Montezuma and Chinese Camp account for the rest of the older placer production.

The New York claim was a drift mine under Table Mountain. The paleochannel averages 18 meters wide and, for a while, yielded 48 ounces per linear foot of channel length. Production totalled about 13,000 ounces of gold. The Oliver claim was also a valuable drift mine, with a total yield of 9700 ounces. One exceptional lot of placer ore from this mine contained 2.6 ounces per ton (Browne, 1868).

MINERALS

The range of collectable minerals produced by the Tuolumne County gold mines has been quite limited. The mines were operated for their native gold content and little interest was given to the accessory minerals. Security around the gold mines discouraged mineral collecting during the active operation of the mines. Since that time, most of the mines have flooded, collapsed, or are under private ownership and, therefore, unavailable to modern collectors. Individual miners are now re-working some of the Pocket Belt mines, but, again, security and secrecy are tight and interest in crystallized mineral specimens, other than gold, is low. Therefore, the full mineral potential of the mines is not known.

Unless otherwise noted, information in this section comes from Murdoch and Webb (1966).

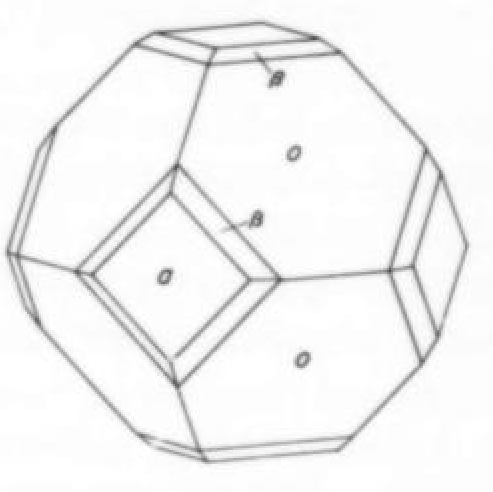

***Figure 8.* Altaite crystal drawing, Sawmill Flat, Tuolumne County (Eakle, 1901).**

Alataite PbTe

Massive altaite with cubic cleavage was reported from the Golden Rule mine in the Mother Lode Belt. Altaite was found in the Pocket Belt mines as individual dark gray crystals (resembling lead birdshot) imbedded in crystalline gold. The 1-2 mm altaite crystals are almost round in appearance to the unaided eye, but under magnification are seen to be a combination of cubic and octahedral faces with trapezohedral and dodecahedral modifications. Specimens of this type have come from the Birney pocket mine near Sawmill Flat (Eakle, 1901) and the Hidden Treasure mine near Columbia (authors collection). W.F. Foshag found gray altaite crystals on crystallized gold at the Sell mine (Pemberton, 1983).

Arsenopyrite FeAsS

Arsenopyrite was a minor constituent of some of the East Belt ores and was specifically identified at the Black Oak mine near Soulsbyville (Logan, 1928).

Calaverite $AuTe_2$

Calaverite occurred with other tellurides at the Golden Rule mine. A single crystal of calaverite measuring 1 x 1.1 cm, flattened against vein quartz, was recovered from the Hidden Treasure mine along with veinlets of massive calaverite (Lewellyn collection).

Calcite $CaCO_3$

Calcite is a gangue mineral which commonly formed coarse vein fillings in both Mother Lode and East Belt mines.

Chalcopyrite $CuFeS_2$

Chalcopyrite was a common accessory mineral in the East Belt mines (Julihn and Horton, 1940). Small grains of chalcopyrite have been identified (by us) from the Harvard mine, associated with pyrite.

Coloradoite HgTe

Coloradoite was associated with other tellurides at the Norwegian mine in the Pocket Belt near Tuttletown.

Galena PbS

Galena was a common accessory mineral in the East Belt mines (Julihn and Horton, 1940).

***Table 2.* Largest recorded gold nuggets from Tuolumne County.**

Year	Location	Troy Ounces Wt.
1848	Wood's Creek	1094
1854	Columbia	1050
1850s	Columbia	962
1850s	Knapp's Ranch	729
1850s	Columbia	547
1850	Sonora Street	510
1849	Sullivan Creek	496
1854	Columbia	488
1859	Gold Hill	437
1850	Sonora	408
1851	Holden's Garden	408
1853	Martinez	343
?	Wood's Diggings	335
1854	Pine Gulch	335
1850s	Spring Gulch	303

Gold Au

Gold was the primary economic mineral of Tuolumne County's gold mines. Gold occurred both in placer and lode deposits. In the lode deposits it was massive, crystalline or disseminated within sulfide minerals. Beautiful crystalline gold specimens have come from many of the Pocket Belt mines, particularly the Sugarman-Nigger, Bananza and Lazar mines near Sonora. The Eureka mine near Big Oak Flat has also produced nice, crystalline gold specimens (Leicht, 1982). One piece, found in 1949 amid loose quartz crystals and talc, measures 33 cm and weighs 67 ounces. Historical research by Leicht (1987) has turned up evidence for crystalline gold production from at least a dozen other Tuolumne County mines.

Crystalline gold occurs in a continuous range and combination of habits from thin, flat leaves to perfectly formed, razor-sharp octahedrons. Some octahedral crystals are skeletal or hollow (Leicht, 1987). Others are identifiable only as raised triangular patterns on leaves (which are basically single crystals elongated parallel to an octahedron face), or as partial octahedrons perched on and around leaves.

Hessite Ag_2Te

Very small crystals of hessite were found in the Reist mine, Whiskey Hill, and in the Jumper mine in the Mother Lode Belt.

Hessite was also reported from the Bonanza mine, Sonora, and the Norwegian mine, Tuttletown, both in the Pocket Belt.

Muscovite $K(Al,Cr,Ni)_2(Al,Si)_4O_{10}(OH)_2$

Muscovite, another gangue mineral, occurs as a chromian variety ("mariposite") containing up to 1% chromium which colors the mica a vivid emerald-green. Crystals are unknown, but unweathered quartz-ankerite-mariposite rock is used for lapidary and building stone applications. Mariposite is common throughout the Mother Lode Belt deposits as disseminated masses.

Petzite Ag_3AuTe_2

Petzite has been identified with other tellurides from the Rawhide and Golden Rule mines. Petzite was also found in the Pocket Belt at the Norwegian mine, Tuttletown, the Bonanza mine, Sonora, and as beautiful specimens with sylvanite and gold from the Sugarman-Nigger mine, Sonora. Pemberton (1983) reports petzite with small amounts of gold from the McAlpine mine.

Pyrite FeS_2

Pyrite is a pervasive mineral throughout the metamorphic rocks of the county. It occurs in all of the gold mines of the county as granular disseminations, veinlets and euhedral crystals from 1 mm to 1 cm in size. Pyrite can be found in almost any unweathered rock exposure in the metamorphic belt. Occasionally crystals are large, and some fine specimens have been found in the Patterson mine, Tuttletown (Mother Lode Belt). Limonite pseudomorphs after pyrite are common in the placer gravels of the County.

Quartz SiO_2

Quartz is the most common vein filling in all three gold belts. It may be crystalline, and small clear quartz crystals can be found in numerous places around the County.

Sphalerite ZnS

Sphalerite was a common accessory mineral in the East Belt mines (Julihn and Horton, 1940).

Sylvanite $(Au,Ag)Te_4$

Beautiful, crystalline plates of sylvanite were found in the Rawhide mine and in the Golden Rule mine, both of which are Mother Lode Belt mines. Sylvanite also occurred as beautiful clusters with petzite and native gold in the Sugarman-Nigger mine, Sonora.

Tellurium Te

Native tellurium was found associated with tellurides of gold and silver in the mines of Tuttletown and Jamestown (probably the Norwegian, Rawhide and Golden Rule mines).

Tetrahedrite-Tennantite $(Cu,Fe)_{12}Sb_4(S_{13}$ to $(Cu,Fe)_{12}As_4S_{13}$

Tetrahedrite and tennantite were occasional accessory minerals in gold mines around the county. Massive tetrahedrite was found in the Golden Rule mine. Tennantite was reported from the Rawhide mine. Minute grains of tetrahedrite were recently identified (by us) in the quartz vein at the Harvard mine.

CONCLUSIONS

Tuolumne County gold production has played a significant part in California gold mining history. Besides ranking third in all time gold production, Tuolumne County has produced some exceptional coarse nuggets and crystalline gold specimens. With the current gold mining boom, Tuolumne County should again rise to prominence as one of California's "Golden" counties.

ACKNOWLEDGMENTS

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notable gold occurrences of

GEORGIA & ALABAMA

Specimen-quality gold from the southern Appalachians was encountered on a regular basis during the early exploration and development of the region's small gold deposits. Though records indicate that many specimens were saved, very few survive today.

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INTRODUCTION

The mines described below have not operated commercially in the past half century and most are apparently closed forever. Many are being taken over slowly by second-home developers of Atlanta and other urban areas and now can scarcely be recognized as old mining sites. The purpose of this paper is to describe the discoveries of crystalline pocket gold early in America's mining history, as synthesized from unpublished records, field notes, rare books and the technical literature. Unfortunately, acquiring gold from these occurrences is quite difficult today, even though records indicate that a significant number of specimens were saved.

HISTORY

Interestingly enough, the first verifiable discovery of gold in the eastern United States was made by none other than Thomas Jefferson in 1782 (Becker, 1894). The find was a 4-pound, gold-bearing cobble that was collected on an outing along the Rappahannock River in Virginia. Although Jefferson's find was a published scientific curiosity, the first discovery leading to commercial development was made by 12-year old Conrad Reed while bow-and-arrow fishing along Meadow Creek in Cabarrus County, North Carolina, one Sunday morning in 1799. Reed's approximately 200-ounce nugget remained an unidentified doorstop for several years until it was recognized as gold by a local jeweler. Mining quickly commenced with at least 153 pounds of large nuggets being recovered by placering on the Reed Plantation in the early years. The largest of these nuggets weighed 28 pounds (Bryson, 1936). A general awareness of the potential presence of gold in southeastern streams slowly spread into other areas of North Carolina, South Carolina and ultimately Georgia and Alabama. With this awareness came new discoveries of placer and lode gold, and the development of what was for years one of America's major mining industries.

The facts concerning the initial discovery of gold in Georgia and Alabama are blurred with age. At least three separate versions and locations are given in the literature related to Georgia. Fluker (1903) suggests that gold was first discovered in 1823 by itinerant Cornish miners near the site of the Columbia mine in McDuffie County. A slave owned by a Major Logan of Loudsville, White County, is also credited with first recognizing gold in a Georgia stream sometime in 1828 (Yeates *et al.* 1896). Perhaps the most believable, first-hand account is that of Benjamin Parks who, at the age of 94, related to a reporter his discovery of gold, also in1828, at what became the Calhoun mine near Dahlonega. This account, originally published in an 1894 edition of the *Atlanta Constitution,* was perpetuated by Yeates *et al.* (1896) in their comprehensive work on Georgia gold deposits. Details of the discovery of gold in Alabama are entirely lacking, but it was reported by Phillips (1892) that in about 1830 gold was being recovered from placers in several Alabama districts. It is believed that many Alabama mines were opened by Georgia miners who had logically prospected to the southwest

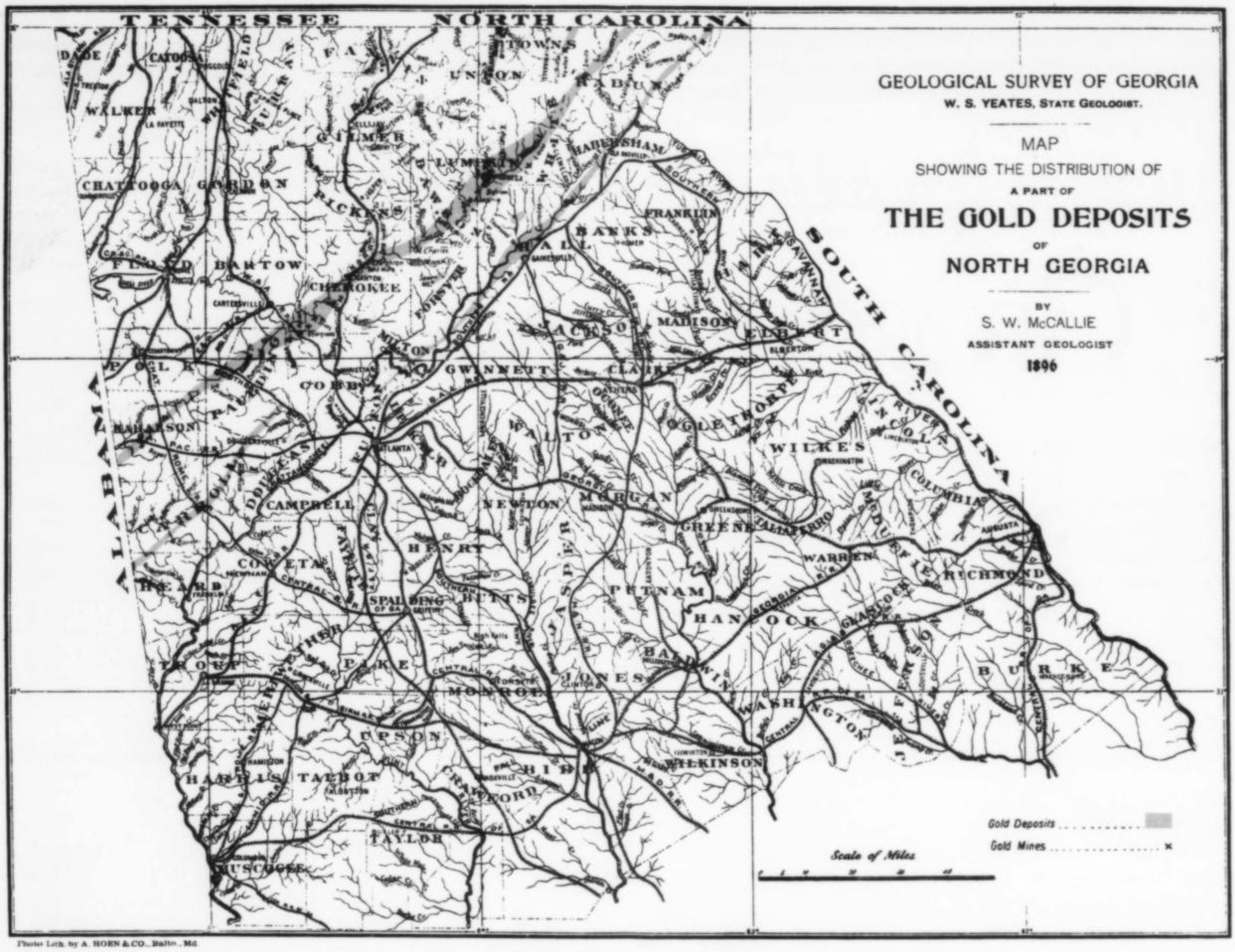


Photo Lith. by A. HOEN & CO., Balto., Md.

Figure 1. **Map showing Georgia's two well-defined gold belts (after Yeates *et al.*, 1896).**

down the gold "belt," and that much of what can be said of Georgia's early gold mining history can be repeated for Alabama as well.

A major rush followed the discovery of gold in the north Georgia hills. Between 6000 and 7000 hopeful miners were reportedly employed in placer mining during the first few years (Becker, 1894). Much of this work was by trespass on Indian land. In response to repeated conflicts over ownership and mining rights, Governor Gilmer sent a strong police force to the territory in an attempt to maintain order. This unsuccessful move was followed by a similar effort by Federal troops. Finally, Georgia declared the Cherokees wards of the state and their lands part of the public domain. The final result was the infamous "Trail of Tears," the forced march of most of the Cherokee Nation to an Oklahoma reservation, and the subsequent disposition of their land by public lottery to would-be miners.

By 1849 many of the initially rich placers were depleted and a significant percentage of Georgia's and Alabama's miners were primed for the announcement of greener pastures somewhere to the west in a place called California. With the southeastern gold miners went much of the mining technology that made possible the early development of western mines, and an array of place and family names that rather faithfully duplicates those of traditional southern mining areas.

The departure of many southern gold miners for the seemingly unending series of western rushes of the 1850s resulted in a diminished production for Georgia and Alabama at the advent of the Civil War. Following the war a new mining technique, appropriately called the "Dahlonega method" (Nitze and Wilkens, 1897), was developed for working large quantities of saprolite by a modified hydraulic process. By 1884, however, production began to decline again as the decomposed saprolite ores gave way at depth to smaller, more difficult-to-work sulfide-bearing lodes. A resurgence in activity occurred between 1894 and 1901, due in large measure to the installation of chlorination plants at some mines in a effort to recover gold bound in sulfides. Both chlorination and the then-rudimentary cyanidization processes proved inefficient in the treatment of Georgia and Alabama ores. This disappointment, coupled with the unexpected low grade and generally small size of most lode occurrences, signaled the beginning of a rapid decline in production from 6000 ounces for Georgia in 1901 to only 333 ounces in 1917. A total of only 121 ounces were produced in Georgia during the World War I years. This low level of production was offset marginally by increased activity in response to high unemployment and the increased value of gold during the depression era (Fig. 2); however, the forced discontinuation of gold mining during World War II dealt a blow from which there has been no recovery (Fig. 3).

Figure 2. **Depression-era attempt to reactivate the 301 mine, 2 km west of Holly Springs, Cherokee County, Georgia. This unsuccessful effort was typical of many such operations in response to $35/ounce gold and the high unemployment of the early 1930s. Note the archaic steam boiler being used for mine power. Photo by R. W. Smith, June, 1934.**

Figure 3. **The last successfully operated production stamp mill in Georgia. This mill was operated at the Fluker (Columbia) mine in McDuffie County until the federal government forced its closure during World War II. Photo by A. C. Munyan, September 11, 1939.**

Although gold was produced continuously in Georgia and Alabama from 1828 through about 1935, production records for the period 1828 to 1880 are sparse and incomplete. Various estimates indicate that about 680,000 ounces were produced during that period in Georgia. Since 1880, at least 172,000 ounces of production are recorded in mint records and other government documents. A United States branch mint was operated at Dahlonega from 1838 until 1861. A total of 1,381,784 gold coins having a face value of $6,190,118 were struck. Pardee and Park (1948) estimate Alabama's total gold production at only 17,300 ounces.

Although it has been decades now since gold was commercially produced in Georgia or Alabama, there continue to be the occasional discoveries of nuggets by weekend suction dredgers and of the rare gold specimen by careful collectors. Industry has not forgotten the deep south, and recent years have seen quiet (though aggressive) exploration by most of the major U.S. metal mining companies. The discovery of the Ridgeway, South Carolina, deposits containing almost two million ounces of gold in low-grade, bulk-mineable proven reserves, and the steady production for over a year of approximately 700 ounces of gold per month at the Haile mine, also in South Carolina, suggest that at least one more chapter is yet to be written in the history of the southern gold mining industry.

GEOLOGY

Almost nothing was published concerning the geology of Georgia and Alabama gold deposits for more than a half-century following their discovery. Finally, William B. Phillips published a preliminary report on a part of Alabama's gold belts in 1892. This publication was followed quickly by a companion report on the remainder of Alabama's deposits (Brewer, 1896). A most informative paper on the geology of gold deposits in the southern Appalachians was published by George F. Becker of the U.S. Geological Survey in 1894. Many of Georgia's almost 500 known occurrences were described in the comprehensive works of Yeates *et al.* (1896) and Jones (1909). Even Waldemar Lindgren visited Dahlonega, publishing the results of his brief study in 1906. Later reports by Adams (1930) and Pardee and Park (1948) complete the list of important papers that were based on early observations, first-hand accounts, and data collected while many deposits were operating and accessible. Modern descriptions based on both detailed and reconnaissance geologic mapping, new genetic models for gold deposits and lithogeochemistry can be found in Cook *et al.* (1984) and German (1985) for the Dahlonega area, and McConnell and Abrams (1982) for occurrences in western Georgia. A general review and modern descriptions of some of Alabama's better known gold deposits are presented by Simpson and Neathery (1980).

Virtually all of the lode gold deposits of Georgia and Alabama are within crystalline rocks of the Piedmont and Blue Ridge Provinces. The majority are found generally along two parallel, northeast-trending belts (Fig. 1). The southeastern belt more-or-less follows the Brevard Zone of cataclasis, the boundary between the Inner Piedmont and Northern Piedmont. The second is approximately 25 kilometers to the northwest along a poorly defined lineament historically known as the "Dahlonega Shear." The northwestern belt becomes poorly defined along strike in Alabama. Additional formerly important deposits such as the Magruder mine lie in the Georgia portion of the Carolina Slate Belt, a group of rocks collectively known as the Little River Series, which occupies the southeasternmost part of the Georgia Inner Piedmont. Other somewhat scattered deposits appear to mark thrust-fault-repeated slices of favorable host units, as suggested by Higgins *et al.* (1985).

Although large in number, individual lode or vein gold occurrences were almost uniformly small, particularly when compared to their weathered (and possibly enriched) shallow derivatives, the formerly productive saprolite deposits. Most lodes consisted of one or more narrow, closely spaced quartz veins or lenticular quartz-rich silicified zones generally oriented parallel to the foliation of their host. Most lodes contained one or more ore shoots. These features typically were very small, generally no more than a few meters wide by tenths of a meter thick. They pitched down the plane of the lode or vein at some northerly angle for no more than a few tens of meters. Ore shoots were characterized by high-grade pockets, elevated sulfide mineral contents and increased grain size of accessory vein silicates such as garnet, staurolite, kyanite and the micas.

Within individual districts such as the Dahlonega area, lodes occurred in close succession along narrow zones that suggest structural or stratigraphic control. The recent work of Cook and Burnell (1983) and German (1985) suggest that at least for part of the deposits within this district, stratigraphic control existed within a dominantly mafic metavolcanic host near its contact with a thick metasedimentary cover sequence. Similar relationships occur farther to the southwest in western Georgia and Alabama. Control of the shape and attitude of ore shoots appears to be related to recrystallization within lodes during a later period of regional deformation as indicated by the localization of shoots along and parallel to small structures within the lodes.

With only a few exceptions, most lode occurrences were worked to only shallow depths, rarely exceeding 100 meters in vertical extent. Scant records and tradition both strongly suggest that ore grades were relatively high above the water table where ores were free milling, as compared to the sulfide-dominated ores that occurred at depth. At least one study in the Dahlonega area indicates upgrading of shallow ore by supergene enrichment (Lesure, 1971).

Mineralogy of Georgia-Alabama lode gold occurrences is simple and, with the exception of native gold, not particularly interesting. In almost every instance the dominant vein mineral was white quartz with minor ankerite. Pyrite with minor sphalerite, chalcopyrite, galena, arsenopyrite and pyrrhotite occurred in variable though generally minor amounts below the water table. Sparse accessory pyromorphite occurred in the Singleton and nearby mines at Dahlonega. Wall rocks typically exhibit minor sericitization and locally contain relatively abundant almandine. Staurolite and kyanite are occasionally encountered as at the Battle Branch mine in southern Lumpkin County, Georgia. Coarsely crystalline biotite and chlorite are reported as vein minerals from some deposits.

DEPOSITS

As mentioned earlier, hundreds of small gold occurrences were once mined in Georgia and Alabama. Most of these went unrecorded; of those for which descriptions have survived, a few definitely produced fine, specimen-quality lode gold. The most important such occurrences are discussed below.

Boly Field mine, Lumpkin County, Georgia

One of the richest pocket mines of the Dahlonega district was that originally belonging to Boling W. Field. The property is immediately adjacent to the Chestatee River on lot 1182, 12th District (Yeates *et al.,* 1896). An extremely rich, small quartz lens in hornblende gneiss was discovered in outcrop here in the early 1840s. The pocket was unusual due to the coarseness of the gold, its relative abundance and its association with a bismuth telluride, probably tellurobismuthite (Jackson, 1859; Genth, 1860; Cook, 1973). According to Blake (1895), several thousand dollars were realized in the first few days of operation by simply blasting hunks of highgrade rock from the outcrop, breaking it up with hammers and pounding the fragments in mortars. During the life of the mine gold was secured on at least one occasion in such a large mass that it was cut up into convenient-sized pieces on a blacksmith's anvil (Jones, 1909).

Sparse records indicate that Boly Field's mine was never operated below the water table or for a significant distance along the vein. Since the deposit's strike carried it beneath the Chestatee River, Dr. M. F. Stephenson * was convinced that by relocating the channel of the river, he would find another rich pocket or shoot exposed in its bed. Immediately prior to the Civil War he was able to raise a large amount of "northern capital" for this undertaking. Unfortunately, a flood destroyed the operation before anything was found (Jones, 1909). Finally, three-quarters of a century later, approximately 300 meters of the Chestatee River were diverted by the Bowsend Mining Company in 1933 (Wilson, 1934). While preparing the channel for placering, an old shaft, thought to be the original Boly Field mine, was found and cleaned out. The inclined shaft followed a narrow quartz vein 20 meters into bedrock. According to the December 12, 1934, field notes of Richard W. Smith, former Georgia State Geologist, what was thought to be the untouched river channel had been worked in the early days and little gold was recovered by the Bowsend effort. Evidence of substantial work, including the remains of a large plank dam, could still be seen in 1966.

Specimens definitely attributable to the Boly Field mine are extremely rare. The association of coarse gold with massive tellurobismuthite(?) and pyrrhotite makes them relatively easy to identify. Other minerals reportedly occurring with gold in specimens from this occurrence include crystalline allanite, ilmenite and apatite (Becker, 1894).

* This is the same Stephenson who was instrumental in bringing the Graves Mountain, Georgia, deposit before the mineralogical community by his close association with C. U. Shepard.

Figure 4. **Early hydraulic mining along the Chestatee River in Lumpkin County.**

Battle Branch mine, Lumpkin County, Georgia

Perhaps the most productive and best known of the Georgia pocket mines is the Battle Branch. The mine is immediately southwest of the Etowah River at Castleberry Bridge, lots 457 and 524, 12th District. Placer work was begun on Battle Branch in 1831 with significant underground production reported for the intervals 1840–1850, 1875–1882 and 1934–1936 (Yeates and others, 1896; Pardee and Park, 1948). The property has been described in detail by Park and Wilson (1936) and Pardee and Park (1948).

The branch and mine received their name for a bloody battle that took place there in May of 1831 between groups of overly competitive Georgia and Tennessee miners. In 1882 a second armed conflict took place over a disputed water ditch between the operators of the Battle Branch and the adjacent Betz mines. Litigation related to this conflict seems to have kept the mine idle for several decades.

The discovery of unusually rich pockets at the Battle Branch mine dates from 1843 when the deposit was in its earliest stages of development by Major John Hockenhull. Several months of fruitless labor had passed, the only reward for the good Major and his crew of 12 miners being a rather large open cut. After all credit had been drawn down and with his miners' wages sadly in arrears, a meeting was called. The situation was explained and all but one miner, John Pasco, elected to abandon the project. According to Yeates *et al.* (1896), within 5 minutes after a rather dejected Hockenhull and Pasco resumed digging, a magnificent pocket containing acorn-sized masses of gold in white quartz was struck. By nightfall 110 ounces had been recovered. A second pocket yield 450 ounces quickly followed, as did a third containing 200 ounces (Yeates *et al.,* 1896). In all, the Hockenhull period of operation is thought to have produced approximately 4,500 ounces of gold, much of it potentially specimen-quality.

The Battle Branch again produced exceptional specimens when, in 1875, Mr. W. G. McNelley and Captain John W. Weaver encountered a pocket that afforded beautiful specimens of coarsely crystalline gold intergrown with galena. Specimens from this find survive today in a number of collections.

The last recorded production for the Battle Branch was during the depression years when deep mining was conducted by Mr. R. A. Newton for the Southern Mineral Development Company. Complete records for this period of activity do not exist, but mint reports indicate a production of 782 ounces between May 24, 1934, and May 20, 1935. Again, exceptional pocket gold was found. Enough free gold was recovered by panning and clean-up to pay for deepening the shaft to 60 meters and construction of a small mill (Wilson, 1934). During the examination of the property by the U.S. Geological Survey, a pocket was found that yielded 60 ounces in one day (Pardee and Park, 1948). Much of the highgrade encountered during this period of activity was very attractive, consisting of sheet-like masses of bright yellow gold on and in galena. Unusual specimens with gold and galena smeared out on fault planes are described by Pardee and Park (1948).

Highgrade pockets at the Battle Branch mine occurred within small shoots of lower-grade ore which themselves were within a general zone of silicified and otherwise mineralized schist. The shoots were very small, pinching and swelling abruptly both along strike and down dip. They were generally less than 2 meters in stope length, by 60 cm in width. They seldom pitched for greater than 30 meters down the plane of the shoot. Accessory minerals included ankerite, staurolite, pyrite and almandine. Some shoots were surrounded by thin, tube-like sheaths of almost pure almandine. Gold and galena sometimes occurred in cracks in garnet, and gold occurred between cleavage planes in accompanying muscovite (Pardee and Park, 1948).

It is believed that a relatively large number of Battle Branch mine gold specimens exist in museum and private collections. Good specimens were still to be seen in the Dahlonega area during the 1960s, at which time a suite of excellent gold and galena specimens attributed to the Battle Branch mine were displayed in the Georgia Capitol Building.

Calhoun-Turkey Hill mines, Lumpin County, Georgia

The Calhoun and Turkey Hill mines occupy adjacent ridges approximately 4 km south of Dahlonega, on land lots 164 and 163, district 11, respectively. Both boast a rather colorful history of pocket discovery. The Calhoun mine is thought by many to be the original site of gold discovery in Georgia. Early in its history, the mine was acquired by Senator John C. Calhoun of South Carolina. Approximately 2000 ounces were recovered by shallow gophering in the first month of operation under Calhoun's ownership (Yeates *et al.*, 1896). According to the April 9, 1833, edition of the Auraria, Georgia, *Western Herald,* a 9-pound, 3-ounce chunk of highgrade form the Calhoun mine that had 124 pieces of gold protruding from its surface was exhibited locally. Control of the property ultimately passed to Senator Calhoun's son-in-law, Thomas Clemson, the founder of Clemson University. Tradition has it that proceeds from Clemson's operation of the Calhoun mine supplied a significant part of the capital necessary to build the original university buildings.

Both the Calhoun and Turkey Hill mines exploited narrow quartz veins or shoots that sporadically contained unusually high-grade pockets of gold in quartz. Most of the richest discoveries were at or above the water table. Specimens from these shallow finds typically contain abundant gold in lightly iron-stained, somewhat sugary quartz. Below the water table, native gold was less abundant and occurred with arsenopyrite in gray to white quartz. During his visit to the Calhoun mine in 1908, Jones (1909) was shown a narrow vein that contained a band of "exceedingly rich quartz" that traversed the vein diagonally. At least five pocket-bearing veins were found at the Turkey Hill mine.

The Calhoun mine was operated intermittently until about 1940, with each period of activity producing more-or-less highgrade gold. The upper workings of the Calhoun mine are permanently dewatered by an approximately 250-meter-long drainage tunnel. Muck which partially clogged this tunnel where it intersected a raise to an overlying stope and the surface supplied small specimens of coarsely crystalline gold and arsenopyrite in white quartz to a few of the more daring local teenagers in years past. Today both mines are privately owned and posted. Small but spectacular specimens from both the Calhoun and Turkey Hill mines are still to be found in some museum and private collections and are occasionally available on the collector's market.

Findley mine, Lumpkin County, Georgia

One of the most famous mines of Georgia's Dahlonega district is the Findley. The mine is located a short distance east of Dahlonega on Findley Ridge, lots 1047, 1048 and 1087, 12th district. Numerous quartz veins have been exploited on the property in large open cuts and in underground workings that reached a depth of approximately 100 meters.

The Findley mine has a long history of promotional activity, litigation, and occasional pocket discovery. One of the richest and most consistently productive shoots was discovered here early in the development of the district, and by the Civil War approximately 11,000 ounces of gold had been produced (Yeates *et al.,* 1896). Some of the more spectacular specimens from this shoot contain gold with galena. Several specimens containing abundant visible gold in quartz with accessory galena and hornblende were displayed for years in the museum of the Georgia State Capitol Building in Atlanta. According to Yeates *et al.* (1896) "large quantities of very rich free gold specimens" were taken from an incline on this shoot.

The discovery of what was to become known as the Findley shoot was made by a prospector, Charles Duncan, in 1858. The shoot was worked down to the water table in only a few months after its discovery. Quoting from Yeates *et al.* (1896) "the rich shoot in the vein was only from four to six inches wide and from 1.5 to 2 inches thick; but it was so rich that masses of gold as large as a man's thumb were not uncommon in the quartz." Gold was reportedly carried to the mint at night in a water bucket to avoid potential theft. Mr. Huff, one of the early leaseholders, reported to Yeates *et al.* (1896) that he once crushed a 1-pound, 11-ounce piece of highgrade and upon panning the crushed material recovered 11 ounces of free gold.

In the late 1870s considerable highgrade was mined from the Findley shoot by a Mr. Hall. The use of this highgrade for promotional purposes is well documented. According to Hall (Yeates *et al.,* 1896), approximately "$3000 in handsome free gold specimens" were taken out of the shaft with a great deal more being left in place, the object of his work being to develop the mine for sale. A Mr. Farmer from Ohio was shown the property and, not to be deceived, chiseled out a pan full of highgrade vein material from the shaft bottom. The crushed ore from this one pan contained 27.3 ounces of gold. The sale was made. Although the records are scant, it appears that Mr. Farmer successfully mined the shoot for about a year at which time (1878) the property was sold for $60,000.

A great deal of gold has been produced from the Findley mine since the days of the rich shoot. Most has been from the working of large quantities of saprolite by a modified hydraulic method and by the milling of low-grade quartz veins.

Specimens from the Findley mine are difficult to acquire and are, for the most part, indistinguishable from those of the nearby Singleton mine and the galena-rich material from the Battle Branch mine far to the south.

Potosi mine, Hall County, Georgia

The Potosi gold mine is one of the few in the Georgia-Alabama area to produce relatively large, euhedral gold crystals. The occurrence is approximately 19 kilometers northwest of Gainesville, within lot 85 of the 11th district. Gold as discovered here in 1834 by a pair of Englishmen (Yeates *et al.,* 1896). An extremely rich shoot as found near the surface and mined only a short vertical distance by the very primitive methods then available. According to Brewer (1895), selected samples from this pocket assayed over $40,000/ton. Numerous attempts have been made to discover the continuation of the original ore shoot, but all appear to have failed.

The Potosi deposit is somewhat anomalous for the district in that the vein cuts across the foliation and apparent bedding of its host schist and is interpreted to have formed by deposition in open spaces as evidenced by quartz crystal-lined vugs. These vugs are generally elongate and lens-like in the plane of the quartz vein The vein has only sparse accessory pyrite and locally is characterized by manganese oxide staining. A number of years ago an exceptional Potosi mine specimen was on display in the museum of the Georgia State Capitol building. The small specimen contained part of a

Figure 5. **Inclined skipway to a shaft on the main ore shoot in the Findley mine open cut, Lumpkin County, Georgia. Photo by S. W. McCallie, August, 1913.**

milky quartz crystal-lined vug in which sat a somewhat crude gold octahedron approximately 1.0 cm in diameter.

Loud mine, White County, Georgia

The Loud mine, located about 8 kilometers west of Cleveland on lot 39, lst district, has produced excellent crystalline gold and large nuggets. Originally a placer, the deposit was regionally well known for its large, relatively unrounded nuggets. Exceptional examples include one of 4 ounces exhibited at the Cotton States and International Exposition in Atlanta in 1895 and an 18.5-ounce mass found in August of 1894.

Sometime in the late 1880s or early 1890s an unusually rich pocket was uncovered by a placer miner while cleaning gravel off of bedrock. According to Yeates *et al.* (1896) magnificent specimens from this pocket consisting of crystalline and wire gold were exhibited in this country and abroad. At the point of discovery a shaft was immediately sunk. For the first 3 meters the richness of the pocket was described as astounding. According to Yeates *et al.* (1896) the quartz vein was litle more than a stringer, never attaining a thickness greater than 2.5 centimeters in the first 3 meters of the shaft. The shoot that contained the rich pocket was followed to a depth of 18 meters before the owners' inability to handle large amounts of groundwater forced abandonment. Below 3 meters, the amount of gold in the shoot was quite low compared to the bonanza-grade shallower portion. Shortly after abandonment, approximately 84 ounces of coarse gold were recovered from a site very near the discovery shaft.

Around 1904 the original shaft was deepened and approximately 10 meters of drift run on the vein. Again water forced abandonment but not before several more very rich pockets had been discovered (Jones, 1909). At the time of Jones' examination of the property for the Georgia Geological Survey, very coarse gold could be panned from debris at the mouth of the shaft.

Gold specimens from the Loud mine are generally small but spectacular. Aggregates of crude crystals with faces up to 4 mm on an edge are typical. Most are in a matrix of variably iron-stained, vuggy, milky quartz.

Pinetucky mine, Randolph County, Alabama

The Pinetucky mine, located in the SE 1/4, Section 12, T18N, R10E, is Alabama's only significant gold specimen locality. The property has a colorful history of early prospecting and production since its discovery in 1845. One of the mine's earliest owners was Alabama Governor W. H. Smith who worked the deposit with convict labor. The property was visited several times in the late 1800s by Assistant State Geologist William Brewer whose various reports contain rather inspiring descriptions. He considered the mine to be a "rich specimen mine" and wrote in 1896 that on one of his visits he saw many specimens of ore showing free gold in great splotches and that in one pile of about two tons of ore, nearly every piece was a "fine cabinet specimen." Brewer's unpublished field notes covering another visit state that "a shot fired while I was present threw out a quantity of ore, in nearly every piece of which native gold was visible to the naked eye embedded in the quartz." A consulting report written in 1893 by Samuel Aughey, an early Wyoming territorial geologist, states that "at many points in the present workings the ore shows nuggets of gold from the size of a small pin head to that of a small bean, but the latter size are rare." Samples collected from an open cut by geologist Aughey contained up to 15 ounces/ton gold. Another report by Brewer (1895) states that extremely rich surface ore, such as that sampled by Aughey, was encountered from time to time and that in one instance an afternoon's run of shallow ore produced 40 ounces of gold from a single stamp mill battery (generally 5 stamps).

As with many of the early southern mines, gold recovery and ore grade at Pinetucky diminished dramatically below the water table. McCaskey (1908) reports that at the time of his visit in 1907 the mine was flooded and the twenty-stamp mill shut down. Pardee and Park (1948) describe the mine as inaccessible and the dumps badly overgrown at the time of their inspection in 1935. The mine was dewatered in the late 1930s but no production is reported. Today the site is under lease and is being considered for commercial exploitation.

The quartz vein containing the remarkably high-grade shoots exploited at Pinetucky varies from 15 to 90 cm in width. Despite its narrowness, it has been prospected by pits, trenches and shafts for a strike length of about 2 kilometers. The vein is anomalous in structural attitude, exhibiting a steep northerly strike and shallow,

Figure 6. **Stock certificate dated 1906 from the Etowah Gold Mining Company, "Mines at Auraria, Lumpkin County." Don Olson collection.**

15 degrees SE to 35 degrees SE dips. The most productive ore shoot was exploited by three closely spaced shafts up to 60 meters deep with approximately 200 meters of lateral workings and stopes.

Pinetucky mine gold specimens typically contain sheet-like masses of deep yellow gold in somewhat bluish quartz. Pyrite is an uncommon accessory, although it was quite abundant in the vein and wall rock below the water table. A large number of gold specimens from this location reached museums and collectors and occasionally turn up today in old collections.

OLD COLLECTIONS

There is little doubt that a significant number of gold specimens from Georgia and Alabama mines were saved initially. Unfortunately, most were found before the days of serious collecting as a widespread avocation. Consequently, the present whereabouts of these specimens is problematical. Two significant collections of Georgia gold, those of Wylie Moore and Sam Cronheim, were put together during the first half of the 20th century. Both gentlemen are deceased and the disposition of their collections is unknown. However, several specimens attributed to the Moore collection are the property of the Georgia Geological Survey, and a number of large nuggets originally belonging to Cronheim were displayed for a number of years in the lobby of Fulton Federal Bank in Atlanta. Similarly, the outstanding collection of Alabama gold once belonging to Robert Russell and periodically displayed in the 1st National Bank of Birmingham dropped from sight with the passing of Mr. Russell several years ago. Other lesser known collections probably existed and may still be intact.

LOCATIONS TO VISIT

Gold, as might be expected, is a tourist commodity in the Dahlonega area these days. ("Dahlonega," incidentally, comes from the local Cherokee word for "yellow money," i.e., gold). Placer gold can be panned in modest quantities from a large number of local streams including several where a fee is charged for the privilege. The Crisson Gold mine, for example, is located north of Dahlonega of Highway 19N on Wimpy Mill Road. To the east are several more including Old Dahlonega, located near the Lumpkin County Hospital. About a mile beyond Old Dahlonega is Gold Miner's Camp, where a 1-ounce nugget was recently panned by a tourist. Most local streams are on private property, owned by people who are well aware of their gold-producing potential and unlikely to grant panning permission to itinerant gold bugs. Visiting one of the commercial sites is easier, and is a pleasant way to spend an afternoon.

The Dahlonega Courthouse Gold Museum is also worth a visit. The courthouse, built in 1836, is the oldest public building in northern Georgia. Bricks for the building were made from local clay and contain assayable amounts of gold. Exhibits include a collection of Georgia gold rush artifacts, locally minted gold coins, and a modest array of specimens including a 5-ounce nugget and a somewhat smaller mass of granular crystalline vein gold. A 30-minute film en-

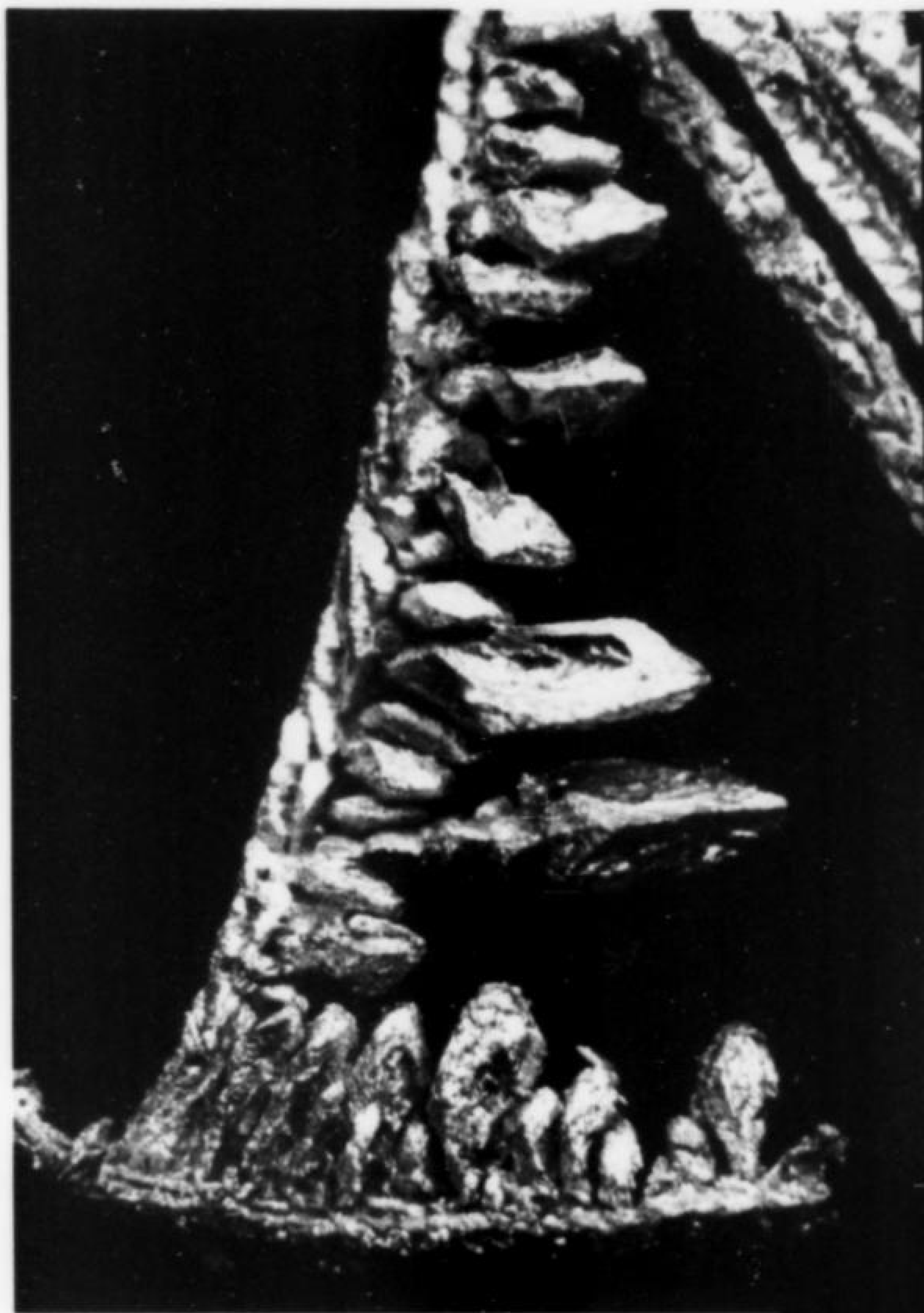
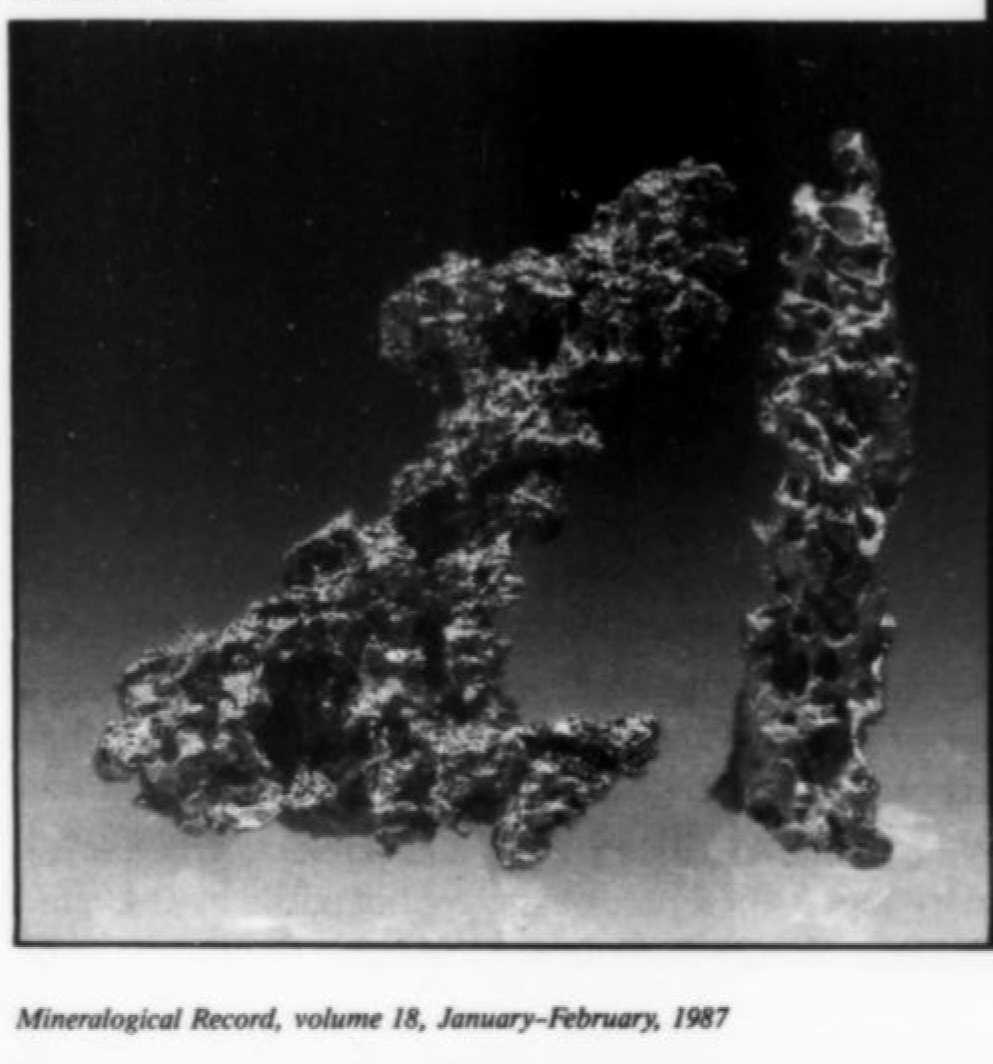


Figure 7. **Gold crystals to 1 mm from the "Dugas" (Loud) mine, near Cleveland, White County, Georgia. Julius Weber photo.**

Figure 8. **Gold recently collected by panning gravel pockets in a stream in Tallapoosa County, Alabama. Nathan Heinrich collection; size about 1 cm.**



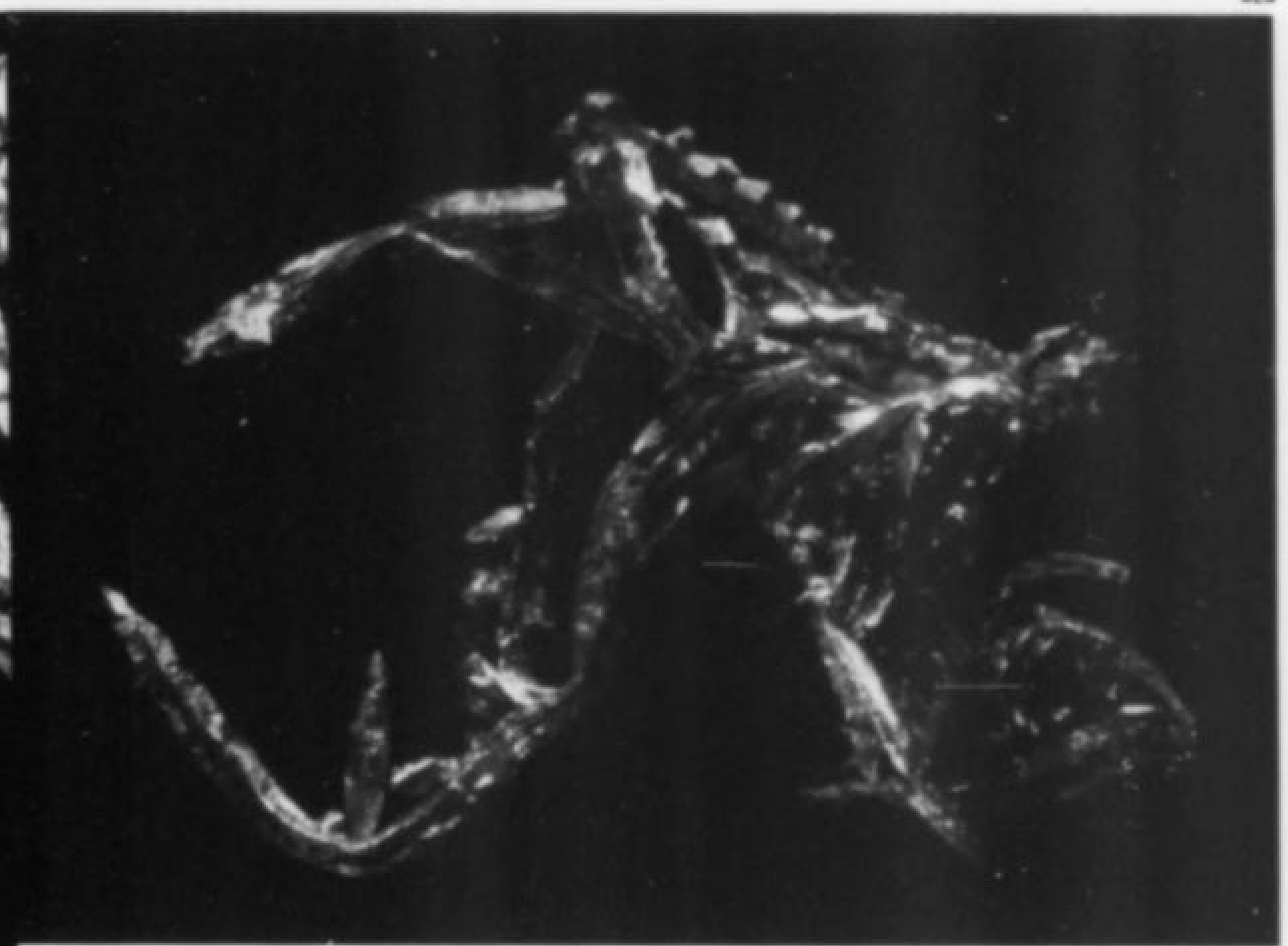


Figure 9. **Crystalline gold recently panned from alluvium immediately downstream from dumps of the Magruder mine near Metasville, Lincoln County, Georgia. The Magruder mine is one of many deposits within the Georgia portion of the Carolina Slate Belt that are characterized by relatively narrow, base metal-rich vein systems in metavolcanic rocks. J. B. Gordon collection; size: 7 mm.**

Figure 10. **Gold crystal group, 3.5 cm, with quartz from Lumpkin County, Georgia. Louisville (Kentucky) Museum of History and Science collection.**

Figure 11. **The Dahlonega Courthouse Gold Museum, originally built as the Lumpkin County Courthouse in 1836. (Photo courtesy of the Dahlonega Gold Museum).**

titled "Gold Fever" describes the mining techniques and lifestyles of prospectors through interviews with members of long-time mining families in the Dahlonega area. Dahlonega Gold Rush Days are held in October. The museum is open year-round, Tuesday-Saturday (9–5) and Sunday (2–5:30). There is a small admission fee. For more information contact the Dahlonega Gold Museum State Historic Site (Public Square, Box 2042, Dahlonega, GA 30533; (404) 864-2257).

CONCLUSIONS

The prospects for new gold specimen production from lodes in the deep South appear poor. Many areas warranting modern exploration are so negatively impacted by urban sprawl or environmental considerations that to hope for renewed mining is unrealistic. However, as mentioned, small to moderate-sized nuggets attributed to local streams are occasionally available in the Dahlonega area and exceptional specimens from imprecisely known but obviously local origin sometimes appear when all-but-forgotten safety deposit boxes are emptied and estates are settled.

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North Carolina Gold

In 1799 a fist-sized gold nugget was found in a North Carolina creek. The local people had never seen gold and could not immediately identify it; but eventually the lump was recognized for what it was and a small gold rush ensued, the first in North America.

INTRODUCTION

The discovery of gold in North Carolina was big news in the early 1800s, long before the California gold rush of 1849 and continuing until the Civil War. Ever on the alert for a good story, the editors of *Harper's New Monthly Magazine* dispatched their roving correspondent and artist, the indefatigable Porte Crayon, to report on the North Carolina gold mines in 1857. His story still makes interesting reading today, and will probably strike some familiar chords with anyone who has ever visited a small working mine. Crayon's article also contains what must surely be the most blithe commentary on child labor in the history of mining literature. For the amusement and interest of our readers, we present on the following pages a facsimile reprint of that article (with minor deletions, recast to our page size and including specimen photos added).

For readers wishing to learn more about North Carolina gold occurrences a bibliography is provided below.

The locality where gold was first found in North Carolina is today preserved as the Reed Gold Mine State Historic Site, administered by the North Carolina Department of Cultural Resources. The visitor's center offers a 20-minute film on the history of North Carolina gold mining, and houses exhibits of gold specimens and mining equipment. A guided tour is conducted through a restored section of the underground workings, and from there to a fully operational 19th century stamp mill designed to crush gold ore. All of these activities are available free of charge. Between April 1 and October 31 a panning area is open where, for $3, you receive two pans of gold-containing ore to play with. The Reed mine is open year round but with some seasonal variations in days and hours. For more information, write or call the Reed Gold mine, Route 2, Box 101, Stanfield, North Carolina 28163 (704-786-8337).

The Reed mine produced its last large nugget in 1896, and the underground workings were finally closed in 1912. The Kelly family of Springfield, Ohio, owned most of John Reed's original farm from the late 1800s until 1971.

Gold Hill, the locality visited by Porte Crayon, is located about 27 km north of the Reed mine. Workings there eventually reached a depth of more than 300 meters, but nothing remains to be seen today.

Wendell E. Wilson
The *Mineralogical Record*
4631 Paseo Tubutama
Tucson, Arizona 85715

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(Continued on page 80)

HARPER'S
NEW MONTHLY MAGAZINE.

NORTH CAROLINA ILLUSTRATED.

BY PORTE CRAYON.

IV.—THE GOLD REGION.

"Earth, yield me roots;
Who seeks for better of thee, sauce his palate
With thy most operant poison. What have we here?
Gold, yellow, glittering, precious gold."

SHAKSPEARE.

THE Gold Region of North Carolina lies west of the Yadkin, and the most important mines are found between that river and the Catawba, in the counties of Rowan, Cabarras, and Mecklenburg.

The following account, furnished by Colonel Barnhardt, is given in Wheeler's History of the State:

"*A Sketch of the Discovery and History of the Reed Gold Mine, in Cabarras County, North Carolina, being the first Gold Mine discovered in the United States.*"

"The first piece of gold found at this mine was in the year 1799, by Conrad Reed, a boy of about twelve years old, a son of John Reed, the proprietor. The discovery was made in an accidental manner. The boy above named, in company with a sister and younger brother, went to a small stream, called Meadow Creek, on Sabbath day, while their parents were at church, for the purpose of shooting fish with bow and arrow; and while engaged along the bank of the creek, Conrad saw a yellow substance shining in the water. He went in and picked it up, and found it to be some kind of metal, and carried it home. Mr. Reed examined it, but as gold was unknown in this part of the country at that time, he did not know what kind of metal it was. The piece was about the size of a small smoothing-iron.

"Mr. Reed carried the piece of metal to Concord, and showed it to William Atkinson, a silversmith; but he, not thinking of gold, was unable to say what kind of metal it was.

"Mr. Reed kept the piece for several years on his house floor, to lay against the door to keep it from shutting. In the year 1802 he went to market to Fayetteville, and carried the piece of metal with him, and on showing it to a jeweler, the jeweler immediately told him it was gold, and requested Mr. Reed to leave the metal with him, and said he would flux it. Mr. Reed left it, and returned in a short time, and on his return the jeweler showed him a large bar of gold, six or eight inches long. The jeweler then asked Mr. Reed what he would take for the bar. Mr. Reed, not knowing the value of gold, thought he would ask a big price; and so he asked three dollars and fifty cents. The jeweler paid him his price.

"After returning home, Mr. Reed examined and found gold in the surface along the creek. He then associated Frederick Kisor, James Love, and Martin Phifer with himself, and in the year 1803 they found a piece of gold in the branch that weighed twenty-eight (28) pounds. Numerous pieces were found at this mine weighing from sixteen pounds down to the smallest particles.

"The whole surface along the creek for nearly a mile was very rich in gold.

"The veins of this mine were discovered in the year 1831. They yielded a large quantity of gold. The veins are flint and quartz.

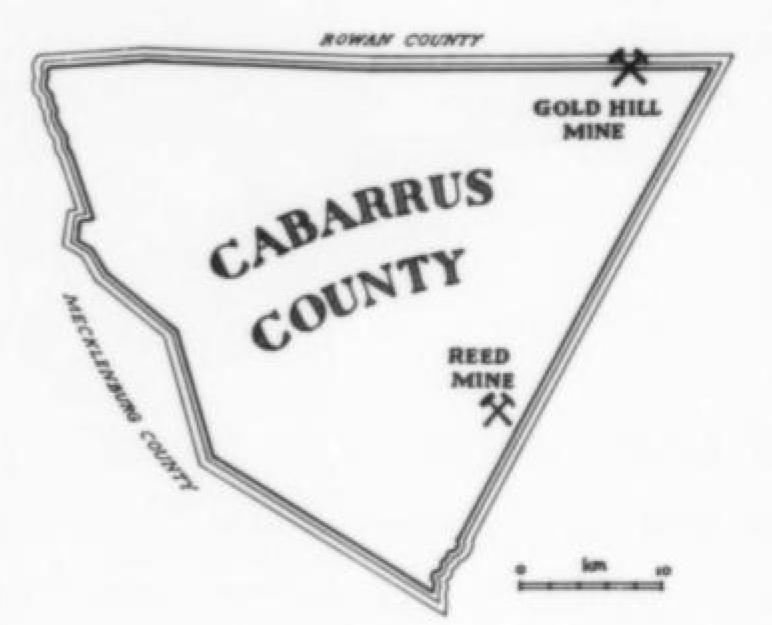
"I do certify that the foregoing is a true statement of the discovery and history of this mine, as given by John Reed and his son Conrad Reed, now both dead.

"GEORGE BARNHARDT.

"*January, 1848.*"

FINDING GOLD.

No. LXXXVII.—AUGUST, 1857.



At the present day the surface gold is very scarce, and the precious ore is found principally in veins of quartz, bedded in the hardest black slate.

The mines are located in what has been from very early times an opulent and well-peopled district, the theatre of many important political and military events before and during our struggle for national independence.

What effect the discovery of gold may have had upon the general prosperity of the region we do not know; but having heard divers and conflicting opinions on the subject, we have discreetly concluded to indulge in no speculations thereon. We will, therefore, resume our narrative of the observations and adventures of our heroic traveler, Porte Crayon.

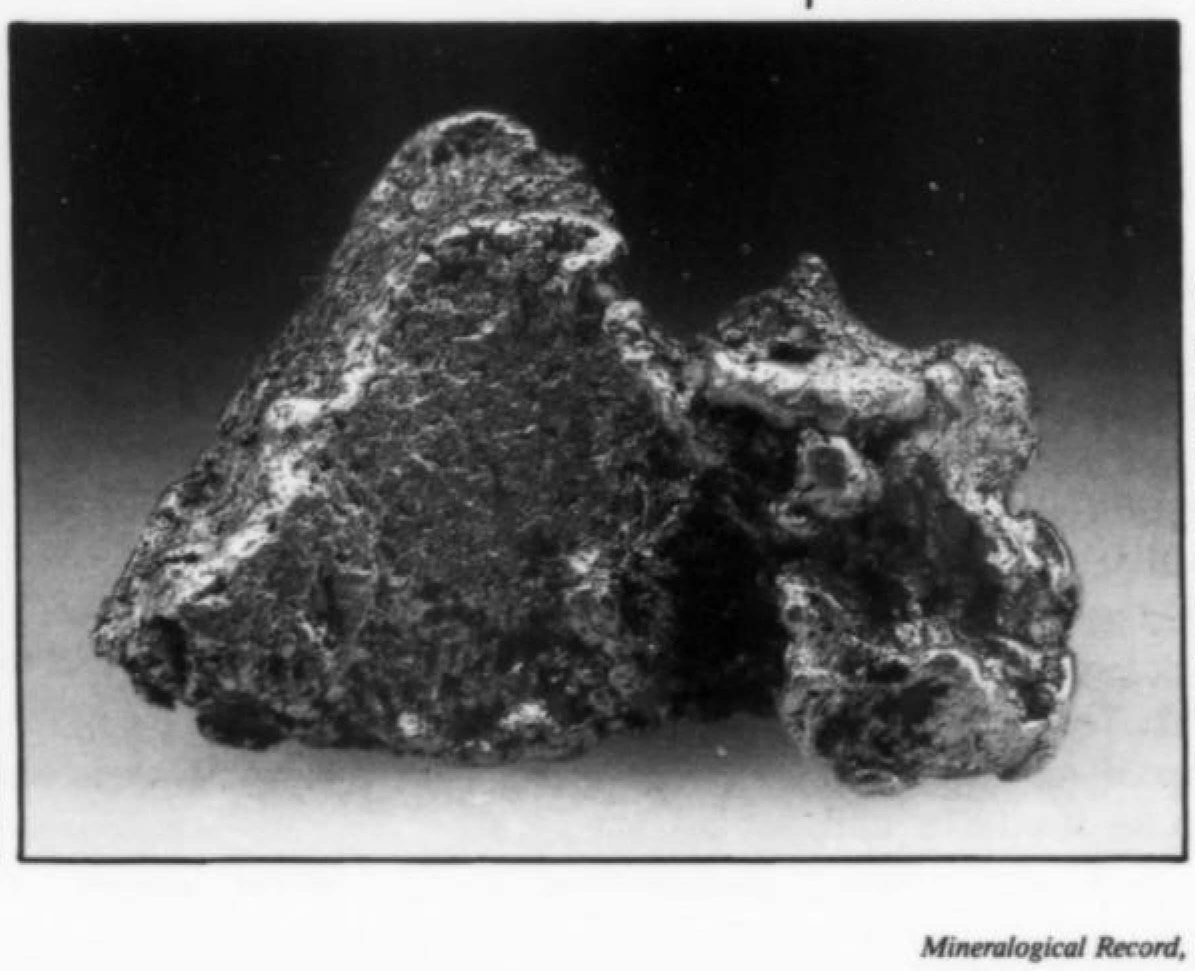
At Salisbury, the seat of justice of Rowan County, he found comfortable quarters at the Rowan House.

Salisbury contains about three thousand inhabitants, and is a well-built, flourishing town. Among other notable objects it contains the office where General Jackson studied law, and the houses which, in earlier times, were respectively the head-quarters of Greene and Cornwallis, as pursued and pursuing they passed through on the famous retreat across the Dan.

From Salisbury Mr. Crayon took the coach for Gold Hill, twenty miles distant. He was accompanied on this journey by a young gentleman from Massachusetts, who, led by a common curiosity, was desirous of visiting the most famous of the North Carolina gold mines. Their road passed through a pleasantly diversified country, budding and blooming under the soft influences of spring. Here and there they remarked heaps of red earth, broken rocks, decaying windlasses, and roofless sheds, designating the spots where men had wasted time and money in searching for "earth's most operant poison."

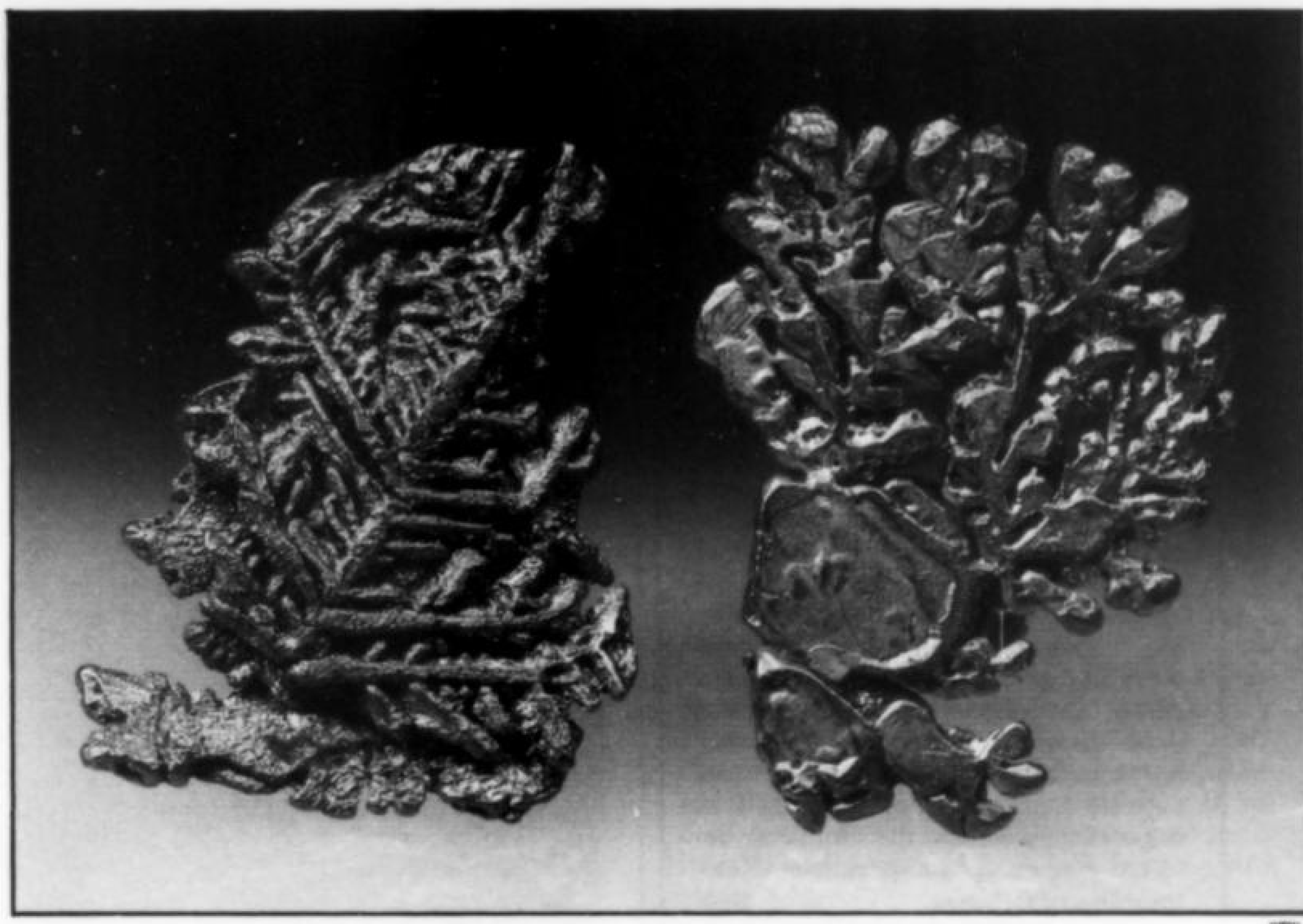
As the terrapin in the fable won the race by steady perseverance, so the vehicle that conveyed Porte Crayon and his friend at length reached Gold Hill. This famous village contains about twelve hundred inhabitants, the population being altogether made up of persons interested in and depending on the mines. There is certainly nothing in the appearance of the place or its inhabitants to remind one of its auriferous origin, but, on the contrary, a deal of dirt and shabbiness. Our philosophic tourist, however, is rarely satisfied with a superficial view of things if he can find opportunity to dive deeper in search of truth.

Having presented their credentials to the superintendent of the works, the travelers were politely received, and in due time arrangements were made to enable them to visit the subterranean streets of Gold Hill. The foreman of the working gangs was sent for and our friends placed under his charge, with instructions to show them every thing. Matthew Moyle was a Cornish man, a handsome, manly specimen of a Briton. With bluff courtesy he addressed our adventurers:



Slightly worn gold nugget, 3.5 cm (1 ounce) collected in 1828 at the Reed gold mine. John Barlow collection, formerly in the Al Buranek collection and before that in a 19th century German collection.

WEW



Gold crystals from Cabbarus County (probably Gold Hill), North Carolina. The left group measures 1.3 cm. Harvard Mineralogical Museum collection.

"Lights in the miners' hats, who are working below, Sir."

Porte Crayon felt a numbness seize upon his limbs.

"And are we, then, crawling like flies down the sides of this open shaft, with no foothold but these narrow slippery ladders, and nothing between us and the bottom but four hundred feet of unsubstantial darkness?"

"This is the road we miners travel daily," replied the foreman; "you, gentlemen, wished to see all we had to show, and so I chose this route. There is a safer and an easier way if you prefer it."

Crayon looked in the Yankee's face, but there was no flinching there.

"Not at all," replied he; "I was only asking questions to satisfy my curiosity. Lead on until you reach China; we'll follow."

Nevertheless after that did our hero remove his slippery buckskin gloves and grip the muddy rounds with naked hands for better security; and daintily enough he trod those narrow platforms as if he were walking on eggs, and when ever and anon some cheery jest broke out, who knows but it was uttered to scare off an awful consciousness that, returning again and again, would creep numbingly over the senses during the intervals of silence?

But we can not say properly that they ever moved in silence, for the dull sounds that accompanied their downward progress were even worse. The voices of the workmen rose from the depths like inarticulate hollow moanings,

"You wish to see every thing right, gentlemen?"

"We do."

"Then meet me at the store at eight o'clock this evening, and all things shall be in readiness."

Eight o'clock soon arrived, and all parties were met at the place of rendezvous. Moyle and his assistant, Bill Jenkins, looked brave in their mining costume. This consisted of a coat with short sleeves and tail, and overalls of white duck. A round-topped wide-brimmed hat of indurated felt, protected the head like a helmet. In lieu of crest or plume each wore a lighted candle in front, stuck upon the hat with a wad of clay. Crayon and his companion donned similar suits borrowed for their use, and thus accoutred the party proceeded immediately to the mouth of the ladder shaft. This was a square opening lined with heavy timber, and partly occupied by an enormous pump used to clear the mines of water and worked by steam. The black throat of the shaft was first illuminated by Moyle, who commenced descending a narrow ladder that was nearly perpendicular. Porte Crayon followed next, and then Boston. The ladders were about twenty inches wide, with one side set against the timber lining of the shaft, so that the climber had to manage his elbows to keep from throwing the weight of the body on the other side. Every twenty feet or thereabout the ladders terminated on the platforms of the same width, and barely long enough to enable one to turn about to set foot on the next ladder. In addition, the rounds and platforms were slippery with mud and water. As they reached the bottom of the third or fourth ladder Crayon made a misstep which threw him slightly off his balance, when he felt the iron grasp of the foreman on his arm:

"Steady, man, steady!"

"Thank you, Sir. But, my friend, how much of this road have we to travel?"

"Four hundred and twenty-five feet, Sir, to the bottom of the shaft."

"And those faint blue specks that I see below, so deep deep down that they look like stars reflected in the bosom of a calm lake, what are they?"

MAT MOYLE AND NICKY TREVETHAN.

and the measured strokes of the mighty pump thumped like the awful pulsations of some earth-born giant.

Heated and reeling with fatigue, they at length halted at the two hundred and seventy foot gallery. Here they reposed for a few minutes, and then leaving the shaft walked some distance into the horizontal opening. At the end they found a couple of negroes boring in the rock with iron sledge and auger. Having satisfied their curiosity here, they returned to the shaft and descended until they reached the three hundred and thirty foot gallery. Here appeared a wild-looking group of miners, twenty

BORING.

or more in number, who had crowded on a narrow gallery of plank that went round the shaft until it seemed ready to break with their weight. A number of negroes were huddled in the entrance of an opposite gallery, and among them our friends preferred to bestow themselves for better security.

The miners were congregated here, awaiting the explosion of a number of blasts in the main gallery. The expectancy was not of long duration, for presently our friends felt and heard a stunning crash as if they had been fired out of a Paixhan gun, then came another and another in quick succession. They were soon enveloped in an atmosphere of sulphurous smoke, and as the explosions continued Boston remarked, that in a few minutes he should imagine himself in the trenches at Sebastopol.

When the blasting was over the men returned to their places, and Moyle, having requested his visitors to remain where they were, went to give some directions to the workmen. During his absence, Boston, with the characteristic sharpness of his people, commenced prying about him.

"What the deuce," quoth he, "is in these bags on which we are sitting?"

"Oh, nothing!" replied Crayon, in a listless tone.

"But the bags are full," persisted the Yankee; "and I guess there must be something in them."

"Salt, perhaps."

"I guess they have no particular use for salt down here."

"Gold dust, maybe," and Crayon yawned.

"I've a mind to see, just to satisfy my curiosity," said Boston, opening his penknife.

He quietly slit one of the canvas bags, and taking out a handful of coarse black grains handed them over to Crayon.

Our hero opened his eyes, and then put a pinch of the substance into his mouth. He sprang up suddenly as if he had been shot at.

"Mind your light! Gunpowder, by Heaven! come, let us leave."

"Wait a minute," said Boston, "until I return the powder and close the bag securely."

And having done this with great *sang froid*, he followed Crayon's suggestion.

When the foreman returned, our friends descended to the bottom of the mine without further stoppages. Here they found a number of men at work, with pick and auger, knocking out the glittering ore. The quartz veins are here seen sparkling on every side with golden sheen. At least so it appears; but the guide dispelled the delusion by informing them that this shining substance was only a sulphuret of copper, the gold in the ore being seldom discernible by the naked eye, except in specimens of extraordinary richness. Several of these specimens he found and kindly presented to the visitors.

Having, at length, satisfied their curiosity, and beginning to feel chilled by their long sojourn in these dripping abodes, our friends intimated to their guide that they were disposed to revisit the earth's surface.

The question then arose whether they should reascend the ladders, or go up in the ore bucket. The ladders were more fatiguing, the bucket more dangerous, and several miners counseled against attempting that mode. Moyle, however, encouraged them with the assurance that they did not lose many men that way. Crayon settled the question by the following observation:

"Sometimes it is prudent to be rash. I'm tired; and, paying due respect to the calves of my legs, I have concluded to try the bucket."

The bucket is a strong copper vessel about the size of a whisky barrel, used to carry the ore to the surface. It is drawn up through the shaft on a strong windlass worked by horse-power. The operation is double—an empty bucket descending as the loaded one ascends. One of the risks from ascending in this way is in passing this bucket. Crayon stuck his legs into the brazen chariot, and held the rope above. Moyle stood gallantly upon the brim, balancing himself lightly with one arm akimbo. The signal-cord was jerked, and up they went.

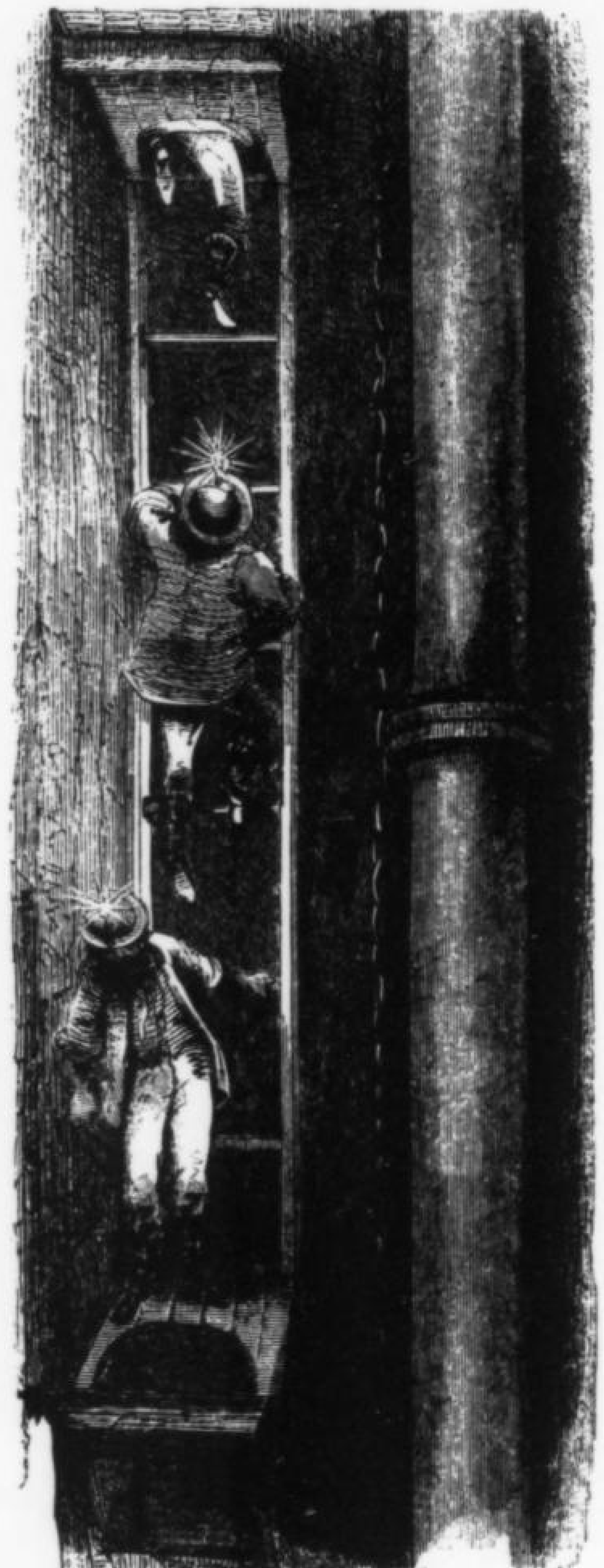
Slowly and steadily they rose. Crayon talked and laughed, occasionally trusting himself with a glance downward, hugging the rope closer as he looked. Moyle steered clear of the descending bucket, and in a short time our hero found himself at the mouth of the shaft. With much care and a little assistance he was safely landed, and the foreman again descended to bring up the Yankee.

As Moyle went down, Crayon, with due precaution, looked down into the shaft to watch the proceeding. He saw the star in the miner's helmet gradually diminish until it became a faint blue speck scarcely visible. Then other tiny stars flitted around, and faint, confused sounds rose from the awful depth. At the signal the attendant at the windlass reversed the wheel, and the bucket, with the men, began to ascend.

While Crayon watched the lights, now growing gradually on his sight, he was startled by a stunning, crashing sound that rose from the shaft. The first concussion might have been mistaken for blasting, but the noise continued with increasing violence. The signal-chains rattled violently, and the windlass was immediately stopped. Loud calls were heard from the shaft, but it was impossible to distinguish what was said amidst the confused roar.

"Stop the pump!" said Crayon to the negro. "I believe the machinery below has given way."

The negro pulled a signal-rope connected with the engine-house, and presently the long crank that worked the pump was stopped; at the same time the frightful sounds in the shaft ceased. The adventurers in the bucket then



DESCENDING THE LADDER-SHAFT

resumed their upward journey. When they arrived at the mouth of the shaft Moyle nimbly skipped upon the platform. Boston, who was in the bucket, was preparing to land with more precaution; but the horse, probably excited by the late confusion, disregarding the order to halt, kept on his round. The bucket was drawn up ten or twelve feet above the landing, and its brim rested on the windlass. Boston, to save his hands from being crushed, was obliged to loose his hold on the rope, and throw his arms over the turning beam. One moment more, one step further, and the bucket, with its occupant, would have been whirled over and precipitated into the yawning abyss from which they had just risen. Moyle looked aghast—the negro attendant yelled an oath of mighty power and sprang toward the horse. The movement would have been unavailing, for the horse was on the further side of his beat; but it appears he understood Mumbo Jumbo, and, at the talismanic word, the brute stood still. Cuffee seized his head and backed him until the bucket descended to the level of the platform, and the Yankee was rescued from his perilous position, altogether less flurried and excited than any of the witnesses.

ASCENDING BUCKET-SHAFT.

Crayon then ascertained that his surmise in regard to the hubbub in the shaft was correct. At a point about a hundred and fifty feet from the bottom some of the pump machinery was accidentally diverted from its legitimate business of lifting water, and got to working among the planks and timbers that lined the shaft, crushing through every thing, and sending a shower of boards and splinters below. The fracas was appalling, and, but for the prompt stoppage of the machinery, serious damage and loss of life might have been the result.

As they were about to leave Porte Crayon approached the negro.

"Uncle," said he, speaking with evident embarrassment, "you have been at some trouble on our account—got us safely out of the shaft. I wish to thank you, and to offer you some remuneration in the shape of a present. If, indeed, you, who are continually up to your knees in gold, would condescend to look upon a pitiful piece of silver."

"Silber, Massa?" ejaculated Cuffee, opening his eyes.

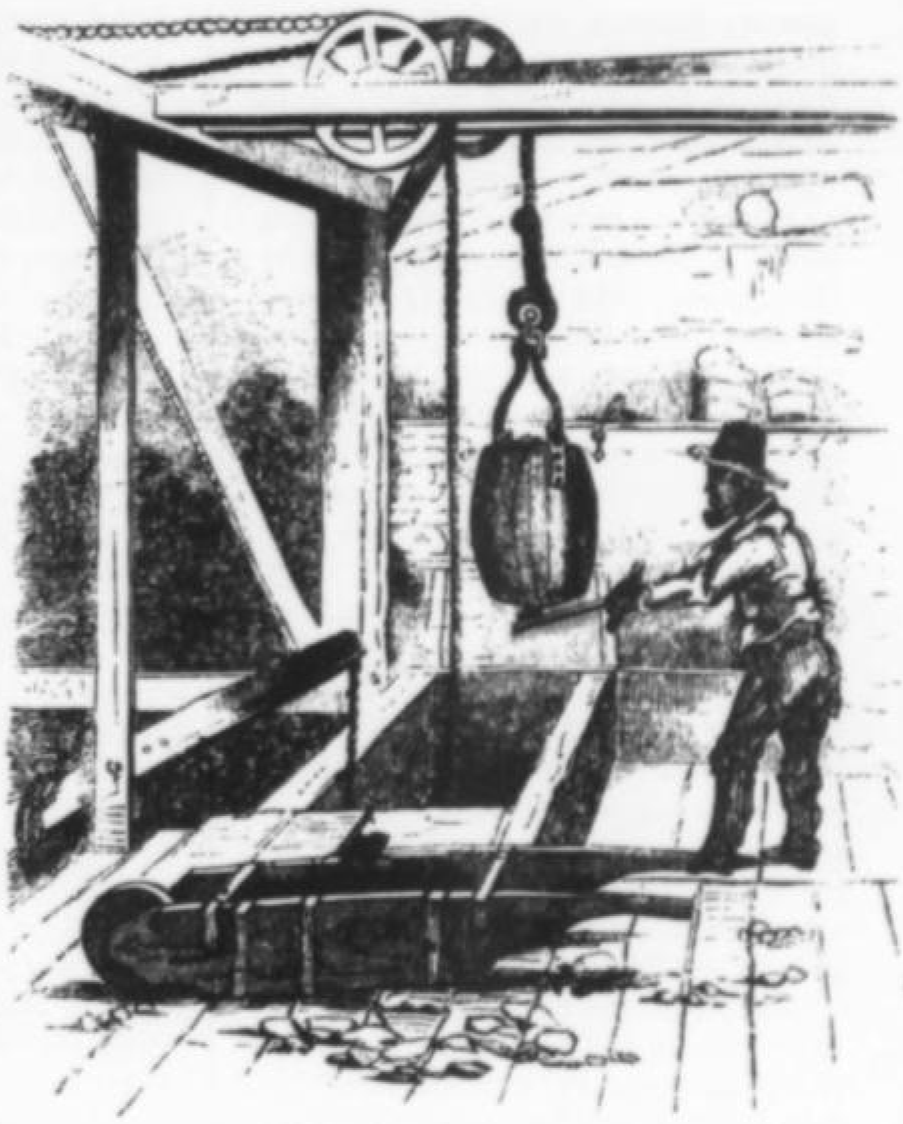
"Yes, I take the liberty," continued Crayon, "of offering you a trifle," and, with a sheepish air, he dropped half a dollar into the extended palm.

"In a place where you habitually tread gold under your feet, I am really ashamed to offer you baser metal."

"Silber, Massa!" said Cuffee, grinning from ear to ear, "why I ain't seed sich a sight sence last Christmas;" and he louted so low that his ragged hat swept the ground.

As the strangers retired the voice was heard still muttering:

"Think nothin' of silber, eh! I like dat—dat's money. Dese yaller stones ain't no use to us. Silber! ke, he—dem's gemplums sure enough."

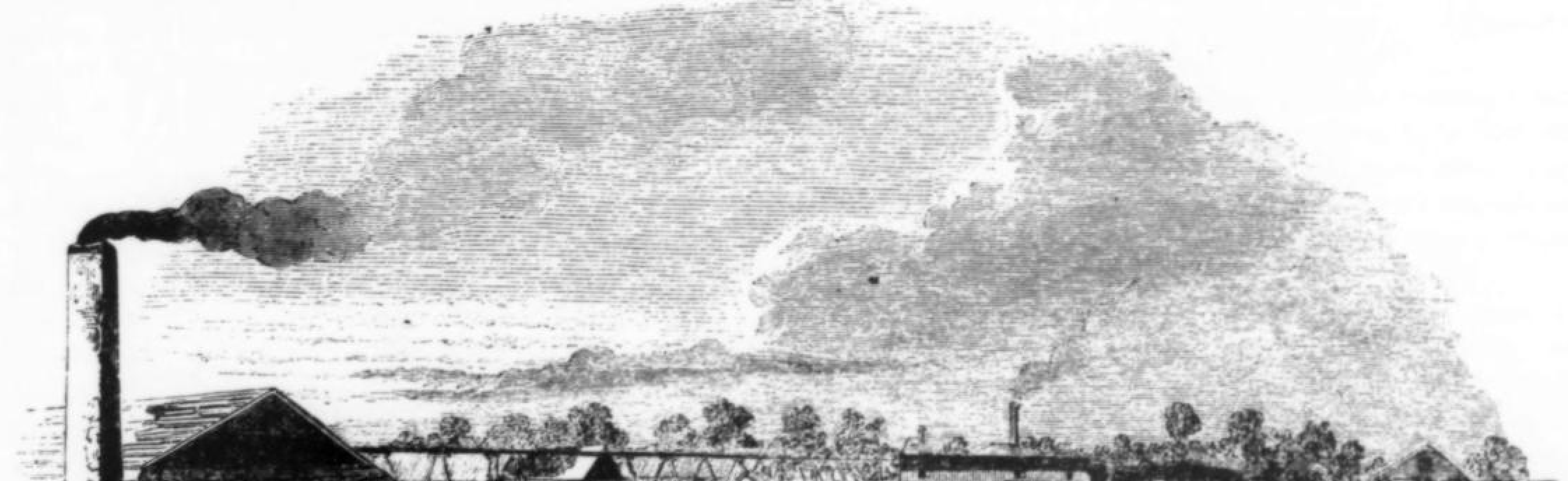


AT MOUTH OF BUCKET SHAFT.

Before they parted Crayon formally returned his thanks to the foreman, and delicately hinted at remuneration. The offer met a polite but decided refusal from the manly Englishman.

Altogether the visit to the mine occupied about four hours, and the travelers were sufficiently fatigued to appreciate their beds that night.

On the following morning they visited the works accompanied by the superintendent, who explained to them in a satisfactory manner the whole process of getting gold. In the first place, the ore taken from the mine is broken with hammers to the size of turnpike stone. It is then subjected to a process of grinding in water,



VIEW OF THE GOLD HILL WORKS.

passing through the crushing, dragging, and stirring mills, until it is reduced to an impalpable powder, or, in its wet condition, to a light gray mud, which is washed down, and collects in a large vat below the mills. From this it is carried in wheel-barrows to the cradles. The cradles are eighteen or twenty feet long, formed from the trunks of trees split in twain and scooped out like canoes. They are laid upon parallel timbers with a slight inclination, and fastened together, so that a dozen or more may be moved with the same power. They are closed at the upper end, open at the lower, and at intervals on the inside are cut with shallow grooves to hold the liquid quicksilver. The golden mud is distributed in the upper end of these cradles, a small stream of water turned upon it, and the whole vigorously and continually rocked by machinery. The ground ore is thus carried down by the water, the particles of gold taken up by the quicksilver, and the dross washed out at the lower end, where a blanket is ordinarily kept to prevent the accidental loss of the quicksilver. After each day's performance the quicksilver is taken out, squeezed in a clean blanket or bag, and forms a solid lump called the amalgam. This amalgam is baked in a retort, the quicksilver sublimates and runs off into another vessel, while the pure gold remains in the retort.

Although this is the most approved mode yet known of separating the gold from the ore, it is so imperfect that, after the great works have washed the dust three or four times over, private enterprise pays for the privilege of washing the refuse, and several persons make a good living at the business.

These private establishments are less complicated and far more picturesque in appearance than the great ones. The only machines necessary there are the cradles and the motive power, half a dozen lively little girls from twelve to fifteen years of age. This power, if not so reliable and steady, is far more graceful and entertaining than steam machinery. Although the fastidious might find fault with their apparel, yet the graceful activity of these barefooted lasses as they skip and dance over their rolling stage, with elf-locks waving free, cheeks rosy with exercise, and eyes bright with fun, is far more pleasing to the eye of taste than the strained, extravagant, and unnatural posturings of your Ellslers and Taglionis that we make such a fuss about, excelling them as the wild rose of nature does the bewired and painted artificial, or—ah!—as the—Crayon suggests—as freckles and dirt excel rouge and tinsel.

As our artist was amusing himself sketching one of these establishments, he observed the children at a neighboring shed apparently in consultation. Presently the tallest one among them approached him, and after hovering around for some time, at length leaned over and addressed him in a whisper:

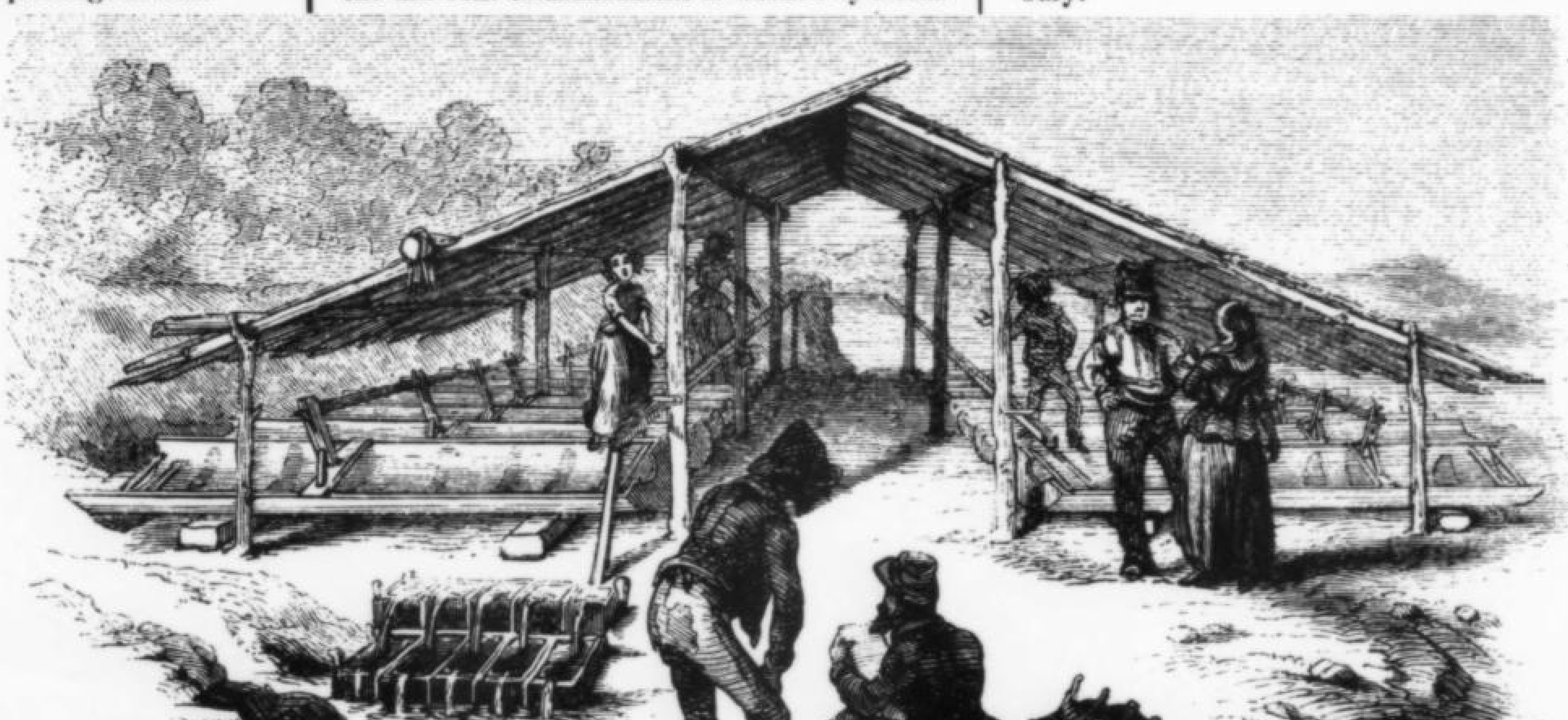
"I say, man, when you've done here, please come up our way and give us a touch."

●

Gold Hill, we were informed, belongs to a Northern company. The works are on a more extensive scale than at any other point in North Carolina. They give employment to about three hundred persons, and seem to be in a highly prosperous condition. The working of the mines is chiefly under the direction of Englishmen from the mining districts of Cornwall, and negroes are found to be among the most efficient laborers. All the machinery of the different establishments is worked by steam power except the windlasses for raising the ore, where blind horses are used in preference.

BILL JENKINS.

Having stuffed his knapsack with specimens of ore, and enriched his portfolio with several portraits of the miners, Porte Crayon with his companion took the stage and returned to Salisbury.



ROCKING CRADLES.

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GOLD

in the California State Mineral Collection

The historic California State Mineral collection contains some outstanding and important gold specimens, including many samples from California, from other states, and from around the world.

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In April of 1880, the California State Legislature passed a bill establishing the State Mining Bureau. The first State Mineralogist and head of the Bureau, Henry G. Hanks, was directed to collect specimens of all geological materials found in the state. The California State Geological Society, an informal organization which came into existence in 1853, donated over 1000 specimens which became the core of the collection.

The Bureau's first home was at 619 Montgomery Street, San Francisco, where the State Museum was established. The original museum displayed rocks and minerals, as well as anthropological and historical artifacts and biological specimens. Over the next two decades, the Bureau moved several times as the need for space and facilities grew, just as San Francisco was growing. While in a building on Sutter Street in 1882, the museum was plagued with robberies. The thieves took only gold and were never caught. In 1898, the Bureau moved to its most permanent home, the new Ferry Building on the Embarcadero at the foot of Market Street. Before making this move, some of the State collections were given to other institutions, reducing the museum collection to just rocks and minerals. The Ferry Building fortunately suffered only minor damage in the great earthquake and fire of 1906 and the museum and library were little affected.

In 1927, the Bureau became a Division of the Department of Natural Resources. In 1961, it became the Division of Mines & Geology under the Department of Conservation. The Division's headquarters were moved to Sacramento in 1970, but the library, museum and laboratory remained with the district office in San Francisco.

Over the years, the space within the Ferry building was changed to accommodate the growing needs of its tennants. Eventually, the mineral museum and the extensive geological library occupied a large area on the second floor. Almost entirely through donation, the collection grew to include over ten thousand specimens of rocks, ores and minerals from all over the world.

In 1982, the Division began looking for a new home. The Port Authority had plans to remodel the Ferry Building, and State budget cuts forced a re-evaluation of the Division's priorities. In the spring of 1983, the State collection was moved from San Francisco to Mariposa County, in the foothills of the Sierra Nevada. The Division offices and library were moved in 1984 to new quarters in Pleasant Hill, about 32 km northeast of San Francisco.

The California Mineral Exhibit Association, a private, non-profit organization, was established in Mariposa County to care for and exhibit the State collection. The precious metals portion of the collection was loaned to the California Academy of Sciences for one year in March 1985. A temporary exhibit, "California Gold," was mounted in the Academy's gem room; it included the best gold specimens from the State and Academy collections.

While at the Academy, the precious metals

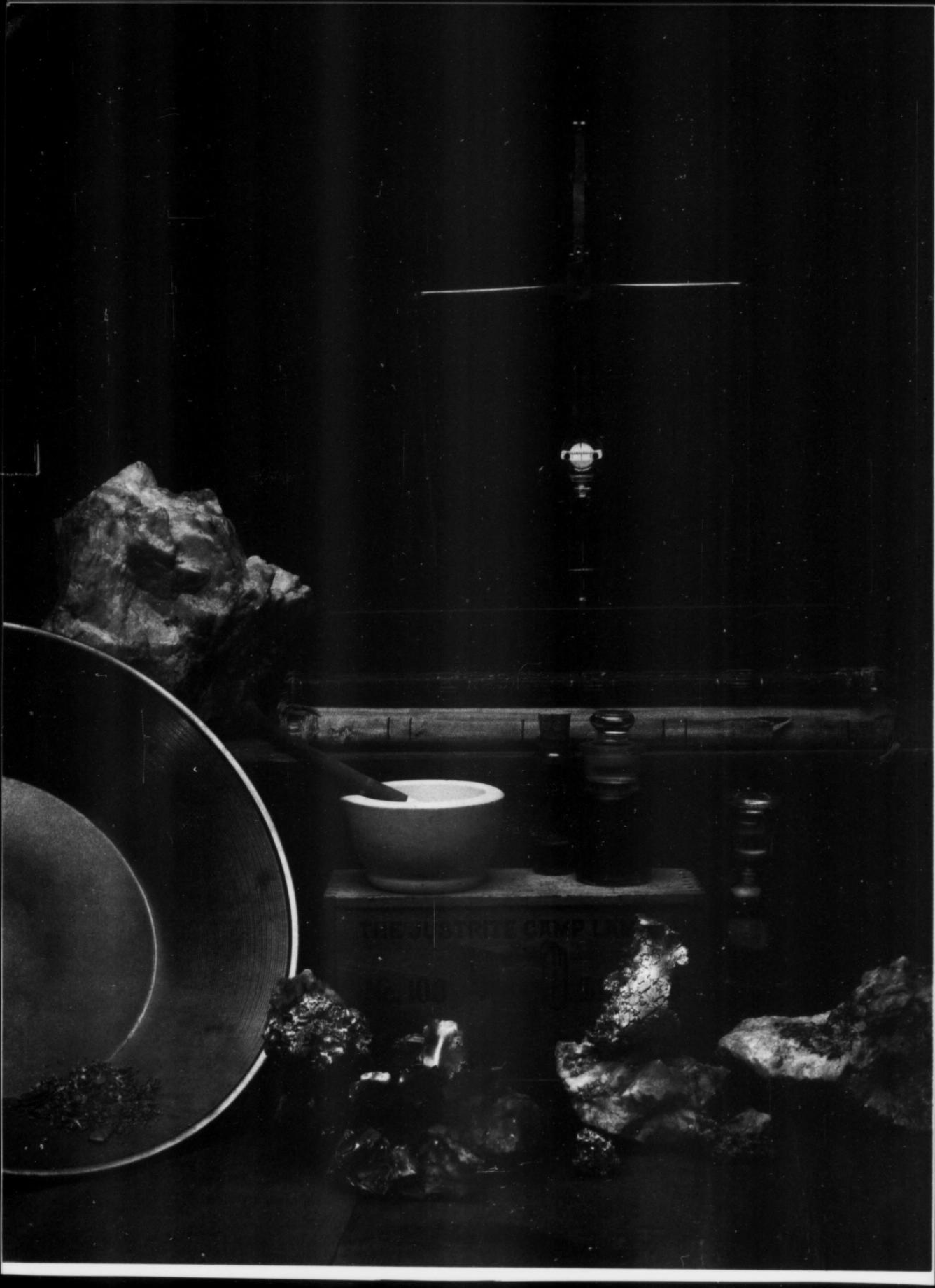

Figure 1. (facing page). Some California gold specimens from the California State mineral collection. From left to right: small nuggets from the Center mine and the Smith & Waltrous mine, Trinity County (in pan); gold ore sample from Nevada County (behind pan); crumpled mass of leaf gold on matrix from the Homestake mine, Siskiyou County; two specimens of leaf gold on quartz from the Nigger Hill mine, Tuolumne County; small, bright mass of crystals with quartz from the 16 to 1 mine, Sierra County; large gold leaf with triangular surface features from the Nigger Hill mine, Tuolumne County; sponge gold with quartz from the Fair Hills mine, Sierra County; and a lump of gold ore from John Neale's mine, Tuolumne County. Photo by James Patton. The specimen on the cover of this issue is also from the California State mineral collection.

Figure 2. The museum at the Ferry Building was popular with the public and with school children of all ages. The floor cases held locality collections and the tall cases held the systematic collection. Photo courtesy of the California Division of Mines and Geology.

collection was thoroughly documented, relabeled and evaluated by a private appraiser. Detailed descriptions and measurements were made of all specimens and copies of a comprehensive inventory were provided to the State and the C.M.E.A.

Although the collection includes several outstanding gold specimens, most lots consist of small nuggets, particles or dust. This material is generally unsuitable for exhibit, but has scientific and historic value because of the localities represented. The following is a list of gold specimens in the California State Mineral Collection, arranged according to locality. Each entry includes the Division of Mines catalog number and a brief description of the specimen(s).

The State collection includes several small specimens of unknown locality, 3 gold coins and several assay buttons that have not been listed here.

The precious metals portion of the State Collection totals 179 lots, 143 of which are gold. The collection also contains specimens of silver, platinum, iridium, diamonds and silver- and gold-bearing sulfides and tellurides. The collection was returned to Mariposa County when the Academy's loan expired in the spring of 1986. The C.M.E.A. plans to mount a temporary exhibit of specimens from the State collection. This interim display will allow the public to enjoy part of the collection while a new museum is being planned and constructed in Mariposa.

Table 1. **Catalog of gold specimens in the California State Mineral Collection.**

Locality Details	*CDMG#*	*Description*
UNITED STATES		
Alaska		
Discovery Claim, Anvil Creek, Cape Nome	15431	small nuggets
Claim #1, near Discovery Claim	15449	small nuggets
(no details)	21212	single crystals in quartz
Arizona		
Maricopa County		
Vulture Mine	20396	veins in quartz
California		
Amador County		
Central Eureka mine	no #	veins in schist
Elephant mine, Volcano	19679	nuggets in sediment
Fremont mine, Drytown	18547	veins in quartz
Keystone mine	18348	crystal on matrix
(no details)	390Z	leaves on quartz
Butte County		
Amo mine, near Oroville	10970	dust
Feather River	29288	nugget
Flowery North mine	11376	crystals on quartz
Spring Valley mine, Cherokee	7497	nugget
Calaveras County		
Altaville Mine Company ledge	8667	crystal mass on quartz
Bonanza Drift mine	9477	small nuggets
Bonanza Drift mine		
Carson Hill mine	18193	veins in quartz with talc & sulfides
Carson Hill mine	20440	veins in quartz with talc & sulfides
Hoosier mine	20397	veins in quartz & crystal clusters
Hoosier mine	20403	veins in quartz & crystal clusters
Melones mine	22223	crystals in quartz
Rio Vista mine	22251	crystals on quartz
(no details)	19008	leaves on quartz
Colusa County		
claim near Clyde mine, Sulphur Creek	9466	rosettes on quartz (may be electrum)
El Dorado County		
Black Oak mine, Garden Valley	22551	vein in quartz
Brust mine	no #	particles in talc
Davis mine, near Placerville	22400	thick wire on quartz
Dry Gulch mine	13479	single crystal
Garden Valley	299Z	veins in schist
Grit mine, Spanish Dry Diggings	19713	crystal masses in calcite &
Grit mine, Spanish Dry Diggings	21142	6 kg crystal mass (cover photo)
Lukens mine	18313	leaves in quartz
Mayflower mine	21404	leaves on quartz
Stuckslager mine, Coloma	14075	veins in schist
Humboldt County		
Orleans	20473	small flakes
Upper Gold Bluff	4198	dust
Kern County		
Exposed Treasure mine, Mojave	20761	vein in quartz
Mariposa County		
Bull Creek	14907	single crystal on quartz
Martin & Walling mine	11611	leaves on quartz
Schroeder mine, Saxon Creek	no #	leaves on quartz

Locality Details	CDMG#	Description
Nevada County		
Alcalde mine, Grass Valley	20419	leaves in calcite
Brunswick Shaft, Idaho-Maryland mine	21438	particles in sulfide
Christmas Hill	20262	vein in worn quartz mass
Gold Quartz mine, Nevada City	4853	leaves in quartz with sulfides
Idaho mine, Grass Valley	20390	single leaf
Mokelumne Placer mine	21828	nugget in sediment
Nevada Hydraulic mine, Chalk Bluff	4043	worn leaf
North Star mine, Grass Valley	no #	particles & veins in sulfides &
North Star mine, Grass Valley	19667	quartz
Peabody mine, Grass Valley	12102	leaf on quartz
Orange County		
Juan Canyon	15524	small nuggets
Plumas County		
Diadem Quartz mine	4491	veins in schist
Independence mine, Winters Creek	19006	cyrstals on sulfide matrix
Shasta County		
Yanley John mine, nr. Redding	21358	veins in quartz
Sierra County		
Fair Hills mine	19183	crystalline masses
Gold Crown mine, Alleghany	21525	particles in schist
Ironside mine, Alleghany	no #	crystal cluster on quartz
Plumbago mine, Alleghany	20420	crystal cluster on quartz
Rainbow mine, Alleghany	no #	leaves on quartz
16-to-1 mine, Alleghany	21397	crystal cluster on quartz
Siskiyou County		
Burton mine, Quartz Valley	19308	single leaf
Campbell mine, Quartz Valley	13193	small nuggets
E.D.M. Quartz mine	12506	leaves in calcite
Homestake mine, Salmon River	19307	dense leaves on quartz
Little Nugget mine, Horse Creek	20379	vein in worn quartz mass
Milne mine, Scotts Bar	19309 & 19310	small nuggets
Rancheria Gulch	10265	small nuggets
(no details)	142Z	nuggets in sediment
Trinity County		
Center mine	11962	small nuggets
Chapman & Fisher mine	12023	small nuggets
Corona de Ore mine	19010	small flakes
Dedrick	no #	single nugget
Evans mine	11966	small flakes
Goyle mine	11961	small flakes
Haas mine	11965	small flakes
Hatchet Creek mine	11960	small flakes
Hayes mine	11967	dust
Hunt & Ellison mine	11964	small flakes
Last Chance mine, near Louden	15466	small flakes
Mammoth mine	12080	worn leaf mass
McMurry & Hupp mine	11963	small nuggets
Red Flat mine	13224	small flakes
Smith & Watrous mine	11968	small nuggets
Ward mine	12024	small flakes
Tulare County		
White River	13959	wire on matrix
Tuolumne County		
Bald Mountain	21398	crystals with pyrite
Bonanza mine, Sonora	10019	veins & crystal clusters on matrix
Bonanza mine, Sonora	13616	veins & crystal clusters on matrix
Golden Rule mine	15176	wire on quartz
Lazaro mine, Bald Mountain	21402	single leaf
John Neale's mine, Sonora	8276	veins in quartz &
John Neale's mine, Sonora	15494	inclusions in crystal
Nigger Hill mine, Jamestown	14344	thick leaves on quartz
Nigger Hill mine, Jamestown	21399	large leaf on quartz
Colorado		
Boulder County		
Golden Age mine	20409	veins in quartz
Golden Gate mine	20345	leaves in quartz
Ouray County		
Atlas mine	20342	leaves in quartz
Ouray	20343	wire & leaves in quartz
San Miguel County		
Butterfly-Terrible mine, Ophir	20400	particles in quartz
Gold King mine, Ophir	20401	wire in quartz

Locality Details	CDMG#	Description
Mayflower mine, Telluride	20391	leaves in quartz
Tom Boy mine, Telluride	20418	particles in quartz
Summit County		
Breckenridge	20394	wire
Little Anne mine	20341	veins in quartz
Ware & Carpenter mine, Breckenridge	20404	wire
Teller County		
Cripple Creek	20288	veins in quartz
Cripple Creek	20370	from roasted Au-Te
Idaho		
Elmore County		
Last Chance mine, Atlanta District	20367	particles in quartz
Nevada		
Humboldt County		
Ten Mile District (Winnemucca)	20421	single leaf
Lander County		
Battle Mountain District	20737	sponge
Storey County		
Comstock Lode, Virginia City	20368	particles in quartz
New Mexico		
Colfax County		
Aztec mine, Ute Creek	20405	wire & crystals on quartz
Nogal mine, White Oaks	20365	sponge & wire
Nannie Beard mine, Jarillas	20366	leaf on quartz
South Homestake mine, White Oaks	20398	wire on matrix
Socorro County		
Black Range	4012	leaves in quartz with malachite
North Carolina		
Franklin County		
Partis mine	20408	particles in quartz
Nash County		
Mann & Arlington mine	20407	vein in quartzite
Oregon		
Baker County		
near Baker City	20319	wire in matrix
Connor Creek mine	20392	veins in quartz
Crocker Creek	20406	small nuggets
Linn County		
Bonanza mine	12656	wire on quartz
Santiam mine, nr. Albany	20293	wire mass on quartz

EXOTIC

Locality Details	CDMG#	Description
Australia		
(no details)	4194	particles in matrix
Wandi Diggings, N.T.	15521	cubic crystals
Beyers & Holterman claim, Hawkins Hill, N.S.W.	21561	crystaline mass on quartz
Brazil		
(no details)	13154	worn crystalline mass
Canada		
Dufferin mine, Salmon River, Nova Scotia	20364	crystals in quartz with arsenopyrite
Nova Scotia	20402	leaves in serpentine
Nova Scotia	20410	crystals in quartz
Withrow mine, Hants County, Nova Scotia	20393	particles in schist
Last Chance Creek, Yukon Territory	no #	single crystals
Hungary		
Verespatek	20495	leaves
Mexico		
Grand Central Mine, Sonora	20412	particles in layered sulfide matrix
Peru		
Eastern slope of Andes	20143	small flakes

Gold from HOPE'S NOSE

Torquay, Devon, England

England is not normally thought of as a source for fine crystalline gold, but an unusual outcrop on the southern coast has yielded many beautiful specimens, some of them palladium-rich.

INTRODUCTION

Though native gold has been reported from numerous localities in the United Kingdom, it has rarely been found in deposits rich enough to furnish good specimen material and none of the deposits worked commercially has produced well-crystallized gold. However a small surface locality discovered earlier this century, very much a mineralogical oddity, has produced some fine gold specimens. The gold is unusual in occurring in calcite veins cutting Devonian limestone, and though not present in economically recoverable amounts the gold is crystallized, usually in arborescent form, in association with some rare palladium minerals. Collecting at this site is difficult and now illegal.

LOCATION

Hope's Nose is a small headland 3 km east of Torquay, a coastal resort on the south coast of Devon, England. The locality is reached by means of a rough footpath down steep slopes and is only some 500 meters from a residential district. The headland is a popular site for geological field trips due to a pronounced raised beach. The locality itself is bisected by the main sewage outfall for the town of Torquay. The veins are exposed on a sea-swept rock platform of 2 to 25 meters width between cliffs and sea, and are eroded by wave action to a depth of 4 meters in places. Parts of the locality are accessible only at low tide and can be dangerous unless the seas are calm.

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HISTORY

In the late 19th century it was reported that a small amount of gold occurred in a quarry at Daddy Hole Plain, southeast of Torquay (Gordon, 1922), and local businessmen put up money to develop the site commercially but no further gold was found (Russell, 1929).

The Hope's Nose occurrence was discovered during a student field excursion in April of 1922, led by Professor W. T. Gordon who observed that some calcite did not cleave as expected because sprigs of gold were holding it together. Gordon recorded this find in 1922 in a brief note in Nature:

> I had occasion recently to conduct a party of my students from King's College, London, over the Devonian rocks in the neighborhood of Torquay, Devon, and had the good fortune to discover an interesting occurrence of gold in the fault-rock of a small fault cutting the limestone near Hope's Nose.
>
> It is premature to dogmatize on the possible commercial value of gold, since time did not permit of a thorough examination of the locality . . . it is intended to proceed further with the matter in case it may prove worth exploitation.

Stress of other work prevented Gordon from further examining the locality (Russell 1929).

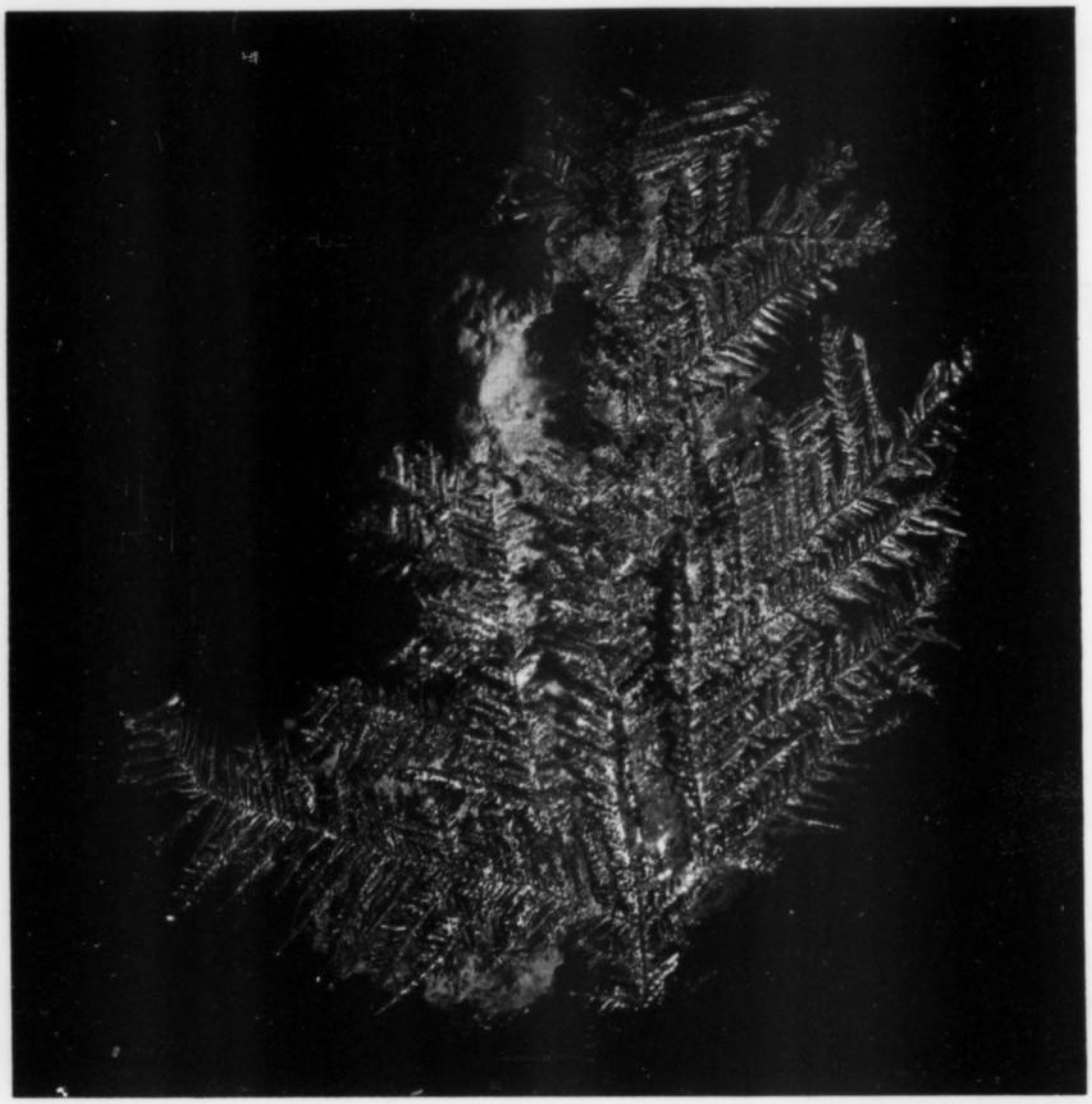
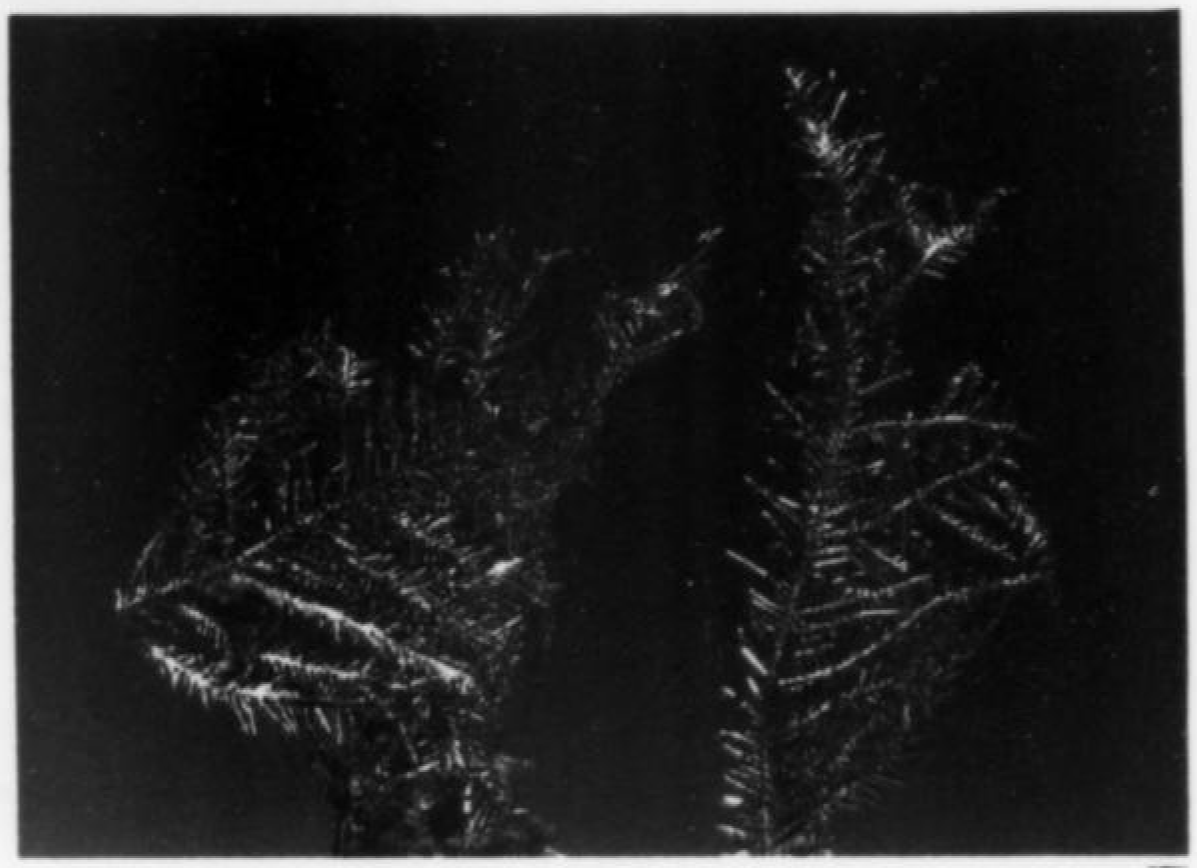


Figure 1. **A very fine fern-like growth of gold crystals, 3 cm tall, showing rich color indicative of relatively high purity. Simon Harrison specimen, now in the S. Adrian collection. Photo by H. Taylor, British Museum (Natural History).**

Figure 2. **Two fern-like crystal groups of gold, the right one measuring 2 cm. Pale color indicates high palladium content. Simon Harrison specimens.**



Sir Arthur Russell, one of the most accomplished and dedicated of British collectors, hearing of the find, visited the locality in 1927 and collected crystallized gold from five calcite veins. He returned in 1928 and put shot holes in the most promising looking vein; he records that "a number of very remarkable specimens of arborescent gold were obtained." The finest of these are now in the British Museum (Natural History).

The locality then appears to have been largely forgotten for some 50 years. Local collectors, finding reference to the locality in Russell's manuscript notes on British gold, held in the British Museum (Natural History), visited the locality in the late 1970s and over a period of three to four years removed most of the readily accessible material. As a result the locality became, in effect, worked out because the veins are now extremely difficult to reach with hand tools and a license is needed to use explosives.

GEOLOGY

The local rocks (Lloyd, 1933) are predominantly Devonian in age, composed of shales, limestones and grits together with some Triassic or Permian sandstone (Dewey, 1948). To the west there is an outcrop of spilitic Middle Devonian basalt flows.

The Hope's Nose headland itself consists of Lower Devonian grits, shales and slates and Middle Devonian calcareous shales and limestones. All these strata have been extensively folded, thrusted and faulted.

The exposures of gold-bearing calcite are confined to a limestone platform roughly 100 meters long and a maximum of 25 meters in width, bounded to the north by some low cliffs and to the south by the sea. The thick-bedded, fossiliferous limestone is cut by numerous thin calcite veins which occupy minor faults and fractures in the limestone. They are steeply dipping, generally near-vertical, and trend about N20°W. They pinch and swell, without any apparent structural control, from 2 to 30 cm in thickness.

There have been fourteen reported gold-bearing pods; though some are closely related, others are separated by up to 20 meters of barren limestone. Many of the veins do not appear to be gold-bearing but, because of the nature of the collecting at the locality, only those parts of veins exposed at the surface have been studied. Whether all or many veins carry gold at some point in their vertical range is a matter for conjecture.

There is an old quarry some 75 meters northeast of this platform and, although extensive searches have been made on many similar calcite veins occurring there, no gold has yet been discovered.

According to Scrivener *et al.* (1982), there are three stages of deposition in the veins:

1. Coarse, euhedral, purple and yellowish cream ferroan calcite which commonly includes angular breccia clasts of the host limestone. Much of the coloration is due to interstitial hematite.

2. Biscuit-colored, fine-grained, anhedral calcite and dolomite of saccharoidal texture and, less commonly, coarser, cream-colored anhedral calcite. Cavities of iron hydroxides are sometimes present. The gold, when it occurs, is in this portion of the vein.

Figure 3. **Hope's Nose gold specimen collected by Sir Arthur Russell in August of 1928, now in the mineral collection of the British Museum (Natural History). The largest fern measures 2 cm. Photo by H. Taylor.**

Figure 4. **Dense growth of fine gold crystals on calcite matrix, 4.3 cm tall. Moderately intense color suggests moderate palladium content. Simon Harrison specimen.**

3. Buff-colored calcite or white aragonite, sometimes with chalcedonic quartz.

Some fluid inclusions in the calcite gangue are monophase at room temperature; others are biphase and homogenize at 65°-120°C. No one has provided an explanation for the presence of well crystallized gold in these apparently low-temperature calcite veins. It may have migrated from local shales and its emplacement may have been caused by purely tectonic mobilization. Russell's (1929) comments are perhaps most apt:

> Altogether the occurrence is an interesting one, as, apart from the exceptional beauty of the arborescent forms in which the gold occurs, the fact of it being present in calcite veins in Middle Devonian limestone is I believe unique. Conjectures as to the origin of the gold would be futile. The finding of a mineral such as gold in so unexpected a quarter is moreover an object-lesson to the mineralogist in the field.

MINERALOGY

Aragonite $CaCO_3$

Aragonite is found as vein fill in either massive white or "flos-ferri" form.

Calcite $CaCO_3$

The main vein constituent, calcite is generally massive but occasionally forms rough scalenohedral crystals, often heavily iron-stained.

Dolomite $CaMg(CO_3)_2$

Found as etched boxworks in prepared specimens and also as very iron-rich varieties, dolomite is sometimes initimately associated with gold.

Gold Au

All the visible gold found at this locality is crystallized, most of it forming fern-like arborescent dendrites. Repeated twinning on the octahedron {111} is responsible, giving rise to a central rod with graduated branches and sub-branches all at 60°. Measurements by

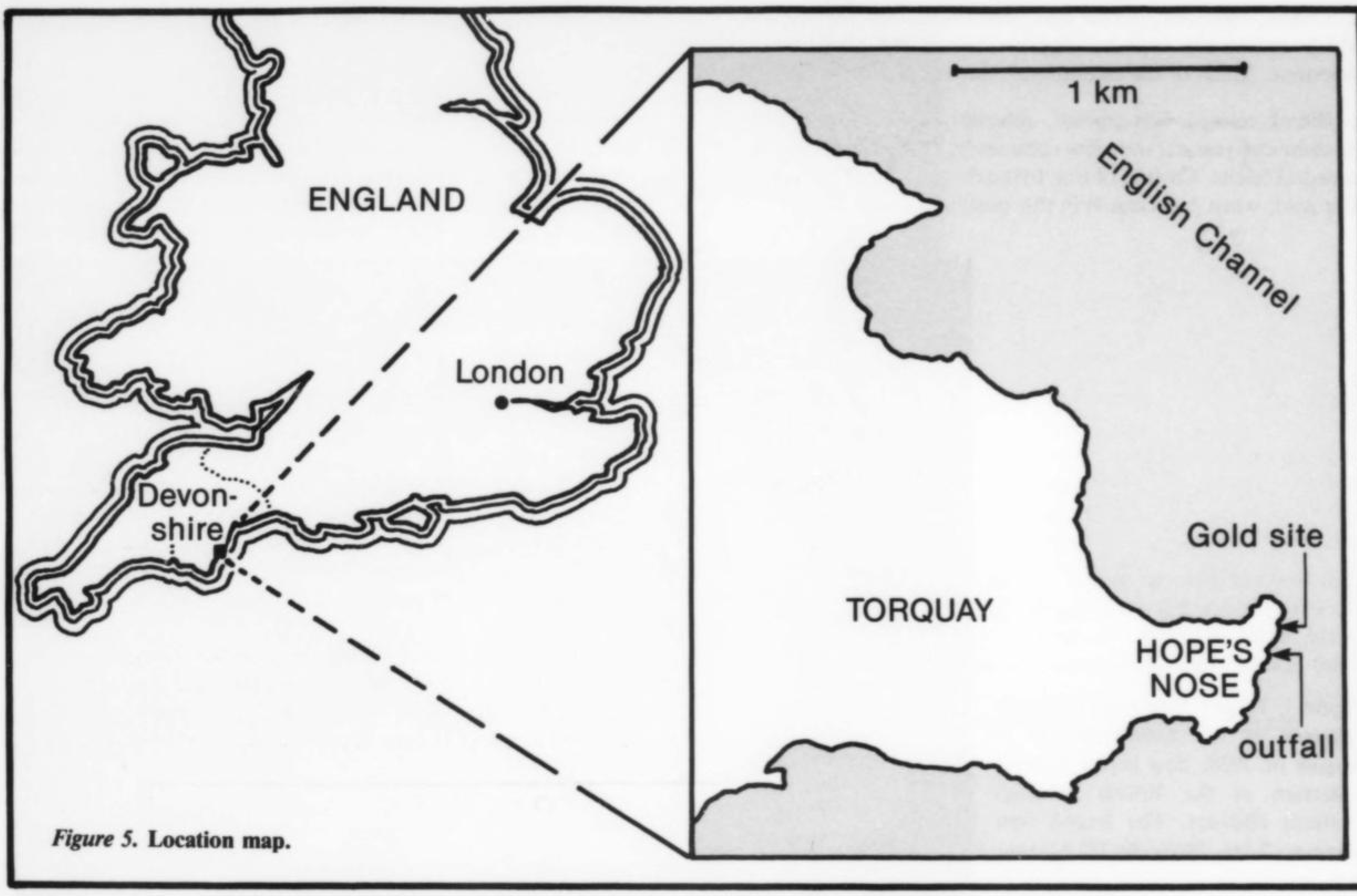


Figure 5. **Location map.**

Russell with the optical goniometer (noted in his 1929 paper) identified the following forms: {100}, {111}, {110}, {210} and {311}. Growth directions of these fern-like crystals are thought to be controlled by micro-fractures in the host calcite. Some recently collected specimens have shown well-formed but small (up to 2 mm) cubic and tapered octahedral crystals grouped together to give dense masses of gold.

A few specimens have been found with the gold visible on a calcite matrix, but most have been exposed by treatment with acetic or dilute hydrochloric acid. Some examples of the very delicate, fern-like aggregates thus revealed reach 5 cm in length (Russell, 1929) but most do not exceed 5 to 10 mm. In color the gold varies from a rich yellow to a bright silver-white. Some of this color range can be seen in the accompanying specimen photos. The explanation for this variation is found not in the silver content (the maximum recorded is 0.9 weight %) but in the quite high, if variable, palladium content. Indeed, the gold at Hope's Nose is unusual in containing up to 16 weight % Pd in solid solution in, or alloyed with, the gold; the higher the Pd content, the whiter the gold.

In addition to palladium-gold alloys, two rare palladium minerals have been reported as overgrowths on, and inclusions in, the dendritic gold (Clark and Criddle, 1982). These minerals, **isomertieite**, $Pd_{11}Sb_2As_2$, and **mertieite-II**, $Pd_8(Sb,As)_3$, occur as minute, euhedral crystals which are normally apparent only in polished section.

CURRENT STATUS

Very little if any surface gold is left at the site: it has been heavily collected! Due to the sewage outfall, the locality can be unpleasant to collect at and any collecting that might be done would require the use of more than handtools. However, the whole of the site is now designated a Site of Special Scientific Interest so that unauthorized collecting at and development of the locality are now illegal.

ACKNOWLEDGMENTS

The authors are indebted to Alan Criddle, Peter Embrey, Paul Hicks and Chris Stanley all of the British Museum (Natural History) for many useful additions and suggestions.

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What's New in GOLD?

VENEZUELAN GOLD

A few years ago some very fine single crystals and small groups of gold from Venezuela began appearing on the mineral market. These were reportedly recovered from a placer deposit located about 40 km west of Santa Elena in extreme southeastern Bolivar state. Operators of the claim, Roger La Rochelle and Jack Carlson, were at first unaware that the beautifully formed crystals had specimen value. The first crystals found were mated with jewelry fittings and sold as pendants. Mineral dealers Lawrence Conklin and Hugh Kennedy recognized the specimen potential, however, and arranged to market the pieces to collectors.

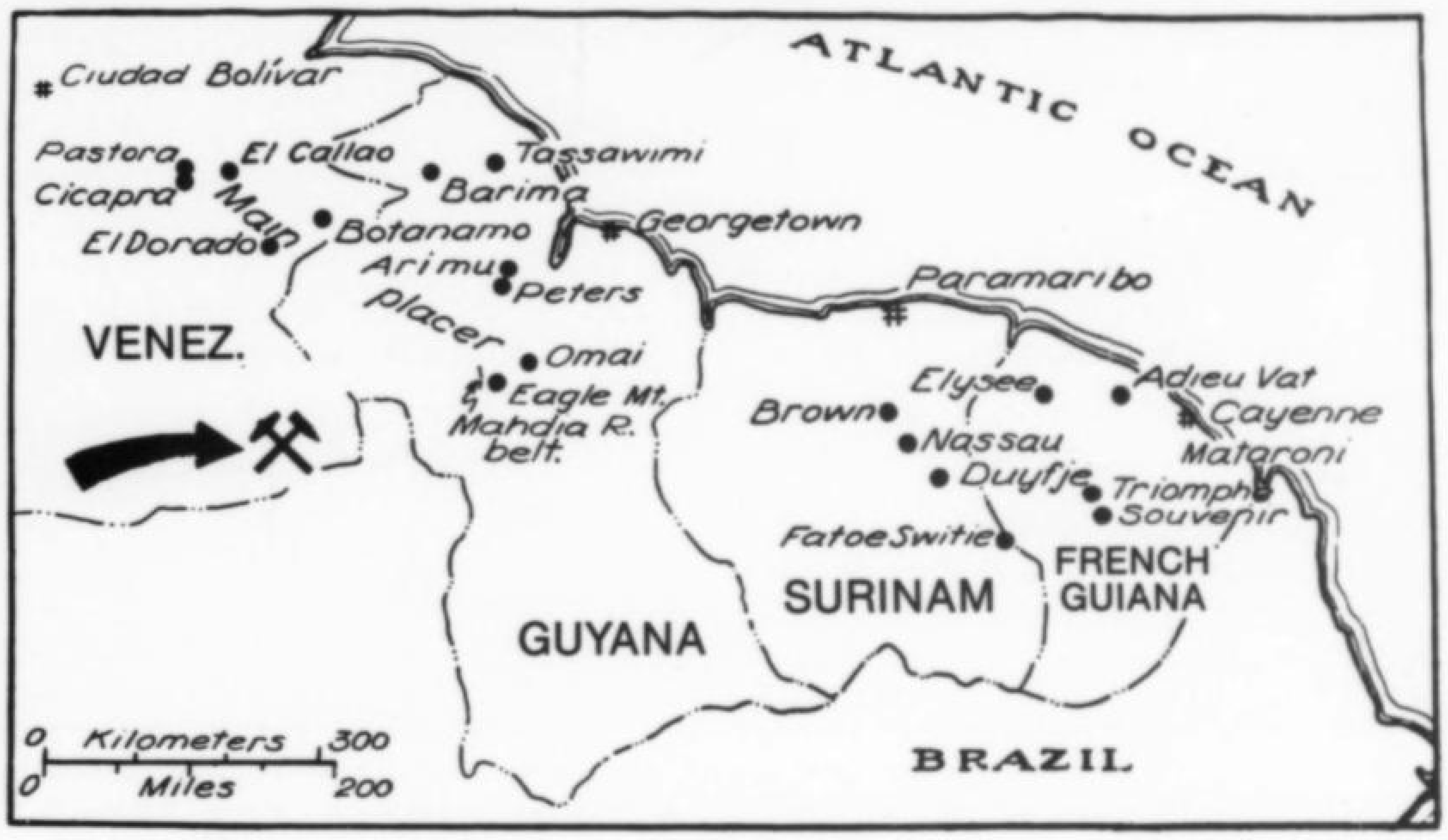

***Figure 1.* Approximate location of the Santa Elena area placer in southeastern Venezuela (arrow). Other important gold occurrences in the Guyana Highlands gold field are also indicated (from *Gold Deposits of the World* (1937) by W. H. Emmons).**

The location appears to be on the southwestern fringe of the Guyana Highlands gold field where most of Venezuela's gold production has historically taken place. Production from the Venezuelan portion of the highlands (1493–1934) has been estimated at 3.7 million ounces. Much of this came from the famous El Callao mine, which was at one time the richest gold mine in the world.

The Santa Elena specimens (if we may call them that, since the operators have refused to divulge the name of the actual claim) are slightly to moderately waterworn and most commonly show only the tetrahexahedron form; these are sometimes twinned on (111). A few crystals show a deeply hoppered octahedral habit. Most crystals are in the 5-10 mm range, although a very few spectacular examples exceed 3 cm in size and reach nearly 3 ounces (89 grams) in weight. These large crystals are very rare, however, and command hefty prices. In fact, the largest and finest group is in a bank vault in New York and is still available for purchase . . . priced at a quarter of a million dollars.

ARIZONA GOLD

Last year a fine batch of gold came on the Arizona market. The material was originally collected in 1955 by Dewey Keith and remained hidden away in a box for 30 years until his recent death. The locality is the Yuba mine (currently registered as the Gold Ledge claim), Santa Rita Mountains, Greaterville district, Pima County, Arizona.

The habit is fine, crystalline wire intermeshed in loose to tight felted masses. The best pieces in the lot measure 2.5 x 3 cm or so and resemble Breckenridge, Colorado, "bird's nest" gold. One specimen (now in the University of Arizona collection) is on a matrix of brownish drusy quartz; the rest are without matrix. At least a dozen very fine specimens and many smaller ones comprised the lot, and these have all found their way into the major Arizona collections, particularly those of Harold Michel, Bob Johnson and Ray Grant.

SIBERIAN GOLD

What could be more surprising than to learn that it is relatively easy to obtain recently mined Siberian gold specimens? The Soviet Union is not generally thought of as a convenient source for fine mineral specimens (although several dealers have been regularly importing modest lots of rare species and study-grade material). It turns out, however, that raw, unprocessed placer gold can be purchased directly from a bank in Moscow in $10,000 lots. The catch is that you are not allowed to highgrade the bags searching for nice crystal specimens among the nuggets; but crystallized pieces are said to be not particularly uncommon so your chances of finding something interesting in each $10,000 grab-bag are reasonably good.

Figure 2. **Venezuelan gold specimens from the collection of F. John Barlow. Sizes: (*top row, left to right*) 1.9 cm, 1 cm, 2.3 cm; (*middle row*) 9 mm, 3.8 cm, 1.2 cm; (*bottom row*) 2.2 cm, 1.3 cm, 1.3 cm. The crystals at left-center and bottom-right are twinned tetrahexahedrons. The crystals at top-center and bottom-center are untwinned tetrahexahedrons. The intergrown group at top-right is composed entirely of tetrahexahedron faces.**

The crystals are generally of cubic habit and slightly to severely waterworn. The mining district is usually given for each bag, but the variability in color (i.e. fineness) suggests that the output of several deposits might be combined in a given lot. The bags are priced somewhat above bullion value but not radically so.

W.E.W.

CALIFORNIA GOLD

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What's new in gold is usually old. To my knowledge, there has not been a single "brand new" specimen gold occurrence located in California in modern times. Specimens periodically come to light, but always from mines whose origins date back many years, in some cases as far back as the great gold rush of 1849. Modern-day prospectors still keep returning to the old deposits, and in fact there is quite a bit of activity currently going on right now in California's Mother Lode country.

During the past year a number of specimens have reached the collector market from the Diltz mine, about 10 km northwest of Mariposa in the Whitlock mining district. The Diltz mine dates back to 1860, when it was discovered by Tom Early (or, some say, by Captain John Diltz). The *Mariposa Gazette* reported in 1886 that Early worked the mine before Diltz acquired it. A landslide in 1884 buried the Rickard shaft, and subsequent landslides continued to hamper operations through 1886. In that year Captain Diltz re-

Figure 3. **Crystalline wire gold on quartz, 4 cm across, from the Yuba mine, Pima County, Arizona. University of Arizona collection.**

Figure 4. **Slightly rounded group of cubic gold crystals, 3.8 cm across, from the Lena River district, Yakutsk, Siberia. John Barlow collection.**

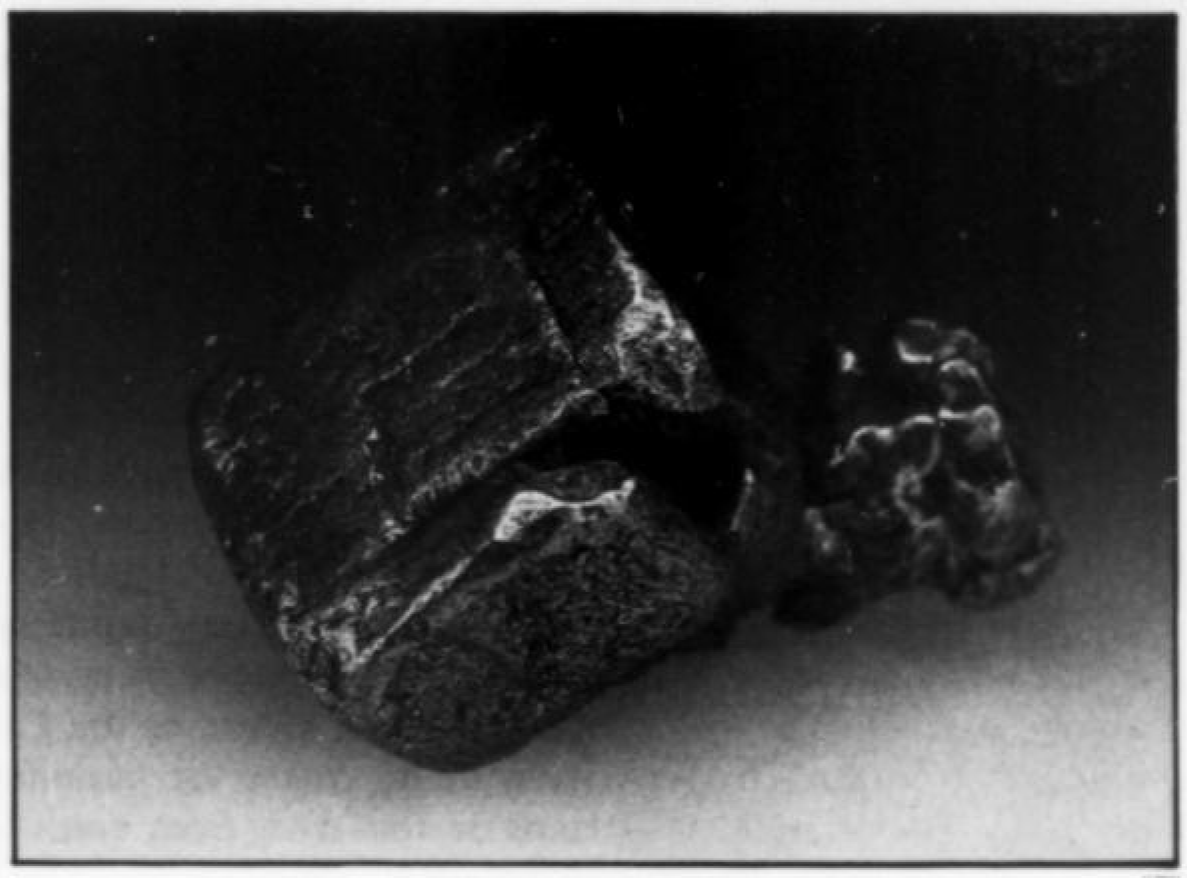

Figure 5. **Slightly rounded cubic crystal of gold, 1.2 cm on an edge, from the Lena River district, Yakutsk, Siberia. John Barlow collection.**

portedly recovered a 151-ounce mass of gold which he sold for $2,000. The mine was not equipped with a mill, and very little ore was custom-milled during Diltz's ownership. A ten-stamp mill was erected there in 1927 but has been more or less idle for the last 35 years. Since Diltz's death in 1895 the mine has had many owners, but has been active only intermittently since World War II.

The gold-quartz veins at the Diltz mine cut a Paleozoic series of pyroxene andesites and greenstones. Intrusive, extrusive and pyroclastic rocks are all present in the series.

Mine workings at the Diltz consist of several shafts and drifts. Ore minerals found include gold, pyrite, arsenopyrite, chalcopyrite, tetrahedrite and galena. Arsenopyrite is the most abundant sulfide.

Diltz mine gold crystals are roughly cubic in habit (somewhat unusual for California), commonly with rounded corners, but most often the crystals are heavily intergrown and distorted into jagged masses which are difficult to characterize crystallographically. Luster ranges from dull to frosty and fairly bright. Very few specimens come with any matrix but, where present, it tends to be white quartz. Good specimens have been found in all sizes, from fine and reasonably priced thumbnails to miniatures and cabinet pieces weighing several kilograms. Pala International has been marketing the most recent lot; see the photo in their advertisement in the last couple of issues.

The Colorado Quartz mine, located about 18 km north of Mariposa, has in recent years yielded many fine specimens of octahedral gold (see vol. 13, no. 6, p. 347). The property is currently shut down and is available for purchase. Adjacent properties including the Artru and Mockingbird claims have recently been purchased by a mining company which intends to mine them for specimens (see following note).

A major revival has taken place at the old 16 to 1 mine near Alleghany in Sierra County. Kanaka Creek Joint Venture is currently carrying out extensive drifting and timbering. The present 16 to 1 mine incorporates a number of earlier claims including the Rainbow, Tightener, Osceola, Red Star and Twenty-One. Some gold has made its way to the specimen market (through us). Typical specimens are heavy, spongy, rather dull and poorly crystallized, but they nevertheless make very attractive display pieces (see the specimens pictured in vol. 12, p. 388). Some fine gold in quartz suitable for lapidary work has also been recovered.

Though not well known for beautifully crystallized gold, the 16 to 1 has on rare occasion produced some striking pieces. Back in the 1960s a pocket of exceptionally lustrous, sharply crystallized octahedral gold was found. The lot had been privately held until 1986, when we obtained it and offered it for sale at the Tucson Show. About 50 specimens comprised the lot, including one spectacular cabinet piece. The current mine owners are well aware of the historic and collector value of specimens, so perhaps more will be forthcoming.

The Carson Hill mine in Calaveras County is currently under intense development by the Carson Hill Gold Mining Corporation. Benching is underway, and a few nice quartz crystals have already turned up. Carson Hill is another old locality; the largest single mass of gold in California history was found there in 1854. It weighed in at a staggering 2,576 troy ounces. Crude gold crystals, some quite large, have been found at Carson Hill but nothing particularly sharp and brilliant. The Stanislaus mine at Carson Hill is the type locality for calaverite; the present property also encompasses the Melones mine, the type locality for melonite.

One area that continues to yield some of the finest, brightest, sharpest crystallized gold in the state is the Michigan Bluff district (see vol. 13, no. 6, p. 384–385). A small "pocket mine" there is being worked by third-generation owners and has produced excellent, mirror-bright, octahedral-dendritic groups as recently as July, 1986. With any luck, this is one more locality that will remain a productive source for crystalline gold in future years.

MOCKINGBIRD MINE TO REOPEN

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James Marshall is erroneously credited with the first discovery of gold in California, in 1848. Actually Sonoran Mexicans were busy working small gold mines in various parts of the state several years before Marshall's find (Bunje and Kean, 1983). As early as 1840, Mexicans were mining in California's Colorado township near the present-day town of Mariposa, and some of their rubble-filled workings can still be seen today.

In 1848 the Treaty of Guadalupe made the Mexican territory of California a part of the United States. American gold hunters arrived in the following year. Mariposa County soon became a beehive of mining activity as new claims were opened and abandoned Mexican workings reactivated. Many mining camps and claims were named for the home states and towns of the forty-niners; examples include Michigan, Plymouth, Nashville, Washington, Chicago Park and Colorado.

Figure 6. **George and William Weston, who in 1915 took out $3000 in crystallized pocket gold from the Mockingbird mine. At the going price of $20.67 an ounce this equalled 145 ounces. Photo courtesy of Charley Schroeder.**

About 19 km north of Mariposa the townsite of Colorado was established and soon boasted a population of 500 people. Saloons catered to thirsty miners, and hardware and mercantile stores did a brisk business. A one-teacher elementary school was established, but operated only during the summer; in the wintertime the roaring creeks made it impossible for children to get to school. Meanwhile Mariposa was booming and in 1854 built a beautiful New England-style courthouse which is California's only original courthouse still in use today.

Miners worked their way through the alluvial gold deposits and eventually tracked the gold back to the original vein sources. These quartz veins were then followed downward with mixed results . . . gold distribution within them proved erratic. Many promising ledges were found to be barren. However, one string of claims atop a long, narrow, northwest-trending structure known as the Colorado dike produced a succession of discoveries of beautiful, crystalline pocket gold. The claims on this dike, from north to

Figure 7. **Mexican mine workings near Mariposa, probably dating to the early 1840s and representing one of California's first lode gold mines. Photo (1981) by P. Bancroft.**

Figure 8. **George Lacy's cabin at the Mockingbird mine in 1927. Photo courtesy of Charley Schroeder.**

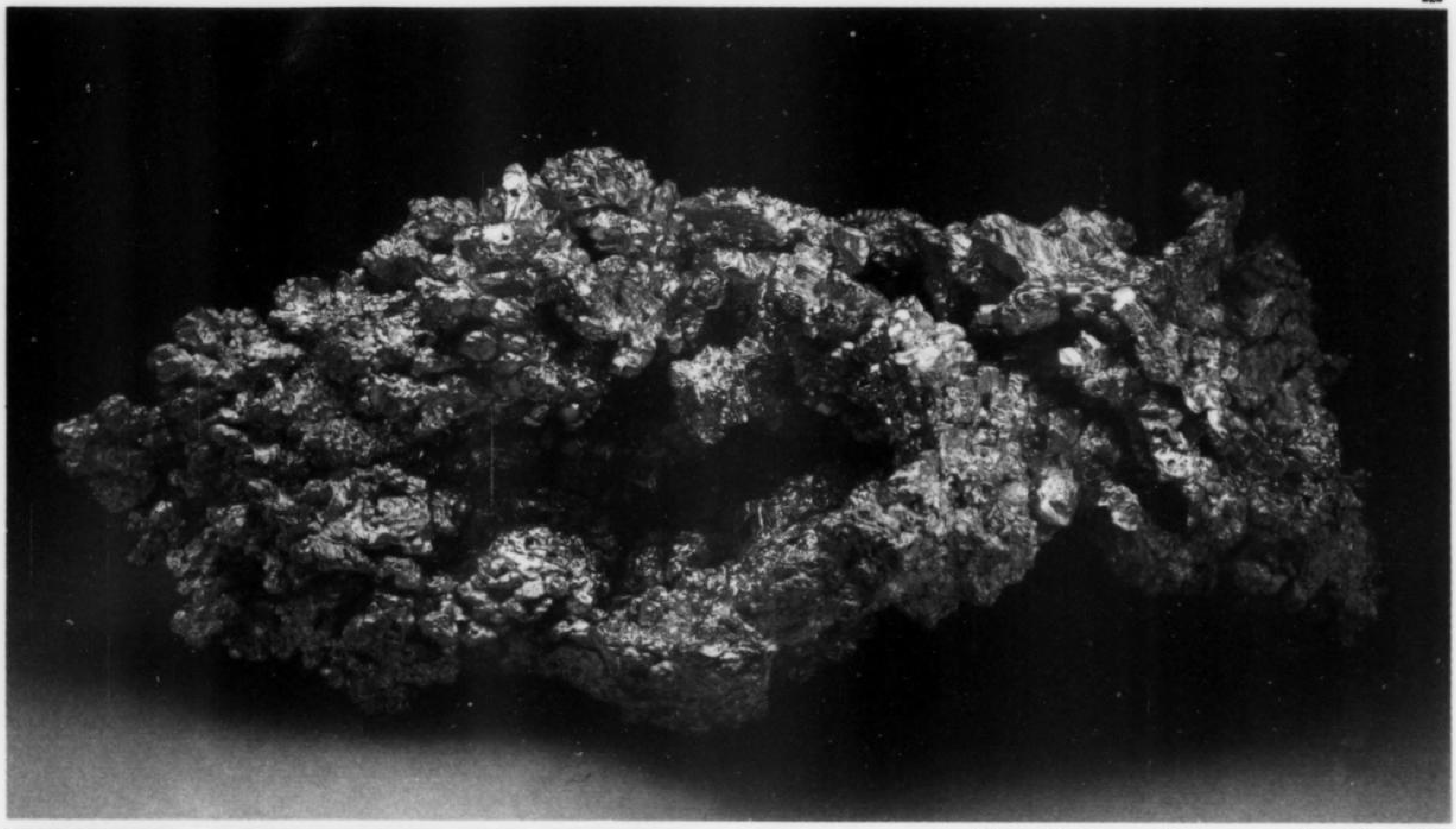

Figure 9. **Large, 11-cm mass of gold crystals weighing 26 troy ounces, from the Diltz mine. Pala International specimen.**

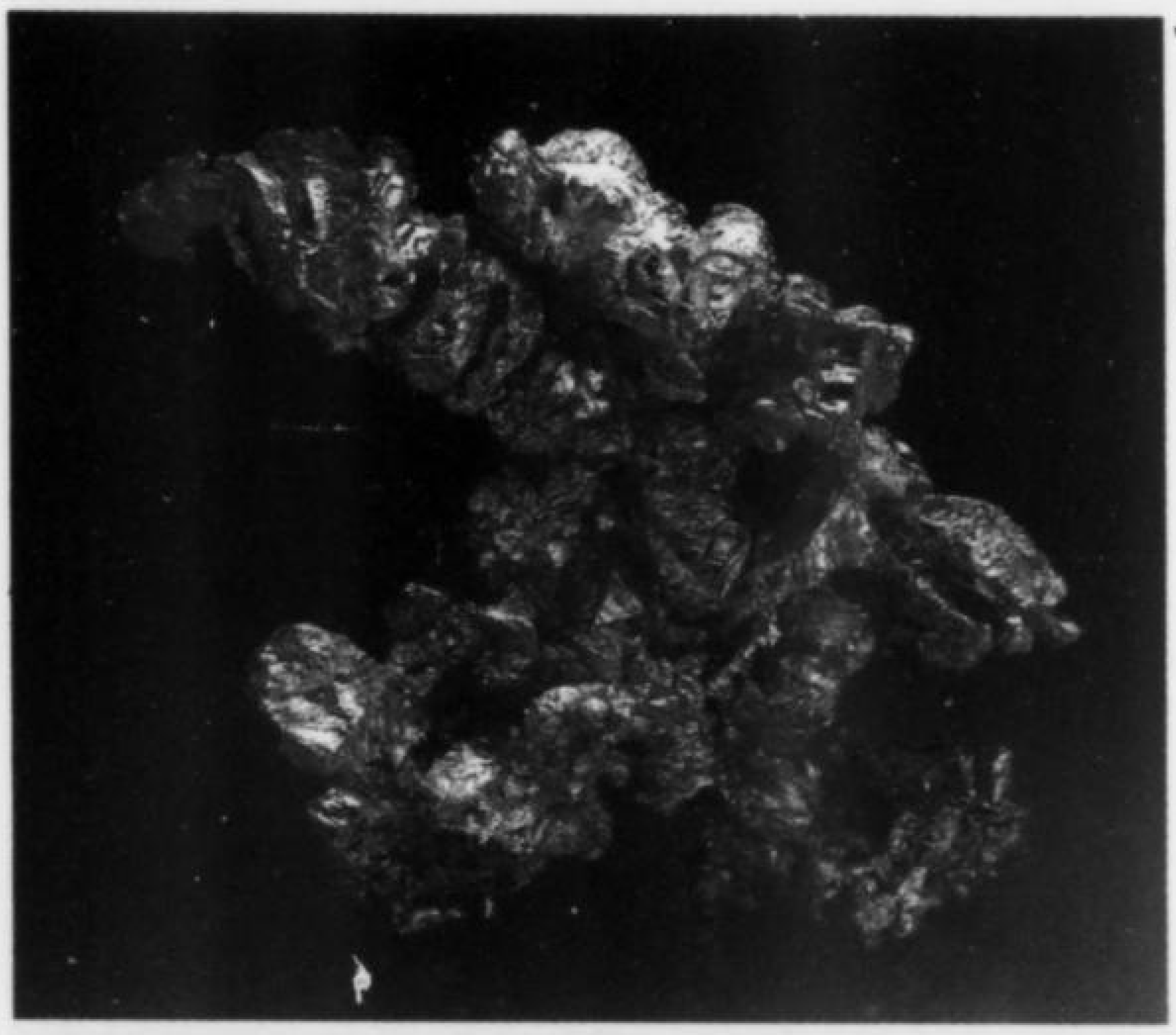

Figure 10. **Miniature-size (3.8 cm) group of sharp but distorted gold crystals from the Diltz mine. Pala International specimen.**

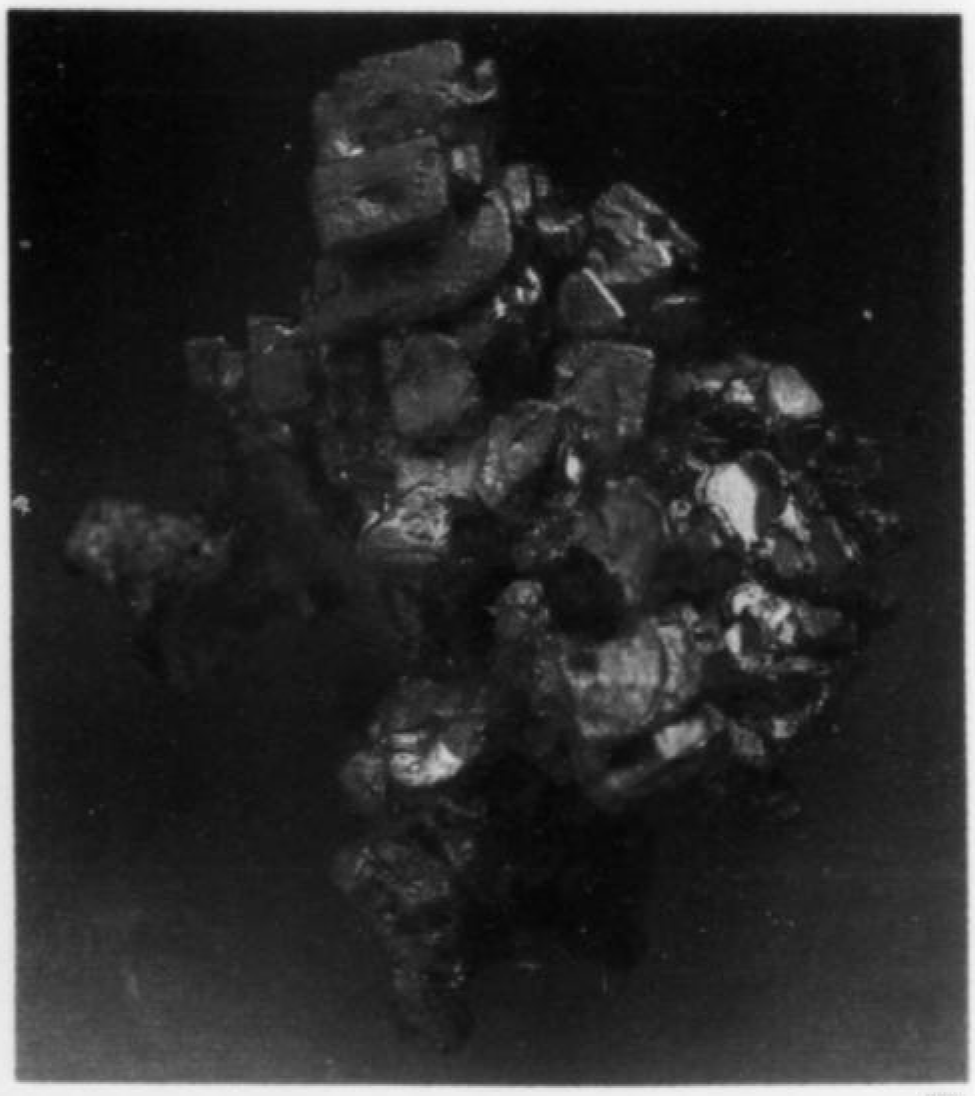

Figure 11. **Cubic gold crystal group, 2.5 cm, from the Diltz mine. Keith Proctor collection.**

Figure 12. **Thumbnail golds from the Diltz mine. The piece at left shows cubic crystals with naturally rounded (not stream tumbled) edges and corners. The specimen at right shows intergrown spear-like crystals on quartz and measures 1.3 cm. Pala International specimens.**

Figure 13. **Gold crystal group, 3.8 cm across, from the Michigan Bluff district. Kristalle specimen; photo by B. C. Space.**

Figure 14. **Gold crystal group, 3.8 cm wide, from the Michigan Bluff district. Kristalle specimen; photo by B. C. Space.**

south, were: the Evans I, Colorado Quartz, Artru (previously known as the Dorothy), Mockingbird (or Mocking Bird Quartz; known prior to 1900 as the Talc and the Lacy), White Oak, White Oak Extension, Landrum, Golden Key (formerly the Austin Group) and the Champion II.

Of these claims, the best gold crystal producers were the Colorado Quartz, Mockingbird and Artru. The Colorado Quartz mine in particular has yielded hundreds of pounds of fine gold crystals, especially in recent years (see Kampf and Keller, 1982). The Mockingbird and Artru also produced their share, but unfortunately most production in the early days was melted down into ingots and little public notice was given to the discoveries.

George Lacy carried out extensive underground mining at the Mockingbird in the early 1890s, beginning with a drift along the main vein. He built a comfortable log cabin with a stone fireplace near the mine entrance. Lacy reportedly took out a significant amount of gold, and was fond of hiding pots and kettles full of gold around his property. He filled an iron tea kettle with gold and buried it in an old campfire pit. Tom Burchard, an acquaintance of Lacy's, is said to have hidden himself in the forest near Lacy's cabin and spied on him as he came out each morning to relieve himself. It was known that miners with buried gold were prone to casting furtive glances at their hiding places to see that nothing had been disturbed. After sufficient surveillance, Burchard concluded that the cache was in the ash pit. Lacy, on his deathbed some time later, told a friend about the tea kettle but when it was dug up it was found to be empty.

Other bured treasures remained hidden longer. In 1934, Dave Dukes, then owner of the Mockingbird, found 60 twenty-dollar gold pieces buried under a log on the property. He later displayed some of these at the Mariposa County Fair.

The Mockingbird has been idle for many years. Charlie Schroeder, a former owner who is now a youngish 79 years old, still lives in Mariposa and recalls working in the Mockingbird as a young boy. He remembers seeing beautiful gold crystals removed and immediately melted down. Over the years he did manage to put aside four large, crystalline gold specimens which have remained to this day in a local bank vault. (These specimens have already been willed to family members.)

Currently the hundred-year-old workings are partially flooded and caved. Supporting timber is down in many of the drifts, and the sheet-iron facing of the old oaken mine rails is rusting away.

The Artru, on the other hand, remains something of a mystery. A 1903 plat map of the claims shows the name "H. Artru" adjacent to the Mockingbird claim, so apparently the claim is named for the early owner. Clarence Silva, the present Artru owner, has recently recovered a number of attractive but tiny gold specimens from the mine (see Fig. 15).

The Colorado dike runs through the Briceburg formation of silty black slates; this unit was called the Mariposa formation by Ransome (1900). The black slates are intercalated with lesser amounts of sandstone and conglomerate, probably of late Jurassic age. The Colorado dike itself is a gray to black altered greenstone which

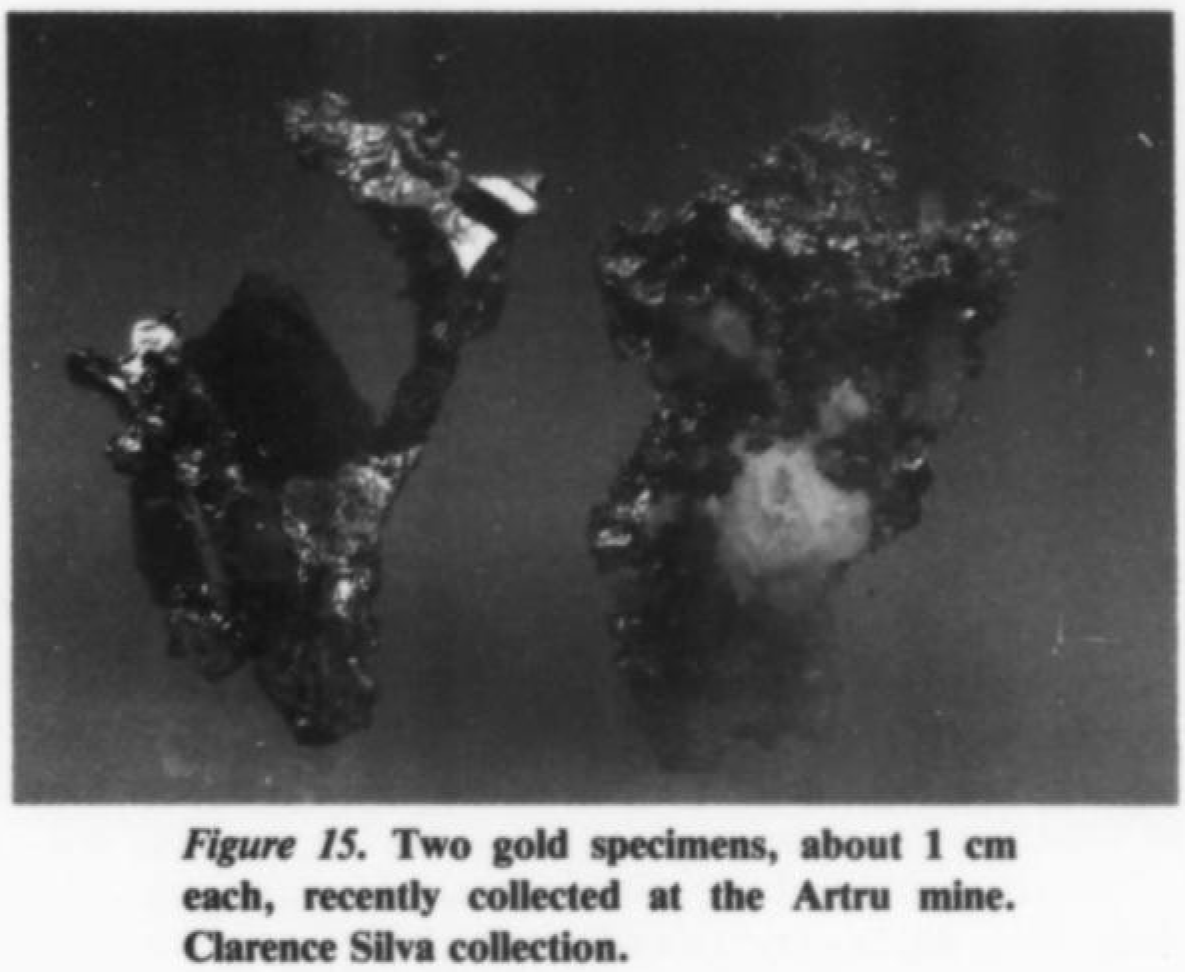

Figure 15. **Two gold specimens, about 1 cm each, recently collected at the Artru mine. Clarence Silva collection.**

Figure 16. **Miners at the Mockingbird mine digging out a pocket of water-clear quartz crystals, September, 1986. Photo by P. Bancroft.**

stands nearly vertical in the area of the Mockingbird mine, and strikes N40-45°W. This and two other major dikes (the Applegate dike and the Colorado Quartz dike) are believed to intersect within the Mockingbird claim. Miners have predicted that the intersection, when found, will prove to be very rich in gold.

Crystal gold in the Colorado dike tends to occur in pockets filled with clay or soft mud stained red to black by iron and manganese oxides. These pockets have been found where "cutter veins" of white quartz terminate at the country rock on the footwall side. In the Mockingbird and the Artru these cutter veins are oriented more or less horizontally, but elsewhere along the dike they dip at up to 20°. Pockets range in size from 2 to 20 cm; very little gold occurs outside of the pockets. There is no known formula for predicting the exact location of gold pockets, which have been likened to the apparently randomly distributed gem pockets found in some pegmatite dikes. Coring and exploratory tunneling are largely ineffective. According to Clarence Silva, the only way to mine pocket gold on the Colorado dike is to follow it until you intersect a quartz cutter vein, then follow that down to the footwall.

Detailed studies of the mineralogy of the Mockingbird and Artu mines remain to be done, but veins in both mines have been found to contain pyrite, arsenopyrite, iron and manganese oxides. The Mockingbird has yielded substantial numbers of interesting quartz crystals and crystal groups. Just recently miners recovered 360 kg of quartz crystals including singles to 4 cm and groups to 25 cm, many with chlorite inclusions and phantoms.

Miners familiar with gold produced from the various claims along the Colorado dike insist that the habit is essentially constant throughout. Crystals are generally octahedral to arborescent, and are commonly distorted or elongated with cavernous faces. The luster ranges from frosty to (in most cases) mirror-bright. Additional forms including the hexoctahedron and dodecahedron were identified by Kampf and Keller (1982) on specimens recently collected at the Colorado Quartz mine. A fine specimen is also pictured in color in Eidahl (1977).

The Mockingbird and Artru mines have recently been leased by the Mockingbird Gold Mining Company (Philip A. Rivera, president). The company plans an extensive search for pocket gold, which will be carefully recovered for sale as specimens. (See their ad, inside back cover of this issue.) A hardrock mining crew from Kellogg, Idaho, is already at work on the site. At this writing, drill rigs, mucking machines, ore trains, tractors and a full compliment of other heavy machinery are being assembled at the mine.

The new operators are highly optimistic about the potential of these claims and have committed to at least two years of work on the site. Numerous unexplored cutter veins and much entirely virgin ground remain to be investigated. With any luck at all, a bonanza of beautiful new gold specimens should soon hit the market.

My thanks to Charley Schroeder, Joe Martin, Clarence Silva, Ed Brown and John Newman for guiding me through the surface and underground workings of the Artru and Mockingbird mines; Pam Brown and Norma Silva provided welcome hospitality during my visit. I also want to thank the Mariposa Historical Museum and the Mariposa Public Library for historical materials, and William Fellows and Wendell Wilson for photographic assistance.

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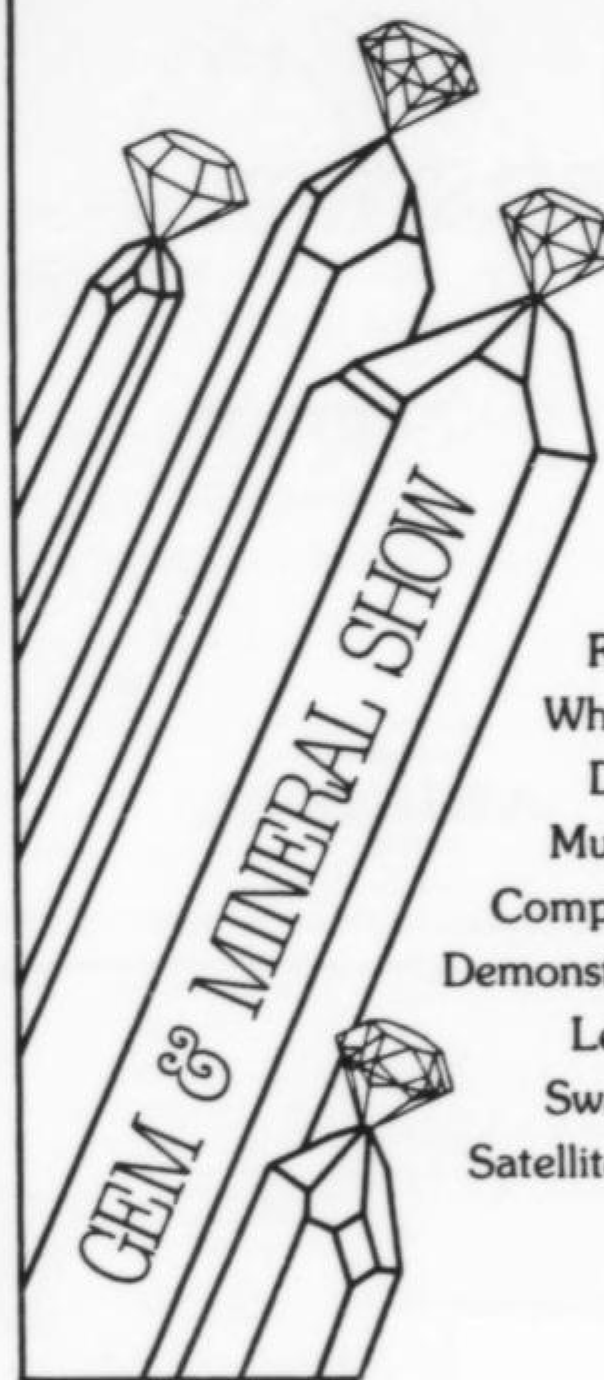

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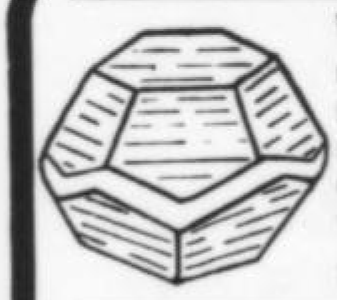

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