the Mineralogical Record

Volume Thirty-three, Number Two
March–April 2002
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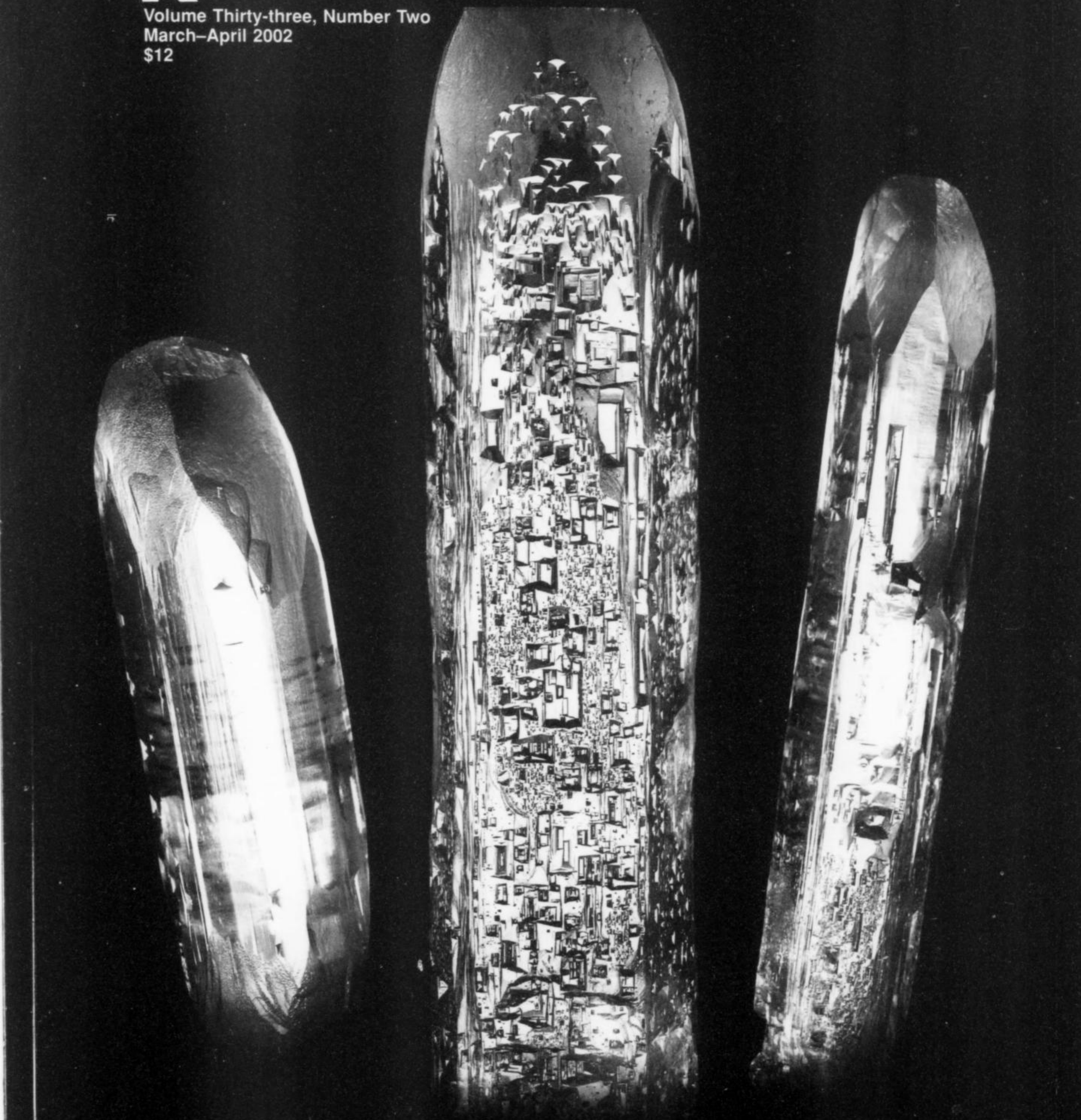

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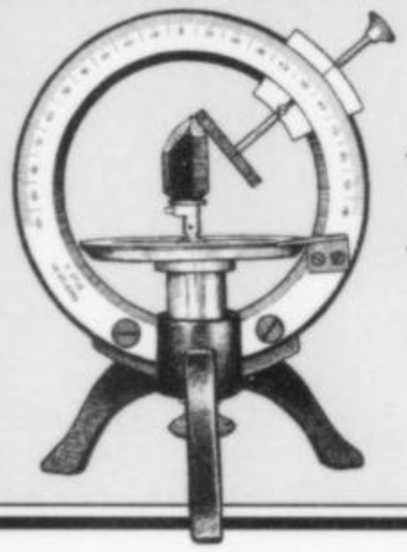

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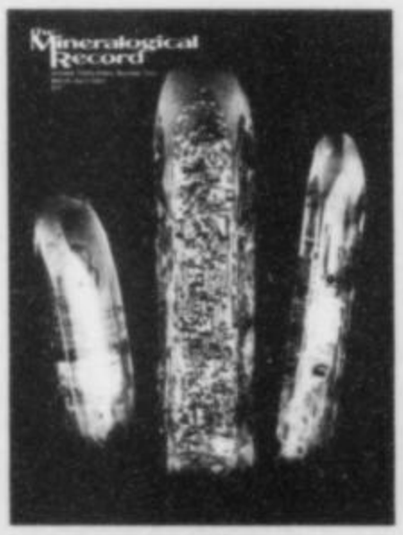
March–April 2002 Volume Thirty-three, Number Two

Articles

Columns



COVER: BERYL crystals, 22 cm, 28 cm, 16 cm, showing etch pits and corrosion surfaces, from the Medra mine, Minas Gerais, Brazil. Keith Proctor collection; Jeff Scovil photo.

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*Continued on p. 199

notes from the EDITOR

IRRADIATION IN THE POST

The recent biological attacks by a terrorist utilizing the mails as a delivery system have prompted the U.S. Postal Service to consider irradiating all mail. The irradiation process would probably rely upon linear accelerators generating powerful electron beams; such equipment is already in common use for the irradiation of food to kill microorganisms. Unfortunately the same process has also been successfully employed to purposely alter or enhance the color of certain gem materials including corundum, spodumene, quartz and topaz.

Recent tests conducted by the Gemological Institute of America have shown that the equipment being used by the Postal Service (manufactured by the SureBeam Corporation of San Diego) can indeed cause distinct color changes in gem materials. Under test conditions, pale blue sapphires (corundum) turned deep orange and pink kunzite (spodumene) turned green. Diamonds were unaffected.

The Mineralogical Record's advisor on this question offered some additional information. First of all, he emphasized that there is no residual radiation resulting from the process, and thus no radiological risk to humans handling irradiated material. A maximum dosage of 11 megarads is prescribed for the sterilization of mail and, although a dosage of only 300 rads is fatal to humans, elements in gem minerals are not made radioactive by the process. The dosage commonly necessary to convert pale blue topaz to the much more valuable deep blue color is on the order of 6,000 to 12,000 megarads. However, color changes can take place in fluorite and quartz at dosages around 20 megarads, and possibly lower, depending on the duration of exposure. Visible changes in various gem materials begin at doses of less than 10 megarads, and within the range utilized by the Postal Service. An unknown number of other non-gem species may also be susceptible.

Clearly the irradiation of mail is a threat to the natural coloration of gems and minerals being shipped. At present the process is said to be used only on small, selected lots of mail in flat envelopes, but that policy could change at any time. I'm not certain what kind of shielding would be necessary to protect the contents of a package, but it would probably be heavy, and could just as well be employed by terrorists; perhaps the Postal Service will consider the irradiation of package mail and other cargo to be impractical. Only time will tell, but the situation bears watching.

MORE MINERAL CABINETS

In previous issues we have occasionally brought to the attention of our readers a number of different custom-made mineral cabinets and cabinet makers. However, for people who like woodworking, there is always the option of making a cabinet for yourself, a process rendered somewhat easier if you have professionally prepared plans to go by. We've always thought that a mechanic's wooden tool chest makes a fine mineral cabinet by itself, and examples can be purchased in many stores; however, the U-Bild Company in Van Nuys, California sells do-it-yourself plans for about $10 showing how to build a nice one. The example pictured here, the Precision Tool Chest No. 788, is 20 inches tall by 24

inches across and 12 inches deep, with 13 felt-lined drawers plus a top compartment (in which to keep your catalog?), rubber feet and brass fittings. It can be constructed inexpensively from just two sheets of plywood, a small piece of standard lumber, and of course the brass hardware, felt, rubber feet, nails, glue and finish. Higher quality wood can also be chosen.

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THANKS

On behalf of our readers we want to publicly thank Steve and Clara Smale of Oakland, California, and now also William Severance of West Grove, Pennsylvania for the beautiful pages they sponsor in each issue. At first glance these pages resemble advertisements, but nothing is actually being sold. Steve, Clara and Bill simply enjoy sharing one of their favorite specimens with our readers each issue, and are willing to reimburse us for the space. It amounts to a sort of slow-motion feature article on the best specimens in their collections, usually accompanied by data on when and how the specimens were acquired. Over time (Steve and Clara have been doing it for three years now) we end up getting a look at quite a selection of wonderful display specimens. The kindness and generosity of these people in sharing their collections with us all is much appreciated. A large part of the fun of collecting is showing off the things we love, and seeing the things our fellow collectors love.

MORE THANKS

Our two long-time major supporters are also still with us: Philip Rust and Randy Rothschild. Year after year they have provided us with the extra funds we need to keep the *Mineralogical Record* richly illustrated with good color photography. The current issue is a good example of the effect they have had; it would be considerably less well illustrated without the help they have provided. Other donations, smaller but just as gratefully appreciated, have been received from Lou Perloff and from Terry and Michelle Wallace. Finally, we cannot fail to mention the help of those who support our Antiquarian Reprint series. They, along with our faithful subscribers (especially overseas where the strength of the dollar makes subscribing even more of a sacrifice) form the essential structure which keeps the *Mineralogical Record* in business. Ours is not an impersonal business; we appreciate every renewal and every order for back issues.

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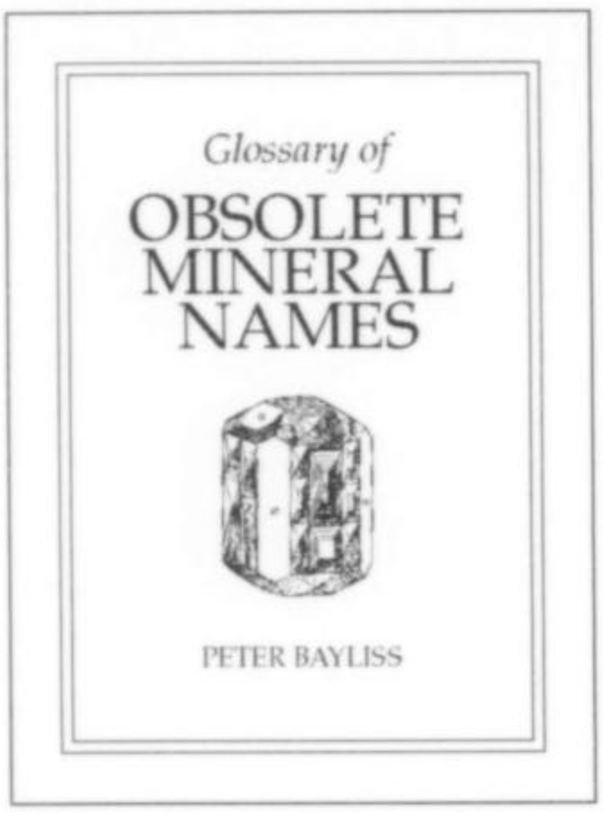

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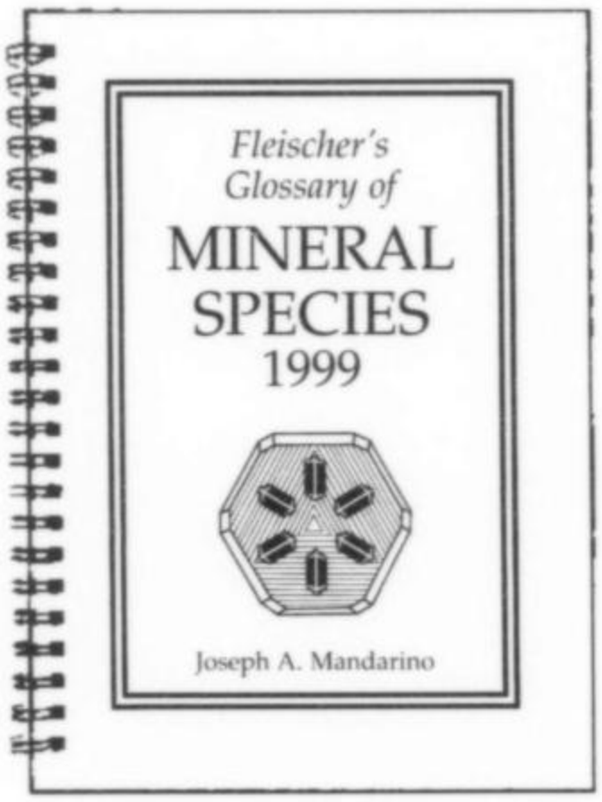

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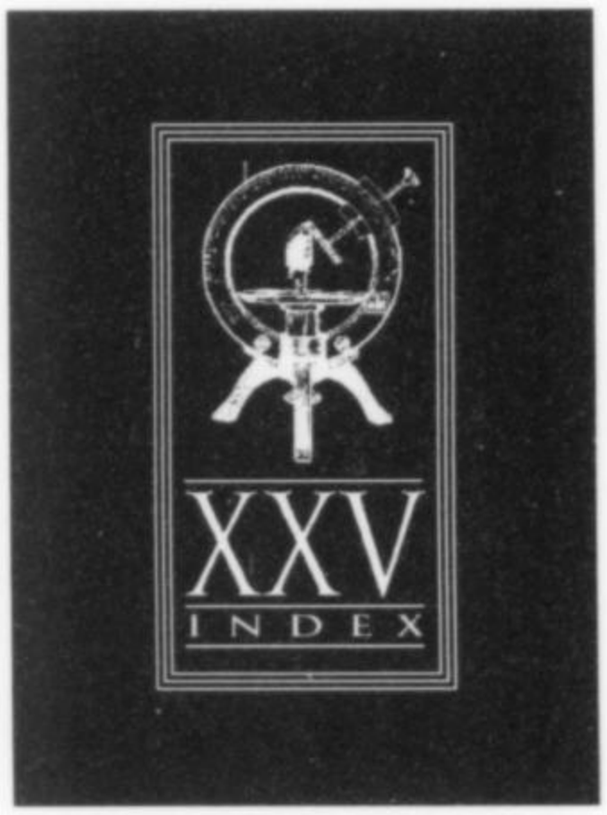

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Cuprian Elbaite *from the* Batalha Mine, Paraíba, Brazil

Wendell E. Wilson
The Mineralogical Record
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Copper-bearing "Paraíba tourmaline," a geochemical oddity, was discovered in Brazil in 1988. Its rich and unique colors have given it extraordinary gemstone value, resulting in the preservation of very few good crystal specimens. Renewed exploration and mining were initiated in 1999.

INTRODUCTION

The tourmaline group consists of 13 species, elbaite, liddicoatite and uvite being among the most colorful. Until the discovery of the Batalha occurrence in the state of Paraíba, northeastern Brazil, however, none were known to be colored by copper. Cuprian elbaite from the Batalha pegmatite veins, unrecognized until the 1980's, has become the most valuable and sought-after of all tourmalines, and remains the rarest in mineral collections. The extraordinary colors resulting from the presence of copper (and, to a lesser extent, manganese), especially an incredibly bright and rich turquoise-blue, are the reason for its fame and popularity.

Although copper is not an element typical of complex pegmatites, the association is not unique to the Batalha deposit. Other pegmatites in the region have been found to contain tourmaline colored by trace amounts of copper, though not of such high quality; and the Khan pegmatite near Rössing, Namibia, is also high in copper content, although it has thus far yielded no tourmalines colored by copper (Haughton, 1969). Just recently, Zang and Da Fonseca-Zang (2001) have reported the presence of copper-bearing elbaite from the Edeko mine near Ilorin in the state of Ojo, Nigeria, which is very similar in color and in main and trace element contents to Batalha mine elbaite.

The cuprian elbaites from the Batalha mine would be merely a mineralogical curiosity were it not for the stunningly beautiful and deeply saturated colors that have resulted from the copper (and manganese) "contamination." That feature has elevated Batalha crystals, now known widely as "Paraíba tourmaline," to the stratosphere of gemological value. Unfortunately for mineralogy, that high value (in some cases exceeding $20,000/carat) has caused nearly all good crystals to be immediately faceted into gemstones. Another factor contributing to the scarcity of good display specimens is the typically broken and/or heavily etched condition of the crystals. This, combined with the tendency for crystals to be found completely embedded instead of in open pockets, has meant that sharp, well-formed, transparent or semi-transparent crystals have been found only very rarely, and good matrix specimens not at all. Surviving uncut crystals are treasured by the few collectors and museums fortunate enough to own one.

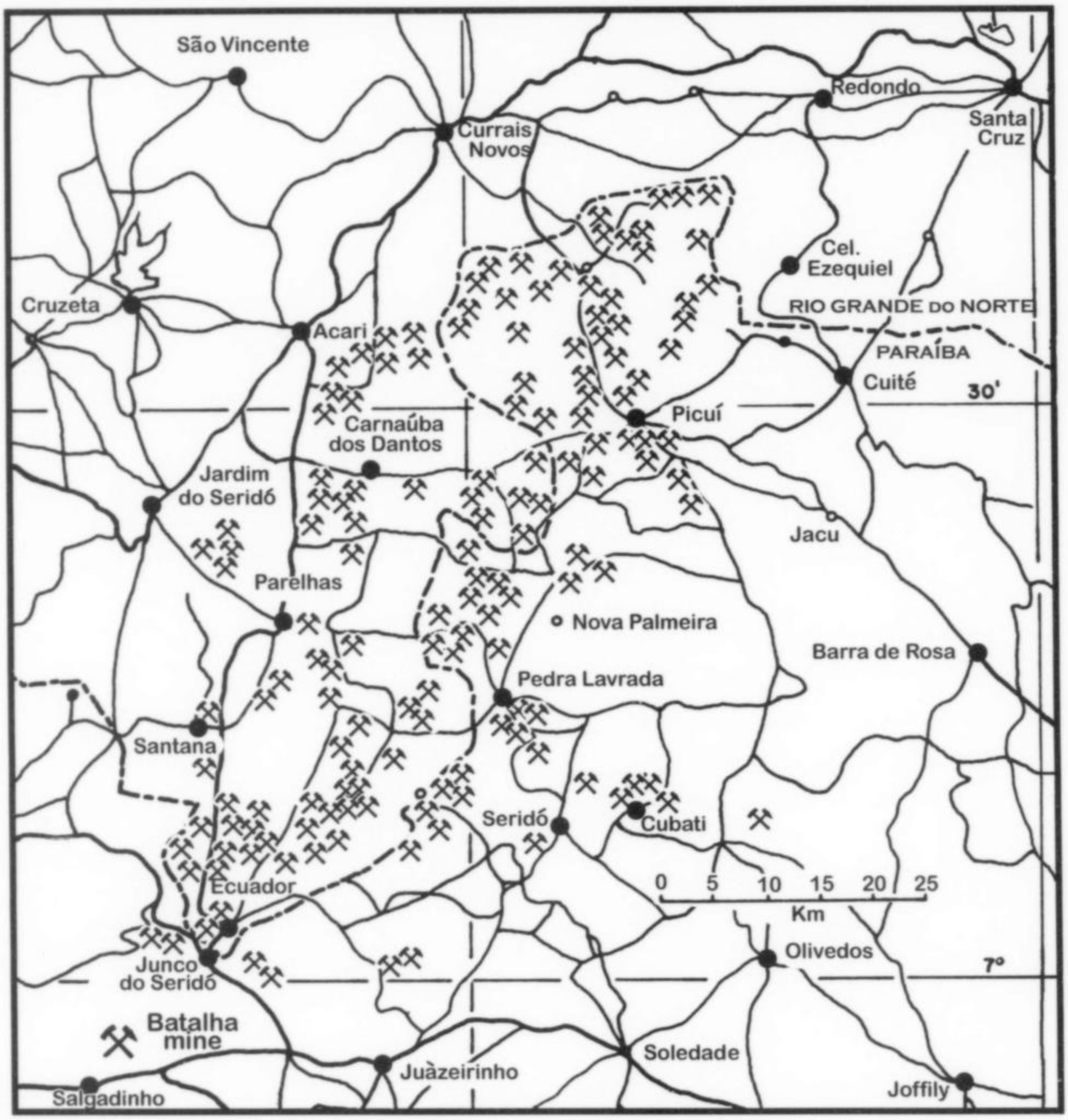


Figure 1. **Location map showing the Batalha mine at the southern end of the Seridó pegmatitic province (adapted from Sinkankas, 1981).**

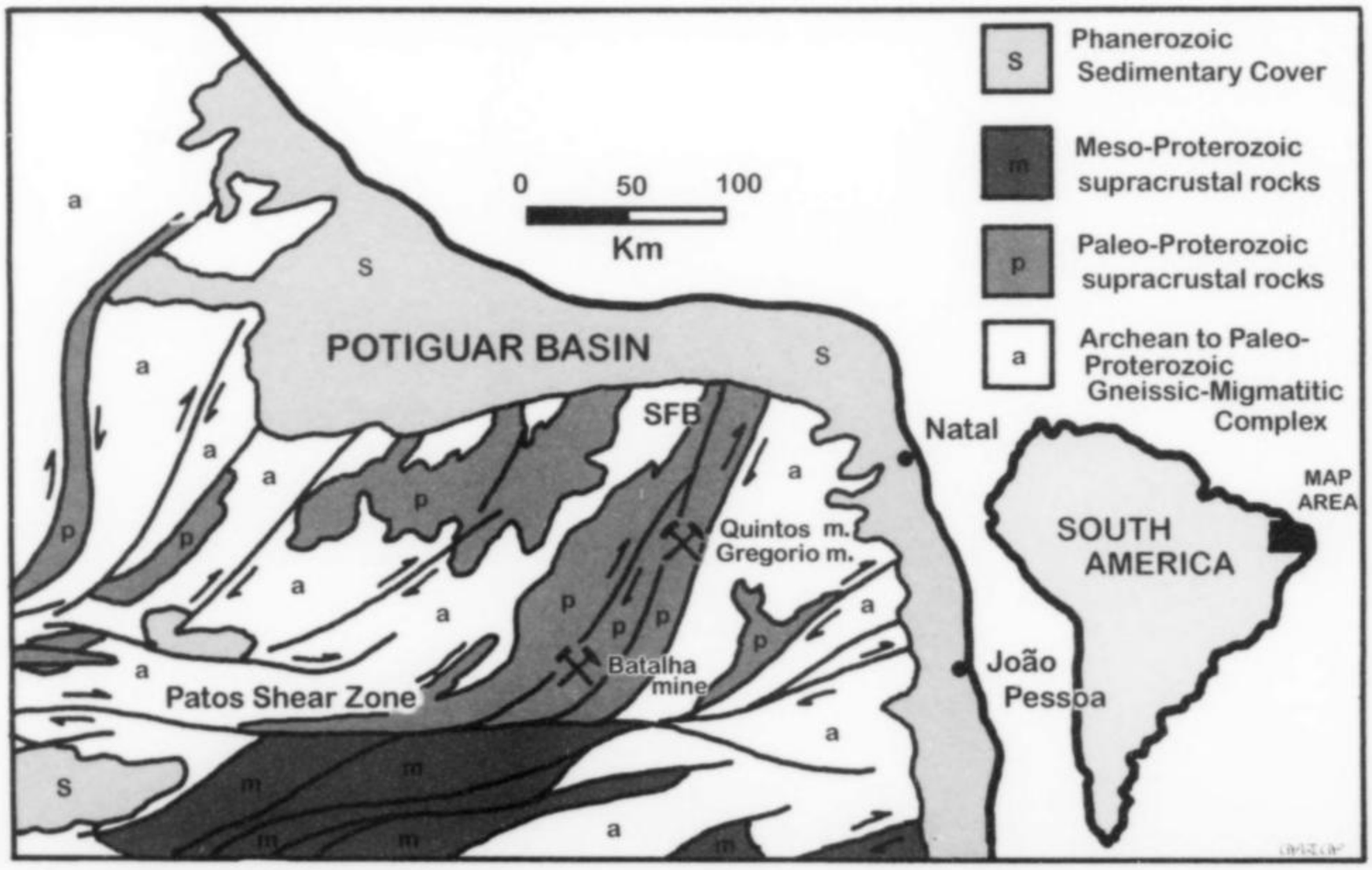


Figure 2. **Location of the Batalha mine and two other mines known for cuuprian elbaite, in the Seridó Fold Belt (SFB) (after Rodrigues Soares *et al.*, 2000).**

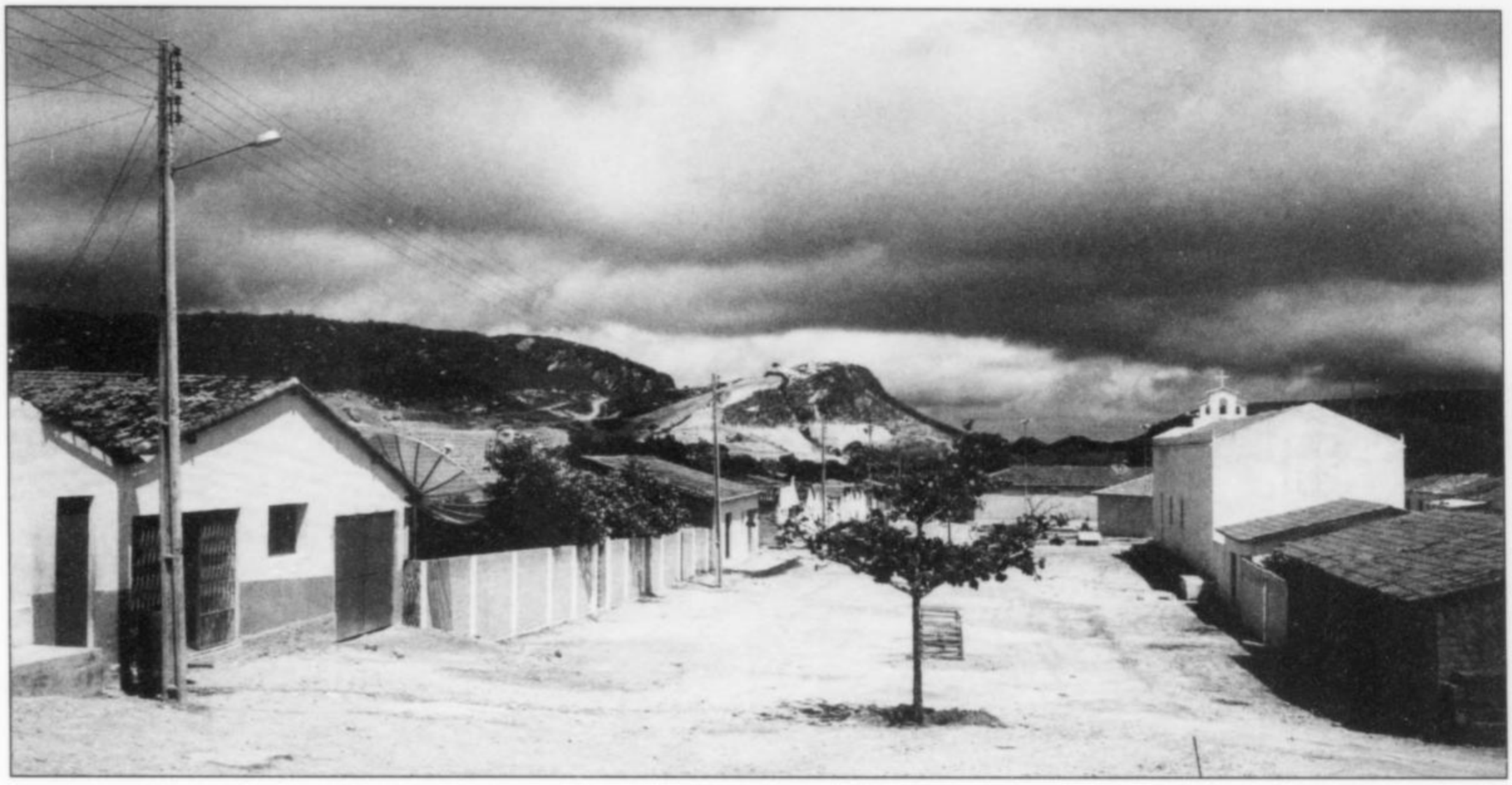


Figure 3. **The village of São José da Batalha; the Batalha mine is visible in the distance. Brendan Laurs photo.**

Because these rare crystals have such significance as specimens for the mineralogist and collector, and because virtually all that has been written about them has appeared only in the gemological literature, the following summary is provided for *Mineralogical Record* readers. Except as noted, all of the information presented here has been taken from Fritsch *et al.* (1990) and from Karfunkel and Wegner (1996).

LOCATION

The Batalha mine ("Mina da Batalha," pronounced "Bat-tal-ya") is situated in the Serra das Queimadas mountain range, on the side of Frade Hill ("Serra da Frade"), very near the village of São José da Batalha, and about 4.5 km northeast of the town of Salgadinho in the state of Paraíba, Brazil. The full name of the mine is "Mina da Batalha a Nova Era" ("Mine of the Battle of the New Era") but "Mina da Batalha" is in general use, and some cite the name of the village (São José da Batalha) as also being the mine name. The harsh and dry scrubland of the area supports little agriculture, but for decades a small local mining industry has focused on industrial pegmatite minerals, especially tantalite. Access is via a good highway west from the town of Campina Grande through Soledad and Juazeirinho, and from there about 42 km more due west to Salgadinho.

HISTORY

Attractive elbaite was first noticed in the area by Marcus Amaral, a geologist with the Mining and Geology Department of the Federal University of Paraíba in the late 1970's, but the potential of the deposits was not immediately recognized. In 1982, Jose Pereira of Patos, a local Paraíba *garimpeiro* and dealer in "black minerals" (columbite-tantalite), found a tantalite specimen containing tiny grains resembling colored sugar. Eventually he offered the specimen to another miner, Heitor Dimas Barbosa, who suspected that the colorful grains (later shown to be cuprian elbaite) might indicate the presence of gem minerals. With Pereira as his guide, Barbosa began exploring the mine dumps and tailings of the area's industrial pegmatites (normally exploited for tantalum, industrial beryl, kaolinite, quartz and mica). In 1983 they finally relocated the source of the specimens, a small, abandoned manganotantalite prospect (Koivula and Kammerling, 1990).

Over the next few years a team of 10 to 16 *garimpeiros* headed by Barbosa excavated shafts and galleries in the decomposed pegmatite, finding primarily tourmaline of various common shades of green. In August of 1988, however, they encountered strikingly colored "electric" blue and sapphire-blue tourmaline: these were the first of what came to be known as "copper tourmaline," or "Paraíba tourmaline."

Barbosa and his associates filed a claim on the deposit in 1988, and formed a mining cooperative (COGASBRA) which they registered with the DNPM (Brazilian National Department of Minerals). Nevertheless, the mining rights were disputed and lengthy litigation ensued, during which time little productive mining activity took place. The controversy was finally resolved in 1998, a consequence of the settlement being that the deposit was broken into three more or less equal pieces, of which Barbosa got one. Heitor and Sergio Barbosa then reactivated their portion of the property (Austin, 2001). Land adjacent to the mine was also opened up for exploration and mining (Cook and Barbosa, 1999). When Laurs and Shigley (2000) visited the mine in August of 2000, mining was proceeding carefully under the guidance of Heitor Barbosa; two teams of miners had begun working new areas of the pegmatite, and underground fluorescent lighting had just been installed. Barbosa was also constructing facilities to process the old mine tailings, and another group, *T.O.E. Mineração Ltda.* (a subsidiary of *Treasures of the Earth*, a Nevada corporation), had recovered considerable quantities of gem rough by processing alluvial sediments down-slope from the mine. In February of 1999 the T.O.E. group signed a 7.5-year agreement to mine the de Souza property, which includes part of Serra da Frade itself and some of the flat land surrounding the hill where alluvial deposits have

Figure 4. **The Batalha mine workings on Frade Hill. Brendan Laurs photo.**

developed; the operation has been very successful. Removal and processing of alluvial/eluvial material has also uncovered additional tourmaline-bearing pegmatite veins (Austin, 2001). The Batalha mine is a labyrinth consisting of shafts 50 to 60 meters in depth connected by several kilometers of hand-dug drifts and adits exploiting the complex system of pegmatite dikes. The narrow tunnels (originally only about 60 x 180 cm, though some have now been significantly enlarged to around 2 meters high and 1.5 meters across) were all worked solely by candlelight, under conditions of poor ventilation, during the 1980's and early 1990's, but have been modernized somewhat in recent years.

It was estimated in 1990 that approximately 10,000 carats (2 kg) of rough crystals and cut stones had been produced from the mine before legal difficulties restricted mining activity. Additional pockets were discovered underground in 1993 and 1998, but since then the bulk of production of gem rough has come from the processing of alluvial material (Austin, 2001).

GEOLOGY

The Batalha occurrence is situated within a large, well-known pegmatite province containing hundreds of pegmatite bodies that have produced feldspar, quartz, mica and columbite-tantalite. At Batalha the geology consists of a parallel to sub-parallel system of steeply dipping, thoroughly decomposed granitic pegmatite dikes cutting across a hard muscovite-quartzite country rock. This rock unit, known as the Ecuador Formation of the Mid-Proterozoic Serido Group, is part of the Borborema geologic province (Almeida *et al.,* 1981). The dikes are thought to have formed during the Upper Proterozoic (650–600 ma) Braziliano thermotectonic cycle. Feldspars in the pegmatites have all been completely altered to white, chalky kaolinite. Gem-quality tourmaline crystals are found embedded in this clay, and within small clay-filled pockets in the core zones of the pegmatites. Most tourmaline crystals have been broken by natural tectonic forces, and show moderate to severe etching. Some crystals have also been partially or completely altered to lepidolite. Associated minerals include quartz, lepidolite, schorl, dark green non-cuprian elbaite and Nb-Ta oxides.

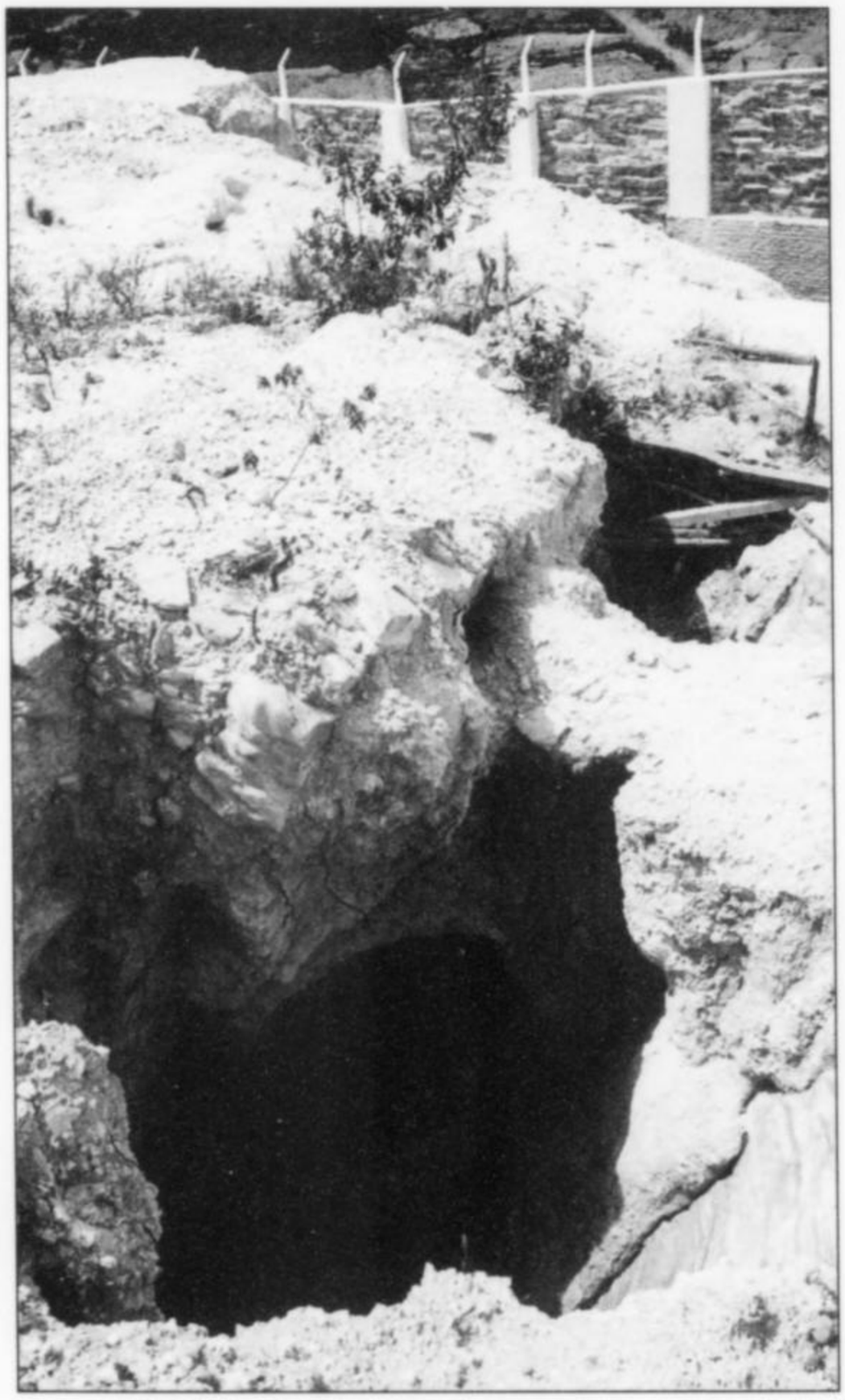


Figure 5. **Old workings at the Batalha mine from which much cuprian elbaite was taken. Brendan Laurs photo.**

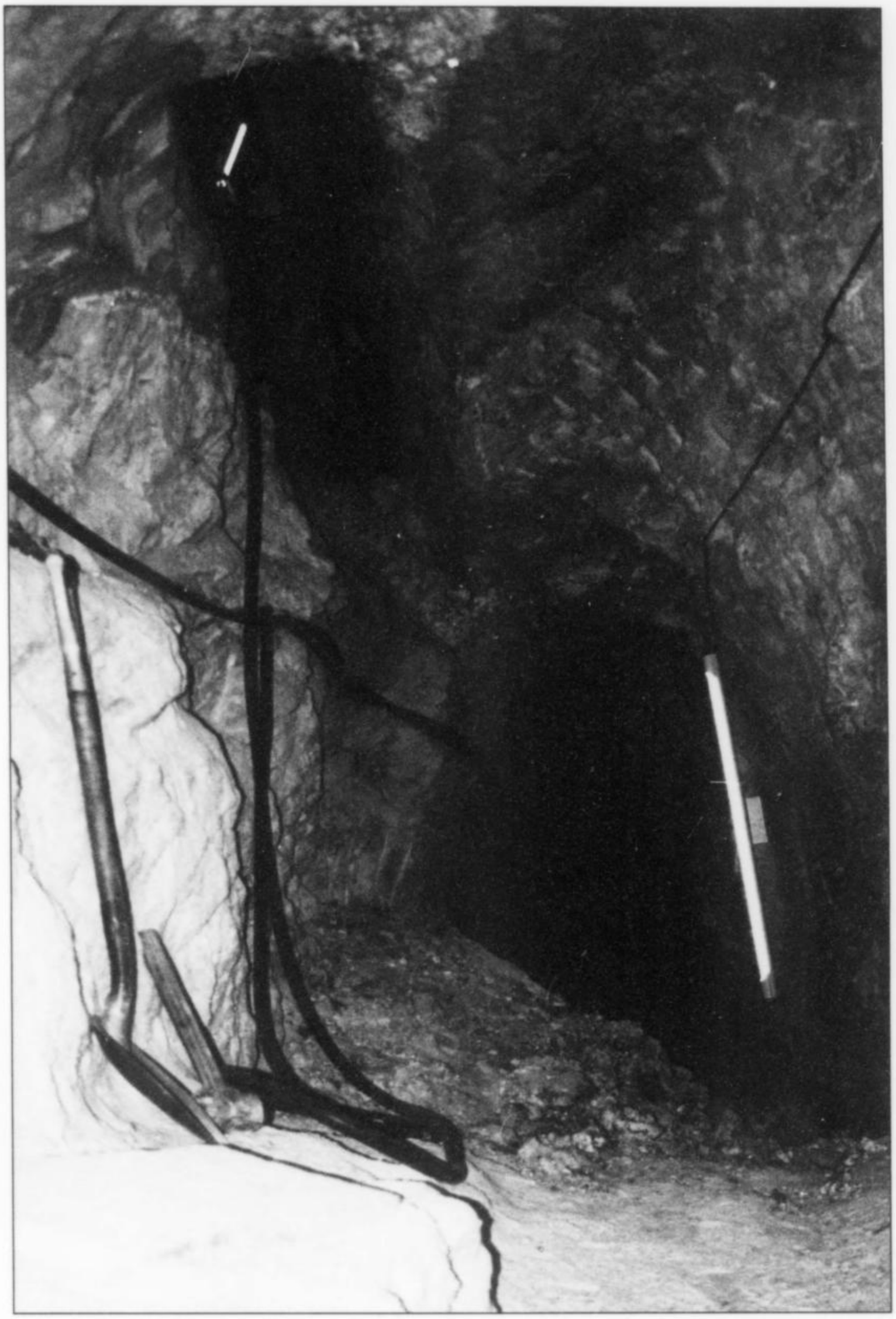


Figure 6. **Active workings in the Batalha mine, at about the 50-meter level, in August of 2000. Pneumatic drills are used to work the pegmatite (here dipping at about 65°). Brendan Laurs photo.**

The vein-like pegmatite bodies measure 20 to 140 cm in thickness. One area that has been particularly productive of gem cuprian elbaite is known as the "Heitorita trend," especially at a depth of about 35 meters (Barbosa and Cook, 1991). The main dikes in the trend are generally referred to by number, one through five.

Other pegmatites in the general area which have been found to contain cuprian elbaite (always of lower quality) plot within a narrow north-northeast-trending band extending for some 90 km. They include the Capoeira pegmatite (where the cuprian elbaite is typically strongly color-zoned pink, blue, purple, green and gray), also known as the Boqueirãozinho pegmatite and the CDM or Mulungu mine. However, erroneous localities for cuprian elbaite have also been circulated, apparently to deter and confuse competing interests; these include names such as Salgadinho, the Pedra Bonita spessartine occurrence near Carnaúba dos Dantas, Cajazeiros, Riach do Pinga, Junco do Seridó, Pedra Lavrada, and Serra dos Quintos, none of which have actually produced any cuprian elbaite. Serra dos Quintos, however, should not be confused with the productive Quintos pegmatite, also known as the Wild mine (Laurs and Shigley, 2000). Traces of copper have also been found in tourmaline from the Gregório pegmatite near Parelhas (Soares *et al.*, 2000; Adusumilli *et al.*, 1994).

The high copper content of the pegmatites was apparently derived from underlying Cu-bearing sediments during chemical mobilization associated with the Brasiliano thermotectonic cycle. Veins containing copper sulfides have been found nearby at Serra Negra, at a site between Parelhas and Pedra Lavrada, at an

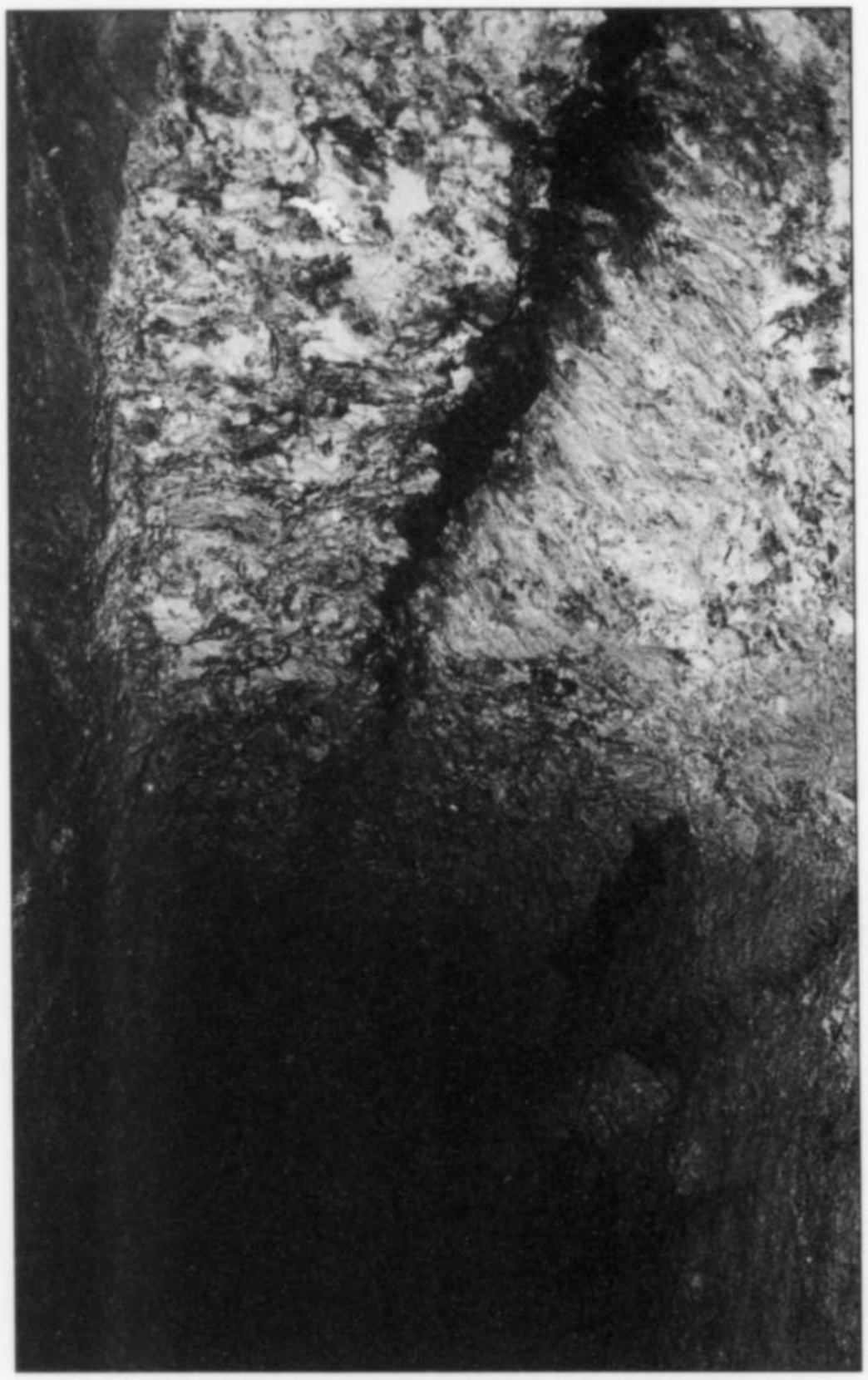


Figure 7. **Across-section of one of the pegmatite veins visible in the roof of a tunnel at the Batalha mine. Brendan Laurs photo.**

occurrence near Nova Palmeira, in the scheelite skarns of Currais Novos, and very near the Capoeira/Boqueirãozinho pegmatite (see Falster *et al.*, 2000, and the article on the latter occurrence by Robinson and Wegner, 1998). Other metallic elements which have also been found locally in pegmatites (U, W, Ta, Sn, Nb, Mn) have been perceived by some authors to be arrayed in broad concentric zones radiating outward from the center of the pegmatite field, the copper-containing tourmaline band being parallel to these zones and therefore presumably genetically related to the core pluton (Cook and Barbosa, 1999); this theory still requires confirmation.

MINERALOGY

Batalha-mine cuprian elbaite occurs in a range of rich colors, from yellow-green to emerald-green, blue-green, turquoise-blue, tanzanite-blue, sapphire-blue, "electric" blue, bluish purple, purple, purplish pink, pink and gray—each color valued differently by the gem market. Many individual crystals are concentrically zoned in several colors. High concentrations of copper (1.5 to 2.3 weight % CuO) plus some manganese are responsible for the turquoise-blue color, whereas lower copper (< 0.6 wt.%) in the presence of manganese results in the purple color. Low manganese (< 0.1 wt.%) and high copper produce a green color. Pleochroism is usually distinct, from medium blue to pale greenish blue. The highest concentration of manganese (2.99 wt.% MnO) was found in a greenish gray crystal. Some colors are produced or enhanced by heat treatment, such treatment not always being determinable after the fact.

Indices of refraction are typical of elbaite (1.618–1.612 and 1.638–1.646); specific gravity (3.03–3.12) is slightly higher than usual. The crystals are unresponsive to longwave and shortwave ultraviolet light. The X-ray diffraction pattern is closely similar to that of standard elbaite, yielding a unit cell of a = 15.883 and c = 7.111 Å.

Numerous yellowish specks have been found included in some crystals; X-ray fluorescence analysis indicated the presence of Mn, Fe, Cu, Zn, Bi and S, suggesting a complex sulfide. However, Brandstätter and Niedermayr (1993, 1994) investigated the metallic

Figure 8. **Cuprian elbaite, 3.3 cm, from the Batalha mine (ca. 1989). Brian Cook specimen; Wendell Wilson photo.**

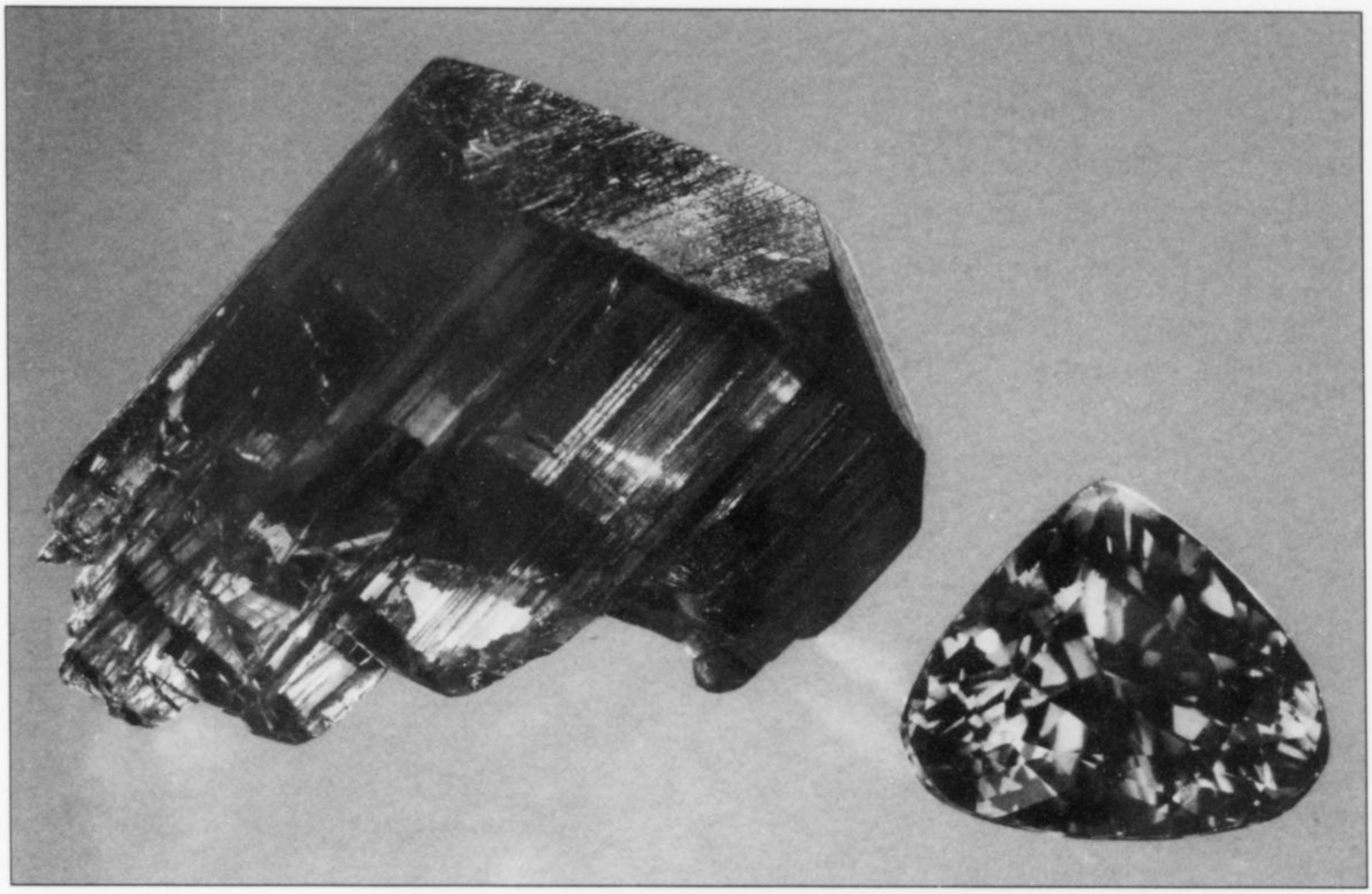


Figure 9. **Cuprian elbaite crystal from the Batalha mine showing blue and turquoise-blue zones, 3 cm, with 2-carat (9-mm) cut stone. Michael Scott collection; Van Pelt photo courtesy of Michael Scott.**

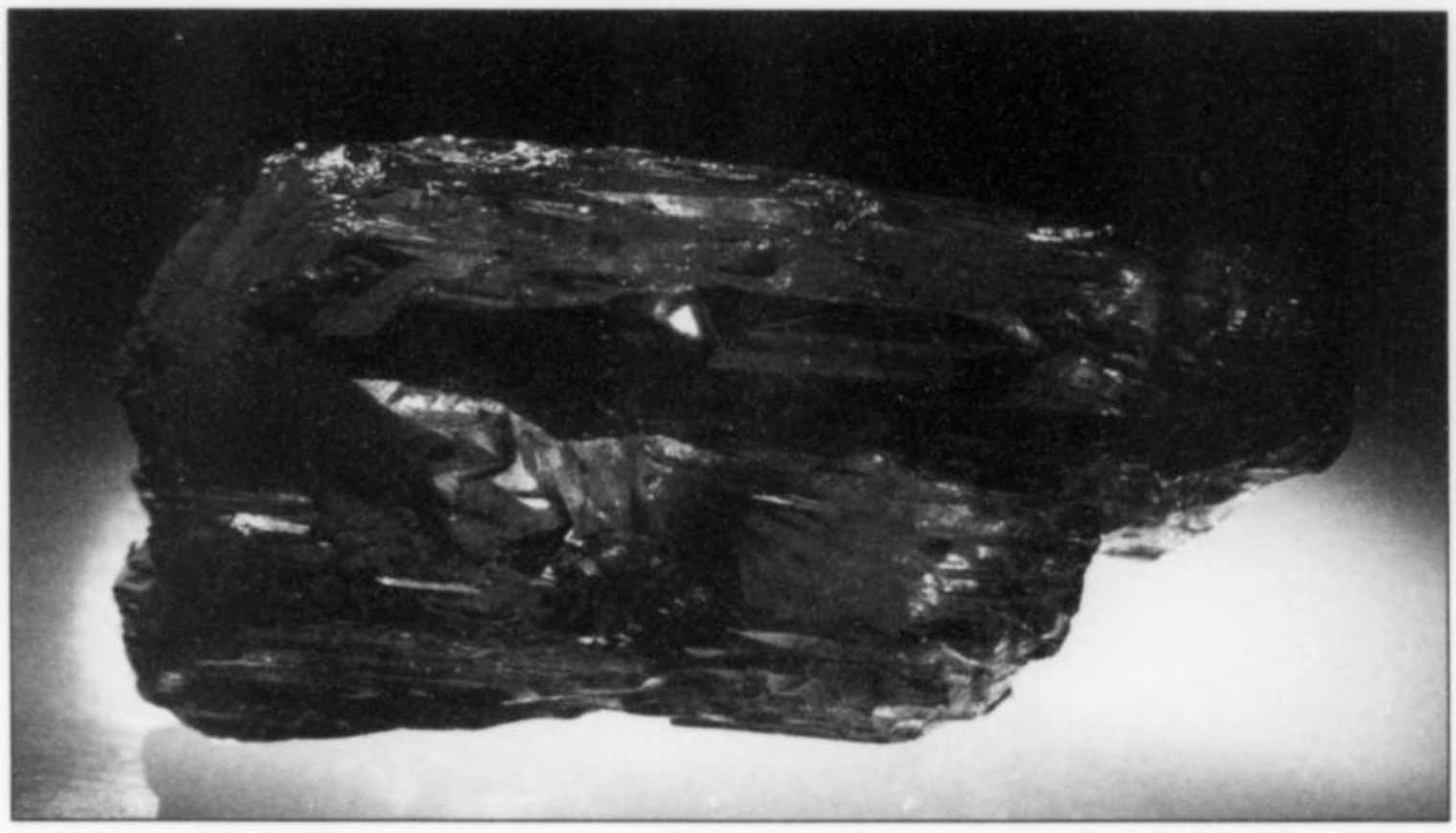


Figure 10. **Cuprian elbaite, 2.2 cm, from the Batalha mine (ca. 1989). Brian Cook specimen; Wendell Wilson photo.**

inclusions noted earlier by others and found them to be native copper; inclusions of black tenorite were also found in elbaite. The copper appears to have formed by epigenetic exsolution from elbaite.

Chemically the Batalha cuprian elbaites are typical of other elbaites in their low Ti (< 0.11 wt.% TiO_2) and Fe (< 0.34 wt.% Fe_2O_3) contents and the virtual absence of V and Cr. The high concentration of Cu is, of course, quite unusual.

Small amounts of Bi, Pb, Zn and Au were also detected in many specimens: these trace elements apparently have no influence on color. Site-occupancy and charge-balance considerations indicate that the copper and manganese are present in the Y crystallographic site, substituting for aluminum. Therefore the formula can be written as: $Na(Li,Al)_3(Al,Cu,Mn)_6(BO_3)Si_6)_{18}(OH)_4$. Heat treatment of the crystals is said to be commonly practiced; the affect is the reduction of Mn^{3+} to Mn^{2+}, removing the pink and purplish colors to leave a pure turquoise-blue. Heat treatment has no effect on the absorption attributable to copper, although blue and green colors can be influenced by heat treatment because of the presence of trace amounts of Mn.

Morphologically the Batalha mine elbaites are roughly trigonal in cross-section but are somewhat irregular in outline. Zoning in some crystals shows that etching has not significantly affected their overall shape, whereas other crystals appear more heavily etched. Terminations, where present, are usually trigonal rhombohedrons or a flat pedion. Terminated crystals, however, are much rarer than broken fragments. One heavily fractured crystal would have measured about 30 cm, had it been recovered intact (Wilson, 1991). Surviving crystals are usually in the 1 to 3-cm size range. Koivula

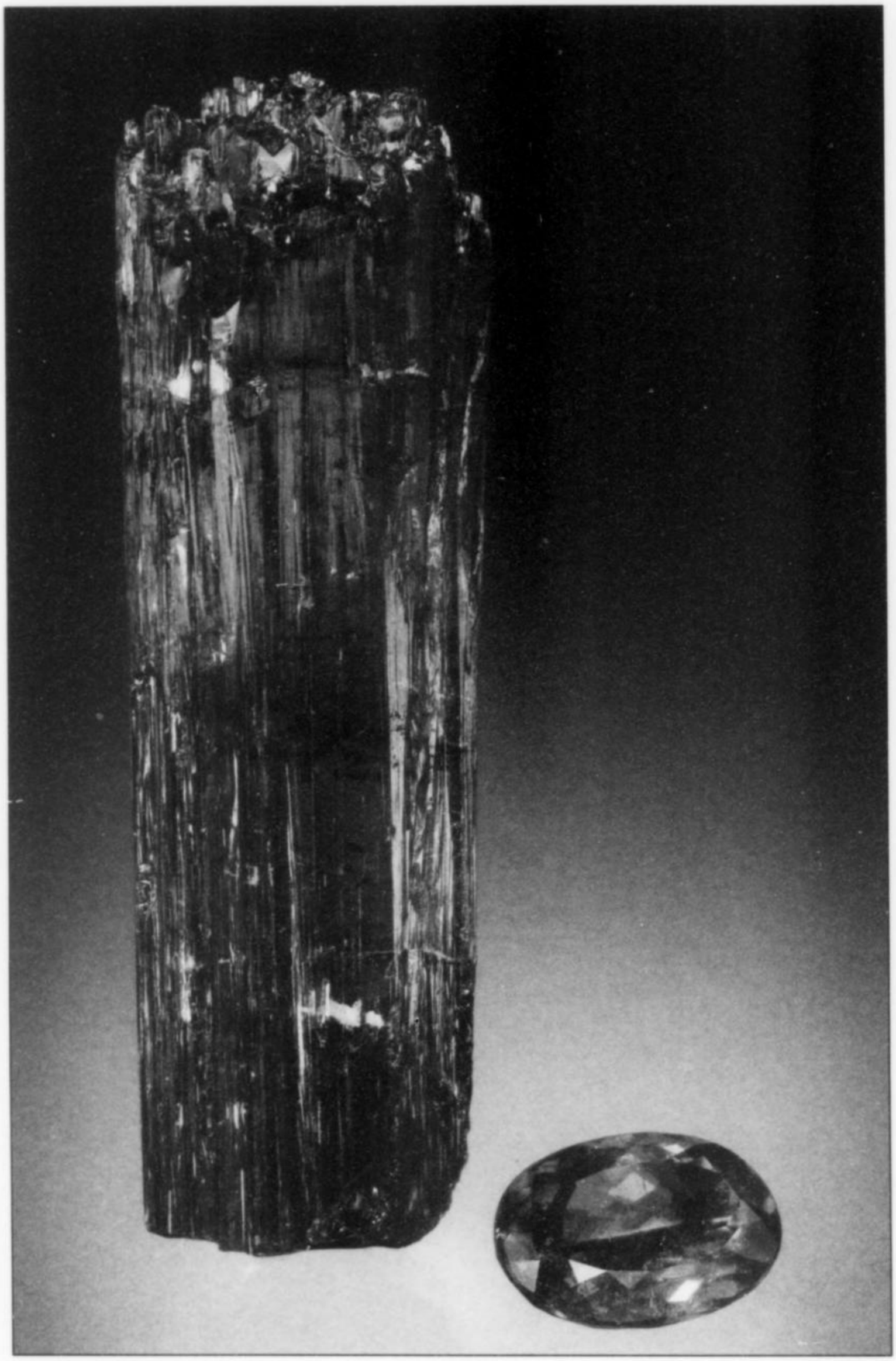


Figure 11. **Cuprian elbaite from the Batalha mine, 5-cm crystal with 1.3-cm (4-carat) cut stone. Michael Scott collection; Van Pelt photo courtesy of Michael Scott.**

and Kammerling (1989) reported a "specimen quality" crystal (presumably meaning that it had no gem value) weighing 100 grams (about a quarter of a pound). Koivula *et al.* (1993) reported seeing an exceptional 4.8-gram bicolored crystal (violet-blue to blue-green) with no eye-visible inclusions and with well-formed, striated prism faces. They also reported seeing dark yellowish green crystals with metallic inclusions which were said to have been found below the level where the brightest blue crystals occur; further down only black schorl is said to be found.

The Natural History Museum of Los Angeles County has an interesting specimen consisting of fractured and mostly unterminated non-gem-grade crystals of good color embedded in white quartz matrix and showing partial alteration to lepidolite. According to curator Anthony Kampf, several hundred such specimens, purportedly from the Batalha mine, were available in Brazil from Emilio Frois (*New Gems Ltda.* and *Color Gemas* company) at his warehouse in Governador Valadares in 2000 and 2001, and some of these later appeared among the stock of other dealers at the 2001 Denver Gem and Mineral Show. These specimens provide systematic collectors and museum curators with an opportunity to acquire study-grade examples of cuprian elbaite at a price well below that of gem-grade crystals. However, it is not at all certain that this material is from the Batalha mine; similar cuprian elbaite specimens sold in Tucson a few years ago came from the Wild mine (the Alto dos Quintos, or just Quintos, pegmatite), owned by Paul Wild of Idar-Oberstein, located about 60 km northeast of Batalha in Rio Grande do Norte state (Brendan Laurs, personal communication, 2001).

Figure 12. **Cuprian elbaite, 2.3 cm, from the Batalha mine (ca. 1989). Brian Cook specimen; Wendell Wilson photo.**

Figure 14. **Cuprian elbaite crystal section, 3 cm, turquoise-blue with purple core, from the Batalha mine (ca. 1989). Brian Cook specimen; Wendell Wilson photo.**

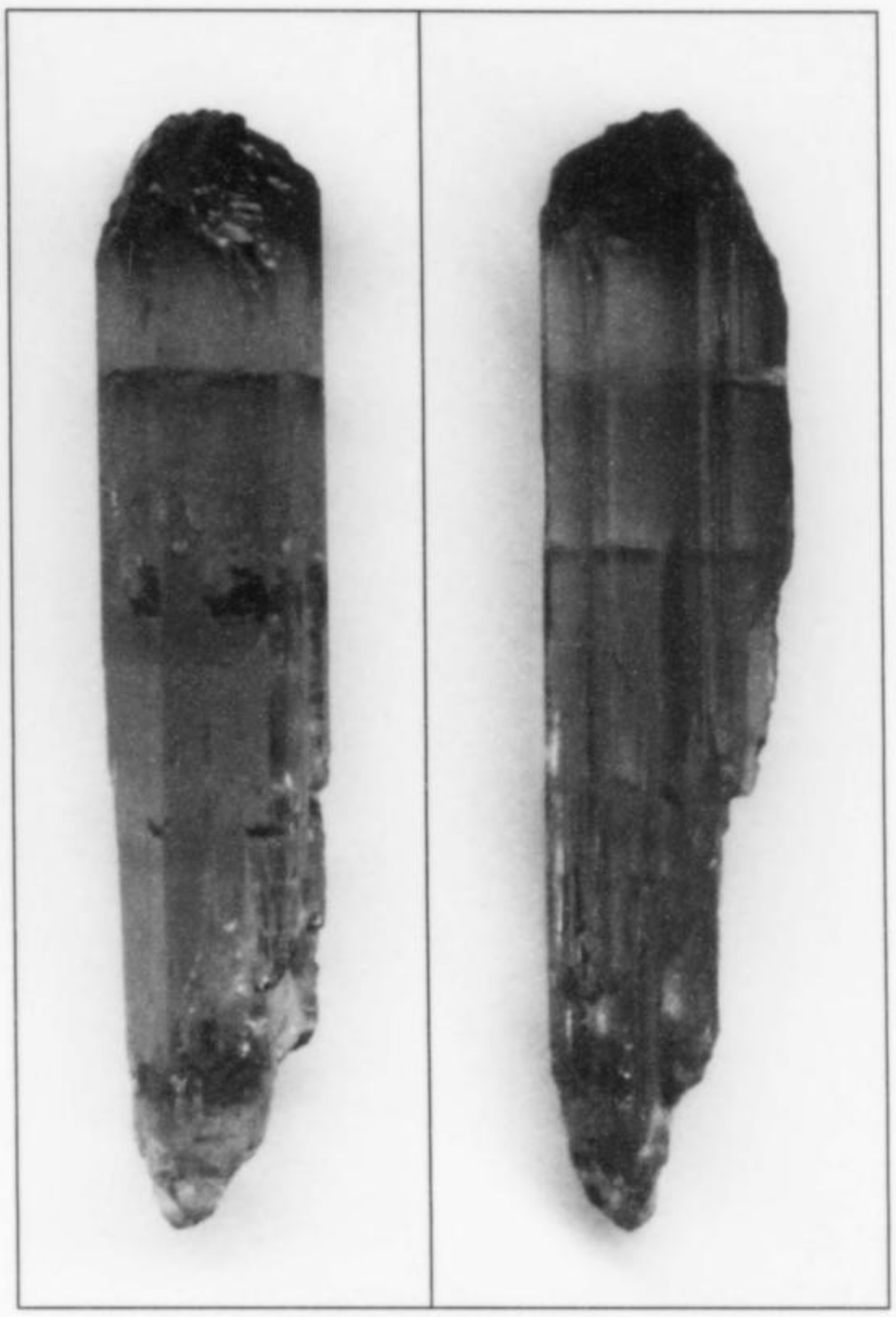
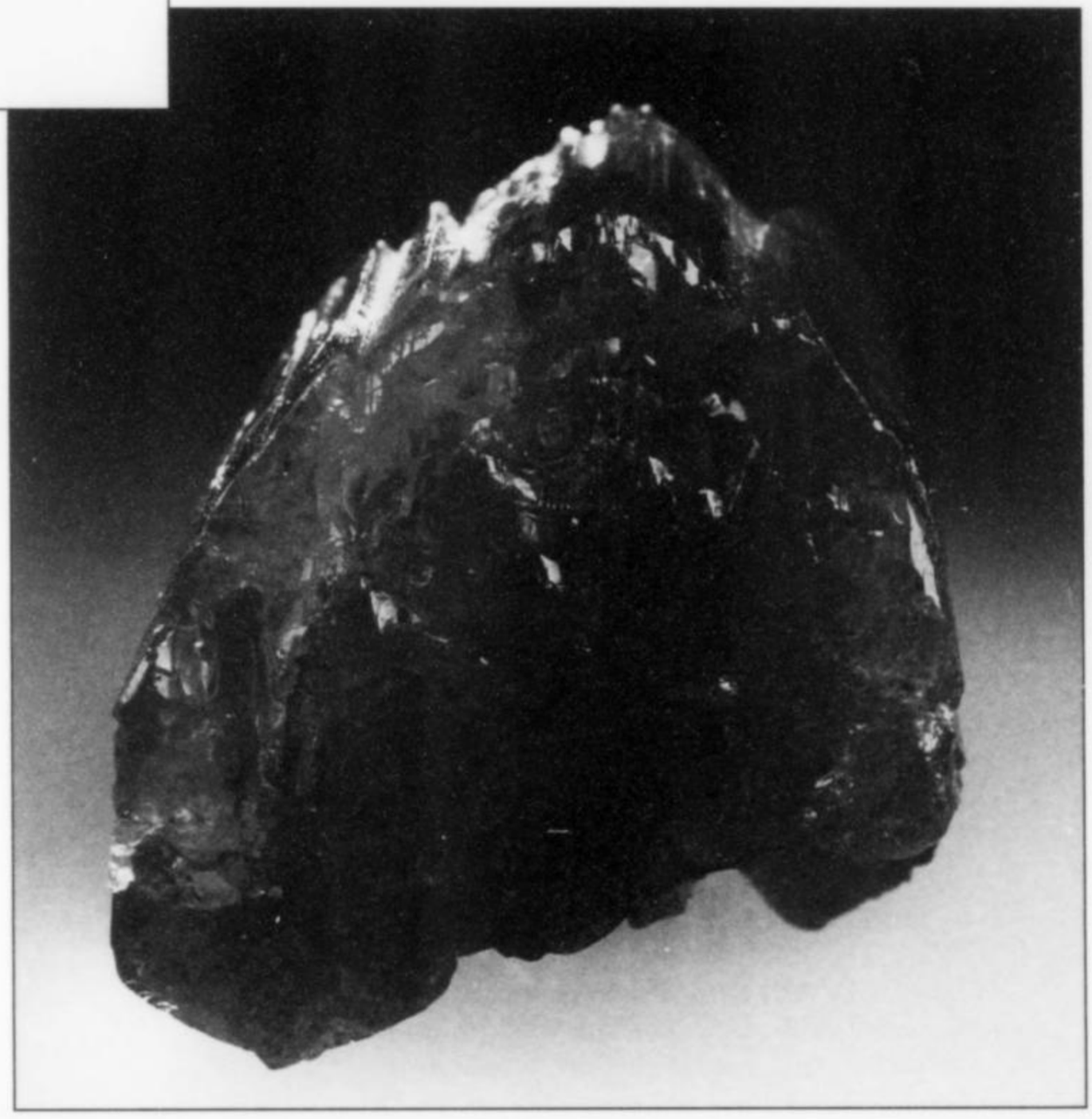


Figure 13. **Cuprian elbaite, 1.7 cm, from the Batalha mine (ca. 1989). Wendell Wilson collection and photo.**



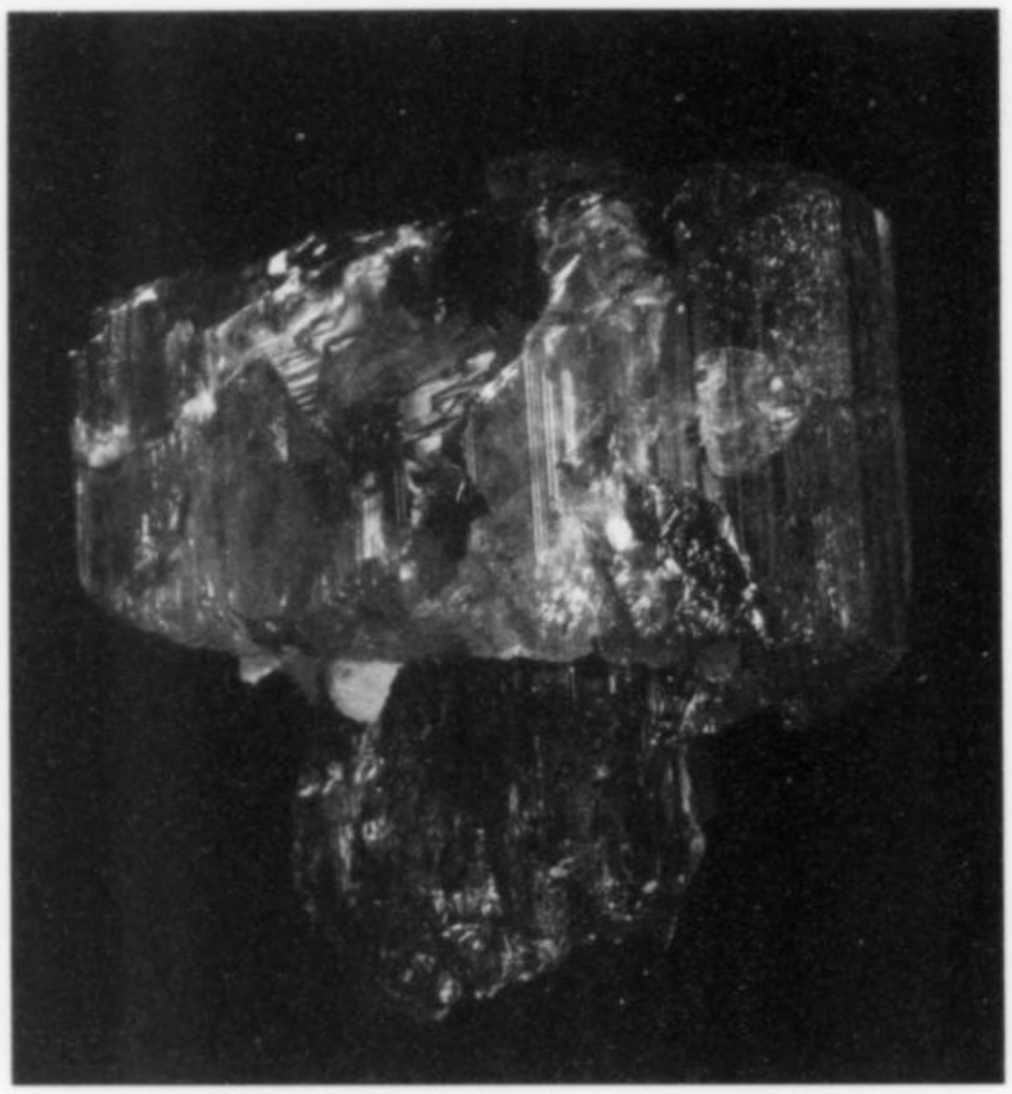


Figure 15. **Cuprian elbaite scepter crystal, 2 cm, from the Batalha mine. Michael Scott collection; Van Pelt photo courtesy of Michael Scott.**

Figure 16. **Faceted cuprian elbaites showing a range of color. Michael Scott collection; Van Pelt photo courtesy of Michael Scott.**

Finally, it should be noted as a warning that some marketers have been offering blue-to-green copper-free tourmaline as Paraíba tourmaline in order to obtain a much higher price

CONCLUSIONS

Although the area in northeastern Brazil where occurrences of cuprian elbaite have been found is fairly large, none of the localities has produced crystals equal to those found at the Batalha mine. Furthermore, almost all good crystals of any size tend to be shattered, and the remainder are generally embedded, non-gemmy and not of good collector quality. As long as mining continues in the area, the possibility of more good crystals being found exists, but their extremely high gem value probably means that most will continue to be cut as gemstones rather than saved as crystal specimens. Consequently, even very small crystals of good color, form and transparency will probably remain very rare in collections and on the market.

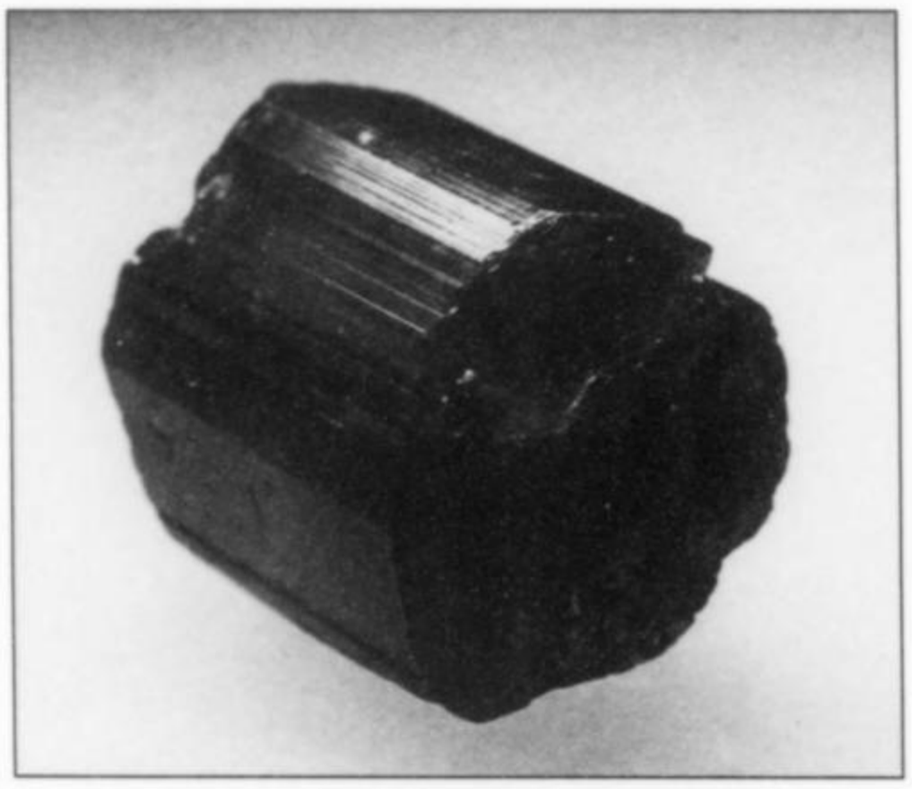


Figure 17 . **Cuprian elbaite crystal section, 1.5 cm, turquoise-blue with purple core, from the Batalha mine (ca. 1989). Brian Cook specimen; Wendell Wilson photo.**

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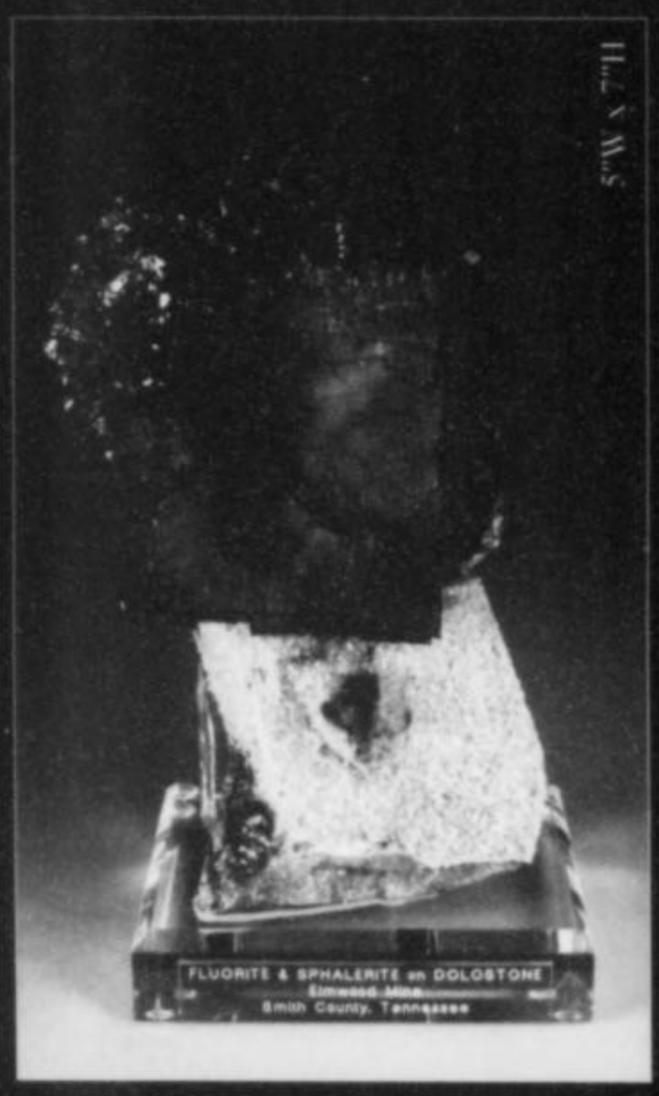

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Two Chinese antimony mines have produced collector-quality stibnite crystals in recent years. The most recent of these to yield fine specimens is the Wuling antimony mine in Jiangxi Province. Highly lustrous, razor-sharp stibnite crystals and crystal groups exceeding 50 cm in length were recovered there in late 2000.

INTRODUCTION

China is believed to account for 50% of the world's reserves of antimony and 80% of world production, primarily from huge ore deposits in Hunan Province, the largest of which is the Xikuangshan mine in Xinhua County. Other deposits are found in the provinces of Guangdong, Guizhou, Yunnan, Anhui, Zhejiang, Fujian, Gansu, Jilin, Shaanxi, Julin, the Guansgxi Zhuang Autonomous Region, and Jiangxi Province (Anonymous, 1980). Until recently, most specimens of Chinese stibnite in collections have come from Hunan, and a few also from Guangxi and Guizhou (Guo and Zhou, 1996). But in the closing months of 2000, two spectacular pockets of stibnite crystals were encountered at the Wuling antimony mine (also known as the Qingjiang

Figure 1. **Location map showing the Wuling [Wuning] mine and De-an [Te-an] area.**

mine), northwestern Jiangxi Province, People's Republic of China.

A significant number of Wuling mine stibnite specimens were recovered, many of which are essentially damage free thanks to the professional collecting techniques used. While the Wuling mine specimens have been collected and transported in a manner that has significantly reduced the numerous nicks and dings which have plagued stibnite specimens from other localities, the collecting of matrix specimens remains as uncommon at the Wuling mine as it has been at other classic stibnite-producing occurrences.

The mine and town name has been spelled "Wuling" or "Wuning," both of which are considered correct. The "Wuling" transliteration is based upon the pronunciation in use at the mine, in the dialect which is prevalent in the surrounding areas of northern Jiangxi, southeast Hubei, and northeast Hunan provinces. The spelling "Wuning" or "Wu-ning," on the other hand, is in accordance with standard rules for transliterating Mandarin Chinese.

HISTORY

The Wuling antimony mine is situated on the southern bank of the Xiushui [= Hsiu Shui] River, near the small hamlet of Qingjiang, 40 km southwest of the city of Wuling (Wuning), in northern Jiangxi Province, China. The deposit, situated along Tuobeishan Hill, was discovered in the 1960's. The Wuling mine was established in the mid-1980's by the Wuling County government, which owned the mine until 1998. Since 1998, the mine has been contracted to the Star Antimony Limited Company.

Tuobeishan Hill, in the lower foothills of the Chiu-ling Range, is littered with old shafts and adits. The underground workings currently being exploited, however, are accessed by four vertical shafts which reach a maximum depth of approximately 65 meters. Mining methods are simple, traditional, and dominated by manual labor. Surface activities such as ore sorting, crushing, and concentrating are likewise accomplished with minimal mechanization. A total of about 300 workers are employed at the Wuling mine.

In 2000, antimony production from the Wuling mine was reported to be 1,200 metric tons (tonnes). (By comparison, the Xikuanshan mine produced well over 30,000 tonnes of antimony and antimony concentrate in 2000.) According to sources at the Wuling mine, more than half of the known orebodies and reserves have been mined thus far.

In 1995 several mineral specimen dealers from Hunan Province began monitoring mining activities at the Wuling mine. These dealers had previously been involved in recovering stibnite specimens from the Xikuangshan mine in Hunan Province and selling them on the international specimen market during the early to middle 1990's. The dealers were the first to recognize the Wuling mine's potential for stibnite specimen production; prior to late 2000 almost all stibnite crystals found at the locality had been processed as ore.

In December of 1997, a very large pocket measuring 20 meters in length, 5 to 6 meters in width and 3 meters in height was found. Stibnite crystals from this pocket were large, up to 15 centimeters in diameter and exceeding 1 meter in length. Unfortunately, the pocket was strongly oxidized and the stibnite crystals had been partially altered to stibiconite.

From 1997 to late 2000, there were no significant stibnite pocket discoveries. Then, in late November of 2000, a large pocket was encountered off of Shaft #2. The dimensions of the pocket were approximately 1 x 2 x 4 meters. Individual crystal size ranged from a few millimeters to 4 cm in diameter and 10 to 30 cm in length. Although the miners at Wuling had, by this time, an increased awareness that stibnite crystals had value as mineral specimens, the collecting and transport techniques employed resulted in heavy damage to most of the stibnite specimens. Most of the specimens recovered were single crystals or small clusters of crystals without matrix.

In general, matrix stibnite specimens from the Wuling antimony mine are extremely uncommon. The recovery of stibnite crystals attached to their silicified limestone matrix rock presents a nearly insurmountable challenge to the miners because of the lack of adequate specimen recovery tools and technology and because of time constraints imposed by the pre-eminent goal of maintaining ore production schedules.

Remarkably, one large, spectacular stibnite matrix specimen was preserved from the Shaft #2 pocket. The miners were able to collect this superb matrix specimen because, in this case, the stibnite had crystallized on a fragment of silicified limestone that had become dislodged within the pocket during previous tectonic movement. The specimen, recognized as the best specimen to have been produced from the mine, measures 57 cm wide by 38 cm high and 25 cm deep with the longest crystals exceeding 27 cm in length. It was originally placed on display in the offices of the Star Antimony Limited Company. The specimen was purchased from the mine owners in early 2001, was transported to the United States (occupying a commercial airline seat . . . in first-class!), and now resides in a private U.S. collection.

Approximately two weeks later, yet another crystal-lined pocket was discovered, this one off of Shaft #3. At the time of the Shaft #3 pocket discovery, several mineral dealers familiar with the specimen collecting and preservation problems that had been experienced at the Xikuangshan mine were visiting the Wuling mine to examine the specimens from the Shaft #2 pocket. These dealers advised the miners about the importance of exercising great care in the collecting and packing of the stibnite crystals from this new pocket. Consequently, the stibnite specimens from the Shaft #3 discovery were very well preserved.

The Shaft #3 pocket measured 1.5 x 4 x 10 meters. Individual crystals from this pocket have superb luster on the prism faces and are very large, some reaching 5 cm in diameter and 50 cm in length, with the average individual crystal length being over 15 cm. Again, the pocket yielded, primarily, single crystals and clusters of three to five or more crystals. Several hundred specimens from this astounding pocket were featured at the 2001 Denver Gem and Mineral Show. Superb specimens from this discovery were also available at the 2002 Tucson Gem and Mineral Show.

GEOLOGY

The antimony deposits of China are distributed primarily to the south of the Yellow River, in four major ore belts: (1) the South China belt, (2) the Western Yunnan belt, (3) the Qinling belt, and (4) the Jilin-Dahinggan-Tianshan belt. Deposits in these belts have been classified into seven genetic types: (1) carbonate, (2) clastic, (3) epimetamorphic, (4) marine volcanic, (5) continental volcanic, (6) post-magmatic, and (7) exogenic accumulation. The Wuling antimony orebodies in the South China belt are characteristic of

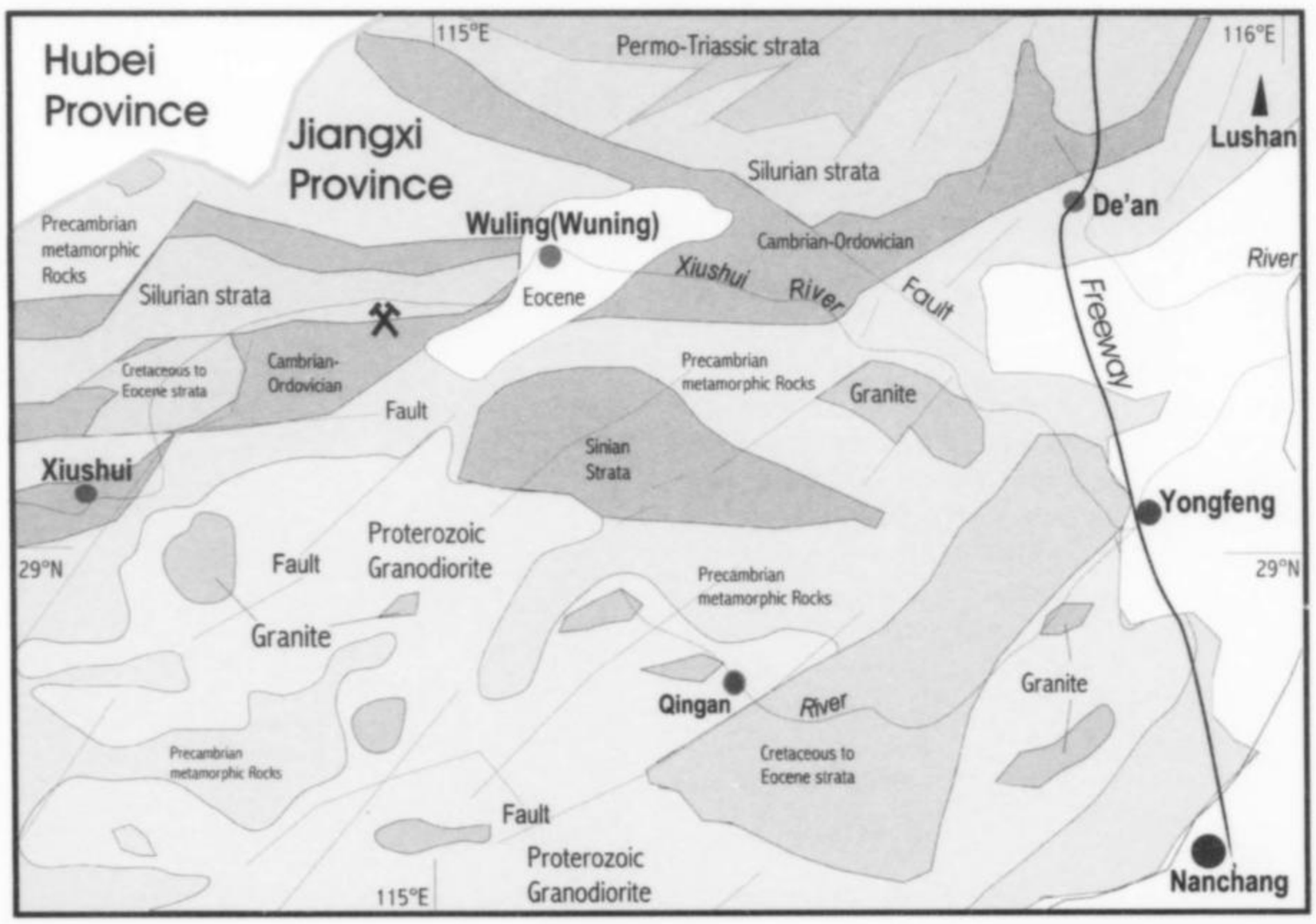


Figure 2. **Geological Map of Wuling (Wuning) area, showing Wuling mine location; Simplified from a map published by *China Geologica Academica* (1985) by Dr. Guanghua Liu.**

Figure 3. **Wuling mine, Shaft #2 (foreground) Tuobeishan Hill and Older Workings (background). Photo by Guanghua Liu.**

type 5: they occur along the margin of a volcanic fault basin in an active platform, associated metallogenetically with continental fissure-type volcanism related to the Late Yanshanian-Himalayan Orogeny. Gases and fluids escaping from the basalt, andesite and lamprophyre layers carried antimony in solution, which eventually became concentrated by various means and deposited as stibnite in open fractures and shear zones (Wu *et al.*,1990).

The east-west-striking zone of antimony occurrences in Jiangxi province is 100 km long and 5 to 10 km wide, extending from the Baoshan deposit in De-an [= Te-an] County in the east to Wuling (Qingjiang) and on to Xianglushan, Hubei Province, in the west. The country rocks are Sinian [= latest Precambrian] to Silurian carbonates, mainly limestone, dolostone and arenaceous shale. In the Wuling area the ore-bearing strata are Cambrian to Ordovician; the richest orebodies and finest stibnite crystallization occur in Middle Cambrian silicified limestone. Mineralization has been characterized as low to medium temperature, and mesothermal grading into epithermal, accompanied by metasomatic silicification.

Chinese antimony deposits are generally strata-bound and are overlain by an argillaceous "shielding layer" which has acted as a semi-permeable membrane. The result was to greatly increase antimony (and silica) concentration in the ore-forming fluid at this boundary, because H_2S, H_2O and CO_3 could readily pass through the shielding layer. With gradually decreasing temperature came a series of reactions involving Na_2S, Na_2CO_3, H_2S and H_2O, accompanied by variations in pH, Eh and $f\,O_2$ which resulted in repeated phases of stibnite crystallization and silicification (Wu *et al.*, 1990).

Stibnite orebodies have been grouped into five types: (1) brecciated stibnite, (2) massive stibnite, (3) stockwork stibnite, (4)

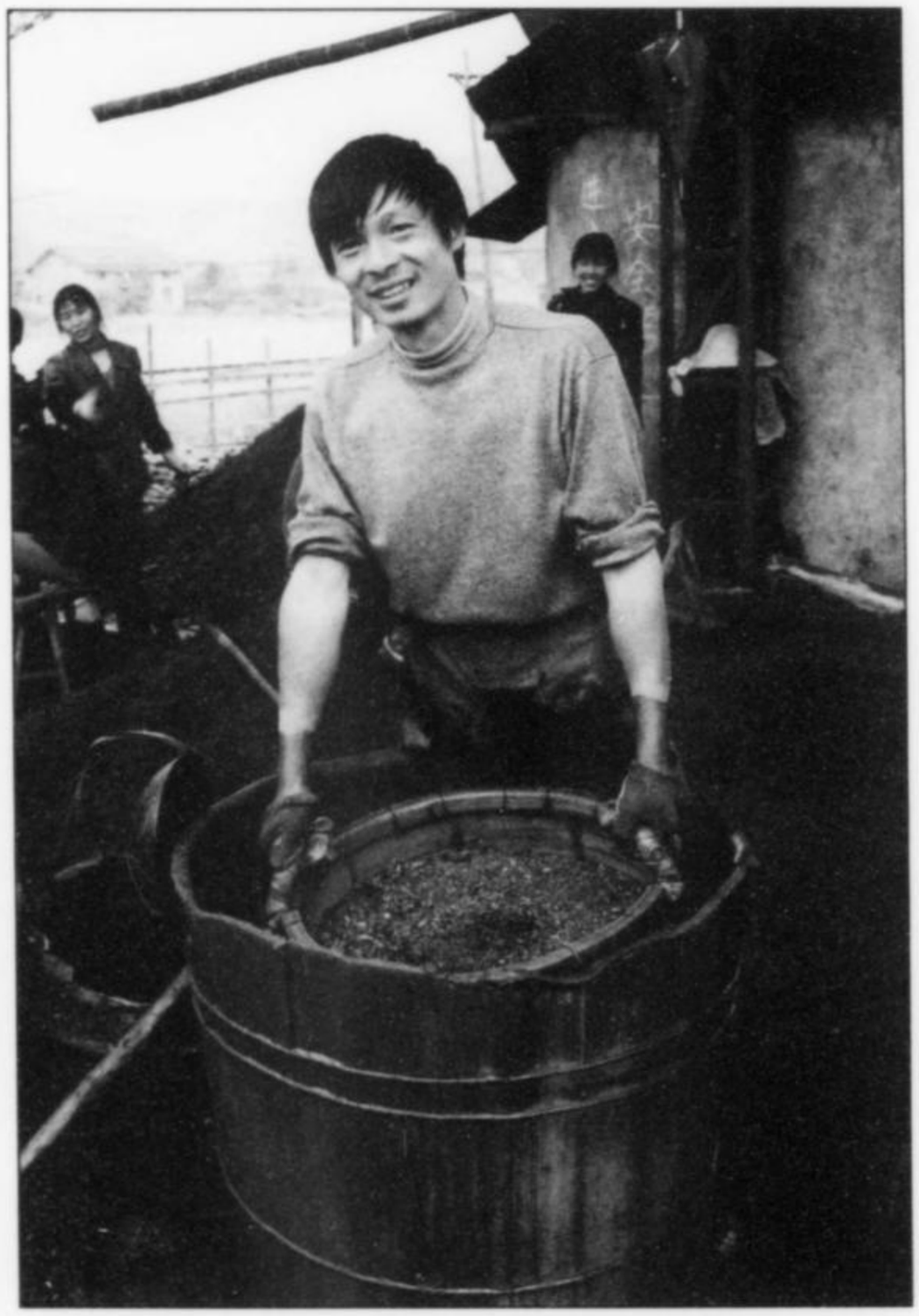


Figure 4. **Mine worker washing crushed antimony ore at Shaft #2. Photo by Guanghua Liu.**

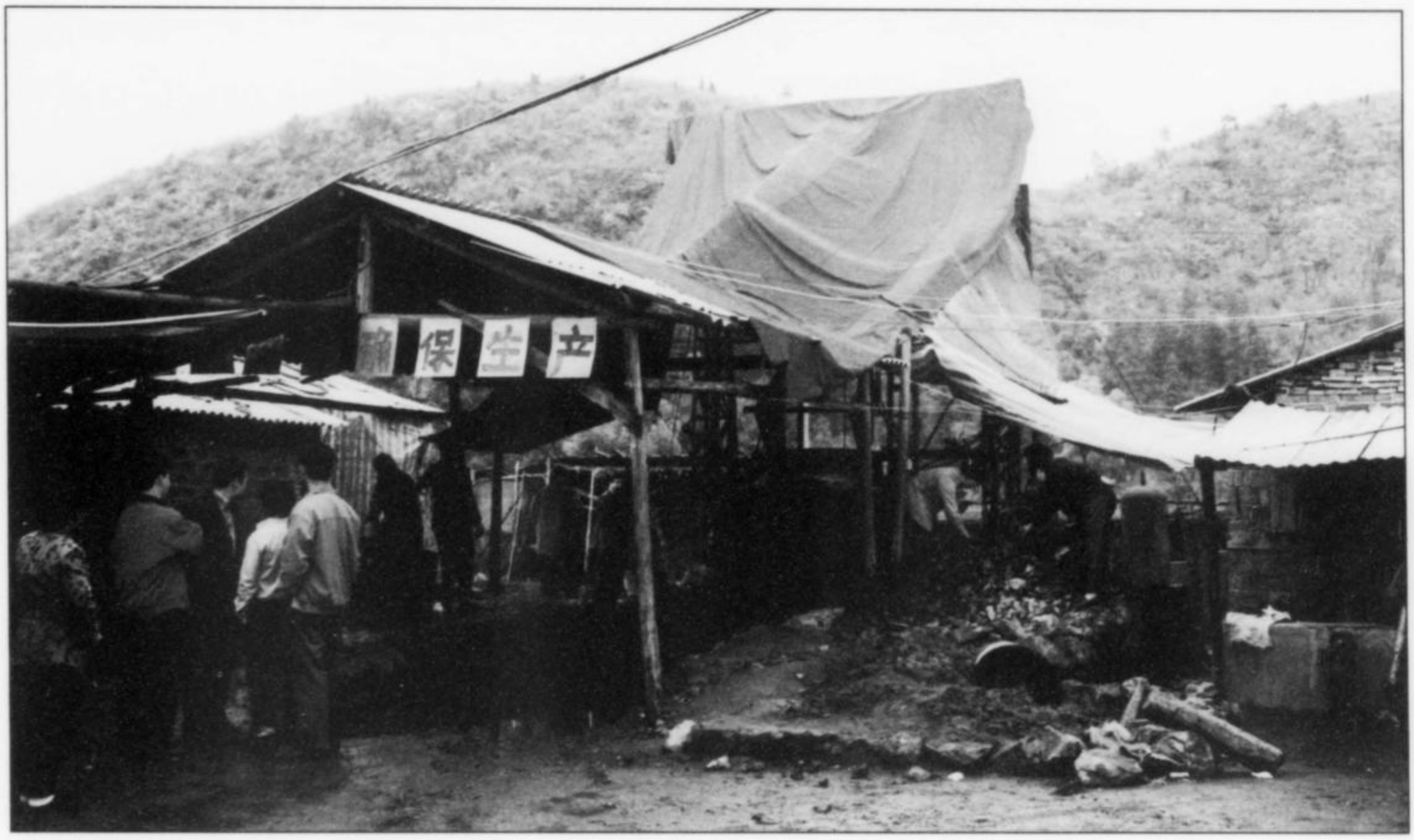


Figure 5. **Wuling mine, Shaft #3 (foreground) Tuobeishan Hill (background). Photo by Guanghua Liu.**

stibnite disseminated in lamprophyre, and (5) stibnite disseminated in silty shale, the first three types being dominant. Ore grade prior to hand-sorting is usually 15–20% Sb.

The most well-developed crystal pockets in the Wuling deposit have formed along the axis of a syncline (the Tuobeishan syncline), where the spaces available for mineralization, opened by intra-strata gliding, tend to be relatively large. There are five ore-bearing belts within the deposit, with the Tongjia-Jieshangping belt having the most well-developed crystal pockets. Stibnite crystals were first encountered at the deposit in the 1980s, within intra-strata openings and occasionally in small karst holes.

According to the mine geologist, crystal pockets normally occur at a depth of 20 to 50 meters. Above the 40 meter level, most pockets are highly oxidized. Stibnite crystals in these upper-level pockets are dull-lustered or are altered to stibiconite. Only at depths of 40 to 50 meters can good, unoxidized crystals be found. No economic antimony deposits have been encountered at the Wuling mine below 65 meters.

MINERALOGY

Chinese antimony deposits of the Wuling type generally contain stibnite as the main ore mineral (with stibiconite and valentinite in the oxidized zone), plus quartz, barite and calcite. According to Wu *et al.* (1990), some deposits also contain microscopic gold and copper particles; other sulfides such as arsenical pyrite, arsenopyrite, pyrrhotite, chalcopyrite, bornite, tetrahedrite, and sphalerite; oxides including hematite, magnetite, cassiterite, ilmenite, chromite, goethite and psilomelane; and sometimes also siderite, dolomite, orpiment, apatite, epidote, chlorite, micas, and even topaz, spinel and tourmaline (although the latter six or seven species are probably unrelated in origin to the antimony mineralization). The species listed below are those which have been preserved as specimens from the Wuling mine.

Barite $BaSO_4$

Barite is encountered infrequently in the Wuling mine. It occurs as colorless to pale yellow, tabular, pseudo-rhombohedral crystals reaching 2 mm in thickness and 1.5 cm on edge. The barite occurs directly on the silicified limestone matrix rock, occasionally associated with stibnite crystals. The miners generally do not attempt to preserve barite crystal specimens, because the barite crystals have frequently suffered significant damage from blasting methods and because the barite crystals found to date have been associated with small and/or unimpressive stibnite crystals.

Calcite $CaCO_3$

Calcite occurs in massive form as colorless to white vein material and fracture fillings that are occasionally included with stibnite crystals. No significant calcite crystal specimens have been encountered.

Stibiconite $Sb^{3+}Sb_2^{5+}O_6(OH)$

Stibiconite is a common secondary mineral in the oxidized zones of the Wuling mine, where it occurs as partial or complete replacements of stibnite crystals.

Stibnite Sb_2S_3

Stibnite, as mentioned above, is the primary ore of antimony at the Wuling mine. Occasionally, large open pockets containing magnificent, stainless-steel-gray crystals of stibnite have been encountered. The stibnite occurs as brilliantly lustrous, lightly striated prisms that can exceed 5 cm in width and 50 cm in length; the majority of the stibnite crystals from the recent discoveries have ranged from 1 to 3 cm in diameter and 10 to 30 cm in length. Terminations are generally matte-gray and a simple chisel shape, some of which are slightly beveled or rounded; some individual crystals ramify into amazingly complex multiple terminations. Crystals exhibiting multiple terminations, begin as rather ordinary

Figure 6. **Bryan Lees of *Collector's Edge Minerals* sorting some of the stibnite specimens from Shaft no. 3.**

Figure 7. **Stibnite crystals groups on the sorting table at Collector's Edge Minerals.**

Figure 8. **Stibnite, 19.9 cm, beautiful spray of crystals radiating from a common base, found at Shaft #3; Collector's Edge Minerals specimen. Photo by Jeff Scovil.**

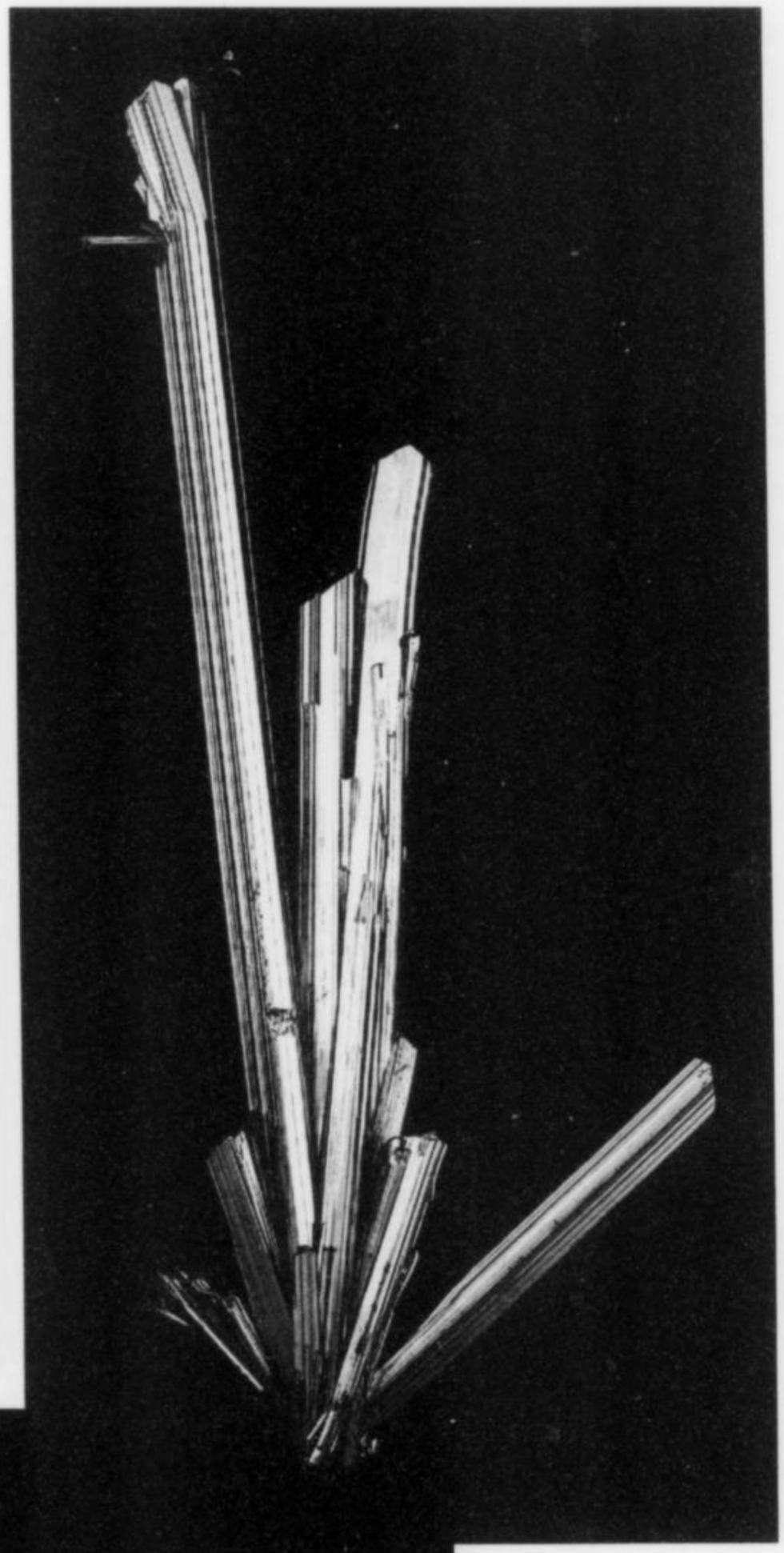
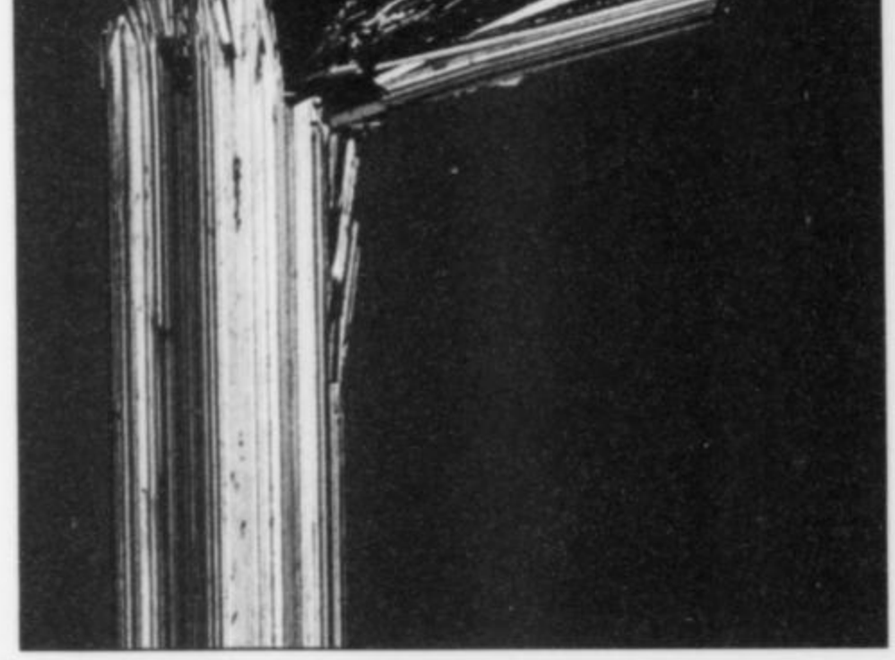


Figure 9. **Stibnite, 12.7 cm, with offshoot fan of crystals, from Shaft no. 3. Collector's Edge Minerals specimen; Jeff Scovil photo.**



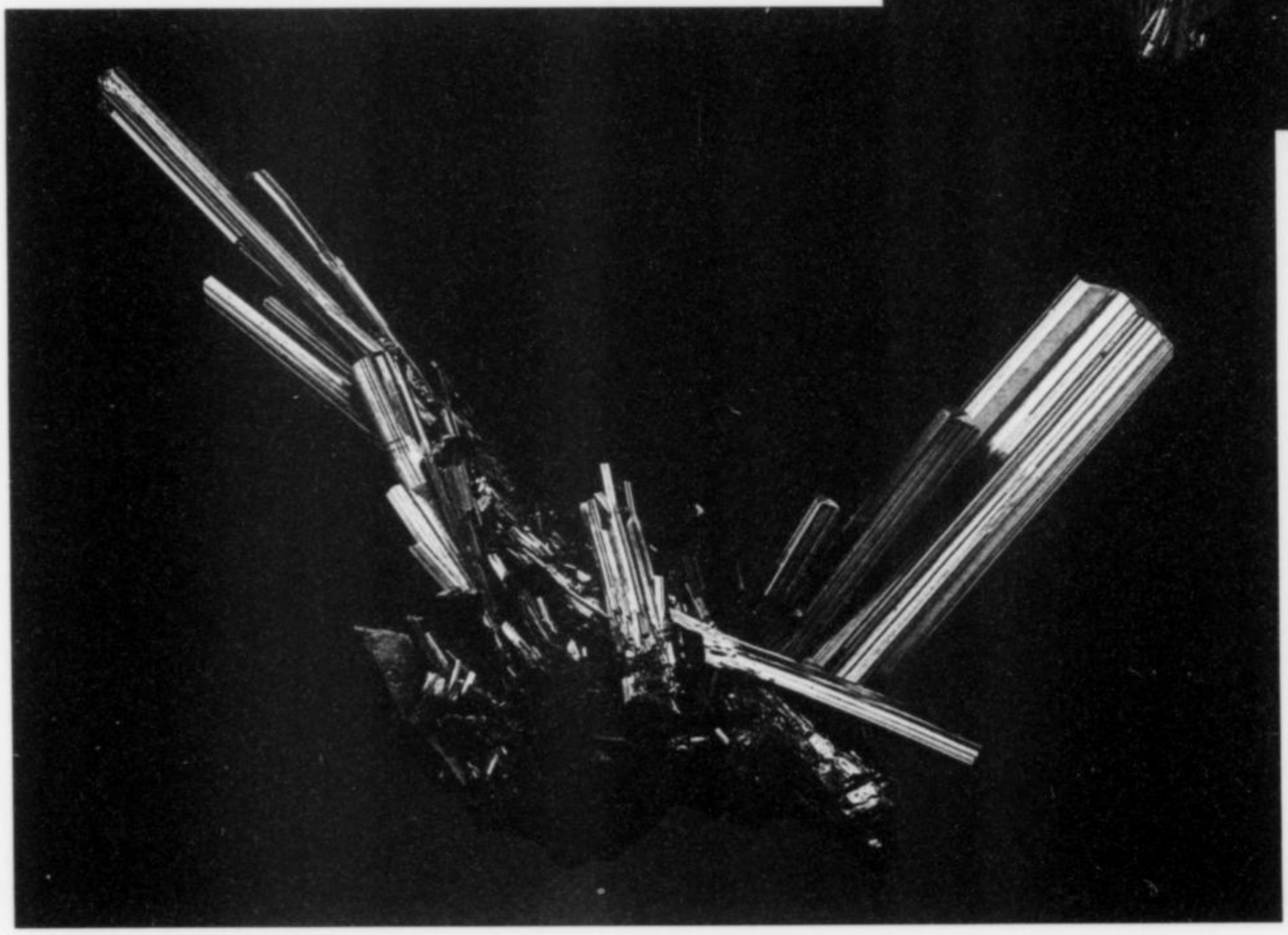


Figure 10. **Stibnite, 16.0 cm, a fine stibnite group on matrix from Shaft #3; Collector's Edge Minerals specimen. Photo by Jeff Scovil.**

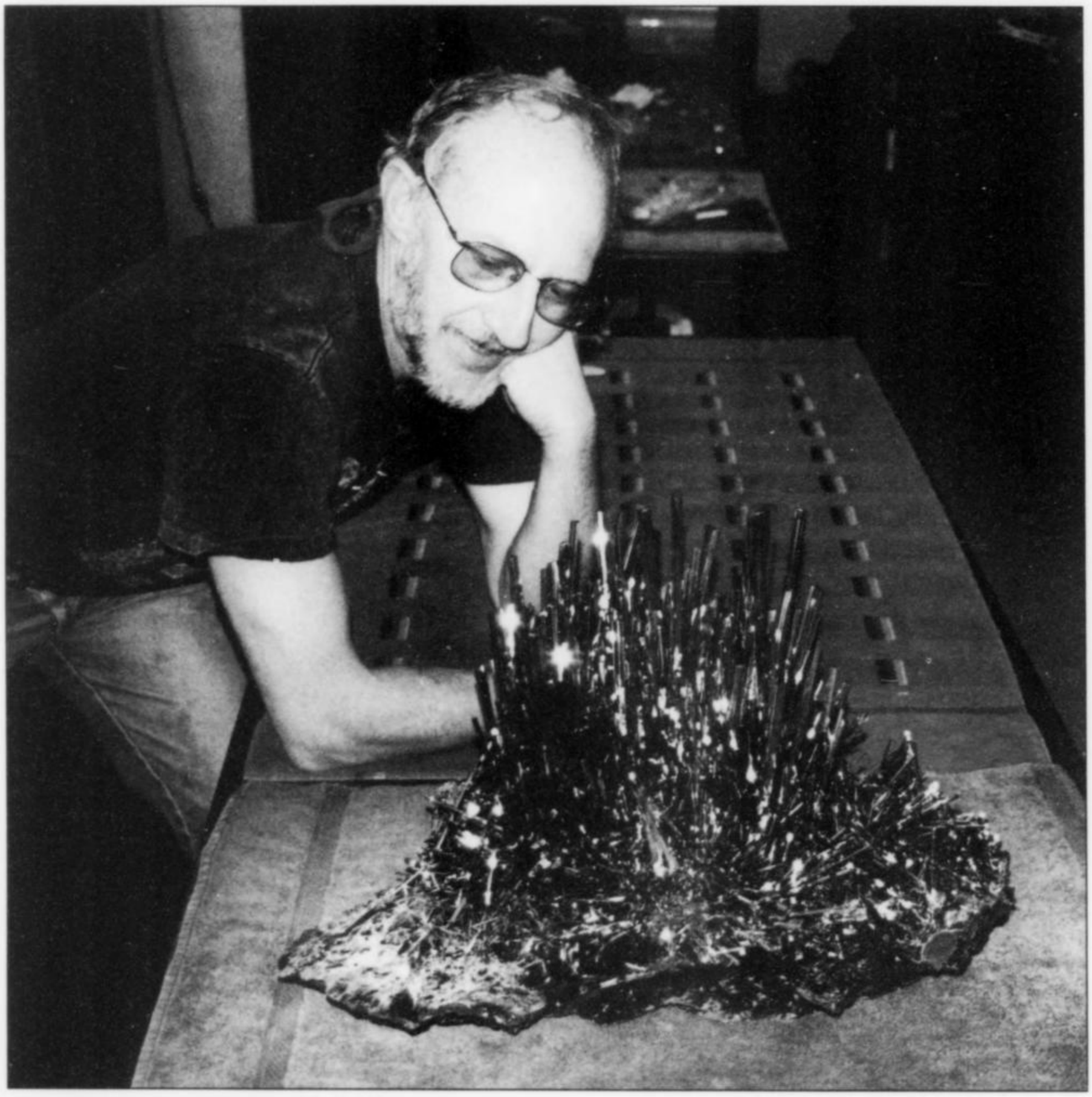


Figure 11. **Bill Hawes of *Collector's Edge Minerals* admiring a 35.5-cm (14-inch) cluster of stibnite crystals from Shaft no. 2.**

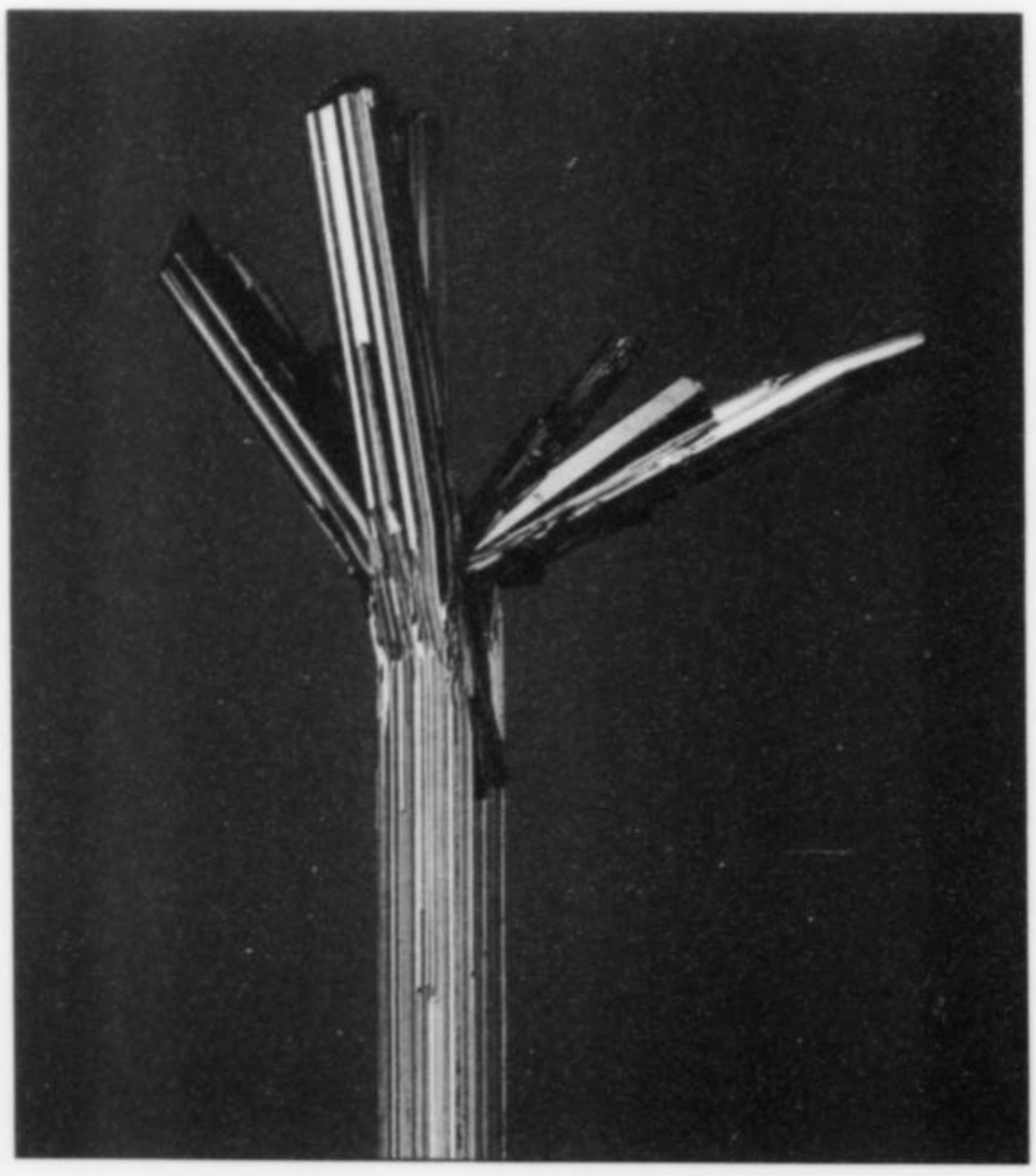


Figure 12. **Stibnite, 16.5 cm, a single crystal from Shaft #3 exhibiting stibnite "arms" that have formed on the sides of the main prism; Collector's Edge Minerals specimen. Photo by Jeff Scovil.**

elongated stibnite prisms that are crowned by tens to hundreds of thin individuals in tightly packed parallel growth. In some cases the small crystals diverge into a broom-like habit, especially where the large, main crystal has grown across the pocket and contacted the opposite wall. A small number of doubly terminated "floater" crystals have also been recovered.

By far, the most common stibnite specimens from the Wuling mine are single crystals without matrix. However, the locality also produces stibnite crystal groups in a wide array of aesthetic compositions: some groups are composed of multiple stibnite crystals in parallel growth; some occur as slightly divergent clusters of individuals radiating from a common base; others occur as individuals intersecting, like crossed-swords, higher on their prism faces; still others exhibit interesting secondary crystal formation from the sides of large, single stibnite prisms, at times these

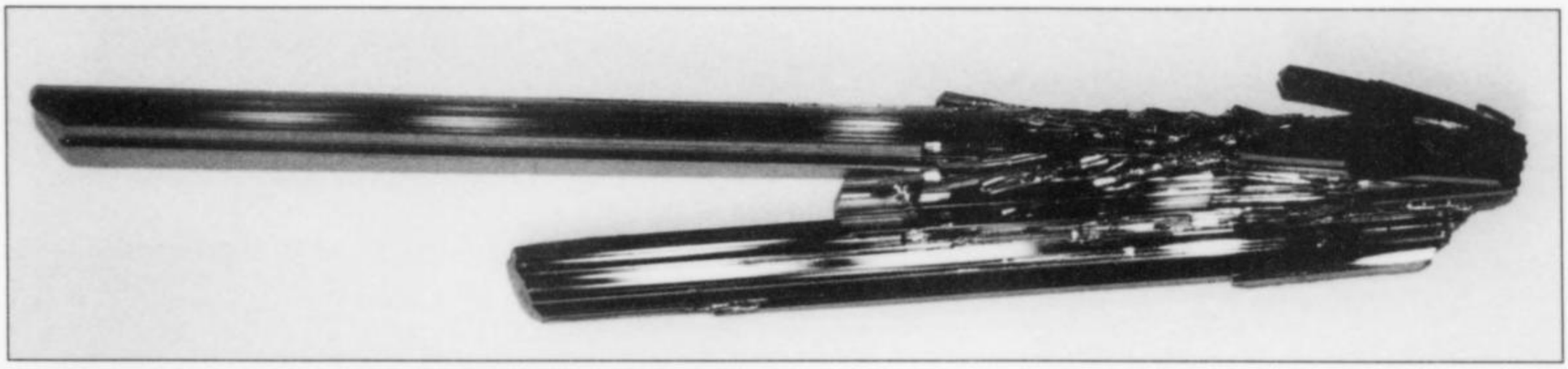


Figure 13. **Stibnite crystal group, about 30 cm long, lying on the sorting table.**

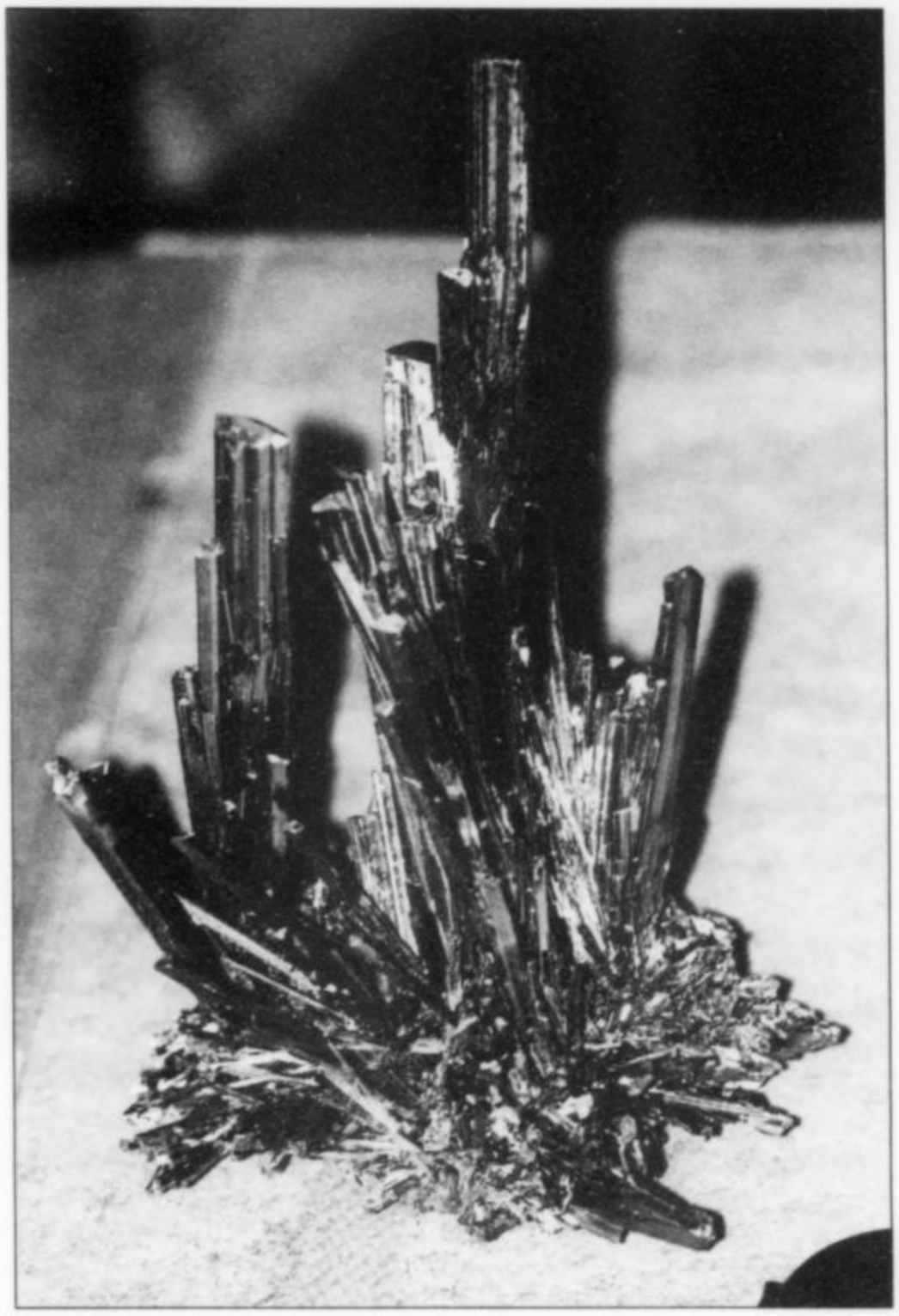


Figure 14. **Cluster of stibnite crystals, about 23 cm, from Shaft no. 3.**

crystal "arms" are naturally bent or curved, mimicking the appearance of a saguaro cactus. Jumbled aggregates of prismatic crystals also occur.

CONCLUSIONS

Remaining antimony reserves at the Wuling mine are estimated at nearly 10,000 tonnes, which should enable the mining operation to continue commercial antimony production for several more years. The history and geology of the occurrence suggest that additional undiscovered stibnite-bearing pockets may exist nearby.

Employing modern specimen collecting tools and techniques at this locality (diamond chain saws, splitters, etc.) might facilitate the extraction of some astounding matrix stibnite specimens. Market forces will dictate whether specimen recovery utilizing these relatively sophisticated collecting tools will be attempted in the future. Whatever the future may hold, the mineralogical treasures already preserved from the Wuling antimony mine rank it among the most important specimen occurrences for stibnite.

ACKNOWLEDGMENTS

The authors wish to thank the owner of the Wuling antimony mine, Mr. Wu Hefu, and the mine geologist, Mr. Yang Moxiang, for their kind hospitality and willingness to share information about the history, geology, and mineralogy of the deposit. We would also like to thank Liu Guanghui and Duan Shengdong for their contributions to this article and for their assistance in China. Dr. Anthony R. Kampf and Thomas P. Moore kindly reviewed the manuscript and provided useful suggestions. Finally, Ken Roberts, formerly of *Collector's Edge Minerals, Inc.*, should also be acknowledged for his keen eye in recognizing the significance of the stibnite specimens from the Wuling mine and for his efforts to ensure that these incredible specimens were made available to mineral collectors around the world.

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Scheelite and Calcite, Mt. Xue Bao Ding, Sichuan, China; 4 inches high.

Clara and Steve Smale
COLLECTORS

PHOTO BY STEVE SMALE

Artificial
"Sicilian" Sulfurs

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In the mid-1970's a prominent Italian ornithologist and natural history enthusiast experimented successfully with growing artificial sulfur crystals in the same habit and size range as natural crystals from the famous Sicilian sulfur deposits. Over a thousand of his creations, grown on authentic matrix from the sulfur mines, were sold worldwide. Most of these specimens are so natural in appearance that positive identification of examples may be impossible.

HISTORICAL BACKGROUND

The art of growing crystals is ancient and well-known. It is not uncommon to see beautiful druses of brightly colored crystals sold at gift shops and mineral shows, sometimes accompanied by kits of ingredients and instructions for making your own. In most cases water-soluble salts are used, such as alum, copper sulfate, nickel sulfate etc. The intentional production of crystals of substances which are not readily soluble in common solvents, such as metals or gemstone materials, is obviously more difficult, and normally the expense involved in such processes is only justified for manufacturing or scientific purposes. Of course, interesting crystal growth may also happen accidentally, sometimes as a byproduct of industrial operations, as in the case of the artificial zincite crystals from Poland which appeared on the mineral market in the early 1990's (Robinson and King, 1991; Cooper, 1993).

In recent times the subject of natural-appearing but man-made mineral specimens has attracted renewed interest in at least one specific area: the growth of artificial wire silver and acanthite crystals (Edwards, 2001). Less well known is the fact that in the past large quantities of artificial "Sicilian" sulfur specimens were produced and found their way to the international mineral market. The crystals were grown in Italy around 1975–1976, on authentic matrix from the Sicilian sulfur mines, and in most cases they resembled natural specimens so closely as to defy detection even by experienced eyes. The appearance of the specimens would have offered little cause for suspicion, especially (as originally was the case with the wire silvers) at a time before the feasibility of manufacturing them artificially was widely known.

The trickle of these sulfur specimens onto the market stopped in the late 1970's. At about that time rumors started to circulate regarding the possibility that they might be man-made. Their

origin, though, was a mystery to most, and concrete evidence was lacking. So the matter slipped from public consciousness and was forgotten for three decades.

The existence of fake Sicilian sulfur specimens would probably have remained unknown forever, had not the man who had mastered the art of growing sulfur crystals, Dr. Sergio Martinat, come out into the open at the Torino Show in 2000. Dr. Martinat, a natural history enthusiast, chemist and entrepreneur, proudly exhibited a showcase full of his artificial sulfur crystals, mixed with some natural specimens for comparison purposes. A flyer, appropriately printed on bright yellow paper, declared the origin of the specimens under the title: *Minerali, che passione!* ("Minerals, what a passion!").

Dr. Martinat was not around for discussion when I visited his stand at that show. Nevertheless, my interest in Sicilian minerals and my long-standing curiosity about these intriguing sulfur specimens were sufficient motivation for me later to call Dr. Martinat's office and to request an interview. The interview was granted and, quite contrary to his reputation of being rather secretive about his process, he was reasonably open and added a good deal of information to what was included in his Torino Show leaflet.

THE INTERVIEW

Dr. Sergio Martinat is a gentleman in his late seventies. A pharmacy graduate, he spends much of his time running the *Martinat Ornithological Park* near Pinerolo, a town in Piedmont some 35 km southwest of Torino. The park occupies an area of about 25 acres, hosting a great variety of birds in cages and large aviaries (one of them covers an area of 13,000 square meters and is said to be the largest in the world). The particularly mild microclimate at this location is ideal for keeping exotic birds, some of which are quite rare or extinct in their original habitat. Other types of wild animals are also represented, to the enjoyment of numerous visitors and school groups.

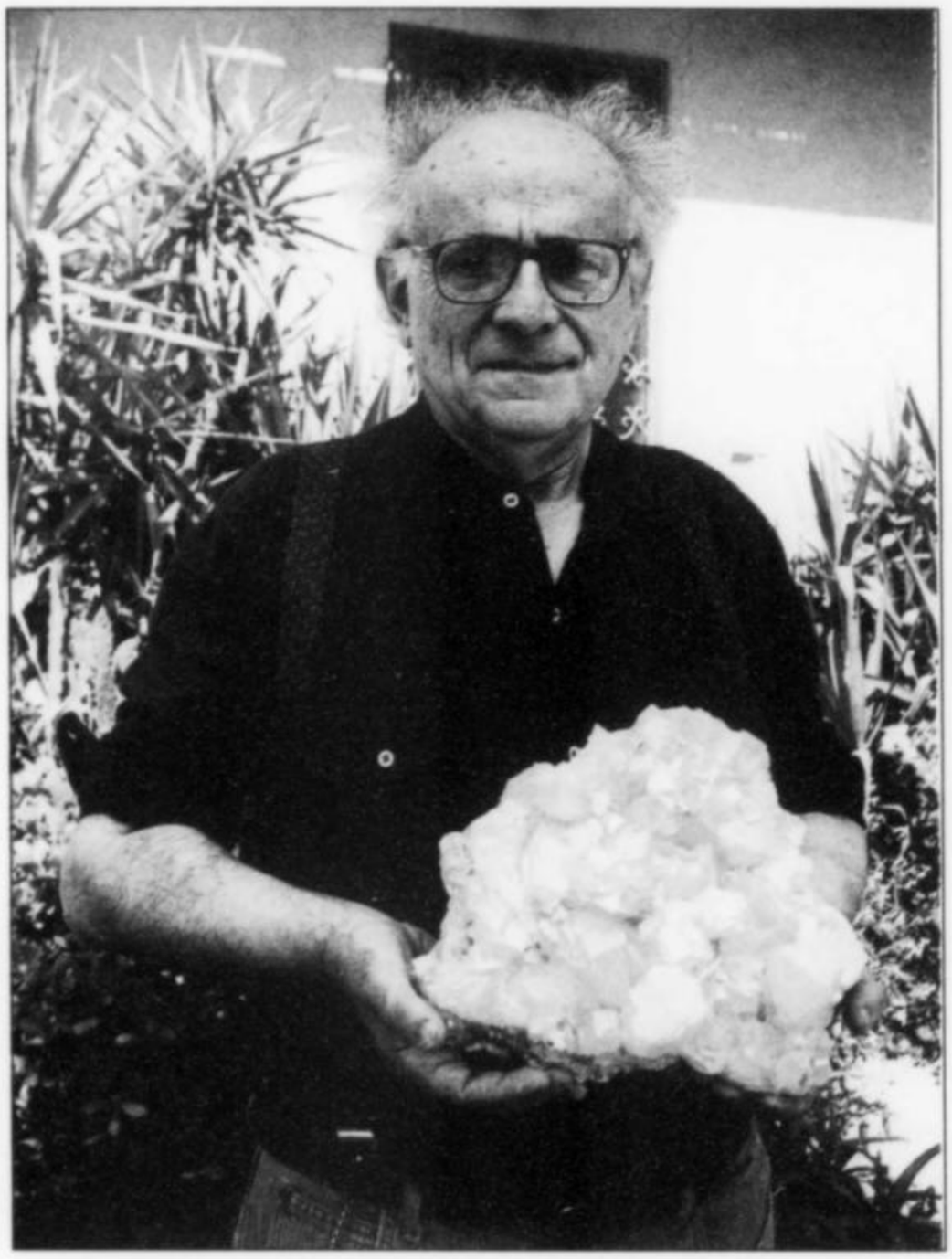

Figure 2. **Dr. Martinat showing one of his larger artificial sulfur specimens. Giorgio Comollo photo.**

Sergio Martinat welcomed me into his office, lined with bookcases and crowded with papers, natural history specimens and, guess what—a glass case full of crystallized sulfur specimens. This sight brought us directly to the subject of our interview.

I began by asking Dr. Martinat how it was that he chose to embark on a project aimed at growing sulfur crystals? The main interest of his life, he replied, had always been to grow things: animals mainly, but also plants and, in a way, businesses. Minerals have a life of their own, he felt, and they could be grown too. Whenever a particular type of natural object becomes scarce or even unobtainable, the obvious way to satisfy the demand is to reproduce it artificially. This principle was applied, for instance, by Kokichi Mikimoto when he invented the process for producing cultured pearls, and later by many laboratories and manufacturers which now produce synthetic gemstones. Artificial flowers and furs are also widely used. Why, then, should these same standards not also be applied to aesthetic mineral specimens? If the purpose is just to please the eye, and add a touch of color in the collector's showcases, where is the harm? Thus Dr. Martinat easily rationalizes the ethical propriety of making artificial specimens available to the collecting and

Figure 1. **The flyer available to visitors at the Torino Show, September 2000: Dr. Martinat's position paper on artificial sulfur and other crystals (in Italian).**

ZOLFO : CHE PASSIONE !

C'era una volta la perla naturale, pescata in fondo al mare con grande fatica, rischi mortali e quindi molto rara e costosa.
Un giapponese, il signor Mikimoto, ebbe l'idea di realizzare il procedimento naturale che porta alla perla, parte in laboratorio e parte in natura, in condizioni controllate.
Le perle coltivate oramai hanno del tutto sostituito le perle naturali: sono identiche, altrettanto belle e meno costose. Tutti oramai le usano senza problemi.
Analogamente molte altre gemme sono ora coltivate.
Così le pellicce, i fiori ed altri oggetti che ci rallegrano la vita.
Persino i fossili rari sono riprodotti in laboratorio anche a scopo scientifico e non solo estetico.
Non si potrebbe fare la stessa cosa per le collezioni estetiche di minerali? (Per quelle scientifiche ovviamente questo discorso non vale).
Vi sono minerali bellissimi oramai introvabili e che non si troveranno mai più.
Con la chiusura e l'esaurimento delle vecchie miniere coltivate a mano, l'elenco dei minerali introvabili diventa sempre più lungo.
Ad esempio, lo zolfo in cristalli. Coltivarlo in laboratorio non è facile, ma è possibile. Così tutti potrebbero possedere campioni esteticamente molto belli a prezzi abbordabili, campioni identici a quelli naturali che anche venti o trent'anni fa erano rari ed appannaggio solo dei collezionisti più danarosi.
Come per le prime perle coltivate, questa ipotesi ora può sembrare blasfema.
Ma avere in collezione un bellissimo pezzo coltivato, con grandi cristalli perfetti, è appagante.
Molti altri minerali esteticamente perfetti, identici ai più bei campioni naturali, potranno seguire...
Si potranno così mettere insieme delle collezioni di grandissimo valore estetico apprezzabili da tutti, anche da chi (e sono la gran massa delle persone) non ha avuto la possibilità di accedere ai pezzi migliori.

Per informazioni : FAX 0121 303077

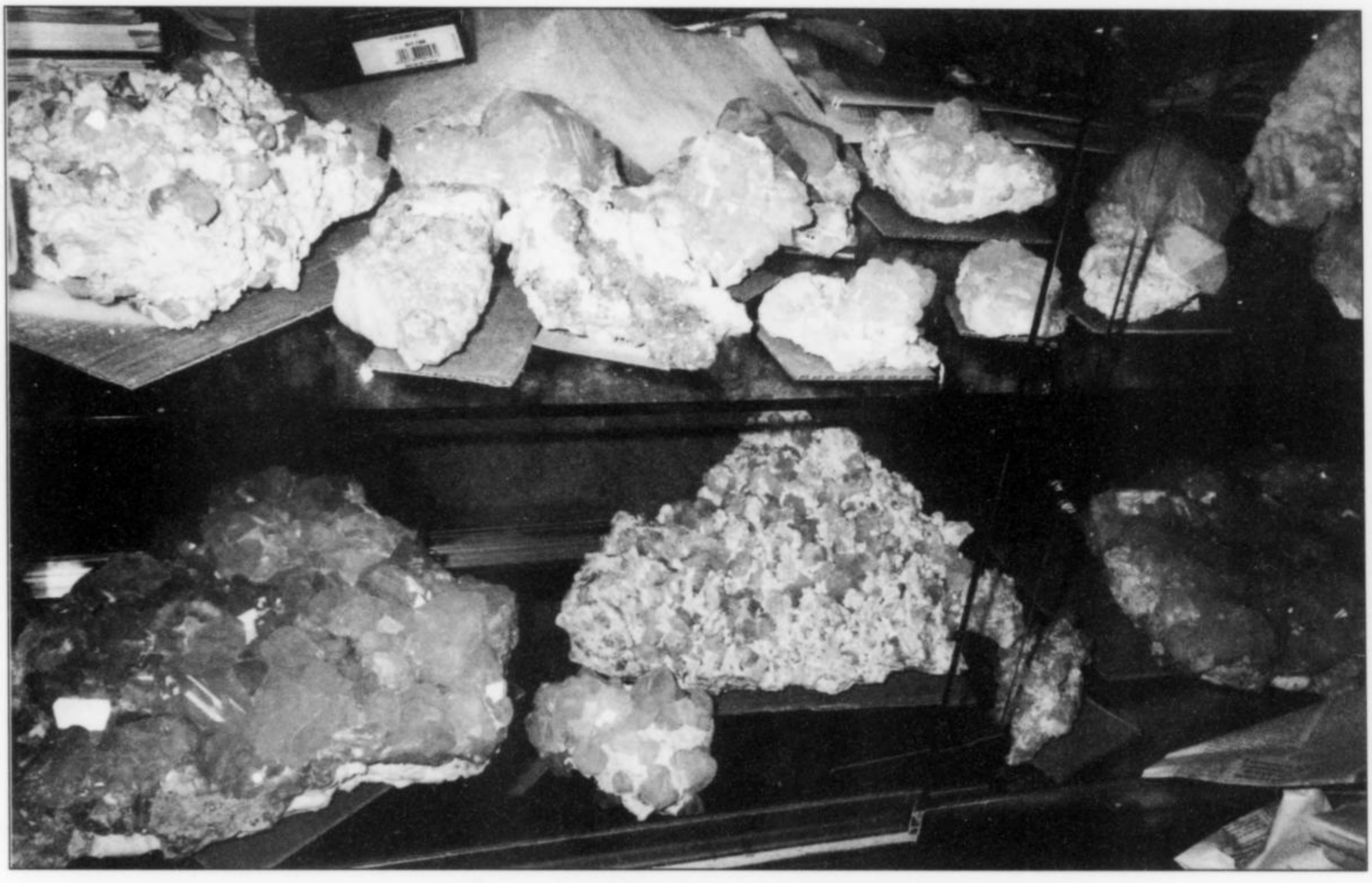

Figure 3. **Artificial and natural sulfur specimens. Which is which? Renato Pagano photo.**

museum community. He now admits, and even publicizes, the fact that his sulfurs are man-made.

THE PROCESS

Dr. Martinat was not willing, of course, to disclose the precise details of the process he developed. But, in general, the technical aspects involved in creating man-made sulfur crystals are easy to understand. A number of organic solvents exist in which sulfur can be dissolved. A matrix is prepared and tiny seed crystals are added to act as crystallization nuclei. Then the prepared matrix is placed in the sulfur-containing solution. The degree of sulfur saturation in the solution seems to be quite critical: when it drops below a certain level, the solution will dissolve the sulfur crystals already deposited, as well as any natural sulfur that may have been present in the matrix. When it is "just right" the sulfur crystals will grow into nice, good size individuals or small groups. When it is too high, or supersaturated, the sulfur deposition will be too fast, tending to cover the matrix completely with a crystalline crust which is not very attractive. The crystal habit can also be affected by the speed of crystallization, with hopper crystals forming when crystallization takes place too rapidly. Dr. Martinat may have solved the problem by restricting the evaporation of the solvent in order to keep the concentration near the ideal level (and to avoid wasting expensive solvent), and perhaps by controlling the rate of crystallization through very gradual reductions in the temperature of the solvent. The slower the process, the better the results. According to Dr. Martinat, up to two months were sometimes required to complete the crystallization process. The small crystals used as nuclei are readily available, as lots of unwanted crystals are deposited during the process, and they are removed to leave just a few significant, larger crystals on the matrix.

The key technical factor in this process is the choice of the solvent: the best being carbon disulfide (Nassau, 1972), a very volatile, poisonous, potentially explosive and carcinogenic fluid. The European Union rules forbid the sale of large quantities of this substance. Other solvents are only a little less dangerous and/or expensive.

Dr. Martinat is not very optimistic about resuming his production of sulfur specimens. The high cost of the solvent may be a factor, as well as safety considerations (not only are such solvents highly toxic, but accidental explosions have taken place in the past). He says, he is experimenting with duplicating other minerals, but will provide no further details on this work.

THE AMAZING RESULTS

But let us return to the sulfur specimens in the showcase: It must be admitted that the results obtained by Dr. Martinat are excellent. The first factor contributing to his success was his selection of the matrix rocks: all bona fide limestone specimens from the Sicilian sulfur mines, generally crossed by typical sulfur veinlets. In the best cases the matrix includes small cavities with aragonite, calcite or celestite crystals or granular aggregates, providing the striking white or gray to yellow contrast so typical of good Agrigento or Caltanissetta province specimens.

The second factor is the artful way in which the crystals were laid out on the matrix. The best pieces show rather sparsely distributed individuals, while others have more complete coverage by the sulfur crystals. The crystals are transparent and their color, luster and habit are quite similar to those of natural crystals. The crystal sizes are normally under 3 cm, but the largest reaches almost 5 cm. Larger crystals, says Dr. Martinat, are very difficult to create with an acceptable level of quality.

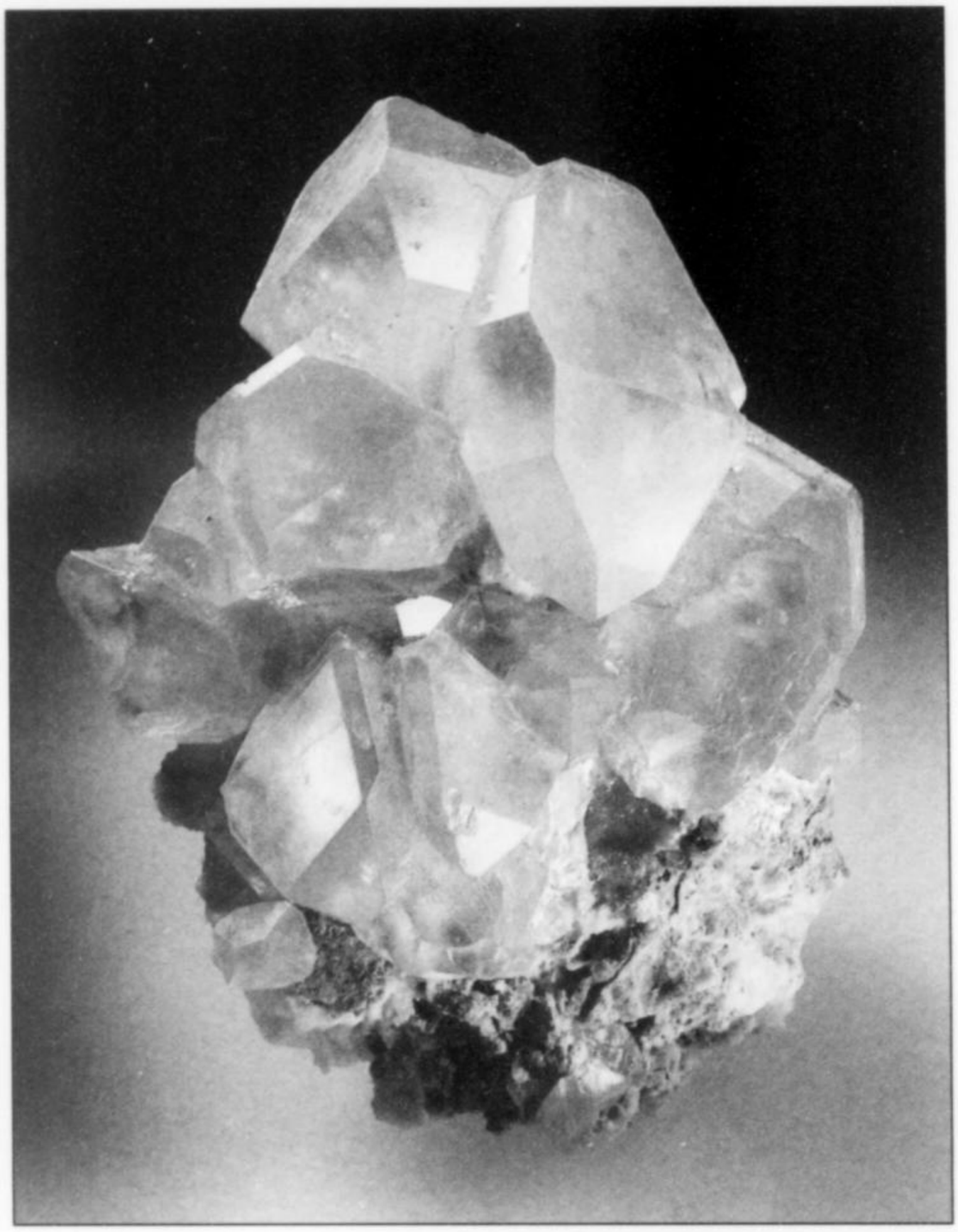

Figure 4. **Artificially grown sulfur crystals, on matrix from Sicily with small celestite crystals; 5.5 x 7 cm. Renato Pagano specimen; Wendell Wilson photo.**

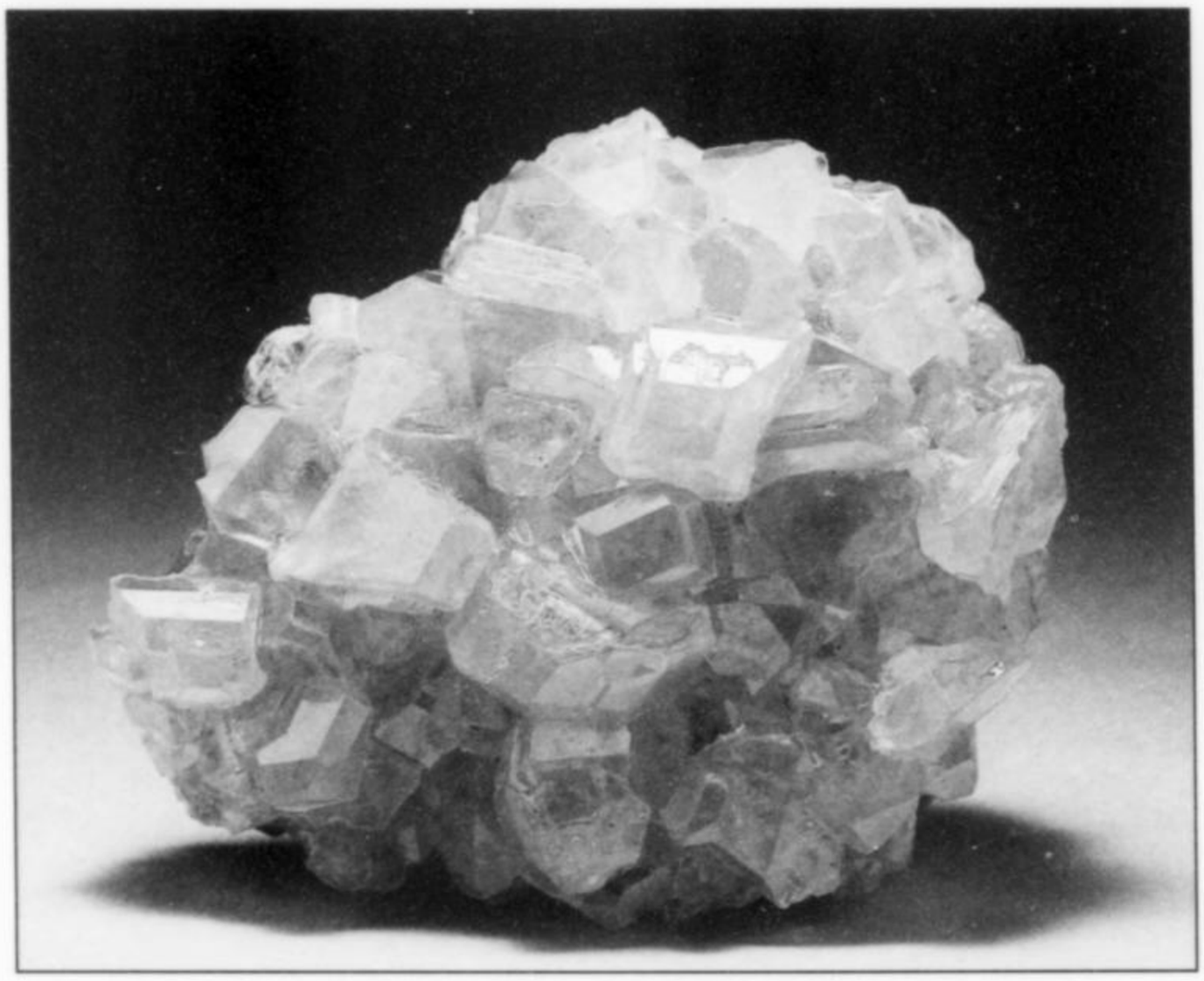

Figure 5. **Artificially grown sulfur crystal cluster, 8.5 cm. Renato Pagano collection; Roberto Appiani photo.**

THE RECOGNITION OF ARTIFICIAL SPECIMENS

How can one recognize a sulfur specimen made by Dr. Martinat? At the suggestion of *Mineralogical Record* editor Wendell Wilson, a chemical approach was attempted, based on identifying trapped liquid inclusion of carbon disulfide CS_2 in the sulfur crystals. (Natural crystals do not precipitate from CS_2 so its presence in inclusions would confirm an artificial origin.) The detection method utilizes phosphines, which are known to react with carbon disulfide. Whenever tri-ethyl-phosphine comes in contact with carbon disulfide, the resulting reaction is as follows:

$$CS_2 + P(C_2H_5)_3 \rightarrow S_2CP(C_2H_5)_3$$

The product of this reaction is a red precipitate. The method is very sensitive and can reveal very small traces of carbon disulfide.

Samples of natural and artificial crystals were tested as follows. Small samples (2–3 grams) were ground in a mortar filled with ethyl ether, so that any particle of carbon disulfide included in the sulfur would be captured in the solvent. The fluid was then quickly tested with tri-ethyl-phosphine.

A recently synthesized specimen, which had been thoroughly dried for several days, did indeed test positive (the solution turned pale pink, and, after drying, the red precipitate was visible at the bottom of the test tube). A natural specimen of sulfur tested negative as expected but, unfortunately, so also did two different Martinat crystals made in the 1970's. Apparently the minute inclusions of solvent which are trapped during crystallization are not stable, and evaporate out through the sulfur crystal structure over time. If this is the case, other methods of analysis, such as gas chromatography, are unlikely to yield better results.

Chemical analyses to determine trace element profiles which might be distinctive are also unlikely to prove useful because crystalline sulfur is usually pure, and is not susceptible to carrying dissolved impurities (like metals do) that might characterize natural specimens vs. artificial ones. [*Ed. note:* George Robinson has suggested stable isotope analysis.] Therefore, given the present state of the art in chemical analysis, careful visual examination is still the best diagnostic approach.

According to my own observations, the most revealing feature is the relationship of the crystals to the matrix. In natural specimens the crystals will always be deposited on pocket or fracture surfaces like those inside a geode or a cleft in the rock. It is normal for the matrix of any specimen to show surfaces were it was broken away during collecting: but crystals should *not* be seen on such surfaces. If they do, it means that the crystals grew *after*, not before the rock was broken. Of course, this is not definitive because natural crystallization can certainly take place following a natural fracturing or brecciation event. But in the case of the Sicilian sulfur deposits such events were rare.

When the matrix includes original sulfur crystals and/or veinlets, occasionally the newly deposited crystals may show a slight difference in color, e.g. bright yellow vs. greenish yellow. In other cases, the crystal faces may show hopper growth or corrosion, indicating that the process was not well regulated, and the concentration of the solution was too high, and the growth too fast, or that the concentration was too low, and corrosion took place. Occasionally, under magnification minute amounts of a waxy material can be noticed on the matrix and/or on the sulfur crystals: these may due to some releasing agent, or protective material used by Dr. Martinat to prevent crystal growth in some areas of the matrix, like the back of a flat specimen.

Also, as far as is known, all of the specimens made by Dr. Martinat are totally free of any blackish asphalt material, so any specimens which *do* have obvious asphault staining are definitely not of his manufacture.

In general terms it can be said that the quality of the Martinat specimens is generally very high, but not always uniform. Of course, a similar statement can be made for natural specimens, which often occur in a variety of different sizes and arrangements of crystals on matrix. Some of the more mediocre artificial specimens may raise a question in the mind of the experienced collector—sometimes it is hard to say why, as they are beautiful, but just a little unusual in some way. The best specimens, however, do not show any of the tell-tale qualities mentioned above, and would easily pass inspection by any unsuspecting observer.

CONCLUSION S

According to my sources, several hundred kilograms of artificial sulfur specimens were produced during roughly a one-year period ca. 1975. Dr. Martinat sold and traded them for the equivalent of about $200/kg in today's money, the trades helping to build his personal mineral collection. This means that probably at least a thousand, and perhaps many more man-made specimens are out there somewhere, including some (Dr. Martinat says proudly) that are now in museum collections, and some which have been photographed and published as being natural.

Dunn *et al.* (1981) have reviewed very extensively the subject of mineral fakes. These sulfur crystals were produced in quantity before their article was published, but are not mentioned there. The fact that, despite a thorough search for fakes in many museums and private collections, the sulfurs were not detected as artificial products by the authors or by the dozens of prominent collectors, dealers and curators who are acknowledged in the article for having provided information to them, bears witness to the deceptively high quality of these specimens.

In conclusion: *caveat emptor*. When in doubt, request the advice of an experienced collector or curator, and do not assume that, just because a specimen is from a 25-year-old collection, it is not man-made. On the contrary, check the specimen's provenance to make sure that it did *not* first appear on the scene during the latter 1970's. Most authentic specimens will be documentably older. Nearly all crystal-producing mines had already closed down by 1970 (hence the impulse at that time to create artificial substitutes), although there may well have been fine, authentic specimens that were circulating on the mineral market during that same time period and later, having been set aside by miners for later sale. More than this we cannot offer.

Dr. Martinat is confident that there simply is no way to independently identify his specimens, and even he himself has problems telling his best artificial specimens apart from the natural ones in his collection. In any case, applicable research is lacking. Sadly, this is an issue that may be irresolvable given the current state of scientific knowledge. It does, however, illustrate the danger of contaminating the scientific knowledge base when artificial crystal specimens are created purposely to mimic natural specimens. If the attempt is too successful, the artificial origin may never again be verifiable once all eye-witnesses have passed away, and only the specimens remain.

ACKNOWLEDGMENTS

The author thanks Dr. Sergio Martinat and the numerous dealers and collectors who shared information and loaned specimens for examination. Special thanks go to Dr. Wendell E. Wilson for his constructive discussions and for his suggestion concerning the identification of liquid inclusions; and to Prof. Paolo Orlandi of the Earth Science Department and Dr. Lorella Marchetti of the Chemistry Department, University of Pisa, for their contribution and experimental work on carbon disulfide detection.

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The Friends of Mineralogy, Inc.

Visit the national Friends of Mineralogy website at www.indiana.edu/~minerals/fm.html

Who We Are:

Vol 1, No 1, Mineralogical Record, Spring 1970

The *Friends of Mineralogy* was founded in Tucson, Arizona, on February 13, 1970. Its objectives were to promote better mineral appreciation, education and preservation. The chief aims and activities of *FM* include:

* Compiling and publishing information on mineral localities, and important mineral collections.
* Encouraging improved educational use of mineral specimens, collections, and localities.
* Support a semi-professional journal of high excellence and interest designed to appeal to mineral amateurs and professionals, through which *FM* activities may be circulated.
* Operating informally in behalf of minerals, mineral collecting, and descriptive mineralogy, with voluntary support by members.

The Mineralogical Record has agreed to an affiliation with the Friends of Mineralogy whereby it will publish its written material and news of its activities. The *Friends of Mineralogy* will support the *Mineralogical Record*, since the aims of both are similarly educational and directed toward better coordination of the interest and efforts of amateurs and professionals.

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Gemstone Deposits of Colorado and the Rocky Mountain Region
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First Announcement and Call for Papers
A symposium on the mineralogy, geology, and field occurrence of gemstones in the Rocky Mountains states.
Sponsored by the Colorado Chapter of Friends of Mineralogy, Colorado School of Mines Geology Museum, Denver Museum of Nature and Science, and U.S. Geological Survey.

The symposium will be held on the Colorado School of Mines campus, Golden, Colorado, Sep. 7–10. It will include 1-1/2 days of lectures (Saturday and Sunday, Sep. 7–8), followed by two days of field trips to selected Colorado gem localities (Sep. 9–10). The symposium will endeavor to bring together professionals and knowledgeable amateurs involved in mining, collecting, mineralogical and geological research on, and curation and display of gem materials from the Rocky Mountain region. Papers on all important gemstone occurrences of the region are being solicited.

The symposium will include a welcoming reception Friday evening Sep. 6 at Colorado School of Mines, a banquet Saturday evening, and a reception Sunday evening at the Denver Museum of Nature and Science.

The symposium will precede the 2002 Denver Gem and Mineral Show, which will be held Sep. 13–15, 2002; the theme of this show will be "Gemstones of Colorado".

Further information about the symposium as it become available can be obtained from the above addresses or from Paul Bartos (CSM, 303-273-3823), Dan Kile (USGS, 303-541-3029), or Tom Michalski (USGS, 303-202-4852).

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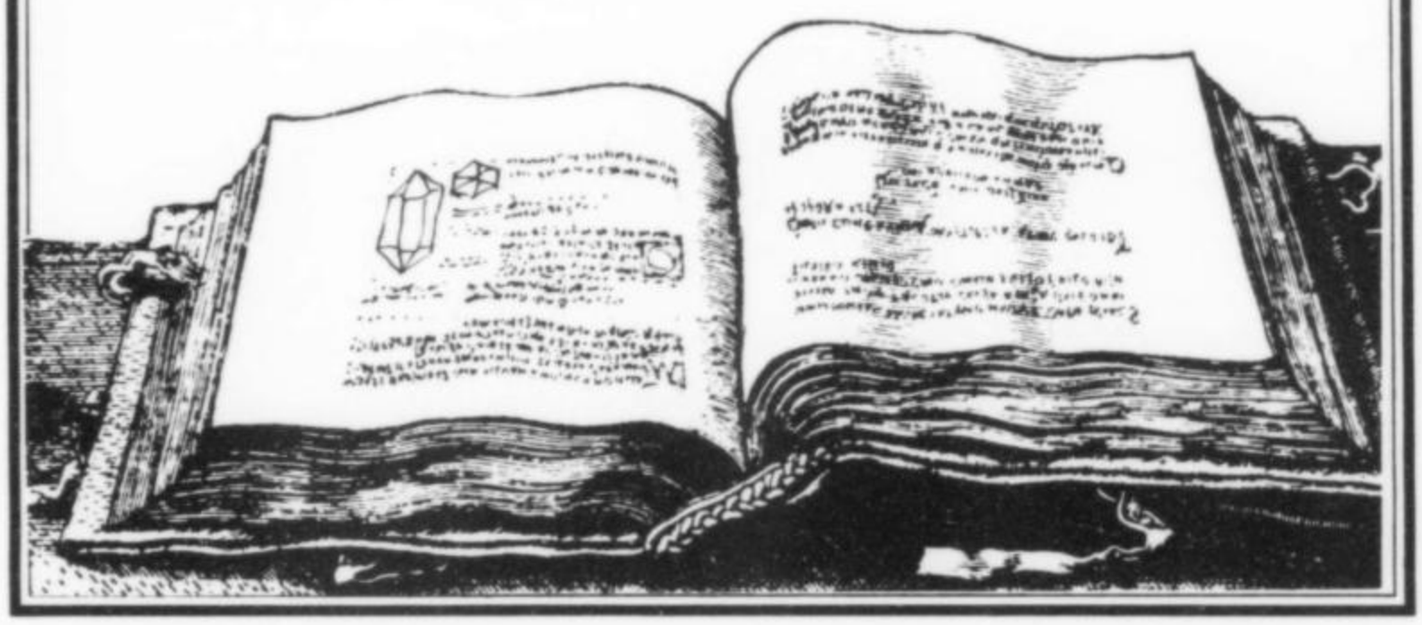


The Book on the Bookshelf

by Henry Petroski, published (1999) by Alfred Knopf, New York; 6 x 9.6 inches. Hardcover or Paperback, 290 pages, $26, $13. ISBN 0375706399.

Henry Petroski, a professor of civil engineering and history at Duke University, has developed a nice niche for himself as a popularizer of engineering and an expositor of manufactured things. The field is as vast as all human creation, and its details can be explained and followed without much of the specialized vocabulary that renders biology and physics semi-opaque to the uninitiated. His best-known work is "The Pencil" (1990), an ingeniously designed volume of more than four hundred pages giving the surprisingly intricate history of this humble and ubiquitous artifact; "The Evolution of Useful Things" (1992) took us deeper than we would have thought possible into the ins and outs of paper clips, beer cans, forks, zippers, and such. His newest excursion into the commonplace, *The Book on the Bookshelf,* arrives at rather thin and overworked terrain. The evolution of the book from papyrus scroll to bound paper is an oft-told story, and for the history of book housing Petroski is noticeably dependent upon two turn-of-the-last-century works by John Willis Clark, *Libraries in the Medieval and Renaissance Periods* (1894) and *The Care of Books: An Essay on the Development of Libraries and Their Fittings, from the Earliest Times to the End of the Eighteenth Century* (1901) To stretch his topic to more than two hundred and fifty pages, Petroski resorts to much chat about the books and shelving in his own home, and tacks on a semi-facetious twenty-page appendix on possible ways to order a personal library, ranging from the obvious (by subject, by author's last name) to the whimsical (by color, by publisher, by author's first name, by opening sentence, by the Dewey decimal system). Engineering proceeds through patient considerations, but the actualities of shelf sag and window light begin to make sleepy reading, and matters of general literate knowledge are rather flatly spelled out:

> Jerome was famous for producing, among other significant works, the Latin translation of the Bible known as the Vulgate, so called because it was rendered in the common or "vulgar" Latin of the time and so was more generally accessible than the original Hebrew and Greek in which the Bible was written.

Nevertheless, we need to be reminded that people did not always live surrounded by books arranged on shelves, with their spines outward and stamped with the title, author, and publisher. (In truth, only in certain circles, smaller than academics like Petroski might imagine, could people be said to be surrounded; I am frequently struck by how many otherwise handsomely accoutred middle-class American homes have not a book in sight.) The first writing was on clay tables or cylinders. The first approximations to books were Greek and Roman papyrus rolls as long as thirty feet, which generally carried their text in columns of lines parallel to the scroll's edges, much like pages. Called *volumina* in Latin, these rolled-up "volumes" were as a rule read from left to right, the read portion held in the left hand and the unread in the right, and had to be rerolled when read, like a videotape. They were tied with string or fastened with straps, and for storage were sometimes kept in hat-box-shaped containers called *capsae.* Commonly, they were stored in divided shelves, and identified by tags attached to their ends. Seneca, the gloomy playwright and doomed adviser to Nero, described a rich man who "buys bookcases of expensive wood" and "goes yawning among his thousands of volumes . . . collected for mere show, to ornament the walls of the house." A library, the Stoic complained, has become "one of the essential fittings of a home, like a bathroom."

Early Christian times saw the spread of parchment (processed sheepskin) and vellum (related etymologically to "veal," though lambs and kids as well as calves were used). These thinned animal hides could be more securely stitched than brittle papyrus, promoting the codex, composed of sheets sewn together—originally in concertina style and then on one side, forming a spine—and protected by substantial covers, usually of wood and sometimes heavily decorated and bejewelled. Such early books, copied and illumined by hand, were rare and precious and mostly found in monasteries. The monks loaned them to one another with careful accountancy, to be perused and copied, and kept them in locked chests; a book chest surviving in Hereford Cathedral is six feet long and equipped with no fewer than three separate locks. When not stacked in such chests, books were propped on tilted surfaces like modern music stands or lecterns. Woodcut representations of fifteenth-century scholars at work show random book dispersal over all available surfaces. Study carrels were built between the pillars of cloisters, and, as literary activity increased and books multiplied, the bookshelf made a fitful, disorganized appearance. An *armarium commune*—a wood-lined recess in a stone wall—that survives from the late twelfth century in the Cistercian abbey of Fossa Nuova, near Terracina, apparently had a single shelf, since removed. Book chests had begun to rise up, in the form of upright *armaria* fitted with doors where the lid had been and shelves in place of an undifferentiated interior. The shelves, however, in what representations survive, appear to have been slanted and held very few books apiece. Collections that numbered no longer in the tens but in the hundreds would require a

crushing number of such *armaria*; a separate book room, a library, of about a hundred and fifty square feet, appeared in the same abbey that contains the *armarium commune*.

The early, late-medieval libraries took the form of long lecterns to which the books, freed from their locked chests, were chained, protecting them from theft, displacement, and perusal by unauthorized eyes. The chains were attached by rings to a rod, which was secured by a lock and key, below the lectern. The images of chained books are among the most haunting in *The Book on the Bookshelf,* since we do not instinctively recognize them as marking a forward stage in the liberation and dissemination of the written word. The stage lasted some centuries, well into the Gutenberg era. Petroski quotes Burnett Hillman Streeter's *The Chained Library: A Survey of Four Centuries in the Evolution of the English Library*:

> Fresh chains were being purchased at Chetham College, Manchester, in 1742, and at the Bodleian in 1751. At The Queen's College, Oxford, the chains were not taken from the books till 1780; at Merton not till 1792. Magdalen was the last college in Oxford to retain them; here they lasted till 1799.

Sixteenth-century examples of chained libraries are preserved at Hereford Cathedral and Florence's Laurentian Library; in both, primitive catalogues at the end of each lectern list the books on its long tilted shelf. Horizontal shelves appeared, above and below the lectern, as books relentlessly increased in number. Eliminating chains made possible the book press, or bookcase, and eventually walls of shelves, with detached benches and reading tables. As books were printed for a mass market, extensive private libraries arose. Samuel Pepys winnowed his hoard of books to stay at three thousand, so as not to overflow his thoughtfully designed, glass-fronted, made-to-order presses. He discovered that more books could be stored if they were arranged by size, with raised shelves holding a row of taller books behind a row of smaller ones; the effect, preserved in the twelve cases that Pepys left, with their contents, to Cambridge's Magdalene College, is impressively harmonious, though somewhat forbidding to a would-be browser.

Even after books came to rest vertically on shelves, their spines were unlabelled and faced inward. Petroski explains:

> The exoskeletal spine, which holds up the innards of the book structurally in a fashion not unlike the way our own spines hold us up, was still the machinery of the book, however, and so it continued to be the part that was hidden as much as possible, pushed into the dark recesses of bookshelves, out of sight. Shelving books with their spines inward must have seemed as natural and appropriate a thing to do as to put the winding machinery of a clock toward the wall or behind a door, or both.

When books were few, they did not need to be labelled, any more than do familiar people. The fore edges, where schoolchildren still write their names, sometimes held painted decorations and identifying marks. But by the end of the sixteenth century lettered spines had become the rule—except in such bastions of conservatism as the library of the Escorial, where books were shelved fore edge out into the twentieth century.

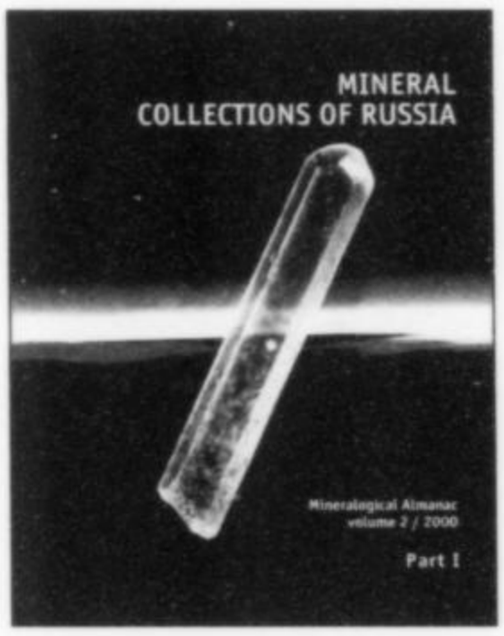
Mountains of books now exist on all sides, and institutional libraries have frequent recourse to the engineering sciences as they seek to house their treasure, which has been estimated to double every sixteen years. The British Museum's renovation of the eighteen-fifties surrounded the great domed Reading Room (a foot larger than the dome of St. Peter's, two feet smaller than that of the Pantheon) with multilevel cast-iron book stacks; this advance was obsolete by 1920, when an attempt to add to the stacks strained the structure. By the end of 1999, twelve million volumes will be moved into the new British Library building, across from St. Pancras Station. Rolling book presses, which enable aisle space to be conserved, were installed in the Toronto Central Circulating Library as early as 1930. Compact shelving on rails—bookcases packed like a deck of thick cards—can double capacity but would dangerously overload the upper floors of most existing structures. CD-roms take up little space, but the computer terminals to read them take up a great deal. Further, computers are vulnerable to hackers and electromagnetic catastrophes. Seldom-consulted books are finding their way into off-site computer-managed warehouses—neutron stars of printed matter, denser and denser.

Microfilm was once thought to be a panacea, but, according to a 1963 study, "experience began soon to show that there was great resistance from readers to the inconvenience of having to read through an apparatus." Now computer science promises us, via a research team at the Massachusetts Institute of Technology, the "Overbook," which

> would be printed in electronic ink known as e-ink, a concept in which page-like displays consist of microscopic spheres embedded within a matrix of extremely thin wires. The ink particles, which have one hemisphere black and one white, can be individually clipped by a current in the wire to form a "printed" page of any book that has been scanned into the system.

Who is to say, at the end of a century that brought us the movies, radio, radar, and the desktop ink-jet printer, that this cannot be? but the concept feels less than bookish. Our notion of a book is of a physical object, precious even if no longer hand-copied on sheepskin by carrel-bound monks, which we can hold, enter at random, shelve for future reference, and enjoy as a palpable piece of our environment, a material souvenir of the immaterial experience it gave us. That books endure suggests that we endure, our inner tale not writ in the water of an Overbook's e-ink.

John Updike



Mineral Collections of Russia

Mineralogical Almanac, vol. 2 (2000), Part I. Published (2000) by Ocean Pictures Ltd., Moscow. Softcover, 22 x 27 cm, 136 pages; Price: $45. Order from Terry Huizing, 5341 Thrasher Drive, Cincinnati, OH 45247. (Make checks payable to Mineralogical Almanac.)

This, the second volume/issue of the new English-language Russian mineral collector's journal, is devoted entirely to reviews and descriptions of 14 private mineral collections dating from the 18th to the 20th centuries. It is divided into two chapters. The chapter on "Historical Collections" covers those of Count Nicolai P. Rumyantsev (1754–1826), Archbishop Nil (1798–1874), Ernst K. Gofman (1801–1871), Mikhail K. Sidorov (1823–1887), Dmitrii I. Mendeleev (1834–1907), Mikhail V. Erofeev (1839–1889), Prince Georgii G. Gagarin (1882–1924) and Viktor I. Stepanov (1924–1988). Chapter 2, dealing with "Contemporary Collections," describes those of Vyacheslav

Kalachev, Vladimir Pelepenko, Dmitry Lisitsyn, Aleksei Timofeev, Boris Kantor and Igor Pekov. The historical collections are now all a part of the State Museum collection.

This book-issue with its 128 color illustrations, shows a wonderful variety of fine Russian mineral specimens, and also makes highly enjoyable reading. The contemporary collections, built by both amateur and professional mineralogists, each reflects the special interests of its owner. Pelepenko, it might be remembered, was the first Russian collector to display his collection at a Western mineral show (Munich, 1988).

Volume 3 is planned to be equally ambitious: twenty Russian mineral museum collections will be featured. The two volumes together will comprise 280 pages with 300 color photos. This is a publication well worth supporting.

Wendell E. Wilson

Minerals of the Kovdor Massif

by G. Yu. Ivanyuk and V. N. Yakovenchuk. Published (1997) by RAS Kola Science Center Publishing, Apatity, Russia. Hardcover, 21 x 31 cm, 117 pages, in Russian and English. Distributed by Christian Weise Verlag, Orleansstrasse 69, D-81667 München, Germany. (to whom enquire for price).

The Kovdor region was developed for iron ore mining in the early 1960's and the mineralogy of the area has been studied since that time. The Kovdor massif, made up of alkaline, ultrabasic and carbonate rocks, was discovered as recently as 1993. It is a large central-type intrusion emplaced in pre-existing biotite-plagioclase gneiss and granite-gneiss about 380 million years ago. It extends over approximately 41 square kilometers and is roughly pear-shaped in plan. The book discusses the geological structure and its component rocks and then describes the different deposits of baddeleyite, apatite, magnetite, vermiculite, francolite, apatite-carbonate ores and carbonatites, summarizing their nature, extent and mining.

The descriptions of the minerals occupy pages 26–113 and are arranged in chemical order. Each entry contains a crystal diagram and details of chemical composition and occurrence. Many entries are accompanied by color photographs (with dimensions given) of quite good quality and some by electron-photomicrographs. Provenance details are provided where appropriate. The book concludes with a list of references (almost all from Russian sources and useful for this reason) and with a list of minerals in both Russian and English. The authors, publishers and sponsors are to be congratulated on a timely and well-produced study of an important area of mineralization.

Michael O'Donoghue

Madagaskar: das Paradies der Mineralien und Edelsteine

Published (1999) by Christian Weise Verlag, Orleansstrasse 69, D-81667 München, Germany. Softcover, 21 x 30 cm, 96 pages; published as ExtraLapis no. 17, ISBN 3-921656-50-8; price: DM 34.80.

ExtraLapis numbers come thick and fast and each one is of equal beauty and usefulness. Those concerned with the world of gemstones have seen how quickly Madagascar has risen (as it should have) to the first rank of producers: today it produces about half of the blue sapphires used in jewelry. When this topic is exhausted there are emeralds and morganites (the latter especially fine), rose quartz (often asteriated), yellow orthoclase and much else. The suggestion is that important pegmatites can be found on the island and they certainly are.

Following the *extraLapis* tradition, the survey of a number of mineralogical topics is presented seamlessly, and it is not always easy to find which sections belong to particular contributing authors (under the editorship of Federico Pezzotta of the Museo Civico di Storia Naturale, Milan): this method, as in previous issues, works very well. To help the reader a list of species occupies the first pages of text: after this the various species and districts are described. Gem-quality specimens feature in many of the superb photographs but those showing occurrences are also good. The only desideratum is the lack of any bibliography, though there is a reference to the standard work, Lacroix (1922), *Minéralogie de Madagascar* (anyone know of an available copy?).

Some of the earlier issues of *extraLapis* are now out-of-print, indicating that despite a possible language difficulty for some, the demand worldwide is considerable.

[*Ed. note:* An English-language edition of this *ExtraLapis* has just been published.]

Michael O'Donoghue

Lovozero Massif: History, Pegmatites, Minerals

by Igor V. Pekov. Published (2000) by Ocean Pictures Ltd., Box 368, Moscow 103009 Russia. Distributed in the USA and Canada by Excalibur Mineral Co., 1000 North Division St, Peekskill, N.Y. 10566. Hardcover, 22 x 28 cm, 480 pp, $79.00 (plus $8.00 domestic shipping). ISBN 5-900395-27-8.

Like many longtime collectors, this reviewer fifteen years ago had not even heard of the Lovozero massif, Kola Peninsula, Russia. Ten years ago I might have dimly recalled seeing its name on a few labels of odd-looking specimens brought in to the Munich Show by bleary-eyed Russians. By five years ago I might have come to imagine Lovozero vaguely as a foggy, barely inhabited, exotic place with perhaps some rare species for micromounters (things with a lot of Z's in their names and rare-earth elements in their chemistries). I could probably have named only three or four species that I knew to occur there in serious specimens for the display collector.

This new book is one of the best you will ever come across for expanding one's mineralogical imagination. Lovozero is probably now certifiable as the most species-rich place on earth; its 341 documented minerals puts it at least even with Franklin and Långban, and ongoing intensive work by Russian mineralogists (the book's author included) is uncovering more species all the time. Nor are all of these species merely exotic trivia—the book's 100+ color photographs provide ample evidence that at least a dozen common to medium-rare species occur at Lovozero in wonderful macrospecimens, some of them the world's best for their species.

The author, Igor V. Pekov, is a mineralogist working at Lomonosov Moscow State University and for the Russian Geological Society. His earlier book, *Minerals First Discovered on the Territory of the Former Soviet Union* (1998), produced by the same publisher (and reviewed here in vol. 30, no. 3, p. 243), has already shown him to be an encyclopedic authority on Russian and former-Soviet Union mineral occurrences once taboo to write about. The old, paranoid Soviet government, Pekov tells us, was always particularly touchy about Lovozero, since one of the massif's unique mineralogical features is a huge deposit of loparite (!) containing the world's largest reserves of tantalum, niobium, and rare-earth elements.

Pekov visited Lovozero for the first time as a student in 1984. He has studied the deposits there seriously since 1992, and began compiling data for this book in 1993. There are 500 bibliographical references, many of them very recent; nearly all of them are technical papers by Russian geologists, geochemists and mineralogists. Pekov, justly calling his book the first "summary" of Lovozero mineralogy and geology, makes clear nevertheless its provi-

sional status by writing that "every new summary publication . . . obligatorily contains [a] significant volume of absolutely new data." And yet the book, despite all its stabilizing weight of research, addresses itself at least as much to non-technical readers (from what Pekov calls "the viewpoint of personal interests and addiction"): offering much collector-targeted information, celebrating the scientific interest and beauty of Lovozero minerals. Most of the specimens photographed (by Nataliya Pekova) come from the author's personal collection, which he proudly describes as containing 175 Lovozero species. And a significant percentage of the original research work in field and lab is the author's too (he even did crystal drawings from measurements he made himself with a goniometer!). The author is both a serious mineralogist and an avid specimen collector—unfortunately a rare combination today.

The book is well-organized, with geography, culture and history, as well as science, respectfully in mind. After an "Editorial" and "Introduction" comes a 15-page "Review of Geography" (large pages, printed in double columns). Then comes an 11-page "Brief Geological and Petrological Review," then a 90-page (!) section on the "History of Study and Exploration" of the massif, summarized helpfully at the end by a chronology of main events. Next, a section called "Pegmatites" details the geology at about 30 mineralogically interesting sites, with an average of a full page of text for each one. The longest section is "Minerals," an alphabetized discussion of all 341 so-far known Lovozero species, this section weighing in at 220 pages. Thirty-five more pages conclude the section with tables on, among other things, minerals first discovered at Lovozero (73; for Långban the number is 67); minerals whose crystal structures were first determined from Lovozero samples; fluorescent Lovozero minerals; and record-sized crystals. Finally there is the bibliography, with, as already mentioned, about 500 titles.

Better than in any other mineral-locality book I know, the "Geography" section conveys a "sense of place" that is almost mystical, and highly evocative of the author's affection for his subject. You might think that feeling this way about a locale in the Arctic Tundra would be difficult—but "tundra" itself, the author points out, really means simply "mountain" or "upland." The Lovozero massif is a circular upland, "a representative of the Lapland Mountains," inhabited (sparsely) by an indigenous people called the Saami, as well as by reindeer, bears and wolves. While the surrounding lowlands are dismal enough—places where "mosquitos stuff nostrils and ears" during the four months or so of perpetually daylit summer—the upland "tundras" are starkly beautiful, dry, dressed modestly in spruce and pine. And how many mineral books spend several lyrical pages in celebration of landscapes decked in mint, burdock, rosebay, cloudberry and reindeer moss? Of course, a generous number of color photographs, as well as geographic sketch-maps, support and validate all this fondness.

The geology/petrology section describes Lovozero as a complex, multiphase intrusion of hyperalkaline rocks pushed up in Devonian times through Precambrian rocks of the Baltic Shield. With an area of about 650 square kilometers, the massif is mineralogically somewhat different from the nearby and larger Khibiny massif; the latter contains economic deposits of fluorapatite, whereas Lovozero contains the loparite ore deposit, with its immense reserves of tantalum and niobium.

In the "History of Study" section, Pekov details many of the adventures and misadventures of previous explorers, missionaries, monks, homesteaders, miners and increasingly serious-minded research scientists who came into the region before and after (mostly after) the discovery of the massif in 1887. Interesting, somewhat spooky old photographs of towns, log cabins, reindeer-powered expeditions, cold-looking people standing by outcrops on the shores of glacial lakes, etc., adorn this section, and there is an increasingly detailed and formalized history of the scientific work, especially after it went into high gear after the "Great Patriotic War," i.e. World War II. Nor does Pekov neglect to salute the efforts of scientists, beginning with A. E. Fersman in the 1920's, who made special efforts to secure good specimens of crystallized Lovozero minerals for museums and private collectors. At present, he says, the largest Lovozero collection, with 1564 specimens as of 1989, is in the Fersman Mineralogical Museum in Moscow. The private collections accumulated in the 1980's by M. F. Korobitsyn and V. G. Grishin are singled out for praise as well.

The "Pegmatites" section takes the reader back to some serious science. Western readers accustomed to thinking of pegmatites as felsic granitic rocks rich in quartz, orthoclase and gem-silicate species like beryl, topaz and the tourmaline group, may be confused at first to discover that Lovozero "pegmatites" are nothing like this at all. Recall that in the strict sense "pegmatite" is a textural designation; it refers to coarse-grained igneous rock with an interlocking texture, usually found as irregular dikes, veins and lenses, especially around the margins of batholiths. The Lovozero pegmatites are sheets, dikes and sills of coarse-grained rock, all right, but the rock is not felsic but hyperalkaline, and so the main groundmass minerals generally are microcline, sodalite, nepheline, aegirine and eudialyte. The other presently active world-class mineral locality of which the reader is constantly reminded is the domelike alkaline intrusive body at Mont Saint-Hilaire, Quebec. The mineral suites at Lovozero are surprisingly similar to those at Mont Saint-Hilaire and at certain other less well-known deposits on the southern fringes of Greenland. As an example of how strange these Lovozero "pegmatites" can be, one of them, which Pekov calls "the narsarsukite occurrence," has a groundmass composed of albite, aegirine, lorenzenite, eudialyte and neptunite, with veins of massive narsarsukite up to 2 meters thick. This section of the book offers precise, detailed, technical descriptions of the structures and mineralogies of 30 of the 1,000 or so noted pegmatite bodies. There are plenty of graphics, especially structural sketches and close-up photographs of rock textures; but there are also surprisingly evocative characterizations such as: "zorite . . . has a pink color . . . resembling that of a bullfinch breast or dawn sky."

The reader thus comes expectantly to the "Minerals" section, with its full descriptions of 341 species. These descriptions treat fully of geologic settings and appearances and sizes of crystals, and are supported by chemical tables showing mineral compositions; there are no X-ray or optical crystallographic data, but for such information the interested reader can consult the professional papers listed in the "References" section. Helpfully, a system of symbols in a prefatory list of mineral species indicates levels of study—from 100% reliably characterized down to "characteristics . . . insufficient to support the diagnostics of the mineral species." And then come the species descriptions, with generous complements of crystal drawings, color photographs of macro and microspecimens, and SEM photographs. A few highlight will serve to demonstrate the significance of this locality for collectors of thumbnail-and-larger specimens: Lovozero has yielded bluish white analcime in sharp crystals to 13 cm; lustrous black prismatic arfvedsonite crystals to 10 cm; yellow belovite-(Ce) crystals "with perfect heads" to 5 cm; chiseled, glassy white, yellow or colorless catapleiite crystals, or catapleiite pseudomorphs after eudialyte crystals, to 3.5 cm; white chkalovite crystals to 5 cm; ivory-colored elpidite in 15-cm clusters of sprays of acicular crystals; the world's finest

eudialyte crystals, red-brown and sometimes partly gemmy, to 7 cm; sharp black ilmenite crystals to 12 cm; snappy bright black interpenetrating-cube twins of loparite-(Ce) to 1 cm; chocolate-brown lorenzenite in blocky, textbook-perfect single crystals and twins to 4 cm; narsarsukite in lustrous yellow or pink transparent crystals to 2.5 cm; good 1.5-cm greenish gray nepheline crystals in red eudialyte matrix; gemmy yellow to orange sphalerite crystals to 1 cm; groups of blocky pale lilac-colored ussingite crystals to 3.5 cm, with sparkling encrustations of colorless microcrystals of gmelinite; and what are probably the world's finest zircon specimens, with brilliant red-brown simple tetragonal bipyramids to 9 cm in sugary albite with green aegirine needles. Finally, this locality, like Mont Saint-Hilaire, is a dreamland for micromounters, pseudomorph specialists, and rare-species aficionados generally. Where else but in this book can you find a good color photograph of a komarovite pseudomorph after vuonnemite?

The book is "heavy" in more ways than one, but a lot of its physical weight is due to the thick, high-quality glossy paper it is printed on. The binding is sturdy, and the jacket design is beautiful and artistic (four small mineral specimens against a background of colorfully flowered tundra). The whole production says durability, care and general "class." The only negative aspect concerns the language of the text, particularly in the opening introductory pages where a scrupulous care for good writing is most important. Although there are two "Editors: Style English" credited, the text can be (depending on the reader's mood) annoying or amusing, but is, in any case, consistently distracting, for its stiff, unidiomatic English and wobbly grammar, and especially for its constant omissions of the little articles "a," "an," and "the." The very first line of text (highlighted in blue) reads "This book is devoted to Lovozero alkaline massif"; the page goes on to say things like "illustrations . . . are very important for characteristics of such rich and beautiful target as Lovozero . . ." and "Complete mineralogical list, long list . . . make this book valuable. . . ." In the Introduction on the next page, meaning itself goes martyred when we read that of 341 species "almost half of them is rare or rarest." The book clearly suffers from an obvious lack of proof editing by a fluently Anglophone eye and ear.

In the table listing species discovered in Lovozero, I counted Pekov's name six times among the names of authors of the original papers—he knows his subject and has brought, in addition, an artistic and specimen-friendly sensibility to the task of writing the first Lovozero "summary" volume. And he has proven that any library containing books on Franklin, Långban, Tsumeb, Cornwall and other great classic localities should also have this one on Lovozero. The price seems reasonable; go for it!

Thomas P. Moore

Diamanten

Published by Christian Weise Verlag, Orleansstrasse 69, D-81667 München, Germany. Softcover, 21 x 30 cm, 104 pages; published as ExtraLapis no. 18, ISBN 3-921656-53-2; price: DM 50.

Following the practice used for the previous monographs in the series, the text flows seamlessly from end to end and the nature and extent of the contributions of the various authors are found only from the index. I find this works quite well. A good deal of attention is paid to the genesis or presumed genesis of the diamond and more, throughout the text, to diamond crystals, which are especially well illustrated. Some notes and illustrations of diamond polishing are included and the troubled and topical question of diamond synthesis and its uncertain history are briefly covered. While there are some illustrations of diamonds in jewelry this aspect of diamonds is touched upon only briefly. Ownership of a set of *extraLapis* is becoming desirable since some of the early numbers are already out of print.

Michael O'Donoghue

L'Émeraude. The Emerald. Connaissances actuelles et prospectives

Edited by Dider Giard, published (199?) by Association française de gemmologie, 48 rue du Faubourg, Montmarte 75009 France. Softcover, 21 x 30 cm, 235 pages, price: contact the publisher.

This is a beautifully illustrated series of papers on emerald, its occurrence, methods of testing and synthesis. The text is arranged by localities, each of which is described with illustrations of characteristic inclusions. Emeralds of gem market importance now have to be accompanied through their commercial wanderings by certificates of origin as well as statements showing whether or not their color has been "improved," so gemmologists will find excellent examples of what they must now seek inside the stones. Readers in this part of the mineral world will find this publication invaluable, coming now quite a long time after the fine survey by Sinkankas, *Emerald and Other Beryls* (1981), since studies are brought right up-to-date with notes on Raman spectroscopy and other fairly new techniques. A retrospective bibliography covers the 1990's and each chapter has its own list of references.

Michael O'Donoghue

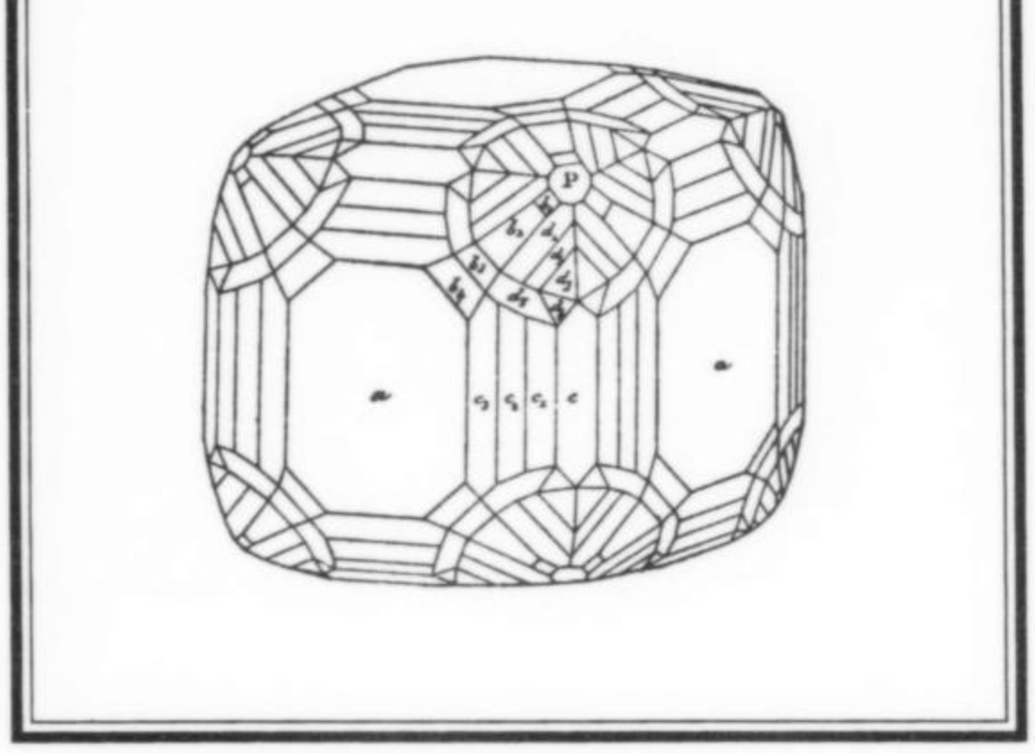
Gold in der Schweiz

by P. Pfander and V. Jans, published (1999) by Ott Verlag, Thun. Second edition, hardcover, 188 pages, ISBN: 3-7225-6300-3; price: DM 43.80 postpaid.

This is the revised edition of a guide to Swiss gold localities first published in 1996, in which the coverage has been enlarged: this is reported to be the result of a greater interest in amateur and other prospecting as well as the probable effect of increased road and other civil engineering projects. After 32 pages of general description of Swiss gold occurrences and gold prospecting methods, the remainder of the text is devoted to a survey of gold occurrences by region: this is roughly in the order central Switzerland, northwest and the Jura, Thun, the Bernese Oberland, Solothurn and Freiburg, western Switzerland and the Geneva area, the upper Valais, Ticino, Grisons and eastern Switzerland. Maps and color photographs illustrate many of the occurrences whose local geology and mineralogy are briefly mentioned. An interesting and useful feature is the use of notes describing the nature of local regulations on prospecting and mining for gold and further notes, where appropriate, on the type of prospecting undertaken. Some local history is also given: there is a general bibliography and some references in the text. The production is attractive and the quality of photographic reproduction good.

Michael O'Donoghue

Abstracts of New Mineral Descriptions



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Bigcreekite

Orthorhombic

$BaSi_2O_5 \cdot 4H_2O$

Locality: The type locality is the Esquire #7 claim (Section 27, T11S, R25E, Mount Diablo Meridian, Lat. 36°55′ N, Long. 119°14′42″ W), along the west side of Big Creek, eastern Fresno County, California, USA. Also along the northwestern slope of Trumbull Peak, Mariposa County, California, USA (NE¼ Section 9, T3S, R19E, Mount Diablo Meridian).

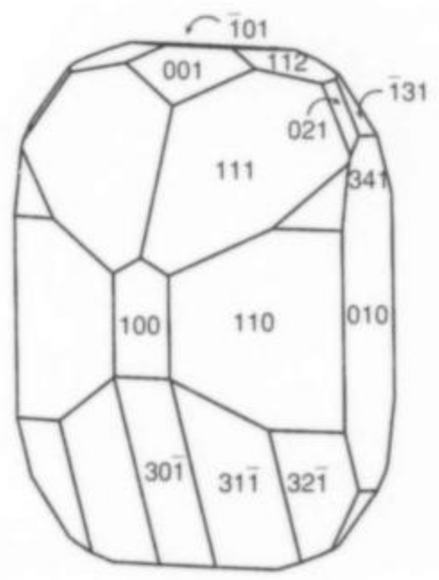
Occurrence: In fractures in gneissic rocks composed of sanbornite, quartz, diopside, pyrrhotite and barium-bearing minerals. Other minerals from the type locality are: alforsite, walstromite, anandite, bazirite, benitoite, celsian, gillespite, fresnoite, muirite, macdonaldite, pellyite, titantaramellite and verplanckite.

General appearance: Subhedral crystalline masses mm in length.

Physical, chemical and crystallographic properties: *Luster:* vitreous to pearly. *Diaphaneity:* probably transparent to translucent. *Color:* white to colorless. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 2 to 3. *Tenacity:* brittle. *Cleavage:* {010} and {001} perfect. *Fracture:* uneven. *Density:* 2.66 g/cm^3 (meas.), 2.76 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, *Pnma*, *a* 5.038, *b* 9.024, *c* 18.321 Å, *V* 833 Å^3, Z 4, *a:b:c* = 0.5583:1:2.0303. Morphology: no forms were mentioned; habit tabular, elongate on [100]. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.068 (100) (013), 4.054 (85) (022), 2.974 (45) (031), 2.706 (60) (124), 2.327 (40) (035), 2.257 (75) (126). ***Optical data:*** Biaxial (+), α 1.537, β 1.538, γ 1.541, 2V(meas.) 59.2°, 2V(calc.) 60°; dispersion r<v, moderate; nonpleochroic; orientation, X = *b*, Y = *a*, Z = *c*. ***Chemical analytical data:*** Means of four sets of electron microprobe data (with H_2O calculated to give $4H_2O$): Na_2O 0.11, CaO 0.03, BaO 48.88, SrO 0.02, SiO_2 38.16, H_2O (22.94), Total (110.14) wt.%. Empirical formula: $(Ba_{1.00}Na_{0.01})_{\Sigma 1.01}Si_{1.99}O_{5.00} \cdot 4.00H_2O$. ***Relationship to other species:*** Its structure has similarities to those of sanbornite and gillespite.

Name: For the locality. ***Comments:*** IMA No. 1999-015.

BASCIANO, L. C., GROAT, L. A., ROBERTS, A. C., GAULT, R. A., DUNNING, G. E., and WALSTROM, R. E. (2001) Bigcreekite: a new barium silicate mineral species from Fresno County, California. *Canadian Mineralogist* **39**, 761–768.



Bradaczekite

Bradaczekite

Monoclinic

$NaCu_4(AsO_4)_3$

Locality: North Breach of the Great fissure eruption, Tolbachik volcano, Kamchatka Peninsula, Russia.

Occurrence: in a fumarole. Associated minerals are: hematite, tenorite, lammerite, urusovite, orthoclase and johillerite.

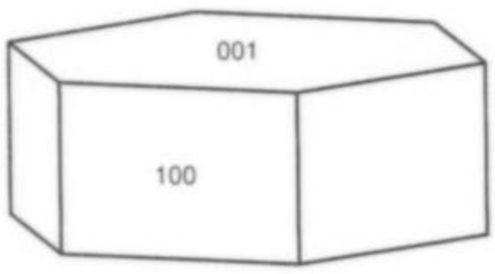
General appearance: Aggregates of elongate plates. Individual crystals are about 0.2 mm long and 0.1 to 0.2 mm across.

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* transparent in transmitted light. *Color:* dark blue. *Streak:* light blue to white. *Luminescence:* nonfluorescent. *Hardness:* not given. *Tenacity:* not given. *Cleavage:* none observed. *Fracture:* not given. *Density:* not given, 4.77 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *C*2/*c*, *a* 12.051, *b* 12.434, *c* 7.2662 Å, β 117.942°, *V* 961.8 Å^3, Z 4, *a:b:c* = 0.9692:1:0.5844. Morphology: {010}, {$\bar{3}$11}, {111}, {$\bar{1}$12} well-developed; {$\bar{3}$01}, {001}, {$\bar{3}$21}, {$\bar{1}$01}, {100}, {021}, {110}, {$\bar{1}$31}, {$\bar{1}$11} and {341} are common. Twinning: none mentioned. ***X-ray powder diffraction data:*** 6.22 (13) (020), 3.60 (21) ($\bar{2}$02), 3.43 (100) ($\bar{1}$12, 310), 3.21 (35) (002), 2.791 (24) ($\bar{4}$02), 2.696 (18) (330), 2.683 (30) (240), 2.665 (17) (400). ***Optical data:*** Biaxial (−), α 1.76, β 1.92, γ 1.96, 2V(calc.) 50°; dispersion not given; strong pleochroism X = violet-red, Y = green, Z = greenish blue; Z = *b*, X∧*c* = 23° (in obtuse angle β), Z∧*c* = 5° (in obtuse angle β). ***Chemical analytical data:*** Means of thirty-seven sets of electron microprobe data: Na_2O 5.17, K_2O 0.35, CuO 43.13, ZnO 0.79, Fe_2O_3 0.38, As_2O_5 49.62, V_2O_5 0.13, Total 99.57 wt.% (given as 99.55). Empirical formula:

$(Na_{1.16}K_{0.05})_{\Sigma 1.21}(Cu_{3.76}Zn_{0.07}Fe^{3+}_{0.03})_{\Sigma 3.86}(As_{1.00}O_{4.00})_{3.00}$. ***Relationship to other species:*** It is the Na-, Cu- and AsO_4-dominant member of the alluaudite group.

Name: For Hans Bradaczek (1940–), crystallographer at the Free University, Berlin. ***Comments:*** IMA No. 2000-002.

FILATOV, S. K., VERGASOVA, L. P., GORSKAYA, M. G., KRIVOVICHEV, S. V., BURNS, P. C., and ANANIEV, V. V. (2001) Bradaczekite, $NaCu_4(AsO_4)_3$, a new mineral species from the Tolbachik volcano, Kamchatka Peninsula, Russia. *Canadian Mineralogist* **39**, 1115–1119.



Carraraite

Carraraite

Hexagonal

$Ca_3Ge(OH)_6(SO_4)(CO_3)\cdot 12H_2O$

Locality: Gioia quarry, Colonnata valley, Carrara basin, Apuan Alps, northern Tuscany, Italy.

Occurrence: In calcite vein cavities within the famous Carrara marble. Associated minerals are: azurite and volborthite. It is a hydrothermal alteration product of copper-vanadium sulfides such as sulvanite and colusite. Crystals of colusite with Ge contents of 1.3 wt.% have been found in the Carrara area.

General appearance: Prismatic to tabular submillimetric crystals.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* white. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* not given. *Tenacity:* not given. *Cleavage:* none observed. *Fracture:* not given. *Density:* could not be measured because of the small size, 1.97 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3/m$, *a* 11.056, *c* 10.629 Å, *V* 1125.2 Å^3, Z 2, *c:a* = 0.9614. Morphology: {100}, {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 9.57 (vs) (100), 5.53 (s) (110), 3.83 (s) (112), 3.56 (ms) (202), 2.74 (ms) (302), 2.53 (m) (213), 2.38 (m) (312), 2.18 (m) (223), 2.13 (m) (313). ***Optical data:*** Uniaxial (−), ω 1.509, ε 1.479, nonpleochroic. ***Chemical analytical data:*** Means of seven sets of electron microprobe data: CaO 35.70, GeO_2 18.15, SO_3 16.19, Total 70.04 wt.%. The sample decomposed in the electron beam. Here, 53.75 wt.% H_2O and 8.75 wt.% CO_2 were added to give 15(H_2O) and 1(CO_3); this raises the analytical total to 132.54 wt.%. Recalculation to give 100.00 wt.% gives: CaO 26.94, GeO_2 13.69, SO_3 12.22, CO_2 (6.60), H_2O (40.55), Total (100.00) wt.%. Empirical formula: $Ca_{3.20}Ge_{0.87}(OH)_{5.84}(SO_4)_{1.02}(CO_3)_{1.00}\cdot 12.08H_2O$. ***Relationship to*** other ***species:*** It is a member of the ettringite group.

Name: For the Carrara region. ***Comments:*** IMA No. 1998-002. Because of the very small size of the crystals, many of the usual physical properties could not be determined. Prof. Merlino kindly supplied additional data. The crystal drawing produced here is based on the SEM image in the paper.

MERLINO, S. and ORLANDI, P. (2001) Carraraite and zaccagnaite, two new minerals from the Carrara marble quarries: their chemical compositions, physical properties, and structural features. *American Mineralogist* **86**, 1293–1301.

Clearcreekite

Monoclinic

$Hg_3^{1+}(CO_3)(OH)\cdot 2H_2O$

Locality: A small prospect pit near the long-abandoned Clear Creek mercury mine, New Idria district, San Benito County, California, USA.

Occurrence: In a brecciated rock consisting mainly of ferroan magnesite and quartz. Associated minerals are: cinnabar and edoylerite.

General appearance: A small cluster of subhedral crystals (up to 0.17 mm).

Physical, chemical and crystallographic properties: *Luster:* given as vitreous but optical data indicate adamantine. *Diaphaneity:* transparent. *Color:* pale greenish yellow. *Streak:* pale greenish yellow. *Luminescence:* nonfluorescent. *Hardness:* could not be measured but probably is low. *Tenacity:* brittle. *Cleavage:* {001} good. *Fracture:* uneven. *Density:* could not be measured, 6.82 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1/c$, *a* 6.760, *b* 9.580, *c* 10.931 Å, β 105.53°, *V* 682.1 Å^3, Z 4, *a:b:c* = 0.7056:1:1.1410. Morphology: {001} major and {010} minor. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.09 (70) (011), 5.40 (30) (110), 5.32 (40) ($\bar{1}11$), 4.62 (90) (012), 3.058 (30) (031), 2.831 (100) (023), 2.767 (100) (211, $\bar{2}21$), 2.486 (30) (202), 2.391 (40) (040, $\bar{2}04$), 1.692 (30) ($\bar{2}44$, $\bar{4}02$). ***Optical data:*** No data could be measured. Indices of refraction probably are higher than 2. ***Chemical analytical data:*** An electron microprobe analysis gave Hg_2O 84.65 and values of CO_2 and H_2O of 6.16 and 6.30, respectively were calculated from the crystal structure data, Total 97.11 wt.%. Empirical formula: $Hg^{1+}_{2.92}(CO_3)_{1.01}(OH)_{0.90}\cdot 2.07H_2O$. ***Relationship to other species:*** It is a monoclinic polymorph of peterbaylissite.

Name: For the locality. ***Comments:*** IMA No. 1999-003. The crystal structure has been solved.

ROBERTS, A. C., GROAT, L. A., RAUDSEPP, M., ERCIT, T. S., ERD, R. C., MOFFATT, E. A., and STIRLING, J. A. R. (2001) Clearcreekite, a new polymorph of $Hg_3^{1+}(CO_3)(OH)\cdot 2H_2O$, from the Clear Creek claim, San Benito County, California. *Canadian Mineralogist* **39**, 779–784.

Ekatite

Hexagonal

$(Fe^{3+},Fe^{2+},Zn)_{12}(OH)_6(AsO_3)_6[AsO_3,HOSiO_3]_2$

Locality: Tsumeb, Namibia.

Occurrence: Associated minerals are: etched quartz and chalcocite.

General appearance: Sprays of striated, fine needles (up to 2 mm long and less than 0.2 mm in diameter).

Physical, chemical and crystallographic properties: *Luster:* given as bright vitreous, but the indices of refraction indicate adamantine. *Diaphaneity:* translucent. *Color:* brownish black. *Streak:* brown. *Luminescence:* nonfluorescent. *Hardness:* about 3. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* not given. *Density:* not measured, 4.11 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3mc$, *a* 12.773, *c* 5.051 Å, *V* 713.7 Å^3, Z 1, *c:a* = 0.3954. Morphology: indistinct {hk0} forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 11.11 (30) (100), 6.37 (50) (110), 3.220 (100) (211, 220), 2.766 (30) (400), 2.420 (70) (401, 410), 1.867 (30) (402), 1.672 (30) (521), 1.507 (30) (701, 531). ***Optical data:*** Uniaxial (+), ω ~ 1.99, ε ~ 2.08, pleochroism O = dark brownish clack, E = medium brown. ***Chemical analytical data:*** Means of two sets of elec-

tron microprobe data: FeO 21.19, ZnO 3.80, Fe_2O_3 27.26, As_2O_3 42.56, SiO_2 2.12, H_2O 3.42, Total 100.35 wt.%. The structure determination was the basis for calculating Fe^{3+} and Fe^{2+} from total Fe and H_2O from OH. Empirical formula: $(Fe^{3+}_{6.02}Fe^{2+}_{5.20}Zn_{0.82})_{\Sigma 12.04}(OH)_{6.07}(AsO_3)_{6.06}[(AsO_3)_{1.52}(HOSiO_3)_{0.62}]_{\Sigma 2.14}$. ***Relationship to other species:*** Structurally related to phosphoellenbergerite, ellenbergerite and holtedahlite.

Name: For Dieter Ekat (1935–1996), a Namibian mining engineer and former owner of the Rubicon mine, Namibia. ***Comments:*** IMA No. 1998-024. The subscripts of the empirical formula given here are slightly different from those given in the paper.

KELLER, P. (2001) Ekatite, $(Fe^{3+},Fe^{2+},Zn)_{12}(OH)_6[AsO_3]_6[AsO_3,HOSiO_3]_2$, a new mineral from Tsumeb, Namibia, and its crystal structure. *European Journal of Mineralogy* **13**, 769–777.

Fencooperite

Trigonal

$Ba_6Fe^{3+}_3Si_8O_{23}(CO_3)_2Cl_3 \cdot H_2O$

Locality: Trumbull Peak, on the western slope of the Sierra Nevada Range in NE S. 9, T3S, R19E, Mount Diablo Meridian (Lat. 37°40′58″ N, Long. 119°47′08″ W), about 67 km northeast of Merced and 8 km west of El Portal, Mariposa County, California, USA.

Occurrence: In barium-silicate-rich lenses in quartzite. Associated minerals are: sanbornite, gillespite, quartz, titantaramellite, anandite and kinoshitalite. The fencooperite occurs in black aggregates which also contain celsian, alforsite, barite, sanbornite, quartz, pyrrhotite and diopside.

General appearance: Anhedral to roundish to platy grains (up to 100 μm).

Physical, chemical and crystallographic properties: *Luster:* vitreous to adamantine. *Diaphaneity:* opaque to translucent. *Color:* jet black to dirty gray-brown (on very thin edges). *Streak:* grayish black. *Luminescence:* nonfluorescent. *Hardness:* VHN_{10} 321 kg/mm², Mohs 4½ to 5. *Tenacity:* brittle. *Cleavage:* none obvious. *Fracture:* uneven to subconchoidal. *Density:* could not be measured, 4.21 g/cm³ (calc.). ***Crystallography:*** Trigonal, *P*3*m*1, *a* 10.74, *c* 7.095 Å, *V* 708.7 Å³, Z 1, *c*:*a* = 0.6606. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 3.892 (100) (201), 3.148 (40) (211), 2.820 (90) (202), 2.685 (80) (220), 2.329 (30) (302, 400), 2.208 (40) (401), 2.136 (40) (222), 2.106 (30) (203). ***Optical data:*** Uniaxial (−), ω 1.723, ε 1.711, strong pleochroism O = blue black, E = light greenish gray. ***Chemical analytical data:*** Means of twelve sets of electron microprobe data: BaO 50.51, MnO 0.15, Al_2O_3 1.35, Fe_2O_3 12.77, P_2O_5 0.16, H_2O (0.98), CO_2 (4.81), Cl 3.23, sum 101.34, less O = Cl 0.73, Total (100.61) wt.%. The valence of Fe and amounts of H_2O and CO_2 were determined from the crystal structure analysis. Empirical formula: $Ba_{5.89}(Fe^{3+}_{2.86}Mn_{0.04})_{\Sigma 2.90}(Si_{8.14}Al_{0.47}P_{0.04})_{\Sigma 8.65}O_{23.18}(CO_3)_{1.95}(Cl_{1.63}O_{1.37})_{\Sigma 3.00} \cdot 0.97H_2O$. ***Relationship to other species:*** None apparent.

Name: For Joseph Fenimore ("Fen") Cooper, Jr. (1937–), of Santa Cruz, California, who helped collect the samples containing the mineral. ***Comments:*** IMA No. 2000-023.

ROBERTS, A. C., GRICE, J. D., DUNNING, G. E., and VENANCE, K. E. (2001) Fencooperite, $Ba_6Fe^{3+}_3Si_8O_{23}(CO_3)_2Cl_3 \cdot H_2O$, a new mineral species from Trumbull Peak, Mariposa County, California. *Canadian Mineralogist* **39**, 1059–1064. GRICE, J. D. (2001) The crystal structure of fencooperite: unique $[Fe^{3+}_3O_{13}]$ pinwheels cross-connected by $[Si_8O_{22}]$ islands. *Canadian Mineralogist* **39**, 1065–1071.

Kampfite

Hexagonal

$Ba_6[(Si,Al)O_2]_8(CO_3)_2Cl_2(Cl,H_2O)_2$

Locality: Esquire #1 claim, Rush Creek, eastern Fresno County, California, USA (NE¼ NW¼ Section 16, T11S, R25E, Mount Diablo Meridian, Lat. 37°05′ N, Long. 119°16′20″ W). Kampfite has been found also at the Esquire #7 claim, along Big Creek, Fresno County, California, USA (SE¼ SE¼ Section 27, T11S, R25E, Mount Diablo Meridian, Lat. 36°56′40″ N, Long. 119°14′28″ W).

Occurrence: In a quartz-sanbornite outcrop. Associated minerals are: celsian, fresnoite, macdonaldite, pyrrhotite, titantaramellite, traskite, witherite, two new minerals and a hydrated form of SiO_2.

General appearance: Irregular masses up to 1 cm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* light blue-gray. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 3. *Tenacity:* brittle. *Cleavage:* {001} well-developed. *Fracture:* uneven. *Density:* could not be measured because of the presence of numerous inclusions, 3.51 g/cm³ (calc.). ***Crystallography:*** Hexagonal, $P6_3/mmc$, $P\bar{6}2c$, $P6_3mc$, $P\bar{3}_1c$ or $P3_1c$. *a* 5.244, *c* 29.83 Å, *V* 710.5 Å³, Z 1, *c*:*a* = 5.6884. Morphology: no forms were observed . Twinning: none observed. ***X-ray powder diffraction data:*** 14.67 (100) (002), 3.883 (100) (104), 3.357 (50) (106), 2.988 (60) (00.10), 2.887 (50) (108), 2.616 (70) (110), 1.969 (50) (1.1.10). ***Optical data:*** Uniaxial (−), ω 1.642, ε 1.594, nonpleochroic. One grain is biaxial (−), α 1.641, β 1.642, γ(calc.) 1.642, 2V(meas.) 20°, dispersion r<v slight. ***Chemical analytical data:*** Means of three sets of electron microprobe data (with CO_2 and H_2O calculated by stoichiometry): Na_2O 0.08, CaO 0.06, BaO 57.72, Al_2O_3 7.76, CO_2 (5.69), SiO_2 20.14, H_2O (1.16), Cl 5.60, sum 98.21, less O = Cl 1.27, Total (96.94) wt.%. Empirical formula: $(Ba_{5.83}Na_{0.04}Ca_{0.02})_{\Sigma 5.89}[(Si_{5.19}Al_{2.36})_{\Sigma 7.55}O_{15.08}](CO_3)_{2.00}Cl_{2.00}[(H_2O)_{1.00}Cl_{0.45}]_{\Sigma 1.45}$. ***Relationship to other species:*** The only other barium silicate carbonate mineral is fencooperite, $Ba_6Fe^{3+}_3Si_8O_{23}(CO_3)_2Cl_3 \cdot H_2O$.

Name: For Dr Anthony Robert Kampf (1948–), Curator and Section Head of Minerals, Los Angeles County Museum of Natural History, for his many contributions to the crystallographic study of new and rare minerals. ***Comments:*** IMA No. 2000-003.

BASCIANO, L. C., GROAT, L. A., ROBERTS, A. C., GRICE, J. D., DUNNING, G. E., FOORD, E. E., KJARSGAARD, I. M., and WALSTROM, R. E. (2001) Kampfite, a new barium silicate carbonate mineral species from Fresno County, California. *Canadian Mineralogist* **86**, 1053–1058.

Krettnichite

Monoclinic

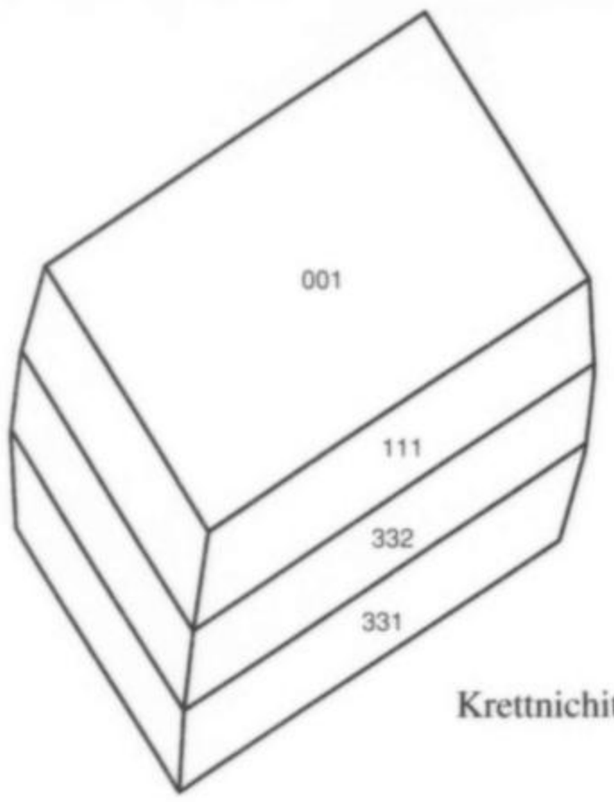
$PbMn^{3+}_2(VO_4)_2(OH)_2$

Locality: Dumps of the manganite deposit at Krettnich, Saarland, Germany.

Occurrence: In vugs in a hydrothermal manganite-quartz vein. Associated minerals are: manganite, quartz, barite, ankerite, mottramite barian brackebuschite and cuprian-cobaltoan pyrobelonite.

General appearance: Radiating aggregates (up to 3 cm in diameter) of platy crystals (less than 1 mm).

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* transparent in thin cleavage plates. *Color:*



Krettnichite

brown to black with orange-red internal reflections. *Streak:* brown. *Luminescence:* nonfluorescent. *Hardness:* VHN_{100} 276 kg/mm² ⊥ (001), 347 kg/mm² ∦ (001), Mohs 4½. *Tenacity:* not given. *Cleavage:* {001} excellent and another at a high angle to {001} distinct. *Fracture:* not given. *Density:* could not be measured but the mineral sinks in Clerici solution (D = 4.04 g/cm³), 4.75 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 9.275, *b* 6.284, *c* 7.682 Å, β 117.97°, *V* 395.4 Å³, Z 2, *a:b:c* = 1.4760:1:1.2225. Morphology: {001}, {111}, {332} and {331}; pseudo-rhombohedral. Twinning: polysynthetic on (001). ***X-ray powder diffraction data:*** 4.695 (34) (11$\bar{1}$), 3.388 (95) (002), 3.270 (100) (11$\bar{2}$), 2.946 (51) (201), 2.850 (49) (021), 2.4910 (93) (310, 220), 1.8693 (35) (113), 1.6970 (83) (004). ***Optical data:*** In reflected light: reddish brown, strong anisotropism but rotation tints are not very colorful; distinct bireflectance, slight pleochroism. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (15.8, 19.2; 4.35, 6.45 %) 470nm, (14.8, 17.8; 3.79, 5.67 %) 546nm, (14.4, 17.3; 3.63, 5.35 %) 590nm, (14.1, 16.8; 3.48, 5.06 %) 650nm. Calculated indices of refraction are: n_1 2.21, n_2 2.39 for light of 590nm wavelength. ***Chemical analytical data:*** Means of fifty-four sets of electron microprobe data: CaO 0.60, NiO 0.04, CoO 2.22, CuO 0.42, SrO 1.48, BaO 0.90, PbO 32.66, Al_2O_3 0.04, Mn_2O_3 24.03, Fe_2O_3 1.25, V_2O_5 29.26, As_2O_5 2.92, H_2O 3.54, Total 99.36 wt.% (given as 99.43). Empirical formula: $(Pb_{0.83}Co_{0.17}Sr_{0.08}Ca_{0.06}Ba_{0.03}Cu_{0.03})_{\Sigma 1.20}(Mn_{1.73}Fe_{0.09})_{\Sigma 1.82}[(V_{1.86}As_{0.14})O_4]_{1.97}(OH)_{2.23}$. The empirical formula has an excess -0.28 charge. ***Relationship to other species:*** It is a member of the tsumcorite group and the Mn^{3+}-dominant analogue of mounanaite, $PbFe_2^{3+}(VO_4)_2(OH)_2$.

Name: For the locality. ***Comments:*** IMA No. 1998-044. The crystal drawing in the paper is not in a standard orientation so it has been redrawn here.

BRUGGER, J., ARMBRUSTER, T., CRIDDLE, A., BERLEPSCH, P., GRAESER, S., and REEVES, S. (2001) Description, crystal structure, and paragenesis of krettnichite, $PbMn_2^{3+}(VO_4)_2(OH)_2$, the Mn^{3+} analogue of mounanaite. *European Journal of Mineralogy* **13**, 145–158.

Levinsonite-(Y)

Monoclinic

$(Y,Nd,Ce)Al(SO_4)_2(C_2O_4)\cdot 12H_2O$

Locality: Alum Cave Bluff, Great Smoky Mountains National Park, Tennessee, USA.

Occurrence: In an evaporite assemblage. Associated minerals are: coskrenite-(Ce), zugshunstite-(Ce), melanterite, halotrichite, pickeringite, apjohnite, epsomite and other hydrated sulfates.

General appearance: Individual euhedral prismatic crystals or groups of five to ten randomly oriented crystals (up to approximately 1 mm long).

Physical, chemical and crystallographic properties: *Luster:* not given but probably vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* none observed. *Hardness:* not determined. *Tenacity:* brittle. *Cleavage:* {101} perfect. *Fracture:* irregular. *Other properties:* soluble in H_2O. *Density:* not determined, 2.18 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *P2/n*, *a* 10.289, *b* 9.234, *c* 11.015 Å, β 108.50°, *V* 992.5 Å³, Z 2, *a:b:c* = 1.1143:1:1.1929. Morphology: {101}, {010}, {$\bar{1}$01}, prismatic along [101] and flattened on {101}. Note: The third form is given by the authors as {101} but probably is {$\bar{1}$01}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 9.3 (100) (010), 6.28 (90) ($\bar{1}$01), 5.20 (40) (111), 4.89 (60) (200), 4.63 (30) ($\bar{1}$12), 4.09 (50) ($\bar{1}$21), 3.700 (30) (112, 121, $\bar{1}$03), 3.447 (30) (022, 301, $\bar{1}$13), 2.867 (30) (301, 113), 2.747 (30) (131, $\bar{3}$21, $\bar{3}$13, $\bar{2}$23, 311), 2.518 (30) ($\bar{4}$02, 014, 123, $\bar{2}$32). ***Optical data:*** Biaxial (sign not given but +), α 1.48, β 1.49, γ 1.55, 2V(meas.) 7°, 2V(calc.) 46°; dispersion none observed; nonpleochroic; X ~ *c*, Y = *b*, Z ∧ *c* given as 19°, but this must be Z ∧ *a* = 19° (in obtuse angle β). ***Chemical analytical data:*** Means of an unstated number of sets of electron microprobe data: Y_2O_3 5.72, La_2O_3 0.50, Ce_2O_3 3.02, Pr_2O_3 0.76, Nd_2O_3 5.94, Sm_2O_3 3.21, Eu_2O_3 0.54, Gd_2O_3 2.23, Dy_2O_3 1.15, Er_2O_3 0.29, Al_2O_3 7.83, SO_3 24.58, C_2O_3 (11.05), H_2O (33.18), Total (100.00) wt.%. C_2O_3 and H_2O were calculated to give 1.00(C_2O_4) and 12(H_2O), respectively. Empirical formula: $(Y_{0.33}Nd_{0.23}Ce_{0.12}Sm_{0.12}Gd_{0.08}Dy_{0.04}Pr_{0.03}La_{0.02}Eu_{0.02}Er_{0.01})_{\Sigma 1.00}Al_{1.00}(SO_4)_{2.00}(C_2O_4)_{1.00}\cdot 12.00H_2O$. ***Relationship to other species:*** None stated.

Name: For Prof. A. A. Levinson (1927–), University of Calgary (Alberta, Canada), originator of the internationally used nomenclature for rare earth element minerals. ***Comments:*** IMA No. 1996-057.

ROUSE, R. C., PEACOR, D. R., ESSENE, E. J., COSKREN, T. D., and LAUF, R. J. (2001) The new minerals levinsonite-(Y) [(Y,Nd,Ce)$Al(SO_4)_2(C_2O_4)\cdot 12H_2O$] and zugshunstite-(Ce) [(Ce,Nd,La)$Al(SO_4)_2(C_2O_4)\cdot 12H_2O$]: Coexisting oxalates with different structures and differentiation of LREE and HREE. *Geochimica et Cosmochimica Acta* **65**, 1101–1115.

Lisitsynite

Orthorhombic

$KBSi_2O_6$

Locality: Koashva quarry, Khibina alkaline massif, Kola Peninsula, Russia.

Occurrence: In an intensely mineralized pipe-like pegmatite body intruded into ijolite-urtite along its contact with an apatite-nepheline rock. Associated minerals are: potassium feldspar, sodalite, cancrinite, pectolite, aegirine, natrite, villiaumite, lomonosovite, chkalovite, nacaphite, fluorcaphite, vitusite, sphalerite and galena.

General appearance: Irregularly shaped grains and subhedral tabular crystals (0.2 to 0.5 mm across).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* fluoresces bright pink under short-wave ultraviolet light. *Hardness:* 5 to 6. *Tenacity:* brittle. *Cleavage:* {010} good. *Fracture:* subconchoidal. *Density:* 2.74 g/cm³ (meas.), 2.75 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, $P2_12_12_1$,

a 9.9630, *b* 10.4348, *c* 4.7044 Å, *V* 489.08 Å^3, Z 4, *a:b:c* = 0.9548:1:0.4508. Morphology: {010} and {110}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.944 (5) (111), 3.495 (8) (021), 3.282 (10) (121, 130), 3.149 (4) (310), 2.704 (4) (301, 131), 2.293 (4) (012, 102). ***Optical data:*** Biaxial (–), α 1.561, β 1.563, γ 1.564, 2V(meas.) 51°, 2V(calc.) 70°; dispersion r>v, strong; nonpleochroic; orientation, X = *a*, Y = *b*, Z = *c*. ***Chemical analytical data:*** Means of five sets of electron microprobe data: Na_2O 0.00, K_2O 23.50, B_2O_3 17.17, SiO_2 58.94, Total 99.61 wt.%. Empirical formula: $K_{1.01}B_{1.00}Si_{1.99}O_{6.00}$. ***Relationship to other species:*** None apparent.

Name: For Apollon E. Lisitsyn (1928–1999), well-known Russian specialist in the mineral resources, geology and mineralogy of boron deposits. ***Comments:*** IMA No. 2000-008.

KHOMYAKOV, A. P., NECHELYUSTOV, G. N., SOKOLOVA, E. V., and HAWTHORNE, F. C. (2000) New borosilicates: malinkoite, $NaBSiO_4$, and lisitsynite, $KBSi_2O_6$, from alkaline pegmatites of the Khibiny-Lovozero complex, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **129(6)**, 35–42.

Londonite

Cubic

$(Cs,K,Rb)Al_4Be_4(B,Be)_{12}O_{28}$

Locality: The type locality is Antandrokomby pegmatite, near Mt Ibity, south of the Sahatany Valley, Madagascar. Also from the Ampanivana and Antsongombato pegmatites.

Occurrence: In the pocket zone of the pegmatite. Associated minerals are: quartz, albite, red tourmaline, microcline and danburite.

General appearance: Two well-formed crystals 1 cm across (type locality). Also up to 7 cm across at Antsongombato.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent to transparent. *Color:* milky white to yellow. *Streak:* white. *Luminescence:* weak yellow-green fluorescence under short-wave ultraviolet light. *Hardness:* 8. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* conchoidal. *Density:* 3.34 g/cm^3 (meas.), 3.42 g/cm^3 (calc.). ***Crystallography:*** Cubic, $P\bar{4}3m$, *a* 7.3205 Å, V 392.30 Å^3, Z 1. Morphology: dodecahedron {110}, tristetrahedron {211}, tetrahedron {111}, deltoid dodecahedron {221} and rare cube {100}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.320 (20) (100), 3.274 (50) (210), 2.9898 (100) (211), 2.4410 (50) (300, 221), 2.2072 (20) (311), 2.1132 (35) (222), 1.9565 (20) (321), 1.8301 (20) (400), 1.7755 (25) (410, 322). ***Optical data:*** Isotropic, n 1.693. ***Chemical analytical data:*** Means of five sets of electron microprobe data (with BeO and B_2O_3 calculated to give 5.00 Be and 11.00 B, respectively): Li_2O 0.04, Na_2O 0.11, K_2O 2.21, Cs_2O 8.37, Rb_2O 1.04, BeO (15.49), MgO n.d., CaO 0.14, MnO 0.05, B_2O_3 ((47.39), Al_2O_3 25.10, Fe_2O_3 0.06, SiO_2 0.07, Total (100.07) wt.%. Empirical formula: $(Cs_{0.48}K_{0.38}Rb_{0.09}Na_{0.03}Ca_{0.02}Mn_{0.01})_{\Sigma 1.01}(Al_{3.97}Li_{0.02}Fe_{0.01})_{\Sigma 4.00}Be_{4.00}[(B_{10.99}Si_{0.01})_{\Sigma 11.00}Be_{1.00}]_{\Sigma 12.00}O_{28.00}$. ***Relationship to other species:*** It is the Cs-dominant analogue of rhodizite, $(K,Cs)Al_4Be_4(B,Be)_{12}O_{28}$.

Name: For Dr. David London (1953–), Professor of Geology and Geophysics at the University of Oklahoma. ***Comments:*** IMA No. 1999-014.

SIMMONS, W. B., PEZZOTTA, F., FALSTER, A. U., and WEBBER, K. L. (2001) Londonite, a new mineral species: the Cs-dominant analogue of rhodizite from the Antandrokomby granitic pegmatite, Madagascar. *Canadian Mineralogist* **39**, 747–755.

Malinkoite

Hexagonal

$NaBSiO_4$

Locality: Mount Karnasurt, Lovozero alkaline massif, Kola Peninsula, Russia.

Occurrence: In an intensely mineralized hyperagpaitic pegmatite intruded into foyaite. Associated minerals are: ussingite, chkalovite, nordite, gerasimovskite and neptunite.

General appearance: Rosette-like intergrowths of wedge-shaped crystals and spherulites (up to 3 mm across).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to slightly turbid. *Color:* colorless, pale pink or greenish-blue. *Streak:* white. *Luminescence:* fluoresces dull pinkish lilac under short-wave and bright greenish yellow under long-wave ultraviolet light. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* {h00} and {001} good. *Fracture:* uneven to splintery. *Density:* 2.90 g/cm^3 (meas.), 2.92 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3$, *a* 13.8964, *c* 7.7001 Å, *V* 1287.8 Å^3, Z 18, *c:a* = 0.5541. Morphology: {h00} and {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.86 (6) (002), 3.61 (6) (012), 2.780 (10) (032), 2.320 (7) (330), 2.216 (9) (331), 1.928 (5) (250), 1.721 (7) (333). ***Optical data:*** Uniaxial (–), ω 1.591, ε 1.582, nonpleochroic. The abstract of the paper states that the mineral is biaxial (-) but it is clearly uniaxial (–). ***Chemical analytical data:*** Means of seven sets of electron microprobe data: Na_2O 24.36, K_2O 0.00, B_2O_3 26.88, SiO_2 47.83, Total 99.07 wt.%. Empirical formula: $Na_{1.00}B_{0.98}Si_{1.01}O_{4.00}$. ***Relationship to other species:*** It has some structural similarities to kalsilite, $KAlSiO_4$, and beryllonite, $NaBePO_4$.

Name: For Svetlana V. Malinko (1927–), well-known Russian mineralogist and discoverer of many boron minerals. ***Comments:*** IMA No. 2000-009. The crystal structure has been solved.

KHOMYAKOV, A. P., NECHELYUSTOV, G. N., SOKOLOVA, E. V., and HAWTHORNE, F. C. (2000) New borosilicates: malinkoite, $NaBSiO_4$, and lisitsynite, $KBSi_2O_6$, from alkaline pegmatites of the Khibiny-Lovozero complex, Kola Peninsula. *Zapiski Vserossiyskogo Mineralogicheskogo Obshchestva* **129(6)**, 35–42.

Micheelsenite

Hexagonal

$(Ca,Y)_3Al(PO_3OH,CO_3)(CO_3)(OH)_6 \cdot 12H_2O$

Locality: The Poudrette quarry, Mont Saint-Hilaire, Rouville County, Quebec, Canada and the Nanna pegmatite, Narsaarsuup Qaava, South Greenland.

Occurrence: Associated minerals at Mont Saint-Hilaire are: aegirine, albite, ancylite-(Ce), catapleiite, fluorite, microcline, monteregianite-(Y), natrolite, nenadkevichite, rhodochrosite and serandite in pegmatites; and natrolite, titanite, calcite and pyrite in hornfels. Associated minerals at Nanna are aegirine, astrophyllite, analcime, calcio-ancylite-(Ce), catapleiite, fluorite, galena, gibbsite, leucophanite, microcline, natrolite, nafertisite, orthoclase, polylithionite, sodalite (var. hackmanite) and todorokite.

General appearance: Acicular to fibrous crystals (up to 2 mm long) in loosely packed radiating groups (up to 3 mm in diameter) and as matted fibers. Also as rounded plates 0.6 mm in diameter and 0.1 mm thick.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* white to

colorless. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 3½ to 4. *Tenacity:* brittle. *Cleavage:* {100} and {001} good. *Fracture:* splintery. *Density:* 2.15 g/cm^3 (meas.), 2.17 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3$, *a* 10.828, *c* 10.516 Å, *V* 1067.8 Å^3, Z 2, *c:a* = 0.9712. Morphology: {001} and probably {100}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 9.38 (100) (100), 4.82 (40) (111), 4.59 (70) (102), 3.77 (50) (112), 3.36 (55) (211), 2.691 (45) (302), 2.491 (80) (213), 2.143 (65) (223). ***Optical data:*** Uniaxial (−), ω 1.532, ε 1.503, nonpleochroic. ***Chemical analytical data:*** Means of three sets of electron microprobe data: CaO 16.90, Al_2O_3 6.70, Y_2O_3 18.07, Gd_2O_3 0.84, Dy_2O_3 2.65, Ho_2O_3 0.51, Er_2O_3 1.88, SiO_2 0.07, P_2O_5 7.80, SO_3 0.53, CO_2 (8.38), H_2O (43.01), Total (107.34) wt.%. CO_2 and H_2O were indicated by infra red and structural data and their amounts were calculated from the stoichiometry. Empirical formula: $(Ca_{1.96}Y_{1.04}Dy_{0.09}Er_{0.06}Gd_{0.03}Ho_{0.02})_{\Sigma 3.20}Al_{0.85}[(P_{0.71}C_{0.24}S_{0.04}Si_{0.01})_{\Sigma 1.00}O_{3.00}(OH)_{1.00}](CO_3)(OH)_{6.00}$. ***Relationship to other species:*** A member of the ettringite group.

Name: For Dr. H. I. Micheelsen (1931–), Professor Emeritus, University of Copenhagen, Denmark. Dr. Micheelsen discovered the Nanna pegmatite in 1963. ***Comments:*** IMA No. 1999-033. The crystal structure has been solved.

MCDONALD, A. M., PETERSEN, O. V., GAULT, R. A., JOHNSEN, O., NIEDERMAYR, G., BRANDSTÄTTER, F., and GIESTER, G. (2001) Micheelsenite, $(Ca,Y)_3Al(PO_3OH,CO_3)(CO_3)(OH)_6 \cdot 12H_2O$, a new mineral from Mont Saint-Hilaire, Quebec, Canada and the Nanna pegmatite, Narsaarsuup Qaava, South Greenland. *Neues Jahrbuch für Mineralogie, Monatshefte* **2001**, 337–351.

Orthojoaquinite-(La)

Orthorhombic

$Ba_2NaLa_2Fe^{2+}Ti_2Si_8O_{26}(O,OH) \cdot H_2O$

Locality: The Ilímaussaq alkaline complex, on the right bank of the Narsaq River at the foot of Kvansfjeld Mountain, south Greenland.

Occurrence: In the intermediate zone of nepheline-syenite pegmatites. Associated minerals are: riebeckite, analcime, sodalite and steenstrupine-(Ce).

General appearance: Banded gneissic masses (up to 4 x 3 x 1 cm) consisting of bent flakes 1 mm long.

Physical, chemical and crystallographic properties: *Luster:* silky. *Diaphaneity:* transparent. *Color:* brown. *Streak:* unknown. *Luminescence:* not reported. *Hardness:* VHN 350-430 kg/mm^2, Mohs about 5. *Tenacity:* unknown, probably brittle. *Cleavage:* {001} good. *Fracture:* not given. *Density:* 4.1 g/cm^3 (meas.), 4.14 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, *Ccmm*, *a* 10.539, *b* 9.680, *c* 22.345 Å, *V* 2280 Å^3, Z 4, *a:b:c* = 1.0887:1:2.3084. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.58 (67.5) (004), 3.00 (8.8) (224), 2.95 (17.0) (206), 2.91 (10.5) (117), 2.80 (100) (313, 008, 225), 2.232 (7.5) (0.0.10), 1.596 (12.8) (0.0.14, 602). ***Optical data:*** Biaxial (+), α 1.754, β 1.760, γ 1.797, 2V(meas.) 40°, 2V(calc.) 45°; dispersion not given; pleochroism strong, Z > X; orientation, Z = *c*. ***Chemical analytical data:*** A wet chemical analysis gave: Na_2O 2.41, K_2O 0.22, CaO (+ SrO) 0.03, MnO 0.70, FeO 4.78, BaO 21.46, Fe_2O_3 0.39, La_2O_3 10.05, Ce_2O_3 9.40, Pr_2O_3 0.99, Nd_2O_3 2.15, SiO_2 33.82, TiO_2 9.20, ThO_2 0.38, Nb_2O_5 2.31, H_2O 1.50, F 0.38, sum 100.17, less O = F 0.16, Total 100.01 wt.%. Empirical formula: $(Ba_{1.99}Ca_{0.01})_{\Sigma 2.00}(Na_{1.11}K_{0.07})_{\Sigma 1.18}(La_{0.88}Ce_{0.81}Nd_{0.18}Pr_{0.09})_{\Sigma 1.96}(Fe^{2+}_{0.95}Mn_{0.14})_{\Sigma 1.09}(Ti_{1.64}Nb_{0.25}Fe^{3+}_{0.07}Th_{0.02})_{\Sigma 1.98}Si_{8.01}O_{26.00}[(OH)_{0.37}O_{0.35}F_{0.28}]_{\Sigma 1.00} \cdot 1.00H_2O$. ***Relationship to other species:*** A member of the joaquinite group.

Name: For the relationship to other members of the joaquinite group. ***Comments:*** IMA No. 00-D.

MATSUBARA, S., MANDARINO, J. A., and SEMENOV, E. I. (2001) Redefinition of a mineral in the joaquinite group: orthojoaquinite-(La). *Canadian Mineralogist* **39**, 757–760.

Petterdite

Orthorhombic

$PbCr_2(CO_3)_2(OH)_4 \cdot H_2O$

Locality: The Red Lead mine, Zeehan-Dundas region (Lat. 41°53′ S, Long. 145°25′ E), northwestern Tasmania, Australia. It also occurs at the Callenberg Nord-1 open cut, near Glauchau, Saxony, Germany.

Occurrence: Associated minerals are: galena, goethite, anglesite, and crocoite. At the German locality, petterdite is associated with crocoite, cerussite, bindheimite, pyromorphite and galena.

General appearance: As thin (up to 0.5 mm) crusts composed of thin, roughly rectangular, platy crystals up to 15 µm across.

Physical, chemical and crystallographic properties: *Luster:* earthy to pearly. *Diaphaneity:* translucent. *Color:* pale grayish to pinkish violet. *Streak:* pale violet. *Luminescence:* nonfluorescent. *Hardness:* could not be measured but is assumed to be about 2. *Tenacity:* could not be observed. *Cleavage:* {100} fair, possibly also {010}. *Fracture:* could not be observed. *Density:* could not be measured because of the high porosity of the aggregates, 3.95 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, space group not determined but assumed to be *Pbnm* by analogy with dundasite, *a* 9.079, *b* 16.321, *c* 5.786 Å, *V* 857 Å^3, Z 4, *a:b:c* = 0.5563:1:0.3545. Morphology: {010}, flattened on {010} and slightly elongate on [001] or less commonly on [100]. Twinning: none observed. ***X-ray powder diffraction data:*** 7.937 (100) (110), 4.686 (50b) (021, 111), 3.633 (70) (131), 3.270 (40) (221), 2.718 (40) (022, 060, 112, 151), 2.690 (40) (241, 301); the broad spacing at 4.686 is resolved into two lines at 4.73 and 4.67 with an automated diffractometer. ***Optical data:*** Biaxial (–), α 1.740, β ≈ 1.802, γ 1.842, 2V could not be measured, 2V(calc.) approximately 62°; dispersion not given; pleochroism X = Y colorless to pale grayish pink, Z grayish pink; orientation, X = a, Y = b, Z = c. ***Chemical analytical data:*** Means of four sets of electron microprobe data (H_2O calculated by difference): PbO 43.13, SrO 1.40, Al_2O_3 3.65, Cr_2O_3 22.64, Sb_2O_5 0.67, CO_2 18.3, H_2O (10.01), Total (100.00) wt.%. Empirical formula: $(Pb_{0.99}Sr_{0.07})_{\Sigma 1.06}(Cr_{1.52}Al_{0.36}Sb_{0.02})_{\Sigma 1.90}(CO_3)_{2.12}(OH)_{3.62} \cdot 1.02H_2O$. ***Relationship to other species:*** It is the chromium-dominant analogue of dundasite, $PbAl_2(CO_3)_2(OH)_4 \cdot H_2O$.

Name: For William Frederick Petterd (1849–1910), an amateur collector who published several significant catalogues on the mineralogy of Tasmania. The name was once used for a phosphatian mimetite. ***Comments:*** IMA No. 1999-034.

BIRCH, W. D., KOLITSCH, U., WITZKE, T., NASDALA, L., and BOTTRILL, R. S. (2000) Petterdite, the Cr-dominant analogue of dundasite, a new mineral species from Dundas, Tasmania, Australia and Callenberg, Saxony, Germany. *Canadian Mineralogist* **38**, 1467–1476.

Phosphoellenbergerite — Hexagonal

$Mg_{14}(PO_4)_6(PO_3OH,CO_3)_2(OH)_6$

Locality: Parigi, Val Varaita, southern Dora-Maira massif, western Alps, Italy. Tingelstadtjern serpentine-magnesite deposit, Modum, southern Norway.

Occurrence: As inclusions in fist-sized pyrope megablasts in coesite-bearing pyrope-kyanite-phengite quartzite at the Italian locality; other associated minerals are: talc and rutile. At the Norwegian locality, the mineral occurs in lenses (up to 200 m long) in serpentine-magnesite rocks; other minerals found in these lenses are: althausite, holtedahlite, heneuite and a new mineral with the formula $Mg_7(PO_4)_2(OH)_8$ isostructural with allactite, $Mn_7(AsO_4)_2(OH)_8$.

General appearance: At the type locality, the mineral occurs as crystals (50 to 300 μm) and as millimeter-size hexagonal prisms. The Norwegian material occurs as anhedral grains less than 0.5 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* azure blue. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 6½ (by analogy with ellenbergerite). *Tenacity:* brittle. *Cleavage:* none. *Fracture:* not given. *Density:* 3.0 g/cm³ (meas.) (Norway), 2.94 g/cm³ (calc.) (Norway), 2.97 g/cm³ (calc.) (Italy). ***Crystallography:*** Hexagonal, $P6_3mc$, *a* 12.47, *c* 5.04 Å, *V* 678 Å³, Z 1, *c:a* = 0.4042 (Italy); *a* 12.467, *c* 5.0437 Å, *V* 678.9 Å³, Z 1, *c:a* = 0.4046 (Norway). Morphology: {100} and {001} (Italy). Twinning: none observed. ***X-ray powder diffraction data:*** 3.685 (100) (201), 3.170 (95) (211), 2.702 (80) (400), 2.381 (70) (401), 2.221 (80) (321), 1.555 (80) (213), 1.426 (80) (522) (Norway). ***Optical data:*** Uniaxial (–), ω 1.606, ε 1.588 and ω 1.609, ε 1.589 (both sets from Norway material), pleochroism O = colorless, E = blue. ***Chemical analytical data:*** Means of four sets of electron microprobe data from Norwegian material: MgO 44.4, CaO 0.5, FeO 1.0, SiO_2 0.7, P_2O_5 37.4, As_2O_5 5.5, SO_3 1.0, CO_2 (2.75), H_2O (5.986), Total (99.236) wt.% (CO_2 and H_2O were calculated). Empirical formula: $Mg_{12.00}(Mg_{1.32}Fe_{0.17}Ca_{0.11}\square_{0.40})_{\Sigma 2.00}[(PO_4)_{4.34}(PO_3OH)_{0.79}(AsO_4)_{0.58}(SO_4)_{0.15}(SiO_4)_{0.14}]_{\Sigma 6.00}[(PO_3OH)_{1.24}(CO_3)_{0.76}]_{\Sigma 2.00}(OH)_{6.00}$. Electron microprobe data from Italian material: MgO 39.68, CaO 0.02, FeO 1.38, Al_2O_3 4.16, CO_2 2.00, SiO_2 5.61, ZrO_2 0.16, P_2O_5 36.16, As_2O_5 1.65, SO_3 1.52, H_2O 6.16, Total 98.50 wt.%. Empirical formula: $(Mg_{12.01}Al_{1.00}Fe_{0.23}Zr_{0.02})_{\Sigma 13.26}(P_{6.21}Si_{1.14}S_{0.23}As_{0.18})_{\Sigma 7.76}O_{38.00}H_{8.34}$. ***Relationship to other species:*** Chemically and structurally related to ellenbergerite, $Mg_6TiAl_6Si_8O_{28}(OH)_{10}$.

Name: For the relationship with ellenbergerite. ***Comments:*** IMA No. 94-006. The formal description of the type material has not been published. Dr. Christian Chopin, the senior author of the IMA proposal, has kindly provided data from the type material for this abstract.

CHOPIN, C. (1984) Coesite and pure pyrope in high-grade blueschists of the Western alps: a first record and some consequences. *Contributions to Mineralogy and Petrology* **86**, 106–118. CHOPIN, C., KLASKA, R., MEDENBACH, O., and DRON, D. (1986) Ellenbergerite, a new high-pressure Mg-Al-(Ti,Zr)-silicate with a novel structure based on face-sharing octahedra. *Contributions to Mineralogy and Petrology* **92**, 316–321. RAADE, G., RØMMING, C., and MEDENBACH, O. (1998) Carbonate-substituted phosphoellenbergerite from Modum, Norway: description and crystal structure. *Mineralogy and Petrology* **62**, 89–101. SIMON, G. and CHOPIN, C. (2001) Enstatite-sapphirine crack-related assemblages in ultrahigh-pressure megablasts, Dora-Maira massif, western Alps. *Contributions to Mineralogy and Petrology* **140**, 422–440.

Pillaite — Monoclinic

$Pb_9Sb_{10}S_{23}ClO_{0.5}$

Locality: The Buca della Vena mine, Apuan Alps, northern Tuscany, Italy.

Occurrence: In thin, late calcite veins which cut a small Fe-Ba ore body and the phyllites and dolomitic limestones in which the deposit is hosted. Associated minerals are: scainiite, zinkenite, boulangerite, robinsonite, tintinaite, sorbyite and other incompletely characterized minerals. Other associated minerals are: sphalerite, cinnabar, galena, andorite, bournonite, tetrahedrite, chalcostibite, gersdorffite, barite, cerussite and stibiconite.

General appearance: Small acicular crystals (up to 1 cm long and 0.1 mm thick).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* black to dark brown. *Hardness:* VHN_{50} 175 kg/mm². *Tenacity:* brittle. *Cleavage:* nothing distinct. *Fracture:* irregular. *Density:* could not be determined because of the small size, 5.80 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 49.65, *b* 4.150, *c* 21.91 Å, β 99.76°, *V* 4449 Å³, Z 4, *a:b:c* = 11.9639:1:5.2795. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.14 (27) (205), 3.88 (20) (12.0.1), 3.621 (26) ($\bar{4}06$, 12.0.2), 3.548 (40) ($\bar{1}2.0.4$, $\bar{1}0.0.5$), 3.480 (100) (206), 3.249 (24) ($\bar{1}2.0.5$), 2.956 (47) ($\bar{5}15$, 16.0.1, $\bar{1}2.0.6$, $\bar{9}14$), 2.780 (22) (13.1.0, 515). ***Optical data:*** In reflected light: color not given, weak anisotropism, weak bireflectance, nonpleochroic, rare red internal reflections. R, ^{im}R: (35.7, 20.10 %) 470nm, (34.2, 18.75 %) 550nm, (34.0, 17.60 %) 590nm, (32.7, 16.45 %) 650nm. ***Chemical analytical data:*** Means of 13 sets of electron microprobe data: Cu 0.16, Pb 49.07, Sb 30.36, S 18.73, Cl 0.98, O 0.21, Total 99.51 wt.%. Empirical formula: $Pb_{9.25}Sb_{9.74}Cu_{0.10}S_{22.82}Cl_{1.08}O_{0.51}$. ***Relationship to other species:*** Related to zinkenite. Pillaite is unusual in having both Cl and O which play an essential role in the stability of its structure.

Name: For Prof. Leopoldo Pilla (1805–1848), one of the most important Italian vulcanologists and mineralogists of his time. ***Comments:*** IMA No. 1997-042.

ORLANDI, P., MOËLO, Y., MEERSCHAUT, A., and PALVADEAU, P. (2001) Lead-antimony sulfosalts from Tuscany (Italy). III. Pillaite, $Pb_9Sb_{10}S_{23}ClO_{0.5}$, a new Pb-Sb oxy-chloro-sulfosalt, from Buca della Vena mine. *European Journal of Mineralogy* **13**, 605–610.

Polyakovite-(Ce) — Monoclinic

$(Ce,Ca)_4(Mg,Fe^{2+})(Cr^{3+},Fe^{3+})_2(Ti,Nb)_2Si_4O_{22}$

Locality: Mine N97, Ilmen Natural Reserve, southern Urals, Russia (Lat. 55°01′ N, Long. 11° E).

Occurrence: In a carbonatite vein. Associated minerals are: dolomite, fluororichterite, chromite, thorianite, forsterite and phlogopite.

General appearance: Anhedral equant grains usually 0.5 to 0.7 cm, but up to 2.5 cm, and as euhedral crystals up to 2 mm.

Physical, chemical and crystallographic properties: *Luster:* given as vitreous, but the optical data indicate adamantine. *Diaphaneity:* translucent in thin fragments. *Color:* black. *Streak:* brown. *Luminescence:* nonfluorescent. *Hardness:* VHN_{200} 874 kg/mm², Mohs 5½ to 6. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* conchoidal. *Density:* 4.75 g/cm³ (meas.), 5.05 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 13.395, *b* 5.698, *c* 11.040 Å, β 100.55°, *V* 828.5 Å³, Z 2, *a:b:c* = 2.3508:1:1.9375.

Morphology: {100}, {001}, {201}, {$\bar{2}$01}, {110}, {111}, {$\bar{1}$11}, {112}, {$\bar{1}$12}, {$\bar{3}$02}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.44 (40) (002), 3.62 (35) (003), 3.18 (50) (311), 3.15 (40) ($\bar{3}$12), 3.12 (35) ($\bar{1}$13), 2.849 (40) (020), 2.715 (100) (004), 2.160 (45) ($\bar{4}$21). ***Optical data:*** Isotropic (due to metamictization), n between 1.931 and 1.935. In reflected light: gray, nonpleochroic. R: (11.1 %) 480nm, (10.9 %) 540nm, (10.8 %) 580nm, (10.5 %) 640nm. ***Chemical analytical data:*** Means of three sets of electron microprobe data and one set of wet chemical data: MgO 2.61, CaO 1.06, MnO 0.05, FeO 1.09, Cr_2O_3 7.42, Fe_2O_3 4.30, Y_2O_3 0.38, La_2O_3 15.94, Ce_2O_3 24.24, Pr_2O_3 2.01, Nd_2O_3 4.76, Sm_2O_3 0.38, SiO_2 19.08, TiO_2 9.49, ThO_2 2.79, UO_2 0.03, Nb_2O_5 3.98, H_2O 0.14, Total 99.75 wt.%. Empirical formula: $(Ce_{1.87}La_{1.24}Nd_{0.36}Ca_{0.24}Pr_{0.15}Th_{0.13}Y_{0.04})_{\Sigma 4.06}$-$(Mg_{0.82}Fe^{2+}_{0.19}Mn_{0.01})_{\Sigma 1.02}(Cr_{1.23}Fe^{3+}_{0.68})_{\Sigma 1.91}(Ti_{1.50}Nb_{0.38})_{\Sigma 1.88}Si_{4.01}[O_{21.80}$-$(OH)_{0.20}]_{\Sigma 22.00}$. ***Relationship to other species:*** It is the Mg- and Cr^{3+}-dominant analogue of chevkinite-(Ce).

Name: For Vladislav Olegovich Polyakov (1950–1993), who contributed greatly to the knowledge of the mineralogy of the Urals. ***Comments:*** IMA No. 1998-029. Mössbauer and thermal analytical data are given and the crystal structure has been solved.

POPOV, V. A., PAUTOV, L. A., SOKOLOVA, E., HAWTHORNE, F. C., McCAMMON, C., and BAZHENOVA, L. F. (2001) Polyakovite-(Ce), (*REE*,Ca)$_4$(Mg,Fe^{2+})(Cr^{3+},Fe^{3+})$_2$(Ti,Nb)$_2Si_4O_{22}$, a new metamict mineral species from the Ilmen Mountains, southern Urals, Russia: mineral description and crystal chemistry. *Canadian Mineralogist* **39**, 1095–1104.

Raadeite

Monoclinic

$Mg_7(PO_4)_2(OH)_8$

Locality: Near Tingelstadtjern, Modum district, southern Norway.

Occurrence: In nodules of apatite and magnesium phosphates in a serpentinite body. Associated minerals are: althausite, holtedahlite, apatite, magnesite and heneuite.

General appearance: Veinlets a few tens of µm wide; rare anhedral inclusions up to 150 µm; as fibrous coronae with apatite, althausite and magnesite replacing cm-size heneuite.

Physical, chemical and crystallographic properties: *Luster:* pearly. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* not mentioned. *Hardness:* could not be determined. *Tenacity:* not given, probably brittle. *Cleavage:* could not be determined. *Fracture:* could not be determined. *Density:* could not be measured, 2.81 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1/n$, *a* 5.250, *b* 11.647, *c* 9.655 Å, β 95.94°, *V* 587.2 Å^3, Z 2, *a*:*b*:*c* = 0.4508:1:0.8290. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.436 (75) ($\bar{1}$11), 3.521 (80) ($\bar{1}$12, 121), 3.145 (70) ($\bar{1}$22), 3.087 (70) (013), 2.905 (100) (131), 2.794 (75) (023, 041), 2.199 (80) (142, 202). ***Optical data:*** Biaxial (–), α 1.5945, β 1.6069, γ 1.6088, 2V(meas.) 45.6°, 2V(calc.) 43°; dispersion r>v, strong; nonpleochroic; Y = *b*, Z probably ~ *a*. ***Chemical analytical data:*** Means of eight sets of electron microprobe data (H_2O calculated to give 8 OH): MgO 55.35, CaO 0.02, MnO 0.30, FeO 0.25, SiO_2 0.05, P_2O_5 28.23, As_2O_5 0.40, SO_3 0.05, H_2O (14.34), Total (98.99) wt.%. Empirical formula: $(Mg_{6.90}Mn_{0.02}Fe_{0.02})_{\Sigma 6.94}[(PO_4)_{2.00}(AsO_4)_{0.02}]_{\Sigma 2.02}(OH)_{8.00}$. ***Relationship to other species:*** It is the Mg- and PO_4-dominant analogue of allactite, $Mn_7(AsO_4)_2(OH)_8$.

Name: For Dr. Gunnar Raade (1944–), Curator of Minerals, Natural History Museum, Oslo, Norway, in recognition of his contribution to the mineralogy of magnesium phosphates. ***Comments:*** IMA No. 1996-034. The paper contains details of the crystal structure.

CHOPIN, C., FERRARIS, G., PRENCIPE, M., BRUNET, F., and MEDENBACH, O. (2001) Raadeite, $Mg_7(PO_4)_2(OH)_8$: a new dense-packed phosphate from Modum (Norway). *European Journal of Mineralogy* **13**, 319–327.

Rambergite

Hexagonal

MnS

Locality: Garpenberg Norra, 19 km north of Avesta, Hedemora district, Kopparberg County, Sweden, Lat. 16°11′32″ N, Long. 60°18′33″ W. Also found in the central part of the Gotland Deep in the Baltic Sea.

Occurrence: At Garpenberg Norra in a skarn. Associated minerals are: calcite, fluorite, barite, sphalerite, galena, apophyllite, pyrite, pyrrhotite, samsonite, pyrargyrite and freibergite. In the Baltic Sea occurrence, it coexists with rhodochrosite in anoxic, laminated sediments rich in organic matter.

General appearance: Hexagonal prisms (up to 1 mm long and 0.5 mm in diameter). Baltic Sea: crystals 200 x 150 µm.

Physical, chemical and crystallographic properties: *Luster:* resinous. *Diaphaneity:* opaque. *Color:* dark brown to black. *Streak:* brown. *Hardness:* 4. *Tenacity:* brittle. *Cleavage:* {110} and {001} observed in polished sections. *Fracture:* uneven. *Density:* 3.28 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3mc$, a 3.9817, c 6.4447 Å, V 88.49 Å^3, Z 2, c:a = 1.6186. Morphology: {100} and {001}, minor {101}. Twinning: uncommon. ***X-ray powder diffraction data:*** 3.445 (89) (100), 3.217 (72) (002), 3.036 (66) (101), 1.988 (82) (110), 1.820 (100) (103), 1.691 (63) (112). ***Optical data:*** In reflected light: steel-gray; brown-red internal reflections; anisotropism, 2.62 to 2.77; bireflectance, 0.15; nonpleochroic. $R_{max.}$ & $R_{min.}$: (24.5, 22.1 %) 470nm, (22.6, 20.5 %) 546nm, (22.1, 20.0 %) 589nm, (21.6, 19.6 %) 650nm. ***Chemical analytical data:*** Electron microprobe data gave the following empirical formula: $(Mn_{0.95}Fe_{0.03})_{\Sigma 0.98}S_{1.00}$. ***Relationship to other species:*** An hexagonal polymorph of alabandite.

Name: For Hans Ramberg, former professor of mineralogy and petrology, Uppsala University. ***Comments:*** IMA No. 1995-028. The complete description has not been published.

KALINOWSKI, M. P. (1996) Rambergite, a new polymorph of MnS with hexagonal structure. *Geologiska Föreningens i Stockholm Förhandlinger* **118**, A53–A54. BÖTTCHER, M. E. and HUCKRIEDE, H. (1997) First occurrence and stable isotope composition of authigenic γ-MnS in the central Gotland Deep (Baltic Sea). *Marine Geology* **137**, 201–205.

Rengeite

Monoclinic

$Sr_4ZrTi_4Si_4O_{22}$

Locality: Two localities in the Itoigawa-Ohmi district in the easternmost part of the Renge belt, Niigata Prefecture, central Japan. The first occurrence is at Oyashirazu shore; it has been found also in the bed of the Kotaki-gawa river.

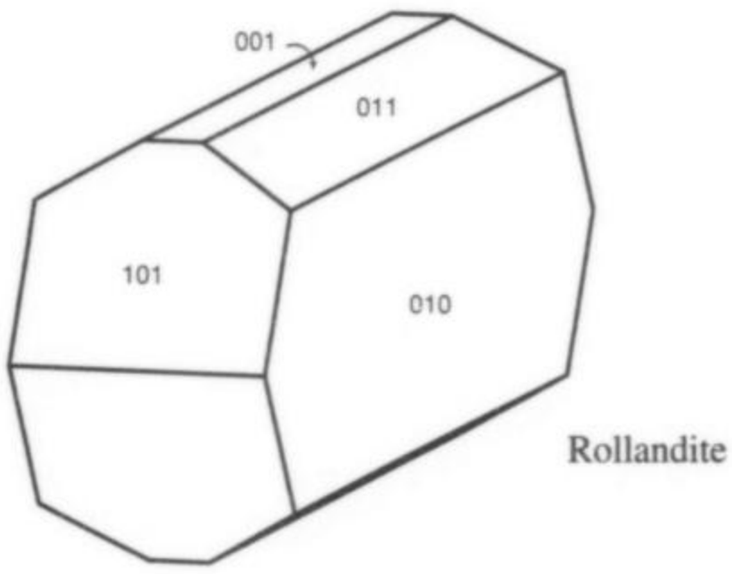
Occurrence: The mineral occurs in blue, lavender or green jade pebbles and boulders. Associated minerals in blue jade are: jadeite, titanian omphacite, sodic amphibole, titanite, rutile, anatase, strontium-apatite and tausonite. In lavender jade, associated minerals are: jadeite, titanian jadeite, rutile, titanite, zircon, natrolite, lamprophyllite, tausonite and an undetermined Sr-Ti silicate. In green jade, it is associated with jadeite, omphacite, titanite and zircon.

General appearance: Anhedral grains (up to ~ 0.5 mm) in blue jade. Fan-shaped aggregate of prismatic crystals (<0.3 mm long) in lavender jade. Elongate aggregates (~ 9 mm) of anhedral crystals in green jade.

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* transparent. *Color:* dark greenish brown. *Streak:* pale greenish brown. *Luminescence:* nonfluorescent. *Hardness:* VHN_{100} 606 to 698 kg/mm², Mohs 5 to 5½. *Tenacity:* not given but probably brittle. *Cleavage:* none. *Fracture:* not given. *Density:* could not be measured, 4.12 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/a$, *a* 13.97, *b* 5.675, *c* 11.98 Å, β 114.26°, *V* 866 Å³, Z 2, *a:b:c* = 2.4617:1:2.1110. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.16 (m) ($\bar{1}12$), 3.13 (s) ($\bar{4}03$), 3.06 (vvs) ($\bar{3}13$), 3.00 (vs) ($\bar{2}04$), 2.86 (s) (020), 2.79 (m) (401), 2.30 (m) ($\bar{4}05$), 2.20 (vs) ($\bar{3}15$). ***Optical data:*** Biaxial (+), indices of refraction are higher than those of titanite and are too high to measure; pleochroism strong from pale green to pale greenish brown; orientation could not be determined. ***Chemical analytical data:*** Means of six sets of electron microprobe data for *REE*-poor material gave: CaO 0.43, FeO 0.10, SrO 34.32, BaO 0.13, Al_2O_3 0.20, Ce_2O_3 0.38, Pr_2O_3 0.10, Nd_2O_3 0.29, Sm_2O_3 0.04, SiO_2 22.58, TiO_2 29.88, ZrO_2 9.49, Nb_2O_5 0.24, Ta_2O_5 0.07, Total 98.25 wt.%. mpirical formula: $(Sr_{3.62}Ca_{0.08}Ce_{0.03}Nd_{0.02}Ba_{0.01}Pr_{0.01})_{\Sigma 3.77}(Zr_{0.84}Ti_{0.09}Al_{0.04}Nb_{0.02}Fe_{0.02})_{\Sigma 1.01}Ti_{4.00}Si_{4.11}O_{22.00}$. ***Relationship to other species:*** It is the Sr- and Zr-dominant analogue of perrierite.

Name: For the locality. ***Comments:*** IMA No. 1998-055.

MIYAJIMA, H., MATSUBARA, S., MIYAWAKI, R., YOKOYAMA, K., and HIROKAWA, K. (2001) Rengeite, $Sr_4ZrTi_4Si_4O_{22}$, a new mineral, the Sr-Zr analogue of perrierite from the Itoigawa-Ohmi district, Niigata Prefecture, central Japan. *Mineralogical Magazine* **65**, 111–120.



Rollandite

Rollandite — Orthorhombic

$Cu_3(AsO_4)_2 \cdot 4H_2O$

Locality: The South group of the Roua copper occurrences in the upper part of the Var valley (the Daluis gorge) at the western margin of the Barrot Dome, Alpes-Maritimes, France.

Occurrence: Associated minerals are: olivenite, conichalcite, clinotyrolite, cornubite, kolfanite, pharmacosiderite, gerhardtite, atacamite, gilmarite, wallkilldellite-(Fe), cuprite, domeykite, algodonite and native copper.

General appearance: Aggregates up to 1 mm in diameter made up of crystals (up to 0.5 x 0.15 x 0.1 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* bottle-green. *Streak:* very light green. *Luminescence:* nonfluorescent. *Hardness:* 4 to 4½. *Tenacity:* very brittle. *Cleavage:* {001} good. *Fracture:* conchoidal. *Density:* 3.9 g/cm³ (meas.), 3.85 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, *Pnma*, *a* 5.6906, *b* 17.061, *c* 9.732 Å, *V* 944.9 Å³, Z 4, *a:b:c* = 0.3335:1:0.5704. Morphology: {010}, {011}, {101}, {001}; habit elongate on [100] and slightly flattened on {010}. Twinning: none observed. ***X-ray powder diffraction data:*** 8.520 (100) (020), 3.721 (60) (131), 3.221 (90) (141, 051), 3.102 (40) (132), 2.817 (35) (103, 033), 2.795 (35) (142), 2.366 (20) (240, 071), 2.350 (25) (143, 053), 2.133 (25) (080, 251). ***Optical data:*** Biaxial (–), α 1.745, β 1.755, γ 1.760, 2V(meas.) 71°, 2V(calc.) 70°; dispersion r<v, strong; nonpleochroic; orientation, X = *a*, Y = *c*, Z = *b*. ***Chemical analytical data:*** Means of ten sets of electron microprobe data: CuO 44.87, As_2O_5 42.44, H_2O (12.69), Total (100.00) wt.%. H_2O calculated by difference. Empirical formula: $Cu_{3.09}(AsO_4)_{2.02}(OH)_{0.12} \cdot 3.80H_2O$. ***Relationship to other species:*** None apparent.

Name: For Pierre Rolland (1940–), an eminent collector of the Roua mines. ***Comments:*** IMA No. 1998-001. The abstractor drew the crystal drawing produced here with the assistance of Dr. Halil Sarp and Prof. André Lalonde.

SARP, H. and ČERNÝ, R. (2000) Rollandite, $Cu_3(AsO_4)_2 \cdot 4H_2O$, a new mineral: its description and crystal structure. *European Journal of Mineralogy* **12**, 1045–1050.

Ronneburgite — Monoclinic

$K_2MnV_4O_{12}$

Locality: The mine dump of the Lichtenberg open-pit at the southwest margin of Ronneburg, Thuringia, Germany.

Occurrence: In a uranium deposit in slates and limestones. Associated minerals are: hummerite, gypsum, epsomite, picromerite, hematite and an unidentified K-Mg-Mn-vanadate. Sincosite, simplotite and straczekite were found a few meters away. More than 230 species are known from the Ronneburg deposit.

General appearance: Crystals of equant, flattened or short prismatic habit (up to 0.5 mm).

Physical, chemical and crystallographic properties: *Luster:* adamantine. *Diaphaneity:* translucent. *Color:* reddish-brown. *Streak:* brownish orange. *Luminescence:* nonfluorescent. *Hardness:* 3. *Tenacity:* brittle. *Cleavage:* indistinct in one direction. *Fracture:* irregular. *Density:* 2.84 g/cm³ (meas.), 2.83 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/n$, *a* 8.183, *b* 9.247, *c* 8.651 Å, β 109.74°, *V* 611.4 Å³, Z 2, *a:b:c* = 0.8849:1:0.9355. Morphology: no forms were mentioned. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.509 (32) ($\bar{1}11$), 3.701 (55) ($\bar{2}11$), 3.336 (100) (121), 3.118 (50) ($\bar{1}22$), 3.000 (36) (112), 2.878 (64) ($\bar{1}03$), 2.752 (68) ($\bar{2}22$). ***Optical data:*** Biaxial (−), α 1.925, β 1.960, γ 1.988, 2V(meas.) 82°, 2V(calc.) 82°; dispersion not given; pleochroism X = brownish orange with a distinct reddish tint, Y = brownish orange, Z = brownish orange; orientation could not be determined. ***Chemical analytical data:*** Means of twenty sets of electron microprobe data: K_2O 16.93, MgO 0.62, MnO 12.44, V_2O_5 68.54, Total 98.53 wt.%. Empirical formula: $K_{1.91}(Mn_{0.93}Mg_{0.08})_{\Sigma 1.01}V_{4.01}O_{12.00}$. ***Relationship to other species:*** It is chemically related to fianelite, $Mn_2V(V,As)O_7 \cdot 2H_2O$.

Name: For the locality. ***Comments:*** IMA No. 1998-069.

WITZKE, T., ZHEN, S., SEFF, K., DOERING, T., NASDALA, L., and KOLITSCH, U. (2001) Ronneburgite, $K_2MnV_4O_{12}$, a new mineral from Ronneburg, Thuringia, Germany: Description and crystal structure. *American Mineralogist* **86**, 1081–1086.

Schiavinatoite — Tetragonal

$(Nb,Ta)BO_4$

Locality: Antsongombato, south of Betafo, some tens of kilometers south of the village of Mahaiz, Madagascar.

Occurrence: In a pegmatite. Associated minerals (in addition to the normal rock-forming minerals of granitic pegmatites) are: behierite, rhodizite, spodumene, elbaite-liddicoatite series of the tourmaline group, danburite, cesian beryl, pollucite, manganoan fluorapatite, uranoan microlite, xenotime, monazite, manganocolumbite, manganotantalite, hübnerite and hafnian zircon. Schiavinatoite occurs intimately associated with behierite, $(Ta,Nb)BO_4$.

General appearance: Part of a well-formed, flattened bipyramidal crystal about 4 mm across. Five similar crystals up, one up to 2 cm long, have been found but not exhaustively characterized.

Physical, chemical and crystallographic properties: *Luster:* vitreous, but the optical properties indicate adamantine. *Diaphaneity:* transparent in thin section. *Color:* grayish pink. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* about 8. *Tenacity:* not given, probably brittle. *Cleavage:* none observed. *Fracture:* not given. *Density:* not measured, 6.57 g/cm^3 (calc.). ***Crystallography:*** Tetragonal, $I4_1/amd$, *a* 6.219, *c* 5.487 Å, *V* 212.2 Å^3, Z 4, *c:a* = 0.8823. Morphology: first and second order tetragonal bipyramid and a tetragonal prism. Twinning: none observed. ***X-ray powder diffraction data:*** 4.115 (100) (101), 3.110 (84) (200), 2.481 (36) (211), 2.328 (49) (112), 1.939 (29) (301), 1.646 (25) (321), 1.598 (42) (312). ***Optical data:*** Uniaxial (+), approximate mean index of refraction 2.30. ***Chemical analytical data:*** In the crystal studied, 38 of the 54 points analyzed by microprobe represent behierite. Means of sixteen sets of electron microprobe data (B_2O_3 calculated to give 1 B): B_2O_3 (16.60), Nb_2O_5 33.08, Ta_2O_5 50.37, Total (100.05) wt.%. Empirical formula: $(Nb_{0.52}Ta_{0.48})_{\Sigma 1.00}BO_4$. ***Relationship to other species:*** It is the Nb-dominant analogue of behierite, $(Ta,Nb)BO_4$.

Name: For Professor Giuseppe Schiavinato (1915–1996) distinguished Italian mineralogist who helped the development of mineralogical sciences in Italy. The name is pronounced "skee-ah-vee-nat-toh-ite". ***Comments:*** IMA No. 1999-051.

DEMARTIN, F., DIELLA, V., GRAMMACCIOLI, C., and PEZZOTTA, F. (2001) Schiavinatoite. $(Nb,Ta)BO_4$, the Nb analogue of behierite. *European Journal of Mineralogy* **13**, 159–165.

Sicherite — Orthorhombic

$TlAg_2(As,Sb)_3S_6$

Locality: Lengenbach quarry, Binntal, Canton Valais, Switzerland.

Occurrence: In dolomitic rock. Associated minerals are: realgar, hutchinsonite, hatchite and jentschite.

General appearance: Aggregates (up to 2 mm across) of individual crystals (up to 0.4 mm).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* dark gray to black. *Streak:* dark brown red. *Hardness:* VHN_{10} 58.3 kg/mm^2, Mohs ≤ 3. *Tenacity:* not given but probably brittle. *Cleavage:* not observed. *Fracture:* uneven to conchoidal. *Density:* not measured, 5.26 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, *Pmnb*, *a* 12.479, *b* 15.522, *c* 5.719 Å, *V* 1107.8 Å^3, Z 4, *a:b:c* = 0.8040:1:0.3684. Morphology: {141} dominant with {001}, {010}, {031}, {301} minor. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.655 (16) (131), 3.363 (50) (301), 3.290 (23) (240, 311), 3.210 (26) (041), 3.118 (27) (141), 2.822 (100) (340, 331, 012), 2.540 (17) (341), 2.070 (15) (600, 071). ***Optical data:*** In reflected light: pure white, very few dark red internal reflections, extremely weak anisotropism. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (31.43, 33.43; 15.98, 18.41 %) 470nm, (28.31, 30.52; 13.48, 15.80 %) 546nm, (27.10, 29.11; 12.54, 4.56 %) 589nm, (25.57, 27.44; 11.36, 13.17 %) 650nm. ***Chemical analytical data:*** Means of 103 sets of electron microprobe data: Cu 0.22, Ag 23.98, Tl 23.63, Sb 10.96, As 19.08, S 21.65, Total 99.52 wt.%. Empirical formula: $Tl_{1.02}(Ag_{1.96}Cu_{0.03})_{\Sigma 1.99}(As_{2.24}Sb_{0.79})_{\Sigma 3.03}S_{5.95}$.

Relationship to other species: Although the chemical composition and unit cell suggest a possible relationship with the hutchinsonite group of merotypes, no simple structural relationship exists.

Name: For Valentin Sicher (1925–) an active member of the Lengenbach syndicates since 1963 who contributed greatly to specimen recovery efforts. ***Comments:*** IMA No. 1997-051.

GRAESER, S., BERLEPSCH, P., MAKOVICKY, E., and BALIĆ-ZŬNIĆ, T. (2001) Sicherite, $TlAg_2(As,Sb)_3S_6$, a new sulfosalt mineral from Lengenbach (Binntal, Switzerland): Description and structure determination. *American Mineralogist* **86**, 1087–1093.

Telluronevskite — Trigonal

Bi_3TeSe_2

Locality: Vihorlat Mountains, 8 km SSE of Snina near Košice in eastern Slovakia, Slovak Republic.

Occurrence: As disseminated grains in quartzite. Associated minerals are: quartz, pyrite, pyrrhotite, sphalerite, chalcopyrite and stannite.

General appearance: Massive aggregates (up to 2 mm in diameter) and disseminated tabular crystals.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* steel gray. *Streak:* black. *Hardness:* VHN_{10} 100 kg/mm^2. *Tenacity:* flexible. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* 8.1 g/cm^3 (meas.), 8.08 g/cm^3 (calc.). ***Crystallography:*** Trigonal, $P\bar{3}m1$, *a* 4.264, *c* 23.25 Å, *V* 366 Å^3, Z 2, *c:a* = 5.4526. Morphology: Only {001} was observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.66 (19) (005), 3.32 (13) (103, 007), 3.12 (100) (104), 2.28 (33) (108), 2.13 (36) (110, 109), 1.935 (16) (115, 00.12), 1.355 (18) (214, 1.0.16). ***Optical data:*** In reflected light: white with a yellow tint, moderate anisotropism, weak bireflectance, pleochroism not noted. $R_{max.}$, $R_{min.}$: (48.5, 46.6 %) 470nm, (51.1, 48.5 %) 546nm, (51.9, 49.5 %) 589nm, (52.8, 50.5 %) 650nm. ***Chemical analytical data:*** Means of four sets of electron microprobe data: Bi 68.84, Pb 0.42, Se 15.41, Te 14.58, S 1.14, Total 100.39 wt.%. Empirical formula: $(Bi_{2.92}Pb_{0.02})_{\Sigma 2.94}Te_{1.01}(Se_{1.75}S_{0.32})_{\Sigma 2.07}$. ***Relationship to other species:*** It is related to the members of the tetradymite group.

Name: For the chemical similarity to nevskite, Bi(Se,S), with the addition of Te. ***Comments:*** IMA No. 1993-027a.

ŘÍDKOŠIL, T., SKÁLA, R., JOHAN, Z., and ŠREIN, V. (2001) Telluronevskite, Bi_3TeSe_2, a new mineral. *European Journal of Mineralogy* **13**, 177–185.

Theoparacelsite

Orthorhombic

$Cu_3(OH_2)As_2O_7$

Locality: The old copper mines of Roua (North and South group) in the upper part of the Var valley (the Daluis gorge) at the western margin of the Barrot dome, Alpes-Maritimes area, about 50 km from Nice, France.

Occurrence: Associated minerals are: dolomite, calcite, aragonite, copper, cuprite, domeykite, algodonite, koutekite, gold, silver, olivenite, cornubite, clinotyrolite, connelite, brochantite, malachite, trippkeite, pharmacosiderite, strashimirite and gilmarite.

General appearance: Aggregates in cuprite cavities 1 mm in diameter. The aggregates consist of crystals (up to 0.2 x 0.1 x 0.05 mm, rectangular elongated crystals (up to 90 x 10 x 5 μm), perfect rectangular crystals (10 x 7 x 2 μm), equidimensional crystal (~ 20 μm), pseudomorphs after thin acicular crystals of olivenite and also as powder.

Physical, chemical and crystallographic properties: *Luster:* vitreous to adamantine. *Diaphaneity:* translucent. *Color:* dark pistachio green. *Streak:* yellowish green. *Luminescence:* nonfluorescent. *Hardness:* could not be measured. *Tenacity:* brittle. *Cleavage:* {001} perfect. *Fracture:* conchoidal. *Density:* could not be measured, 4.73 g/cm^3 (calc.). ***Crystallography:*** Orthorhombic, *Pmma*, *a* 8.3212, *b* 2.9377, *c* 4.6644 Å, *V* 114.02 Å^3, Z 2/3, *a:b:c* = 2.8326:1:1.5878. Morphology: {001}, {010}, {100}, {110} and {101}. Twinning: none. ***X-ray powder diffraction data:*** 4.065 (15) (101), 3.104 (100) (201), 2.486 (70) (011), 2.400 (25) (210), 2.330 (15) (002), 1.672 (30) (212), 1.596 (25) (411), 1.330 (25) (601, 221). ***Optical data:*** Biaxial (+), α 1.81, β 1.82, γ 1.86, 2V(meas.) 57°, 2V(calc.) 54°; dispersion r>v, moderate; pleochroism X = light olive green, Y = olive green, Z = dark pistachio green; orientation, X = *a*, Y = *c*, Z = *b*. ***Chemical analytical data:*** Means of five sets of electron microprobe data (with H_2O by difference): CuO 48.77, As_2O_5 47.68, H_2O (3.55), Total (100.00) wt.%. Empirical formula: $Cu_{2.99}(OH)_{1.92}As_{2.02}O_{7.08}$. ***Relationship to other species:*** None apparent.

Name: For Philippus Aureolus Bombastus von Hohenheim (1493–1541), called Paracelse which is a Greco-Roman translation of Hohenheim meaning "close to the sky." Paracelse was an important physician, chemist, alchemist and doctor who also worked in mineralogy (*De Mineralibus, De Elemento Aquae & Fructibus eius*). He is known in toxicology for having said "All is poison, nothing is poison, it is the dosage which makes the poison." ***Comments:*** IMA No. 1998-012.

SARP, H. and ČERNÝ, R. (2001) Theoparacelsite, $Cu_3(OH_2)As_2O_7$, a new mineral: its description and crystal structure. *Archives de Science Genève* **54(1)** 7–14.

Woodallite

Trigonal

$Mg_6Cr_2(OH)_{16}Cl_2\cdot 4H_2O$

Locality: The Mount Keith deposit, 94 km NNE of Leinster in the northeastern Goldfields district, Western Australia, Australia.

Occurrence: In lizardite+brucite-altered dunite in a large, low-grade disseminated nickel sulphide deposit. Associated minerals are: chromite. lizardite, iowaite, pentlandite, magnetite, tochilinite and brucite.

General appearance: Whorls and clusters (up to 6 mm across) of minute platelets (5 to 100 μm).

Physical, chemical and crystallographic properties: *Luster:* resinous to waxy. *Diaphaneity:* transparent. *Color:*deep magenta to purple. *Streak:* pale pink to white. *Luminescence:* nonfluorescent. *Hardness:* 1½ to 2. *Tenacity:* flexible but not elastic. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* 2.062 g/cm^3 (meas.), 2.04 g/cm^3 (calc.). ***Crystallography:*** Trigonal, $R\bar{3}m$, *a* 3.103, *c* 24.111 Å, *V* 201.14 Å^3, Z 3/8, *c:a* = 7.7702. Morphology: no forms were mentioned, tabular on {001}. Twinning: none mentioned.

X-ray powder diffraction data: 8.0361 (100) (003), 4.0205 (48) (006), 2.6239 (3) (012), 2.3488 (5) (015), 2.0072 (6) (0.1.12), 1.6977 (2) (0.1.11), 1.5237 (2) (113, 1.0.13) Note: the last spacing is indexed erroneously as ($2\bar{1}3$, 1.0.13). ***Optical data:*** Uniaxial (–), ω 1.555, ε 1.535, pleochroism distinct from violet to pinkish lilac. ***Chemical analytical data:*** Means of an unspecified number of sets of electron microprobe data (corrected for loss of volatiles): Mg 22.90, Cr 9.56, Fe 4.30, Al 0.60, H_2O 10.96, OH 41.40, Cl 8.71, S 0.03, CO_3 1.52, Total 99.98 wt.%. CO_3 content is based on total C measured by Leco carbon analyser. Empirical formula: $Mg_{6.23}(Cr_{1.21}Fe_{0.51}Al_{0.15})_{\Sigma 1.87}(OH)_{16.08}[Cl_{1.62}(CO_3)_{0.17}(SO_4)_{0.01}]_{\Sigma 1.80}\cdot 4.02H_2O$. ***Relationship to other species:*** It is a member of the hydrotalcite group, specifically the Cr-dominant analogue of iowaite, $Mg_6Fe_2(OH)_{16}Cl_2\cdot 4H_2O$.

Name: For Roy Woodall (1930–), eminent Australian geologist. ***Comments:*** IMA No. 2000-042.

GRGURIC, B. A., MADSEN, I. C., and PRING, A. (2001) Woodallite, a new chromium analogue of iowaite from the Mount Keith nickel deposit, Western Australia. *Mineralogical Magazine* **65**, 427–435.

Zaccagnaite

Hexagonal

$Zn_4Al_2(OH)_{12}(CO_3)\cdot 3H_2O$

Locality: Calagio quarry, Colonnata valley, Carrara basin, Apuan Alps, northern Tuscany, Italy.

Occurrence: In cavities in calcite veins in the famous Carrara marble. Associated minerals are: hydrozincite and fraipontite. It formed as an alteration product of sphalerite by reaction with aluminum-rich hydrothermal fluids.

General appearance: Minute hexagonal crystals less than 0.2 mm long and 0.02 to 0.03 mm thick. These are covered by a thin crust of fraipontite and resemble so-called "Brugola" screws (i.e., set-screws).

Physical, chemical and crystallographic properties: *Luster:* subvitreous. *Diaphaneity:* transparent to translucent. *Color:* white. *Streak:* white. *Luminescence:* not given. *Hardness:* not given. *Tenacity:* not given. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* could not be measured, 2.84 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3/mmc$, *a* 3.0725, *c* 15.114 Å, *V* 123.62 Å^3, Z ⅓, *c:a* = 4.9191. Morphology: no forms were mentioned but {001} and {100} probably are present. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.51 (vs) (002), 3.794 (m) (004), 2.65 (w) (100), 2.511 (mw) (102), 2.175 (mw) (104), 1.890 (w) (008), 1.830 (mw) (106), 1.542 (ms) (108), 1.539 (ms) (110). ***Optical data:*** could not be determined because of the small size, the fragility and the coatings on the crystals. ***Chemical analytical data:*** Means of four sets of electron microprobe data: CuO 0.24, ZnO 56.01, Al_2O_3 18.44, SiO_2 0.09, Total 74.78 wt.%. Here, 28.63 wt.% H_2O and 7.85 wt.% CO_2 were added to give 9(H_2O) and 1(CO_3); this raises the analytical total to 111.12 wt.%. Recalculation to give 100.00 wt.% (and ignoring SiO_2) gives: CuO 0.22, ZnO 50.40, Al_2O_3 16.59, CO_2 (7.02), H_2O (25.76), Total (100.00) wt.%. Empirical

formula: $(Zn_{3.90}Cu_{0.02})_{\Sigma 3.92}Al_{2.05}(OH)_{11.99}(CO_3)_{1.00}\cdot 3.00H_2O$. ***Relationship to other species:*** It is a member of the hydrotalcite group.

Name: For the late scholar Domenico Zaccagna (1851–1940) who was born in Carrara and died in Rome. He published the first geological map of the Apuan Alps and was a competent collector of minerals from the Carrara marble. His collection is preserved in Museo di Storia Naturale e del Territorio at the University of Pisa. ***Comments:*** IMA No. 1997-019. Because of the very small size of the crystals, many of the usual physical properties could not be determined. Prof. Merlino kindly supplied additional data. The crystal structure was determined.

MERLINO, S. and ORLANDI, P. (2001) Carraraite and zaccagnaite, two new minerals from the Carrara marble quarries: their chemical compositions, physical properties, and structural features. *American Mineralogist* **86**, 1293–1301.

Zincowoodwardite

Trigonal

$[Zn_{1-X}Al_X(OH)_2][(SO_4)_{X/2}(H_2O)_n]$

Locality: Laurion, Greece and also the Hilarion mine and the Christiana mine both at Kamariza near Laurion, Greece.

Occurrence: Associated minerals are: glaucocerinite, natroglaucocerinite, zaccagnaite, serpierite and hemimorphite.

General appearance: Botryoidal crusts of tabular crystals (5 to 10 μm).

Physical, chemical and crystallographic properties: *Luster:* waxy. *Diaphaneity:* translucent. *Color:* pale bluish to bluish-white. *Streak:* white to bluish-white. *Luminescence:* not mentioned. *Hardness:* 1. *Tenacity:* sectile. *Cleavage:* not discernible. *Fracture:* not mentioned. *Density:* 2.66 g/cm^3 (meas.), 2.71 g/cm^3 (calc.). ***Crystallography:*** Trigonal (Rhombohedral), probably $R\bar{3}m$ for the -3*R* polytype, *a* 3.065, *c* 25.42 Å, *V* 206.8 Å^3, Z 3, *c*:*a* = 8.2936 (See Comments). Morphology: no forms were mentioned. Twinning: none mentioned. The -1*T* polytype gave the following data: Trigonal, probably $P\bar{3}$, *a* 3.063, *c* 8.91 Å, *V* 72.4 Å^3, Z 1, *c*:*a* = 2.9089. Analysis by AAS and CHN gave the empirical formula: $[Zn_{0.55}Cu_{0.12}Al_{0.33}(OH)_{2.00}][(H_3O)_{0.11}Na_{0.04}(SO_4)_{0.17}(CO_3)_{0.07}(H_2O)_{0.96}]$. ***X-ray powder diffraction data:*** The -3*R* polytype: 8.50 (100) (003), 4.248 (33) (006), 2.600 (5) (012), 2.354 (4) (015), 2.039 (3) (018), 1.532 (2) (110), 1.508 (2) (113). The -1*T* polytype: 8.9 (100) (001), 4.47 (90) (002), 2.65 (30) (100), 2.55 (60) (101), 2.28 (50) (102), 1.98 (30) (103), 1.53 (30) (110), 1.51 (30) (111). ***Optical data:*** Uniaxial (sign unknown), ω 1.5636, ε could not be measured, nonpleochroic. The -1*T* polytype has ω 1.558. ***Chemical analytical data:*** ICP-MS analysis gave: CaO 10.4, ZnO 33.3, Al_2O_3 17.2, SO_3 12.6, H_2O 25.1, Total 98.6 wt.%. Empirical formula: $[Zn_{0.47}Cu_{0.15}Al_{0.38}(OH)_{2.00}][(SO_4)_{0.18}O_{0.01}(H_2O)_{0.59}]$. ***Relationship to other species:*** It is a member of the hydrotalcite group and closely related to woodwardite, honessite, glaucocerinite, hydrowoodwardite and zaccagnaite. The descriptions of natroglaucocerinite and zaccagnaite are in press.

Name: For the relationship to woodwardite. ***Comments:*** IMA No. 1998-026.

WITZKE, T. and RAADE, G. (2000) Zincowoodwardite, $[Zn_{1-X}Al_X(OH)_2][(SO_4)_{X/2}(H_2O)_n]$, a new mineral of the hydrotalcite group. *Neues Jahrbuch für Mineralogie, Monatshefte* **2000**, 455–465.

Zugshunstite-(Ce)

Monoclinic

$(Ce,Nd,La)Al(SO_4)_2(C_2O_4)\cdot 12H_2O$

Locality: Alum Cave Bluff, Great Smoky Mountains National Park, Tennessee, USA.

Occurrence: In an evaporite assemblage. Associated minerals are: coskrenite-(Ce), levinsonite-(Y), melanterite, halotrichite, pickeringite, apjohnite, epsomite and other hydrated sulfates.

General appearance: Equant, stubby individual crystals (up to 1.0 mm in diameter) and subparallel aggregates (up to 1.5 mm in diameter).

Physical, chemical and crystallographic properties: *Luster:* not given but probably vitreous. *Diaphaneity:* transparent. *Color:* pale pink under incandescent light, pale blue under fluorescent light. *Streak:* white. *Luminescence:* none observed. *Hardness:* not determined. *Tenacity:* brittle. *Cleavage:* {010} poor. *Fracture:* irregular. *Density:* not determined, 2.12 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, *C*2/*c*, *a* 8.718, *b* 18.313, *c* 13.128 Å, β 93.90°, *V* 2091.0 Å^3, Z 4, *a*:*b*:*c* = 0.4761:1:0.7169. Morphology: {010}, {012} dominant; {111} minor. Twinning: none mentioned. ***X-ray powder diffraction data:*** 7.9 (100) (110), 5.36 (50) (022), 5.01 (40) (130), 3.93 (70) (023, 220, $\bar{1}13$, 132), 3.74 (20) (042, $\bar{2}02$, 113), 3.29 (20) ($\bar{1}15$, 222, 004), 3.07 (20) ($\bar{1}14$, 024, 060). ***Optical data:*** Biaxial (sign not given but +), α 1.455, β 1.485, γ 1.528, 2V(meas.) 85°, 2V(calc.) 82°, dispersion r>v, medium; nonpleochroic; orientation not observed. ***Chemical analytical data:*** Means of an unstated number of sets of electron microprobe data: Y_2O_3 n.d, La_2O_3 2.16, Ce_2O_3 13.17, Pr_2O_3 1.68, Nd_2O_3 6.50, Sm_2O_3 0.80, Eu_2O_3 0.27, Gd_2O_3 0.14, Dy_2O_3 n.d., Er_2O_3 n.d., CaO 0.04, Al_2O_3 6.92, Fe_2O_3 1.11, SO_3 24.01, C_2O_3 (10.80), H_2O (32.41), Total (100.01) wt.%. C_2O_3 and H_2O were calculated to give 1.00(C_2O_4) and 12(H_2O), respectively. Empirical formula: $(Ce_{0.54}Nd_{0.26}La_{0.09}Pr_{0.07}Sm_{0.03}Eu_{0.01}Gd_{0.01})_{\Sigma 1.01}(Al_{0.91}Fe^{3+}_{0.09})_{\Sigma 1.00}(SO_4)_{2.00}(C_2O_4)_{1.00}\cdot 12.00H_2O$. ***Relationship to other species:*** None stated.

Name: For the locality; it is the authors' best approximation of an anglicized equivalent to words used by the Cherokee Indians to refer to the Great Smoky Mountains (Tsu-g-shv-sdi). ***Comments:*** IMA No. 1996-055.

ROUSE, R. C., PEACOR, D. R., ESSENE, E. J., COSKREN, T. D., and LAUF, R. J. (2001) The new minerals levinsonite-(Y) $[(Y,Nd,Ce)Al(SO_4)_2(C_2O_4)\cdot 12H_2O]$ and zugshunstite-(Ce) $[(Ce,Nd,La)Al(SO_4)_2(C_2O_4)\cdot 12H_2O]$: Coexisting oxalates with different structures and differentiation of LREE and HREE. *Geochimica et Cosmochimica Acta* **65**, 1101–1115.

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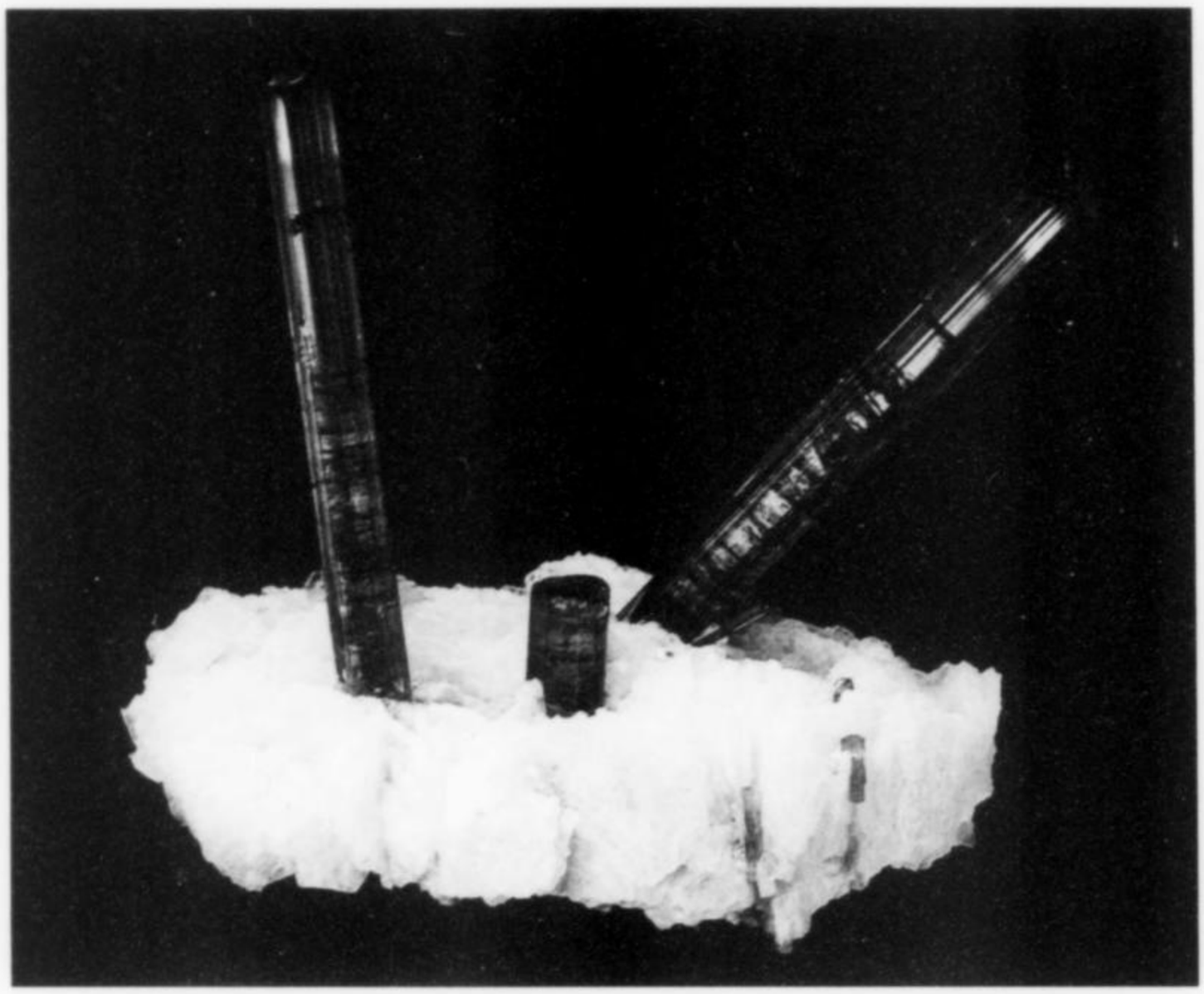

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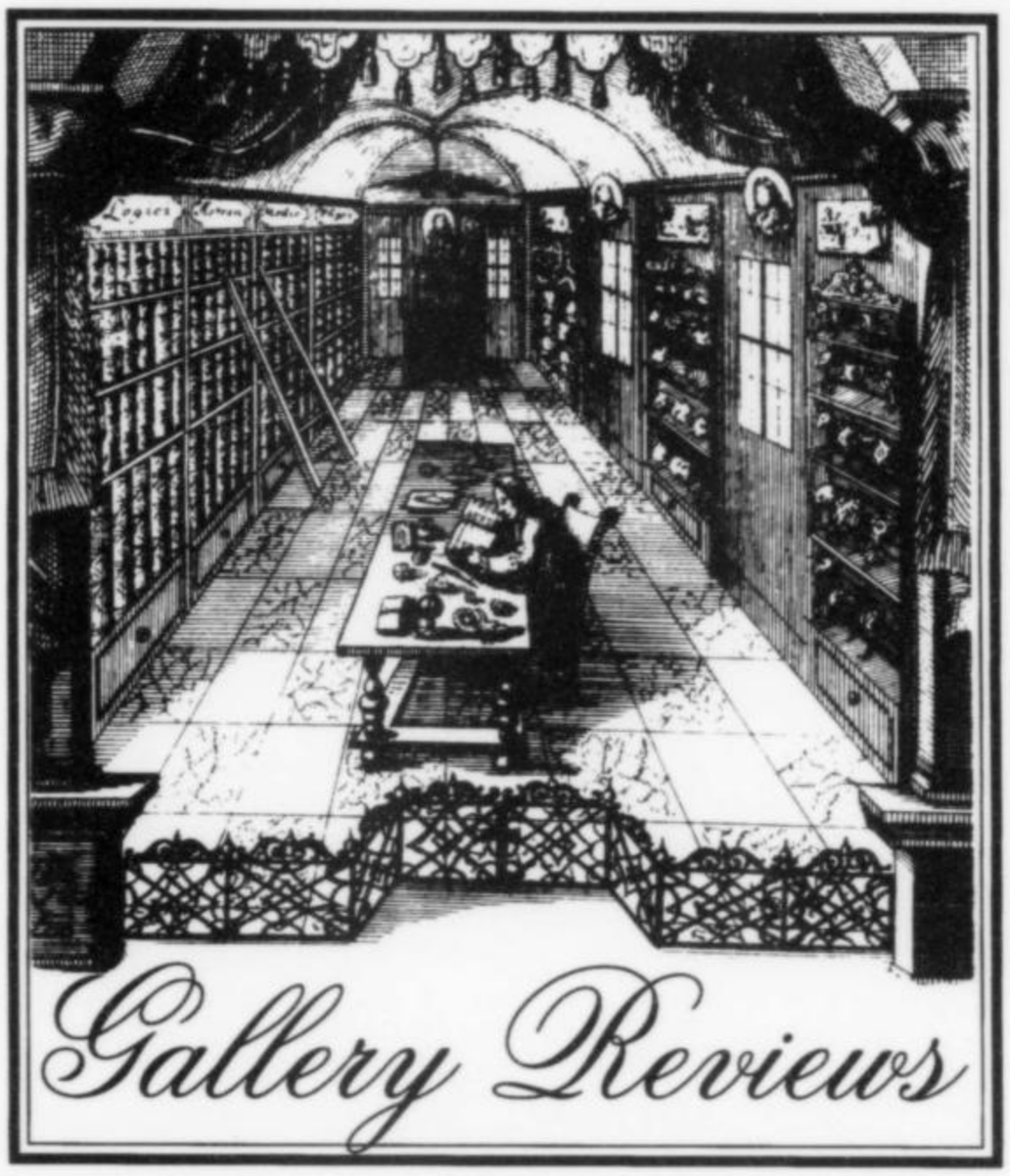
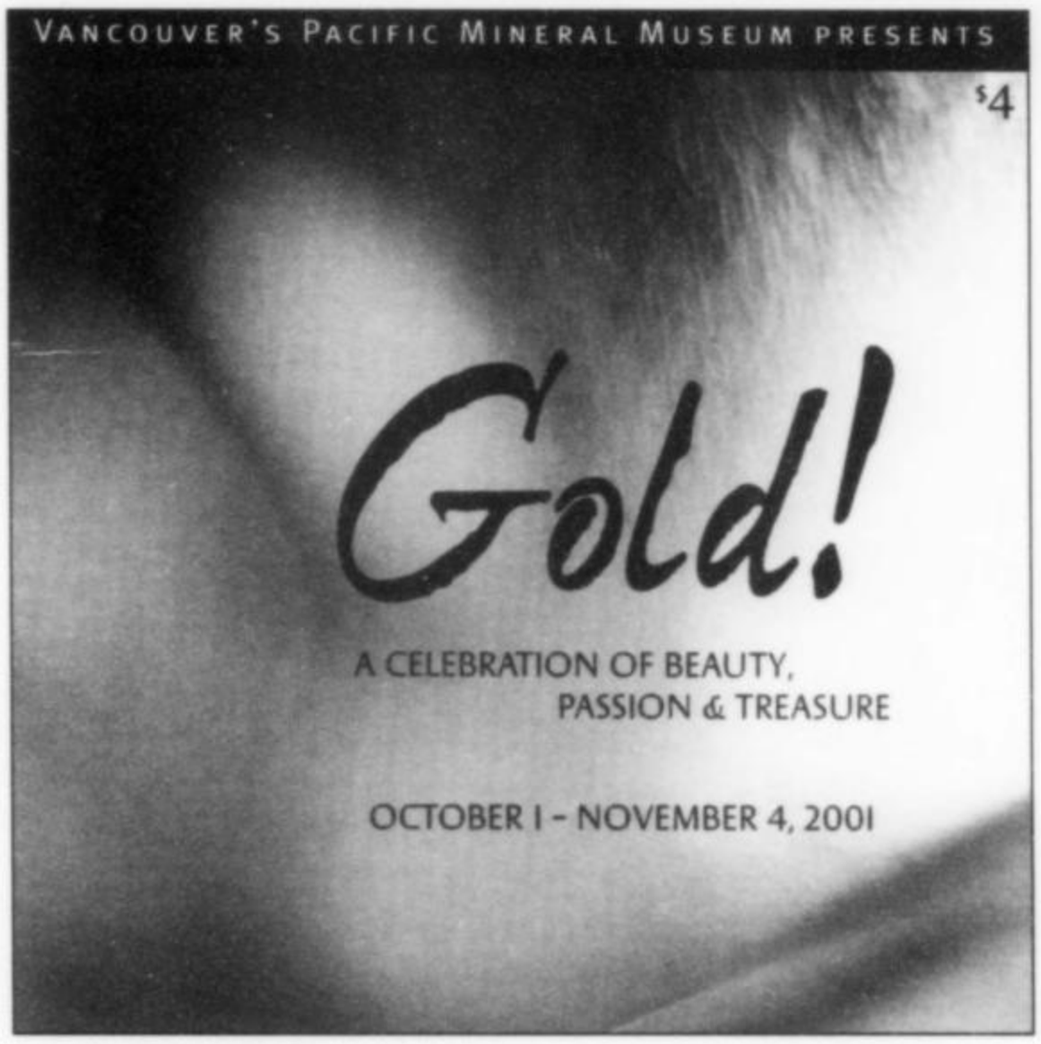




Pacific Mineral Museum Gold Show

by Bill Smith

[October 1—December 9, 2001]

The Pacific Mineral Museum in Vancouver, British Columbia first opened its doors to the public on January 22, 2000. On October 1, 2001 they mounted a remarkable show devoted to element 79. For this event they removed almost all of the permanent exhibits so as to provide ample space for the visiting exhibits. (Since the permanent exhibits were not in place at the time of my visit, a "Gallery Review" relating to them must be deferred to a later date.)

"Gold! A Celebration of Beauty, Passion and Treasure" surveyed the entire world of gold: properties, occurrence, mineralogy, mining methods, recovery, refining, coinage, jewelry, trading, fabrication for the sciences and art. Although Gold! was not a purely mineralogical show, any lover of native gold could not fail to be entranced by what man has done with the raw metal.

The museum's director, Mark Mauthner, did a remarkable job of assembling support for his show; among the contributors were Barrick Gold, Homestake Mining, Placer Dome, Newmont Mining, Teck, the World Gold Council, the Toronto Stock Exchange, the Royal Canadian Mint, N.M. Rothschild & Sons, and Natural Resources Canada. W.R. Danner contributed a surprising variety of specimens (some acknowledged as fake), coins, and artifacts to be exhibited. This list of supporters is in addition to the many sponsors of the Museum proper, who include Deloitte Touche, Battle Mountain Gold, Price-Waterhouse Coopers, Bank of Montreal, Northgate Exploration, and Cominco.

The entire second floor of the museum building (the usual exhibit space) was occupied by 45 glass cases and stands, of which nearly 25 contained mineral or ore specimens. Most of the specimens were, of course, native gold, but one case held examples of minerals that combine gold with other elements; one such specimen was Harvard's petzite on gold, which must be the world's best petzite. Another case had some beautiful specimens of other minerals recovered during gold mining, including Meikle mine barites [see vol. 30 p.187] and Twin Creeks mine orpiment [see vol. 30 no. 3 p. 187–196]. Extensive credit was given to Barrick Goldstrike Mines and Newmont Mining for arranging for the recovery of these specimens; such publicity is of positive benefit to the mineral world, since the visitors (and sponsors of) this show included much of the North American mining community—go thou and do likewise!

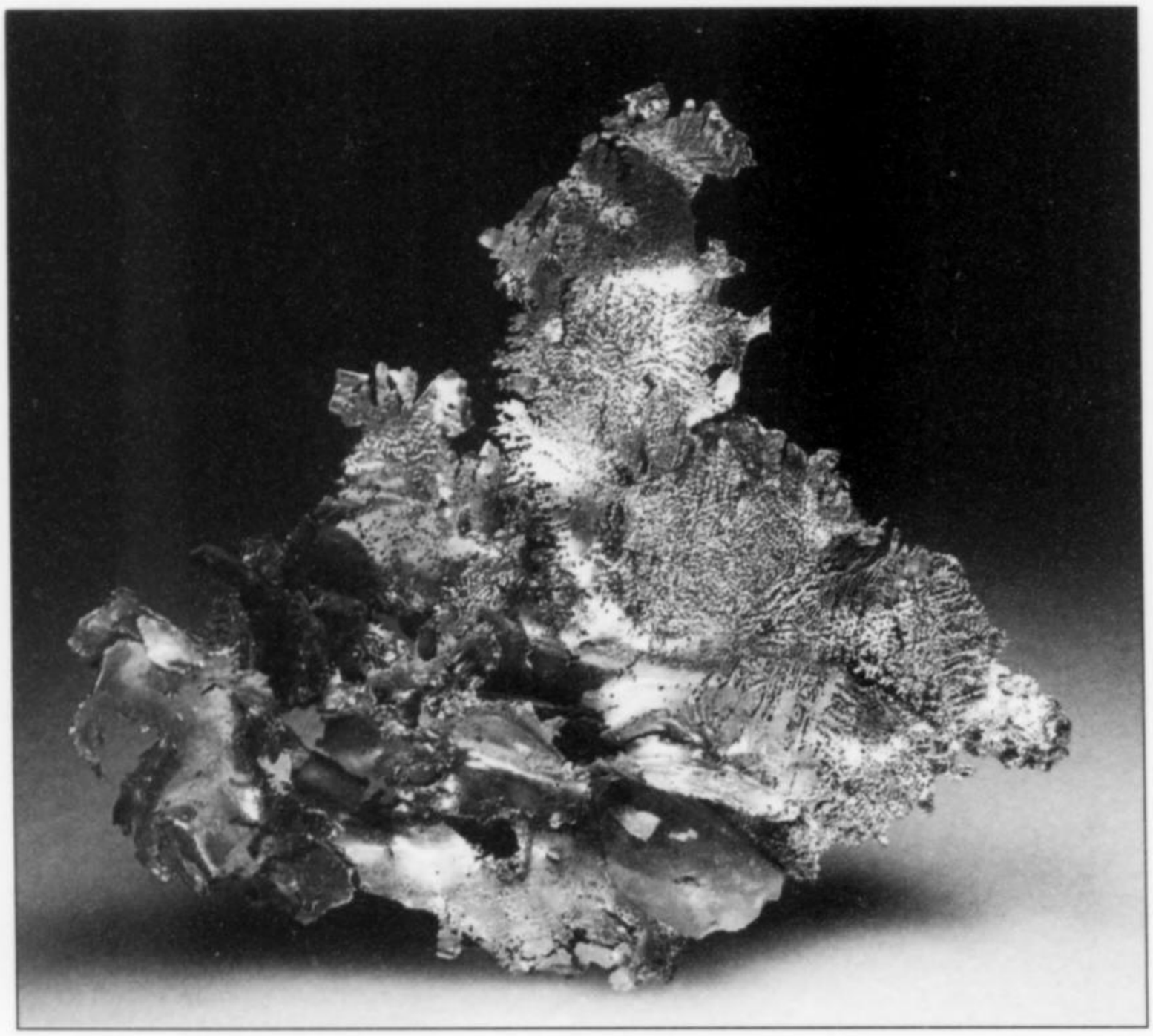
Harvard University provided six cases of their magnificent (mostly Burrage collection) gold specimens, as well as a few specimens scattered in other cases (petzite!). One old friend was the gold "horn" from the Groundhog mine, Gilpin, Colorado that was informally acclaimed as the finest gold specimen at the 1997 Denver Show where gold was the featured mineral. (This was before the discovery of the Colorado Quartz mine specimen known as the "Dragon".)

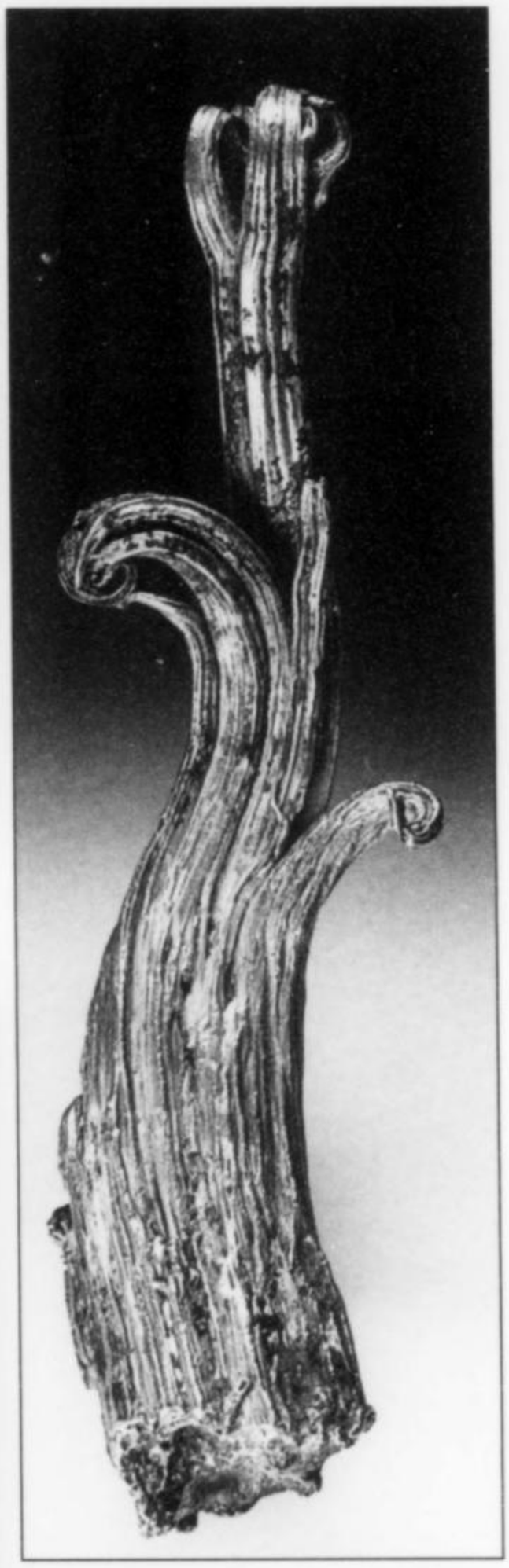
Wayne and Dona Leicht displayed a case of five specimens from Romania, Colorado, and California, including the Red Ledge mine "Corsage," and a second case of six specimens, all from Tuolumne and Placer counties, California. Most of the specimens in the latter case are beautifully crystallized, especially a large leaf gold from "Christmas Pocket" at the Jamestown mine.

Bryan and Kathryn Lees had a case of classic Breckenridge, Colorado leaf and wire golds, all from eight different properties on Farncomb Hill. There was also, as might be expected, a number of fine Canadian, and especially British Columbia, golds on display. I was especially delighted to see another old friend: the gold-plated drill bit and the rock in which it had seized up, still bearing the bit's imprint in the mass of gold—this piece among others from the Royal Ontario Museum, Toronto.

As a mineral collector, I am supposed to love natural specimens above all others, but I must confess that the high point of the show for me was the Kaminsky Collection of ancient Greek and Roman coins. Dr. Felix Kaminsky, a 1959 Moscow University graduate, has prospected and evaluated diamond deposits throughout the world, becoming in the process one of the most highly regarded experts on diamond geology and mineralogy. His work in geology has provided him with the resources to assemble a truly remarkable *coin* collection, of which he had 76 pieces on display, concentrating on the Hellenistic and Roman world, but including a number of Asiatic coins (would you believe a Genghis Khan dinar?) and also some European examples. Here they all were: the stater, solidus,

Wire and leaf gold, 7.4 cm, from the Magenta mine, Nevada County, California; loaned for the exhibit by Wayne and Dona Leicht; W. Wilson photo.





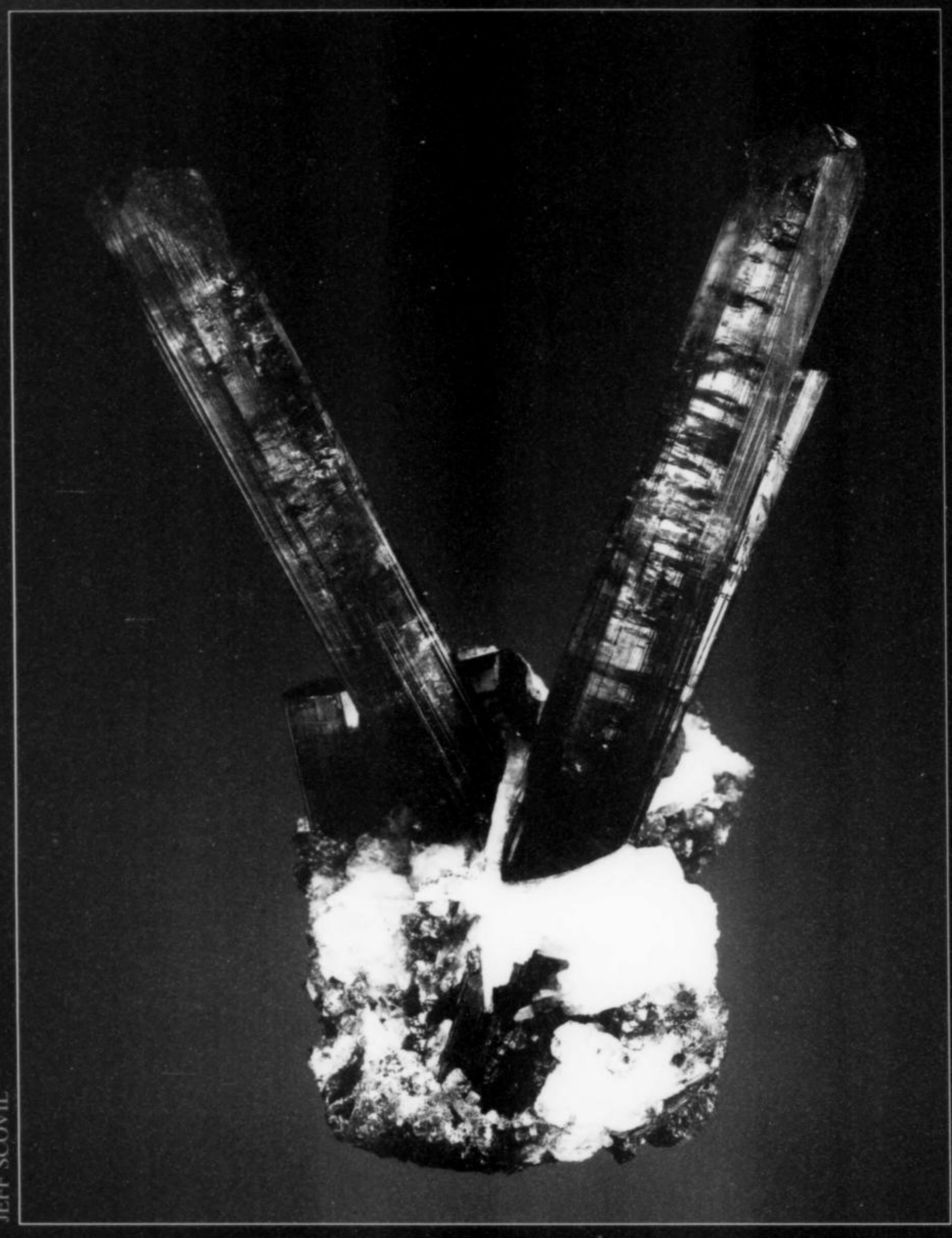
Wire gold from the Groundhog mine, Gilman, Colorado; 11.7 cm; loaned for the exhibit by the Harvard Mineralogical Museum; W. Wilson photo.

Leaf gold, 12.5 cm, from the Red Ledge mine, California; loaned for the exhibit by Wayne and Dona Leicht; W. Wilson photo.

and aureus, as well as the ducat, bezant, and zecchino. Here was the aureus of Gordianus II, who was killed two weeks after enthronement, the only other example of this coin residing in the British museum. And here was the father of them all, the first pure gold coin ever minted: King Croesus's heavy stater.

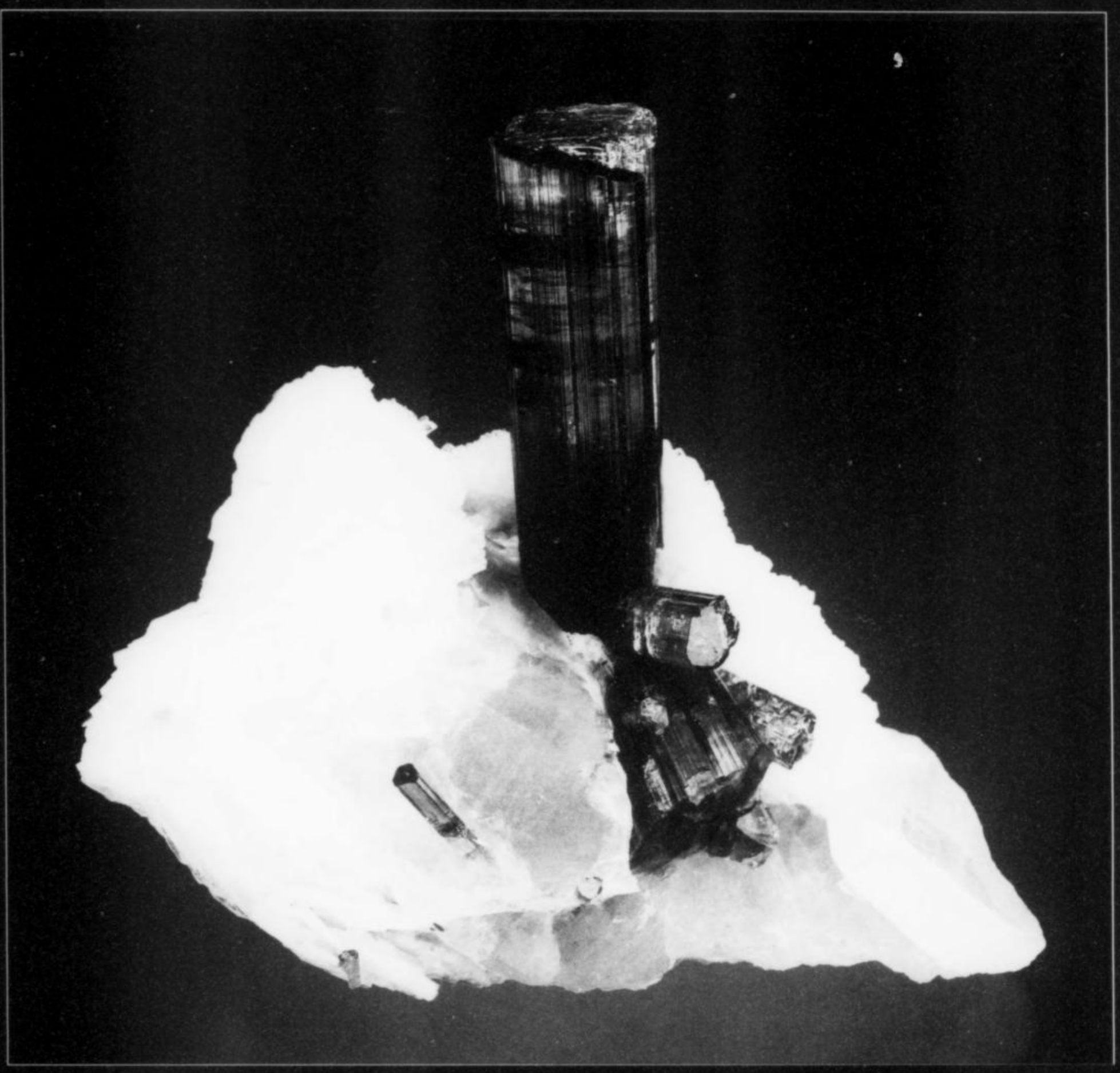
And then there were the bars: cast bars and minted bars, bars from three grams to the kilobar (1000 g), tola bars, tael bars, and biscuits and boats, baht bars and koban bars, pig bars and hologram bars. And in the last case, the ultimate gold authority, the London Good Delivery (LGD) bar; the bar used for serious gold deliveries.

The caption for case 12 could have been the title for the entire show: "Heckuvalottagold." This was truly a special exhibition that would have thrilled any mineral collector, regardless of his or her specialty.



Elbaite, 10.5 cm, from the Pederneira mine, Minas Gerais, Brazil

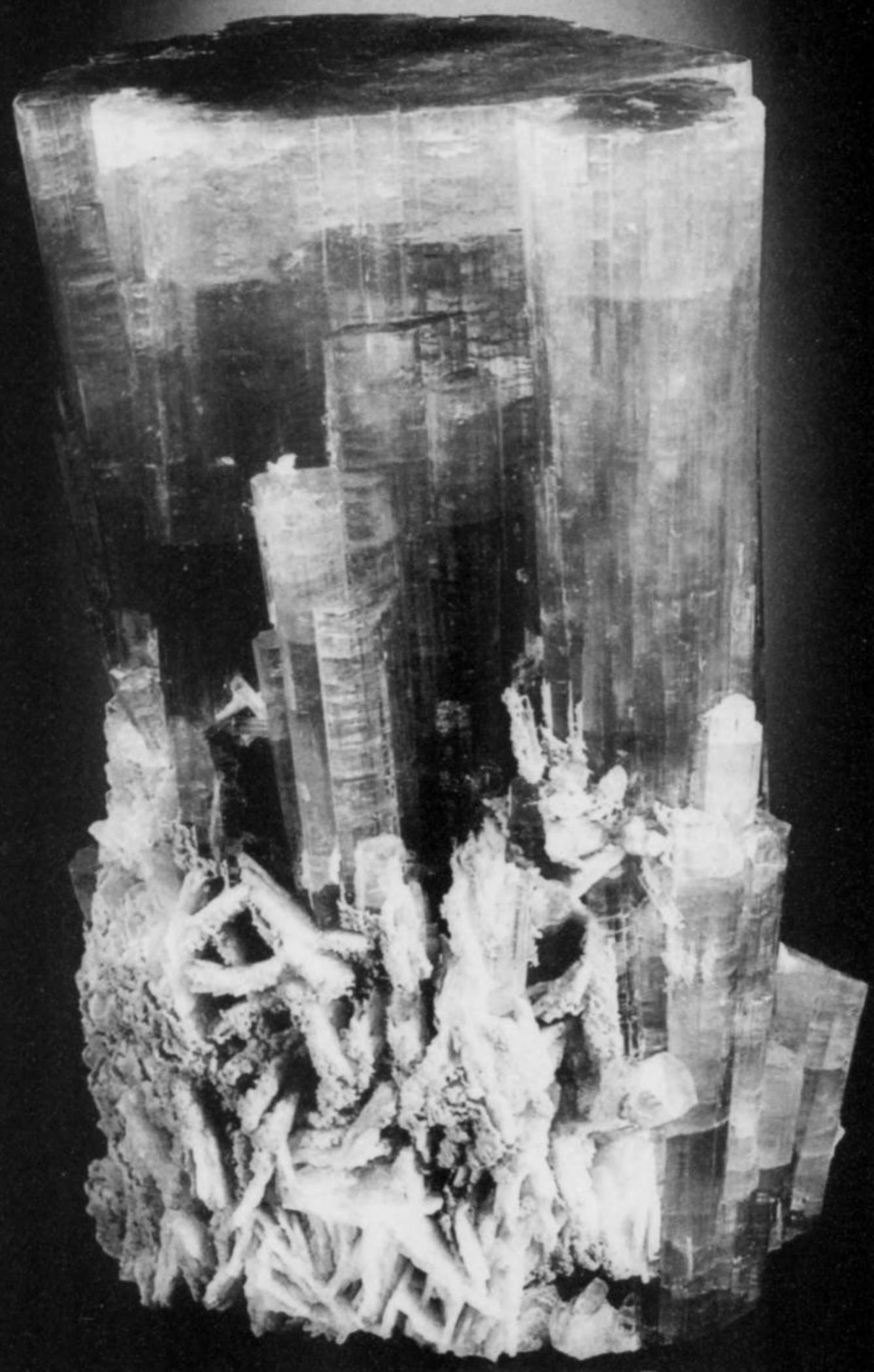
JEFF SCOVIL



JEFF SCOVIL

Elbaite, 12.4 cm wide, from the Pederneira mine, Minas Gerais, Brazil

Stuart & Donna Wilensky



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Collector Profile:

Ralph Clark

Thomas P. Moore
5755 East River Road, no.820
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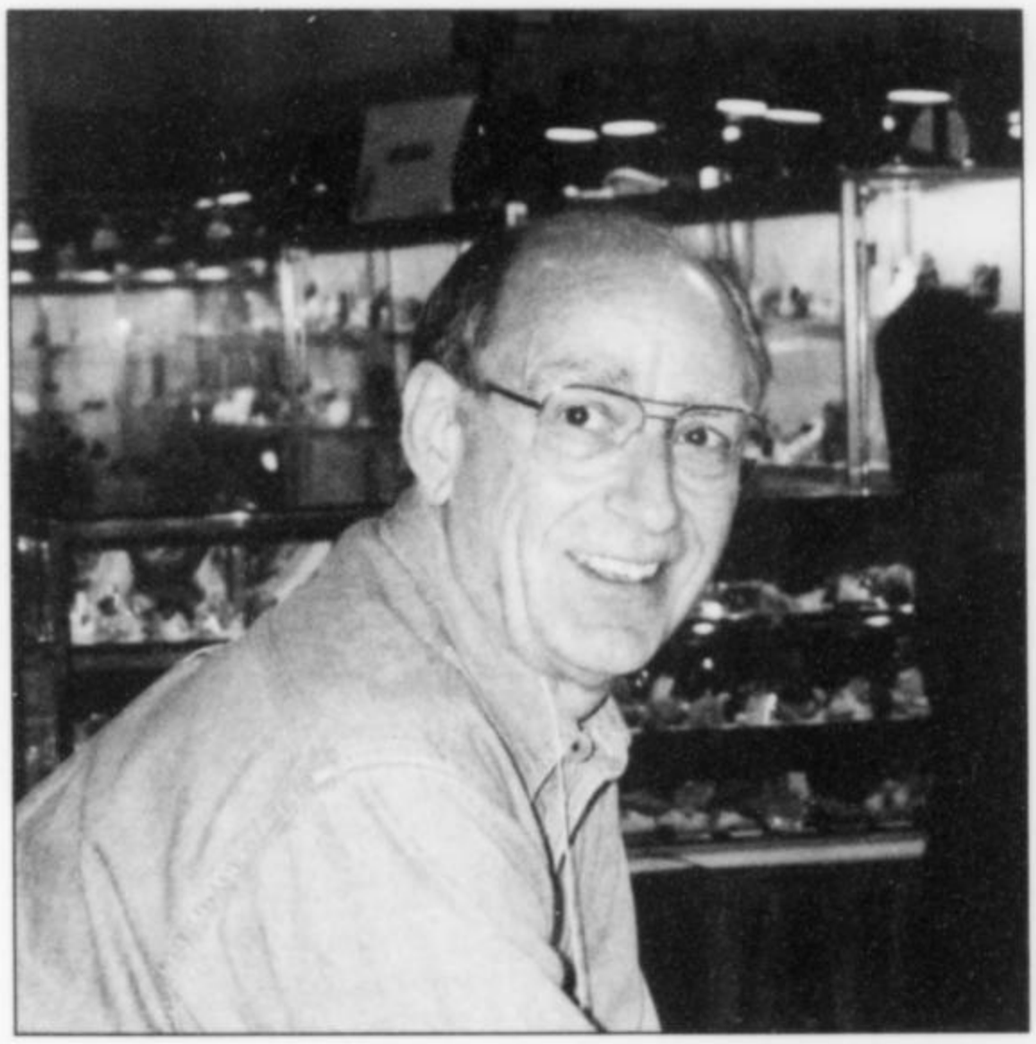
Interested in building a "small" collection of large significance? Look no farther for a role model than Ralph Clark, a thumbnail collector from Denver, Colorado. His amazing accumulation of little jewel-like one-inch specimens shows connoisseurship in aesthetics, science and rarity, driven by passion and just plain perseverance.

Thumbnail collectors are a breed somewhat apart from the larger mineral-collecting community. They tend to have their own goals, priorities and enthusiasms. But mineral folk of other inclinations who don't try to steer completely clear of the thumbnail world will have noticed how commonly the name of Ralph Clark comes up in discussions, and with what high respect the name is mentioned. Ralph collects *only* thumbnails (specimens that would fit within a one-inch cube), and his constantly evolving collection seems to stay at around 250 specimens of amazingly high overall quality. Piece-for-piece it is clearly one of the finest such collections on earth. Indeed the jargon among many thumbnailers these days has evolved to include the term "Ralph Clark specimen." This is understood instantly as denoting not that the piece is necessarily owned by him but that the possibility of improving upon it defies the imagination. A "Ralph Clark specimen" is *the one* you would take if you could choose among *all* those of that kind which you have seen or might ever expect to see. Now that is high praise! To understand this, simply examine the photos shown here of "Ralph Clark specimens" which happen actually to be owned by Ralph Clark. Any questions?!

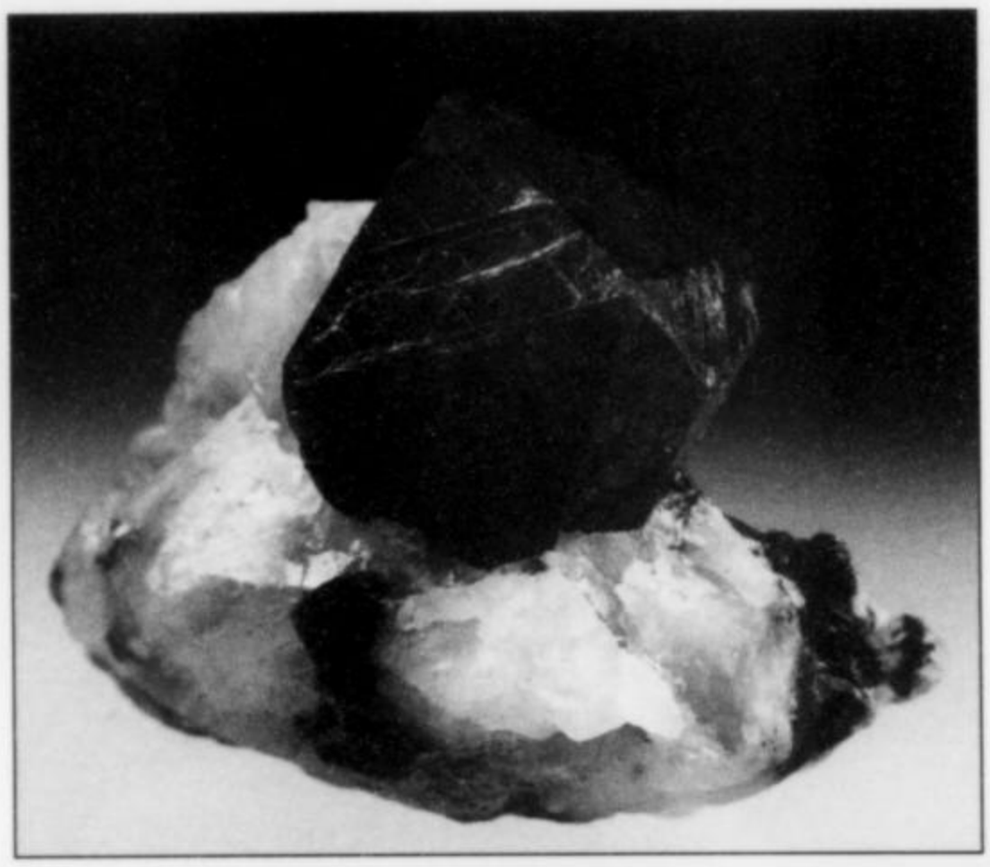
Ralph is not a professional mineralogist, not a curator, prospector, or dealer, not even a particularly wealthy man. He is an "amateur" who came to serious mineral collecting from a successful career in business. He now works—"works?"—close to full-time at cultivating his mineralogical knowledge, friendships, and contacts while refining his connoisseurship so that he may keep shaping and re-shaping his collection. Sitting down with Ralph during the Tucson or Denver shows for a little "show and tell" is always a high point. The specimens he has in his pocket can be memorable enough, of course, but trading stories and listening to Ralph tell about how he came by his acquisitions is always fun. With only a little irony, Ralph himself likes to call the passion for serious collecting "a healthy sickness," but it is obviously much more health and enjoyment than pathology as Ralph does it.



Ralph Clark, Tucson Show 1998; Cal Greaber photo.

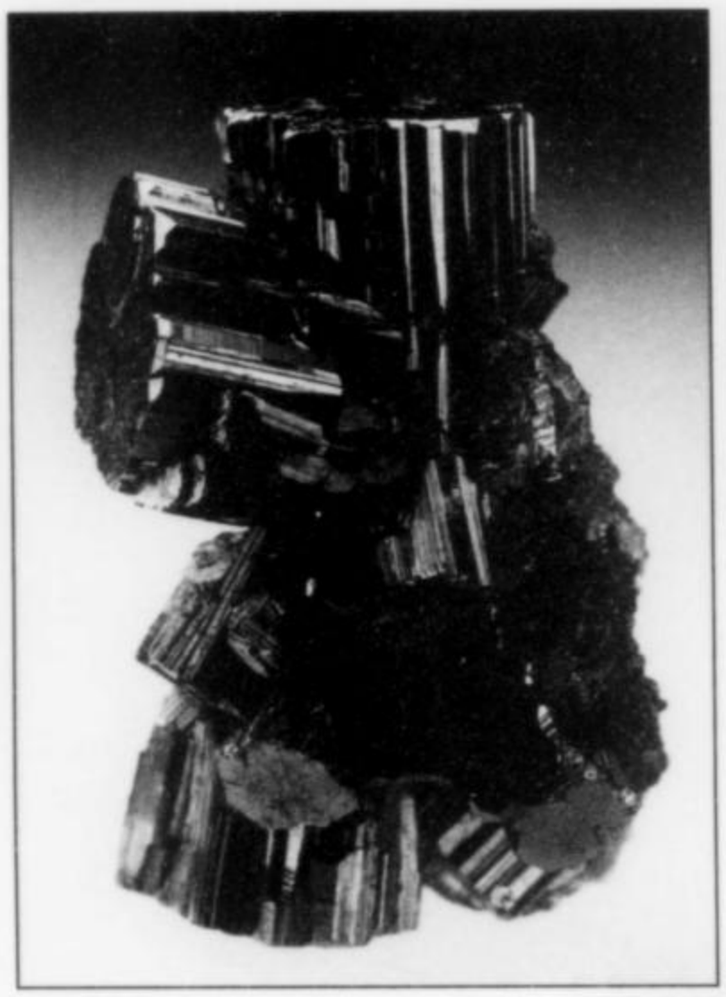
There are no special mineralogical antecedents in Ralph's early life: his father, John P. Clark, was a tractor salesman; his mother, Mary J. Clark, a full-time housewife. Ralph was born (April 12, 1937) in Denver, and there he has stayed all his life except for a three-year hitch in the Air Force and one business-related, two-year stay in Dallas, Texas. At the Community College of Denver and at the University of Colorado he studied electrical engineering, business administration and consumer electronics. His career has

Chromian cerussite; Dundas Extension mine, Dundas, Tasmania; 2.6 cm; W. Wilson photo.

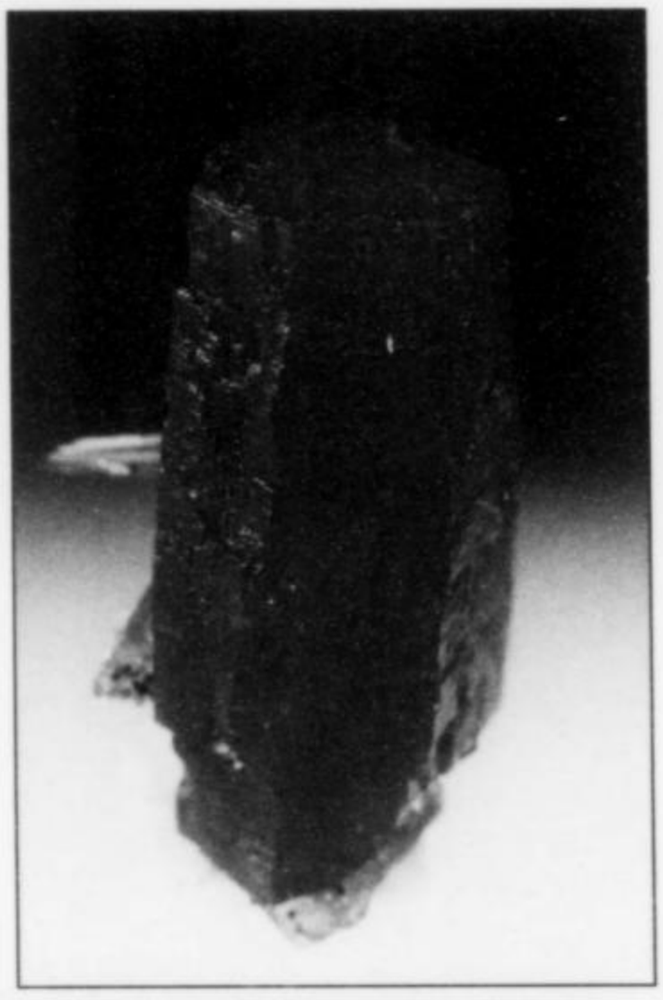


Corundum (ruby); Jegdalek, Afghanistan; 1-cm crystal; W. Wilson photo.

Veszelyite; Black Pine mine, Phillipsburg, Montana; 1.4-cm crystal; W. Wilson photo.



Bournonite; Yan Gou Shi, Hunan, China; 2.3 cm; W. Wilson photo.

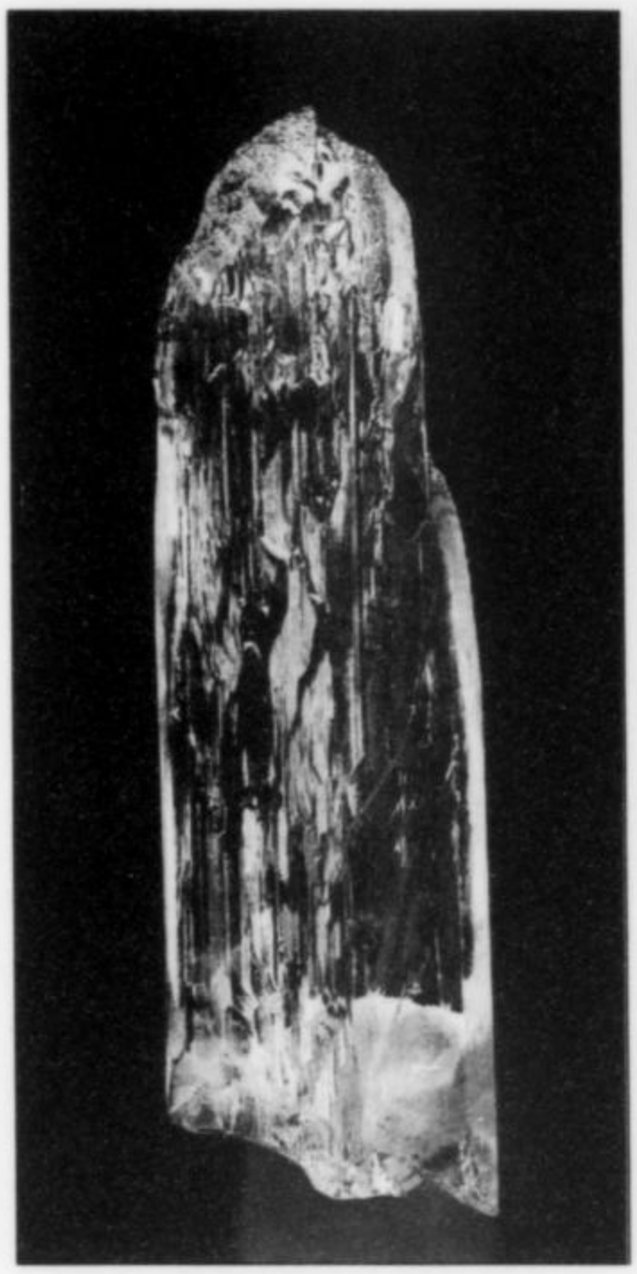


Manganpyrosmallite; Broken Hill, New South Wales, Australia; 1.6-cm; W. Wilson photo.

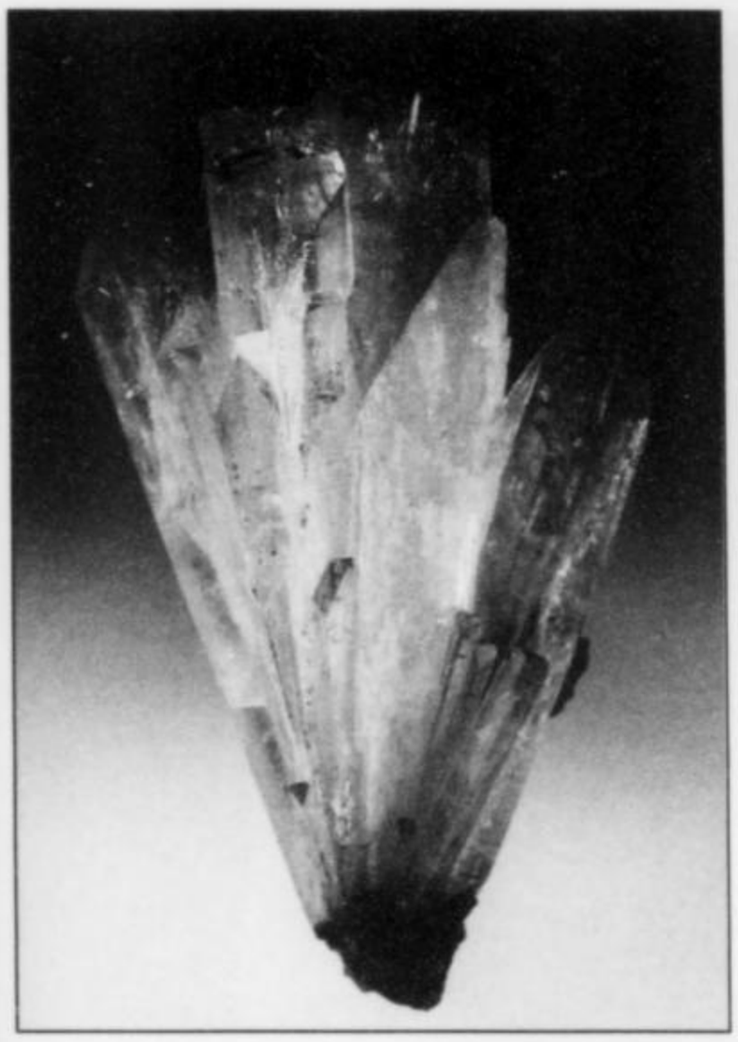
Cuprian adamite with ferrilotharmeyerite; Tsumeb, Namibia; 1.2-cm crystals; W. Wilson photo.

included 17 successful years with J. C. Penney in positions of increasing responsibility in Product Service management, ranging from Manager of their "pilot service center" in Denver, to District Product Service Manager, and later Regional Product Service Manager in Dallas, where he was responsible for planning, organizing, developing and implementing product services and meeting business objectives and goals for a nine-state region. When J. C. Penney decided to discontinue the Product Service branch of its operations in 1983, Ralph went on to similar success working for RCA as Manager of their consumer and commercial service operations branch in Denver, then for General Electric (which acquired RCA in 1986) as Regional Quality Assurance Manager for their Major Appliance Division. His work there covered various programs in quality assurance, replacement parts, customer relations, technical training, and consumer services in the field of electronic and major appliance products for the company's largest geographic region. In 1989, when General Electric downsized their operations and closed their Denver Regional Office, he chose to retire from General Electric, although they had offered him the option of moving to Louisville, Kentucky to continue with the company.

Currently Ralph works a full-time job for a real estate management company. Unpretentiously comfortable, and with three grown

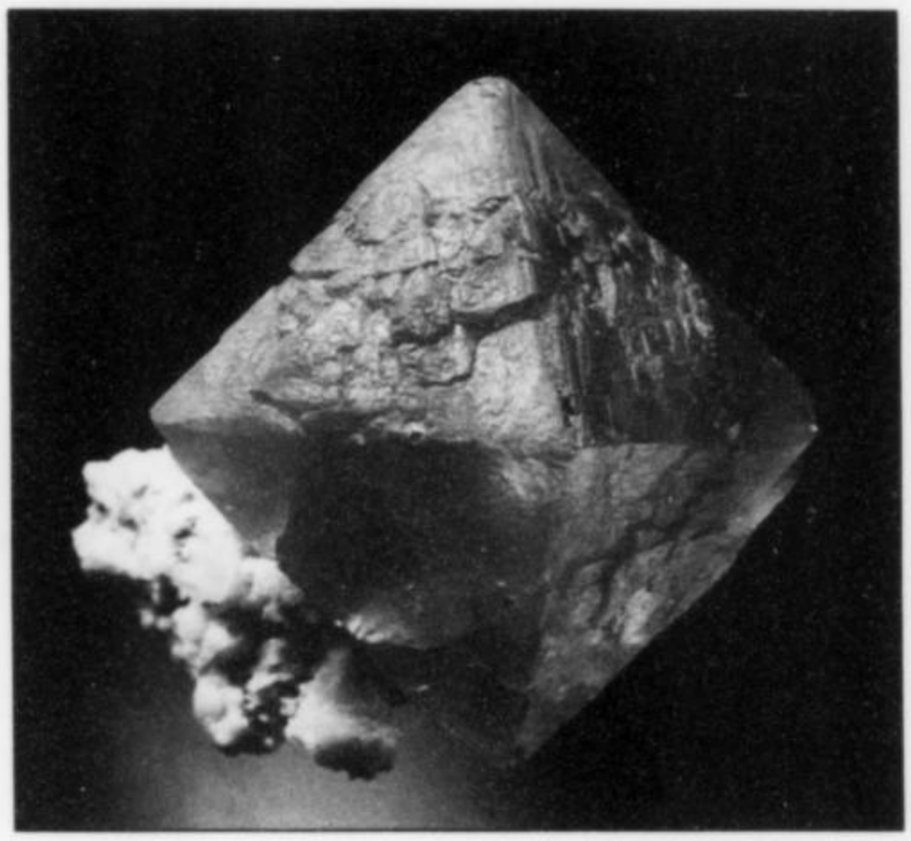


Chromian spodumene (hiddenite); Adams Farm, Hiddenite, North Carolina; 3.3 cm; J. Scovil photo.



Manganoan adamite; Ojuela mine, Mapimi, Durango, Mexico; 3 cm; W. Wilson photo.

Meta-autunite; São Pedro mine, Malacacheta, Brazil; 3.1 cm; W. Wilson photo.



Fluorite; Chamonix, France; 2.3-cm crystal; J. Scovil photo.

Gold; Colorado Quartz mine, Mariposa County, California; 2 cm; W. Wilson photo.

children (and four grandchildren) doing well on their own, Ralph does not really need the extra real-estate money for normal living expenses. In fact, he could just as well retire, but he enjoys using the extra income for—you guessed it—building his mineral collection. This has to be one of the best approaches I've ever heard of to the archetypal problem of how a man might build a new, active, interesting life after retiring from a successful business career: Pursue the world's best South African poldervaartite thumbnail! (Hey, it's more exciting than golf!)

JoAnn, Ralph's wife of 45 years, has other interests herself, but she is wholly supportive of Ralph's passion for minerals and is respectful of his concentrated pursuit of connoisseur thumbnails. (Although I do remember him complaining wistfully about not having found anything at the Tucson Show a few years ago . . . "My wife would call it a 'great show'!" he said with a warm laugh!)

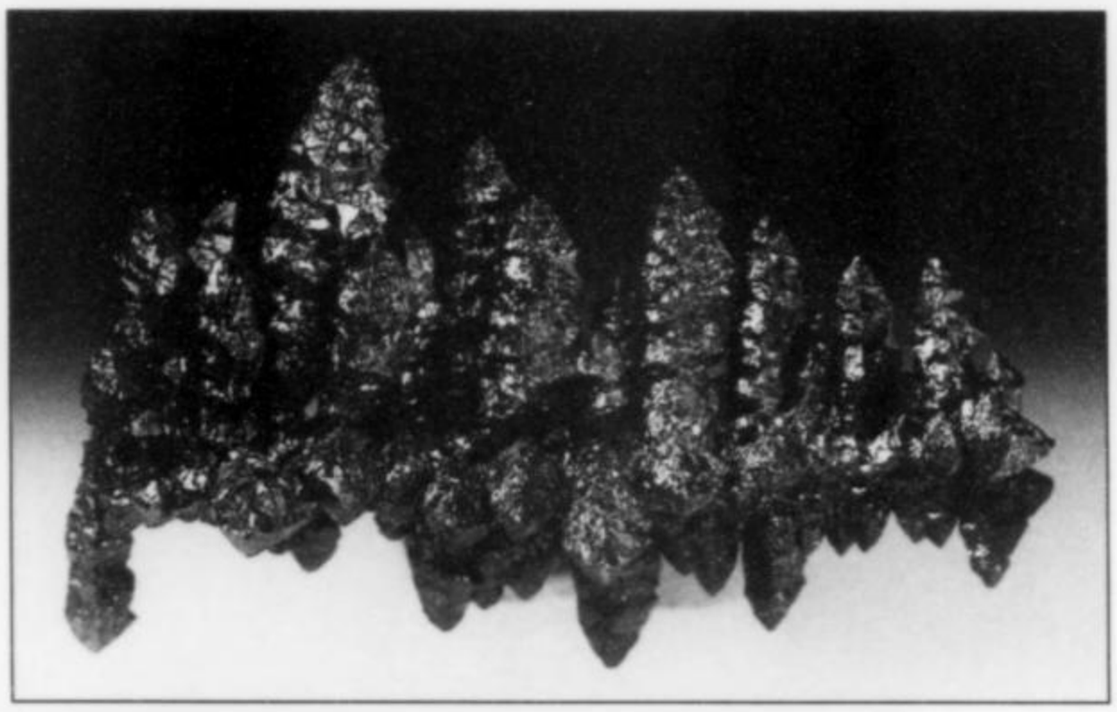
It is always interesting to learn how someone first became a mineral collector. In Ralph's case the hobby had its origins in family life. One day back in 1969 Ralph's son Todd had come home from first grade very excited by a "show and tell" (naturally!) about fossils that one of the other kids had presented in class. Ralph and JoAnn soon found themselves joining the Gates Rock and Mineral Club and haunting rock shops during family trips. Tumbling, cabochon-cutting, and other lapidary amusements eventually gave way to crystal pursuits when Manuel Ontiveros, an El Paso, Texas dealer in Mexican minerals, showed the Clarks his personal collection, the first serious one they had ever seen. Ontiveros pointed them toward the Tucson Show and was otherwise very encouraging, but strongly advised that they should acquire only *high quality* specimens, and not go "vacuum-cleanering" around the shows, merely scooping up pretty rocks in quantity. Promptly disregarding that advice, the Clarks purchased a flat of 20 Mexican miniatures for $20 from Ontiveros himself. But they soon learned to do better.

In 1971 mineral dealer Richard Kosnar ("Mineral Classics") moved to the Denver area, and the Clarks, after seeing his ads in the *Mineralogical Record*, paid him a visit. Ralph and his other son,

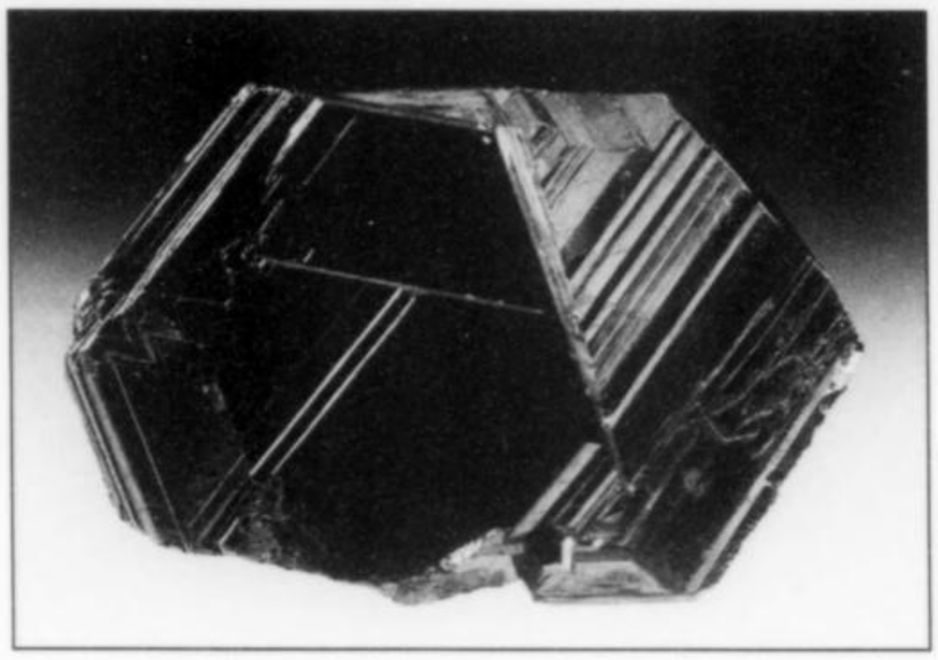
Fluorapophyllite; Poona, India; 3 cm; W. Wilson photo.

Proustite; Svornost mine, St. Joachimsthal, Czech Republic; 2.7 cm; W. Wilson photo.

Iowaite; Phalaborwa, Transvaal, South Africa; 2.3 cm; W. Wilson photo.



Silver; Kongsberg, Norway; 1.5 cm; W. Wilson photo.

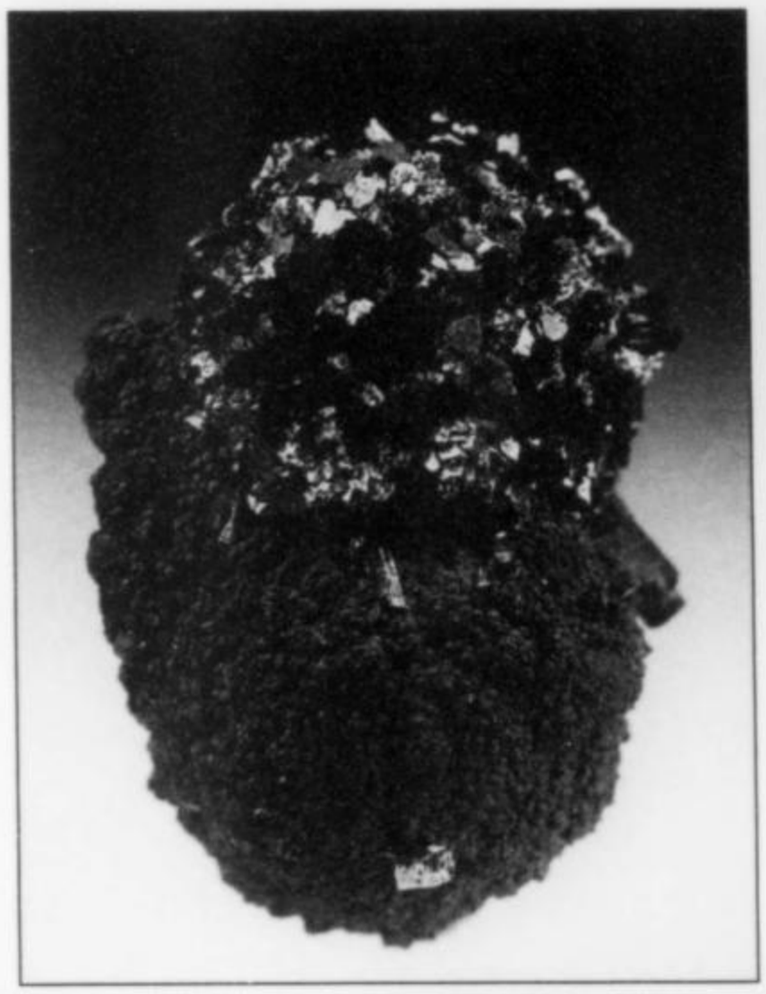


Acanthite-coated silver; Himmelsfürst mine, Freiberg, Germany; 2.7 cm; W. Wilson photo.

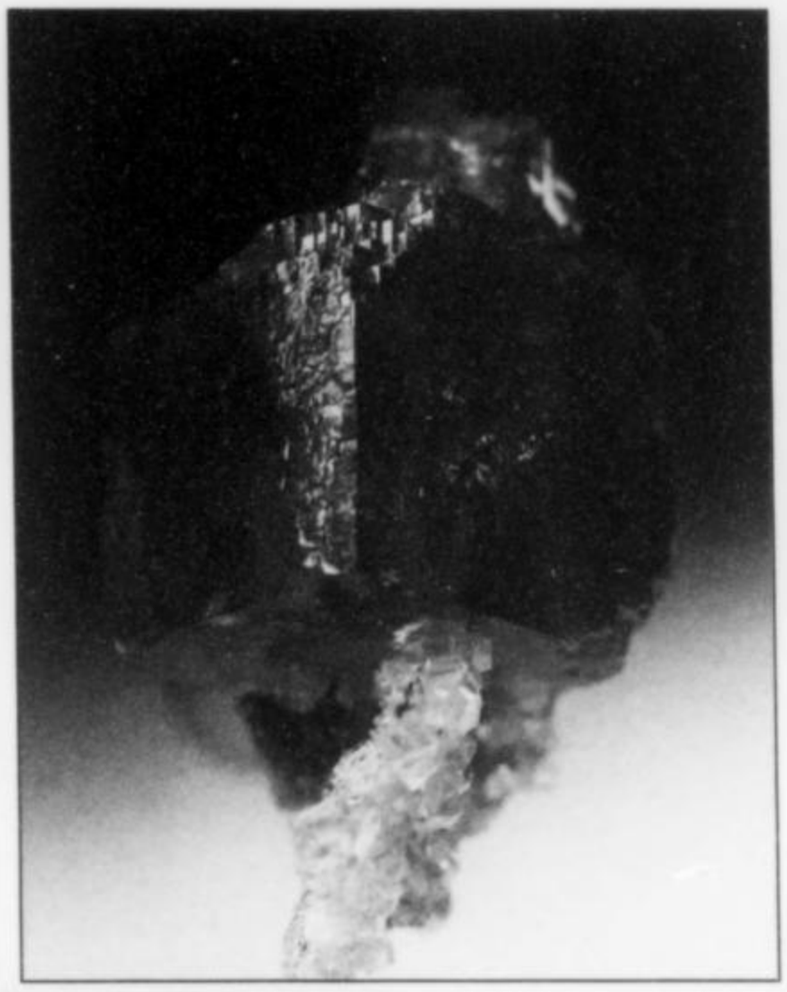
Polybasite; Fresnillo, Zacatecas, Mexico; 2.1 cm; W. Wilson photo.

Don, became friends with Kosnar. They accepted him as their mentor in mineral collecting, and learned much from him. Although Kosnar himself favored miniatures, Ralph and Don zeroed in on thumbnails and began to build a serious, sophisticated, all-out all-thumbnail collection. Todd lost interest in collecting around 1974, but Don and Ralph continued to build their first collection until they sold it in 1977, just as Don was entering college. Today Ralph admits that (like many of us who have ever sold our minerals) there is a handful of pieces from his older collection that he would love to have back again.

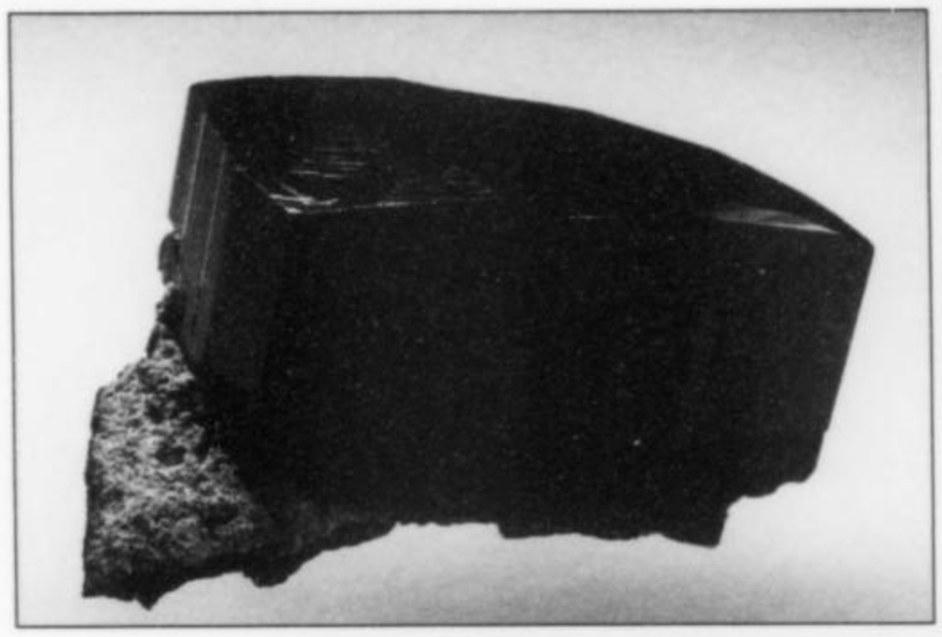
A hiatus set in after 1977, and Ralph ended up waiting until 1986 to begin collecting again, all on his own this time. The first-generation collection was fine enough to have won the AFMS National Award for thumbnail minerals in 1974 and 1977. The second-generation collection has scored six more major competitive-display awards: "Best of Species—Thumbnails" at the Denver Gem & Mineral Show in 1990 and 1993, "Best Master Minerals" at the Tucson Gem & Mineral Show of 1991, the "Richard Pearl Trophy" at the Denver Gem & Mineral Shows in 1992 and 1995, and the AFMS National Award for thumbnail minerals in 1993.

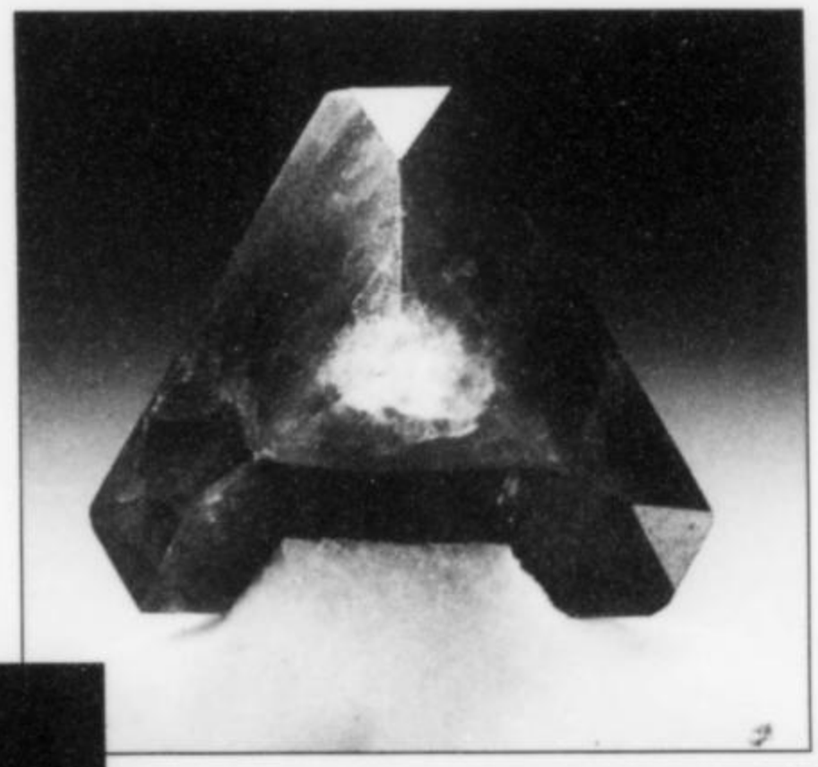


Crostedtite; Wheal Jane Cornwall, England; 1.5 cm across; W. Wilson photo.



Azurite; Tsumeb, Namibia; 2.3 cm; W. Wilson photo.



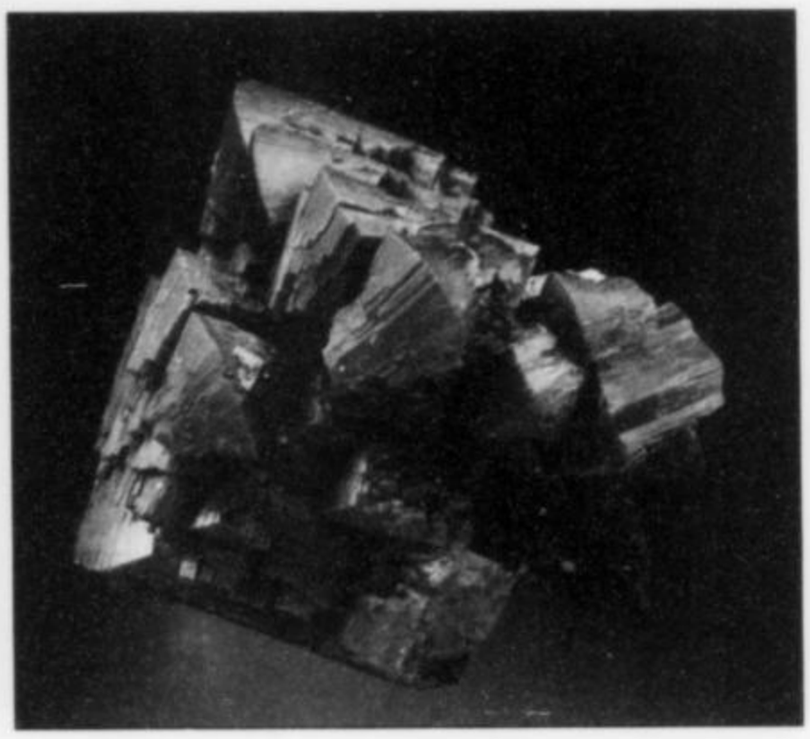


Cuprian smithsonite; Tsumeb, Namibia; 1.3-cm crystal; W. Wilson photo.

Benitoite; Benitoite Gem mine, San Benito County, California; 1.7-cm crystal; W. Wilson photo.

Metatorbernite; Margabal, Aveyron, France; 2.2 cm; J. Scovil photo.

Bixbyite; Thomas Range, Utah; 2.1 cm; J. Scovil photo.



Ralph has displayed about a dozen times at major shows, not always competitively, but always effectively. His top 35 pieces, set against black satin in his custom-built case, have made passing showgoers stop as if having been suddenly nailed to the floor, their minds filled with wonder and covetousness ("maybe he'd trade me *that* one for my own best three dozen pieces . . .").

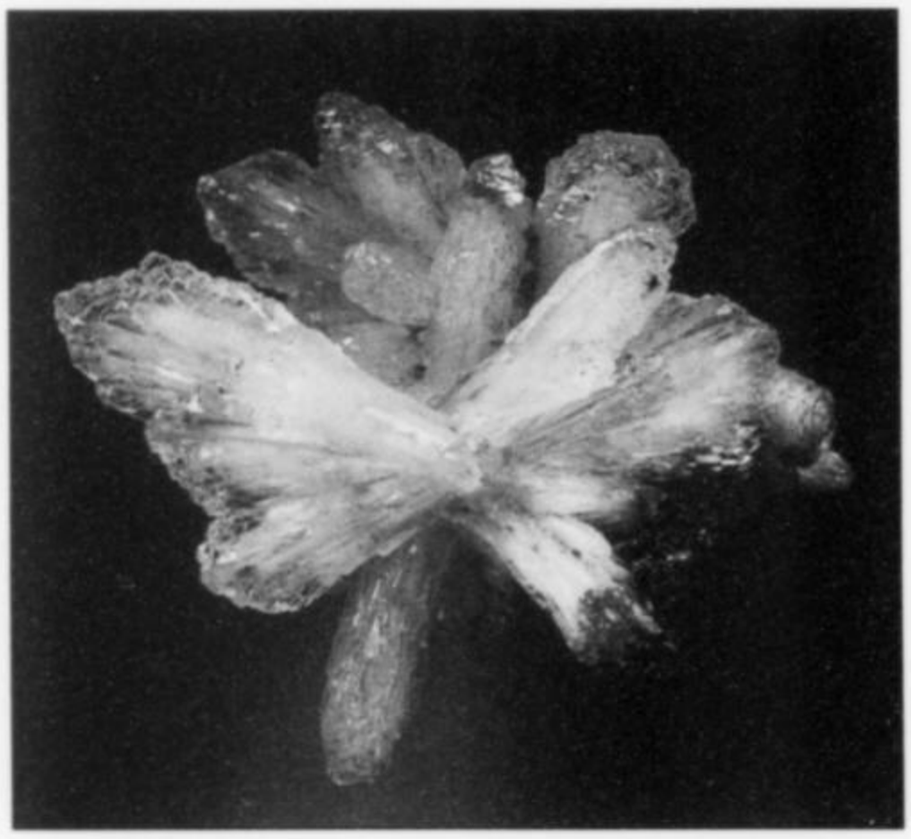
The philosophy that underlies a collection of this sort is also simple, and simply inferred, although Ralph states it well: "it doesn't take a fortune to build a significant collection . . . what's needed is a capacity to learn, a degree of expendable income, a cultivated eye, and a singular passion to collect only what you love." What Ralph loves are mineral species that are essentially at their best in the thumbnail size range, and not known to improve in larger sizes. He does make exceptions: recently, for example, he acquired some extraordinary thumbnails of Freiberg silver, N'Chwaning mine rhodochrosite, Moroccan erythrite, and even Dal'negorsk fluorite (the exquisite "invisible" octahedron on sphalerite pictured here), all of which also exist in world-class miniatures and cabinet specimens. And once in a while he can't resist buying very inexpensive and "ordinary" specimens simply because they

Fluorite; 2nd Sovietskiy mine, Dal'negorsk, Russia; 1.4 cm crystal; W. Wilson photo.

Crocoite; Dundas, Tasmania; 1.7-cm crystal; W. Wilson photo.

Milarite; Jaguaraçu, Minas Gerais, Brazil; 2 cm; W. Wilson photo.

Poldervaartite; Wessels mine, South Africa; 2 cm; J. Scovil photo.



strike him as interesting in some way, or because they somehow appeal to his aesthetic sense. Nevertheless, the really distinctive and most impressive pieces in the collection are those which combine rarity of species, exceptional form and/or crystal size (for the species), absolute freedom from damage, and the most impeccable aesthetics. Some of his pieces, small as they are, are arguably the world's best examples of their species! The big question that always comes to mind is one that Ralph hears a lot: "How do you do it?"

He does it through the constant activity and patient tenacity that are Ralph's real hallmarks as a collector. He is quick to point out that, if you really seek the best of the best, you cannot be content with just saving your money to be spent all within a few days, on whatever happens to meet your eye at shows or on other spot occasions. Rather, his approach is to keep up a constant flow of inquiries, letters and follow-up letters, connections to connections, etc., with personal visits as necessary, directed at potential sources literally throughout the world. He has often pursued a particular specimen for many years before finally acquiring it. Once, in the company of his good friend Dr. Steve Neely (a cabinet-specimen collector—no risk of competition between them), Ralph impulsively made a quick trip to Germany in pursuit of some specimens. He came back empty-handed but, typically, consummated some years later the negotiations begun on that trip. Another German experience Ralph likes to relate is the one about how, when he was staying at the home of a German dealer just before the Munich Show, he picked up a copy of the German magazine *Lapis,* and saw there a color photograph of a blue euclase specimen from Zimbabwe. It was specimen-love at first sight. At the show a few days later, he located the stand of the dealer who owned the specimen, "camped out" there for days of negotiating and sweet-talking, and finally walked out of the show with the prize. The qualities of "focus," specific goals and priorities, plus flexibility, alertness and open-mindedness are essential to his approach. People skills, too, are important, along with rationality about working within a budget, tact, warmth, and a fundamental generosity of spirit.

Sharing is one of the joys of collecting, and Ralph is always an eager and complimentary audience when others want to show off their own minerals. Likewise he hospitably welcomes appreciative visitors to his own home, and is always up for a "show and tell," especially if the guest is a serious thumbnailer. (Weekends are best for visits: remember, he still works more or less full-time to make all this collecting possible.) He has no "mineral room" or other sort of display facility in his home—just a dinette table, a strong lamp, and a warm coffee pot. After all, one advantage of collecting thumbnails is that you can have a relatively large and very important collection, yet put the entirety of it into a couple of small boxes easily stored in a safe-deposit box, to be carried out and presented effortlessly, like servings of gourmet courses—which is exactly how Ralph does it.

In his demanding specialty Ralph is one of today's top collectors, and knowing him is a treat, whether you are a fellow collector of thumbnails or not. And if you *are*, well, a little humbling is good for all of us sometimes.

William Severance Collection; Jeff Scovil Photo

Copper and Fluorapophyllite, 8.7 cm

Phoenix mine, Phoenix Fissure
Keweenaw County, Michigan
Ex Clarence S. Bement collection, 1873

THE MUSEUM DIRECTORY

New York State Museum

Curator (Geol.): Dr. William Kelly
Tel: 518-474-7559
Collections Mgr. (Geol.):
Michael Hawkins
Tel: 518-486-2011
Fax: 518-486-3696
3140 Cultural Education Ctr.
Albany, NY 12230-0001
Website: www.nysm.nysed.gov
Hours: 10–5 daily (closed Thanksgiving, Christmas, New Years)
Specialty: New York & worldwide minerals
Support Org.: NY State Acad. of Mineralogy (www.nysm.nysed.gov/nysam)

Geology and Meteorite Museums University of New Mexico

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Tel: (505) 277-4204
Dept. of Earth & Planetary Sciences
Northrop Hall, Univ. of New Mexico
Albuquerque, NM 87131
Hours: 8–12, 1–4 M–F (closed on school holidays)
Specialties: Worldwide minerals and meteorites, New Mexico fossils, Harding Pegmatite Mine Collection

Colburn Gem & Mineral Museum

Curator of Collections: Christian Richart G.G. (GIA)
Tel: (828) 254-7162
Fax: (828) 257-4505
Website: www.main.nc.us/colburn
Pack Place Education, Arts & Science Center
2 South Pack Square
Asheville, NC 28801
Hours: 10–5 Tues.–Sat.
1–5 Sun.
Closed Mondays and holidays
Specialties: North Carolina and worldwide minerals and gems
Accessible to persons with disabilities

Montana Tech Mineral Museum

Curator: Dr. Richard Berg
Tel: 406-496-4172
Fax: 406-496-4451
e-mail:dberg@mtech.edu
Program Director: Ginette Abdo
Tel: 406-496-4414
e-mail:gabdo@mtech.edu
Website: www.mbmg.mtech.edu/museumm.htm
Montana Bureau of Mines & Geology
Montana Tech of UM,
1300 W. Park Street
Butte, Montana 59701
Hours: Mem/Day to Labor Day 9-6 daily; Rest of year M-F 9-4; Open Sat & Sun May, Sept & Oct 1-5 pm
Specialties: Butte and Montana minerals, worldwide classics

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William Metropolis
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24 Oxford Street
Cambridge, Mass. 02138
Hours: 9–4:30 M–Sat.; 1–4:30 Sun.
Specialties: Systematic Mineral Coll'n

Western Museum of Mining & Industry

Curator: Terry A. Girouard
Tel: (719) 495-2182
email: curatewmmi@juno.com
Dir. of Educ.: Gary Renville
Tel: (719) 488-0880
Fax: (719) 488-9261
www.wmmi.org
1025 North Gate Road
Colorado Springs, CO 80921
Hours: 9–4 M-Sat., (12-4 Sun., June–Sept. only), closed holidays
Specialties: Colorado minerals & ores, Western mining memorabilia, 14,000-vol. research library

The Gillespie Museum of Minerals, Stetson University

Curator: Dr. Bruce Bradford
Tel: (904) 822-7331
E-mail: bbradfor@stetson.edu
Assistant Director: Holli M. Vanater
Tel: (904) 822-7330
E-mail: hvanater@stetson.edu
Fax: (904) 822-7328
234 E. Michigan Avenue
DeLand, Florida
Mailing: 421 N. Woodland Blvd., Unit 8403, DeLand, FL 32720-3757
Hours: 9–noon, 1–4 M–F when university is in session (closed on holidays, university breaks & in the summer)
Specialties: Worldwide comprehensive collection of rocks & minerals; Florida rocks, minerals & fossils; large historic fluorescent collection

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Curator of Geology: Jack A. Murphy
Tel: (303) 370-6445
Dept. of Earth Sciences
20001 Colorado Blvd.
Denver, CO 80205
Hours: 9–5 daily
Specialties: Colorado minerals

Geology Museum Colorado School of Mines

Curator: Paul J. Bartos
Tel: (303) 273-3823
Golden, Colorado 80401
Hours: 9–4 M–Sat., 1–4 Sun.
(closed on school holidays & Sundays in the summer)
Specialties: Worldwide minerals; Colorado mining & minerals

A. E. Seaman Mineralogical Museum

Director: Stan Dyl
Curator (mineralogy): George W. Robinson
Adjunct Curator: Dr. John A. Jaszczak
Tel: (906) 487-2572
Michigan Technological Univ.
Houghton, Michigan 49931
Hours: 9–4:30 M–F
Specialty: Michigan minerals, copper minerals & worldwide minerals

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Fax: (713) 523-4125
1 Herman Circle Drive
Houston, Texas 77030
Hours: 9–6 M–Sat., 12–6 Sun.
Specialty: Finest or near-finest known specimens

Natural History Museum of Los Angeles County

Fax: (213) 749-4107
Website: http://nhm.org/minsci
Curator (Mineral Sciences):
Dr. Anthony R. Kampf
Tel: (213) 763-3328
e-mail: akampf@nhm.org
Collections Manager:
Dorothy L. Ettensohn
Tel: (213) 763-3327
e-mail: dettenso@nhm.org
900 Exposition Blvd.
Los Angeles, CA 90007
Hours: 9:30–5:00 Daily
Specialties: Calif. & worldwide minerals, gold, gem crystals, colored gemstones
Support organization:
The Gem and Mineral Council

California State Mining and Mineral Museum

Website: http//parks.ca.gov/parkpages/park_page.asp?lvl_id=227
Curator: Peggy Ronning
Tel: (209) 742-7625
Fax: (209) 966-3597
e-mail: mineralcurator@sierratel.com
5005 Fairgrounds Rd.
Mariposa, CA 95338
Mailing Address:
P.O. Box 1192
Mariposa, CA 95338
Hours: 10–6 Daily (May–Sept.)
10–4 Wed.–Mon. (Oct–Apr.)
Specialties: Gold, California minerals, California mining

Arizona Mining & Mineral Museum

Department Director: Doug Sawyer
Curator: Sue Celestian
Tel: (602) 255-3795
1502 W. Washington Avenue
Phoenix, AZ 85007
Hours: 8–5 M–F, 11–4 Sat., closed Sun. & holidays
Specialty: Arizona minerals

Carnegie Museum of Natural History

Collection Manager: Marc L. Wilson
Tel: (412) 622-3391
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Hours: 10–5 Tues.–Sat., 10–9 F, 1–5 Sun., closed Mon. & holidays
Specialty: Worldwide minerals & gems

Museum of Geology

Curator: Thomas J. Campbell
Tel: (605) 718-2288
South Dakota School of Mines & Technology
501 E. St. Joseph St.
Rapid City, SD 57701-3995

New Mexico Bureau of Mines & Mineral Resources—Mineral Museum

Director: Dr. Virgil W. Lueth
Tel: (505) 835-5140
E-Mail: vwlueth@nmt.edu
Fax: (505) 835-6333
Associate Curator: Robert Eveleth
Tel: (505) 835-5325
E-mail: beveleth@gis.nmt.edu
New Mexico Tech,
801 Leroy Place
Socorro, NM 87801
Hours: 8–5 M–F, 10–3 Sat., Sun
Specialties: New Mexico minerals, mining artifacts, worldwide minerals

Penn State Earth & Mineral Sciences Museum

Curator: Dr. Andrew Sicree, PhD
Tel: (814) 865-6427
E-mail: sicree@geosc.psu.edu
Steidle Building
University Park
State College, PA 16802
Hours: 9–5 M–F & by Appt. (closed holidays)
Specialties: Mineral properties exhibits; "velvet" malachite; old Penna. minerals, mining art

Arizona-Sonora Desert Museum

Collections Manager & Mineralogist: Anna M. Domitrovic
Tel: (520) 883-1380 ext. 152
Fax: (520) 883-2500
2021 N. Kinney Road
Tucson, AZ 85743-8918
Hours: 8:30-5 Daily (Oct.-Feb.)
7:30-6 Daily (Mar.-Sept.)
Specialty: Arizona minerals

Pacific Mineral Museum

Director/Curator: Mark Mauthner
Tel: (604) 689-8700
E-Mail: markm@pacificmineralmuseum.org
848 West Hastings Street
Vancouver, B.C., Canada V6C 1C8
Hours: M–F 10–5, Weekends 10–6 (Closed Mondays in winter)
Specialties: BC–Yukon–Pacific NW, worldwide, gold, silver

U.S. National Museum of Natural History (Smithsonian Institution)

Curator: Dr. Jeffrey E. Post
e-mail: minerals@nmnh.si.edu
Collection Managers: Paul Pohwat and Russell Feather
(Dept. of Mineral Sciences)
Washington, DC 20560-0119
Hours: 10 am–5:30 pm daily
Specialties: Worldwide minerals, gems, research specimens

William Weinman Mineral Museum

Asst. Curator: Doug Gravely
Tel: (770) 386-0576
51 Mineral Museum Dr.
White, GA 30184
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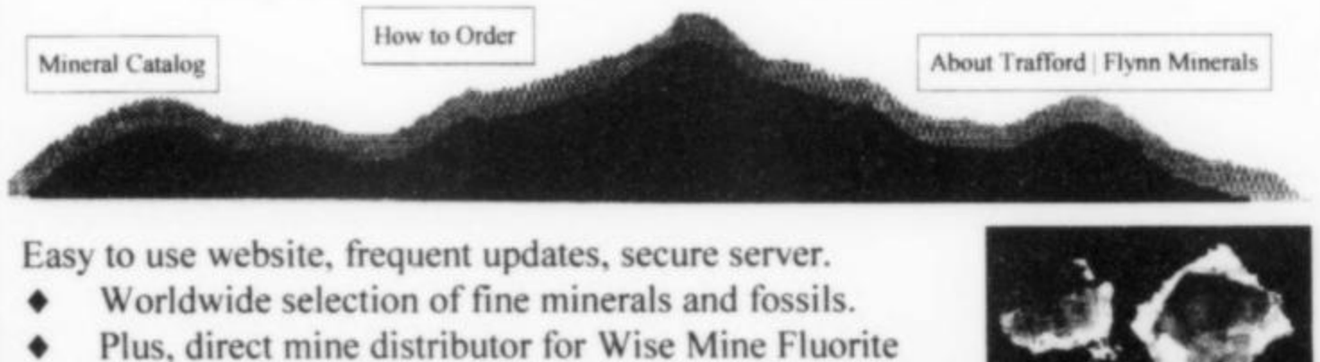

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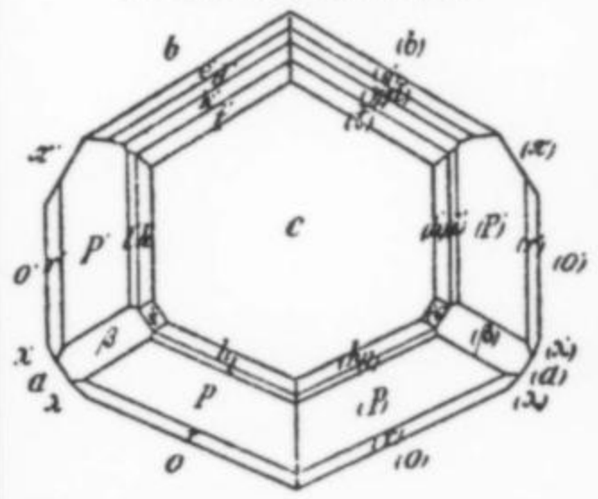

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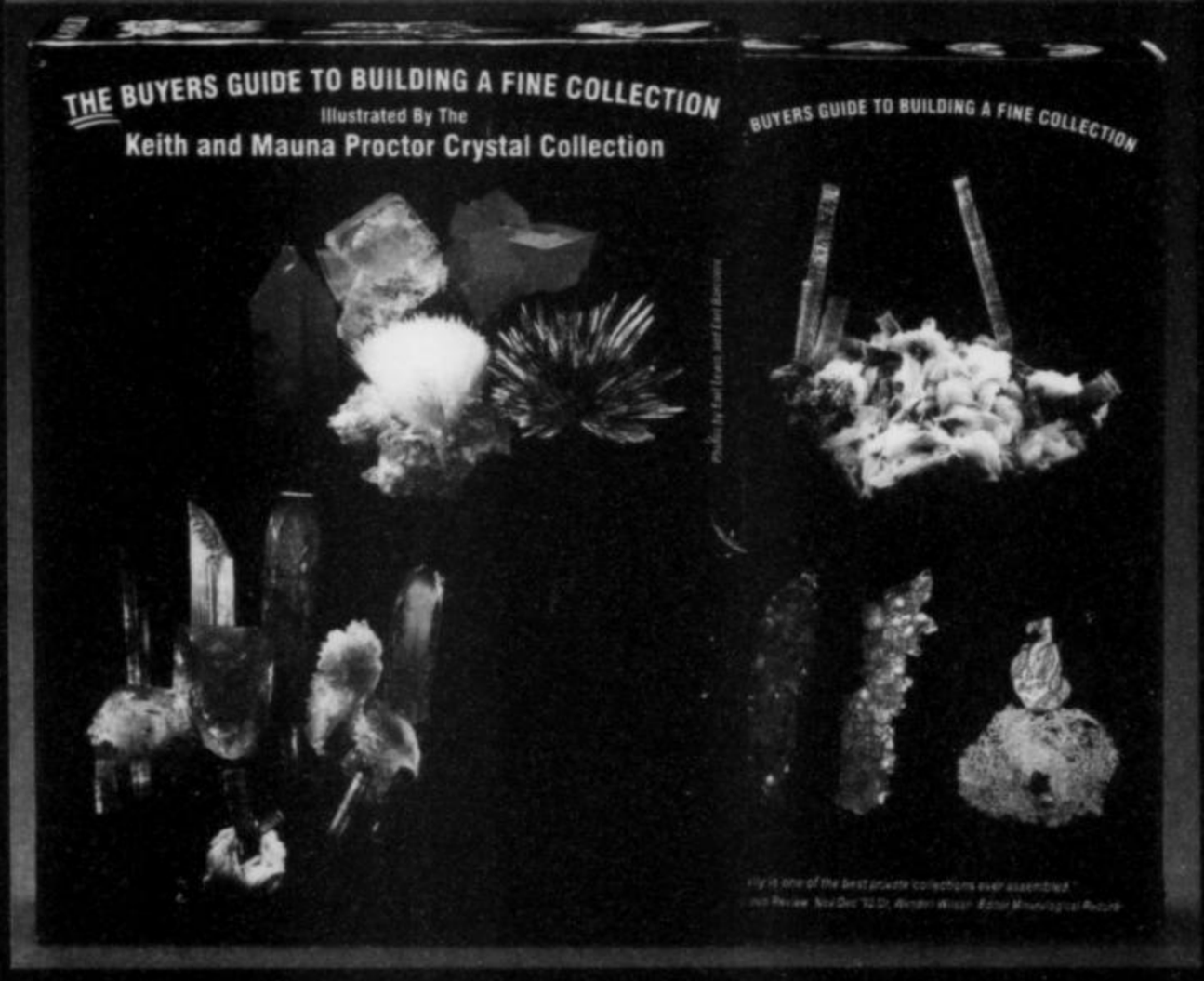

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