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November–December 2001
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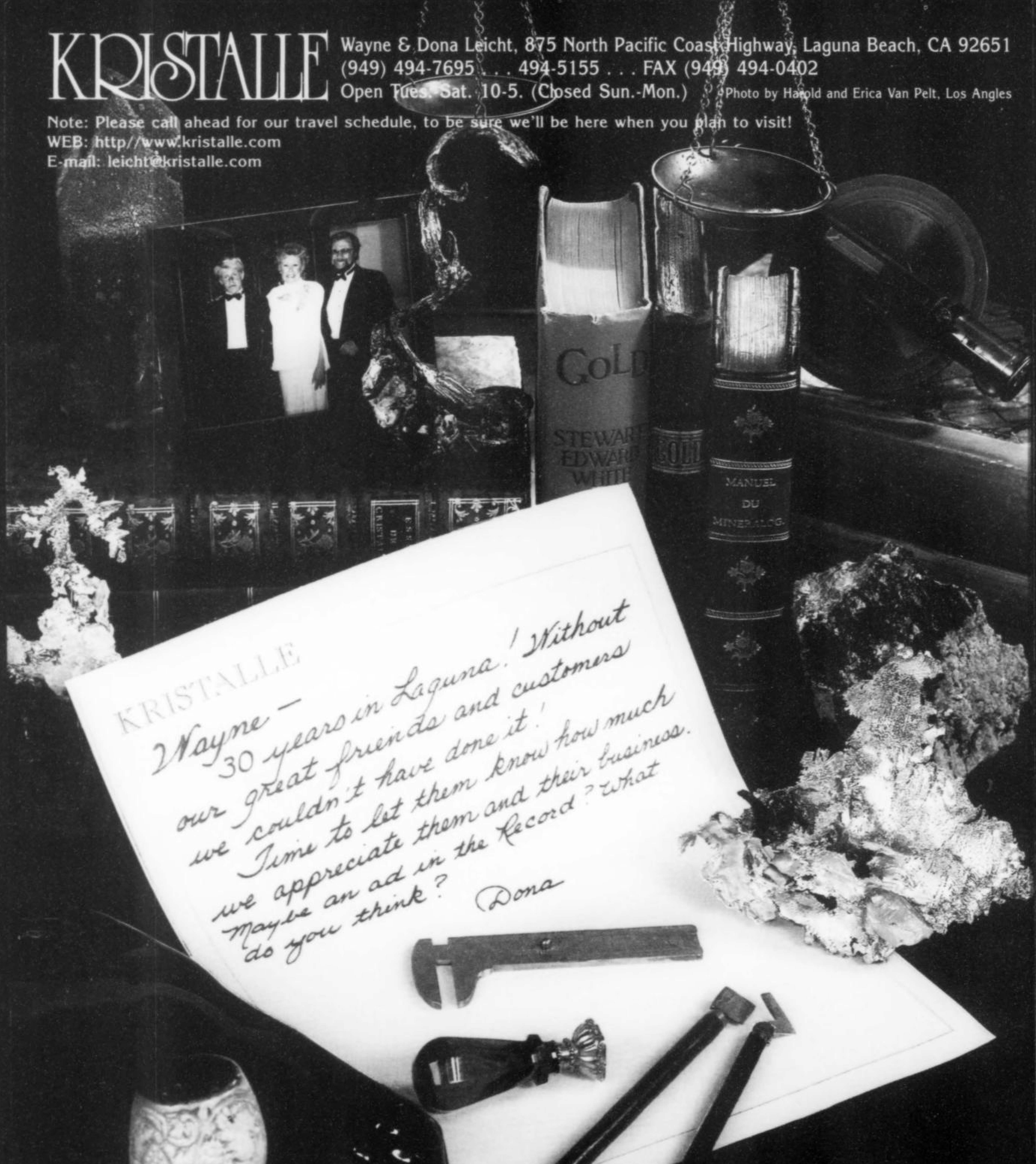
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Articles

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COVER: BORNITE crystal, 1.6 cm, on quartz , from Dzezkazgan, Kazakhstan. Houston Museum of Natural Science collection; Jeff Scovil photo.

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notes from the EDITORS

OLD YUMA MINE

Another great mineral locality has now been closed for good. Arizona collectors in particular are fondly familiar with the long-famous Old Yuma mine near Tucson (see R. L. Jones, "Famous mineral localities: the Old Yuma mine," in vol. 14, no. 2, p. 95–107). Locals have also known that the property has been owned by Richard Bideaux's Arizona Exploring and Mining Company for quite a few years. Bideaux and Wayne Thompson reopened the plugged incline, restoring access to the old 200-foot-level cross-cut. This leads to the stope where some of the finest Arizona vanadinite ever found was discovered by Bideaux and friends back in 1949 when he was only a teenager.

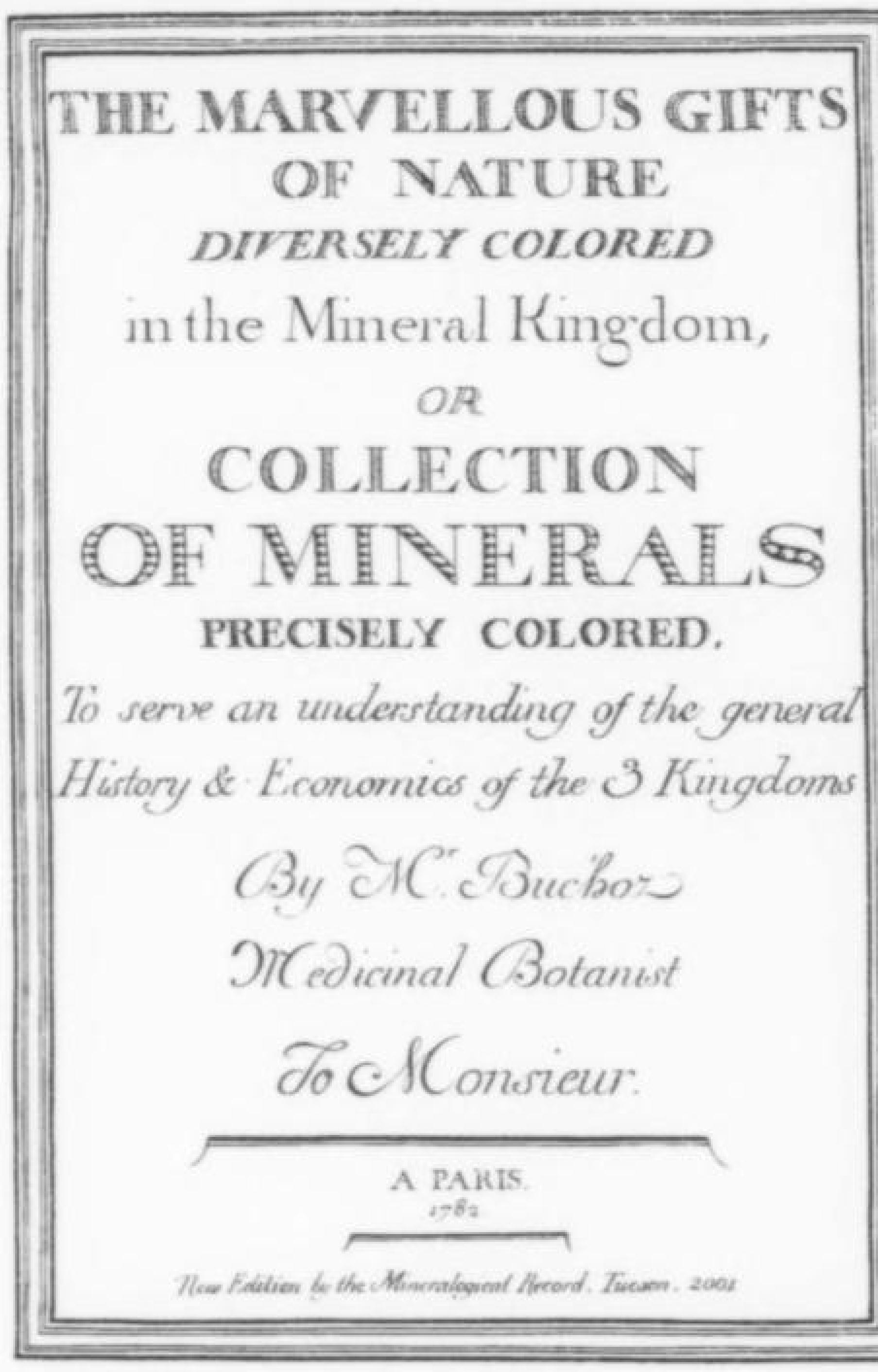
Following the recent brief period of activity, access to the mine was cut off in 1984. In 1996 the mine area was absorbed into the Saguaro National Monument, now the Saguaro National Park. Its existence, close to residential areas, had come to be regarded as a thorn in the side of environmentalists and anti-mining interests in the state.

The issue was finally resolved in July of 2001, when the Federal Government purchased the claim from Arizona Exploring and Mining Company for the sum of $558,000. The mine is now owned outright by the Federal Government, and mineral collecting there is now and forever after forbidden by Federal law.

ANTIQUARIAN REPRINT #12

Another year has passed, and we are finally ready to issue the next volume in the Antiquarian Reprint Series: #12, Pierre Joseph Buc'hoz' ***The Marvellous Gifts of Nature in the Mineral Kingdom*** (1776-1782). Buc'hoz ("Boo-Koh") was a French naturalist who published many color-plate books on botany but only three on minerals, two of which were identical except for the title pages. Our reprint combines *all three*, reproduced in full "folio" size (nearly 11x17 inches!) like the originals, on heavy, archival 24-pound cotton paper, in a beautiful binding consisting of maroon-colored leatherette boards and maroon calfskin spine with gold stamping and head- and tail-bands. This beautiful book, one of the greatest "coffee table" books of the 18th century, was exhausting to reproduce at every stage.

CONTENTS: [1] A new title page in English closely imitating the original, beautifully engraved title page in French. [2] An Introduction to the new edition, with full biographical notes and information on the different editions, in English—written [by WEW and Curtis Schuh] after a *lot* of research. Included are discussions of all 100 plates and their origins, something never before done. [3] Sixty big folio-size plates showing a great many minerals and fossils from famous 18th-century Parisian collections, each in both colored and uncolored state as originally issued in the first Buc'hoz book, *Planches Enluminées,* and also his second book, *Collection de Planches* (i.e. 120 plates, 60 colored and 60 uncolored), in 1776-1781 and 1778-1782 respectively, plus title pages as issued for each set of ten plates. [4] Title page from his third book, *Le Dons Merveilleux* . . . (1782). [5] Beautifully engraved pages of figure captions in French as published with the third book. And [6] the 40 additional plates (uncolored in our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DIVERSELY COLORED
in the Mineral Kingdom,
OR
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OF MINERALS
PRECISELY COLORED,
To serve an understanding of the general History & Economics of the 3 Kingdoms
By M. Buc'hoz
Medicinal Botanist
To Monsieur.
A PARIS.
1782
New Edition by the Mineralogical Record, Tucson, 2001

edition) which were combined with the original 60 from the first two books to make the third Buc'hoz book in 1782. Today all three books, in original copies, might well bring together over $100,000, *if* they could be found at all.

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Remember that all $10 back issues will be going up to $12 as of January 1, 2002. Now is a good time to place an order and fill out your collection as much as possible while we still have the ones you need. See the complete listing of available back issues in the previous issue. For special issues see page 503 of this issue!

SUBMITTING ARTICLES ELECTRONICALLY

We hate contradicting ourselves after just two months, but we have been developing a system to handle electronic article submissions faster than we expected. Several trial runs involving articles submitted as e-mail attachments [we prefer *Microsoft Word*], then forwarded electronically to reviewers, edited, approved by authors,

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THE 48th ANNUAL

TUCSON

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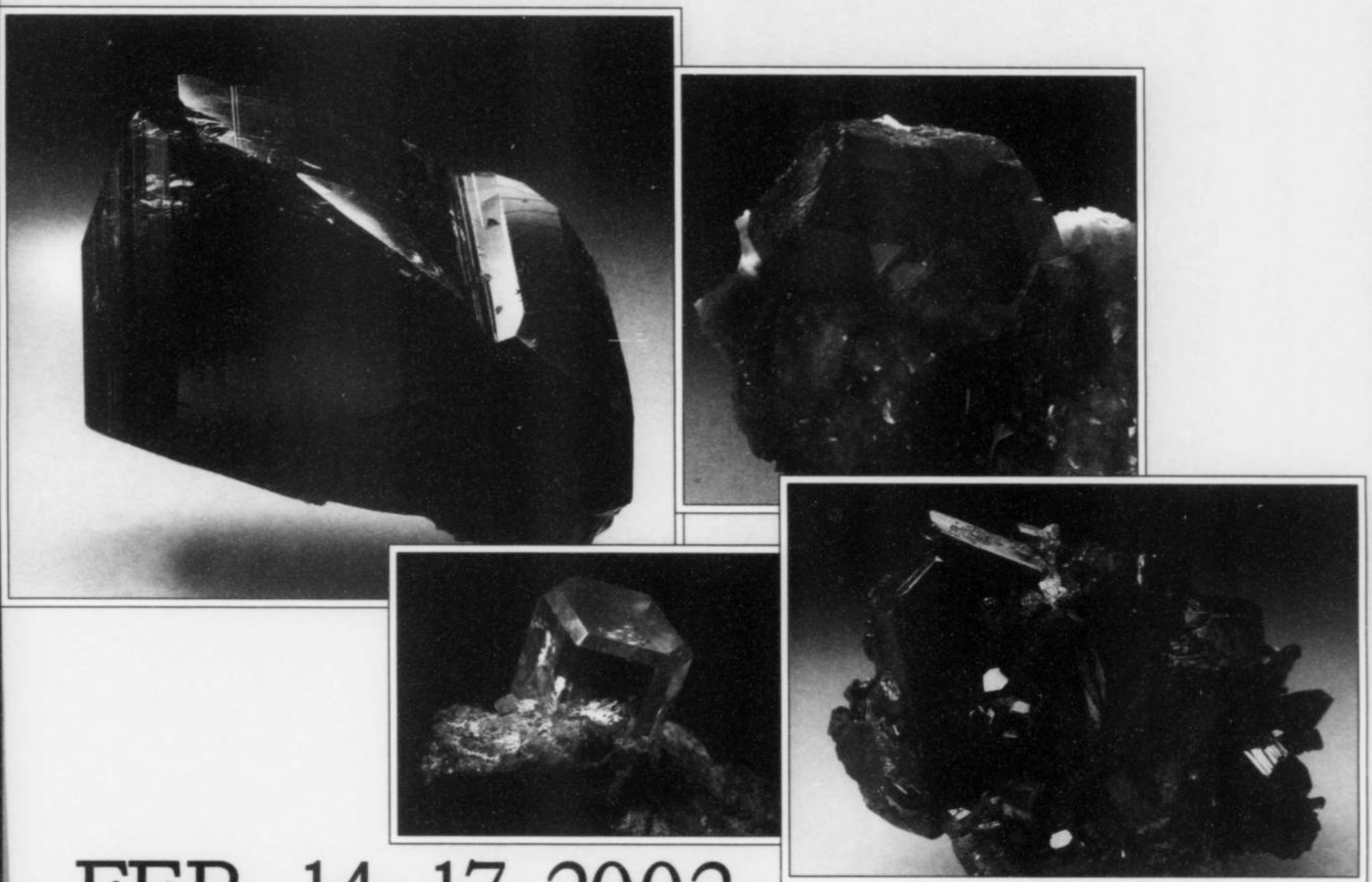

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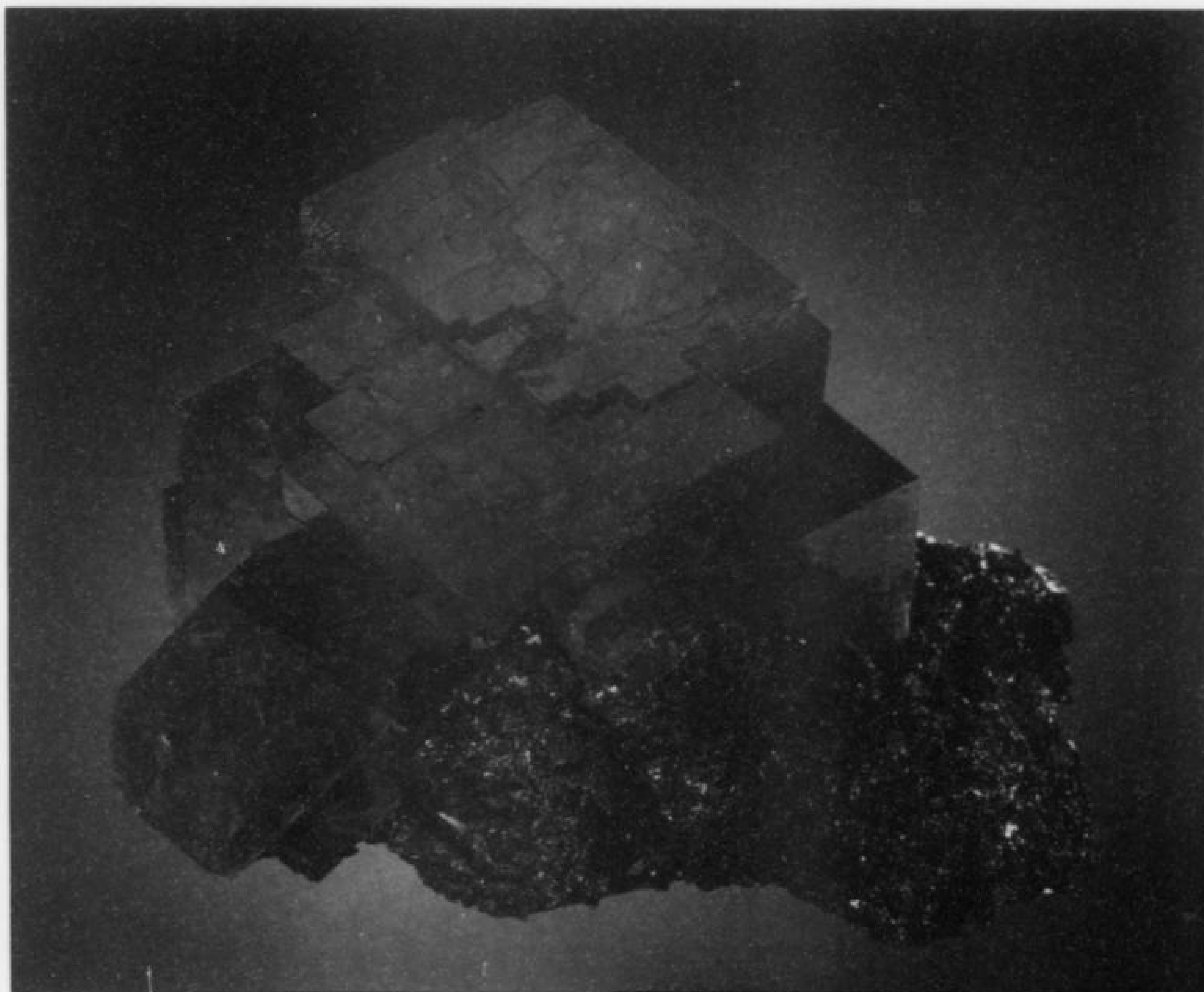

Jeff Scovil

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Sweet Home Mine Project
September, 1992

AMAZONITE
Two Point Mine Project
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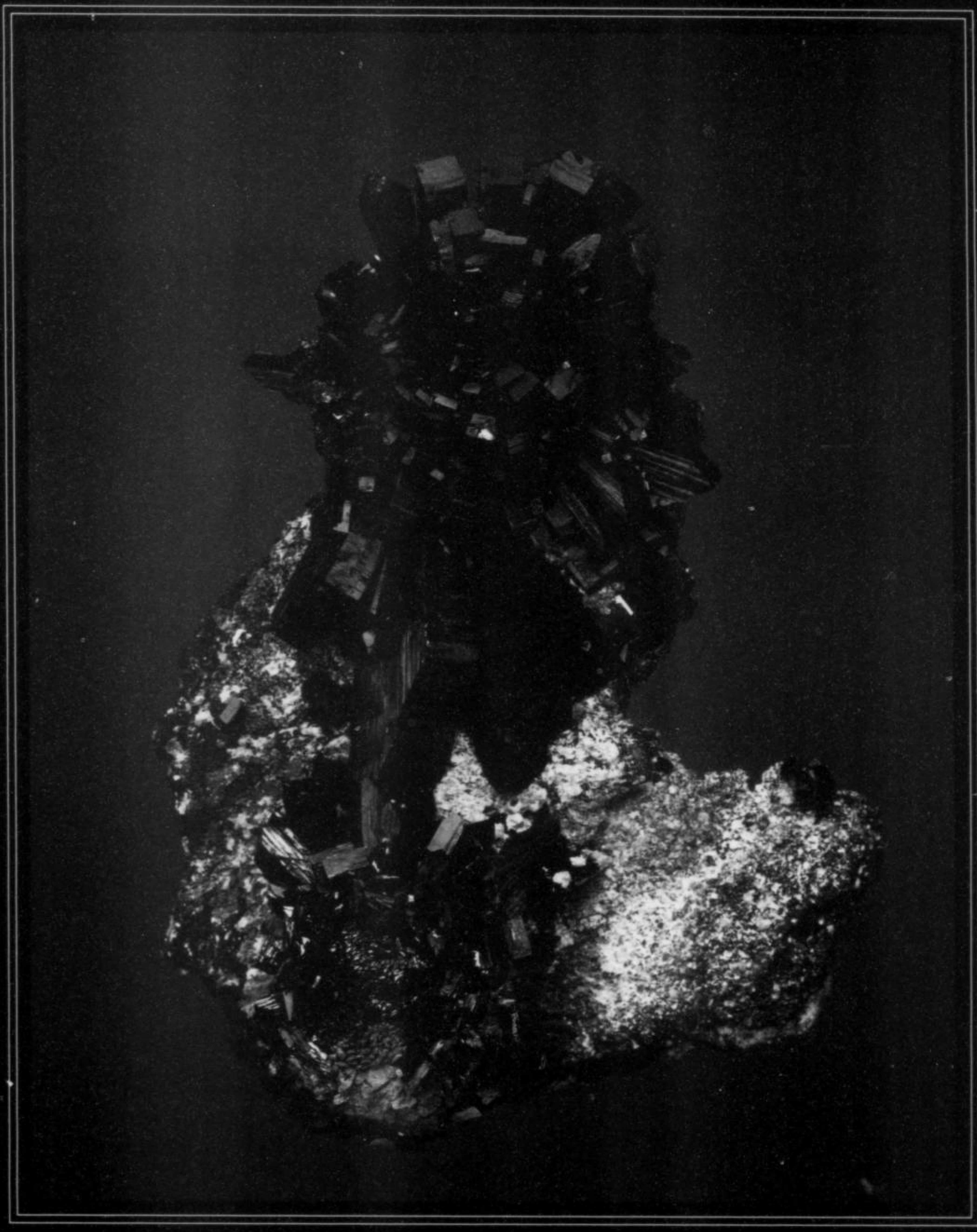


Azurite, 17.8 cm, Tsumeb mine

Famous Mineral Localities:

The Bristol Copper Mine Connecticut

Robert W. Jones
5911 East Peak View Road
Cave Creek, Arizona 85331

The Bristol mine in Connecticut has produced world-class specimens of crystallized chalcocite and bornite, fine examples of which are held in major museums and private collections around the world. Although production of the best specimens was limited to a few years in the late 1840's, the history of intermittent copper mining at Bristol covers 150 years, not ceasing permanently until 1953.

INTRODUCTION

The Bristol Copper mine is located near the city of Bristol, in Hartford County, north-central Connecticut. After some tentative beginnings, commercial mining began here in 1837, and ended in 1857; apparently, all of the fine chalcocite and bornite specimens now extant were found during this phase, especially during the late 1840's. A second major period of mining, during which very rich ore was struck, commenced in 1888, but economic difficulties and mismanagement of the mine forced closure in 1895. In 1946, some exploratory work led to partial dewatering of the mine and attempts to exploit remaining ore reserves, but the fall of copper prices from their World War II levels forced the mine to close for a third and certainly final time in 1953. (The main shaft is now filled with junk cars.)

The superbly crystallized Bristol chalcocite specimens (along with a much smaller number of equally fine bornite specimens) found during the 1837–1857 period rival the famous Cornwall, England, specimens for crystal size and quality. During this period, Bristol was the most important copper mine in the United States, preceding the great Michigan, Montana and Arizona copper bonanzas.

The Bristol orebody is scientifically important in the evolution of ideas about ore formation; Bateman (1923) used it to demonstrate for the first time that chalcocite could occur as a primary hypogene mineral. Until his work was published, it had been assumed that chalcocite was always a product of supergene enrichment in copper deposits.

Bristol offers much of historical interest as well. The mine property was originally owned by the Yale family, after whom Yale University is named. During the period of major development in the mid-19th century, several prominent Yale people were involved in the ownership and operation of the mine. These included Benjamin Silliman Sr. and Jr., James Dana Whitney, and John M. Woolsey. The English-born Charles M. Wheatley of New York, later to manage and give his name to the famous Wheatley lead

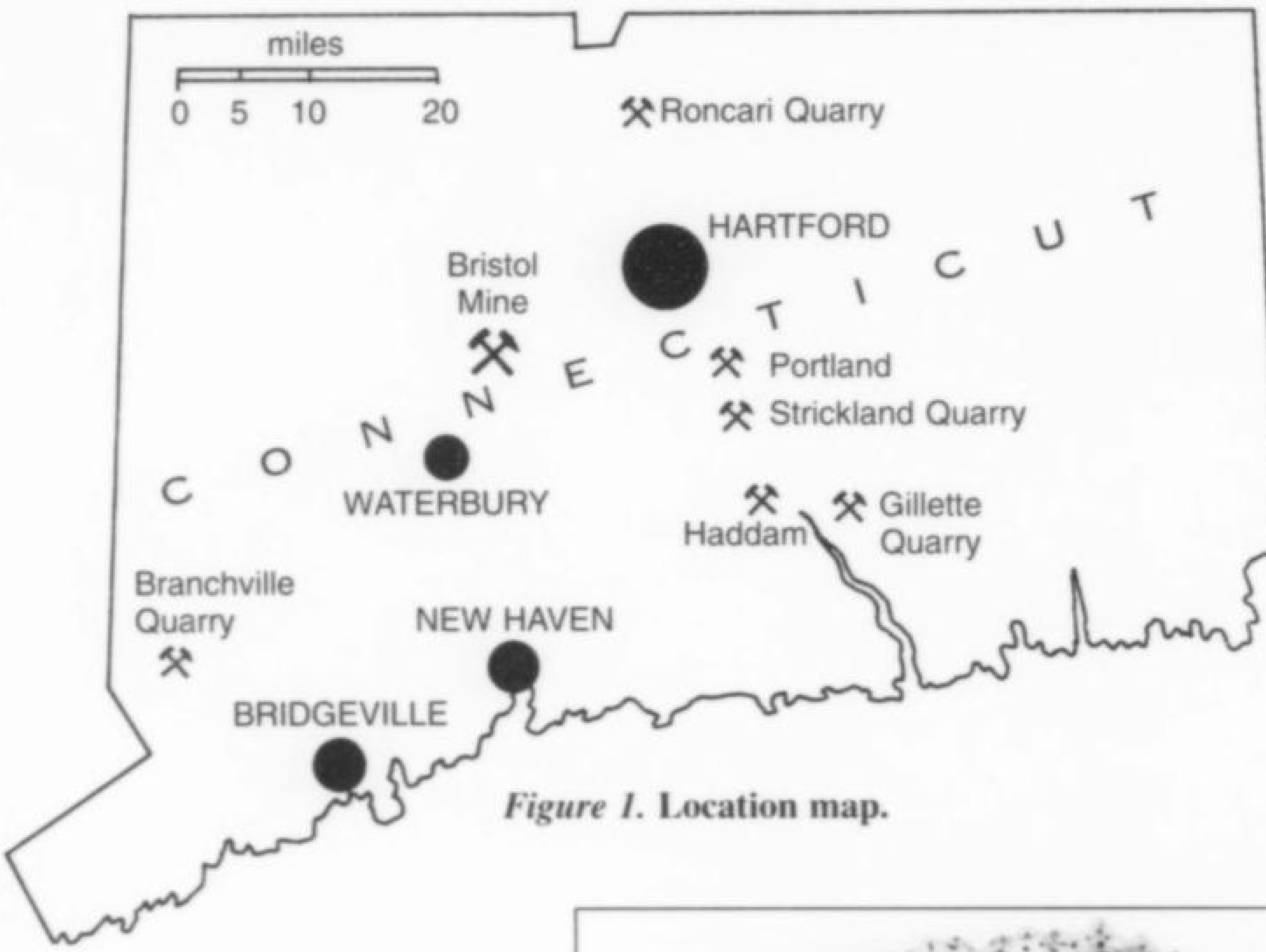
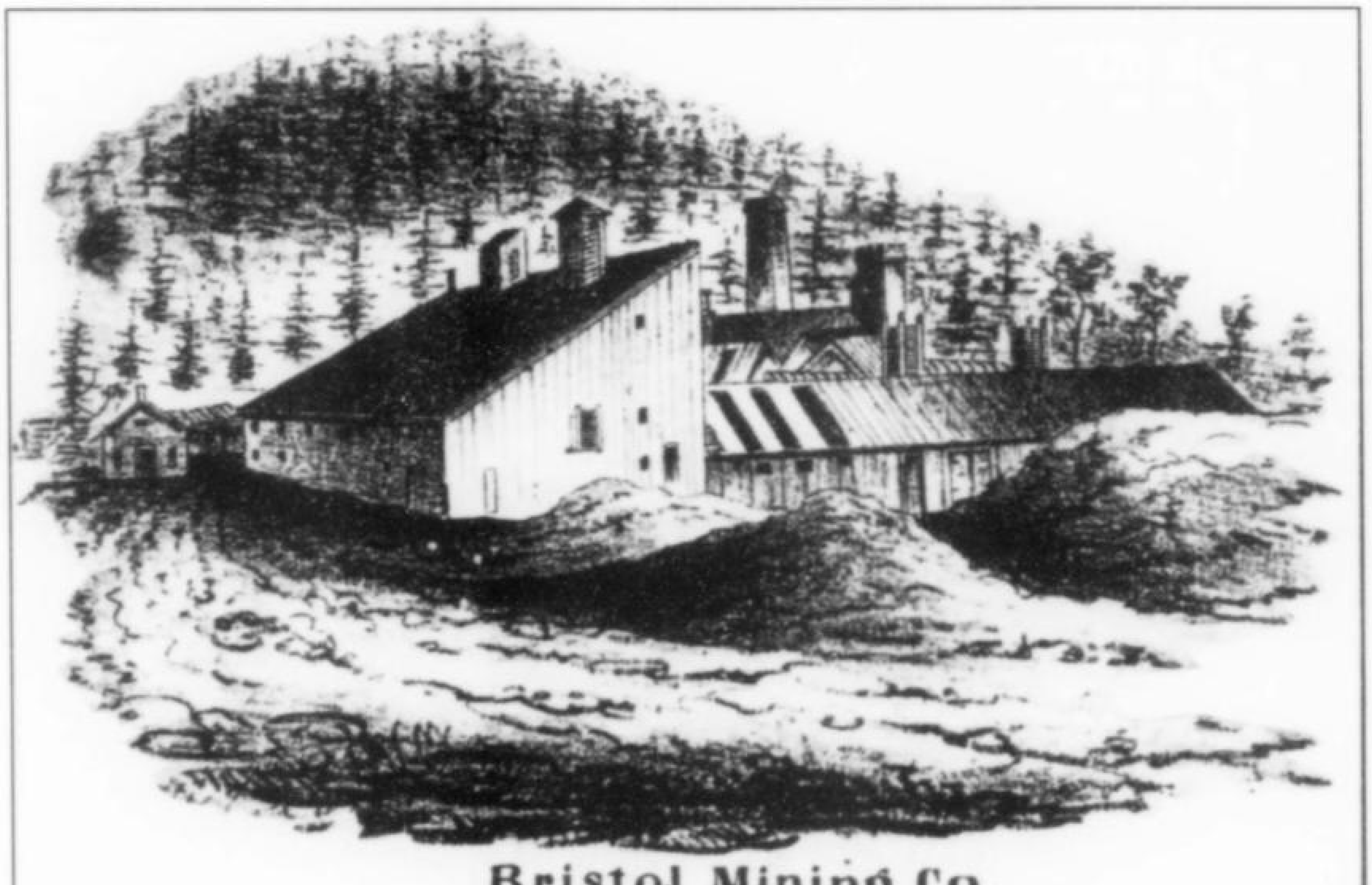


Figure 1. **Location map.**

Figure 2. **Early illustration of the mine buildings at Bristol in the 1840's. Bristol Public Library Archives.**



mines at Phoenixville, Pennsylvania, came on as manager of the Bristol mine just as the great chalcocite and bornite specimens were about to be discovered. Wheatley, Whitney and Benjamin Silliman Jr. all protested vehemently against the mine owners' wishes to process fine crystal specimens as ore, and are no doubt responsible for the preservation of most of the best specimens that have survived.

HISTORY

The Earliest Phases of Mining

The discovery of the copper deposit at Bristol originated in the determination of John Winthrop, Jr., first Governor of the colony of Connecticut, to explore his territories for mineral resources. In 1651, Winthrop was granted automatic permanent ownership of any ore deposits he located, plus any timber and water resources within three miles of his mines. Connecticut colonists everywhere were soon searching for secondary mineralization that would betray the presence of metals. Connecticut's first copper mine was begun at Simsbury in 1709, and operated for the next 70 years; it was also put to use during the Revolution as a prison for captured British soldiers. Today the mine area, known as "Simsbury Mine and Newgate Prison," near East Granby, is a Connecticut Historic Site and popular tourist attraction.

There is some archaeological evidence to suggest that the Bristol copper deposit was worked by Native Americans long before English colonization. In 1798 a local farmer named Theophilus Botsford investigated a spring of greenish water issuing from a spot beside an old Indian trail at the base of Zack's Mountain, a small hill near Bristol. The water was killing nearby vegetation, and Botsford correctly assumed there was copper in the spring water. With a yoke of oxen he plowed away some of the ground near the spring, and discovered a vein of copper ore. He did not, however, follow up on the discovery (Hurlbert, 1897).

In 1800, Asa Hooker, operator of a Bristol brass foundry, obtained a lease on the property from Sarah Yale, the widow of Abel Yale, descendent of Elihu Yale, founder of Yale University (Beals, 1954). Hooker turned the lease over to Luke Gridley, a local blacksmith and fence inspector, who promised Sarah Yale a one-thirtieth share of the ore or any other valuable "treasure" that might be found. Gridley worked the outcrop for eight years with hand tools, extracting small amounts of ore which he smelted in his

Figure 3. **Earliest known photo (1840) of the Bristol mine open cut. Bristol Public Library Archives.**

nearby forge. This product was probably turned over to Hooker for use in his foundry business (Harte, 1944). But Gridley died in 1810, and the property lay dormant for the next 26 years.

Major Development, 1836–1846

In 1836 the Bristol brass industry was growing fast, and George Bartholomew, associate of E. N. Welch, owner of the Welch Foundry, obtained a 15-year lease on the Bristol property from Abel Yale, Jr., son of Sarah Yale, the new managers promising Abel one-twelfth share of the proceeds from mining. For two decades the copper mine undoubtedly played a major role in the early development of Bristol's industries such as the Bristol Brass Company and two major clock manufactories for which Bristol gained fame; all these came under the control of Welch (Hurlbert, 1897).

When Bartholomew obtained the property he immediately trenched it to determine its values, opening an area measuring 10 by 20 feet and 17 feet deep. Beals (1954) describes what this trenching exposed: "The variegated copper vein, copper, sulfur, iron and silver ore between granite and sandstone was so rich, about 70% copper content, it needed only to be trimmed with a hammer to go into the smelter furnace." The term "variegated copper" referred to bornite (Cu_5FeS_4).

Ores from this early operation were shipped overseas—probably to Swansea, Wales—for processing. There is evidence of smelter slag on the shores of New Haven harbor but no evidence has been found to connect it with the Bristol mine. That the property showed a profit is a tribute to the richness of the ore values mined.

Bartholomew was persuaded by several local businessmen to raise investment funds and establish the first Bristol Mining Company. When the company was incorporated by the Connecticut State Legislature on December 7, 1837, it had a capitalization of $60,000, raised by the sale of 2400 shares at $25 each. The original partners were Bartholomew, Bristol clockmakers Erastus and Harvey Case and Sylvester Willard, and Andrew Miller, "a capitalist and practical miner" from Fleming, New Jersey (Domonell, 1991). Miller, who held 1200 shares, was president of the company. Intense activity to develop the mine then got under way. A large adjoining tract of land was leased and buildings erected, miners were hired, and a dam was built to impound the waters of Poland Creek for power. A main shaft was begun, and at 60 feet the first crosscut was put in to intersect the vein. A 4-foot ore zone was located only 13 feet from the shaft. A deeper crosscut proved the vein to be 10 feet wide further down (Clouette and Roth, 1984).

In 1837 the mine was visited by Connecticut state geologist Charles Upham Shepard, who described the deposit briefly and with little enthusiasm, saying "vitreous copper occurs in small quantity in the Bristol Copper Mine intimately associated with variegated copper." Shepard's report gives no indication that at this time he saw any crystallized specimens of chalcocite ("vitreous copper") or bornite ("variegated copper"). By 1839 Benjamin Silliman, Sr., had visited the property and had written a much more enthusiastic report, though likewise without mention of good crystals.

Andrew Miller, with his controlling interest in The Bristol Mining Company, apparently was a competent and financially responsible mine manager until his death in 1846. But Miller sold half of his interest for $28,000 to a group of English investors: Lawson Ives, Chauncey Ives, and Almon Farrell. Soon thereafter, the ore was shipped to England for smelting, at excessive cost. Miller made new arrangements with local farmers to haul the ore to Plainville, Connecticut, from whence it was taken via the Farmington Canal to a smelter at East Haven, and the copper taken from there to the Tyson copperworks at Baltimore, Maryland.

Miller brought in skilled miners from Cornwall, England—the famous "Cousin Jacks"—to increase the efficiency of the operation. These miners reportedly found the Bristol orebody to be reminiscent of those at Truro, Redruth and Penzance, Cornwall. In the late 1840's the "Cousin Jacks" would be on hand for the discovery of vugs lined with crystallized chalcocite, and may have troubled to preserve many specimens. Dr. Steven Chamberlain of Syracuse, New York, has reported that when he visited numerous

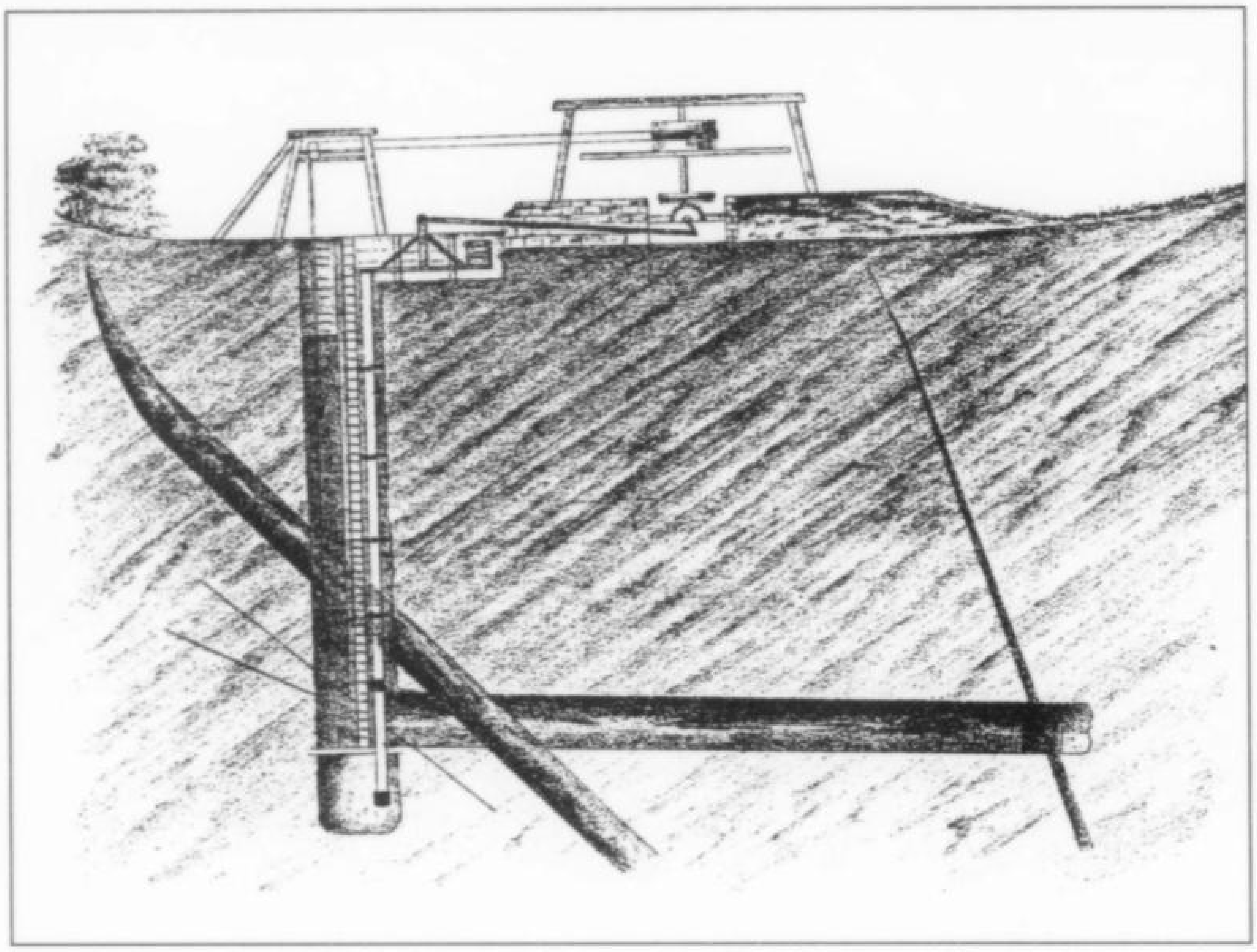


Figure 4. **Cross-section of the Bristol mine showing the primitive hoist mechanism originally used, from Richardson (1854).**

private collections in Cornwall, England, over a hundred years later, "he observed, unexpectedly, a number of fine Bristol chalcocites which had been assigned a Cornwall pedigree," apparently brought or sent home by Cornish miners (Heitner and Lininger, 1997).

During the months just before Andrew Miller's death, there was apparently friction between him and his English partners; the annual reports for 1843 and 1845, prepared by Chauncey Ives, were not signed by Miller. When Miller unfortunately drowned in the Tunxis River early in 1846, Lawson Ives became the mine manager, and the financial situation deteriorated. A number of lawsuits were filed successfully against the company, and in 1846 the first Bristol Mining Company collapsed.

The Peak Period, 1847–1857

In 1847 an opportunistic New York investor, Richard F. Blydenburgh, negotiated a long-term lease on the Bristol property with Abel Yale, then sold two-thirds of his interest to another New Yorker, Hezekiah Bradford, for $61,849. Dr. Eliphalet Nott, the president of Union College in Schenectady, New York, then mortgaged the property from Blydenburgh and Bradford. By 1851, Nott had bought up the other interests and become sole owner of the mine's lease, appointing himself president of the second Bristol Mining Company (Hislop, 1971). Major stockholders included Yale people such as John M. Woolsey, Josiah D. Whitney, and Professor Benjamin Silliman, Jr.—son of Benjamin Silliman, Sr., the great mineralogist who "almost single-handedly took Yale into pre-eminence in early American education in chemistry, geology and mineralogy" (Moore, 1999). This connection with the Sillimans of Yale would prove fortuitous for Bristol and its great mineral specimens.

The position of mine manager went to 24-year-old Charles Moore Wheatley. Although already a successful businessman, Wheatley had only an amateur naturalist's interest in geology and mineralogy, and no experience in mine management. However, his quick intelligence, enthusiasm, hard work, and dedication to mineralogy soon won him the support and respect of Benjamin Silliman, Jr. The warm relationship would pay continuing dividends for the Peabody Collection at Yale when Wheatley later took charge of the lead mines at Phoenixville, Pennsylvania, which now bear his name, and sent many fine specimens from there to Silliman in New Haven. Unfortunately, his tenure at Bristol lasted only until 1849, when he left to work at the Perkiomen and Ecton mines in Pennsylvania (Evans, 1984).

Under the leadership of its new cadre, the Bristol mine flourished, and soon was rated the most important copper mine in the northeastern United States (Smith and Smith, 1907). Some of the miners, still resenting the earlier management, and knowing of Wheatley's inexperience, distrusted the new mine manager, but Wheatley won them over by working underground with them in a friendly way and learning all he could from them. He overcame another early crisis in the form of the first labor strike at the mine, this by Irish miners who asked for, and were refused, time off with pay to attend Mass in New Britain. Some angry miners threatened the young manager, and several even devised a plot to lure him into the mine and kill him, but Wheatley ended the strike by arranging to have Father Luke Daly come from New Britain to say Mass at the mine. It is interesting to note that the strikers were receiving only 70 cents an hour when they went on strike (Clouette and Roth, 1984).

With steam power now in place, Eliphalet Nott and his associates sank a second shaft of impressive size, 6 feet by 8 feet, eventually dropping 240 feet in depth. Crosscuts were put in, and ore valued at over $200,000 was recovered. This was selected ore averaging 33% copper, according to Bateman (1923). One main source of copper was the "flucan" (a Cornish term for a wide fault-gouge zone filled with decomposed mineral matter), described by Silliman and Whitney (1855) as a talco-micaceous slate that was completely disintegrated such that no blasting was required, as it "ran" easily. The second and more important source of ore was the vein system.

Many of the historically important specimens now in the Yale-Peabody collection certainly came to light at this time. A large number of fine chalcocite specimens also went to Union College, which is not surprising considering that Eliphalet Nott was president of that institution while also heading the Bristol Mining Company in the late 1840's. Many more fine chalcocites also went to Union College in 1858, when Charley Wheatley sold his collection to the school, Josiah Whitney having arranged the sale.

Heitner and Lininger (1997) provide a historical analysis of early collecting at Bristol; some of it necessarily is inferential and

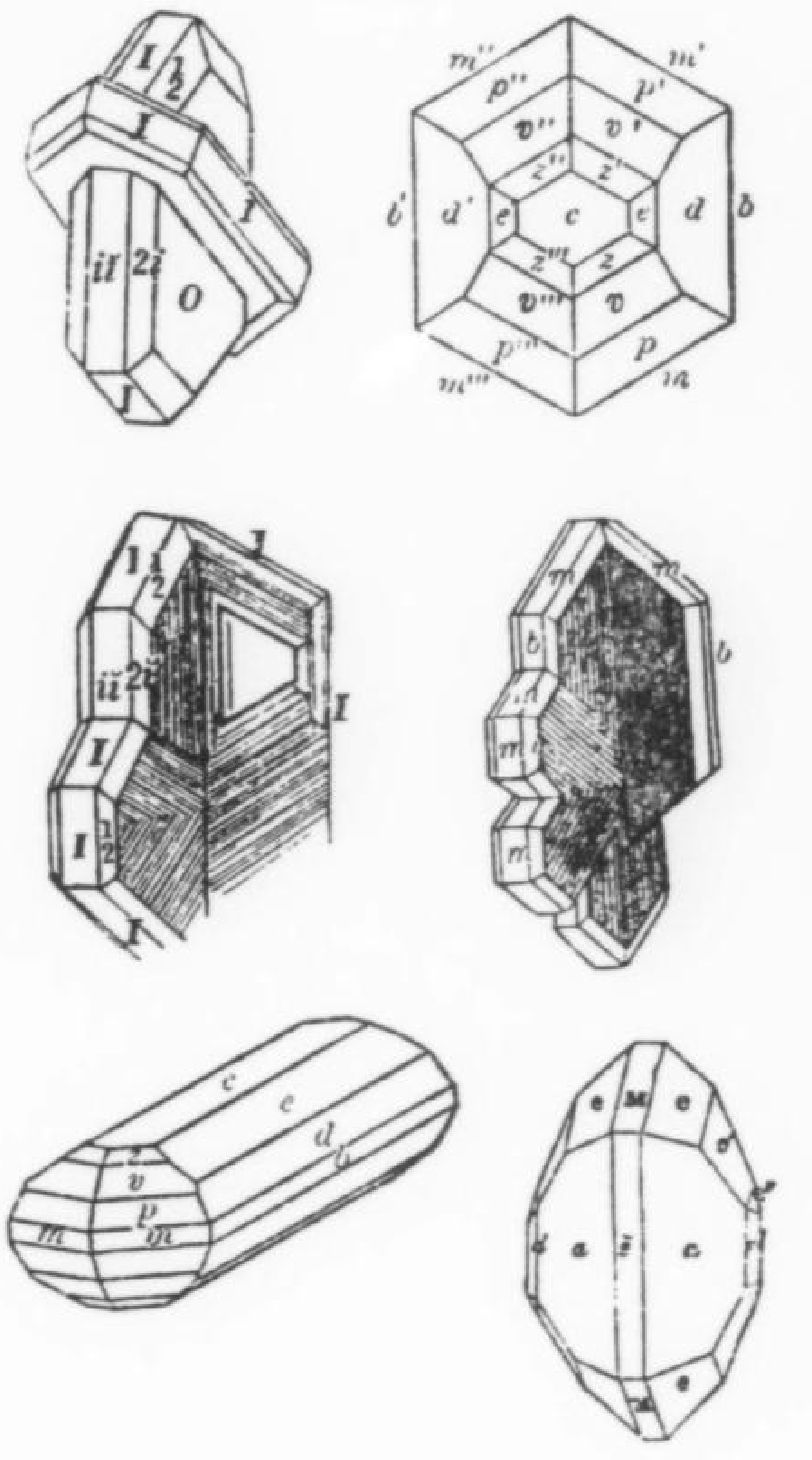


Figure 5. **Bristol chalcocite crystal drawings from Dana's *System of Mineralogy* (1855, 1892).**

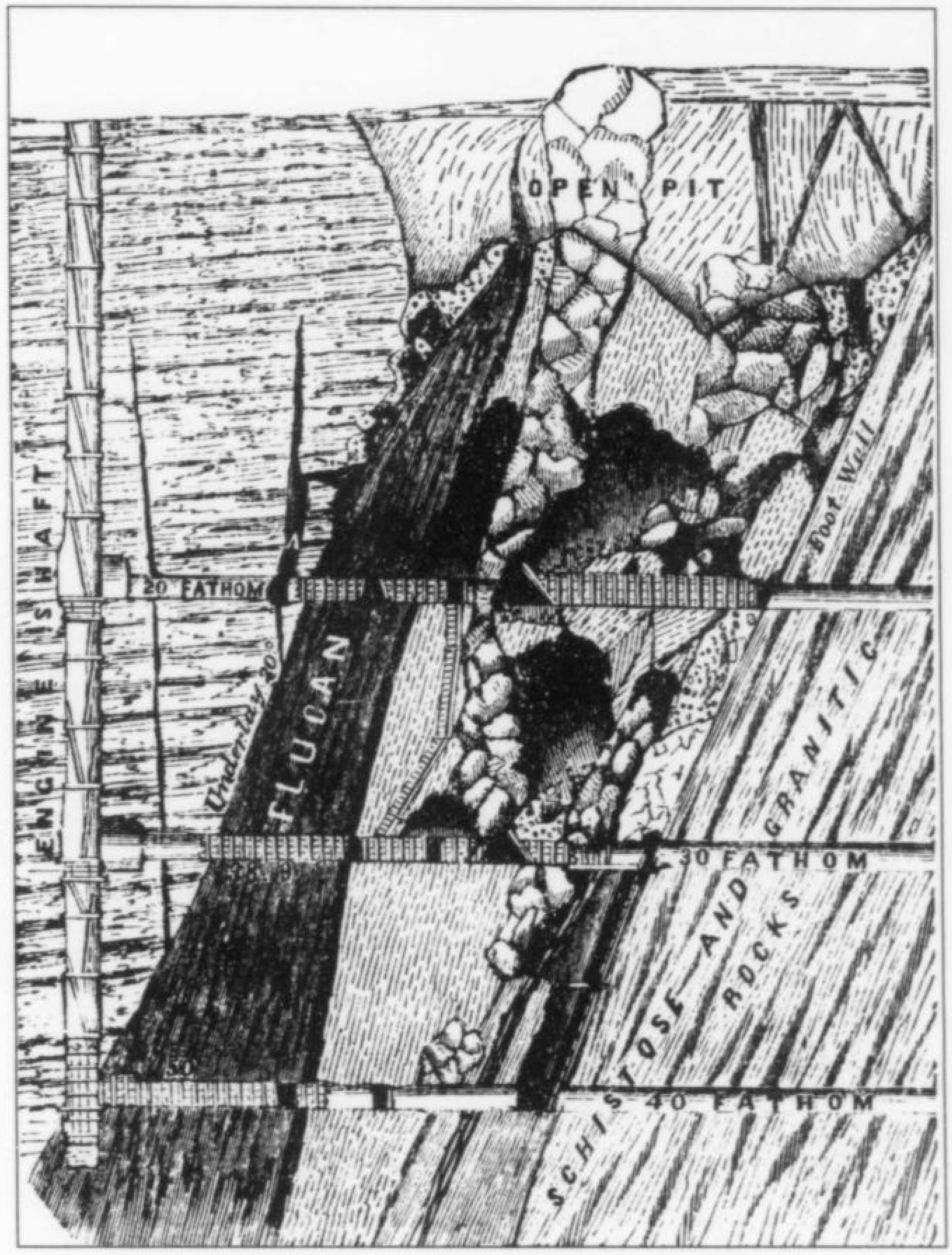


Figure 6. **Cross-section of the Bristol mine from Silliman and Whitney (1855).**

speculative, but it makes a fascinating account. They begin with the Third Edition of J. D. Dana's *System of Mineralogy* (1850), which contains the first mention of chalcocite in "large and brilliant crystallizations" from "a vein at Bristol, Conn." As Dana in 1844 had mentioned only a "fine vein" at Bristol, and Shepard in the same year had cited only "vitreous copper" in massive form from Connecticut (and crystals from Cornwall), it seems safe to assume that the first crystal vugs at Bristol were struck early during the second major start-up of the Bristol mine, between 1847 and 1850, the period for which assay figures show the richest ore being produced. In 1852, Shepard writes of "splendid crystallizations" which occurred at Bristol "a few years since, but of late this locality has wholly ceased to produce them." There is no extant description of the vugs themselves, but the mining engineer Charles Richardson, who visited in February 1854, states that "where vugs occur, the ore is very rich."

No real evidence exists as to who found the vugs, or who first collected specimens from them. Charles M. Wheatley left no written account of these matters, as we might have expected him to; Heitner and Lininger (1997) attribute this to the fact that "he was probably too busy collecting." In a personal letter to John H. Redfield on August 30, 1847, Wheatley writes ". . . the only consolation I have for being in this wilderness is that twice a day I have brought up from our levels some very fine things. . . . Vitreous Copper, Very good copper! oh! oh! oh!!" And on November 17, 1847, "I am over head & ears in X2 copper and the way I will astonish the natives at the Lyceum about New Year will be a caution . . . ." When Dana and Silliman came to the mine in July, 1848, Wheatley writes, they "feasted their eyes with X vitreous all day," and when Silliman left he took away with him enough specimens to cause Wheatley to complain to Redfield that "The confounded fellow came up with a mighty large basket!" In September 1848, Mr. W. Lettsom wrote from London to tell Wheatley that "Your Bristol copper glance is beautiful and I am really much indebted to you for them."

Some of the Yale specimens seem to have been sold to Silliman, shortly after someone collected them, by one Ludwig Stadtmüller, a Bavarian immigrant and graduate of Yale's Sheffield Scientific School. Stadtmüller worked as an assayer at the mine during this period, and later became a mineral dealer in New Haven. Silliman may also have personally collected more specimens when he went with George Jarvis Brush and some Yale students on a field trip to the mine in 1849.

Of fine chalcocite specimens retained in Bristol, Smith and Smith (1907) gives a glimpse by quoting from a history of the Bristol school district written by Mrs. H. S. Bartholomew, daughter-in-law of the George Bartholomew who had worked the mine in the 1830's: "For many years after the 'Mine' was in operation or worked the ancient Culver house stood on its grounds surrounded by huge piles of waste material (tailings). Sometimes its windows revealed to outsiders a row of extra fine specimens of copper and quartz crystals, with some silver." Note here that in researching this

Figure 7. **Bristol mine ruins overlooking the open cut. Photo courtesy of John Pawloski.**

article only one specimen showing native silver was seen (in the Smithsonian collection).

The 1850's saw a major disagreement among the owners and managers of the mine about what to do with the fine crystal specimens being found. Most of the owners wanted the specimens simply sent to the stamp mill to increase the yield, but Silliman (?) objected strongly. Hurlbert (1897), describing the management of the mine during 1855–1857, writes "It was during this administration that specimens of chalcocite of peculiar form could have been easily sold as cabinet specimens for hundreds of dollars, [but] were crushed for ore in spite of the protest of the mineralogist." Heitner and Lininger (1997) speculate that this "mineralogist" was Benjamin Silliman, Jr., or possibly Josiah Whitney or Ludwig Stadtmüller. It was perhaps in part to protest the fate of these specimens that Silliman and Whitney sold out their holdings at the same time as did Nott—in 1857. Their reason also may have been the financial extravagance of Henry R. Sheldon, hired in 1851 as mine manager and bringing with him a Cornishman, Captain Williams, to oversee the property and production.

The period 1851–1857 proved to be a troubled one. Sheldon, having declared his intention to ensure large profits by holding down expenses, nevertheless spent money wildly on sinking another main shaft, constructing large buildings, and trying a costly experiment with an unorthodox ore separator that cost more than $10,000 (Heitner and Lininger, 1997). The pattern of extravagant spending kept the mine running deficits, despite raising large amounts of rich ore.

One problem not of Sheldon's making that arose in the early 1850's was a serious flood of groundwater trapping many miners at the face. Fortunately, they escaped without loss of life. This flooding required much clean-out work and created a need to secure the ground before mining could resume (Hurlbert, 1897). It should be noted that in spite of this event a report in the 1855 *Mining Magazine* stated that this was not a wet mine!

Silliman became more directly involved at this time in the management of the mine where, despite the best of intentions, he only reinforced Sheldon's improvidence. "The Professor [was] a fine theorist but a very poor practical miner. Hundreds of thousands of dollars, from first to last, were poured into the mine" (Norton 1872). For example, Sheldon and Silliman wasted much money in trying to replace steam with water as a source of power for the mine. To produce water power, a $30,000 dam was built half a mile from the mine, a sluiceway constructed, and a 38-foot water wheel installed; steam as a source of power was removed (Richardson, 1854). Nott took strong issue with Silliman over the installation of the water wheel. In a letter dated Jan. 2, 1855 he wrote, "I am not surprised at the delay in getting the works in order at the mine. You are aware, I presume, that in England the opinion changed in relation to the gain of power using high steam, also the improvement made in the generation in steam by Mr. Pond at the works of Hartford and New London Machine Shop. If you have not been aware of these facts you will, perhaps, inform yourself more fully." Clearly, this was Nott's polite way of saying that Silliman had made an incompetent decision to use water for power. When, indeed, the expensive dam later broke, flooding the surrounding area (Hurlbert, 1897), it was decided to return to steam power, but to fuel the steam boilers with peat mined nearby. The cost of this mining, and of the ovens which needed to be constructed to dry the peat, meant a total cost "several times as much as [for] an equal amount of any other fuel" (Heitner and Lininger, 1997).

Sheldon's personal extravagance also worsened the situation:

> The company's agent . . . kept eight or ten fast horses at his stables in Farmington and others at the mine. . . . Once a dance was given in the storeroom which had been provided with

***Figure 8.* Forty-foot-high hoisting house and stamp mill at the Williams shaft, Bristol. Photo courtesy of John Pawloski.**

steam pipes for heating it on this occasion as it was winter. Sibley's Band of Hartford, the best in the state at that time, was hired for $100. The supper was a costly one, wine of several kinds being furnished. That this wine was not an imitation may be inferred from the fact that those at the supper table amused themselves by throwing turkeys and chickens at each other. (Hurlbert, 1897)

By 1855, Whitney and a presumably wiser Silliman were suggesting ways to get the mine's finances back under control. They saw to it that a new shaft was sunk in the best place to exploit more fully the ores in the flucan; when these ores were processed in the Bradford ore separator (earlier put in place) the mine briefly turned profits of $1800/month. But nothing, in the longer term, could reverse the effects of the extravagance of the mine manager. When Silliman, Whitney and Nott sold out their interests in 1857, financial disaster was clearly imminent. The rebuff of Silliman regarding the fate of the crystal specimens may have seemed to him merely a final, symbolic insult. James M. Woolsey became the primary owner, and the company "became bankrupt in 1857, the year of the financial crash. This was in spite of the fact that $2,000 a month above business expenses had been earned during the last six months of the company's existence" (Domonell, 1991).

With the shutting down of the mine in 1858 came the inevitable auction of equipment and supplies. The ore hopper suffered an ignominious fate. It was bought and inverted to become the roof of a chicken coop (Smith and Smith, 1907). The mine bell met a more noble end: it was bought by factory owner E. L. Dunbar, who installed it in the belfry of his spring factory on South Street, and rang it 99 times each night, as a curfew bell (Peck, 1932). When Dunbar died, the ringing of the bell was stopped, but the townspeople petitioned the new factory owners and the ringing was resumed at a more reasonable rate (Smith and Smith, 1907). The bell was shifted from place to place and finally, in the 1970's, became available to the town. Suggestions were solicited, and an officer of the Bristol Fire Department suggested that it be erected outside the main fire station as a memorial to those firefighters who had fallen in the line of duty to the town. The City Fathers obtained the bell and the memorial was constructed, but later it was discovered that no one in Bristol had ever died in the line of duty as a fireman. Ironically, the first fireman later to do so was the officer who had originally suggested the memorial (Bristol fire officials, personal communication).

Renewed Efforts, 1888–1895

The coming of electric lighting in the 1880's inspired a huge demand for copper, and a subsequent rise in copper prices. Consequently, many old American copper mines, including the Bristol mine, drew new interest from speculators. Burton Cowles, a former Bristol resident and later the proprietor of a wood engraving company in Pittsfield, Massachusetts (Heitner and Lininger, 1997), had an idea for using iron to extract copper from mine solutions at Bristol. Cowles experimented with samples from the mine tailings dump, using acid to leach the material; the dissolved copper was deposited on scrap iron. Cowles claimed that $300,000 worth of copper could be won in this way from the existing mine dumps, and although the *Waterbury American* newspaper (May 10, 1888) opined that he was "practicing transmutations while romancing the public," Cowles was indeed able to raise enough capital to re-open the mine. In 1888, he and Edgar G. Hubbell, librarian and curator of the Pittsfield Athenaeum, raised some $500,000 in investment capital and acquired title to the mine, plus its surrounding tract of 120 acres, from the estate of John W. Woolsey. During the spring and summer of 1888, Cowles and three hired laborers worked hard enough to be able to recover 35 pounds of pure copper daily from the old dumps; the local newspapers began to speak more favorably of the project, and "copper fever once again returned to Bristol" (Heitner and Lininger, 1997).

Soon Cowles turned his attention from the dumps to the underground workings. The old Williams shaft was dewatered by round-the-clock pumping during the autumn of 1888, and excitement increased when some recovered ore samples were found to contain significant silver. On November 12, 1888, the new concern—optimistically named the Bristol Copper and Silver Mining Company—acquired all the property that Cowles and Hubbell had received from the Woolsey estate. The officers (and investors) in the company included William E. Tillotson, President; William E. Robertson, Vice-president; Edward S. Francis, Treasurer; Hubbell, Secretary and General Manager; and Cowles, mine foreman. The old Williams shaft (soon to be re-named the Tillotson shaft) was extended from its original 240 feet to 400 feet, a 40-foot-high hoisting house was built over it, and a new stamp mill was ordered. In January 1889 a large derrick and portable hoisting engine were added, the slumped open-cut was re-opened, and underground blasting was begun on a crosscut at the 180-foot level. A Captain John Juliff, later called "Bill Silica," who had been an active miner in the West, was hired to assist Cowles as mine manager.

Newspapers at the time touted a new era of wealth and prosperity. They reported ore assaying at 73.41% copper, containing 23 ounces of silver per ton (Perry, 1975). In July 1890, the *Bristol Herald* reported that "a four-foot-wide body of yellow ore" had been encountered, and took the occasion to claim that the copper mines of Bristol were probably "the most profitable mines worked in the United States today"—this while Butte, Bingham, Bisbee and the Keweenaw Peninsula were working. Professor Silliman was quoted as saying that the ore veins extended from Bristol to Hamden, a distance of 25 miles at least. He also suggested that the mines would provide work for 30,000 people. Cowles meanwhile continued also to promote the value of working the mine tailings by his original acid-leaching method, and told the *Southington Phoenix* that the company expected to pay for this operation in full by the recovery of silver values from the mine.

Intensive mining between 1889 and 1891 continued to yield apparent good news, exaggerated by Cowles' public-relations efforts and newspaper "hype." Very rich veins of ore were struck on the newly re-opened surface workings, the 180-foot level, and the 285-foot level; this last vein yielded ore showing 74% copper and 17% silver. But an ominous note was struck in early 1890, when Charles M. Rolker, a consulting mining engineer and metallurgist, investigated the mine thoroughly and reported to Tillotson that the belief that "a vein increases in richness as it goes down" is "an hallucination," while at the same time, inevitably, mining costs increase with depth (Heitner and Lininger, 1997).

Surely, costs were increasing, and the management, like its predecessor in the 1850's, was spending recklessly. Rapidly climbing costs of pumping and ore recovery in the ever-deepening shaft, as well as a miners' strike and repair costs for broken equipment in the concentration plant, were by the early 1890's putting the company in debt. In September 1892, at the 400-foot level, the miners struck a mass of ore "so nearly pure as to admit of bending," but pumping for these depths had to proceed at a rate of 115 gallons per minute. Copper prices meanwhile were falling, and sales becoming anemic. And despite the fantasies of Cowles, Silliman and the local newspapers, the fact was that this was a fairly small orebody, now rapidly nearing the end of its exploitability. In July of 1893, Edward S. Francis, Treasurer of the company and a cashier for the Pittsfield National Bank, committed suicide; Hurlbert (1897) suggests that he did so because he had "defaulted his home trust" because of his heavy outlay of capital in the mine. Walter Cutting, who had succeeded Tillotson as company President, served to Edgar Hubbell legal papers which attached the mine, machinery and property of the company for $100,000, and the Connecticut courts awarded a judgment against the company, such that Cutting became sole owner on December 5, 1893. Cutting continued to operate the mine into 1894. Its death knell tolled in 1895, as a result of "a classic mining scam" (Heitner and Lininger, 1997) involving the alleged discovery of gold underground. A mining engineer known only as Major Allen was hired, having come highly recommended as a metallurgist and chemist (Domonell, 1991). To show his authority, he discharged several mine employees immediately. At a meeting with the board of directors, Allen confided that there was a body of very rich gold ore deep in the mine; he showed specimens of the ore, and urged that more investment be secured to enlarge the deeper workings downward and laterally. Money was borrowed—but management was suspicious enough to hire detectives, who found that Allen, under an assumed name, had had some mysterious wooden crates shipped in from the west to a freight station near Bristol. Then, of course, he had salted the mine with the "foreign" gold. Allen, his scam discovered, submitted his resignation, but not before Cutting had been swindled out of a large sum; afterwards, Cutting "never wanted to hear the name of the Bristol copper mine mentioned as long as he lived" (Domonell, 1991). This was the end of the Bristol mine in the late 19th century.

There is no record of crystal specimens being recovered during this phase of mining. Heitner and Lininger (1997) write that "a thorough search through the 15-year run of the *Mineral Collector* magazine revealed no new material on the market" from Bristol during the 1890's. Given the tendency of mine management and the local press to trumpet any good or interesting news from the Bristol mine at this time, it is reasonable to infer that no new chalcocite or bornite crystal specimens came to light.

Final Attempts, 1946–1953

For five decades the Bristol mine lay dormant, suffering deterioration and vandalism. Its only good moment during this time was the December 1922 visit of Yale geologist Alan M. Bateman, whose report in *Economic Geology*, entitled "Primary chalcocite: Bristol Copper Mine, Connecticut," expanded understanding of copper sulfide orebodies (see below).

The world wars had brought on copper shortages and high copper prices, and Allen Hearst of Forestville, Connecticut, convinced himself, both that there were still significant ore reserves in the Bristol mine, and that 20th-century technology could profitably extract copper even from low-grade ores at Bristol.

Hearst formed the Connecticut Mining and Milling Company with the express purpose of extracting silver and copper from the tailings on the site. He also undertook some limited dewatering and building. But the fall of world copper prices from their wartime highs finally saw to it that the venture was not successful; the mine was abandoned again in 1953. The property, zoned for industrial use, is now leased by a fuel oil company with a portion of the property used for a rubble dump and equipment storage site. The shafts have been filled and sealed, and access to the underground workings of the deposit will probably never again be possible.

GEOLOGY

The geology of Bristol is relatively straightforward. The ores occur largely along a major fault, the Bristol Fault, which forms the boundary between two major rock types, the Hartland Schist to the west and the Triassic-age red arkose of the Newark Formation to the east. The ores were found both within the fault system and as disseminated grains and blobs in selected sandstone beds of the arkose.

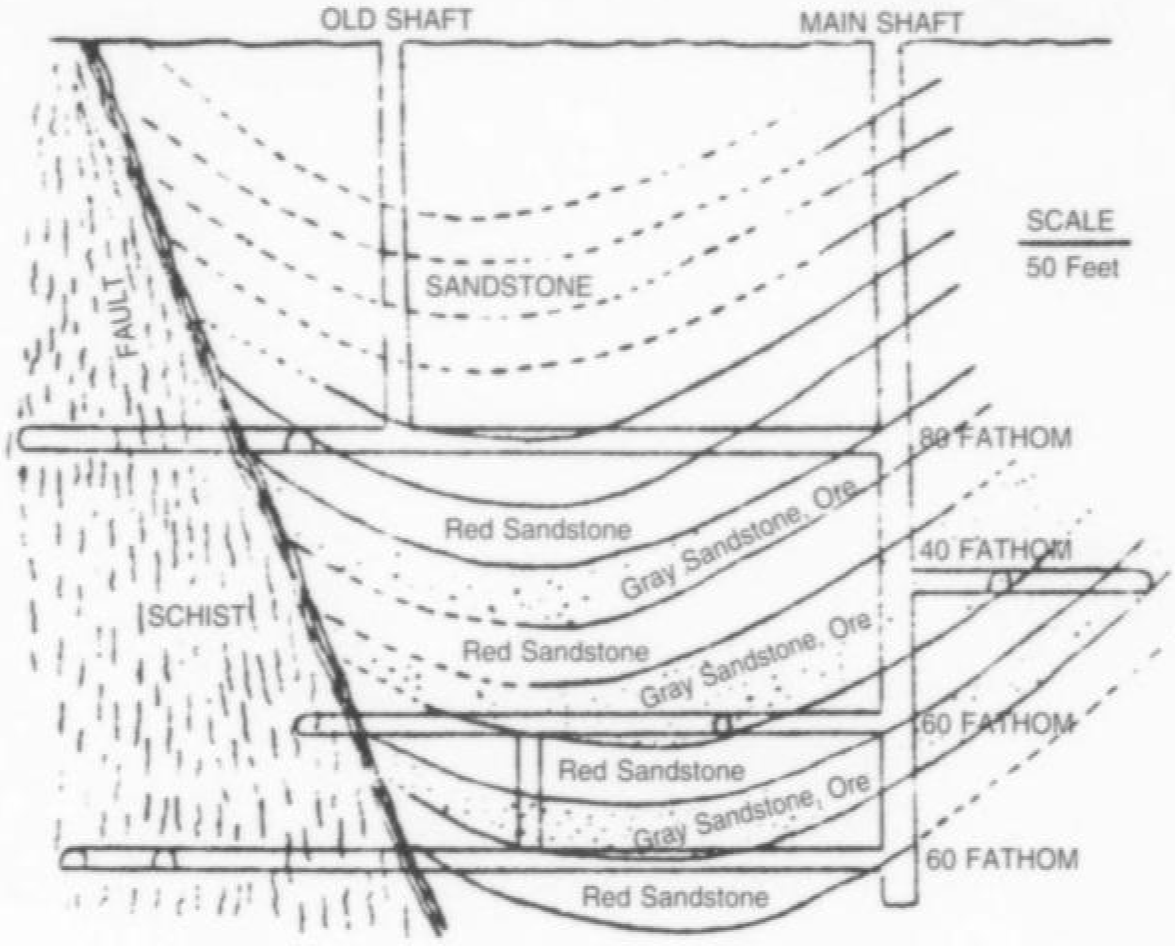


***Figure 9.* Cross-section of the Bristol mine from Ricketts and Banks (1895) showing the Bristol fault and the deformed sandstone beds adjacent to it.**

The Hartland Schist is a highly foliated rock consisting mainly of muscovite, quartz and garnet. It forms the footwall of the deposit, and its material forms the matrix of some specimens. Bateman (1923) reports the following accessory minerals in the schist: plagioclase, biotite, tourmaline, calcite, rutile, kyanite, chlorite and staurolite. Some of the collections viewed for this study revealed discrete garnet crystals in schist from this formation, but these were found outside the deposit. In addition, talc specimens labeled "Bristol" may well have come from outside the ore zones.

In earlier descriptions of the deposit, large "horses" of granite were reported in the ore zone (Silliman and Whitney, 1855). This study found no ore specimens confirmed as having granite attached. The inference is that the horses reported were actually blocks of sandstone from which the iron cementing agent had been leached: discrete crystals, particularly of chalcocite, are seen commonly on gray sandstone from Bristol. The horses are significant in that they created an environment conducive to deposition of ore sulfides, particularly in well-crystallized form. The leached sandstone will be discussed below, as the leaching process, according to Bateman (1923), played a significant role in the deposition of copper.

The Triassic arkose of the Connecticut River Valley, as well as occurrences in New Jersey and Pennsylvania, have been carefully studied and are well-known. The arkose belongs to the larger Newark Formation which crops out frequently in the Northeast, and has yielded some copper in several localities. At East and West Rocks, near New Haven, as well as elsewhere in the Valley, the arkose is overlain by later volcanics, which Bateman (1923) cites as the source of the copper-bearing solutions. Percival (1842) describes the arkose as a coarse sub-talcose granite—an example of the freedom with which the term "granite" was used in the early literature. The arkose consists of quartz and feldspar grains with some mica and chlorite, cemented with red iron oxide, a typical cementing agent of sedimentary rocks.

As already mentioned, copper ore was found in two modes: in rich masses and veins, sometimes with spectacular crystals of chalcocite and bornite, and in the so-called flucan, or fault gouge, filling. The vein system ranged from 6 inches to 3 feet in width, and tended to follow fractures parallel to the schist foliation (Richardson, 1854). Bateman (1923) reported solid copper sulfide on the wall rock of the footwall vein to a thickness of 8 inches and running 50% copper. Ore was also mined as disseminated grains and knobs and in pockets in the sandstone layers permeable to the ore-bearing solutions. The richest disseminated ore was that located closest to the vein system.

The original aqueous ore solutions were rich in copper and carbon dioxide; they also contained sulfur, silver, calcium, gold, lead and zinc (Bateman, 1923). Where they came into contact with the red sandstone, chemical reactions occurred. In comparing the red and gray sandstone arkose, Bateman (1923) found no significant differences save for the color; he concluded that the gray sandstone resulted when the red sandstone had its iron oxide cementing material leached away by the ore solutions. The iron was oxidized by the sulfur "in a continual and gradual manner" (Bateman, 1923), and this caused the solution to grade from cupric to cuprous as controlled by iron oxide availability. The gradual change resulted in the sequential deposition of copper sulfides ranging from chalcopyrite to bornite to chalcocite. Specimens reviewed for this study show the same overlapping sequences as reported by Bateman, with some apparently quite pure end-members being observed. Other specimens show one species replacing another; Posnjak *et al.* (1915) report extensively on this phenomenon. One exceptional example observed several times by this writer was of chalcopyrite in stalactitic form, sometimes a fine yellow, sometimes iridescent, with an inner core of a black mineral assumed to be bornite.

Bateman's study led him to the conclusion that the chalcocite at Bristol is a primary ore mineral. This was significant and important, as the assumption had been that all chalcocite found in copper orebodies was of secondary (supergene) origin. Finally, Bateman (1923) hypothesized that if enough iron oxide had been present to use up the sulfur completely, the ore solutions would have produced native copper much like that found elsewhere in the Newark Formation and in northern Michigan. It is fortunate indeed for the mineral collector that the chemical process stopped at the chalcocite stage, and that the "horses" were present to provide vuggy areas suitable for the deposition of crystals.

MINERALS

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

Azurite was seen only as small blebs and coatings on a few specimens.

Barite $BaSO_4$

The early literature of Bristol touts the superb barites found here, in some cases comparing them favorably with the classic spectacular blades once found at Cheshire, Connecticut. For example, Kemp (1906) refers to "unusually fine chalcocites and barites [which] made the mine famous the world over," and Shepard (1837) describes "white heavy spar in which are embedded perfect crystals of quartz." Examples of these latter specimens were seen during this study. However, fewer than ten Bristol barites were examined in all. Two habits were noted: white, bladed, opaque crystals forming sub-parallel, petal-like groupings; and transparent tabular crystals. None of these resembled the barites typical of Cheshire.

Two Union College specimens are quite attractive, with 2.5-cm white blades free-standing on mottled quartz points (#54), and a 5-cm sheaf of similar bladed barite crystals, again on mottled quartz points (#53). The color of the barite in both cases is a porcelaneous white. Three Yale specimens are also worthy of note. Specimen #1162 is similar to those at Union College save that the blades are

Figure 10. **Bornite crystals to 5 cm, from Bristol. Harvard specimens; R. W. Jones photo.**

Figure 11. **Bornite crystals to 4.4 cm, from Bristol. Yale collection (#799 and #569); R. W. Jones photo.**

smaller and more scattered, while Yale specimens C1156 and C1157 show the square tabular habit. Barite crystals on C1156 are colorless, measure 2 cm, and rest on matrix; crystals on C1157 are pale yellow, doubly terminated, and rest on quartz with minor chalcopyrite.

Bornite Cu_5FeS_4

Bristol is recognized as one of the world's better sources of fine bornite crystals, though they were found there only rarely. Most bornite from Bristol is in the form of massive vein material in layers and stringers throughout the vein system, and as rounded blebs in white calcite or on quartz matrix. When crystallized, bornite shows the typical dodecahedron form (as in the recent very large, sharp crystals from Dzhezkazgan, Kazakhstan). Less commonly it is found in cubes showing slight modifications. Most crystals are slightly to severely rounded, and dull black. Some surfaces are slightly altered, with a steel-blue patina or thin coatings of a green mineral, most likely malachite. A number of specimens seen show bornite coating chalcopyrite, and in some cases replacing it, as in the stalactitic specimens. Some have been labeled as bornite pseudomorphs after chalcopyrite or chalcocite; individual study of these specimens may prove interesting.

The best bornite seen during this study is specimen #569-C1270 in the Yale collection. It consists of two very sharp dodecahedrons, each measuring slightly more than 3 cm, forming a 5-cm group with no matrix. Also in the Yale collection are three crystals mounted on wooden pegs, each showing a different form. Some 30 bornite specimens from Bristol are to be found in the Yale collection, ranging from massive to the fine crystals described above.

The Harvard collection has several Bristol bornites, the best being a fine group of sharp dodecahedrons with individual crystals to 2 cm in a 6.25 x 8.75 cm cluster.

Calcite $CaCO_3$

Quartz may be the most abundant gangue mineral here, but calcite is the most important. Its very frequent association with chalcocite, as tiny scalenohedral crystals, is a feature that distinguishes Cornish from Bristol chalcocite.

Calcite occurs in massive form, as druses of tiny crystals, and as larger crystals. The massive material occurs intimately associated with bornite, and formed simultaneously with it, early in the mineral sequence: salt-and-pepper chunks of this type of ore are common. Fine small calcite crystals in druses and as discrete crystals with chalcocite came later in the sequence—Bateman suggests, in fact, that they were the last to form—and it is when

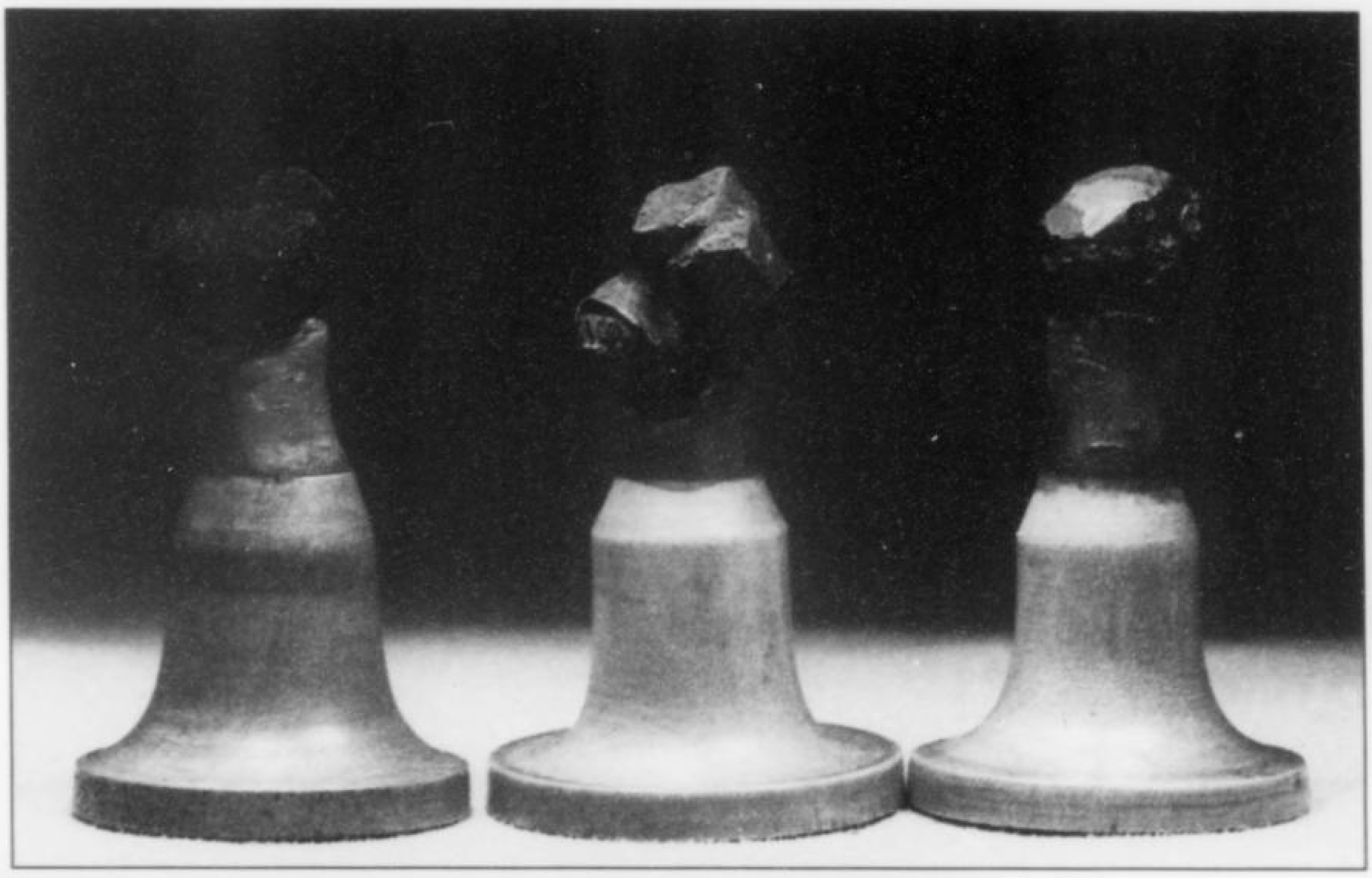


Figure 12. **Bornite crystals to 1 cm mounted on pedestals, from Bristol. Yale collection (#797, #801, #802); R. W. Jones photo.**

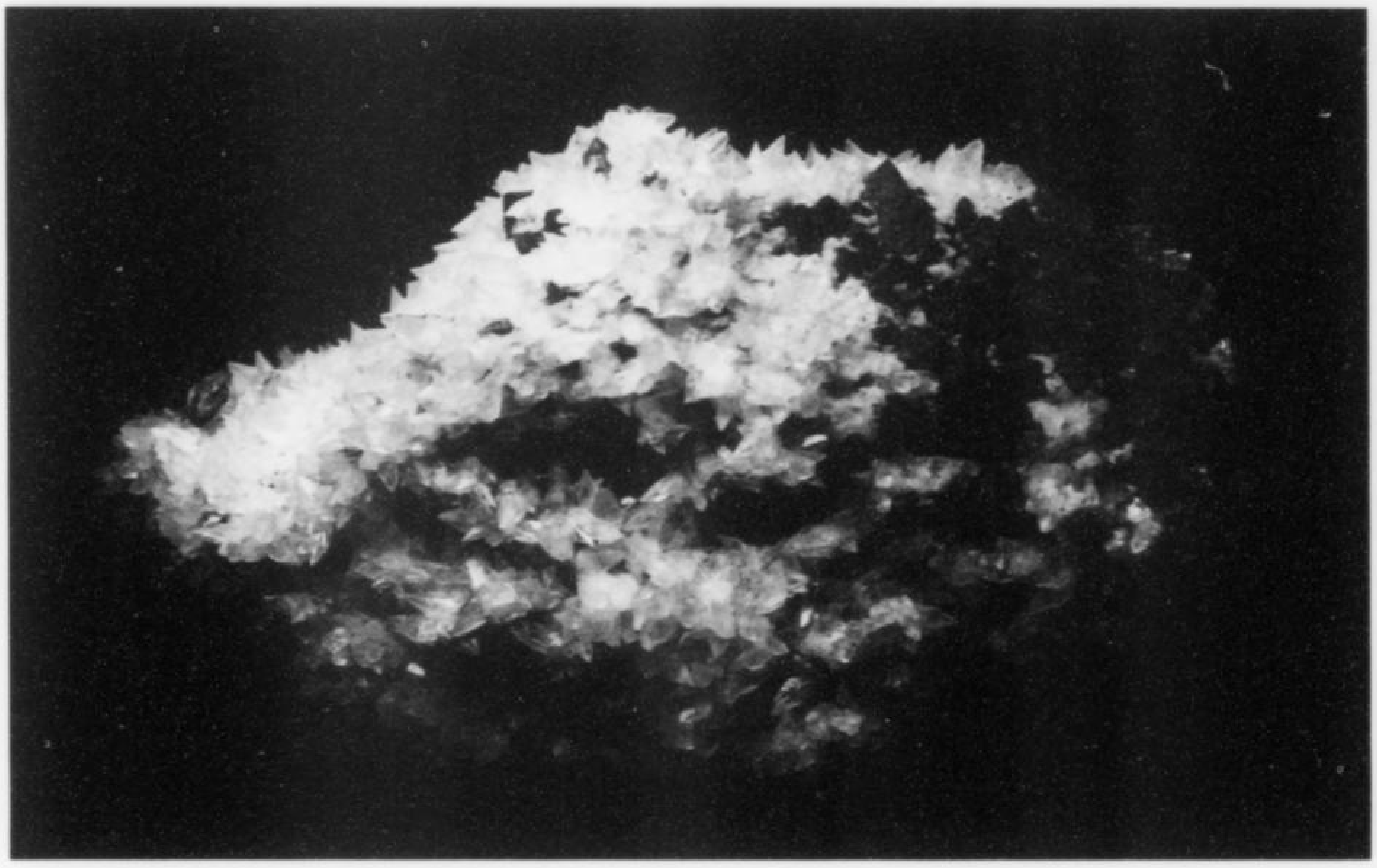


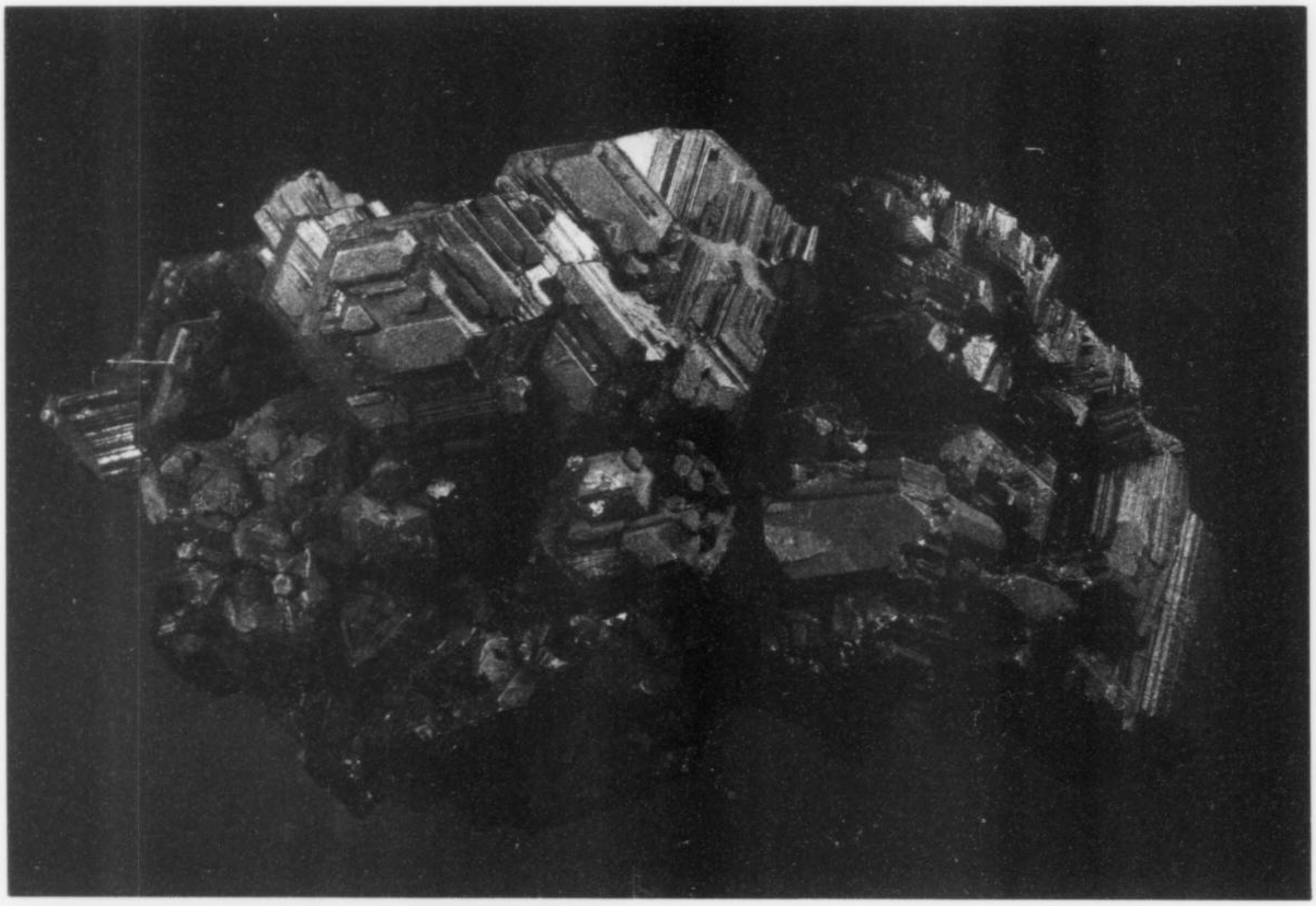
Figure 13. **Calcite crystals on quartz, 15 cm, from Bristol. Union College collection; R. W. Jones photo.**

Figure 14. **Crystal drawing of "nailhead"-habit calcite from Bristol (Dana, 1868).**

these two minerals occur together that they form the finest Bristol specimens. The Pinch/Royal Ontario Museum specimen is one superb example. Another form of calcite, noted here in a specimen from Union College (#286), is a lovely delicate pink color and consists of scalenohedrons in a 3.25-cm subparallel spray free-standing on quartz. Yet another Union College specimen (#319) is similar, but the calcite is white and the quartz has a reddish tinge. The Yale collection has a specimen of the pink calcite (#435), a group of 2-cm crystals. Nailhead calcites occur here as well; the best known is in the Yale collection and is figured in Dana's *System of Mineralogy,* Fifth Edition, Figure 576. The specimen, acquired from Stadtmüller in 1870, has crystals only 6 mm high standing at the end of a plate of smaller calcites. There are several other examples of this type of calcite in the Yale collection.

Chalcocite Cu_2S

Chalcocite specimens from Bristol have been compared favorably with those from Cornwall, England, often considered the premier locality for this copper sulfide. One early writer (Richardson,



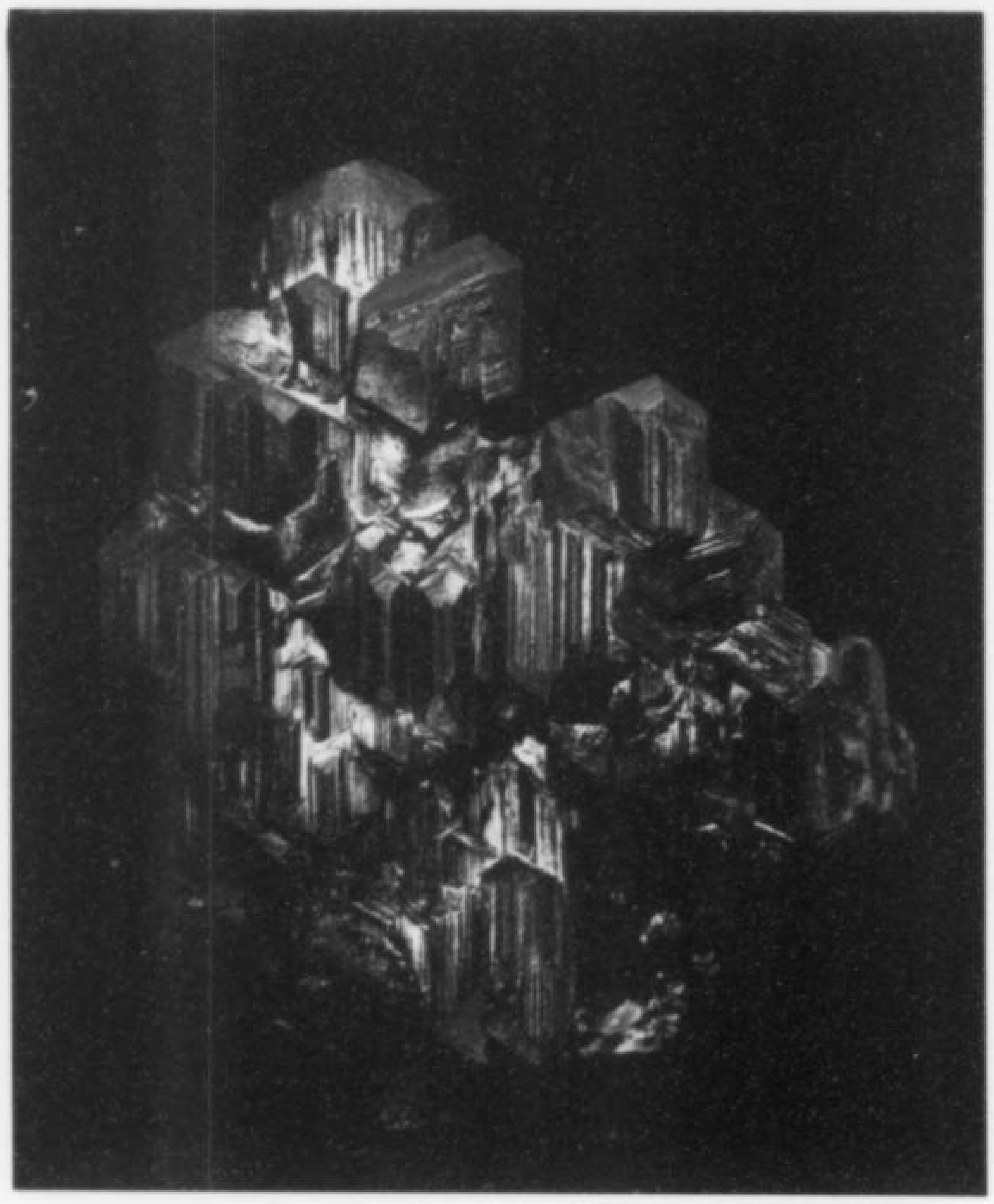


Figure 15. **Chalcocite crystal cluster, 8 cm, from Bristol. Ex–F. John Barlow collection; now in the Houston Museum of Natural Science Collection; Malcolm Hjerstedt photo courtesy of F. John Barlow.**

Figure 16. **Chalcocite crystals in parallel growth, 4.4 cm, from Bristol. James Minette collection; Jeff Scovil photo.**

1854) was so enthusiastic in his reporting that he compared the Bristol deposit with one of Cornwall's best mines, the Devon Consols. In the 20th century, excellent chalcocite specimens have appeared from several other localities: Michigan, Tsumeb, Kazakhstan, Australia, and most especially the Flambeau mine, Ladysmith, Wisconsin. But Bristol and Cornwall are the two great "classic" localities from earlier times. Since they were contemporaries, one purpose of this study was to seek out ways one might distinguish examples from these two deposits.

Bristol chalcocite occurs as superb orthorhombic crystals, many showing twinning. Some are heavily striated, others not so prominently so. Crystals often show a pseudohexagonal symmetry, and discoidal pseudohexagonal crystals are common (as also in some of the Cornwall mines). Tabular crystals also occur in abundance. The largest crystal seen in this study is in the Yale University collection: a 6.25-cm deeply striated crystal with several smaller crystals attached. This is a Stadtmüller specimen (#989-1284). Twinned crystals may be pseudohexagonal, or may be pairs joined on (110) or (032) to form cruciform twins. Most attractive are the "arrowhead" twins wherein tabular crystals join along the (110) faces and are pointed at one end. They are often striated, and often show a small re-entrant angle of matching *e* faces. One fine example, measuring 2 cm, is in the Harvard collection (#82783).

Significant Bristol chalcocite specimens were seen in several collections. The finest privately owned specimen (at the time seen) was in the William Pinch collection, and is now in the Royal Ontario Museum. All the major Yale specimens, as noted, came in

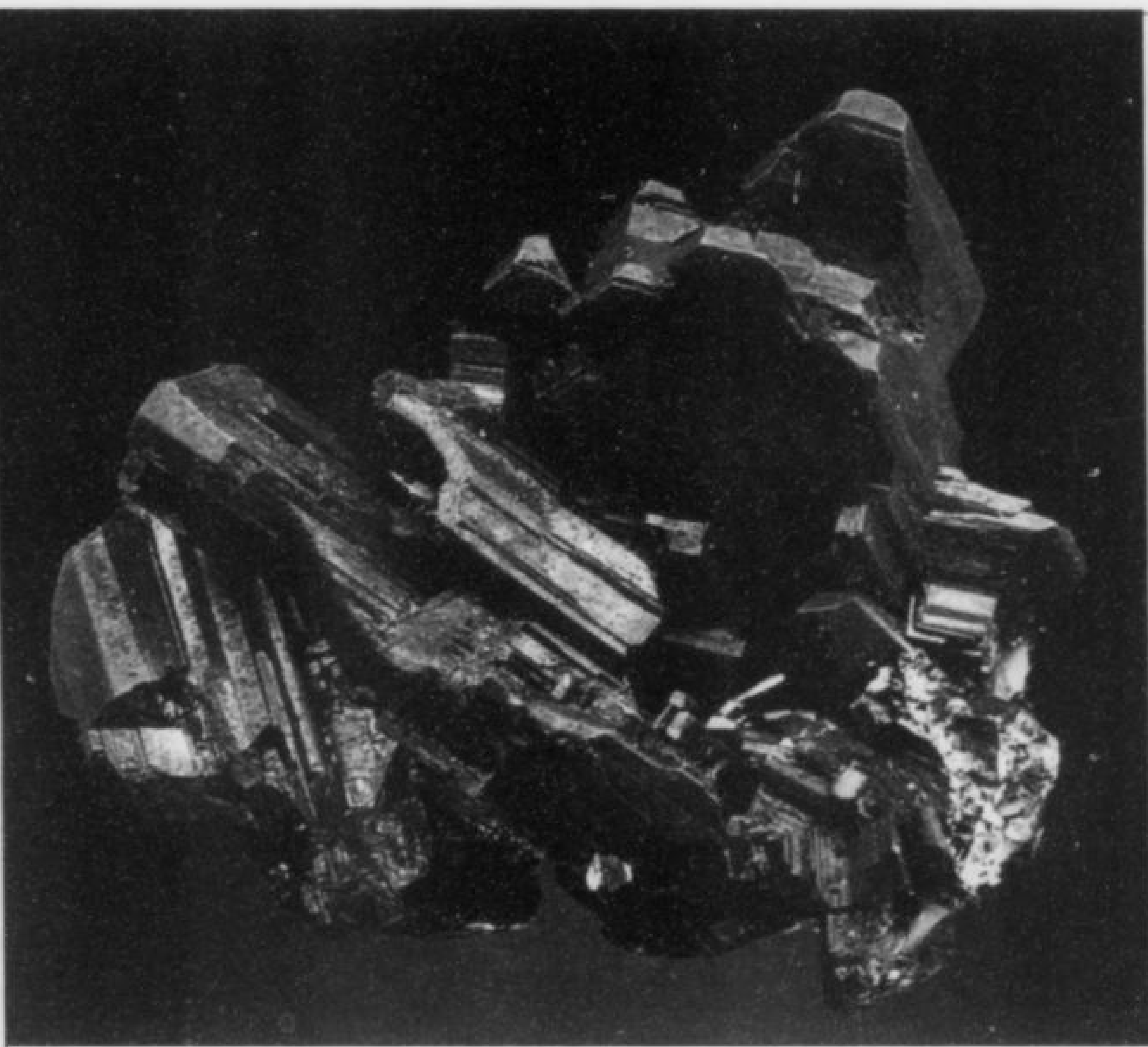


Figure 19. **Chalcocite crystal cluster, 5.6 cm, from Bristol. Ed David collection; Jeff Scovil photo.**

Figure 20. **Chalcocite crystal cluster, 4 cm, from Bristol. Forrest and Barbara Cureton collection; Wendell Wilson photo.**

Figure 17. **Chalcocite 4.1 cm, Bristol. Russell Behnke specimen; Wilson photo.**

Figure 18. **Chalcocite crystal, 4 cm, from Bristol. Kent England collection; Wendell Wilson photo.**

the mid-19th century through Ludwig Stadtmüller, Benjamin Silliman, or (directly or indirectly) Charles M. Wheatley. The collection at Harvard contains several excellent Bristol chalcocites. Of the many specimens preserved at the Smithsonian, two are unusual and noteworthy. Specimen #389-5 is the only example of chalcocite associated with wire silver seen in this study; the silver occurs as fine, hair-like wires with calcite on the chalcocite. The second specimen has a note on its label written by the late collector John Jago, who suggests the presence of freieslebenite, having detected silver and antimony in studies he made of the piece.

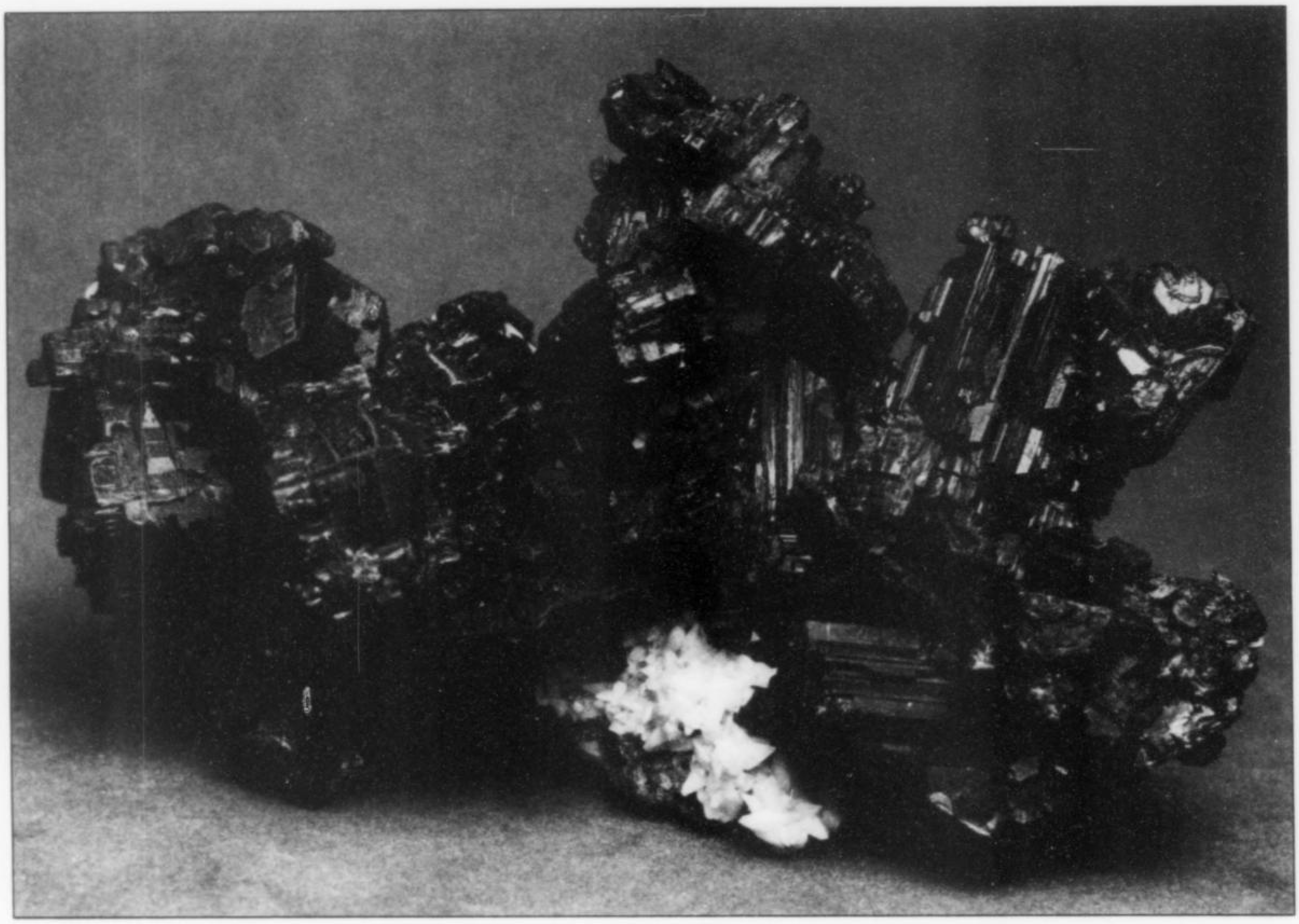


Figure 21. **Chalcocite crystal cluster, 11.5 cm, with calcite crystals, from Bristol. Royal Ontario Museum collection; S. C. Chamberlain photo.**

Chalcocite was one of the last ore minerals to form at Bristol, along with calcite in tiny white scalenohedral crystals, barite, and quartz. When present, the small white calcite crystals, commonly on a quartz layer but also appearing directly on the chalcocite, seem diagnostic for the locality, as no such association was found on any Cornwall specimens checked. The Cornwall specimens often show a flat "schiefer-type" calcite, distinctly different from the Bristol calcite. Specimen BM1905,207 is one such example on display at the Natural History Museum, London (Embrey and Symes, 1987).

Frequently observed in this study, and also mentioned by Embrey and Symes 1987), is a black, sometimes bronzy, very soft soot-like coating on crystals of chalcocite. Its exact identity is currently unknown, but it may be djurleite. Some collectors say that this sooty coating can be easily removed by a quick wash in a weak phosphoric acid solution, followed by a thorough rinse and neutralization. (As we cannot personally vouch for this method, it would be wise to experiment first on a low-value fragment before attempting to clean a high-value specimen.)

Chalcopyrite $CuFeS_2$

Chalcopyrite is ubiquitous in the Bristol vein system. It occurs as small grains in the rock, and as discrete crystals showing the normal tetrahedron form, usually on white quartz on schist. It is often iridescent. In one specimen at Wesleyan University, Middletown, CT (#2646), 1.25-cm chalcopyrite crystals are associated with massive pyrrhotite. One Union College specimen (#121) shows chalcopyrite associated with white barite replaced by quartz; another Union College specimen (#60) has several fine rosettes of small crystals, the rosettes ranging up to 2.5 cm across, coated with a thin dusting of bornite. This combination was seen time and again during this study.

Chalcopyrite also occurs commonly in mammillary form at Bristol, with knobs to 2.5 cm or more, jutting from thick massive crusts of the mineral. The chalcopyrite has a hackly surface and a dull luster, and is often coated with iridescent bornite. The most unusual form of chalcopyrite observed in this study does not seem to have been reported in the literature on the deposit. Specimens at Yale, Union College, Wesleyan and Harvard all show stalactitic or tube-like, curving forms, sometimes associated with club-like growths. Some of the tubes are hollow, or have black (bornite?) cores; they are often coated with bornite, and may be iridescent. They range from toothpick-sized to pencil-sized. No other mineral save bornite seems to be associated with this form of chalcopyrite at Bristol.

Bristol chalcopyrite is associated with a greater variety of minerals than any other species in the deposit. It can occur with quartz, calcite, bornite, barite, dolomite, siderite, galena, sphalerite, and rarely with chalcocite. Bateman (1923) also reports chalcopyrite associated with covellite, but only in his thin section studies.

Copper Cu

There are some reports of copper occurring in the Bristol ores but none was seen during this study. Specimens of native copper, and native gold as well, reportedly found during the promotional days of the very late 1800's, were likely the result of salting by the promoters. One newspaper account of 1889 mentions a Mr. Elijah

Figure 22. **Botryoidal chalcopyrite, 11.4 cm, from Bristol. Union College collection; R. W. Jones photo.**

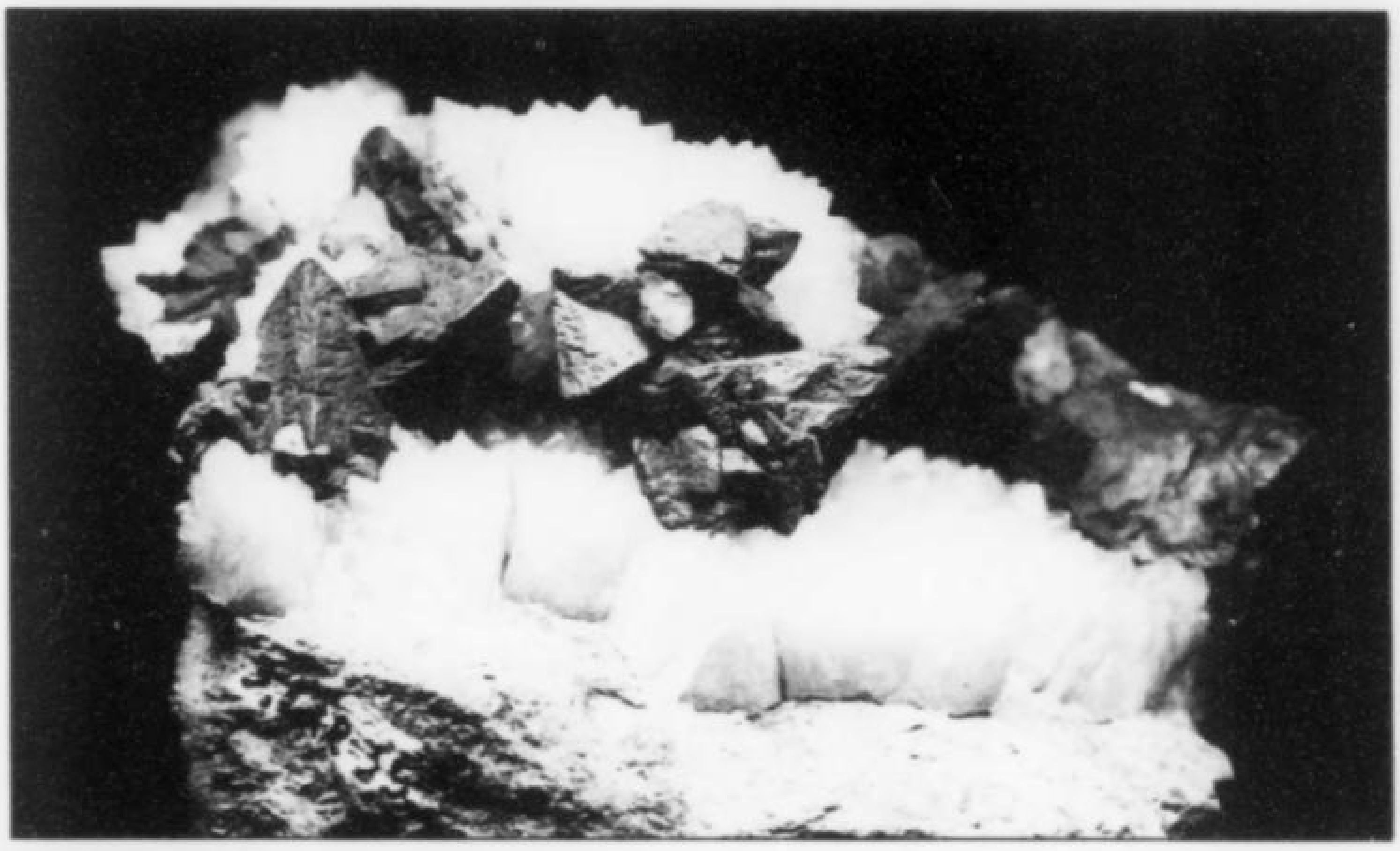


Figure 23. **Chalcopyrite crystals to 1.3 cm on quartz, from Bristol. Union College collection; R. W. Jones photo.**

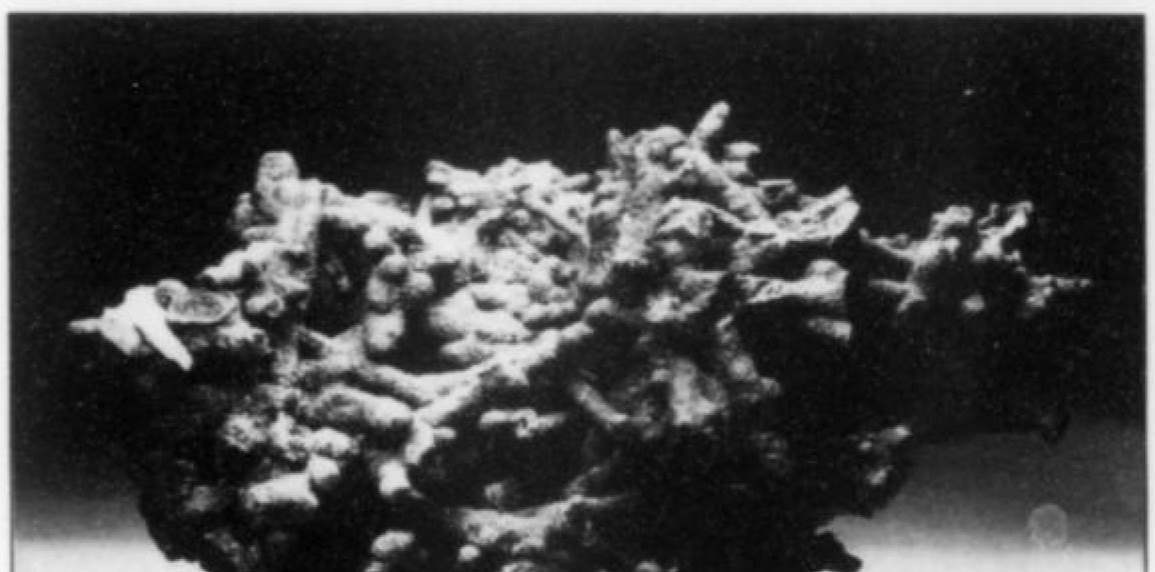


Figure 24. **"Stalactitic" chalcopyrite, 10 cm, from Bristol. Harvard collection; R. W. Jones photo.**

Roberts, formerly of the Lake Superior copper region, as working at the mine. Accounts by Harte (1944) and Peck (1932) refer to native copper, and more particularly native gold (see also Perry, 1975) appearing during the 1890's promotional period.

Another name that surfaces has already been mentioned: Mr. Allen, the former Western miner. Peck reports that the mysterious boxes shipped to Allen from the West during his tenure as mine captain were of great weight. One only has to read the skeptical accounts in newspaper articles of the time to realize that reports of quantities of native copper and native gold being found during this time period were at the least overenthusiastic and at worst downright hogwash. However, Moore (1999) mentions seeing some native copper specimens from Bristol in the Yale collection.

Covellite CuS

Bateman (1923) mentions covellite as seen only in thin section studies. He suggests that the lack of covellite is a significant indicator in the paragenesis of the deposit.

Cuprite Cu_2O

Schairer (1931) mentions cuprite from Bristol, without details. None was seen in this study.

Digenite Cu_9S_5

Specimen #1839 at Wesleyan is labeled "chalcopyrite and digenite." The label is dated 1883 and has no documentation to support the species attribution. No other specimens of this mineral were seen during this study, although it is speculated that some of the sooty coating may prove to be either digenite or djurleite.

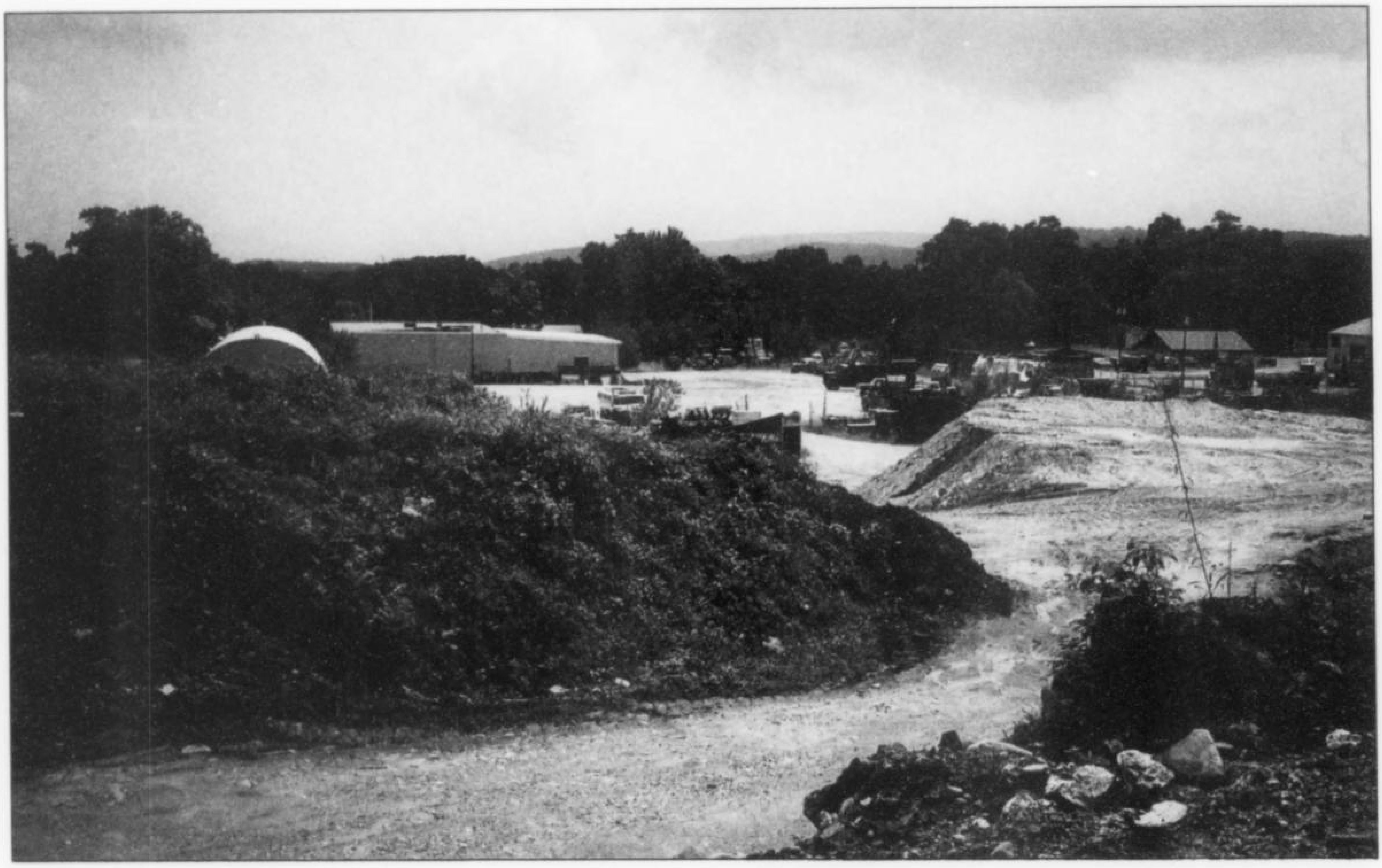


Figure 25. **The Bristol mine area today. R. W. Jones photo.**

Dolomite $CaMg(CO_3)_2$

The Yale collection contains at least one example of dolomite from Bristol. Specimen #442 shows 2-cm curving crystals of white to tan color associated with chalcopyrite. Another specimen (#426) is labeled quartz but is clearly dolomite, with crystals to 3 mm on a 5 x 7-cm matrix.

Galena PbS

Hurlbert (1897) reports that galena at Bristol is silver-bearing. He describes "a stratum of galenite carrying a wonderfully rich percentage of silver [with] zincblende and striking ores of copper." Only one galena specimen was examined during this study—Yale #60-C1644-734. It consists of simple 2.5-cm cubes with minor octahedral modification. Small quartz crystals are implanted on some of the galena faces, and chalcopyrite is associated.

Malachite $Cu_2(CO_3)(OH)_2$

Malachite occurs as green coatings on bornite. Thin stringers of a green mineral seen in massive bornite are probably also malachite. The best Bristol malachite specimens are in the Wesleyan University collection in Middletown, Connecticut. Specimen #8719 is a 10 x 12.5-cm plate of rock with the upper surface covered with pale green botryoidal malachite bubbles measuring up to 1 cm across. Specimen #4568, the best seen in the course of this study, is a 2.5 x 3.5-cm fibrous mass of the green mineral.

Pyrite FeS2

Bateman reports massive pyrite, and one specimen of a distorted pyritohedron, but a search of the Yale collection did not reveal the piece.

Quartz SiO_2

Quartz is the most common gangue mineral in the deposit: foot-wide massive veins have been reported in the vein system. Bateman (1923) reports that this is low-temperature quartz. The mineral is most often seen as comb-like layers of crystalline material formed directly on the rock, a palette upon which Nature has arranged finely crystallized ore minerals. Some of the nicest specimens from Bristol are crystals of chalcocite on comb quartz, or intergrown with quartz. Discrete quartz crystals were also found, as small prisms terminating in rhombohedral faces. Union College specimens #53 and #54 both show layers of quartz points to 1 cm, mottled gray-white and completely covering the rock matrix; perched on the quartz are barite blades of exceptional form. A third Union College specimen (#121) is a boxwork of white quartz which may well be a pseudomorph after barite, with minor chalcopyrite. The entire specimen is a 10 x 15 cm mass, with blades to 3 cm across. Harvard specimen #117773 is similar, with blades to 1 cm, and minor calcite and chalcopyrite.

Silver Ag

Silver was one of the minor but important ore minerals at Bristol. Its presence is reported often in the old literature, but only one specimen was seen during this study (as already mentioned). Smithsonian specimen #C389-5 consists of small chalcocite crystals intergrown with white scalenohedral calcite crystals to 4 mm long; the silver is seen as hair-like wires to perhaps 5 mm projecting from the chalcocite, and also as suspended networks of hairs across the calcite. Early assays of Bristol ore done by LeDoux and Company, New York, and reported in the *Bristol Herald* (November 21, 1889) describe silver ore assaying 17–23 ounces per ton. Remember, however, that this too was during the promotional days.

Sphalerite ZnS

Seen only sparingly in this study, sphalerite occurs at Bristol with chalcopyrite or quartz. Yale specimen #906-C2220 is a fine interpenetrating twin of very pale yellow color, showing a typical resinous luster, with chalcopyrite. Crystals of this type, famously found at Franklin, New Jersey, were once referred to as "cleiophane" and have a very low iron content. There is a similar Yale specimen (#907-C2221) of pale yellow resinous crystals to 5 mm, with bornite on quartz.

Other Minerals

Some gangue and accessory minerals, including muscovite, biotite, garnet and tourmaline, were seen only as grains in rock, or else were mentioned in the literature or collection catalogs but were not available for study. Still others, such as talc, garnet and magnetite specimens seen at Yale, were simply labeled Bristol and could well have come from other occurrences.

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Bolivia

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Bolivia, a landlocked nation three times as large as Montana, has been producing great mineral wealth since pre-Incan times, and remarkable mineral specimens for the last century and a half. Over the years, inadequate documentation, inaccurate copying, and deliberate falsification have introduced much corruption into Bolivian specimen labels. We hope to reduce the confusion with this gazetteer.

INTRODUCTION

Most people think of Bolivia as a land of great mountain ranges and high cold plains much resembling Tibet, but this description only fits the southwestern third of Bolivia. The two thirds of the country to the north and east are tropical lowlands, ranging from hilly to completely flat, and covered with swamps, prairies, thorn forests and Amazonian jungle. Geologically this vast area (roughly the size of Texas) is an extension of the Brazilian Shield, formed mainly of Precambrian granites and schists. Most of the Bolivian part of the Brazilian Shield is buried up to 3 kilometers deep by the sediment that has been washing down from the Andes Mountains ever since they rose in late Cretaceous times. This "Green Hell" thrills the hearts of biologists but is depressingly barren for the mineral collector. Luckily, Precambrian shield rocks are still exposed in the hilly areas of central and eastern Santa Cruz Department, and smaller areas of Beni and Pando Departments. Although these rocks have been far less explored than their counterparts across the border in Brazil, interesting mineral deposits have been discovered here over the last fifty years, including numerous pegmatite districts with beryl and tantalum minerals, several amethyst deposits (including the unique La Gaiba "ametrine" district), and the world's largest carbonatite outcrop, Cerro Manomó. The northeastern two thirds of Bolivia contains the fastest growing regions; industrial development will surely unearth new and more diverse mineral deposits.

The highland part of Bolivia is much better known to mineral collectors, because of the abundance and variety of antimony,

Figure 1. **Location map showing some important localities in Bolivia.**

bismuth, silver, tin and tungsten minerals. The Andean Cordillera runs 8,000 kilometers from Venezuela to Tierra del Fuego along the entire western side of South America, but reaches its widest development in Bolivia, where it splits into two parallel mountain chains: the Cordillera Occidental (Western Andes), forming the border between Bolivia and Chile, and the Cordillera Oriental (Eastern Andes), The Cordillera are separated by the Altiplano, the high plains (3,600 to 4,500 meters above sea level) covered by llama grazing lands, lakes, and salt flats, including the Salar de Uyuni which, at 12,000 square kilometers, is the largest salt flat in the world. The famous Bolivian "tin belt" runs down the western flanks of the Eastern Andes and in "island" mountains in the Altiplano, from southern Peru to northern Argentina.

The Eastern Andes are composed mainly of a monotonous series of Paleozoic and Cretaceous sediments. About the latitude of Cochabamba (17°S) there is a bend in the Andes; north of the bend the Andes run northwest-southeast, but south of the bend they run north-south. This bend is called "el codo (the elbow) de los Andes," and there are interesting differences in the mineral deposits north and south of this "elbow." To the north, in La Paz Department, there are large granitic batholiths intruding the Paleozoic sediments. The many tin, tungsten and bismuth deposits here are mainly associated with the batholiths and the hornfels and slate aureoles around them. There are no significant silver deposits. South of the "elbow" there are few batholiths, and most of the minerals are found in Tertiary subvolcanic deposits (i.e. formed under extinct volcanos) which, in addition to holding the tin, tungsten and bismuth, also hold large quantities of silver minerals. The most famous of these subvolcanic deposits are Oruro, Potosí, Llallagua, and Colquechaca, but there are 40 of them altogether. Some Sn-Ag and Bi-W deposits, such as Colquiri, Huanuni, Poopó and Tazna, have mineralogies remarkably similar to those of the subvolcanic ores even though they are not associated with volcanoes. A great diversity of antimony sulfosalt species (and to a lesser extent Bi- and Ge-sulfosalts) is characteristic of the ores south of the "elbow," whereas arsenic sulfosalts are almost nonexistent. North of the "elbow" one finds more enargite and other arsenic sulfosalts; these deposits resemble the polymetallic orebodies of Peru.

Apart from the complex Sn-Ag-Bi-W ores of the "tin belt," the Eastern Andes also holds hundreds of gold and stibnite veins in quartz gangue. And there are literally thousands of galena-sphalerite-chalcopyrite veins in siderite and barite gangue. The mineralogy in these mesothermal siderite-barite veins tends to be simple and holds little of collector interest. Notable exceptions are the two unique selenide veins of Pacajake and El Dragón.

In the Altiplano, west of the tin belt, is a parallel belt of copper deposits. Secondary minerals are not well-developed in these copper mines. The most famous collector-interest specimens here are the copper pseudomorphs after aragonite from Corocoro.

Unlike in Arizona or Tsumeb, colorful secondary oxide-zone minerals are generally only poorly developed in Bolivia, with very few such species being of collector interest. Since colorful phosphates are characteristic of many oxide zones worldwide, it has been falsely assumed that the beautiful Bolivian phosphates like phosphophyllite, vivianite, ludlamite and vauxite are oxide zone minerals. In reality they are always associated here with fresh unweathered sulfides in the deepest levels of Sn-Ag mines, hydrothermally deposited, far from any oxide zone. The excellent valentinite crystals found at several Bolivian mines, and even the Lomitas mimetite and austinite, are hydrothermal rather than secondary oxides!

The host rock for hydrothermal ores in Bolivia is almost always volcanic rock, sandstone or shale. Carbonate-hosted ores (as in Tsumeb, Laurion, Mississippi Valley Type, etc.) are insignificant in Bolivia, and calcite is rare in the gangue. Without the neutralizing action of calcite and dolomite, weathering of sulfides produces extremely acidic solutions, carrying metal ions out of the oxide zone. This may explain the paucity of well-crystallized secondary minerals in the Bolivian Andes.

The Western Andes are much younger than the Eastern Andes, being formed of Tertiary, Pleistocene and Recent volcanic rocks rather than sediments. (The Altiplano formed after the Western Andes grew, cutting off sediment transport westwards to the Pacific, leading to deep accumulation of sediments in the closed basin between the two Andean chains.) The Western Andes have numerous large deposits of native sulfur with other fumarolic minerals. There are also several mining districts with Cu-Ag-Au ores in veins and disseminated in altered volcanic rocks. Finally, the salt pans in the Altiplano at the foot of the Western Andes hold the world's largest supply of evaporite minerals, including ulexite and lithium-rich brines.

POLITICAL GEOGRAPHY

Bolivia historically has been divided into nine departments, which were in turn divided into 112 provinces, 294 sections, and 1408 cantons. Recently the nation has been redivided into municipalities that roughly follow the old section lines. This division has been too recent to appear on mineral labels or references, or on maps available in U.S. libraries. The sections and cantons as such play no part in the following table, and only 52 of the provinces in 7 departments figure here. The department names are unambiguous, but not so the province names; there are four Cercados, two Saavedras, and a Carangas, Nor Carangas, and Sud Carangas (lest the American reader take umbrage with these complexities, note that there are thirty Washington Counties in the U.S.). Because some provinces have been subdivided, it is possible that specimens from the same mine may be reported as from two different provinces; the province given here is the current one.

We have encountered labels that have quoted compound names differently (usually due to English speakers' unfamiliarity with the Spanish patronymic) such as Dalence, Pantaléon Dalence (also correct), Pantaléon Dalence Jiménez (also correct), and Jiménez (incorrect). For this reason those compound provincial names that might cause confusion (especially with an alphabetic lookup) are listed below with the accepted form that we use in **bold**.

Department	*Provinces*
Cochabamba	Marciso **Campero** Leyes
La Paz	José Ramón de **Loayza**
	Pedro Domingo **Murillo**
	José Manuel **Pando** Solares
	Juan Bautista **Saavedra** Mallea
Oruro	Eduardo **Avaroa**; but some times called Challapata
	Pantaléon **Dalence** Jiménez
	Puerto de **Mejillones**
Potosí	Rafael **Bustillo**
	Daniel **Campos** Cortez
	Tomás **Frías** Ametller; but sometimes called Cercado
	José Alonso de **Ibañez**
	José María **Linares** Lizarazu
	Modesto **Omiste**
	Antonio **Quijarro** Quevado
	Cornelio de **Saavedra**
Santa Cruz	Germán **Busch** Becerra
	Ñuflo de Chávez
	Angel **Sandoval**
	José María del **Velasco** Franco

Readers will occasionally encounter labels with the name of a vein ("veta"); these may or may not be identified as such, and they may or may not have the name of the associated mine or district. We provide the following list to make the needed association, with the caution that popular names like San José and Salvadora may apply to several different veins and several mines, all quite independent.

Vein	*Mine*
Bismarck	Siglo XX
Blanca	Siglo XX
Bronce	Oruro town
Colorada	Chocaya
Contacto	Siglo XX
Coro	Siglo XX
Cotamitas	Cerro Rico
Crucero	Morococala
Embudo	Colquechaca
Exaltación	Pazña district
Farellon	Tazna
Ferrier	Chacaltaya
Francke	Chorolque
Gallofa	Colquechaca
Gabriel	Tazna
Grande	La Colorada
Inca	Colquiri
Irruputuncu	Porco
Krause	Cerro Rico
La Vieja	Animas
Lisi	Tazna
Negra	Laurani
Pie de Gallo	Porco
Plata	Siglo XX

Vein	*Mine*
Plomo	Chacaltaya
Purisima	Oruro town
Recorte Grande	Chacaltaya
Reggis	Siglo XX
Rosario ("Section")	Aceromarca
Salvadora	Siglo XX
San Carlos	Chalcaltaya
San José	Siglo XX
San Juan	Animas
San Luis	Oruro town
San Pedro	Siglo XX
Serrano	Siglo XX
Tajopolo	Siglo XX
Verde	San José Mine, Oruro

There are many Bolivian mines with the same name; this is especially true for Saints' names. We distinguish them by appending a numerical suffix: San Felipe 1, San Felipe 2, etc.

In the following table, mineral species are ascribed to mines, and to larger entities such as towns, cities, and districts. If a mineral, such as alunite, is ascribed to a mine, such as the San José at Oruro, it is not automatically ascribed to the larger entity (Oruro). The minerals ascribed to the larger entity are from labels that did not specify a mine name—as is often the case, unfortunately. If the species on your label is not on the list for the larger entity, check the mine names following "See . . . ."

If you cannot find your locality in the following table, add or delete *el, la,* or *los.* A mountain might be under its proper name, or it might have *Cerro, Nevada,* or *Volcán* preceding it. Delete *Mina* which means *mine.* Watch out for letter slippages: i for y, s for z, k for c, or h for g.

We have encountered "Bolivian" specimens that were collected before the locality was annexed by a neighboring country. Between 1868 and 1938, Bolivia was reduced by over a million square kilometers in cessions to Argentina, Brazil, Chile, Paraguay and Peru; as far as we can tell, significant mineral localities occur only in the losses to Chile (e.g. Caracoles), and Argentina (e.g. Pululus). We have not included these localities in our table. Well after the loss of the Atacama desert to Chile in the War of the Pacific (1879–1884), the Chuquicamata mine was developed; what might this mine have done for the Bolivian economy?

The distances provided are only approximate; some were estimated from maps that are known to have mis-located towns by as much as 10 minutes of arc (approximately 18 km).

SOURCES

Approximately 4,525 Bolivian specimen records were examined, from seven major repositories of Bolivian minerals. As was expected, many errors were encountered; there were even obvious cases of deliberate misidentification of the locality. We also had access to several thousand entries in the Herzenberg and Ahlfeld collection catalogs. We cannot, of course, guarantee anything like absolute accuracy for our compilation, but we did require that the match of specimen-to-locality meet at least a plausibility standard. Much use was made of the acronym BIKONRISNOT: "But I know of no reason it should not occur there"; when a locality known to have bismuth also has bismite ascribed to it, bikonrisnot is about all one can say. On the other hand, "proustite" is most implausible as a constituent of an Oruro vein system; with no further confirmation, such an attribution would be discarded.

The following publications on Bolivia were consulted frequently:

AHLFELD, F., and Schneider-Scherbina, A. (1964) *Los Yacimientos Minerales y de Hidrocarburos de Bolivia.* Ministerio de Minas y Petróleo, La Paz.

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ANTHONY, J. W., BIDEAUX, R. A., BLADH, K. W., and NICHOLS, M. C. (1990–2000) *Handbook of Mineralogy,* 4 vols., Mineral Data Publishing Company, Tucson.

COOK, R. B. Jr. (1975) The mineralogy of the Department of Oruro, Bolivia. *Mineralogical Record,* **6**, 125–137.

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GAINES, R. V., SKINNER, H. C. W., FOORD, E. E., MASON, B., and ROSENZWEIG, A. (1997) *Dana's New Mineralogy.* Eighth edition. John Wiley & Sons, New York.

PALACHE, C., BERMAN, H., and FRONDEL, C. (1944, 1951) *The System of Mineralogy of James Dwight Dana and Edward Salisbury Dana. Yale University 1837–1892.* Seventh edition. Vol. I and II, John Wiley & Sons, New York.

RIVAS, S., and AHLFELD, F. (1998) *Los Minerales de Bolivia y sus Parajes.* 2 volumes, Santa Cruz. (This is basically a rehash of Ahlfeld 1955 with some newer localities added.)

USGS (1992) Geology and mineral resources of the Altiplano and Cordillera Occidental, Bolivia. *U.S. Geological Survey Bulletin* **1975**.

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Bolivian Minerals and Localities

* = Type Locality *(?) = Type Locality Disputed

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Aceromarca	Mine		Mururata 2 District, Sud Yungas Prov., La Paz Dept., E slopes Taquesi batholith	Pyrite, pyrrhotite, scheelite, sphalerite, tourmaline, wolframite

Bolivian Minerals and Localities *(continued)*				
		* = Type Locality		*(?) = Type Locality Disputed
Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Aguas Calientes	Village		Arque Prov., Cochabamba Dept., on the RR	See La Salvadora 2
Aiquile	Town		135 km SE of Cochabamba, Campero Prov., Cochabamba Dept.	See Santa Marta
Alasca	Mine		2 km from Pongo	Cassiterite, pyrrhotite, scheelite
Alcacoya	Mine		San Vicente	Stibnite
Aliada	Mine		Colquechaca	Teallite
Alto Chapare	District		Chapare Prov., Cochabamba Dept., ~30 km W of Villa Tunari	Aegirine, aragonite, boracite, danburite, dolomite, dravite, ericaite, hematite, *magnesioriebeckite ("crocidolite"), magnesite, microcline, *povondraite, pyrite; see Limbo
Amayapampa	Town	18°29′ 66°26′	Bustillo Prov., Potosí Dept., 40 km SE of Uncía, near Chayanta	Gold, pyrite
Amigos	Mine		Sud Lípez Prov., Potosí Dept.	Stibnite
Amutara	Mountain		Inquisivi Prov, La Paz Dept., 30 km NW of Chicote	Wolframite
Anahi	Mine		Near La Gaiba	Quartz (ametrine)
Ancohuma (west side)	Peak 6550 m	15°50′ 68°35′	Primary peak of Illampú massif, Larecaja Prov., La Paz Dept.	Bismuth, bismuthinite, orthoclase, rutile
Ancoma	Town	19°07′ 65°41′	Larecaja Prov., La Paz Dept., 20 km NE of Sorata	See Polo Sur, (The) Consolidated
Ancoraimes	Town	15°54′ 68°58′	Omasuyos Prov., La Paz Dept., 113 km NW of La Paz, on shores of Lake Titicaca	Hübnerite, realgar; see Magariñas
Andacaba	Mine, district		30 km SSE of Cerro Rico, in Kari-Kari range, Linares Prov., Potosí Dept.	Arsenopyrite, boulangerite, canfieldite, cassiterite, cerussite, galena, *potosíite, pyrite, siderite, sphalerite, wolframite; see Santa Barbara
Andamarca	City	18°46′ 67°31′	Sud Carangas Prov., Oruro Dept., 105 km SW of Oruro	See Calama
Andina	Mine		Mururata 2 district	Cassiterite, wolframite
Animas	Mine, village	20°57′ 66°33′	Animas-Chocaya sub-district	Apatite, *aramayoite, argyrodite/canfieldite, bismuthinite, cassiterite, *(?)franckeite, freibergite, galena, hocartite, jamesonite, marcasite, miargyrite, pyrite, quartz, siderite, stannite, stephanite, tetrahedrite, wurtzite, zinkenite; see Chocaya, Gran Chocaya.
Animas-Chocaya	Sub-district		Part of Atocha-Quechisla district	See Chocaya, Oploca 1, Siete Suyos, Animas, Chocaya Grande
Antequera (also called El Salvador, Bolivar)	Mine, village	18°28′ 66°50′	Pazña Dist., 13 Km SSE of Poopó, Poopó Prov., Oruro Dept.	Cassiterite (needle tin), greenockite, pavonite, sphalerite, stannite, teallite, wurtzite, zinkenite; see Venus, Cerro Chunchu
Antofagasta	Mine		Oruro Dist.	Stibnite with interstitial gold
Araca	Town			See Viloco
Ascensión	Mine		Condeauque district	Azurite, barite, cerussite, hemimorphite, minium, scheelite, siderite, smithsonite
Asiento				See Quioma
Asiento de Araca	town		8 km WNW of Viloco	See Rosario 1
Asunta	Mine		4 km NE of San Vicente	Franckeite, greenockite, stannite

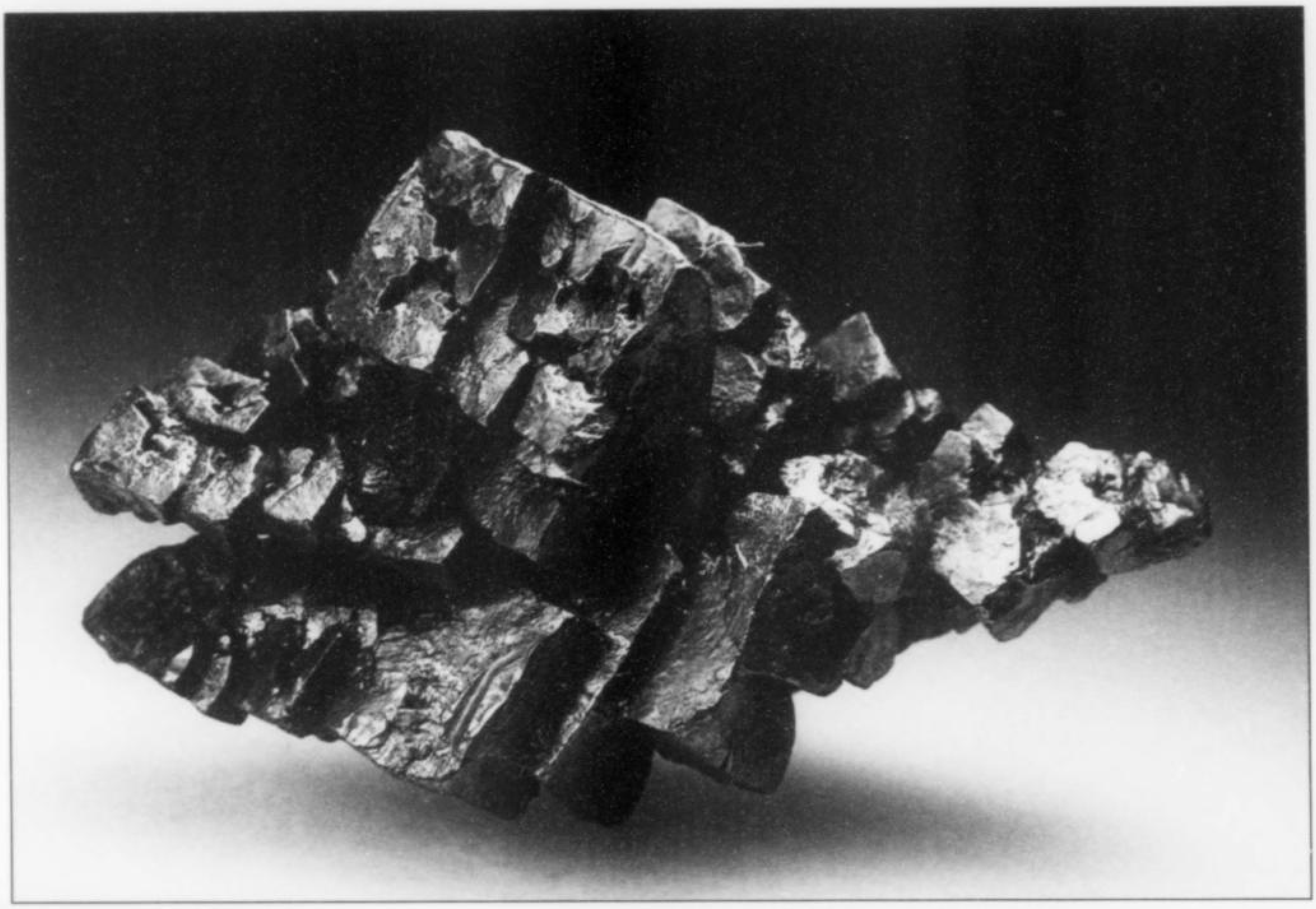

Figure 2. **Acanthite crystals in parallel growth, 6.2 cm, from Colquechaca. Gene Schlepp specimen, now in the Carnegie Museum of Natural History collection; Wendell Wilson photo.**

Figure 3. **Ferberite crystal, 2.2 cm, with quartz, from the Chicote Grande mine. Ralph Clark collection; Jeff Scovil photo.**

Figure 4. **Phosphophyllite crystal, 3.7 cm, on matrix from Cerro Rico, Potosí. William Larson collection; Wendell Wilson photo.**

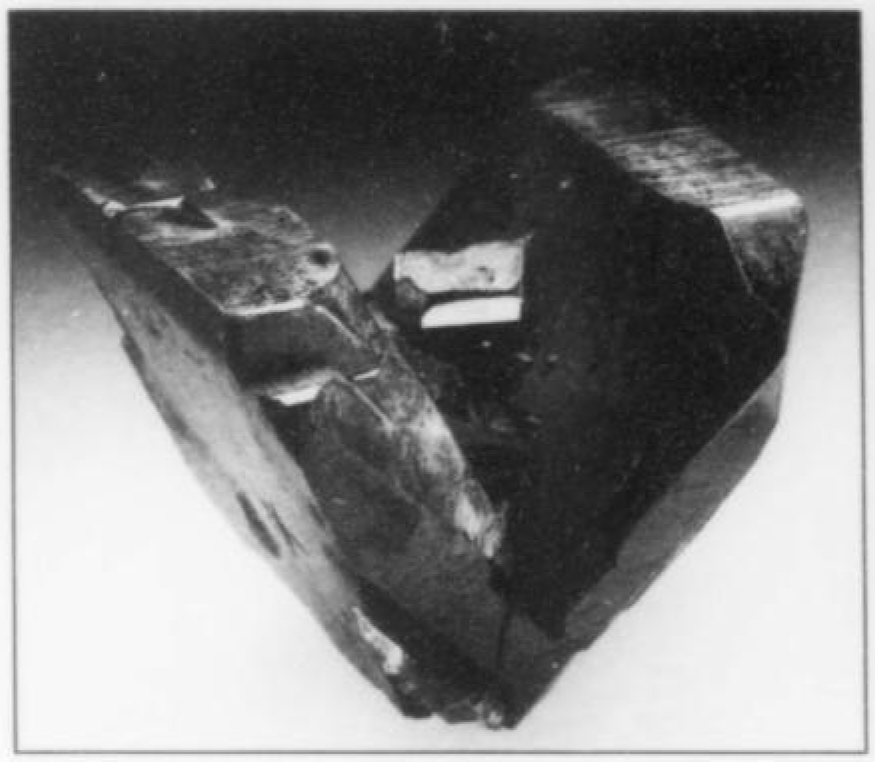

Figure 5. Ferberite crystals, 4.1 cm, from the Atoche-Quechisla district. Jewell Tunnel imports specimen; Jeff Scovil photo.

Figure 6. Acanthite crystals to 1.8 cm from Cerro Rico, Potosí. Terry Wallace collection; Wendell Wilson photo.

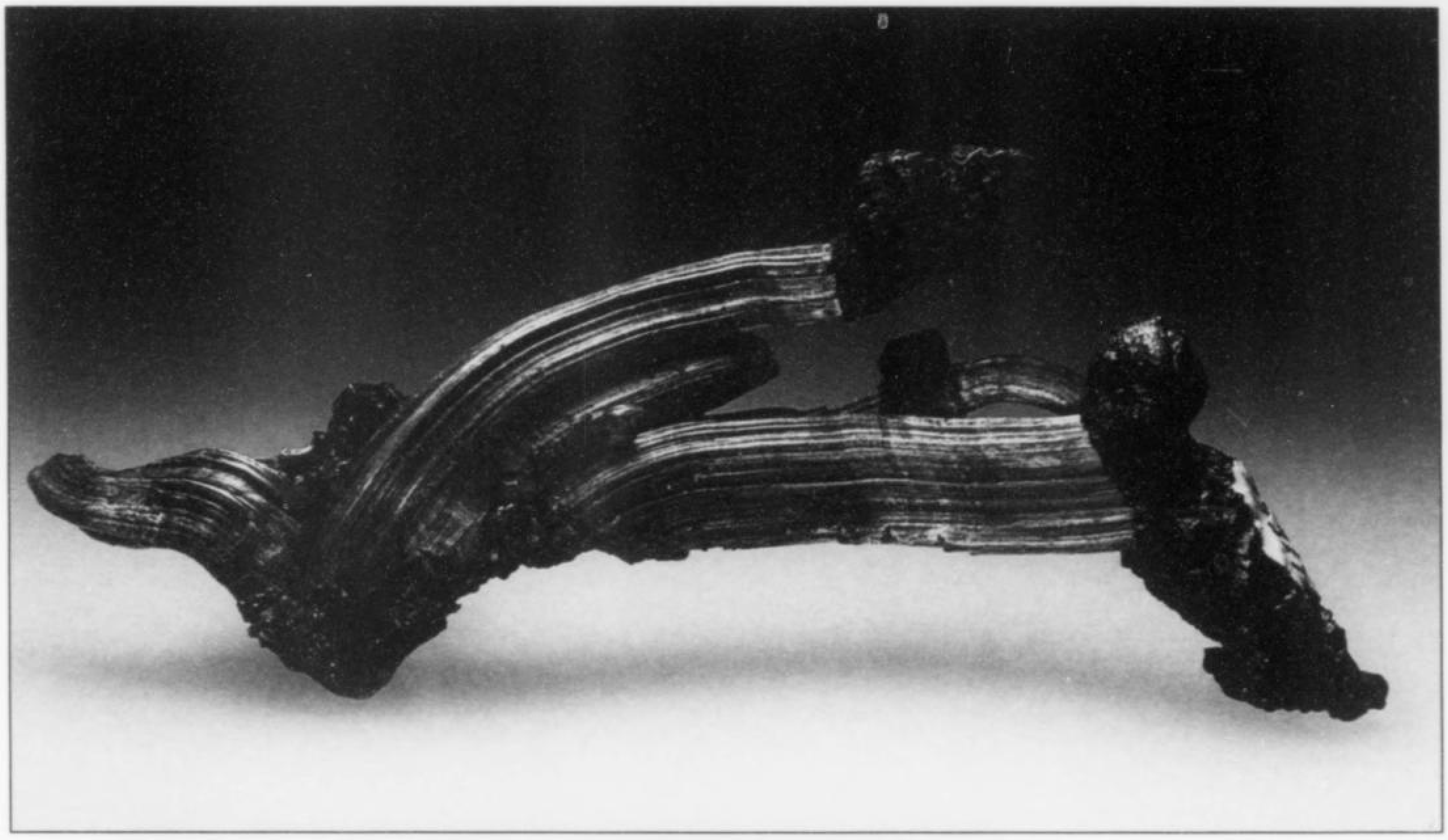

Figure 7. Wire silver with acanthite, 7 cm, from Colquechaca. Harvard collection; Wendell Wilson photo.

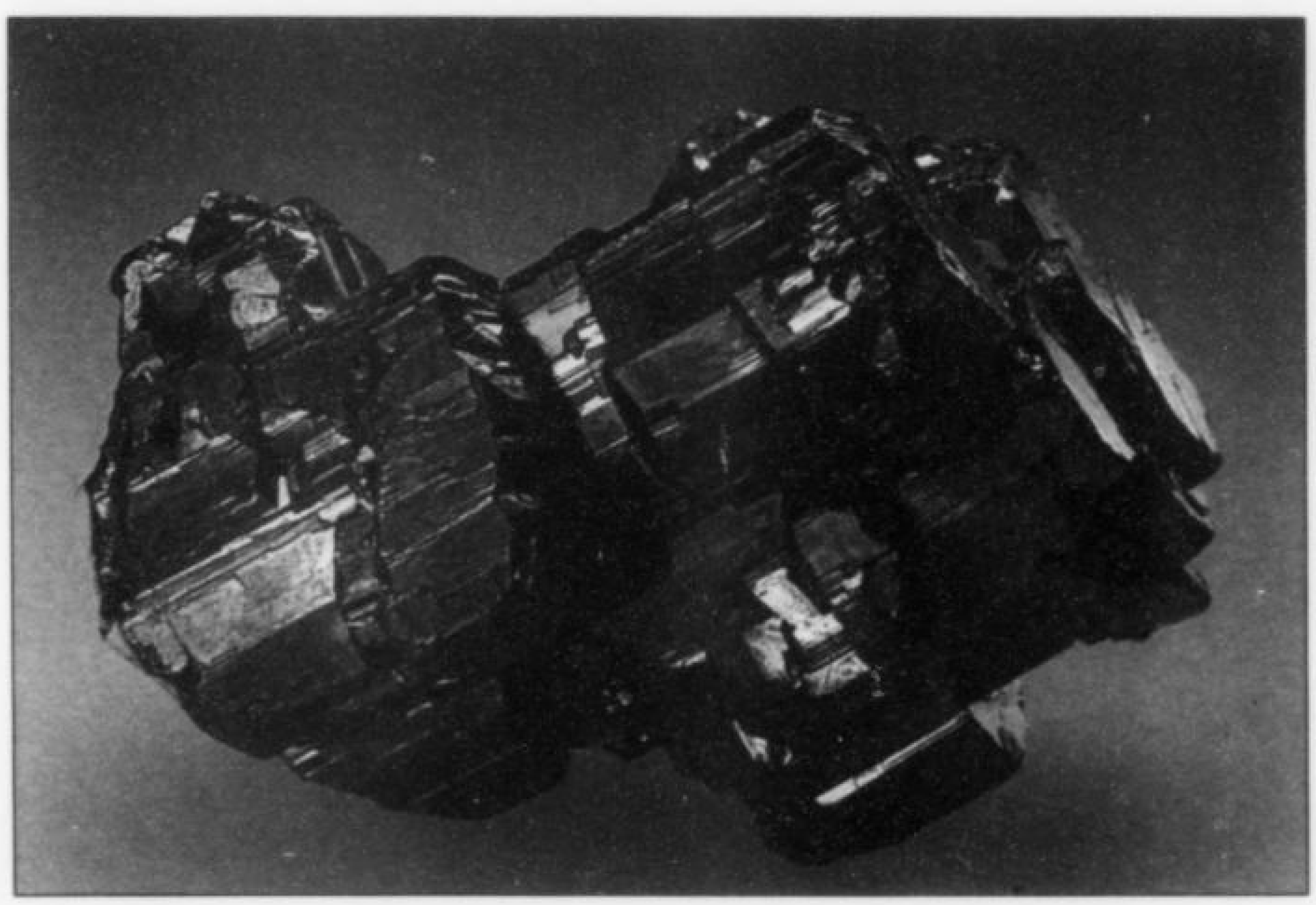

Figure 8. Stephanite crystals in parallel growth, 3.8 cm, from Colquechaca. Smithsonian specimen (Canfield collection, no. C831-1); Wendell Wilson photo.

Bolivian Minerals and Localities *(continued)*

			* = Type Locality	*(?) = Type Locality Disputed
Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Atocha	Town, district, river	20°56′ 66°14′	Sud Chichas Prov., Potosí Dept. 80 km SE of Uyuni	Minerals said to be from Atocha are actually from the Atocha-Quechisla district. A sub-district of this district is Animas-Chocaya district. Ferberite
Aullagas	Ghost town		On Colquechaca Mountain	See Colquechaca
Avicaya	Mine	18°50′ 67°00′	Pazña Dist., Poopó Prov., Oruro Dept., 10 km NNE of Pazña	Cassiterite, jarosite, stannite, vivianite
Ayoreíta	Mine		La Gaiba District	Amethyst, hollandite, smoky quartz
Berenguela	Mine		Cerro Grande district	Cassiterite, pyrite, pyrrhotite, silver sulfosalts
Berenguela	Mine, town, district	17°17′ 69°14′	Pando Prov., La Paz Dept. 22 km SE of Santiago de Machaca	Apatite, greenockite, quartz, siderite, sphalerite. See Jocullani, San Luis 1
Bolivar 1	Mine	21°48′ 66°27′	S flank Cerro Bonete, E. Sud Lípez Prov., Potosí Dept.	Aikinite, ankerite, benjaminite, berryite, bismuthinite, chalcopyrite, krupskaite, *pavonite, pyrite, siderite
Bolivar 2	Mine		Pazña Dist	See Antequera, El Salvador
Bolivia	Mine		5 km east of Poopó	Jamesonite
Bolsa Negra aka Nevada	Mine		Yanacachi sub-district	Ferberite, scheelite, wolframite
Cacachaca	Village		Avaroa Prov., Oruro Dept., ENE of Challapata	Chalcostibite. See Rosita, Terremoto
Cachilaguna	Dry lake	21°44′ 67°57′	On the border of Nor Lípez and Sud Lípez Provs., Potosí Dept.	Halite, natron, thermonatrite, trona, ulexite
Calacalani	Mine			Full name: San Antonio de Calacalani; see San Antonio 1
Calama	Town	18°44′ 67°40′	Sud Carangas Prov., Oruro Dept., 13 km WNW of Andamarca	Bismuth, gold, gypsum, silver
Caluyo	Town	16°49′ 68°06′	Inquisivi Prov., La Paz Dept., 48 km SSE of Inquisivi	Stibnite. See Pacopampa, Titina
Candelaria	Mine		7 km S of Poopó town	Siderite, teallite, "montesite," wurtzite
Canutillos	Mine		Colavi	Barite, cassiterite, opal, pyrite, siderite
Capa Circa, also Capacirca	Mine		Bustillo Prov., Potosí Dept., 24 km SE of Uncía	Gold, stibnite
Carabuco	Mine		Choquetanga district	Scheelite (pink to orange, with tourmaline inclusions)
Caracoles	Mine, village	16°59′ 67°24′	Inquisivi Prov., La Paz Dept., 15 km W of Inquisivi	Ankerite, apatite, bismuthinite, cassiterite, chlorite, pyrite, tourmaline
Caracollo	Town	17°39′ 67°10′	Cercado Prov., Oruro Dept., 39 km NW of Oruro	See Tarumita
Caracota	Mine		Quijarro Prov., Potosí Dept., 25 km ESE of Yura	Gold, stibnite
Carangas	Mine	18°56′ 68°38′	Mejillones Prov., Oruro Dept., 29 km ESE of Sabaya	Chlorargyrite, rhodochrosite, silver, silver sulfosalts
Carguaicollo; also Carguaycollo, Carhuaycollo	Town	19°31′ 66°40′	Quijarro Prov., Potosí Dept., 80 km S of Huanchaca	Anglesite, cassiterite ("wood tin"), franckeite, greenockite, pyrite, quartz, sphalerite, stibiconite, teallite, wurtzite. See Cerillos
Carmen Pampa	Town		15 km S of Coroico	Siderite, tetrahedrite
Carmen; also Carmen-Aurora	Mine		La Union district	Bindheimite, bismuth, bismuthinite, cassiterite, jamesonite, pyrite
Cascabel	Mine		Quiabaya	Anglesite, boulangerite, galena, jamesonite

Bolivian Minerals and Localities *(continued)*

* = Type Locality   *(?) = Type Locality Disputed

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Cataricagua	Mine		E slopes of Mt. Pozoconi; next to Huanuni Mine	Cassiterite, goethite, scorodite
Catavi	Mill (See note #?)		Bustillo Prov., Potosí Dept., 3 km NE of Llallagua	All minerals ascribed to Catavi came from the Siglo XX mine (= Llallagua)
Caxota	Town	17°07′ 67°20′	Loayza Prov., La Paz Dept., 10 km NE of Yaco	See Viloco, Santa Cruz 1
Cebadillas	Mine		Near Chuquiuta	Gold, stibnite
Cerillos	Small mountain		near Carguaicollo	Teallite
Cerro Bonete	Mountain		Sud Lípez Prov., Potosí Dept., 20 km N of Esmoraca	See Rosario 2, Bolivar 1
Cerro Chunchu	Mountain		near Antequera	Cassiterite (some Fe-rich "varlamoffite"), hydrocerussite
Cerro Colorado	Mountain		Cotagaita	Cinnabar
Cerro Grande	Mine, district		Arque Prov., Cochabamba Dept., 60 km Sw of Cochabamba	Apatite, cassiterite, siderite. See Berenguela
Cerro Malmisa	Mountain		Maragua	Antimony, ferberite, molybdenite
Cerro Negro 1	Mountain		Sud Yungas Prov., La Paz Dept., 15 km SE of Illimanì	Pyrophyllite, wolframite
Cerro Negro 2	Mountain		E of Vichacla	Annabergite, gersdorffite, löllingite
Cerro Pozoconi	Mine, mountain		Huanuni	See Pozokoni: also written Posokoni
Cerro Rico (also: Cerro de Potosí)	Mountain		Potosí City	Acanthite, alunite, andorite, apatite (fluor?), arsenic, arsenopyrite, arsenosulvanite, barite, *berndtite, bismuthinite, bournonite, calcite, cassiterite, chalcopyrite, chlorargyrite, diaphorite, franckeite, freibergite, galena, goethite (iridescent), goslarite, halotrichite, hematite, jamesonite, jarosite, matildite, melanterite, miargyrite, nacrite, *ottemannite, phosphophyllite, pickeringite, pyrargyrite, pyrite, pyrostilpnite, quartz, siderite, sideronatrite, siderotil, silver, smithsonite, sphalerite, stannite, stephanite, stibnite, tetrahedrite, valentinite, voltaite, wavellite, wolframite, wurtzite
Cerro San Pedro	Hill		Oruro City	Large orthoclase phenocrysts, often replaced by quartz, chlorite, siderite, etc.
Cerro Sapo	Mountain		Ayopaya Prov., Cochabamba Dept., 18 km N of Independencia	Amesite-2H, analcime, ankerite, barite, chalcopyrite, dawsonite, galena, natrolite, nordstrandite, sodalite
Cerro Ubina			near Ubina	Bismuthinite, pyrite, tourmaline
Cerro Vilacota	Mountain		Charcas Prov., Potosí Dept., between Acacio and San Pedro de Buena Vista	Barite, galena
Chacaltaya	Mountain (5400 M), mine		Murillo Prov., La Paz Dept., 40 km N of La Paz	Arsenopyrite, cassiterite, fluorite, muscovite, nacrite, ullmannite (As-rich "korynite"); see San Carlos 2
Chacarilla	Town	17°50′ 68°00′	Villaroel Prov., La Paz Dept., 30 km NW of San Pedro de Curahuara	Copper, chalcocite, malachite
Chajolpaya	Village		Larecaja Prov., La Paz Dept., 15 km E of Mt. Illampu	Cassiterite
Challahuilque	Village		Just N of San Cristobal	Chlorargyrite

Figure 9. Ludlamite crystal cluster, 4 cm, with vivianite on pyrite, from the Huanuni mine. Cal Graeber specimen; Jeff Scovil photo.

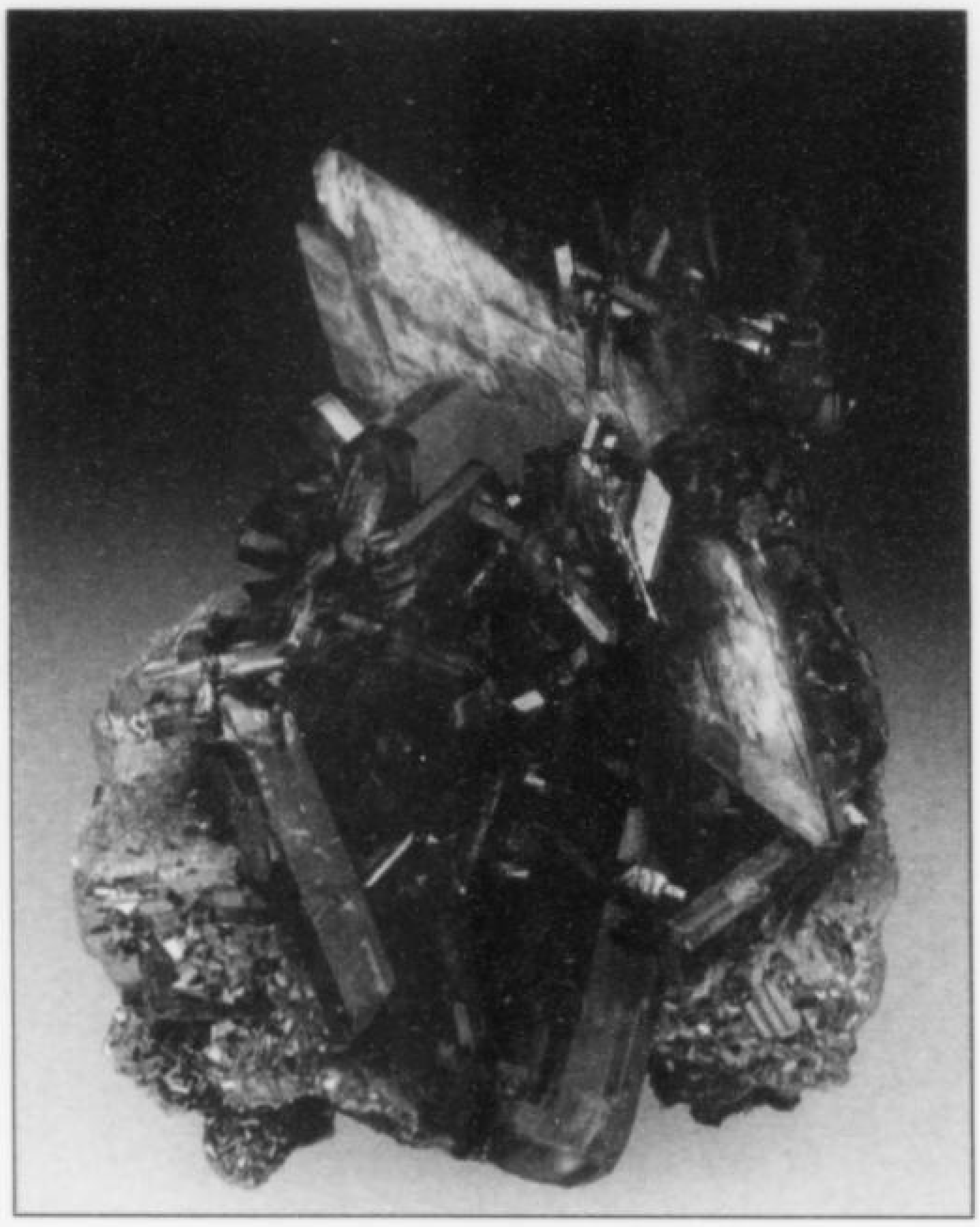

Figure 10. Vivianite crystals with ludlamite, from the Huanuni mine. Jeff Scovil photo.

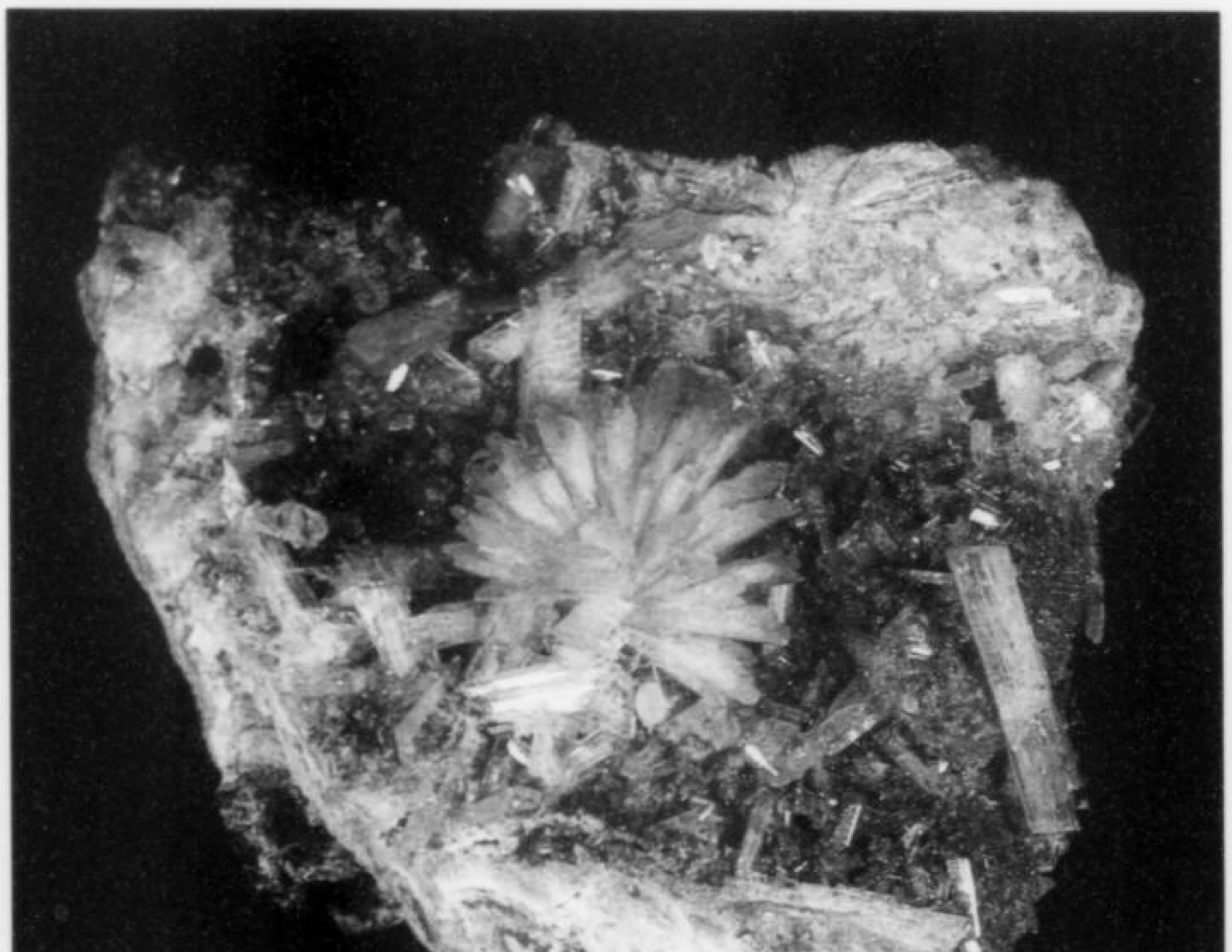

Figure 12. Paravauxite with childrenite, 6.5 cm, from the Siglo XX mine, Llallagua. Mark Bandy collection; Jeff Scovil photo.

Figure 11. Paravauxite crystal, 3.3 cm, from the Siglo XX mine, Llallagua. Ralph Clark collection; Wendell Wilson photo.

Figure 13. Vivianite crystals on pyrite, 17 cm, from the Morococala mine, Oruro. Carnegie Museum of Natural History collection; Van Pelt photo.

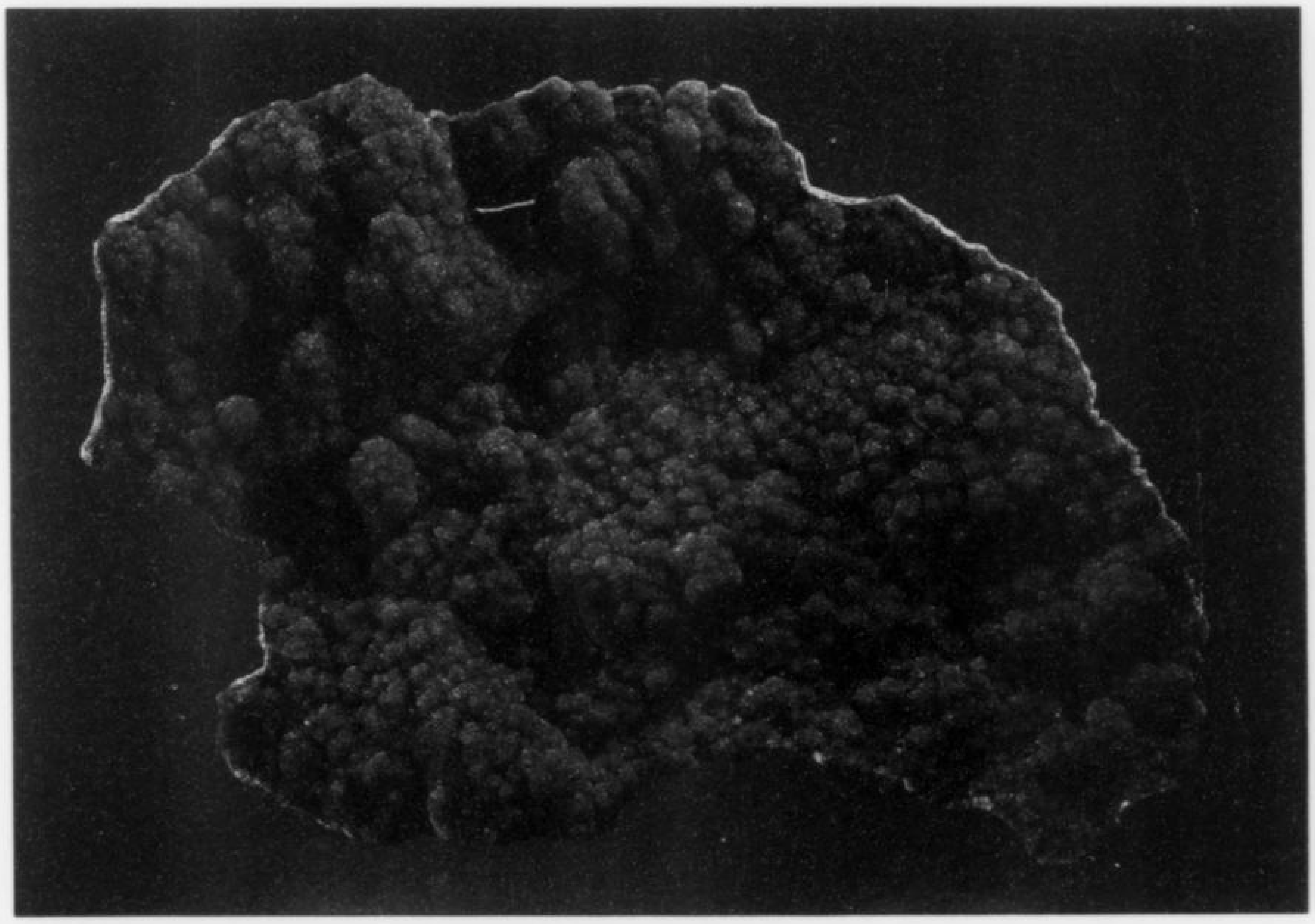

Figure 14. Vauxite druse, 22.5 cm, from the Siglo XX mine, Llallagua. Carnegie Museum of Natural History collection; Van Pelt photo.

Figure 15. Mandarinoite crystals, 1 mm, from the El Dragón mine. Photo by Gunther Schnörrer-Kohler.

Figure 16. Schmiederite spray, 1 mm, with chalcomenite crystals, from the El Dragón mine. Gunther Grundmann photo.

Bolivian Minerals and Localities *(continued)*

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
			* = Type Locality	*(?) = Type Locality Disputed
Challana	River, village		Larecaja Prov., La Paz Dept.	In the vicinity are found columbite, heterosite, rutile, spodumene, triphylite, triplite; see Fabulosa
Challapata	Town	18°54′ 66°47′	Avaroa Prov., Oruro Dept., 113 km SSE of Oruro	Chalcostibite, teallite, wurtzite. See Terremoto, Vicuñita
Challviri	Town		Ibañez Prov., Potosí Dept.	Stibnite
Chambillaya	Mine		Near Quime	Apatite, arsenopyrite, quartz twins, wolframite
Chayanta	Town	18°27′ 66°30′	Bustillo Prov., Potosí Dept., 13 km E of Uncía	Apatite, cassiterite, silver; see Capacirca, Pucro, Vila Apacheta
Chicote Chico	Mountain		Ayopaya Prov., Cochabamba Dept., 6 km N of Kamí	Wolframite. See Tamiñani
Chicote Grande	Mountain, mine		Inquisivi Prov., La Paz Dept., 8 km NW of Kami	Arsenopyrite, ferberite, muscovite, pyrite, quartz (Japan law twins), scorodite, siderite, tungstite; see Lapiani
Chijmuni	Village	17°20′ 67°50′	Aroma Prov., La Paz Dept., 8 km W of Sica Sica	See Lili. Chijmuni is very close to the Laurani Mine.
Chilcani	Mine		50 km NNE of Oruro, Lequepalca Dist.	Bindheimite, chalcostibite, gold in stibnite
Chocaya	Mine, town		Animas-Chocaya sub-district	Apatite, aramayoite, argyrodite, arsenopyrite, barite, bismuth, cassiterite, "elaterite", franckeite, *hocartite, jarosite, marcasite, pyrite, quartz, *ramdohrite, stannite, tetrahedrite, wavellite, wurtzite. See Animas, Gran Chocaya, Siete Suyos, Oploca 1
Chocaya Grande	Mine		Animas Chocaya sub-district	Pyrargyrite
Chojlla	Mine, town		Yanacachi sub-dist., Alonso de Ibanez Prov., Potosí Dept., 16 km W of Caripuyo	Brown to pink cassiterite, feldspar, ferberite, muscovite, quartz, tungstite, wolframite; see Socavón Carmen
Chojñacota	Mine		Loayza Prov., La Paz Dept.	Arsenopyrite, cassiterite, chalcopyrite, pyrite, quartz, siderite, sphalerite
Choquecamata	Town	16°55′ 66°37′	Ayopaya Prov., Cochabamba Dept., 13 km NE of Cocapata	Gold
Choquetanga	Mine, mountain, district		Inquisivi Prov., La Paz Dept., 100 km SE of La Paz, 20 km NW of Quime	Scheelite; see Jachahuance Cuclio, Carabuco
Chorolque	Mountain, mine, district	20°55′ 66°02′	Atocha-Quechisla Dist., Sud Chichas Prov., Potosí Dept., 35 km E of Atocha	Bismuth, bismuthinite, bournonite, cassiterite (some after apatite, pyrite, and bismuthinite), daubréeite, ferberite, goethite, gold, jamesonite, pyrite, scorodite, tourmaline, tungstite; see Espíritu, La Reforma, San Miguel 2, San Carlos 1
Chulchucani	Deposit		Frías Prov., Potosí Dept., 25 km NE of Potosí, near Huari Huari	See San Luis 2
Chuma	Town	15°30′ 68°56′	Muñecas Prov., La Paz Dept., 145 km NNW of La Paz	See Hualpani
Chuquiuta	Town	18°33′ 65°26′	Bustillo Prov., Potosí Dept., 12 km SW of Amayapampa	See Cebadillas
Churiña	Mine		Macha	Siderite, stibnite
Churquini	Mine		Pampa Grande	Galena, hydrozincite, linarite, sphalerite, stibnite
Chusi	Village		Tipuani	Gold
Cobrizos	Mine	20°60′ 69°13′	San Cristobal	Copper, gypsum, silver

Bolivian Minerals and Localities *(continued)*

		* = Type Locality		*(?) = Type Locality Disputed
Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Coipasa	Town	19°17′ 68°17′	Atahuallpa Prov., Oruro Dept., 20 km S of Sabaya	Halite, ulexite
Colavi	Mine, town, district	19°21′ 65°33′	Saavedra Prov., Potosí Dept., 36 km NE of Potosí	*Bismite, goethite after siderite, opal, pyrite, siderite, valentinite; see Canutillos, Mosojllacta, Machacamarca
Colquechaca	City, mountain	18°42′ 66°00′	Chayanta Prov., Potosí Dept., 105 km NNW of Potosí	Acanthite, argentopyrite, argyrodite, arsenopyrite, barite, bismuth, bournonite, calcite, *canfieldite, cassiterite, chalcostibite, cylindrite, dyscrasite, "elaterite," franckeite, galena, hocartite, jamesonite, löllingite, marcasite, miargyrite, polybasite, (proustite?), pyrargyrite, pyrite, quartz, siderite, silver (some after pyrargyrite and stephanite), sphalerite, stephanite, vivianite, wurtzite; see Aliada, Nueva Virginia, Aullagas
Colquiri	Mine, town	17°25′ 67°08′	Inquisivi Prov., La Paz Dept., 78 km N of Oruro	Cassiterite, *colquiriite, creedite, fluorite, gearksutite, gypsum, madocite, pyrite, ralstonite, sphalerite; see San Antonio 1
Comanche	Town	17°01′ 68°27′	Pacajes Prov., La Paz Dept., 10 km SW of Collana	See Miriquiri; also a 15 meter bromeliad
Concordia, also called Santo Domingo	Mine		ENE slopes of Nevada Cunocallo, Cordillera Santa Vera Cruz, Inquisivi Prov., La Paz Dept.	Cassiterite, tourmaline Elevation to 5060 m! (= 16,600 feet)
Condeauque, or Conde Auque	District		NE of Lequepalca	Dolomite, fluorite, scheelite; see Ascención, Santa Isabel
Consolidated (Correctly, "The Consolidated")	Mine		Ancoma	Arsenopyrite, cassiterite, chalcopyrite, muscovite, pyrrhotite, scheelite, tourmaline, tungstite
Constancia	Mine		Tazna	Daubréeite
Coricoya	Mine		near Molínero	Bornite, brochantite
Coriviri	Mine		Poopó Prov., Oruro Dept., between Poopó and Machacamarca	Bismuth, bismuthinite, gold, wolframite
Corocoro	Mine, district	17°12′ 68°29′	Pacajes Prov., La Paz Dept., 89 km SSW of La Paz	Algodonite, aragonite, azurite, celestine, chalcophyllite, copper, cuprite, domeykite, fluorite, gypsum, jamesonite, malachite, silver, tenorite ("melaconite"), tetrahedrite; see Marcocoya, Pucara, San Agustin 1, San Francisco 2, Remedios
Coroico	City	16°11′ 67°44′	Nor Yungas Prov., La Paz Dept., 55 km NE of La Paz	See Carmen Pampa
Cotagaita	Town, river	20°50′ 65°37′	Nor Chichas Prov., Potosí Dept., 65 km N of Tupiza	See Churquini, Pampa Grande, Cerro Colorado, Tapi
Cristalmayu	Creek		Between Filadelfia and San Franciso Mines, Alto Chapare Dist.	See Alto Chapare
Cuprita	Mine		Turco	Chalcedony, copper
David Mosiah	Prospect		Mt. Huañaquino, near El Molino village, 15 km NW of Potosì, Frías Province, Potosí Dept.	Barite, hematite, hydroxylapatite, carbonate-hydroxylapatite, ilmenorutile, magnetite, schorl, rutile after ilmenite
Don Diego	Village		Border of Frías and Saavedra Provinces, Potosí Dept., 20 km NE of Potosí	See Tricolore
Dos Amigos	Small mine		E slope of Cord. Santa Vera Cruz, Cercado Prov., Oruro Dept.	Antimony (some after stibnite)
El Barco	Mine		Yanacachi	Cassiterite

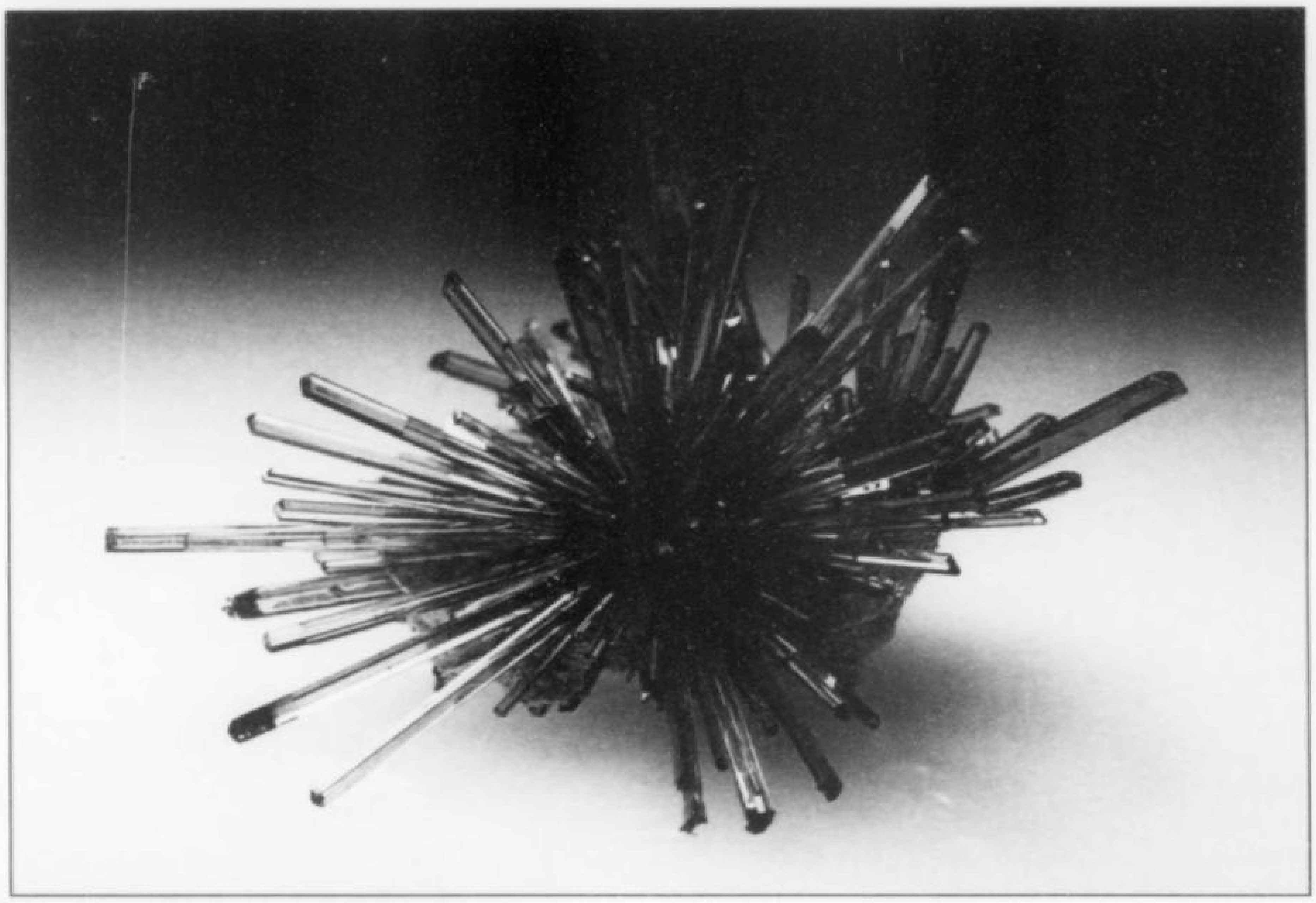

Figure 17. Vivianite spray, 3 cm, from the Huanuni mine. Gene Schlepp specimen; Wendell Wilson photo.

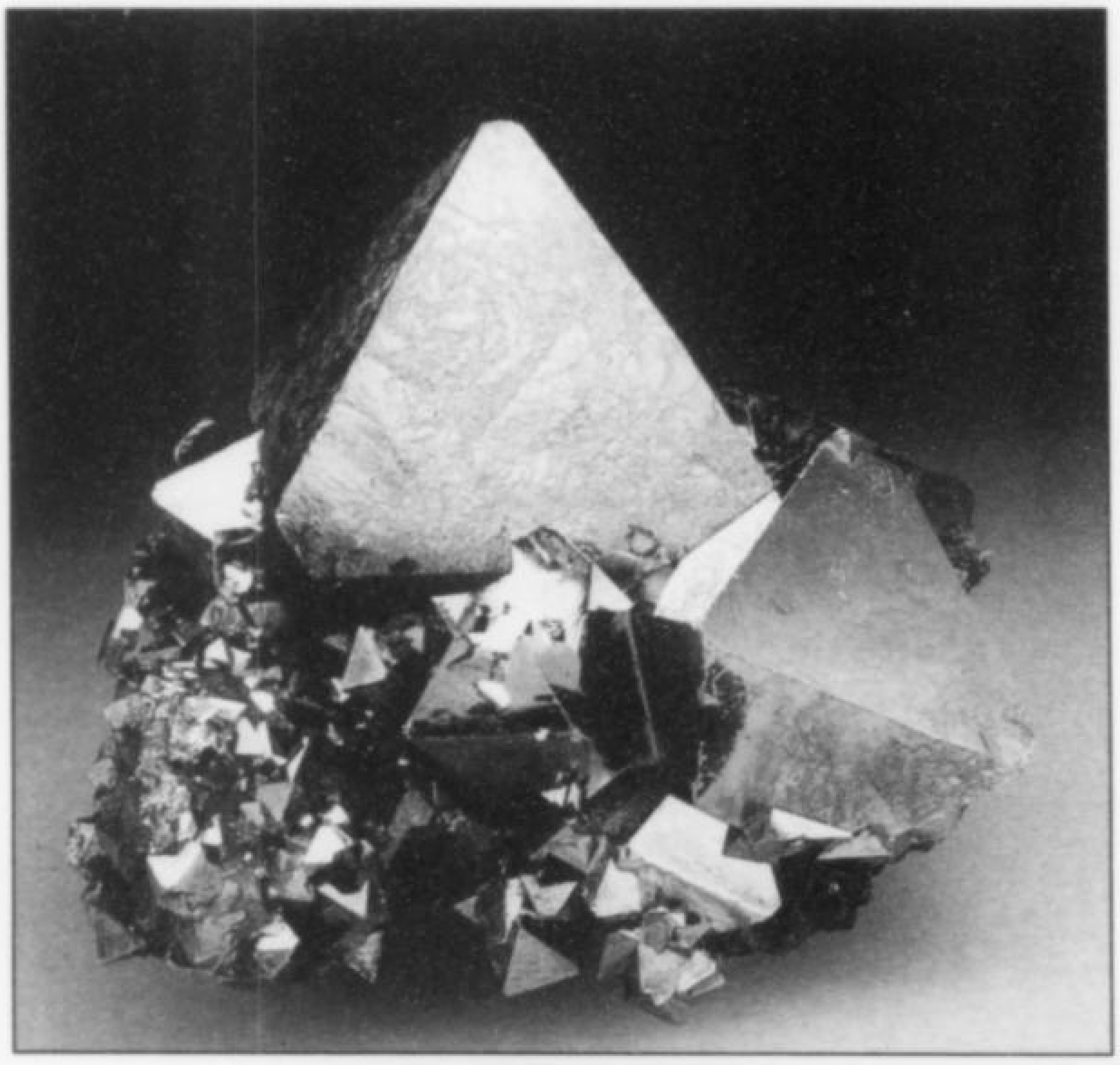

Figure 18. Pyrite crystal cluster from Tazna. Jeff Scovil photo.

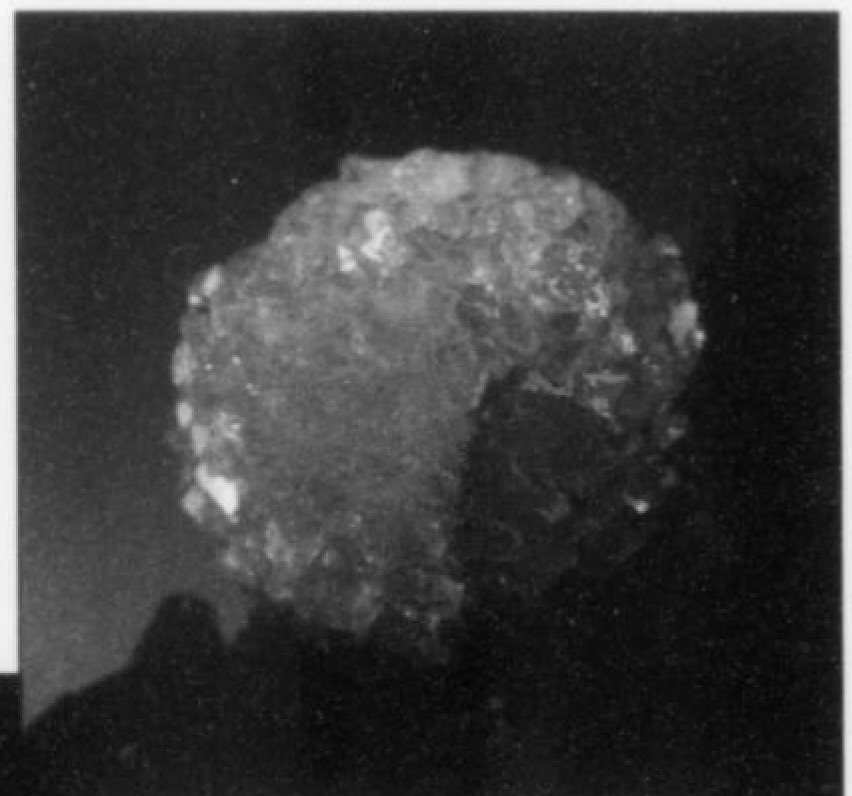

Figure 19. Wavellite crystal cluster, 9 mm, from the Siglo XX mine, Llallagua. University of Arizona collection; Wendell Wilson photo.

Figure 20. Valentinite crystals to 1 cm, from Tatasi. Ed Swoboda collection; photo by Rock Currier.

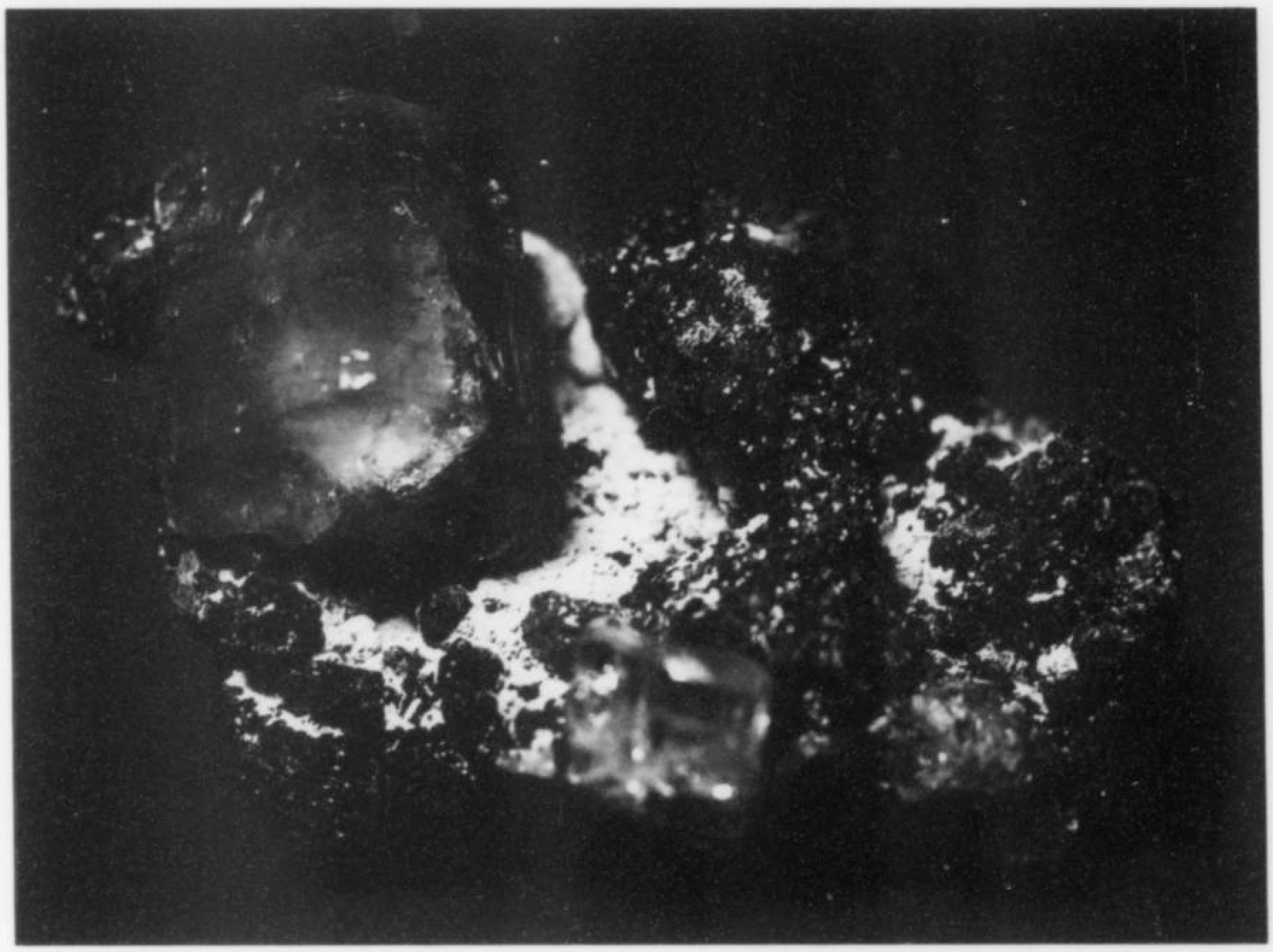

Figure 21. **Fluorapatite crystal, 3 cm, from Poopó. William Larson collection.**

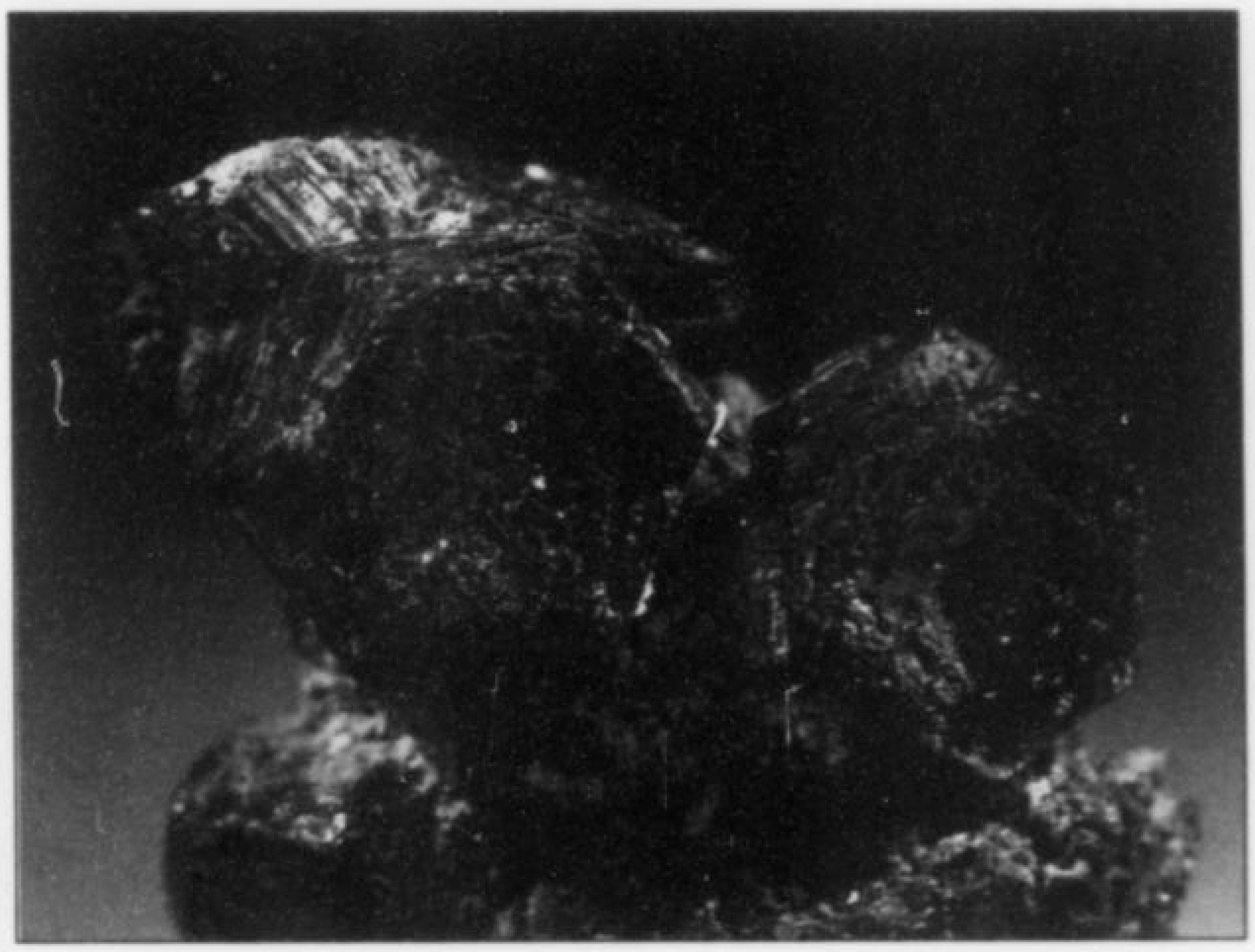

Figure 22. **Wurtzite crystal cluster, 1.2 cm, from the Siglo XX mine, Llallagua. Forrest and Barbara Cureton collection; Wendell Wilson photo.**

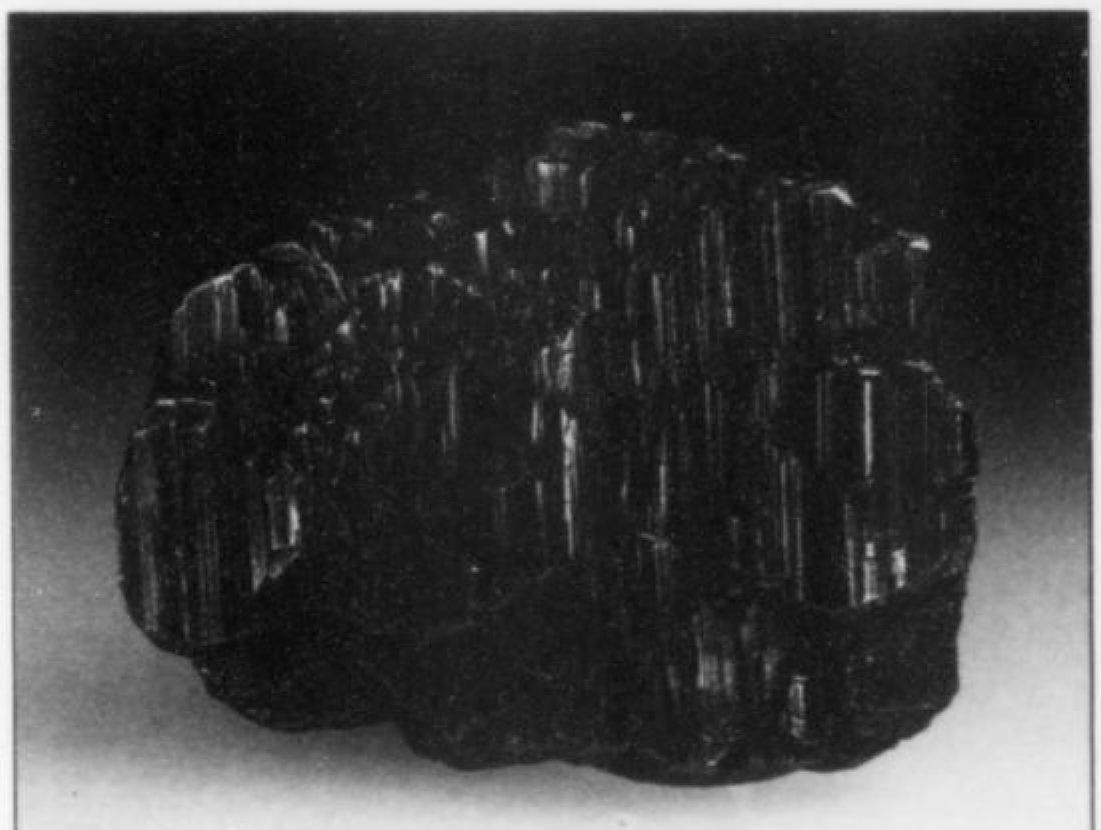

Figure 23. **Andorite crystal, 3.7 cm, from Oruro, Bolivia. Terry Wallace collection; Wendell Wilson photo.**

Figure 24. **Canfieldite crystals to 1.6 mm, from Colquechaca. Terry Wallace collection; Wendell Wilson photo.**

Bolivian Minerals and Localities *(continued)*				
		* = Type Locality		*(?) = Type Locality Disputed
Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
El Dragón	Mine		Quijarro Prov., Potosí Dept., 10 km E of Porco. Near Sala Kuchu	Ahlfeldite, allophane, alunite, anglesite, barite, basaluminite, berzelianite, chalcomenite, chalcopyrite, clausthalite, clinochalcomenite, dolomite, eskebornite, esperite, kerstenite, klockmannite, krutaite, lepidocrocite, linarite, malachite, molybdomenite, olsacherite, penroseite, reevesite, schmiederite, selenium, tiemannite, trogtalite, umangite
El Salvador	Mine		Pazña District	See Antequera
Empexa	Salt flats	20°20′ 68°29′	Campos Prov., Potosí Dept.	Ulexite; see Sijsihua
Esmoraca	Town	21°42′ 66°15′	Sud Chichas Prov., Potosí Dept., 40 km SE of San Pablo	See Pueblo Viejo, Sucre, Rosario 2
Espíritu Santo	Mine		Chorolque	Bismutite
Fabulosa	Mine		E. flank Cord. Real, Larecaja Prov., La Paz Dept., 10 km upstream of Challani Village	Almandine, andalusite, arsenopyrite, cassiterite, chalcopyrite, cordierite (iolite), lazulite, molybdenite, muscovite, pyrite, pyrrhotite, quartz, sphalerite, stannite, triphylite, triplite, vivianite
Farellones	Mine		Tazna	Bismuthinite, ferritungstite, tungstite after ferberite
Fenix				See Juliana
Filadelfia	Mine		Alto Chapare District	See Alto Chapare
Gran Chocaya	Mine		Animas-Chocaya sub-district	Pyrargyrite
Gruta de San Pedro				See San Pedro
Guadaloupe				This is the name of the company that operated Tatasí from 1890–1902
Gutierrez	Mine		Porco	Cerussite
Hiaco	Mine		Chayanta Prov., Potosí Dept., 20 km NNE of Colquechaca	Barite, cerussite, galena, zincian argentite; see Pacajake
Huallatani	Mine		Huayna Potosí	Bismuth, cassiterite
Hualpani	Mine		Chuma	Anglesite, galena, sphalerite
Huanchaca (another name for the Pulacayo Mine)	Mine, town	20°20′ 66°39′	Near Pulacayo, Quijaro Prov., Potosí Dept., 30 km NE of Uyuni	See Pulacayo
Huanuni	Mine, town	18°17′ 66°51′	Dalence Prov., Oruro Dept., 45 km SSE of Oruro	*Aheylite, apatite, beidellite, bismuthinite, bournonite, cassiterite, chalcanthite, cronstedtite, ferberite, fibroferrite, fluorite, franckeite, halloysite, herzenbergite, hisingerite, hydrozincite, jamesonite, jarosite, kaolinite, linarite (?), ludlamite, marcasite, opal, owyheeite, pyrrhotite, plagionite, pyrite, semseyite, siderite, sphalerite, stannite, tourmaline, valentinite, variscite, vivianite, wavellite, *(?)wurtzite; world's richest cassiterite deposit; see María Francisca, Miraflores, Perez, Cerro Posokoni, Porvenir 1, Quimsacoya
Huari	Town	18°46′ 65°41′	Avaroa Prov., Oruro Dept., 121 km SSE of Oruro	See María Teresa
Huari Huari	Town, range	19°25′ 65°38′	25 km NE of Potosí, Frías Prov., Potosí Dept.	See Orco Cuchillo
Huayna Potosí, also Huayna, Huaina	Village	16°16′ 68°11′	Los Andes Prov., La Paz Dept.	Bismuth, bismuthinite, cassiterite, pyrite, tetrahedrite; see Carmen-Pampa, Huallatani
Huayoco	Gully, village		Condor Iquiña Plateau, 25 km SSE of Macha, 30 km SW of Ocuri	Wood tin
Hucumarini	Mine		Sorata	Bismuthinite

Bolivian Minerals and Localities *(continued)*

* = Type Locality *(?) = Type Locality Disputed

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Ichucolla	Mine		Pazña Dist.	Old name for Monserrat Mine
Illimani	Mountain 6457 m	16°39′ 67°48′	Murillo and Sud Yungas provinces, La Paz Dept., 45 km ESE of La Paz	See Urania, Ancohuma, Palca
Inquisivi	City	16°41′ 67°10′	Inquisivi Prov., La Paz Dept., 115 km ESE of La Paz	See Caluyo
Iscaisca	Mountain		Nor Chichas Prov., Potosí Dept., 28 km N of Tupiza	Semseyite. See Kentiyok
Itos	Mine		Oruro City	Acanthite, arsenopyrite, augelite, andorite, cassiterite, chalcostibite, dolomite, franckeite, freibergite, heteromorphite, jamesonite, kaolinite, metastibnite, miargyrite, natroalunite, pyrite, sakharovite, silver, stannite, stibnite, tetrahedrite, zinkenite
Jachahuance Cuclio	Mine		Choquetanga District	Quartz
Japo	Mine			Same as Negro Pabellón
Jocullani	Mine		Berenguela District	Sphalerite
Juliana (also called Fénix)	Mine		Cercado Prov., Oruro Dept., on Cochabamba border	Ankerite, hydrotungstite, scheelite, tungstite. See La Bomba
Kami	Mountain, town, mining district	17°22′ 66°58′	SW Ayopaya Prov., Cochabamba Dept.	Apatite, arsenopyrite, cassiterite, ferberite, jarosite, jeromite, lazulite, pyrite, pyrrhotite, quartz twins, scorodite, siderite, tourmaline, wolframite
Kari-Kari	Mountain range	19°40′ 65°40′	E and SE of city of Potosí, mostly in Frías Prov.	Almandine, epidote, hopeite; see Andacaba
Kentiyok	Mine		2 km N of Mt. Iscaisca	Galena
Kesñiri	Mine		Between Toro Toro and San Pedro de Buena Vista, Charcas Prov., Potosí Dept.	Barite, galena, pyromorphite
La Bella	Mine		San Ramón District, 40 km E of San Ramon	Beryl, columbite, fergusonite, fluorite, monazite, topaz
La Bomba	Mine		2 km NW of Juliana Mine	Fluorite, scheelite
La Colorada	Mine		Oruro city	Bournonite, cassiterite, franckeite
La Escosasa	Mine		Patacamaya	Galena
La Gaiba	Village, lake, district	17°45′ 57°43′	On Brazilian/ Bolivian border, 130 km N of Puerto Suarez, Sandoval Prov., Santa Cruz Dept.	See Anahi, Ayoreíta
La Joya	Mountain	17°46′ 67°29′	Cercado Prov., Oruro Dept., 48 km NW of Oruro	Gold, muscovite
La Paz	City (capital) Department	16°30′ 68°09′	Murillo Prov.	
La Ponderosa	Mine		Turco	Chalcedony, copper
La Reforma	Mine		Chorolque	Bismuth, bismuthinite
La Salvadora 1 (see Socavón)	Mine		Oruro City	La Salvadora is the name of the cooperative operating the Socavón.
La Salvadora 2	Prospect		Aguas Calientes	Barite, galena, stibnite
La Salvadora 3	Mine		Sud Yungas Prov., La Paz Dept., ~40 km E of La Paz, E flank of Taquesi batholith	Apatite, cuprotungstite, scheelite, tourmaline, wolframite

Bolivian Minerals and Localities *(continued)*

* = Type Locality *(?) = Type Locality Disputed

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
La Sorpresa	Mine		10 km S of Tapacarí	Annabergite, gersdorffite, nickeline
La Unión	District		Los Andes Prov., La Paz Dept., W of Milluni	See Carmen-Aurora
La Verde	Mine		5 km NW of San Augustín 2, 35 km E of San Ramón	Columbite, topaz, green muscovite
Laguna Cachi				See Cachilaguna
Lapiani	Mine		Chicote Grande	Pyrite, siderite
Laurani	Mine	17°23′ 67°47′	Sica Sica	Enargite, *lammerite, lavendulan, luzonite
Lequepalca	Canton	17°38′ 66°55′	Cercado Prov., Oruro Dept., 30 km E of Caracollo	Ferberite, hydrozincite, linnaeite, stibiconite, stibnite. See San Miguel 3, Condeauque.
Lili	Quarry		Chijmuni	Austinite ("brickerite"), mimetite, pitticite, "travertine"
Limbo	Village (uninhabited)		Alto Chapare district	Actinolite, anhydrite, aragonite, augite, magnesioriebeckite, hydromagnesite, magnesite, pyrite, talc
Lípez Huayco	Mine		Ocurí	Cassiterite (some after teallite), herzenbergite ("montesite"), teallite
Llallagua	Town	18°25′ 66°38′	Bustillo Prov., Potosí Dept., 5 km NNW of Uncía	Allophane, alunite, arsenic, arsenopyrite, augelite, bismite, bismoclite, bismuth, bismuthinite, bismutite, brochantite, cassiterite, chalcanthite, chalcocite, childrenite, chrysocolla, copper, cordierite, crandallite, creedite, cronstedtite, cylindrite, diadochite, evansite, ferberite, florencite, fluorapatite, franckeite, goethite, greenockite, hagendorfite, halotrichite, hematite, hisingerite, hübnerite, jamesonite, jarosite, *jeanbandyite, kaolinite, marcasite, melanterite, *metavauxite, miargyrite, monazite, muscovite (after cordierite), natantite, orthoclase, *paravauxite, pickeringite, plumbogummite, pyrite, pyromorphite, pyrrhotite, quartz twins, rhodochrosite, scheelite, sericite after orthoclase, siderite, *sigloite, sphalerite ("gumucionite"), stannite, stibnite, teallite, tetrahedrite, tourmaline, variscite, *vauxite, vivianite, wavellite, wickmanite, wurtzite, xenotime, zinkenite. All of the Llallagua minerals came from the Siglo XX mine.
Llavisa	Village		16 km SW of Ocurí, Chayanta Prov., Potosí Dept.	Adularia, cassiterite (wood tin), gersdorffite, topaz
Lomitas	"Little hill," RR station	17°24′ 67°50′	Near Laurani Mine, 10 km SW of Sica Sica	Austinite ("brickerite"), chalcedony, mimetite, pitticite; see also Lili
Luribay	Town	17°14′ 67°44′	Loayza Prov., La Paz Dept., 90 km SE of La Paz	
Macha	Town	18°49′ 66°05′	Chayanta Prov., Potosí Dept., 16 km SSW of Colquechaca	See Milluri, Churiña, Huayoco, Santiaguillo; these "wood tin" localities are often given on labels as "near Macha"
Machacamarca (not the Machacamarca in Litoral Prov., Oruro Dept.)	Mine, ghost town	19°24′ 65°33′	Colavi District, Saavedra Prov., Potosí Dept., 30 km NE of Potosí	Augelite, chlorargyrite, bindheimite, bournonite, diaphorite, freibergite, jamesonite, pyrite, pyromorphite, quartz, siderite, tetrahedrite after bournonite ("stylotypite"); see Víboras
Magariñas	Mine		Ancoraimes	Ferberite, geocronite
Maragua	Town	18°56′ 65°48′	Chayanta Prov., Potosí Dept., 8 km S of Ocuri	Cassiterite; see Santiaguillo, Vetillas, Cerro Malmisa
Marcamarcani (formerly San Baldomero)			Sorata District	Arsenopyrite, tellurian bismite, bismuth, bismuthinite, bismutoferrite, erythrite, joseite, löllingite, skutterudite ("smaltite")

Bolivian Minerals and Localities *(continued)*				
		* = Type Locality		*(?) = Type Locality Disputed
Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Marcocoya	Mine		Corocoro District	Copper after aragonite
Margarita	Mine		Quime	Vivianite, wolframite
María Francisca	Mine		Huanuni	Cylindrite, *(?)franckeite, jamesonite, stannite
María Teresa	Mine		Huari	Berndtite, *herzenbergite, ottemannite, stannite
Mariana	Mine		Tazna	Jamesonite
Marta	Mine		Pongo	Zinnwaldite
Matilde	Mine		12 km NE of Ancoraimes, Omasuyos Prov., La Paz Dept.	Cerussite, galena, siderite, sphalerite
Mercedes del Illampu	Mine		Alto Chapare	Magnesioriebeckite
Mesa de Plata	Mine		San Antonio de Lípez	Acanthite, andorite, bromargyrite, pyrargyrite, silver, tenorite
Millipaya	Village		10 km SE of Sorata, Larecaja Prov., La Paz Dept.	Dravite, hedleyite, jamesonite, molybdenite, molybdite, monazite, pyrite, quartz, schorl, tungstite, wolframite; see Marcamarcani, Hucumarini
Milluni	Village		Los Andes Prov., La Paz Dept., 20 km N of La Paz	Cassiterite. Specimens ascribed to Milluni can be from either Los Andes or Murillo Province.
Milluri	Mine		Macha	Cervantite
Miraflores	Neighbor-hood		Of Huanuni town, which see	The beautiful "blue lace" vauxites ascribed to Miraflores have exact counterparts from the Siglo XX Mine. The supposed find from "Miraflores" (Huanuni Mine) was unique, and no vauxite associates (metavauxite, paravauxite, childrenite, etc.) have ever been reported from Huanuni. We conclude that these vauxites are from the Siglo XX Mine.
Miriquiri		16°58′ 68°25′	near Comanche	Apatite, hematite, magnetite
Mizque	City	17°56′ 65°19′	Mizque Prov., Cochabamba Dept., 115 km SE of Cochabamba	See Quioma, Coricoya
Mochará	Village		24 km NE of Tupiza, Sud Chichas Prov., Potosí Dept.	See Pirpintuyok
Mocoya				See Tanapaca
Mojo	Village, district	21°54′ 65°33′	30 Km N of Villazón, Omiste Prov., Potosí Dept.	See Volcano
Molinero	Village	18°15′ 65°24′	Mizque Prov., Cochabamba Dept., 50 km S of Mizque town	See Coricoya
Molino	Mine			Mistaken name for David Mosiah Prospect.
Monserrat (formerly Ichucolla)	Mine		Pazña District	Brackebuschite, cassiterite (needle tin), cylindrite, franckeite, galena, "hochschildite", pyrite, stannite, *teallite, vivianite, wurtzite (some: "pufahlite"), zinkenite. See Santa Rosa
Moquegua	Mine		Ubina	Pyrite, tourmaline
Morococala	Mine	18°10′ 66°44′	Santa Fe Dist., Dalence Prov., Oruro Dept. 40 km ESE of Oruro	Cassiterite, hisingerite, phosphophyllite, pyrite, siderite, vivianite
Moscari	Town	18°19′ 66°02′	Charcas Prov., Potosí Dept., 11 km SSW of San Pedro	Ferberite, stibnite, wurtzite
Mosiah				See David Mosiah
Mosojllacta	Mine		Colavi	Bismuth, bismuthinite, goethite, opal, pyrite, siderite
Mururata 1	Village	16°07′ 67°45′	Nor Yungas Prov., La Paz Dept., 20 km NW of Coroico	See Bolsa Negra

Bolivian Minerals and Localities *(continued)*

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
			* = Type Locality	*(?) = Type Locality Disputed
Mururata 2 (District includes Mururata 1)	Mountain, district	16°30′ 67°50′	Sud Yungas Prov., La Paz Dept., 31 km ESE of La Paz	Molybdenite, scheelite, tungstite, wolframite. See Andina, Bolsa Negra, Aceromarca, Chojlla
Mutún	Mountain		30 km SSW of Puerto Suarez, Busch Prov., Santa Cruz Dept.	Cryptomelane, hausmannite, hematite, magnetite (30 billion tons of iron ore), pyrolusite
Napa	District		San Pablo de Napa	Potassium-alum, sulfur, ulexite
Negra	Mine	21°02′ 68°18′	Nor Lípez Prov., Potosí Dept., 8 km NNE of Cosca, Chile	Arseniosiderite, pyrolusite
Negro Pabellón (Also called Japo)	Mine	15°00′ 66°58′	Santa Fé District, Dalence Prov., 30 km SE of Oruro	Cassiterite, hisingerite, pyrrhotite, siderite, vivianite
Nueva Venecia	Ranch		Ñuflo de Chavez Prov., Santa Cruz	Columbite, ilmenite (to 3.5 cm)
Nueva Virginia	Mine		Colquechaca	Cylindrite
Obrajes	Hot springs		20 km NE of Oruro, Cercado Prov., Oruro Dept.	Jarosite, thermonatrite
Ocurí	Town	18°50′ 65°50′	Chayanta Prov., Potosí Dept., 26 km SE of Colquechaca	Cassiterite, pyrargyrite, stibiconite; see Huayoco, Lípez Huayco
Oploca 1	Mine		Animas-Chocaya sub-district, 8 km NE of Chocaya	Argyrodite/canfieldite, cassiterite, hocartite
Oploca 2	Village		Sud Chichas Prov., Potosí Dept., 16 km NNW of Tupiza	Marcasite on pyrite, stibnite
Orco Cuchillo	Mine		Huari Huari	Marcasite
Orlandini (mine owner's name)	Mine		Ubina	Cassiterite, pyrite, tourmaline
Oruro	Town, Department	17°59′ 67°08′	Cercado Prov.	Andorite, arsenopyrite, augelite, barite, boulangerite, bournonite, cassiterite, cerussite, chalcopyrite, chalcostibite, cylindrite, diadochite, diaphorite, franckeite, galena, jamesonite, kesterite, marcasite, metastibnite, miargyrite, natroalunite, orthoclase, plagionite, pyrite, quartz, rhomboclase, semseyite, siderite, sphalerite, stannite, stibnite, teallite, tetrahedrite, tourmaline, valentinite, vivianite, wavellite, *(?)wurtzite, zinkenite; see San José, Santo Cristo, Itos, Socavón, Antofagasta, Tetilla, San Felipe, La Colorada, Cerro San Pedro, Socavon
Pacajake (or better: Virgen de Surumi, in Pacajake Canyon)	Mine		Chayanta Prov., Potosí Dept., 2 km E of Hiaco Mine; 20 km NE of Colquechaca	*Ahlfeldite, barite, clausthalite, chalcomenite, cobaltomenite, grimaldiite, hematite, *mandarinoite, molybdomenite, naumannite, *olsacherite, *penroseite ("blockite"), selenium, siderite, tiemannite
Pacopampa	Mine		Caluyo	Ferberite, siderite
Pacuani	Mountain		Aroma Prov., La Paz Dept., 20 km E of Patacamaya	Bournonite, galena, jamesonite
Pacuni Chico	Mine		Quime	Wolframite
Pailaviri	Mine			See Cerro Rico
Palca	Mine		Illimani	Stibnite
Pallaya	Mine		Yani	Gold
Pampa Grande	District		Sud Chichas Prov., Potosí Dept., 35 km SE of Tupiza	Aurichalcite, galena, linarite; see Churquina
Paragüi	Mine		30 km NW of Colquiri, Inquisivi Prov., La Paz Dept.	Chalcedony, hübnerite, stibnite

Bolivian Minerals and Localities *(continued)*

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
		* = Type Locality		*(?) = Type Locality Disputed
Patacamaya	Town	17°14′ 67°55′	Aroma Prov., La Paz Dept., 80 km S of La Paz	See Pacuani, La Escosasa
Pazña	Town, district	18°36′ 66°55′	Poopó Prov., Oruro Dept., 85 km SSE of Oruro	See Exaltación, Antequera, Avicaya, Totoral, Monserrat
Perez	Mine		Huanuni	Wolframite
Pirpintuyok (also known as Copacabana)	Mine		Mochará	Anglesite, galena
Poconota	Mine		Toropalca	Gold, stibnite
Polo Sur	Mine		Ancoma	Cassiterite
Pongo	Village		Murillo Prov., La Paz Dept.	Cassiterite, ferberite, hydrotungstite, tungstite; see Martha, San Antonio 3, Alasca
Poopó	District, town	18°22′ 66°58′	Poopó Prov., Oruro Dept., 48 km SSE of Oruro	Cassiterite, *cylindrite, fluorapatite, *(?)franckeite, *incaite, jamesonite, kermesite, silver, stannite, teallite, vivianite, wurtzite, zinkenite; see Coriviri, San Francisco 3, Santa Cruz 2, Trinacria, Rosario 3, Bolivia, Candelaria
Porco	Mine, town	19°50′ 65°59′	Quijarro Prov., Potosí Dept., 35 km SW of Potosí	Acanthite, ankerite, argyrodite, barite, calcite, cervantite, galena, marcasite, pyrargyrite, pyrite, pyrrhotite, quartz, siderite, silver, sphalerite; see Tornohuico, Gutierrez
Porvenir 1	Mine	17°08′ 67°38′	Huanuni	Boulangerite, cassiterite (needle tin), cylindrite, franckeite, greenockite, freieslebenite, jamesonite, pavonite, plagionite, semseyite, sphalerite, stannite, stibiconite, teallite, valentinite, wurtzite
Porvenir 2, also Socavón Porvenir	Mine		Next to the Rosario 1 mine	Gold, tourmaline
Porvenir 3				Misnomer for Bolivar 1
Posokoni (Pozokoni)	Mountain		Huanuni	Cassiterite, jarosite, opal, scorodite, sphalerite, tourmaline; see Cataricagua
Potosí	City, Depart-ment	19°35′ 65°45′	Bustillo Prov.	See Cerro Rico
Pucara	Mine		Corocoro District	
Pucro	Mine		Chayanta town	Cassiterite, pyrite, pyrrhotite, siderite
Pueblo Viejo	Mine		Esmoraca	Bismutite
Puerto Suárez	Town	18°56 57°50′	Busch Prov., Santa Cruz Dept.	See La Gaiba, Mutún
Pulacayo (also called Huanchaca Mine)	Mine		Huanchaca	Anhydrite, arsenolite, bournonite, chalcopyrite, chalcostibite, enargite, freibergite (?), galena, geocronite, gypsum, jamesonite, miargyrite, metastibnite, pyrargyrite, pyrite, quartz, siderite, sphalerite, tennantite, tetrahedrite, wurtzite, zinkenite
Quechisla	Town, district	20°54′ 66°01′	Nor Chichas Prov., Potosí Dept., 64 km NNW of Tupiza	Minerals ascribed to Quechisla actually came from the Atocha/Quechisla district.
Quetena Grande	Town	22°18′ 67°23′	Sud Lípez Prov., Potosí Dept., 97 km SW of San Pablo	Metasideronatrite, malachite
Quiabaya	Village	15°37′ 68°46′	Larecaja Prov., La Paz Dept., NE of Chichulaya	Jamesonite. See Cascabel.
Quime	Town		Inquisivi Prov., La Paz Dept., 10 km SSW of Inquisivi	Antimony, calcite, pyrite, scheelite valentinite, wolframite; see Chambillaya, Margareta, Pacuni Chico

Bolivian Minerals and Localities *(continued)*

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Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Quimsacoya	Mine		Huanuni Dist., Dalence Prov., Oruro Dept.	Hübnerite, stibnite
Quioma, also Asiento	Mine		40 km SSW of Mizque, Mizque Prov., Cochabamba Dept.	Galena (Ag rich), litharge, minium, sphalerite
Ramiro	Mine		San Pedro De Buena Vista	Cassiterite, pyromorphite
Recompensa	Mine		La Bella District	Ferrocolumbite, monazite
Remedios	Mine		Corocoro	Calcite
Rincón del Tigre	Village		Busch Prov., Santa Cruz Dept., 140 km NNW of Puerto Suarez	Chrome-chalcedony, quartz with bubbles; see also Anahi
Rosario 1 (sometimes Socavón Rosario)	Mine		Asiento de Araca	Cassiterite, ferberite twins, gold, jamesonite, quartz with tourmaline inclusions, plagionite, scheelite; see Porvenir 2
Rosario 2	Mine		W slopes of Cerro Bonete	Pyrargyrite, silver
Rosario 3	Mine	18°23′ 66°58′	Poopó town	Cylindrite, franckeite, sphalerite
Rosario 4 (sometimes Tazna-Rosario)	Mine		Tazna	Bismuth, bismuthinite, ferberite twins, quartz twins, pyrite
Rosita	Mine		Cacachaca	Chalcostibite
Sabaya	Town, river, pampa	19°00′ 68°22′	Atahuallpa Prov., Oruro Dept., 177 km SW of Oruro	Ulexite; probably from near the mouth of the Sabaya river into the Salar de Coipasa
Sacaba	City	17°23′ 66°02′	Chapare Prov., Cochabamba Dept., 13 Km E of Cochabamba	Siderite
Salar de Empexa				See Empexa
Salo			20 km N of Tupiza	See Tamacaya
Salvadora 1	Mine		Oruro City	See Socavón
Salvadora 2	Mountain, stock			This mountain contains the Llallagua deposit. All minerals come from the Siglo XX mine.
San Agustin 1	Mine		3 km N of Corocoro mine	Copper after aragonite, cuprite, malachite
San Agustín 2	Mine, village		35 km ESE of San Ramón	Columbite, magnetite, monazite, muscovite
San Antonio 1 (full name: San Antonio de Calacalani)	Mine		12 km S of Colquiri, Cercado Prov., Oruro Dept.	Ferberite, *hydrotungstite, stibnite, tungstite
San Antonio 2	Mine		3 km from Viloco	Cassiterite (Some specimens from here may be labeled Viloco.)
San Antonio 3	Mine		Pongo	Ferritungstite, tungstite, wolframite
San Antonio de Lípez	Town	21°47′ 66°48′	30 km SW of San Pablo, Sud Lípez Prov., Potosí Dept.	Cerargyrite; see Mesa de Plata
San Baldomero			Sorata District	Old name for Marcamarcani gold mine
San Carlos 1	Mine		Chorolque	Bismite
San Carlos 2	"Mine"		Chacaltaya	Cassiterite, chalcopyrite, fluorite, gersdorffite, muscovite, pyrite, quartz, tourmaline
San Cristobal	Town, mountain	21°07′ 67°12′	Nor Lípez Prov., Potosì Dept., 90 km SSW of Uyuni	See Cobrizos, Challahuilque
San Felipe	Mine		Oruro city	Augelite, andorite, pyrite, stannite
San Francisco 1	Mine		Alto Chapare district	See Alto Chapare

Bolivian Minerals and Localities *(continued)*

Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
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San Francisco 2	Mine		Corocoro District	
San Francisco 3	Mine		Poopó Dist.	Cylindrite, kermesite
San Javier	Town	16°20′ 62°38′	Ñuflo de Chávez Prov., Santa Cruz Dept., 60 km SW of Concepción	Tantalite
San José	Mine		Oruro City	Alunite, andorite, arsenopyrite, augelite, boulangerite, bournonite, cassiterite, cerussite, chalcopyrite, chlorargyrite, cylindrite, diaphorite, dickite, franckeite, galena, halotrichite, jamesonite, jarosite, kesterite, marcasite, metastibnite, plagionite, pyrite, rhomboclase, semseyite, stannite, stibnite, teallite, tetrahedrite, tourmaline, valentinite, vivianite, wurtzite, zinkenite
San José de Culini	Mine		Sud Yungas Prov., La Paz Dept., 7 km E of Chalcaltaya Mtn.	Galena, pyrrhotite, siderite, sillimanite, ullmannite
San Luis 1 (also known as Mary Mary; Heil Hitler; and Kairiri)	Mine	17°16′ 69°13′	Berenguela District	Azurite, copper, galena, greenockite, sphalerite, tennantite
San Luis 2	Mine		Chulchucani.	Asbolane, cuprian heterogenite
San Miguel 1	Town		Velasco Prov., Santa Cruz Dept., 35 km S of San Ignacio de Velasco	Staurolite
San Miguel 2	Mine		Chorolque	Wittichenite
San Miguel 3	Mine	18°02′ 67°57′	Lequepalca	Ferberite, some coating stibnite, jarosite, stibiconite, sulfur
San Pablo de Churiña				See Churiña
San Pablo de Napa	Abandoned village	20°29′ 68°39′	Campos Prov., Potosí Dept., 170 km WSW of Uyuni	See Napa
San Pedro	Village		10 km NW of Sorata	Remarkable karst cavern > 1 km long, entirely in gypsum
San Pedro de Buena Vista	Town	18°13′ 65°59′	Charcas Prov., Potosí Dept., 155 km N of Potosì	Barite, bismuth, bismuthinite, gold; see Santa María, Ramiro
San Ramón	Town, district		Ñulflo de Chavez Prov., Santa Cruz Dept., 80 km SW of Concepción	See La Bella, San Agustín 2, La Verde
San Simón				See Serranía
San Vicente	Mine, town	20°15′ 65°33′	Sud Chichas Prov., Potosí Dept., 40 km S of Atocha	Freibergite (unconfirmed); part of the Atocha (Quechisla) District. Butch Cassidy and the Sundance Kid were killed and buried here; see Alcacoya, Asunta, Soracaya, Tatasí
Santa Ana	Town	16°37′ 60°43′	Velasco Prov., Santa Cruz Dept., 35 km SE of San Ignacio de Velasco	Beryl, limonite after almandine, muscovite, staurolite, tantalite
Santa Barbara	Mine		Andacaba Dist.	Wolframite
Santa Cruz 1	Mine		Loayza Prov., La Paz Dept., between Caxata and Yaco	Mottramite
Santa Cruz 2	Mine		Poopó town	*Cylindrite, franckeite, kermesite, zinkenite
Santa Fé	Mine, district		Dalence Prov., Oruro Dept., 3 km from Morococala	Cassiterite, crandallite, freieslebenite, matildite, miargyrite, muscovite, pyrargyrite, quartz, silver; see Negro Pabellon, Morococala
Santa Isabel	Mine		Condeauque	Ferberite, hübnerite, zinkenite
Santa María	Mine		San Pedro de Buena Vista	Bismuthinite, gold

Bolivian Minerals and Localities *(continued)*

		* = Type Locality		*(?) = Type Locality Disputed
Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Santa Marta	Mine		12 km W of Aiquile	Acanthite, galena, silver
Santa Rosa	Mine		Monserrat	Siderite, *teallite
Santiago	Mine		Oploca 2	Dickite
Santiaguillo	Gully, village		15 km SE of Macha	Adularia, cassiterite (wood tin), hematite, *rooseveltite, topaz
Santo Cristo	Mine		Oruro city	Andorite, augelite, aurichalcite, cassiterite, franckeite, jamesonite, metastibnite, pyrite, stibnite
Sayari	Mountain		Arque Prov., Cochabamba Dept., 50 km SW of Cochabamba city	Cerussite, chlorargyrite, galena, manganese oxides
Serranía San Simón	Hills	13°35′ 62°10′	Eastern Iténez Prov., Beni Dept.	Hausmannite, "psilomelane", pyrolusite
Sica Sica	Town	17°22′ 67°44′	Aroma Prov., La Paz Dept., 105 km SSE of La Paz	See Laurani, Lomitas. Sica Sica is very close to Chijmuni and the Lili quarry.
Siete Suyos	Mine		Animas-Chocaya sub-district	Apatite, boulangerite, bournonite, freibergite, hocartite, jamesonite, pyrite, stannite
Siglo Veinte or XX	Mine		Llallagua	See under Llallagua
Sijsihua	Village	20°07′ 68°19′	Empexa	Nitratine
Socavón (also called La Salvadora 1)	Mine		Oruro City	Augelite, bournonite, franckeite, chalcostibite, plagionite, pyrite, sphalerite, stannite, stibnite, tetrahedrite, wavellite
Socavón Carmen	Adit		Chojlla	Cassiterite, feldspar, muscovite, wolframite
Socavón Rosario				See Rosario 1
Soracaya	Mine		Atocha District, 10 km ESE of San Vicente	Pyrargyrite, tetrahedrite
Sorata	Town, district	15°47′ 68°40′	Larecaja Prov., La Paz Dept., 146 km NNW of La Paz	See Millapaya, Hucumarini, Marcamarcani
Sucre	Mine		10 km N of Esmoraca	Gold, stibnite
Tacora	Mountain		Avaroa, Nor Lípez Prov., Potosí Dept.	Sulfur
Tamacaya	Mine		10 km N of Salo	Boulangerite
Tamiñani	Elluvial mine		4 km N of Mt. Chicote Chico	Arsenopyrite, tungstite, wolframite
Tanapaca (also called Mocoya)	Mine		3 km NW of Viloco	Arsenopyrite, bismuth, bismuthinite, cassiterite, gold (Some specimens from here may be labeled Viloco.)
Tapacarí	Town	17°31′ 66°36′	Tapacarí Prov., Cochabamba Dept., 45 km WSW of Cochabamba	Stibnite, sulfur; see La Sorpresa
Tapi	Mine		Cotagaita	Chalcostibite, stibnite
Tarabuco	Town, region		64 km ESE of Sucre Yamparáez Prov., Chuquisaca Dept.	Amethyst, chalcedony, copper, cuprite, zeolites
Tarapaya	Village, hot springs	19°28′ 65°47′	Frías Prov., Potosí Dept., 15 km NNW of Potosí	Hematite
Tarumita	Mine		4 km NE of Caracollo	Celestine, cervantite, cinnabar on stibnite, tripuhyite
Tatasí	Mine		Sud Chichas Prov., Potosí Dept., 25 km ENE of San Vicente	Andorite, canfieldite (?), cerussite, miargyrite, ramdohrite, valentinite

Bolivian Minerals and Localities *(continued)*				
		* = Type Locality		*(?) = Type Locality Disputed
Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Tazna; also Tasna	Mine, mountain	20°37′ 66°11′	Atocha (Quechisla) District	Arsenobismite, arsenopyrite, augelite, bindheimite ("taznite"), bismite, bismoclite, bismuth, bismuthinite, bismutite, cassiterite (included stream tin), *daubrèeite, ferberite, fluorapatite, jamesonite, jarosite, pyrite, quartz twins, siderite, tungstite, vivianite;see Constancia, Farellones, Mariana, Rosario 4
Terremoto (or Pepito)	Mine		10 km N of Cacachaca, Avaroa Prov., Oruro Dept.	Chalcostibite, stibnite
Tetilla	Mine		Oruro City	Anglesite, barite, galena, sphalerite, tetrahedrite
Tihua	Mining Company		Quijarro Prov., Potosí Dept.	Operated Carguaicollo Mines, which see
Tipuani	Town, river		Larecaja Prov., La Paz Dept., 72 km NE of Sorata	Cassiterite, garnet, gold, pyrite; see Chusi
Titina	Mine		Caluyo	Tetrahedrite (2% Hg)
Tolapalca (also Thola Palca)	Mine		30 km ENE of Oruro City, Cercado Prov., Oruro Dept.	Ankerite, stibnite
Tornohuaico	Mine		Porco District, 2 km S of Porco	Acanthite, argyrodite/canfieldite, galena, silver, stannite, stephanite, siderite
Toro Toro	Town	18°07′ 65°46′	27 km ENE of San Pedro, Charcas Prov., Potosí Dept.	Calcite, descloizite
Toropalca	Town	20°21′ 65°46′	Nor Chichas Prov., Potosí Dept., 51 km N of Cotagaita	Cassiterite, chalcostibite; see Poconota
Totoral	Mine		Pazña District	Vivianite
Tras Cuarenta	Mine		Adjoins Viloco Mine	Ferrimolybdite, molybdenite, tourmaline, wolframite
Tricolore	Mine		Don Diego	Chrysocolla
Trinacria	Mine		6 km SSE of Poopó	Cylindrite, franckeite, zinkenite
Tupiza	City	21°24′ 65°54′	Sud Chichas Prov., Potosí Dept., 201 km S of Potosí	Almandine, epidote; see Salo
Turco	Town	18°10′ 68°11′	Sajama Prov., Oruro Dept., 120 km WSW of Oruro	Azurite, chrysocolla, copper, cuprite; see La Ponderosa, Cuprita
Ubina	Canton, mountain, mine	20°29′ 66°29′	Quijarro Prov., Potosí Dept., halfway between Tazna and Pulacayo	Barite, enargite, jamesonite, orthoclase, pyrite, tetrahedrite; see Moquegua, Orlandini, Cerro Ubina
Uncía	City	18°28′ 66°36′	Bustillo Prov., Potosí Dept., 77 km SE of Oruro	All Specimens ascribed to Uncía except pyrargyrite, psilomelane and (common) opal, are from the Siglo XX mine. See Amayapampa, Salvadora 2
Unificada	Mine		Potosí	See Cerro Rico
Urania	Mine		S slope of Illimani, Murillo Prov., La Paz Dept.	Ferberite after scheelite, wolframite
Uturuncu	Volcano and hot springs area	22°13′ 67°14′	Sud Lípez Prov., Potosí Dept.	Alunogen, opal, pickeringite, pyrolusite, pink sulfur
Valle Zongo (see Zongo)	Valley			
Venus	Vein system		near Antequera mine, perhaps part of it	Cassiterite, hydrocerussite, varlamoffite
Vetillas	Mine		Maragua	Stannite, franckeite
Víboras	Mine		Machacamarca	Bournonite, chlorargyrite, tetrahedrite

Bolivian Minerals and Localities *(continued)*

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Location	*Loc. Type*	*L/L*	*Higher Order*	*Mineral species*
Vichacla	Village	20°38′ 65°38′	Nor Chichas Prov., Potosí Dept., 35 km W of Camargo, Nor Cinti Prov., Chuquisaca Dept.	See Cerro Negro 2
Vicuñita	Prospect		4 km S of Maria Teresa Mine	Cassiterite ("needle tin"), galena, teallite
Vila Apacheta	Mine	19°55′ 66°16′	Near Chayanta	Apatite, cassiterite, gypsum, *rhodostannite, magnesite, pyrite, sphalerite, stannoidite
Vilaque	River		Murillo and Los Andes Provinces, La Paz Dept	Alluvial bismuth, bismutite, gold
Villa Tunari	Town		Chapare Prov., Cochabamba Dept., 90 km NE of Cochabamba	See Alto Chapare
Viloco (Interchangeable with Araca)	Mine	16°53′ 67°37′	Loayza Prov., La Paz Dept., 41 km NNE of Luribay	Arsenopyrite, cassiterite, chamosite, molybdenite, ferrimolybdite, pyrite, quartz, siderite, sphalerite, "tourmaline"; see San Antonio 2, Tanapaca, Asiento de Araca
Virgen de Surumi (preferred name for Pacajake Mine)	Mine		Pacajake	
Volcano	Mine		Mojo	Cerussite, pyromorphite, wulfenite
Yaco	Town	17°09′ 67°24′	Loayzo Prov., La Paz Dept., 29 km ESE of Luribay	See Santa Cruz 1
Yanacachi	Town, sub-district of Murumata 2 district	16°23′ 67°43′	Mururata district, Sud Yungas Prov., La Paz Dept.	See Reconquistada, Chojlla, Bolsa Negra, El Barco
Yani	Town	15°36′ 68°35′	Larecaja Prov., La Paz Dept., 20 km NNE of Sorata	See Pallaya
Yarvicoya	Mine	17°37′ 66°55′	Cercado Prov., Oruro Dept., 40 km NE of Oruro, near Lequepalca	Brochantite, chalcanthite, chalcopyrite, cuprite, stibiconite, stibnite
Yura	Town, district	20°04′ 66°08′	Quijarro Prov., Potosí Dept., 40 km SSW of Porco	See Caracota
Zongo: at least 30 mines here, including Fabulosa	Valley		45 km N of La Paz, Larecaja and Murillo Provs., La Paz Dept.	Hypothermal veins with pegmatite characteristics: almandine, apatite, biotite, cassiterite, chalcopyrite, chlorite, erythrite, hübnerite, lazulite, molybdenite, muscovite, quartz, sphalerite, stannite, triphylite, triplite, vivianite

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What's New in Minerals

Spring Shows 2001

by Jeff Scovil

As usual, my spring show schedule started off with the *Rochester Mineral Symposium* held this year April 19 through 22. Pickings were rather slim for things that were truly new, but I did catch up on a few things that showed up at Tucson that I did not get to photograph then. These finds included Gilles Haineault's killer **carletonites** from Mont Saint-Hilaire, Quebec, Canada (see Tom Moore's Tucson Show report in the May-June 2001 *Mineralogical Record*). In contrast to the small, loose singles we have been seeing for some time, these are clusters of deep blue crystals to over 7 cm.

The **chevkinites** in *Mountain Minerals'* booth from Arondu, Baltistan, Pakistan, were not esthetic but quite large for their size—over 4 cm. Ross Lillie told me that only 11 of the metallic, black, tabular crystals with rough terminations were found in November of 2000. Something else that turned up at Tucson was very sharp octahedrons of **magnetite** modified by the dodecahedron and cube. The crystals are associated with a member of the chlorite group and are from the Karzemkkul deposit, Kustanay Oblast, Kazakhstan. The best of the lot were bought by Bill Butkowski of *The Mineral Cabinet*, who only had four pieces left.

During the summer of 2000 a find of very nice **prehnite** crystals was made at the famous Jeffrey quarry in Asbestos, Quebec. About 50 clusters of pale yellow crystals were collected by miners and Jonathan Levinger who, along with *True North Minerals*, were selling them at Rochester.

Bill Pinch turned up an oddball recently from a Chinese dealer. The specimen was sold to Bill as a cassiterite, but it did not look quite right, so Bill had it tested. It turned out to be a very nice, doubly terminated **manganotantalite** from Ximen, Hunan, China. Bill had the specimen in a display of recently acquired, mostly rare specimens.

Iran seems to be in the news recently, what with the finds of very nice cerussite made last year, and this year, **chromian andradite**. The sharp, loose, dark green crystals are purportedly from Registan, Iran, but Dudley Blauwet says they are from Quntiwan, Badakshan, Afghanistan. Some of the garnets have that "melted" look that some crystals from metamorphic environments have. Leonard Himes of *Minerals America* was selling them and told me that the only association was some fibrous material looking like the mountain leather that demantoid from Italy is usually found in. Twelve of the crystals, to 4 cm in diameter, were bought by Mike Ridding from a dealer in Idar-Oberstein, Germany about a year ago in the spring of 2000. They had been sent to the dealer as possible facet rough. Dudley also had some bi-colored, highly etched but very attractive **spodumene** crystals from Ghash, Dara Pech, Kunar, Afghanistan.

Dave Bunk obtained some gemmy, tabular **euclase** crystals from Minas Gerais, Brazil, up to 6.8 cm long. He is working on getting the exact locality. Another very pleasant surprise in Dave's booth was superb, green puff balls of **olivenite** associated with small **azurite**. The locality is El Cobre mine, Concepcion del Oro, Zacatecas, Mexico.

The last bit of information on new minerals is not derived from attending a mineral show, but from an annual seminar on mineralogy in Kongsberg, Norway. I was invited as a speaker and then did some photography afterwards. It seems that there is a lot more to Norway than just silver and anatase. During the summer of 2000 a find was made of some very fine **molybdenite** crystals in an old molybdenum mine in Bandaksli, Tokke, Telemark, Norway. The crystals are quite sharp, occurring as singles and clusters. A road cut near Drammen, Buskurud, Norway, has exposed a granite with some bizarre forms of common minerals. **Schorl** occurs there as black hemispheres to 2.3 cm across. There are also strange rosettes of **orthoclase** crystals. In the fall of 2000 a pocket of **prehnite** 1.5 meters long was encountered at the Valberg quarry, Kragero, Telemark, Norway. Associated with the prehnite were unidentified pseudomorphs after ilmenite. The host rock is a metasomatized gabbro.

Sainte-Marie-aux-Mines Show 2001

by William F. Larson

[June 21–24]

The town of Ste.-Marie-aux-Mines, situated at the intersection of several narrow, heavily forested valleys, can be reached via Route 416 from Ribeauville, along lovely, winding roads through beautiful green countryside. Numerous signs point the way to the Val d'Argent, "Valley of Silver," where the ruins and remnants of ancient mining activities are common. Customs officials stopped us as we entered the town, but once they realized we were carrying no luggage they waved us through. The customs officers, we were told, are generally looking for cut gemstones and are not too concerned with mineral specimens. Dealers planning to attend the show should familiarize themselves with the regulations in France regarding gems and minerals.

Across from the Office of Tourism stands the most modern building in town, a combination mineral museum and textile museum. Though charming, it will disappoint those looking for beautiful mineral specimens. There is a good display of fluorescent minerals, many examples of various kinds of ore, and a few specimens from worldwide localities donated by sympathetic mineral dealers.

This year was the show's 38th, hosted, as usual, by Michael Schwab. Over 16,000 visitors and 550 dealer/exhibitors from 45 countries turned out (including at least 30 Americans).

The dealer areas, both indoor and outdoor, are well marked out along two intersecting streets lined with white dealer tents. At the center of the show area stands a large two-story "theater" building

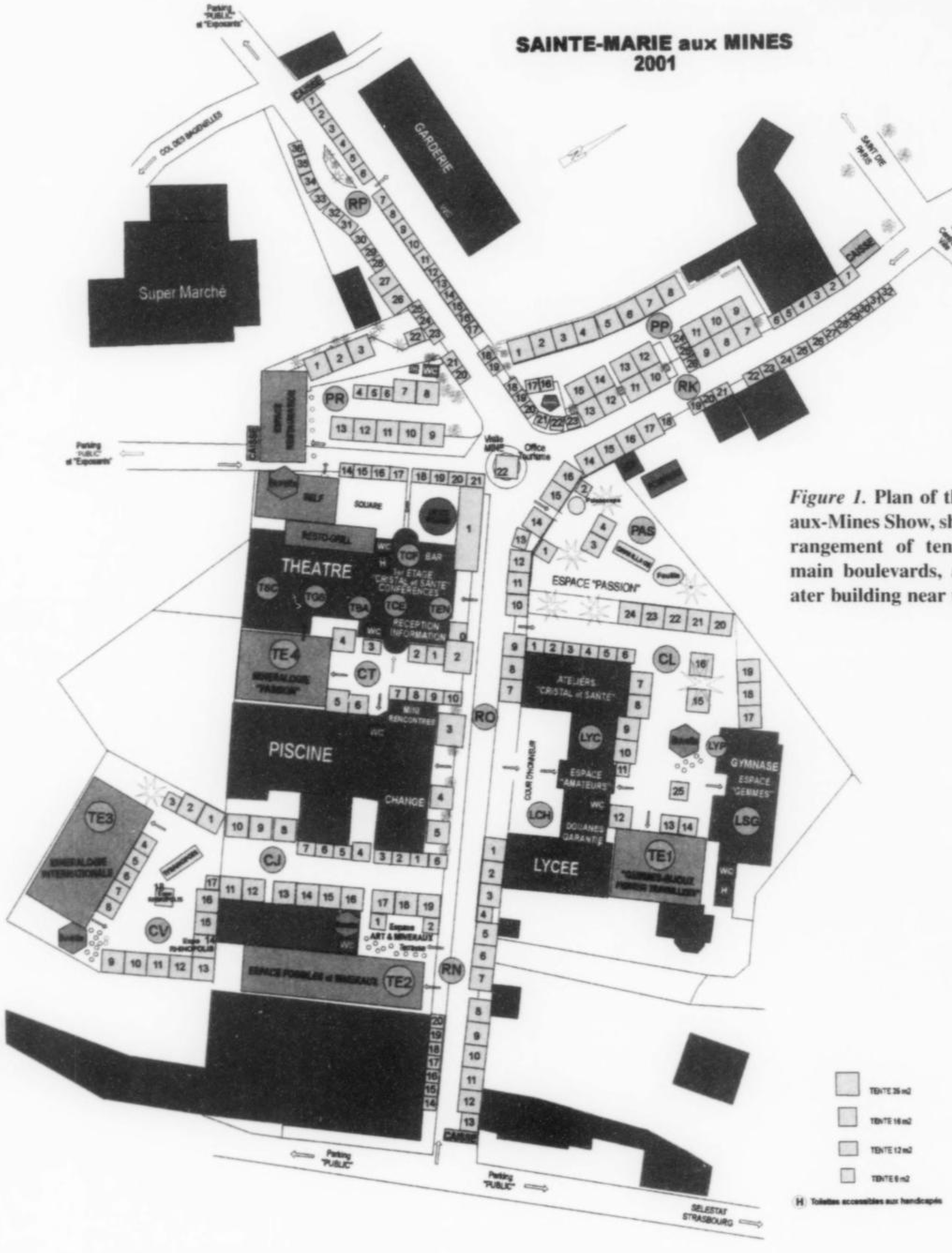


Figure 1. **Plan of the Ste-Marie-aux-Mines Show, showing the arrangement of tents lining the main boulevards, and the Theater building near the center.**

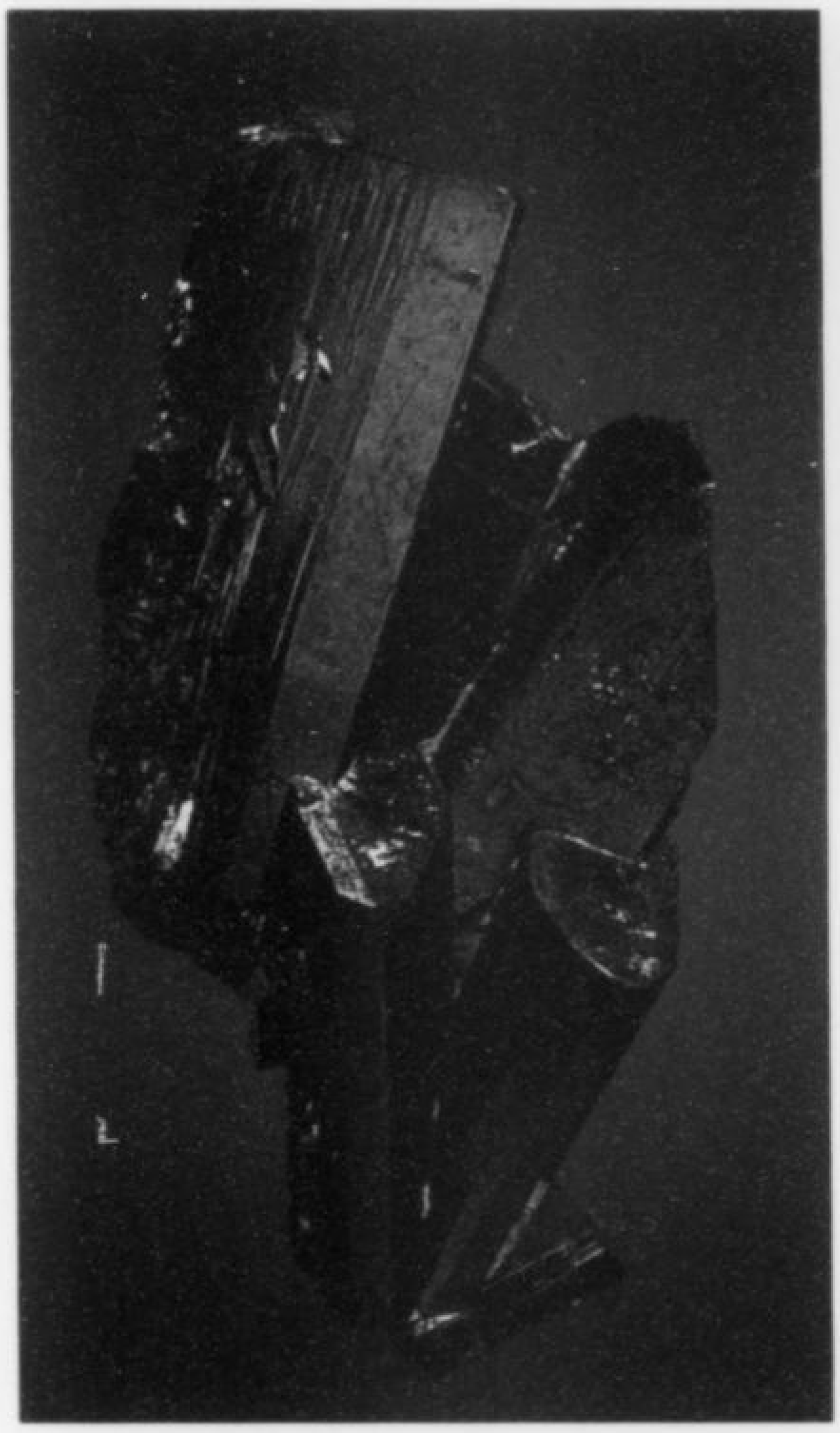
that houses the top mineral dealers. Pre-show rumors abounded on the street, including a report that 160 miners were currently working the Mibladen mine in Morocco for specimens, and that some wonderful vanadinite would consequently be available. China was also expected to supply some exciting things.

The show opens officially on Thursday, so there is always much preparatory activity going on the day before: many languages and cultures intermingle, and there is a cacophony of noisy drills driving tent spikes, the rumble of carts passing by, and the noise of cars streaking up and down the lanes. Visiting foreign buyers are allowed to wander about as the dealers work at setting up. First purchases are often the best.

This year there was somewhat of a scramble going on during set-up, especially when the new Moroccan dealers started to unwrap, piece by piece, several hundred freshly mined **vanadinite** specimens. A small feeding frenzy ensued as the best 100 pieces were quickly consumed.

The dealer tents lining the street are less formal than the booths at most American shows. Material is displayed on tables in flats, unlabeled and unpriced, after being hastily unwrapped and set up. The exciting part for collectors is that many more bargains can be found amidst this kind of chaos and informality.

On the first street we entered the first six dealers were dealing in fossils, polished pieces, and amethyst geodes. But the seventh



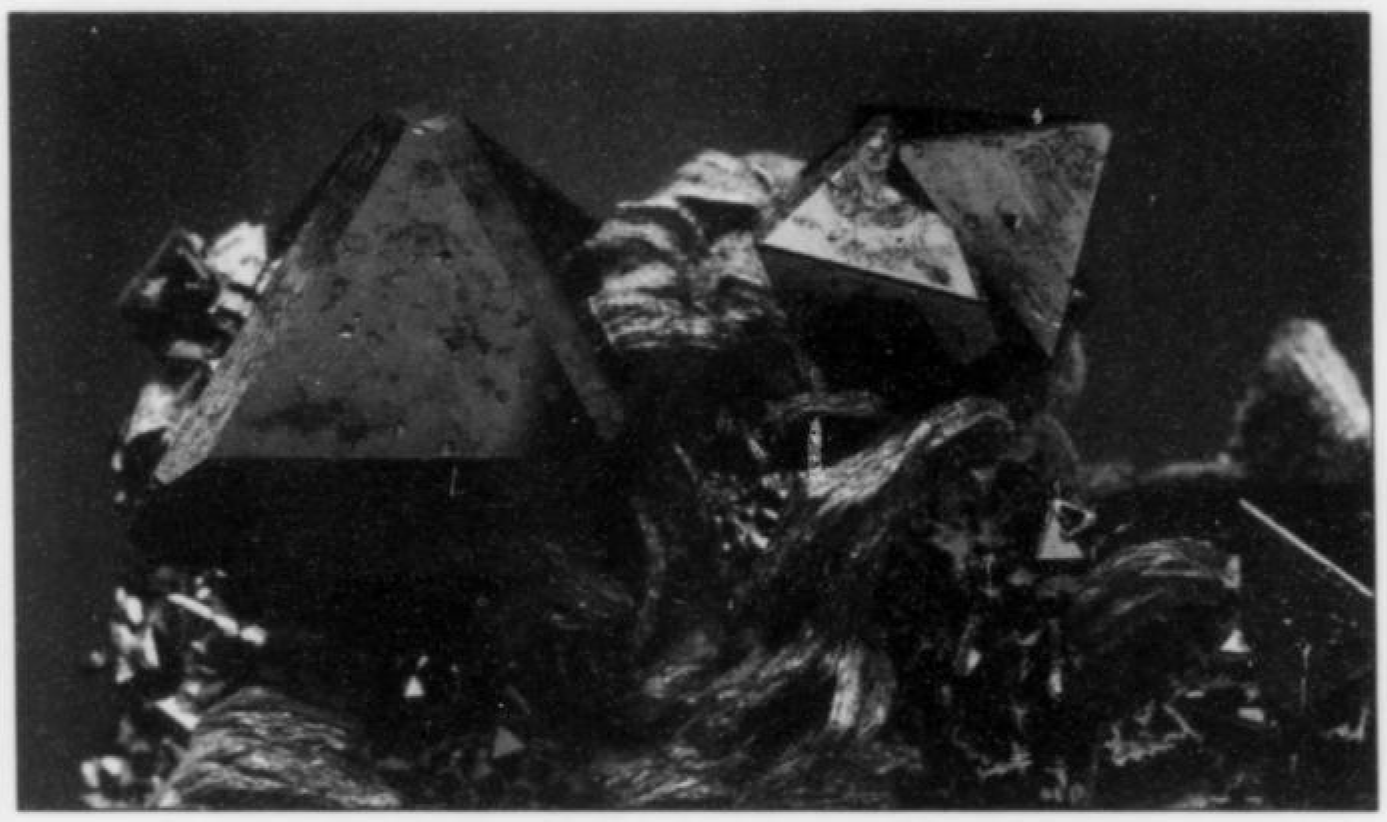


Figure 2. **Magnetite crystals to 1.2 cm on chlorite, from the Karzemkkul deposit, Kustanay Oblast, Kazakhstan. *The Mineral Cabinet* specimen; Jeff Scovil photo.**

Figure 3. **Chevkinite-(Ce) crystal group, 5.7 cm, from Arondu, Haramosh Range, Baltistan, Pakistan. *Mountain Minerals International* specimen; Jeff Scovil photo.**

Figure 4. **Fluorite crystal with 1.4-cm scheelite crystal, from Yaogangxian, Hunan, China. Michel Carré collection; Jeff Scovil photo.**

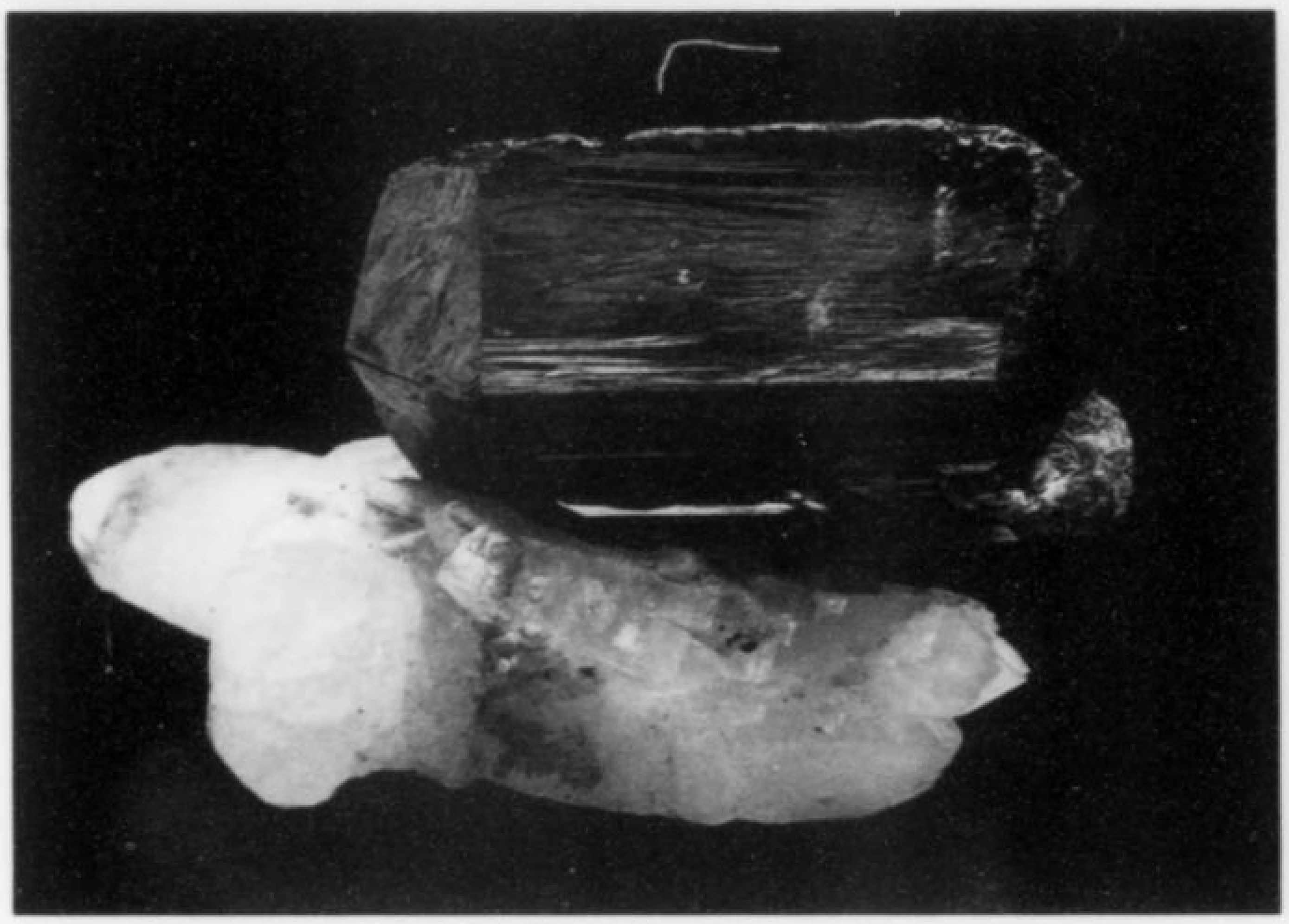


Figure 5. **Manganotantalite crystal, 3 cm, on quartz, from Ximen, Hunan, China. William Pinch collection; Jeff Scovil photo.**

dealer, Lásló Pálinkás (*www.koorszag.com*) from Hungary, had brought some marvelous things from the Rudabanya area, including quite respectable **cuprite** and **malachite** showing great promise for the future.

Across the street, *Abdelah Laaroussi* from Morocco (18 rue El Jiraoui, 54350 Midelt) had a typical selection of everything Moroccan, from fine **vanadinite** to thumbnail **azurite** specimens from Nubroden. The azurites averaged (at something over 13¢ to the French franc) about $14 each. Farther down the street we passed several bead and jewelry dealers before arriving at the central plaza where the better mineral dealers had congregated.

One of the many Chinese booths was operated by Mr. Yunfu Gao (*Hunan Sinophile Mineral*, 215 Shuguang Zhong Rd., 40007 Changsha), who had brought a complete representation of the minerals currently being mined in China; his prices ranged from $4 for single stibnite crystals to $695 for some fine fluorite specimens. At another stand, much more casual and littered than comparable stands at American shows, *Jon-Pierre Clerc* (24 rue Armezeaux, F-41350 Langon, France) had completely covered a 10 x 10-foot table with self-collected water-clear Spanish **gypsum** crystals in pockets in massive alabaster, from the Zaragoza area.

After passing another two dozen booths we came across a friend from Morocco, *Mr. Ali Hmanai* (18 verger St. Jean, 60000 Oujda). He was offering **azurite**, **erythrite** and (of course) **vanadinite** at

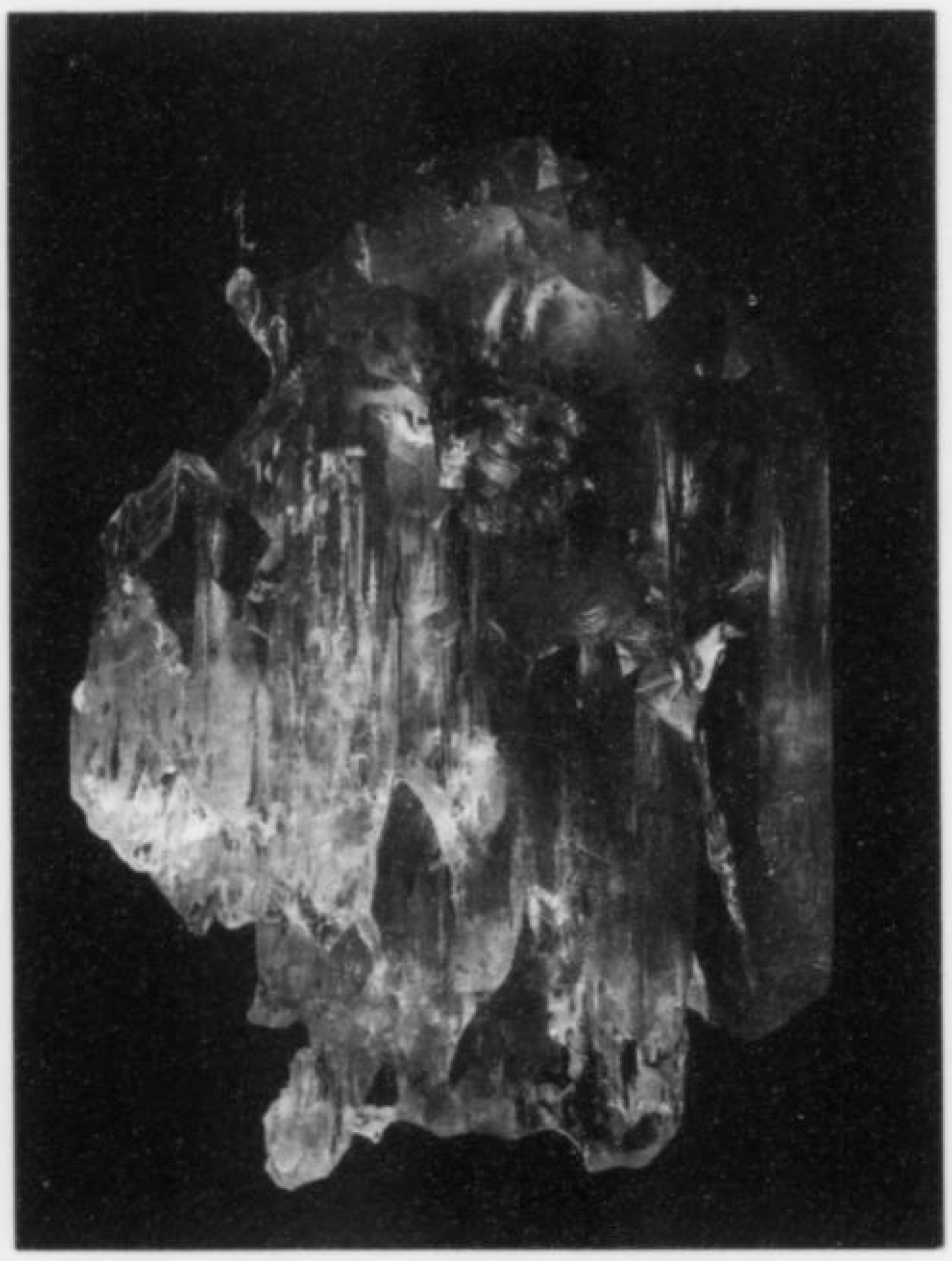
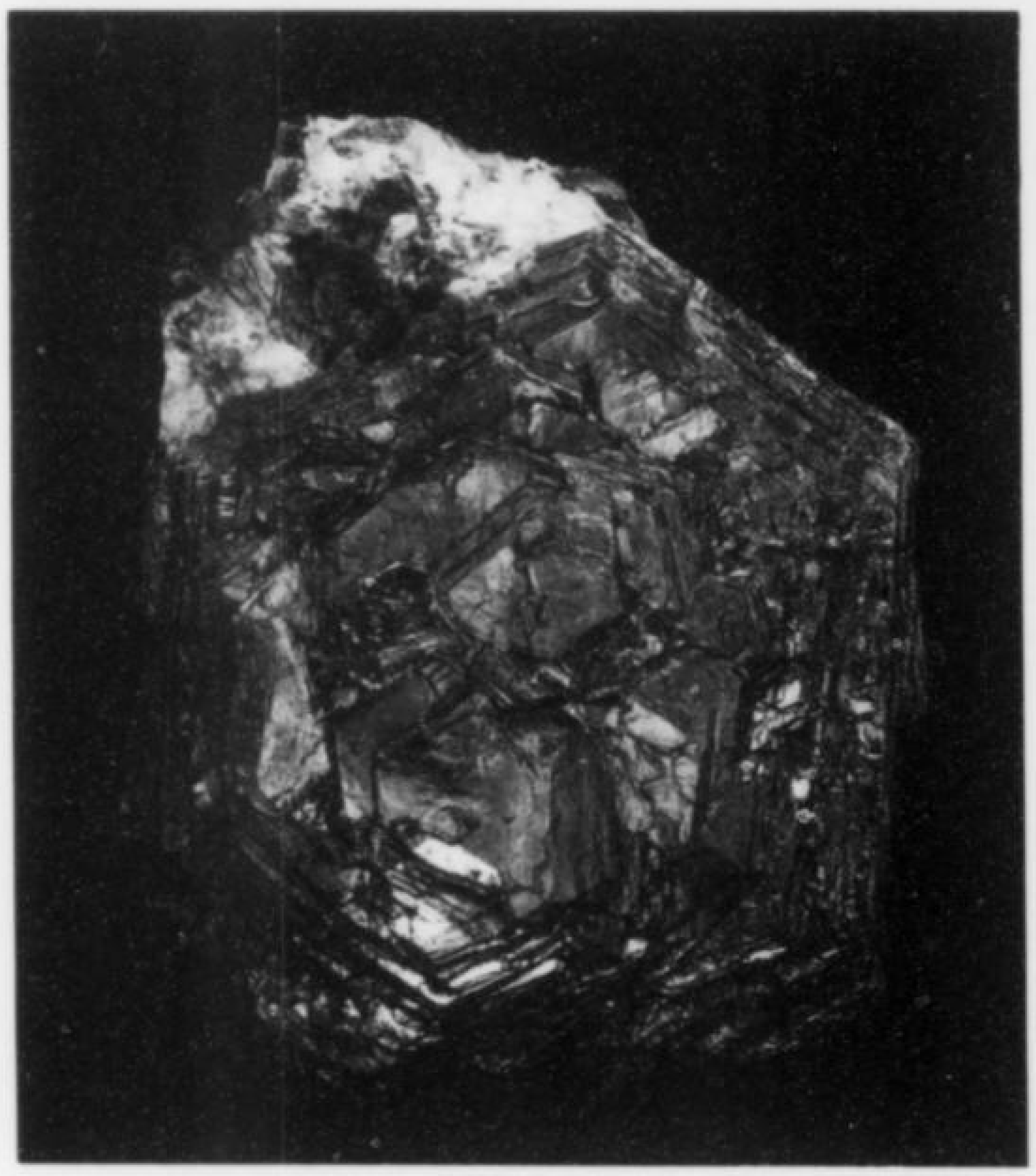


Figure 6. Blue and pink spodumene crystal, 10.4 cm, from Ghash, Dara Pech, Kunar, Afghanistan. *Mountain Minerals International* specimen; Jeff Scovil photo.

Figure 7. (left) Malachite, 9.7 cm, from Guangdong, Sichuan, China. *Great Basin Minerals* specimen; Jeff Scovil photo.



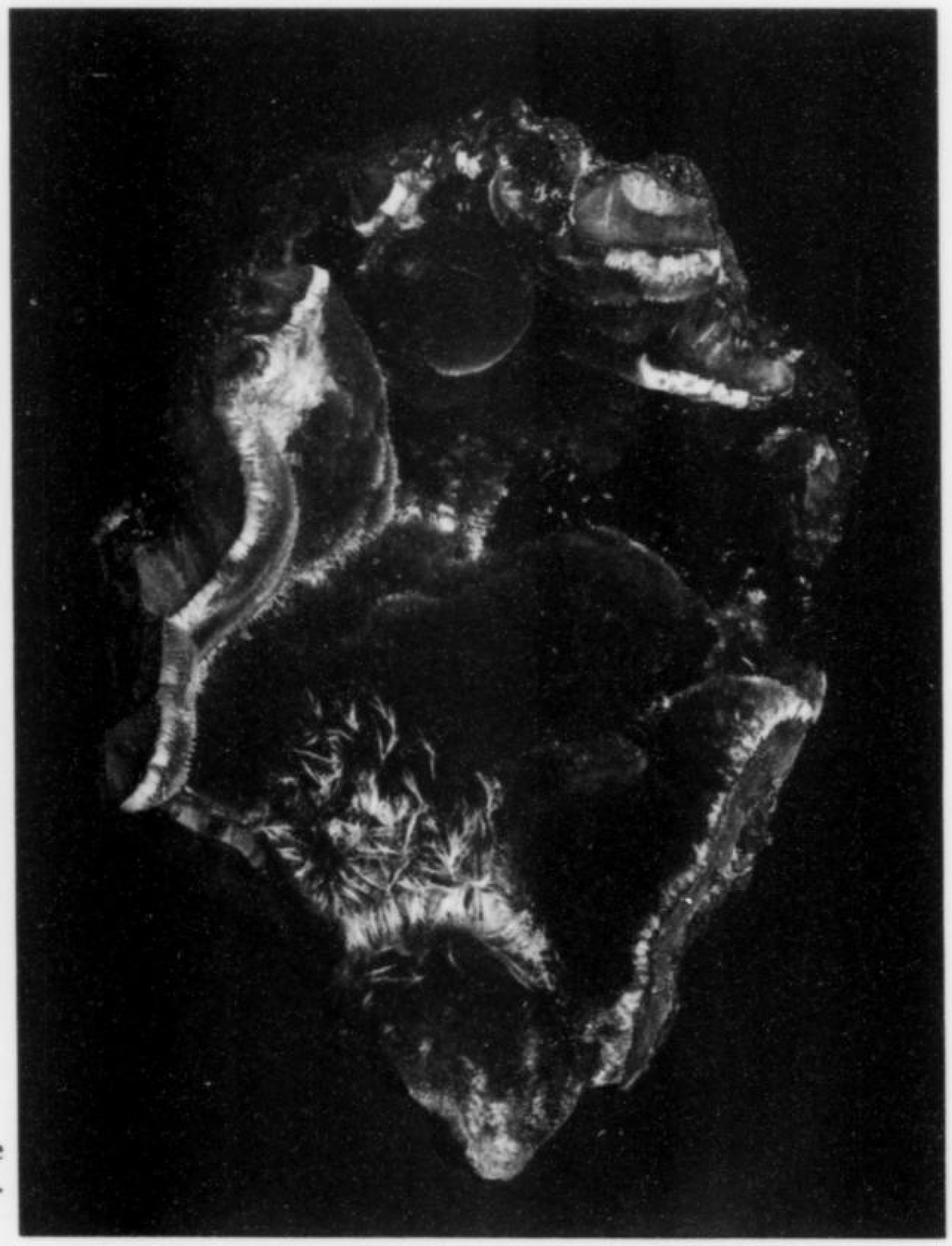


Figure 8. Molybdenite crystal, 6.8 cm, from Bandaksli, Tokke, Telemark, Norway. Morten Ånensen collection; Jeff Scovil photo.

Figure 9. Olivenite (green) with azurite, 7.8 cm, from the El Cobre mine, Concepcion del Oro, Zacatecas, Mexico. *Dave Bunk Minerals* specimen, now in the Harvard collection; Jeff Scovil photo.

Figure 10. **Outdoor dealer tents at the Ste-Marie-aux-Mines show. Jeff Scovil photo.**

prices starting around $13. He also had a small group of choice specimens from various world localities, including very nice **carletonite**, **serandite** (both from Mont Saint-Hilaire, Quebec) and **sperrylite** (from Russia) miniatures priced at $190 to $280.

The next several booths proved to be a potpourri of Brazilian geodes, rutilated quartz, and other typical Brazilian materials. To the right, another 10-foot booth overflowed with newly mined Moroccan **vanadinite**, crystal-covered matrix specimens to 46 cm (18 inches). Though of little interest to the sophisticated collector, they are quite extraordinary for size and flash.

The Office of Tourism is located in the central area of the show, where dealers come to get their badges. The three roadways comprising the main open-air aisles of the show radiate from this point like the spokes of a wheel, and additional smaller lanes are also lined with tents. Most tents have a frontage measuring 3 to 5 meters, but a few are up to 10 meters.

Many companies that routinely come to the Tucson Show are also represented at Ste.-Marie-aux-Mines. *Mikon Mineralien* came with a complete selection of equipment and a great variety of inexpensive minerals and fossils. *Krantz* also offered a selection of equipment, including rock trimmers. *Marcus Budil* (Sendlingerstr. 24+25, D-80331 Munich, Germany) had two different booths, one wholesale and another for superb-quality minerals. In the tents, he had a large representation of Chinese pyromorphite at $417 per flat of 2.5-cm pieces, and several flats of the new **brazilianite** from Brazil, priced at $556 per flat (perhaps 20 specimens). Budil also had a pocket of dark green **tourmaline** and quartz from Brazil, which the local European dealers bought with great fervor; the largest specimen is 45 cm wide with fine quartz crystals. Another excellent booth was that of *Horst Burkard* (Dornheckenstr. 20, D-53227 Bonn, Germany), who is, of course, always present in both Denver and Tucson. But here he had many more minerals and fossils—especially a large selection of very fine, newly mined Moroccan **vanadinite**. Several good Moroccan **erythrite** specimens and one very good **roselite** were also available. The best erythrite measures 12.5 x 16 cm, with a small vug of 1.25-cm crystals covering perhaps a third of the specimen; this piece was marked at $2,365. [Editor's note: remember that the "asking price" and the ultimate selling price can often vary significantly.] A selective buyer could have assembled a whole collection of vana-

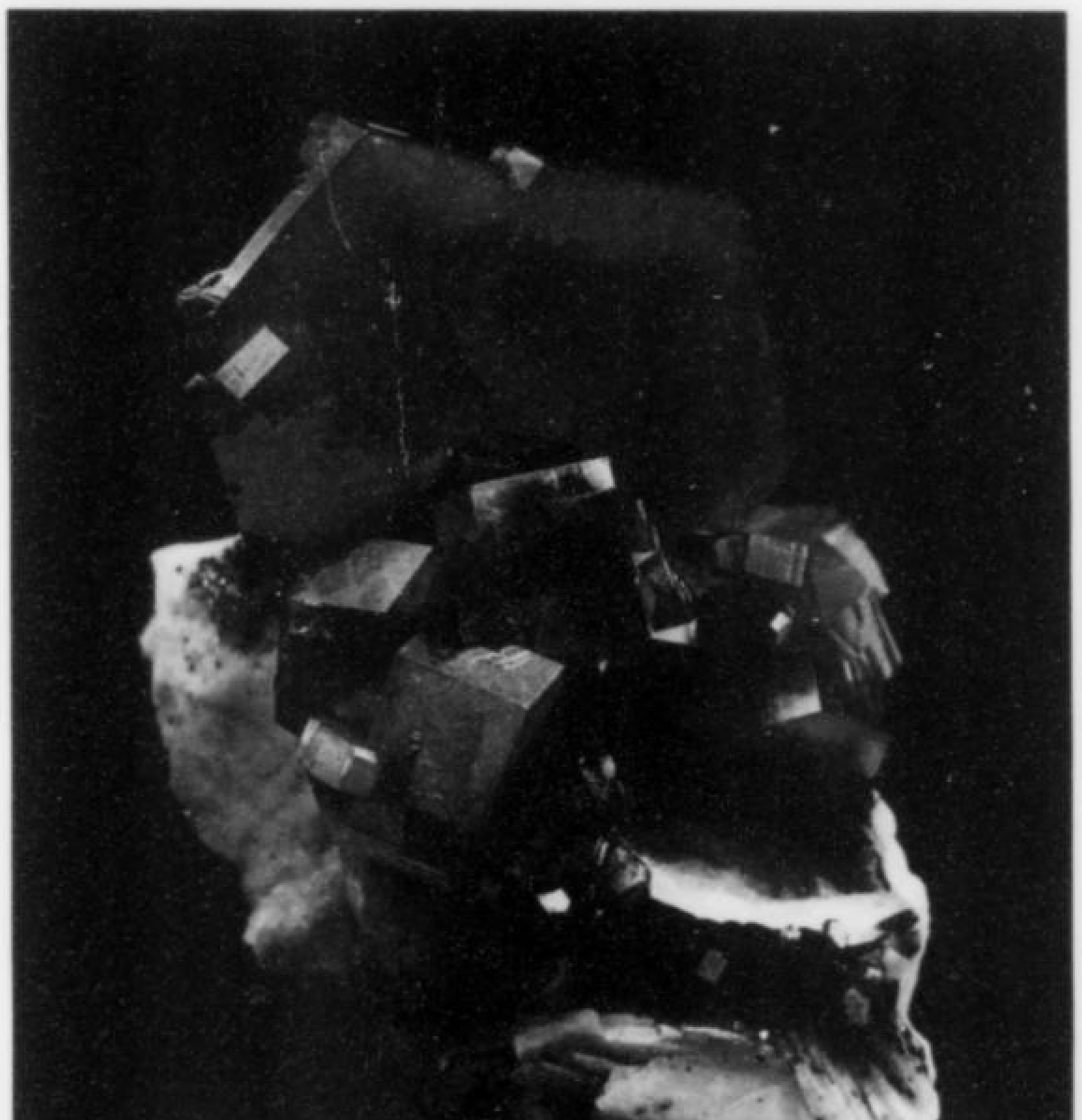
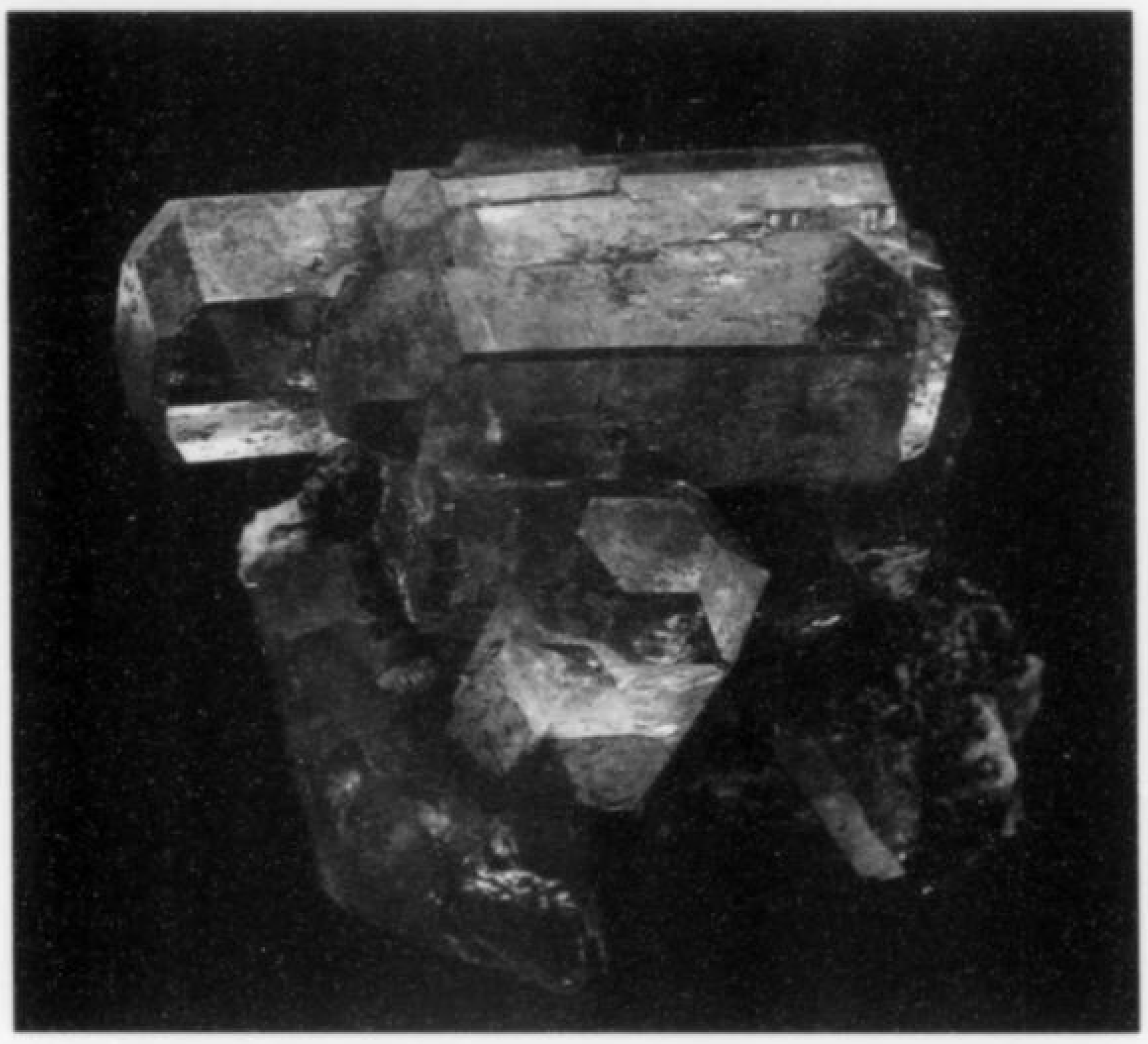


Figure 11. **Vanadinite crystals on matrix, 4.7 cm, from Mibladen, Morocco. Christine Gaillard specimen; Jeff Scovil photo.**

Figure 12. **Carletonite crystal cluster, 7 cm, from Mont Saint-Hilaire, Quebec. Gilles Hainault specimen; Jeff Scovil photo.**

Figure 13. **Fluorapatite crystal group, 2.7 cm, from Imilchil, Morocco. Daniel Gol collection; Jeff Scovil photo.**



dinites in many different habit variations, since many different pockets have now been encountered and the vanadinite from each has its own individual characteristics.

Most dealers at Ste-Marie have never set up in the United States, so opportunities to make new contacts abound. A very large booth, just past the central information booth, was that of *Minerama* (Maurice Eyraud, 49 rue République, F-42800 Rive-de-Gier), a dealership from France which specializes in Brazilian and Madagascar material. Most of the *Minerama* materials are sold wholesale, by the flat, somewhat reminiscent of the *Jewel Tunnel Imports* operations. In the front of this booth were several "Arizona Display" glass cases filled with individual specimens of **pyromorphite** from China, Moroccan **vanadinite**, and, what was most interesting, a group of Madagascar heliodor (yellow **beryl**) crystals, and many Japan-law twinned **quartz** specimens. The specimens are all between 2.5 and 7.5 cm, and were priced retail from $17 to $278, but were keystoned (offered at half that price). The booth appeared to be about 10 x 20 meters and was absolutely filled with these specimens.

The steps of the "theater-show" building became an informal meeting ground, where some fine minerals were often pulled out of shirt and pants pockets. Sometimes up to 60 people waited in the shade for their friends to join them. As we walked into the first room of the "theater," we immediately noticed a dramatic increase in the quality of the minerals for sale—beginning with those offered by the Spanish dealer *Luis Miguel Fernandez* (Escosura 22–Pral Centro, 50005 Zaragoza). He had very fine minerals from Peru, including some wire **silvers**, one of which reportedly sold for $5,560. He also had a very fine lot of **stibnite** specimens, perhaps 50 pieces, from Baia Sprie, Rumania. I was particularly interested in a couple of his fine **hübnerite** clusters, one of which remained unsold on Thursday afternoon, at only $428; it measures about 3 x 7 cm and is doubly terminated, with a very high luster.

The French mineral magazine *Le Regne Minereaux* had an attractive booth selling magazines and modern books, mostly in European languages, although I did notice a John Barlow Mineral Collection catalog, as well as the book on the Desmond Sacco collection. There was much interest in what the magazine people had, and I noticed many people were purchasing books to peruse later.

Coming into a hallway, we found the very large booth of *Laverriere Mineraux*, (9 bis rue Colombier, F-69380 Chazay d'Azegues, France), selling mixed European and overseas minerals. The booth was perhaps 30 feet long, with 500 specimens from various localities, including one **vivianite** cluster about 20 cm long, reserved with no price. Laverriere also had a very fine Le Bex, France blue **fluorite**, again with no price.

The hall opens into the main room containing fine mineral specimens; present were perhaps 40 top dealers from Europe, and a few dealers from elsewhere, in no particular order. *Barras-Gauthier* (Le Besset, F-63880 Olliergues, France) had extremely well-displayed and colorful minerals from many recent finds, including Indian **cavansite**, Chinese **quartz** and **pyromorphite** and **scheelite**, and new **crocoite** specimens from Tasmania. His emphasis seemed to be on very beautiful pieces. Looking at a few more of the finer examples, there was a lovely spray of **calcite** crystals, up to 10 cm long individually, in an **amethyst** cluster from Uruguay, at $1,043; a very large red Moroccan **vanadinite**, 15 x 20 cm, with crystals up to 2.5 cm; a **hematite** cluster from China at $50; and a superb small **fluorite** from China at $38.

Figure 14. **Steps of the Theater building, Ste-Marie-aux-Mines Show. Jeff Scovil photo.**

Another French dealer, *Merveilles de la Terre* (Claudette Cabrol, 21 allée Sully, F-38130 Echirolles, France), had a fine selection (again) of more colorful things, including a whole 4-foot display of Elmwood mine, Tennessee **calcite** and **fluorite**, perhaps 50 good specimens from miniatures up to large cabinets. One superb **calcite** from Russia was on a rotating stand, and priced at $500: a perfect white 20-cm rhombohedron, covered in drusy calcite—a very attractive specimen for a museum. Next came *Fabre Minerals*, well known from Tucson and Denver. Jordi Fabre had about 25 feet of space filled with a wide range of worldwide specimens, in miniature and small-cabinet sizes. Two Indian dealers were also on hand, including one based in France, *Mineral de L'Inde*. They had a wonderful selection of the classic Poona and Nasik pieces. One excellent 7.5-cm green Nasik **apophyllite** on a 10 x 10-cm basaltic matrix covered with small stilbite crystals was priced at $362. Another French dealership, *Collonge*, had a display case devoted to a new find from Chipral, Pakistan: **chevkinite**, a black rare-earth silicate mineral, in spectacular, individual thick-tabular crystals to 2.5 x 7.5 cm. The crystals are somewhat shiny to matte black; specimens include singles and nice clusters of sharp, distinct crystals. Perhaps 30 pieces in all were available, including one very large museum-type specimen measuring 20 x 25 cm.

Gilbert Gauthier (7 avenue Alexandre III, F-78600 Maisons-Lafitte, France) had his wares laid out on a 10-foot table in front of the stage, very similar to his Tucson display. Gilbert had two flats of absolutely first-class **carrollite** specimens from the recent find in the Congo Republic, with individual crystals up to 5 cm, slightly damaged but mirror-bright. *Marcus Budil*, in his second booth here, had absolutely superb minerals, the finest things on public display at the show (of course, as in all shows, no one knows what transpires behind the scenes). Some of these new pieces included Pederneira, Brazil flawless green **tourmaline** crystals up to 20 cm, at high prices typical of gem-grade crystals. Two outstanding single crystals showed a bit of sceptering at one end; both are bicolored, from a yellowish green to a bluish green, and both are flawless, respectively 7.5 cm and 8.5 cm long. Budil also had some beautiful blue fluorapatite crystals on green elbaite from Paraiba, Brazil. One whole showcase was filled with superb **pyromorphite** from the Daoping mine in China. Three classic **vivianite** specimens from Bolivia were available, at high prices; the crystals average 6 cm, though one brilliant green, undamaged crystal measures 3 x 7.5 cm, on a matrix of siderite. Also there was an excellent, non-heat-treated **tanzanite** (zoisite) crystal, 2 x 2.5 cm and very lustrous, on a 5 x 5 cm matrix.

Across from Marcus, *Crystal Classics* (Ian Bruce, Halberton Road, The Old Unhay-Wod, Willand Cullompton, Devon EX15 2QF England) had a case of very fine old classics and about 20 feet of various miniature and small cabinet-sized specimens. The buzz here concerned some new Bisbee-like **azurite** which they had just mined in their "Tsumeb project." In the next booth was the only American dealership set up inside: *Kristalle* (Wayne and Dona Leicht), who brought the finest classics to the show. Among these were a fine Kongsberg **silver**; a spectacular **manganite** cluster from the Harz Mountains measuring 10 x 12 cm; **epidote** from Austria; and a superb **hematite on quartz** from St. Gotthard. Another French dealer with Chinese material had an excellent selection of the normal Chinese things, in addition to which he offered a new find of pink microcrystalline **inesite**, the best specimen being a 15 x 20-cm vug with beautiful glistening pink microcrystals.

Andreas Weerth, a standby at the Tucson and Denver shows, had an excellent selection (probably the best at this show) from Pakistan and Afghanistan. Included was a new find of **sapphire** from Hunza, Pakistan, the best of which was a 3-cm single complex crystal of an odd purplish red color on a 5 x 6.5-cm calcite matrix, for $2,780. Andreas also had a particularly fine specimen of **albite** from Pagecomvel, Afghanistan. It is a cluster of pink crystals up to 1.7 x 3 cm individually, maybe 20 crystals in all in a radiating cluster on a 10 x 12-cm matrix. A dealer from Madagascar, *Optic Stone*, had an entire booth filled with nothing but **Japan-law quartz twins** from Madagascar, small ones for $27 up to some larger pieces for $320. Imagine a booth of all Japanese twins! They seemed to be selling briskly.

Italy was represented by several dealerships, among them another Tucson veteran, *Pregigemme*. At this booth there was a very good selection of Pakistan **aquamarine** from Hunza, **anatase** from Norway, and some new **tourmaline** from the Lavrarita Barbosa in Brazil. The tourmalines are quite dark, almost black-green, on

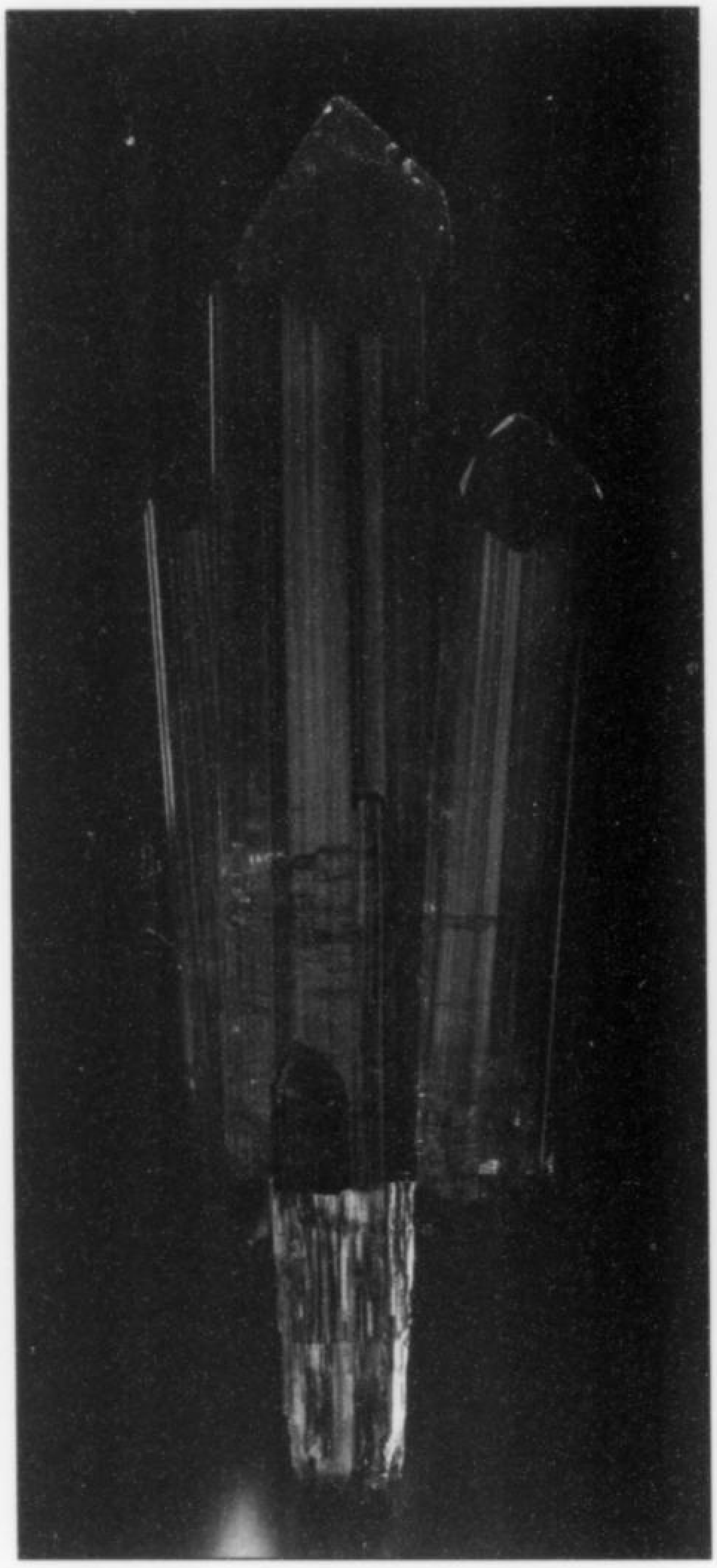


Figure 15. **Elbaite crystal group, 10.3 cm, from the Pederneira mine, Minas Gerais, Brazil. Marcus Budil and Danny Trinchillo specimen; Jeff Scovil photo.**

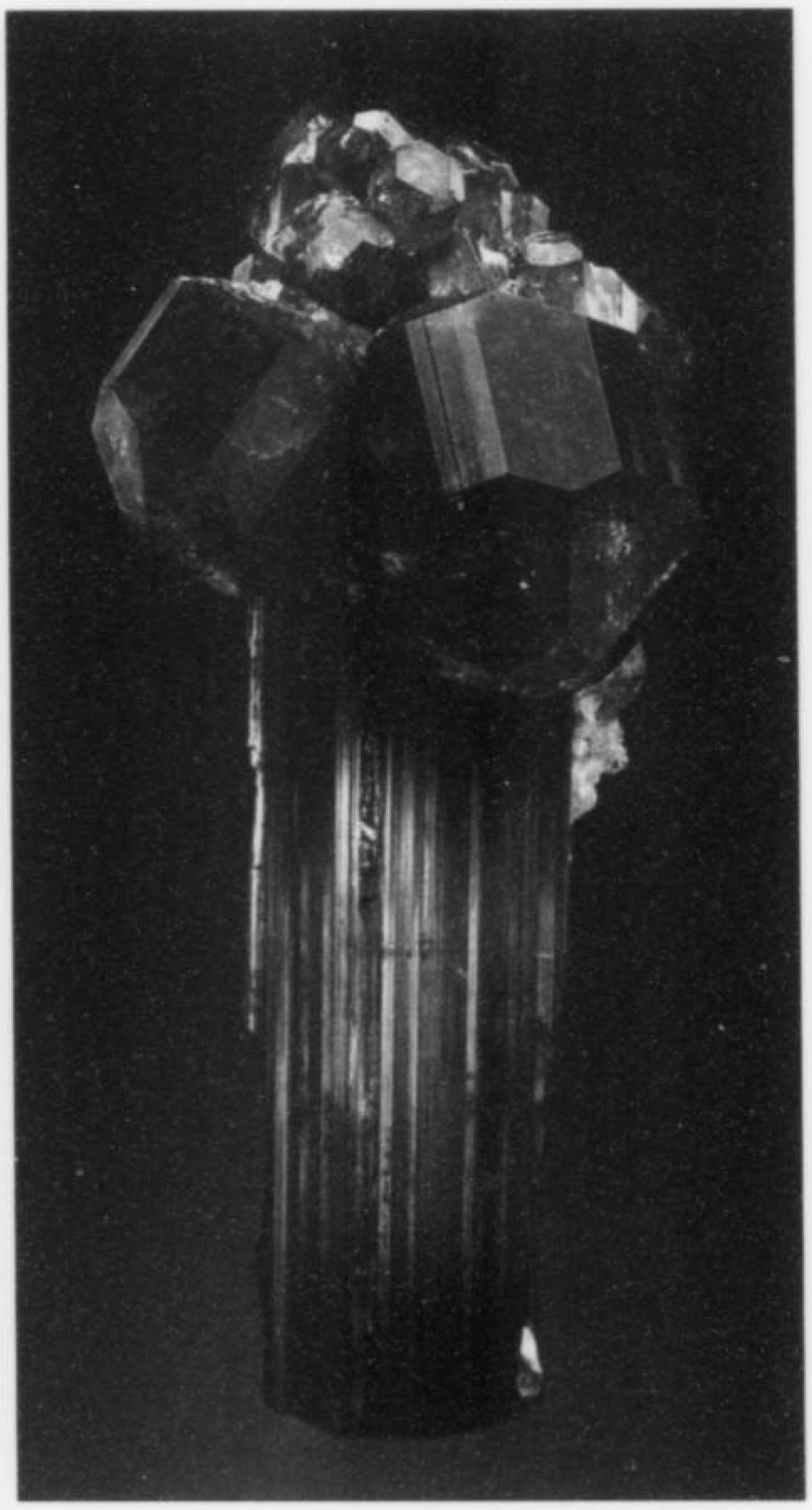


Figure 16. **Deep blue fluorapatite crystals on a green elbaite crystal, 5.5 cm, from Paraiba, Minas Gerais, Brazil. Marcus Budil and Danny Trinchillo specimen; Jeff Scovil photo.**

water-clear quartz crystals—quite aesthetic, asking $1,100 for one superb small cabinet piece, with a 10-cm tourmaline crystal coming across the top of a quartz termination and a 5-cm one coming across the center.

Another Tucson veteran (but more as a customer in Tucson than as a dealer) is *Marcus Grossmann* (Holzkirchenerstr. 20-a, D-83626 Valley, Germany). His taste in specimens marks him as a collector, with every single piece obviously selected individually, and quite excellent. Among those that caught my eye were a single **demantoid** gem crystal from Erongo that would make a super thumbnail, and some unusual **parisite** crystals from Malawi, in clusters up to 5 x 5 cm, fascinating in their form. Across from Grossmann was *Chris Gobin* (Gobin Bijouterie, "Ourika" chem. Terres Longues, F-13770 Venelles, France), who specializes in minerals from the Congo Republic. Gobin's booth had been the subject of much initial buzz at the show, since it offered some of the fabulous new **carrollite**, in mirror-bright crystals up to 7.5 cm across, some with little or no damage. The selection of several hundred specimens here exceeded even the selection which Gobin sold in Tucson. I believe that this dealership shows great promise for getting new things from this locality in the future.

For rare mineral collectors there were some **sulvanite** specimens from Tuscany, Italy, recently mined, with the Italian dealer *Dr. G. Carlo Fioravanti*. *Tom Kapitany* (20 Fiveways Blvd., Keysborough, Victoria 3173 Australia) had a wide selection of things from his native Australia, including some superb **opal** belemnites in matrix which went up to $888, and some new **copper** specimens from the Selwyn mine, Queensland, Australia, perhaps 20 pieces in all. Two or three of the finest of these are excellent miniature specimens.

The last dealership in the hall, with over 30 feet of space, was that of *Minerive* (François Lietard and Christine Gaillard, 18 rue Vaganay, F-69850 St. Martin-en-Haut, France). They had a mixed group of beautiful, newly mined **vanadinite** specimens, many of which had been sold before the show in some very large private dealings. One beautiful miniature caught my eye, marked at $3,060, its white barite matrix contrasting sharply with very red vanadinite crystals to 2.5 x 2.5 cm. François and Christine also had **erythrite** from the new find, including a beautiful miniature 3 x 5 cm, with 2.5-cm crystals, at $1,950. At this stand was also a fine Afghanistan **emerald** crystal, 4 cm, on matrix, a surprising new find of very bright blue **spinel** crystals, up to 2.5 cm, on calcite from Hunzar, Pakistan, and a selection of excellent single green **demantoid** (chromian andradite) garnets from Iran. One piece is 2.5 x 3 cm, showing some distortion, but enormous for a single crystal.

Outside, between tents of jewelry and amber, sat *Alain Martaud* (33 Rue Compans, F-75019 Paris, France), who had many surpris-

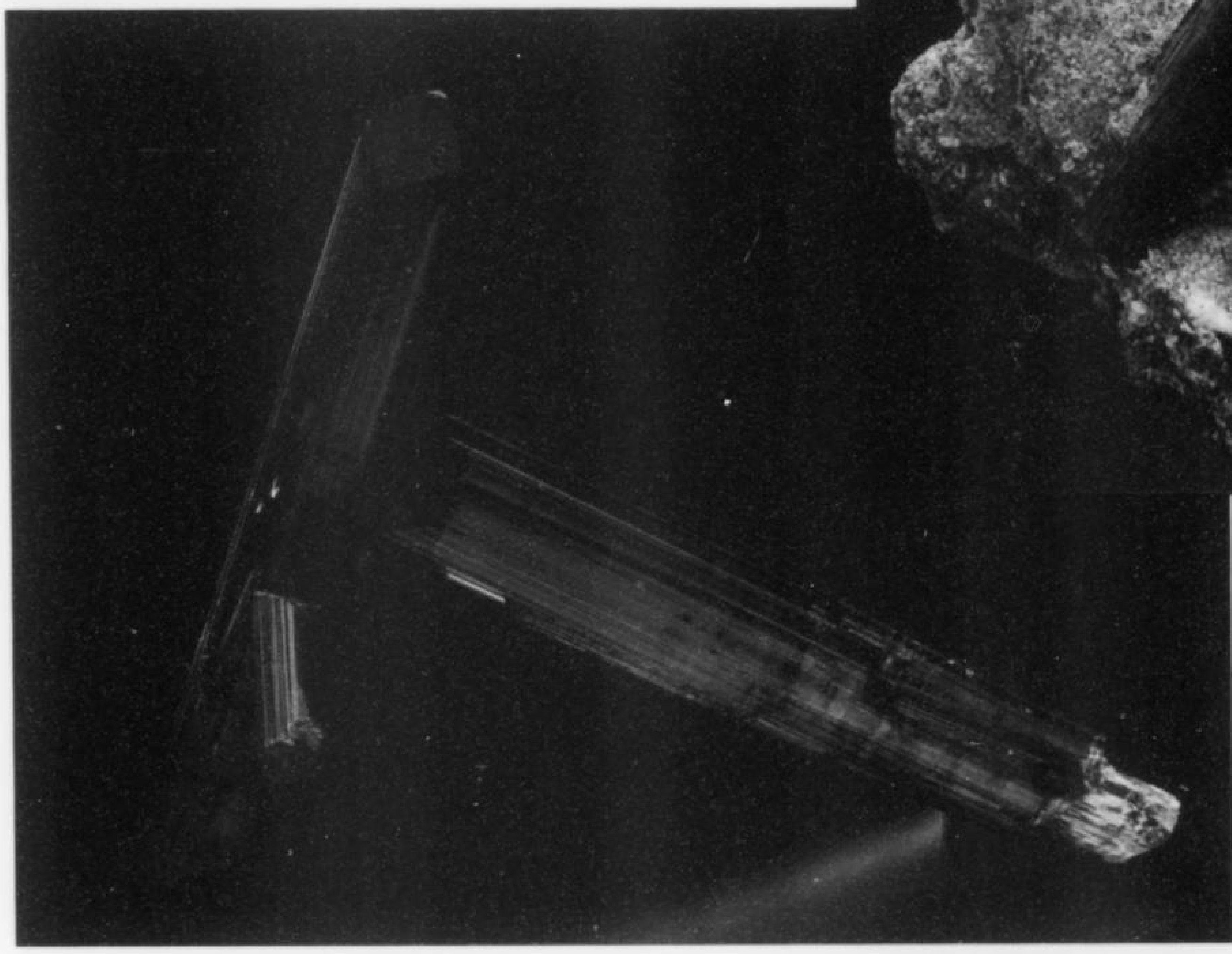


Figure 17. **Elbaite crystal group, 12.5 cm, from the Pederneira mine, Minas Gerais, Brazil. Marcus Budil and Danny Trinchillo specimen; Jeff Scovil photo.**

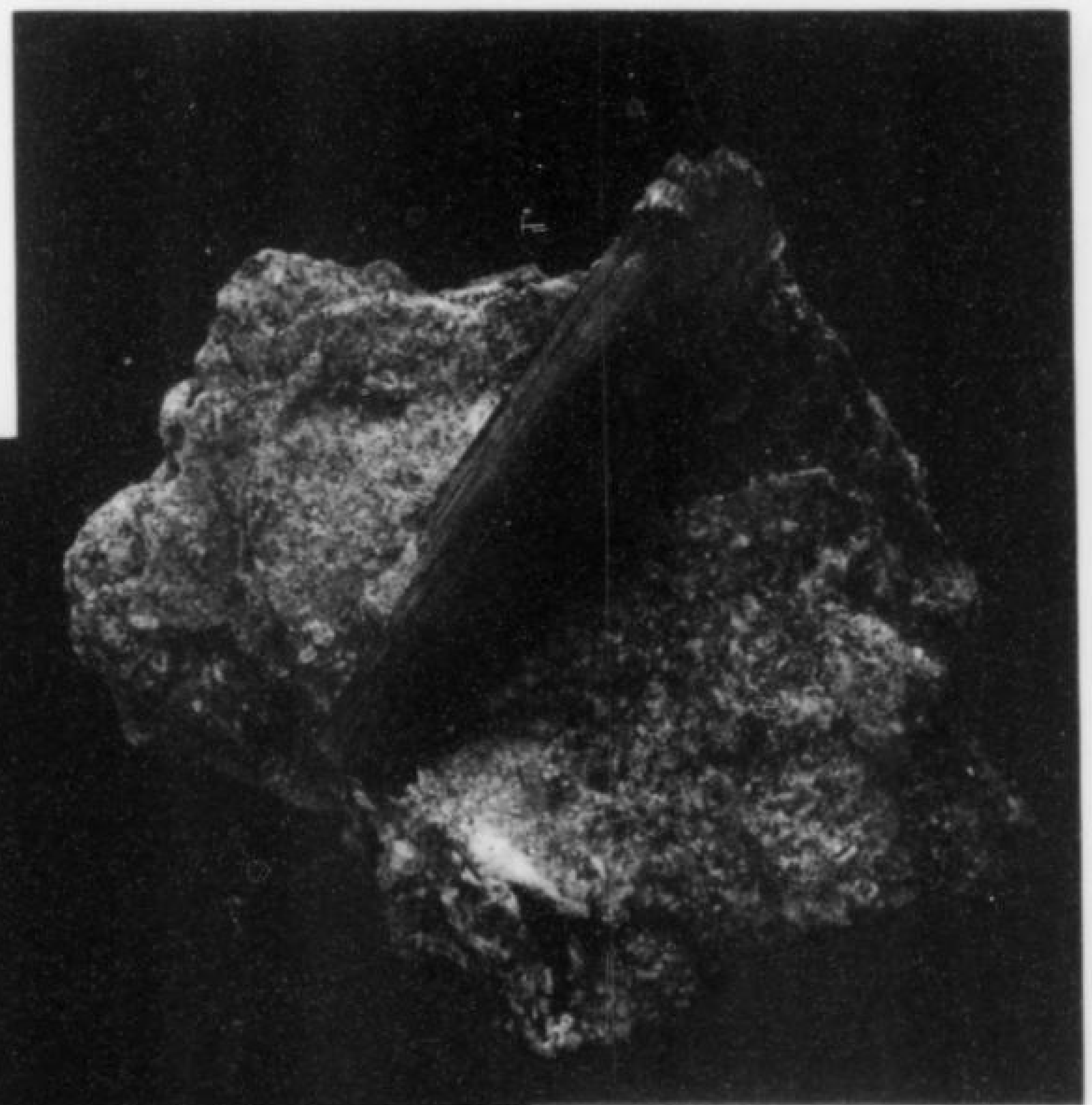


Figure 18. **Beryl (emerald) crystal, 4 cm, on matrix, from the Panshir Valley, Afghanistan. François Lietard specimen; Jeff Scovil photo.**

Figure 19. **Spinel crystal in matrix, 3.4 cm, from Aliabad, Hunza Valley, Pakistan. François Lietard specimen; Jeff Scovil photo.**

ing classic African minerals from the Behier collection. Behier wrote a mineralogy of Mozambique (1957) and a supplement to the mineralogy of Madagascar (1960); consequently his collection was strong in Madagascar minerals, including tourmaline, betafite, thorianite, and other pegmatite species. I noticed a sharp 2.5-cm **thorianite** crystal, a "reinite" (**ferberite** pseudomorph after scheelite) from Uganda, and a razor-sharp dodecahedral **betafite** of about 2 cm.

Ste.-Marie is obviously one of Europe's best shows, and a good choice for Americans to visit. Well-run (thanks to Michael Schwab), and located in a beautiful setting, with many dealers not seen elsewhere, and often with comparatively reasonable pricing on mineral specimens, it is easy to recommend. For more information check the show's website, *www.minerapole.com.*

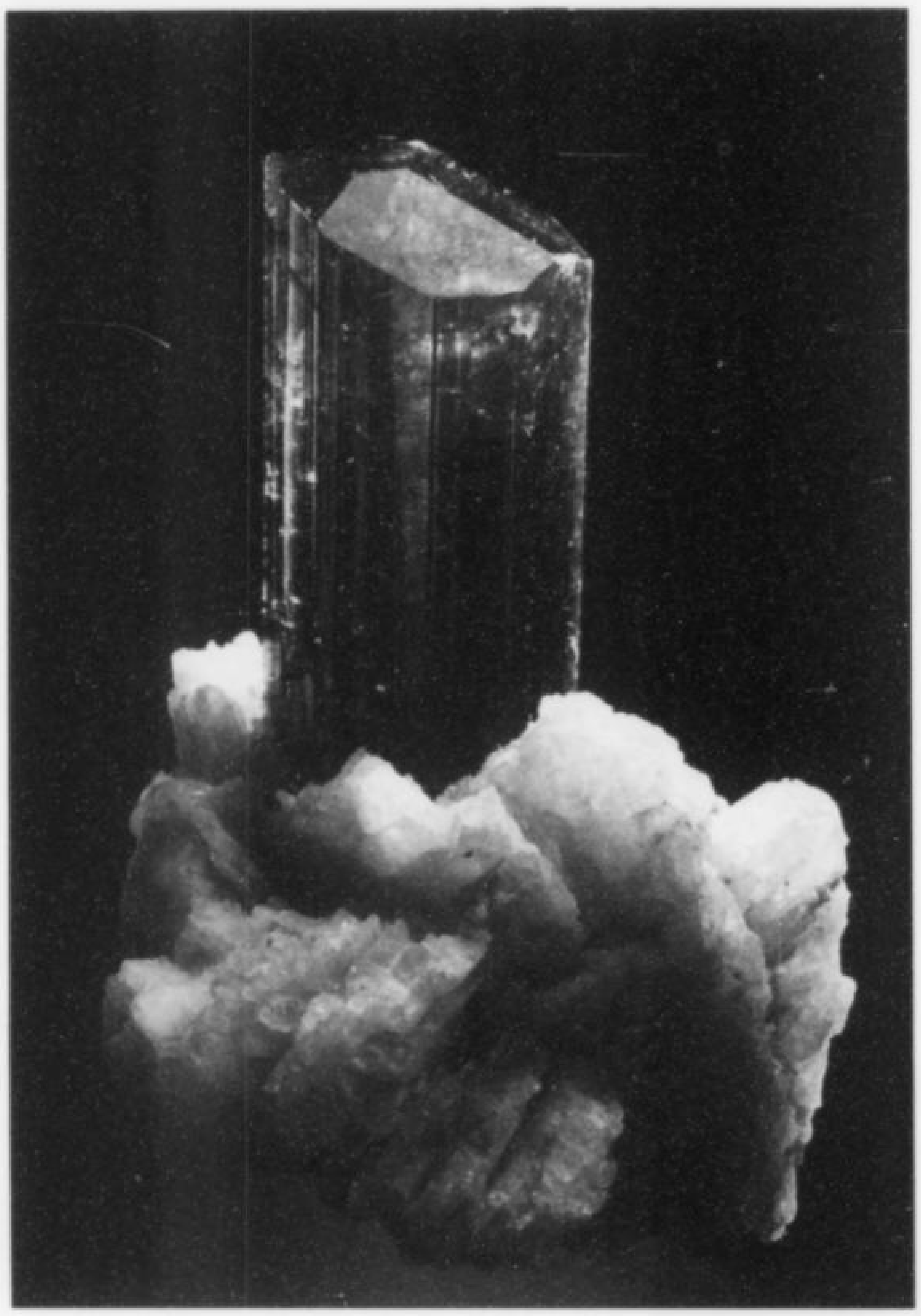
Springfield, Massachusetts Show 2001

by Joe Polityka

[August 10–12]

In retrospect it does not seem like another year has passed already since the Springfield 2000 show. Fortunately, I was able to attend the show this year, but with an added responsibility: writing the show report. As everyone knows by now, Tom Moore (formerly of nearby Connecticut), the traditional Springfield correspondent, was hired as an Editor by the *Mineralogical Record* and has moved to Tucson. Tom will now be assisting Wendell Wilson way out West, and I will be trying to fill Tom's big reportorial shoes at the Springfield Show.

In order to be prepared to write up the show I sat down recently and read Tom's past reports with the goal of "stealing" some of his ideas. Having done the required reading and research, I set out from my home on Friday, August 10th at 5:00 AM. I arrived at the show around 9:00 AM, was issued a pass by Marty Zinn, and started to make my rounds of the (approximately) 170 mineral, fossil, jewelry and meteorite dealers (retail and wholesale) who were open for business.



Before getting into what's new in minerals, a comment is in order regarding this year's "special exhibit" of Arizona Minerals from the holdings of Phoenix collectors Les and Paula Presmyk and Evan Jones: in the vernacular of today's youth—Awesome!!! The 60 or so cases were loaded with top-of-the-line goodies from the country-sized state of Arizona. Yes, Arizona is about as large as Italy and bigger than a lot of European countries. And it has a rich mineral heritage, born of the local geology. Thank heaven for the Gadsden Purchase, or else Bisbee, Ajo and many other famous mines would today be in Sonora, Mexico!

The display cases were set up in roughly a U-shaped pattern with a central core of about eight cases which contained the most aesthetic specimens. The cases were organized by mine or region, and were each topped with a large topographic map which gave the viewer an accurate indication of where the mine is located.

When one thinks of Arizona minerals, two locations come immediately to mind: the first is Bisbee, with its fabulous copper minerals; and the second is the Red Cloud mine, with its gorgeous red wulfenite unparalleled in the mineral world.

Needless to say both mines were well represented by fabulous specimens, some of which were pictured in past issues of the *Mineralogical Record*. There were many examples of lustrous Bisbee azurite crystals to 5 cm, and myriad combinations of azurite and malachite in stalactites and botryoidal aggregates; and don't forget the beautiful Bisbee cuprite and malachite-included calcite! Huge crystals of Red Cloud mine wulfenite sat proudly on matrix, the red crystals reminiscent of chisel points. Once past the Red Cloud and Bisbee cases, more famous localities came to view, including the mine at Morenci: there were three cases dedicated to specimens mined "before 1900," "before 1975" and "1975 to present." Specimens with azurite crystals to 5 cm were accompanied by large botryoidal combinations of azurite with malachite to 12 cm in diameter.

Figure 20. Elbaite crystal on albite, 3.3 cm, from the Melkhan deposit, Transbaikalia, Russia. *Stone Flower* specimen; Jeff Scovil photo.

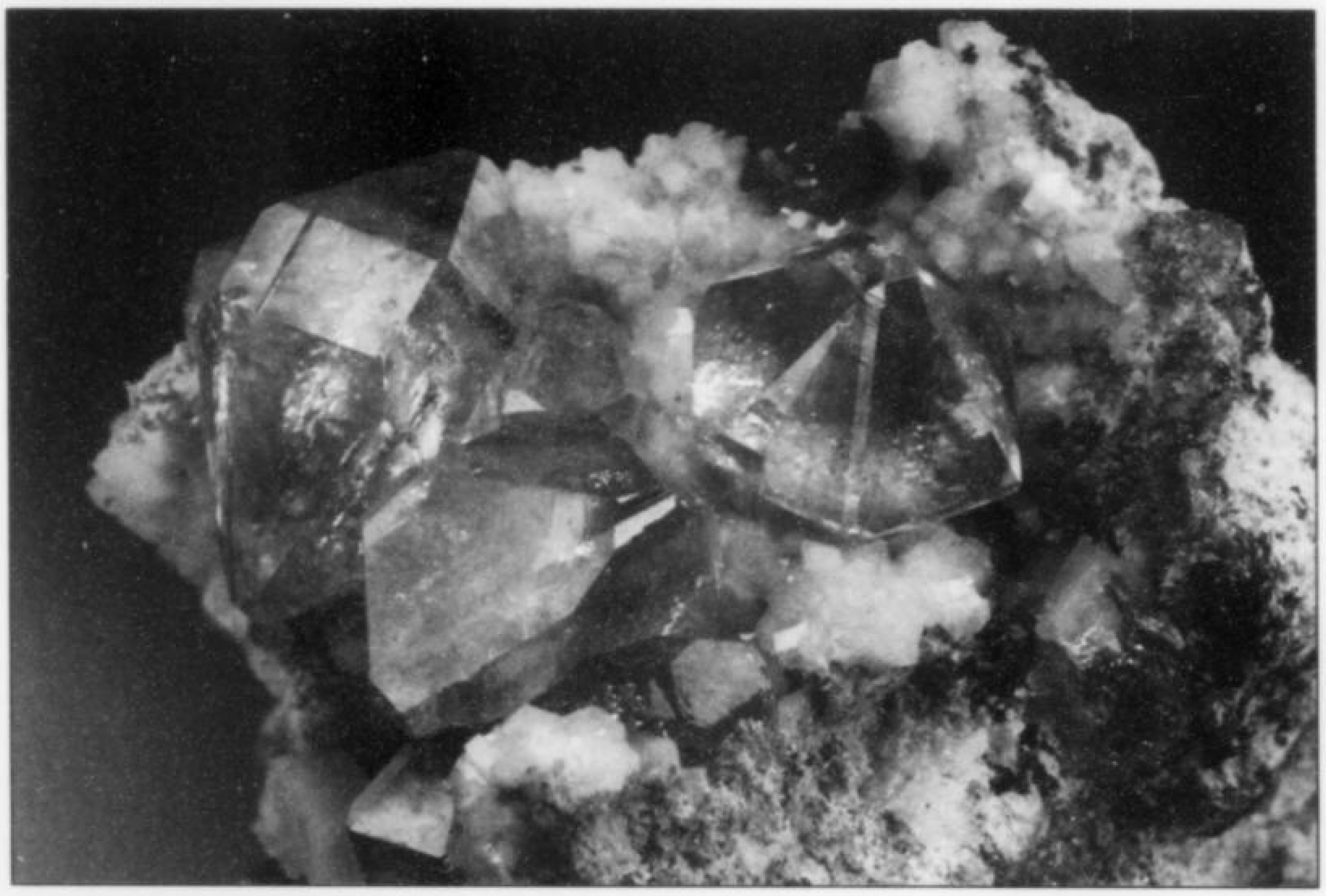


Figure 21. Cerussite twins to 1.1 cm, on matrix, from the Tsumeb mine, Namibia. *Crystal Classics* specimen; Jeff Scovil photo.

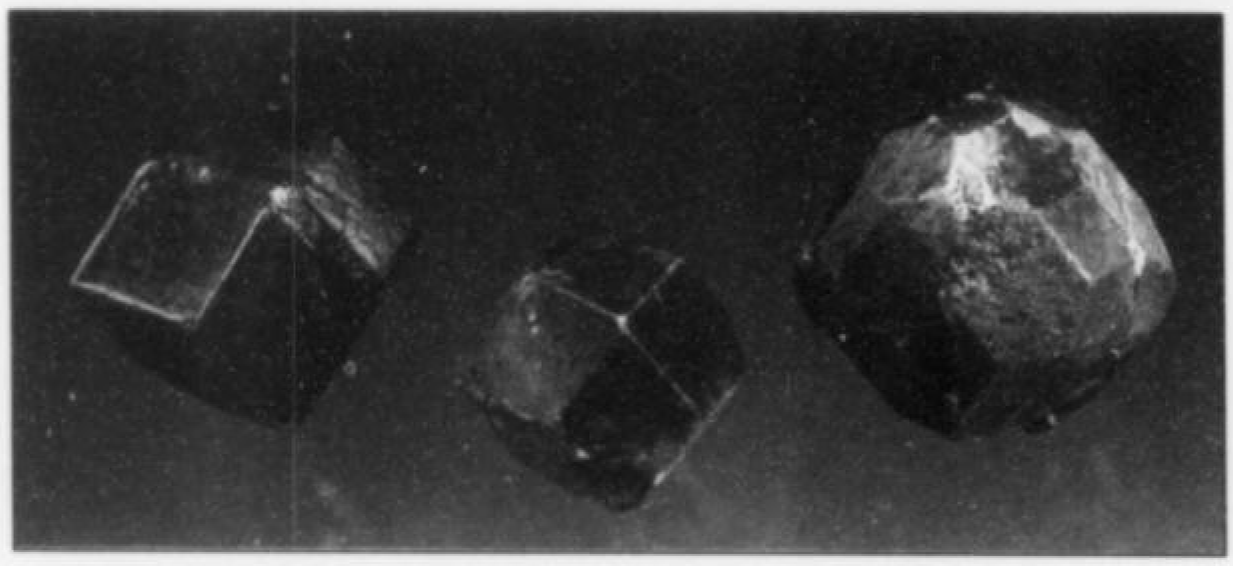


Figure 22. Chromian andradite ("demantoid") crystals to 1.2 cm, from Registan, Iran. *Minerals America* specimen; Jeff Scovil photo.

Lest the Bisbee, Red Cloud and Morenci mines be thought to overshadow other Arizona mines and minerals, there were some excellent singular specimens from other noteworthy locations. How about a miniature specimen of abundant silver wires on matrix from (yes) the Gold District, Mohave County, Arizona; or gold, a miniature, in branching crystals from Steamboat Wash, Gila County, Arizona? Not to mention fine specimens from the New Cornelia mine at Ajo, the 79 mine, Washington Camp, the Mammoth-St. Anthony Mine (Tiger), and the Apache Mine! They were all well represented, along with plenty of other mines, prospects and nameless pits too numerous to mention here. Still not convinced you should have made the trip to Springfield? How about top-quality specimens of leadhillite, cerussite, linarite, turquoise, vanadinite, smithsonite, zunyite, cyanotrichite and hematite? They were all on display. Next year, for the 2002 show you will be able to see, if all goes as planned, the renowned collection of James and Dawn Minette of Boron, California. They will exhibit a worldwide collection with specializations in thumbnails, smithsonite and borates. I hope I have whetted your appetite for 2002; you have no excuses, you have been notified!

Now on to what's new in minerals: The talk of the show was the lot of **calcite** specimens being offered by *North Star Minerals* and *Hawthorneden*. The pure white, spherical aggregates of tabular, parallel-growth calcite crystals to 7.5 cm sit on a mixed sulfide matrix. One 6-cm ball on matrix has parallel-growth crystals that remind me of the ridges on morel mushrooms. The specimens are from the Turt mine, Satu Mare, Maramures, Romania, and were recently mined; they were said to be the best of the lot, future classics, which outclass the best specimens found previously.

Speaking of *Hawthorneden*, Frank and Wendy Melanson had some exceptional **rutile** crystals, in lustrous thumbnails and miniatures (singles and twins) from Diamantina, Brazil. They had one excellent V-twin thumbnail and also miniatures, in parallel groups to 4 cm with doubly terminated crystals. These specimens are lustrous with no visible damage. Frank and Wendy also had what I can only describe as pregnant-looking **anatase** crystals. These single crystals, without matrix, are from Jabotica (rhymes with Polityka) Tubas, Minas Gerais, Brazil and average about 1 cm in size. The anatase crystals have a zone in the center that is distorted to about twice the diameter one would normally expect.

Paul Corey of *Iteco* was handling part of the Carlton Davis thumbnail collection. Paul had mostly **sulfides** from classic locations such as Butte, Montana, in addition to his usual inventory of rhodochrosite from the Sweet Home Mine, Colorado accompanied by faceted stones of the same species.

At the booth of *Lambert Minerals, Canada* I was attracted by some **gold** specimens on matrix out of the Red Lake mine, Balmertown, Ontario, Canada. The leaf-type gold is generously distributed on a massive quartz matrix, in miniature and small cabinet sizes.

A "sea of green" reminiscent of Ireland characterized the booth of *Toveco Specimen Mining*. The men of Toveco operate the William Wise mine in Westmoreland, New Hampshire strictly for specimen production. These dedicated and adventurous souls have recovered sea-green **fluorite** octahedrons, some associated with small **quartz** scepters, up to 8 cm across. Do not take this fluorite for granted!

Rob and Mandy Rosenblatt of *Rocko* had herkimer-type **quartz** crystals in fantastic cabinet-sized sculptural groups from the Treasure Mountain mine, Little Falls, New York. The quartz crystals average about 2.5 cm and the groups were, of course, reconstructed. However, the crystal arrangements are spectacular, indeed, with interconnected crystals branching in all directions on each specimen. Rob also had some nice scepters from the same location (single or multiple crystals sitting on narrow dark stems) in miniature sizes.

At the booth of *Cardinal Minerals* (2 Tulip Lane, Shelton, CT 06484), the owners Howard and Janet Van Iderstine had some interesting pseudomorphic **quartz** casts after calcite from the Droukouvo mine, Laki, Rhodope Mountains, Bulgaria. These tan casts of long-gone calcite crystals reach about 5 cm in size and are sharp reproductions of the original scalenohedral calcite crystals. The specimens are reminiscent of the quartz casts after anhydrite from the Paterson, New Jersey area.

Dennis and Diane Beals of *XTAL* had their usual inventory of Mexican minerals which included some very reasonably priced **quartz** crystals with mud inclusions from Taman, San Luis Potosi, Mexico. The crystals are typically singles, 2.5 cm in size, doubly terminated with mud inclusions in the terminal faces (you selected your own out of a flat for five dollars each). Some groups were available with intergrown crystals to 4cm. Dennis told me the prospect is in a steep jungle area which is difficult to reach. He hopes to have more in the future.

Jeff and Gloria's Minerals had some specimens of **cyanotrichite with azurite** from the Hilarion mine, Laurium, Greece. The attractive, bright blue, acicular cyanotrichite crystals reach about 3 mm, and contrast nicely with the associated massive azurite. The limonite matrix is present mainly in miniature sizes or smaller.

I saw quite a few **silver** wires on massive quartz matrix from the Uchucchacua mine, Ancash Province, Peru in dealers' booths but no one had more of these than *Dan Weinrich*. Stout wires up to about 4 mm thick and of varying length protruded out of massive quartz matrix, from thumbnail to small cabinet sizes. As is typical of native silver wires, they show a devil-may-care attitude by curling in every direction. I was told the area in which the silver was found has now collapsed, but only time will tell how much more is available.

Several dealers from India were selling **zeolites** from the Deccan Plateau of India. However, prices for typical specimens seem now to be two to three times what I might be willing to pay. In fact, I saw one specimen I contemplated buying at last year's show for $100.00 which was now sporting a $400.00 price tag.

Among his high-quality gem crystals and minerals from Asia, Dudley Blauwet of *Mountain Minerals International* had some **amethyst** crystals on varied matrix from Bamiyan Province, Afghanistan. The crystals, some doubly terminated, have a pleasing grape-purple color and are mostly translucent. Cabinet-sized specimens were available sporting crystals to 8 cm long and 4 cm wide; some specimens have single crystals while others have multiple crystals. The crystals seemed to have grown in a massive quartz-calcite matrix. Dudley also had attractive botryoidal purple **fluorite** in miniature sizes from Nyaung Yin, Tha Pelk Gyn District, Mandalay Division, Myanmar [Burma].

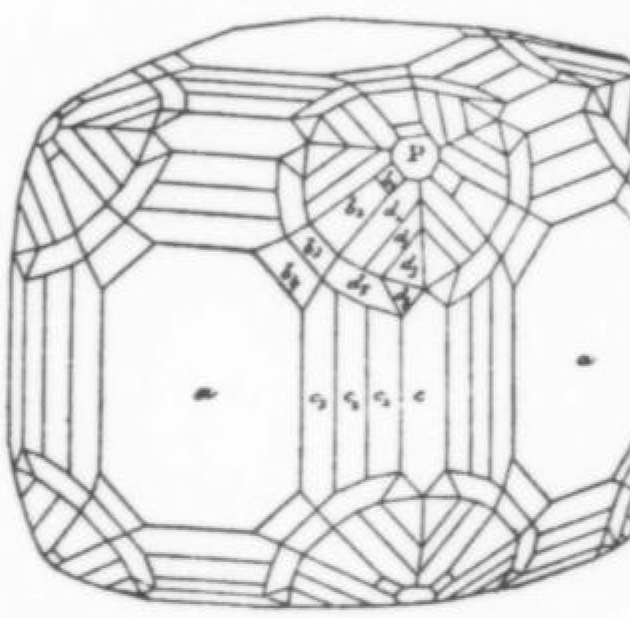
Danny Trinchillo of *DeTrin Minerals* had a huge 15 x 20-cm matrix specimen of **pyromorphite** from the Daoping lead-zinc mine, Guangxi Province, China. This fabulous specimen sports lime-green crystals to 1 cm which are aggregated into rosettes scattered about the matrix, with no visible damage! It is the best piece I have seen from this location.

Chris Wong of *Terrafind Enterprises* (508-890-2311) had specimens of botryoidal **fluorite** from the Altai region of China. Chris also had **quartz** scepters with **pyrite** from the Shangbao mine, Leiyang, Hunan Province, China.

Max Mpoyi Muteba is an African dealer specializing in **malachite**, and is the owner of *Malachite & Gems of Africa* (P.O. Box 2160, Lynn, MA 01903). Max is big enough to play linebacker in the National Football League and has a smile and heart as big as his physique. If you are looking for top-quality malachite specimens from Zaire contact Max.

Well, my 2001 Springfield saga is over. I spent several enjoyable days scouting and perusing every dealer's table and spent lots of time gawking, talking and walking around the show floor. I couldn't help thinking gratefully of the late Ron Bentley, founder of the show, who was determined to bring a top-quality show to New England; and of Marty Zinn, who has made the Springfield Show what it is today: the "Best of the East"!

Abstracts of New Mineral Descriptions



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New Minerals and Mineral Names
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Adamsite-(Y) — Triclinic

$NaY(CO_3)_2 \cdot 6H_2O$

Locality: Poudrette Quarry, Mont Saint-Hilaire, Rouville County, Quebec, Canada.

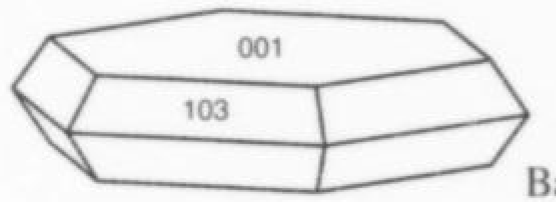
Occurrence: A late-stage, low-temperature hydrothermal phase in cavities in a large alkaline pegmatite dike. Associated minerals are: aegirine, albite, analcime, ancylite-(Ce), calcite, catapleiite, dawsonite, donnayite-(Y), elpidite, epididymite, eudialyte, eudidymite, fluorite, franconite, gaidonnayite, galena, genthelvite, gmelinite, gonnardite, horváthite-(Y), kupletskite, leifite, microcline, molybdenite, narsarsukite, natrolite, nenadkevichite, petersenite-(Ce), polylithionite, pyrochlore, quartz, rhodochrosite, rutile, sabinaite, sérandite, siderite, sphalerite, thomasclarkite-(Y), zircon and an unidentified Na-*REE*-carbonate (UK91).

General appearance: Flat, acicular to fibrous crystals (up to 2.5 cm long). Typically as spherical groups of radiating crystals and rarely as reticulated groups

Physical, chemical and crystallographic properties: *Luster:* vitreous to pearly. *Diaphaneity:* transparent to translucent. *Color:* colorless to white, also pale pink and rarely pale purple. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 3. *Tenacity:* brittle. *Cleavage:* {001} perfect, {100} and {010} good. *Fracture:* not mentioned. *Density:* 2.27 g/cm^3 (meas.), 2.27 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, *a* 6.262, *b* 13.047, *c* 13.220 Å, α 91.17°, β 103.70°, γ 89.99°, *V* 1049.1 Å^3, Z 4, *a*:*b*:*c* = 0.4800:1:1.0133. Morphology: {010} and {001}, elongate on [001] and flat on {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 12.81 (100) (001), 6.45 (70) (002), 4.456 (60) ($\bar{1}\bar{2}1$m $\bar{1}20$, 120, $\bar{1}21$), 4.291 (60) (003), 2.869 (30) ($\bar{1}24$, $1\bar{2}3$, 024), 2.571 (60) (005, 043), 2.050 (50) (125, plus 8 others). ***Optical data:*** Biaxial (+), α 1.480, β 1.498, γ 1.571, 2V(meas.) 53°, 2V(calc.) 55°; dispersion not given; nonpleochroic; X = c, Y = b, Z ∧ a = 14° (in obtuse angle β). ***Chemical analytical data:*** Means of seven sets of electron microprobe data: Na_2O 8.64, CaO 0.05, Y_2O_3 22.88, Ce_2O_3 0.37, Nd_2O_3 1.41, Sm_2O_3 1.02, Gd_2O_3 1.92, Tb_2O_3 0.56, Dy_2O_3 3.28, Ho_2O_3 0.90, Er_2O_3 2.83, Tm_2O_3 0.27, Yb_2O_3 1.04, CO_2 25.10, H_2O 29.90, Total 100.17 wt.%. Empirical formula: $Na_{1.00}(Y_{0.72}Dy_{0.06}Er_{0.05}Gd_{0.04}Nd_{0.03}Sm_{0.02}Yb_{0.02}Ho_{0.02}Tb_{0.01}Ce_{0.01}Tm_{0.01})_{\Sigma 0.99}(CO_3)_{2.04} \cdot 5.94H_2O$. ***Relationship to other species:*** It is chemically and structurally related to thomasclarkite-(Y), $NaY(HCO_3)(OH)_3 \cdot 4H_2O$.

Name: For Frank Dawson Adams (1859–1942), geologist and professor at McGill University, Montreal. Among his numerous contributions to the geology and petrography of Quebec and Ontario, is his research on the Monteregian Hills, of which Mont Saint-Hilaire is a member. ***Comments:*** IMA No. 1999-020.

GRICE, J. D., GAULT, R. A., ROBERTS, A. C., and COOPER, M. A. (2000) Adamsite-(Y), a new sodium-yttrium carbonate mineral species from Mont Saint-Hilaire, Quebec. *Canadian Mineralogist* **38**, 1457–1466.



Batiferrite

Batiferrite — Hexagonal

$Ba[Ti_2Fe^{3+}_8Fe^{2+}_2]O_{19}$

Locality: The Slabik company quarry at Üdersdorf (5 km SSW of Daun), the Stolz quarry at Graulai (1 km NNE of Lammersdorf) and Altburg (1.5 km W of Schalkenmehren), western Eifel area, Germany.

Occurrence: In cavities and in rare pegmatite-type veins hosted in melilite-nephelinite basalt (Üdersdorf and Graulai) and leucite-nephelinite basalt (Altburg). Associated minerals are: hematite, magnetite, titanite, götzenite, clinopyroxene, nepheline and biotite. About another 40 minerals are known from the paragenesis.

General appearance: Euhedral to subhedral platy grains (0.5 to 1 mm in diameter and 0.02 to 0.125 mm thick).

Physical, chemical and crystallographic properties: *Luster:* submetallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* dark brown. *Hardness:* VHN_{50} 793 kg/mm^2, corresponding to Mohs 5½ to 6. *Tenacity:* brittle. *Cleavage:* {001} perfection not stated. *Fracture:* given as "no special form." *Density:* not measured, 5.02 g/cm^3 (calc.). *Other properties:* ferrimagnetic. ***Crystallography:*** Hexagonal, $P6_3/mmc$, *a* 5.909, *c* 23.369 Å, *V* 706.6 Å^3, Z 2, *c*:*a* = 3.9548. Morphology: {001}, {103} and {100}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 2.799 (80) (107), 2.631 (100) (114), 2.429 (60) (203), 1.672 (50) (217), 1.638 (40) (2.0.11, 304), 1.490 (40) (2.1.10, 1.0.15), 1.478 (47) (220), 1.397 (40) (2.0.14). ***Optical data:*** In reflected light: pale gray, moderate anisotropism, distinct (air) and weak (oil) bireflectance, nonpleochroic. R_O, R_E; $^{im}R_O$, $^{im}R_E$: (22.1, 20.1; 8.4, 7.1 %) 470nm, 21.0, 19.4; 7.8, 6.6 %) 546nm, (20.2, 18.8; 7.4, 6.3 %) 589nm, (19.3, 18.3; 6.8, 5.9 %) 650nm. ***Chemical analytical data:*** Means of forty-seven sets of electron microprobe data: Na_2O 0.18, K_2O 0.30, MgO 1.38, MnO 2.44, FeO 5.71, SrO 0.53, BaO 11.89, Al_2O_3 0.32, Fe_2O_3 62.61, TiO_2 13.38, Total 98.74 wt.%. Empirical formula: $(Ba_{0.84}K_{0.07}Na_{0.06}Sr_{0.06})_{\Sigma 1.03}(Fe^{3+}_{8.48}Fe^{2+}_{0.86}Ti_{1.81}Mg_{0.37}Mn_{0.37}Al_{0.07})_{\Sigma 11.96}O_{19.00}$. ***Relationship to other species:*** A member of the magnetoplumbite group.

Name: For the main chemical composition and relationship to the hexaferrites. ***Comments:*** IMA No. 1997-038. Details of the crystal structure are given. The crystal drawing in the paper has been redrawn here in the standard orientation. The ideal formula has been changed here to reflect the Fe^{3+} and Fe^{2+} contents necessary for charge balance.

LENGAUER, C. L., TILLMANNS, E., and HENTSCHEL, G. (2001) Batiferrite, $Ba[Ti_2Fe_{10}]O_{19}$, a new ferrimagnetic magnetoplumbite-type mineral from the Quaternary volcanic rocks of the western Eifel area, Germany. *Mineralogy and Petrology* **71**, 1–19.

Dashkovaite — Monoclinic

$Mg(HCO_3)_2 \cdot 2H_2O$

Locality: From a borehole at the Korshunovskoye boron deposit, Irkutsk district, Siberia, Russia.

Occurrence: In dolomite marble. Associated minerals are: shabynite, iowaite, ekaterinite, korshunovskite, halite, hydromagnesite and a serpentine mineral.

General appearance: Veinlets 1 mm thick made up of fibers (up to 3 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* white. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 1 (for aggregates). *Tenacity:* sectile. *Cleavage:* not observed. *Fracture:* uneven. *Density:* not measured, 1.76 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/c$, *a* 8.64, *b* 7.15, *c* 9.38 Å, β 98.0°, *V* 574 Å³, Z 4, *a:b:c* = 1.2084:1:1.3119. Morphology: no forms were observed; habit prismatic. Twinning: none observed. ***X-ray powder diffraction data:*** 4.90 (9) (11$\bar{1}$), 4.64 (8) (002), 4.30 (7) (200), 3.68 (8) (210), 3.40 (10) (112). ***Optical data:*** Biaxial (+), α 1.465, β 1.486, γ 1.516, 2V(meas.) not given, 2V(calc.) 81°; dispersion not observed; nonpleochroic; X = elongation direction. ***Chemical analytical data:*** Means of two sets of electron microprobe data (Mg and Mn), selective sorption of high temperature combustion in oxygen (H and C) and O by difference: Mg 16.4, Mn 0.2, C 16.2, H 3.9, O 63.3, Total 100.0 wt.%. Empirical formula: $(Mg_{1.03}Mn_{0.01})_{\Sigma 1.04}H_{1.88}C_{2.06}O_{4.03} \cdot 2H_2O$. ***Relationship to other species:*** It is the second formate mineral found; the first is formicaite.

Name: For Ekaterina Romanovna Dashkova (1744–1810), Director of the St. Petersburg Academy of Sciences and President of the Russian Academy of Sciences (1783–1796). ***Comments:*** IMA No. 2000-006.

CHUKANOV, N. V., BELAKOVSKIY, D. I., MALINKO, S. V., and ORGANOVA, N. I. (2000) Dashkovaite $Mg(HCO_3)_2 \cdot 2H_2O$—a new formate mineral. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **129(6)**, 49–53.

Fluorannite — Monoclinic

$KFe^{2+}_3AlSi_3O_{10}F_2$

Locality: The western suburb of Suzhou City, about 80 km west of Shanghai, People's Republic of China.

Occurrence: In the Huangshan granite. Associated minerals are: quartz, hafnian zircon, tantalite-columbite, fluorite and magnetite.

General appearance: Euhedral to subhedral grains and tabular sheets. Most grains are 2 to 4 mm long and 1 to 3 mm thick.

Physical, chemical and crystallographic properties: *Luster:* submetallic. *Diaphaneity:* translucent. *Color:* iron-black. *Streak:* gray. *Luminescence:* nonfluorescent. *Hardness:* VHN_{50} 109 kg/mm². *Tenacity:* sectile. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* 3.18 g/cm³ (meas.), 3.30 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 5.369, *b* 9.289, *c* 10.153 Å, β 100.49°, *V* 498 Å³, Z 2, *a:b:c* = 0.5780:1:1.0930. Morphology: no forms were mentioned. Twinning: none observed. ***X-ray powder diffraction data:*** 10.09 (100) (001), 5.02 (13) (002), 3.336 (56) (003), 3.160 (10) (112), 2.933 (10) ($\bar{1}$13), 2.649 (10) (200), 2.507 (14) (131, 004), 2.004 (10) (204, 005), 1.671 (10) ($\bar{1}$35). ***Optical data:*** Biaxial (–), α 1.596, β 1.648, γ 1.648, 2V(meas.) ≈ 0°, 2V(calc.) 0°; pleochroism X = pale brown, Y = dark green, Z = reddish; Y = *b*. ***Chemical analytical data:*** Means of ten sets of electron microprobe data: Li_2O 0.47, Na_2O 0.19, K_2O 8.73, Rb_2O 0.42, Cs_2O 0.02, MgO 1.49, MnO 0.68, FeO 26.19, NiO 0.01, ZnO 0.27, SrO 0.01, BaO 0.44, Al_2O_3 13.89, Fe_2O_3 7.86, SiO_2 34.12, TiO_2 1.29, H_2O 0.91, F 3.91, sum 100.90, less O = F 1.65, Total 99.25 wt.%. Empirical formula: $(K_{0.92}Li_{0.16}Na_{0.03}Rb_{0.02})_{\Sigma 0.98}(Fe^{2+}_{1.82}Fe^{3+}_{0.49}Al_{0.19}Mg_{0.18}Li_{0.16}Ti_{0.08}Mn_{0.05}Zn_{0.02})_{\Sigma 2.99}Al_{1.00}(Si_{2.83}Al_{0.17})_{\Sigma 3.00}O_{10.00}[F_{1.03}(OH)_{0.50}\square_{0.47}]_{\Sigma 2.00}$. ***Relationship to other species:*** It is a member of the mica group, specifically the F-dominant analog of annite, $KFe^{2+}_3AlSi_3O_{10}(OH)_2$. It is the -1*M* polytype.

Name: For the relationship with annite. ***Comments:*** IMA No. 1999-048.

SHEN GANFU, LU QI and XU JINSHA (2000) Fluorannite: a new mineral of mica group from western suburb of Suzhou City. *Acta Petrologica et Mineralogica* **19(4)**, 356–362 (In Chinese with an English abstract).

Fluoro-magnesio-arfvedsonite — Monoclinic

$NaNa_2(Mg,Fe^{2+})_4Fe^{3+}[Si_8O_{22}](F,H_2O)_2$

Locality: The west slope of the Ilmen mountain ridge, Ilmen Nature Reserve, South Urals, near Miass, Chelyabinsk region, Russia.

Occurrence: In albite-microcline fenites in the contact zone of the Ilmen alkaline massif. Associated minerals are: microcline-perthite, microcline, albite, phlogopite, quartz, titanite, rutile, apatite, pyrite and zircon.

General appearance: Short prismatic grains (up to 0.7 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* gray. *Streak:* white. *Luminescence:* not given. *Hardness:* 5½. *Tenacity:* brittle. *Cleavage:* {110} good. *Fracture:* uneven. *Density:* 3.09 g/cm³ (meas.), 3.05 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 9.81, *b* 18.05, *c* 5.29 Å, β 103.9°, *V* 910.2 Å³, Z 2, *a:b:c* = 0.5435:1:0.2931. Morphology: {110} and {010}. Twinning: none observed. ***X-ray powder diffraction data:*** 8.42 (34) (110), 3.392 (11) (041), 3.264 (23) (240), 3.129 (100) (310), 2.804 (28) (330), 2.716 (10) (33$\bar{1}$), 2.708 (17) (151), 1.895 (10) (510), 1.654 (10) (511). ***Optical data:*** Biaxial sign given as (+), but the indices and calculated 2V indicate (–), α 1.618, β 1.629,

γ 1.632, 2V(meas.) 50 to 70°, 2V(calc.) 55°; dispersion r>v; pleochroism X = yellowish nearly colorless, Y = pale lilac, Z = greenish-blue; Y = *b*, Z ∧ *c* = 15 to 16°. ***Chemical analytical data:*** Wet chemical analysis gave: Na_2O 7.50, K_2O 1.62, MgO 20.10, CaO 2.86, MnO 0.29, FeO 0.79, Al_2O_3 1.47, Fe_2O_3 5.76, SiO_2 56.76, TiO_2 0.51, H_2O 0.84, F 2.80, sum 101.30, less O = F 1.18, Total 100.12 wt.%. Empirical formula: $(Na_{0.45}K_{0.29})_{\Sigma 0.74}$-$(Na_{1.57}Ca_{0.43})_{\Sigma 2.00}(Mg_{4.16}Fe^{3+}_{0.60}Al_{0.12}Fe^{2+}_{0.09}Ti_{0.05}Mn_{0.03})_{\Sigma 5.05}(Si_{7.88}Al_{0.12})_{\Sigma 8.00}O_{21.99}[F_{1.23}(OH)_{0.78}]_{\Sigma 2.01}$.

Relationship to other species: A member of the amphibole group.

Name: For the approved nomenclature of the Amphibole group. The name approved by the CNMMN of IMA is fluoro-magnesio-arfvedsonite, not fluormagnesioarfvedsonite.

Comments: IMA No. 1998-056.

BAZHENOV, A. G., NEDOSEKOVA, I. L., KRINOVA, T. V., MIRONOV, A. B., and KHVOROV, P. V. (2000) Fluormagnesioarfvedsonite (*sic*) $NaNa_2(Mg,Fe^{2+})_4Fe^{3+}[Si_8O_{22}](F,H_2O)_2$—a new mineral species of the amphibole group. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **129(6)**, 28–35.

Gladiusite — Monoclinic

$Fe^{3+}_2(Fe^{2+},Mg)_4(PO_4)(OH)_{11}(H_2O)$

Locality: The Kovdor alkaline-ultramafic complex, southwestern Kola Peninsula, northwestern Russia (Lat. 67°35′ N, Long. 30°20′ E).

Occurrence: In hydrothermal assemblages in vugs in cataclastic and mineralized dolomite carbonatite. Associated minerals are: pyrite, rutile, a ternovite-like phase, catapleiite, rimkorolgite, bobierrite, collinsite, juonniite, strontiowhitlockite, pyrrhotite and strontian collinsite.

General appearance: Acicular masses and free-standing radiating clusters (up to 2 mm in diameter) of arrow-head crystals. Crystals have subtly curved faces and a habit similar to a double-edged sword. Acicular crystals are 0.5 to 7 µm thick and 10 to 500 µm long.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* opaque in aggregates and translucent in thin needles. *Color:* dark green to almost black. *Streak:* olive-green, but changes to brownish red in 10 to 12 hours. *Luminescence:* nonfluorescent. *Hardness:* VHN_{20} 300 kg/mm², Mohs 4 to 4½. *Tenacity:* brittle. *Cleavage:* not observed. *Fracture:* uneven. *Density:* 3.11 g/cm³ (meas.), 3.10 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/n$, *a* 16.959, *b* 11.650, *c* 6.266 Å, β 90.00°, *V* 1238 Å³, Z 4, *a:b:c* = 1.4557:1:0.5379. Morphology: no forms were mentioned. Twinning: extensive on [001], causing pseudo-orthorhombic symmetry. ***X-ray powder diffraction data:*** 9.61 (53) (110), 6.87 (77) (210), 5.83 (89) (020), 4.805 (100) (220), 3.787 (62) (130), 3.533 (84) (230), 2.868 (66) (140). ***Optical data:*** Biaxial (–), α 1.722, β 1.730, γ 1.737, 2V not measured, 2V(calc.) 86° (given erroneously as 78.3° in the paper's abstract); dispersion not given; pleochroism X olive green, Y grayish blue, Z dark green with a blue tint, absorption X > Y > Z; orientation not given. ***Chemical analytical data:*** Means of twenty-three sets of electron microprobe data: MgO 11.16, MnO 0.78, FeO 25.00, Fe_2O_3 29.90, TiO_2 0.04, P_2O_5 12.46, H_2O 20.18, Total 99.52 wt.%. Empirical formula: $Fe^{3+}_{2.00}(Fe^{2+}_{2.02}Mg_{1.61}Fe^{3+}_{0.17}Mn^{2+}_{0.06})\beta_{3.86}(PO_4)_{1.02}(OH)_{10.83}\cdot 1.08H_2O$.

Relationship to other species: None apparent.

Name: For the appearance of the crystals which resemble double-edged swords (*gladius* in Latin). ***Comments:*** IMA No. 1998-011. The Gladstone-Dale compatibility is given as -0.0062, superior; the actual value is 0.087, poor.

LIFEROVICH, R. P., SOKOLOVA, E. V., HAWTHORNE, F. C., LAAJOKI, K. V. O., GEHÖR, S., PAKHOMOVSKY, Y. A., and SOROKHTINA, N. V. (2000) Gladiusite, $Fe^{3+}_2(Fe^{2+},Mg)_4(PO_4)(OH)_{11}(H_2O)$, a new hydrothermal mineral species from the phoscorite-carbonatite unit, Kovdor complex, Kola Peninsula, Russia. *Canadian Mineralogist* **38**, 1477–1485.

Kapitsaite-(Y) — Triclinic

$(Ba,K)_4(Y,Ca)_2Si_8(B,Si)_4O_{28}F$

Locality: The moraine of the Dara-i-Pioz glacier, Garm region, Tajikistan (Lat. 39°30′ N, Long. 70°40′ E).

Occurrence: Associated minerals are: quartz, reedmergnerite, leucosphenite, polylithionite, pectolite, pyrochlore and aegirine.

General appearance: A sheaf-like aggregate (1 x 2 cm) of elongated grains (0.5 x 2 to 8 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* pale pink. *Streak:* white. *Luminescence:* fluoresces pale pink in short-wave ultraviolet light. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* absent. *Fracture:* conchoidal. *Density:* 3.74 g/cm³ (meas.), 3.80 g/cm³ (calc.). ***Crystallography:*** Triclinic, $I\bar{1}$, *a* 11.181, *b* 10.850, *c* 10.252 Å, α 90.64°, β 90.05°, γ 89.97°, *V* 1243.6 Å³, Z 2, *a:b:c* = 1.0305:1:0.9449. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.80 (70) ($\bar{1}\bar{1}0$), 3.77 (100) (202), 3.73 (70) ($\bar{3}00$), 3.24 (75) (013), 2.93 (80) (321, $\bar{2}\bar{3}1$), 2.90 (90) ($\bar{3}12$), 2.74 (65) ($0\bar{4}0$). ***Optical data:*** Biaxial (+), α 1.624, β 1.628, γ 1.637, 2V(meas.) 69°, 2V(calc.) 68°; dispersion r<v, weak; nonpleochroic; orientation not given. ***Chemical analytical data:*** Means of seven sets of electron microprobe data: Na_2O 0.46, K_2O 0.87, CaO 3.12, MnO 0.05, FeO 0.01, BaO 38.18, PbO 1.95, B_2O_3 8.68, Al_2O_3 0.04, Y_2O_3 7.93, La_2O_3 0.01, Ce_2O_3 0.09, Pr_2O_3 0.03, Nd_2O_3 0.32, Sm_2O_3 0.36, Gd_2O_3 0.64, Dy_2O_3 0.70, Ho_2O_3 0.14, Er_2O_3 0.36, Yb_2O_3 0.20, SiO_2 34.98, F 1.40, Cl 0.01, sum 100.53, less O = F + Cl 0.59, Total 99.94 wt.%. Empirical formula: $(Ba_{3.55}K_{0.26}Pb_{0.12}Na_{0.07})_{\Sigma 4.00}(Y_{1.00}Ca_{0.79}Na_{0.14}$-$Gd_{0.05}Dy_{0.05}Nd_{0.03}Sm_{0.03}Er_{0.03}Ce_{0.01}Ho_{0.01}Yb_{0.01})_{\Sigma 2.15}(Si_{7.99}Al_{0.01})_{\Sigma 8.00}(B_{3.55}Si_{0.30})_{\Sigma 3.85}O_{27.95}F_{1.05}$. ***Relationship to other species:*** It is the Y-dominant analogue of hyalotekite.

Name: For Professor Peter Leonidovich Kapitsa 1894–1984), famous Russian physicist. ***Comments:*** IMA No. 1998-057.

PAUTOV, L. A., KHVOROV, P. V., SOKOLOVA, E. V., FERRARIS, G., IVALDI, G., and BAZHENOVA, L. F. (2000) Kapitsaite-(Y) $(Ba,K)_4(Y,Ca)_2Si_8(B,Si)_4O_{28}F$—a new mineral. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **129(6)**, 42–49.

Australia and Callenberg, Saxony, Germany. *Canadian* mentioned.

Editors Notes *continued from p. 426*

and finally submitted for typesetting by e-mail have gone very smoothly. So I guess we are ready to officially open the door to that format. But be sure to **mention the name of the attached file** in your e-mail cover letter, or we will **not open it**, as a precaution against possible viruses. And even for articles submitted in the traditional way we do appreciate also receiving a disk copy of the text, along with the usual three paper copies. Line drawings, charts, graphs and maps can also be submitted electronically. However, **color photos must still be submitted as original transparencies** and not as data files. That requirement is unlikely to change for quite some time.

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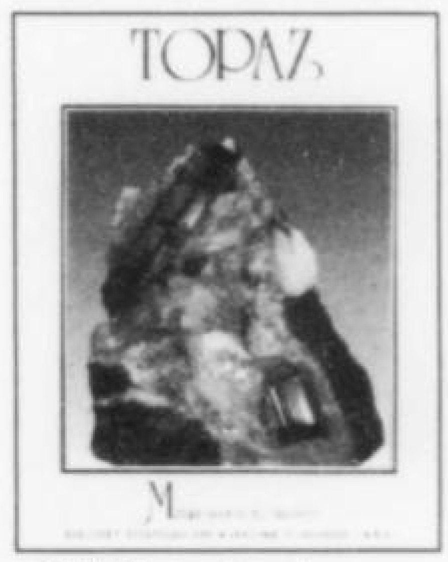

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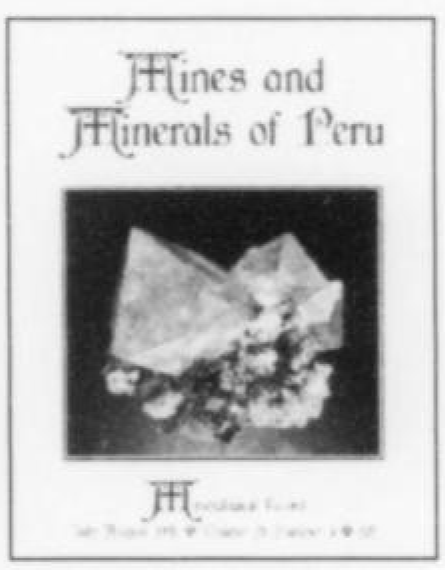

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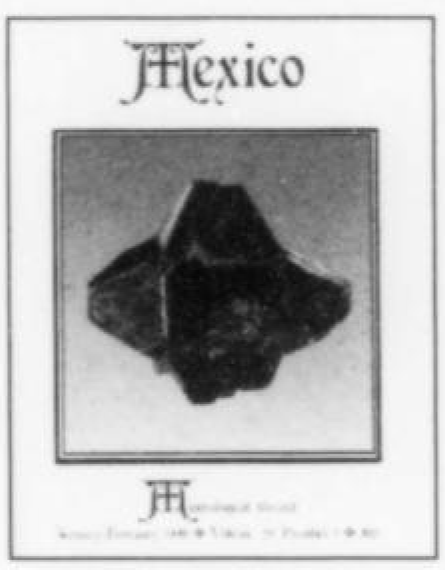

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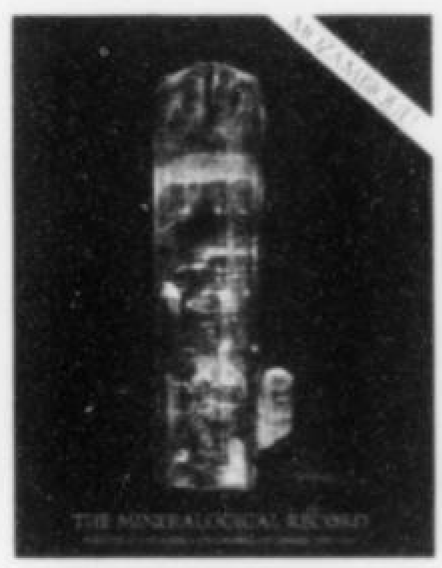

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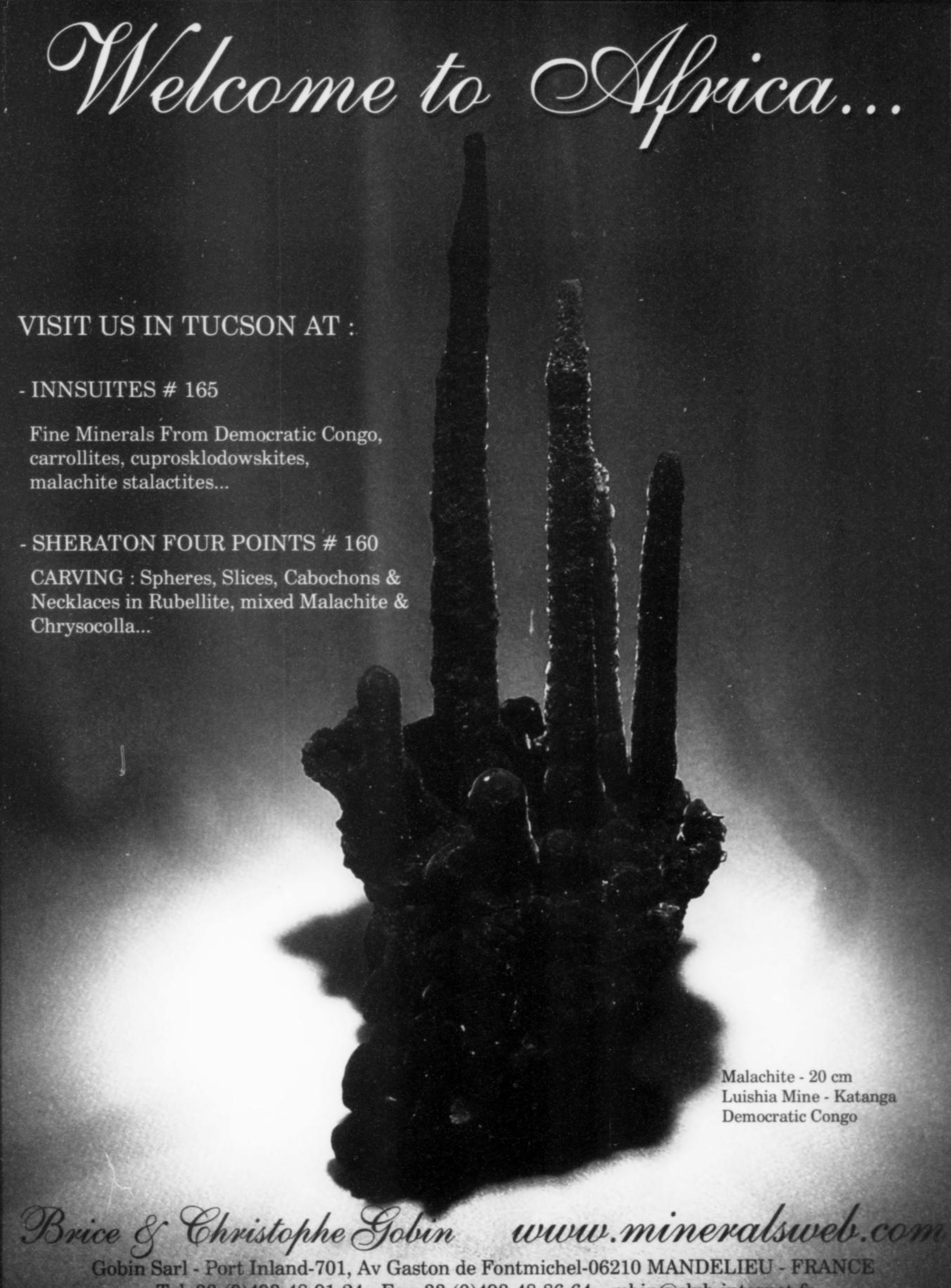
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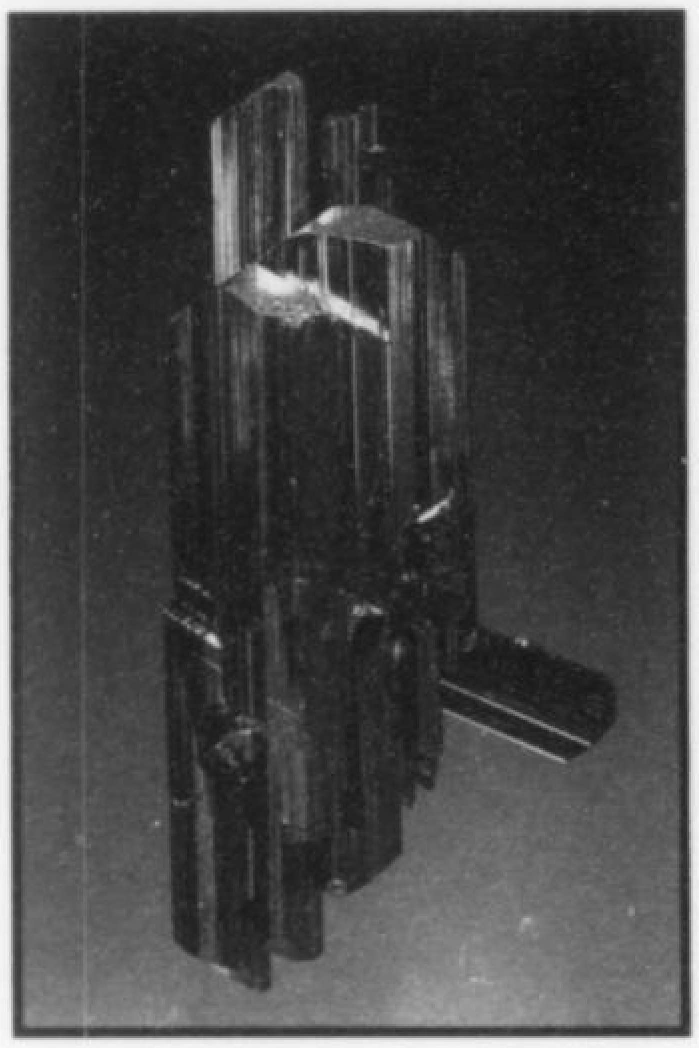

Rutile; Bahia, Brazil; 5.4 cm

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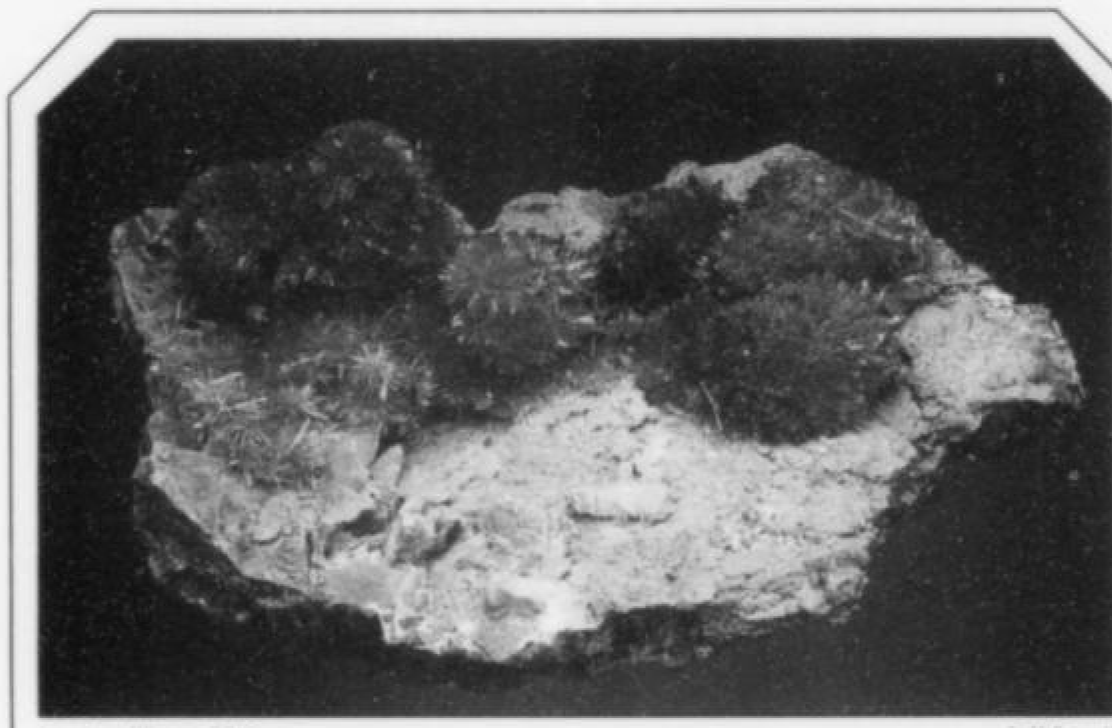

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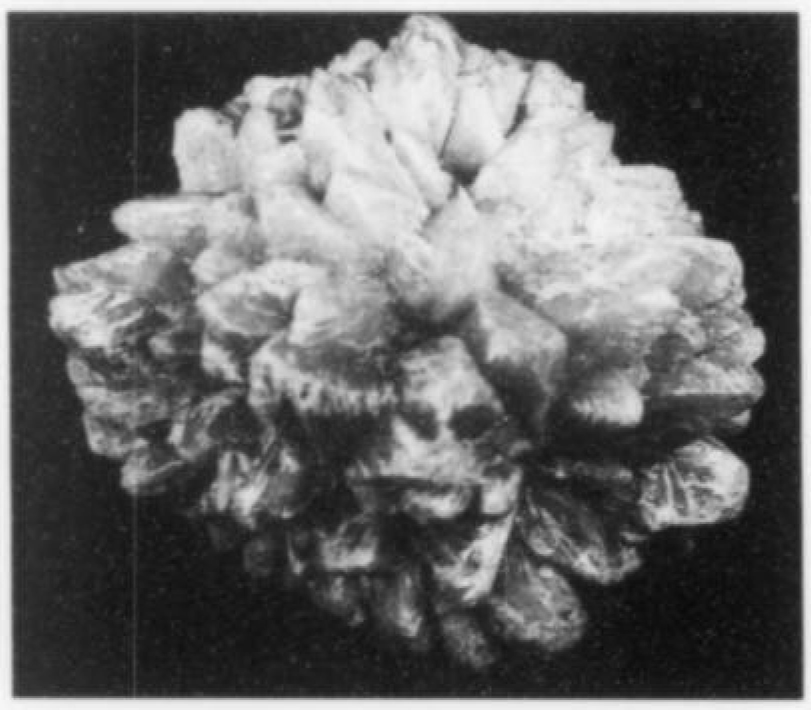

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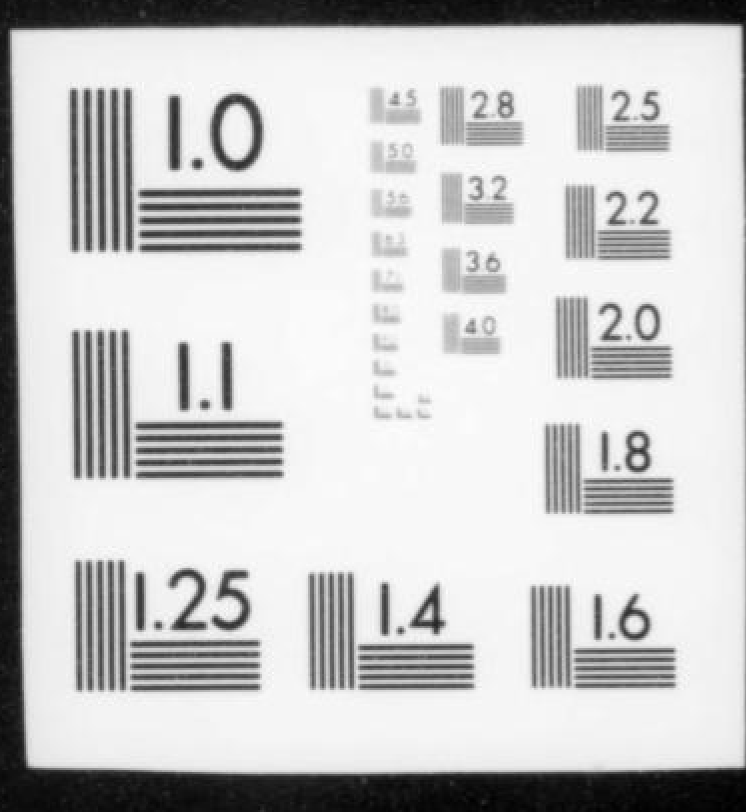
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