the
Mineralogical
Record

Volume Thirty, Number Five
September–October 1999
$10

THE MINERALOGICAL RECORD
September–October 1999 Volume Thirty, Number Five

Articles

Columns

Gallery Reviews

Editing, advertising
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Subscriptions
(Subscriptions, back issues, reprints, book sales, shows)
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COVER: ROSE QUARTZ on pale smoky/citrine quartz, the specimen known as "the Van Allen Belt," 25 cm. Smithsonian collection; photo by Harold and Erica Van Pelt. Long thought to be from the "Sapucaia mine," this specimen and others (representing the first major discovery of rose quartz crystals) actually came from the Berilo Branco mine. See the article beginning on page 361.

The Mineralogical Record
(ISSN 0026-4628) is published bi-monthly for $42 per year (U.S.) by Mineralogical Record, Inc., a non-profit organization, 7413 N. Mowry Place, Tucson, AZ 85741. Periodicals postage paid at Tucson, Arizona and additional mailing offices. POSTMASTER: Send address changes to: The Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740.

notes from the EDITOR

PAPER vs. CYBERMEDIA

Now well into the electronic age and about to step into the new millenium, some people wonder whether electronic media will make the book and the magazine (like the *Mineralogical Record*) obsolete. The answer is: possibly, but don't count on it anytime soon. Digital storage and recall are beginning to show some serious shortcomings, which suggest that you would be well advised to save and protect your back issues.

Arlyn Gajilan, writing recently in *Newsweek*, points out that huge amounts of data (e.g., from NASA's Viking mission to Mars, and from census records in storage) are being lost due to the obsolescence of their electronic formatting. In other words, although the data are there, the machines and the software that can read and retrieve them are fast disappearing.

Then there is the problem of simple disintegration. Data stored on magnetic tape may not last more than a decade. Floppy disks, videotape, and computer hard drives are just as vulnerable. Even laser-read CD-ROMS, once thought to be eternal, can be damaged by "stray magnetic fields, oxidation, humidity and material decay."

"Any technology can go the way of eight-track tape and Betamax," says Abby Smith of the Council on Library and Information Resources. "Information [stored electronically] doesn't have much of a chance, unless you keep a museum of tape players and PC's around." What should be done? "That's a question no one really has an answer for," says Smith.

We know one thing for certain: old-fashioned books and magazines printed on acid-free or alkaline-reserve paper (like the *Mineralogical Record*), will be able to be easily accessed by anyone centuries from now. It's a format that will stand the test of time. ⊠

The Friends of Mineralogy

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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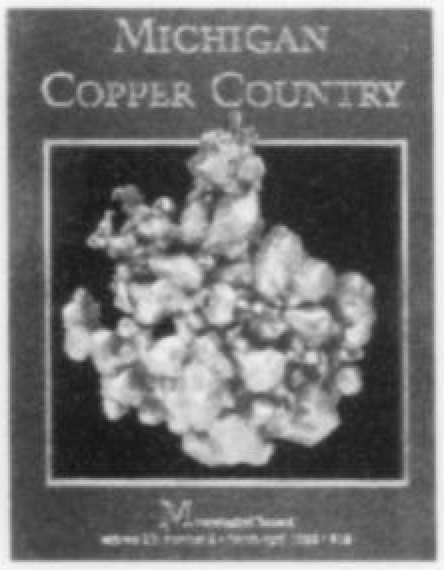

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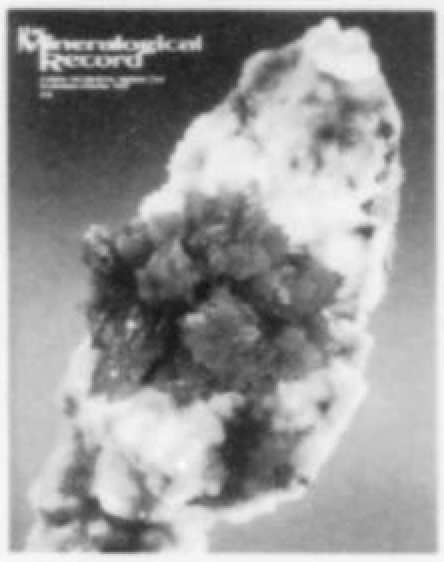

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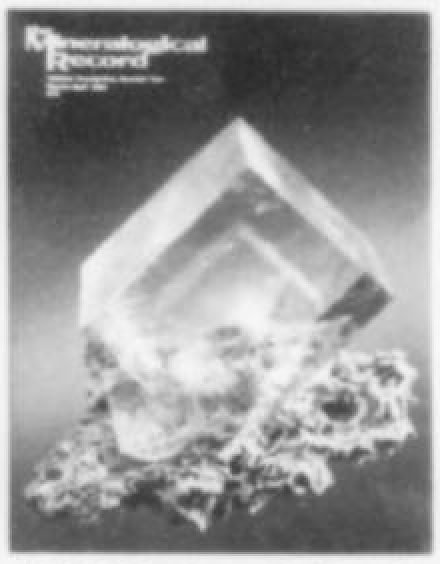

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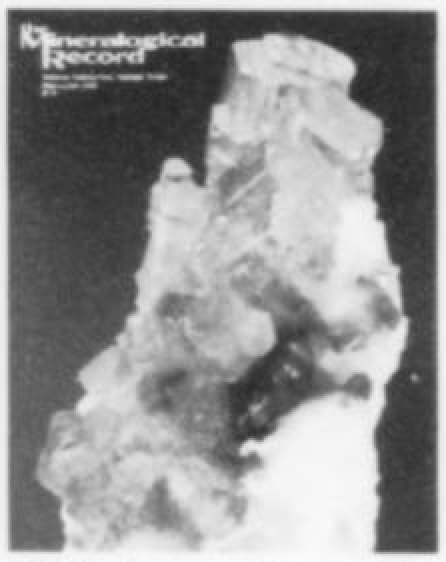

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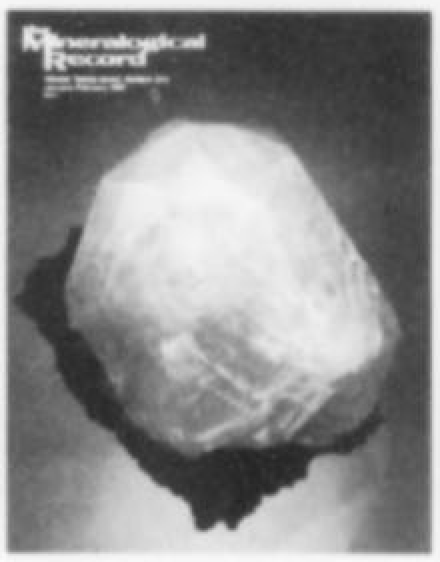

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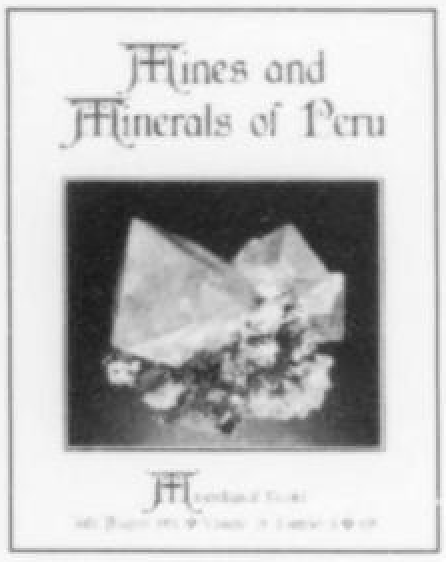

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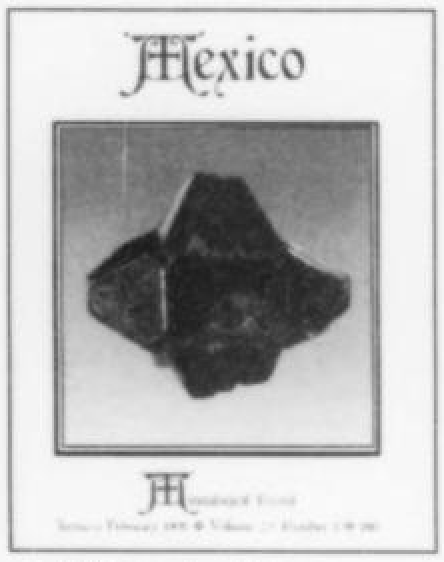

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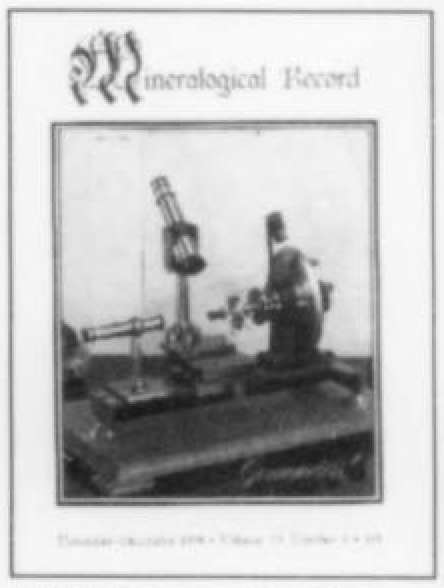

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The Mex-Tex mine, in New Mexico's famous Hansonburg district, has been operated solely for mineral specimens since 1987. Fine specimens of spangolite, brochantite, creedite, cyanotrichite, fluorite, linarite, tsumebite and wulfenite have been recovered.

INTRODUCTION

The history, geology and mineralogy of the Hansonburg mining district, including the Mex-Tex mine, was comprehensively covered by Taggart, Rosenzweig and Foord in an article published in Volume 20 (1989) (The New Mexico Issue) of the *Mineralogical Record*. A great deal of activity and new information specifically related to the Mex-Tex mine has come to light in the years following that publication. The intent of this article is to present a chronology of significant events that have occurred at the mine related to the discovery of new or important minerals and also other incidents which have impacted on mineral collecting at the Mex-Tex mine.

Activity at the Blanchard mine, which is approximately 1 mile south of the Mex-Tex mine, has in many ways paralleled developments at the Mex-Tex. The mineralogy of the two mines to a large extent is also very similar, but notable differences do exist and are worthy of separate discussion.

HISTORY

Mining activity in the Hansonburg district can be traced back to 1872, but specific references to the location now known as the Mex-Tex mine were not made until 1947, when a claim was located by A. R. Hickey, W. Hickey and F. Kay of Artesia, New Mexico. They held 30 or more claims in the area (Clippinger, 1949). A second group of claims known as the Royal Flush was also located at the same time as the Mex-Tex group. The Royal Flush group is about a mile north and east of the Mex-Tex and has for some purposes been considered as part of the "Mex-Tex group." The Royal Flush will not, however, be considered as part of the Mex-Tex mine for the purposes of this article.

The group of 30 claims known as the Mex-Tex, owned by A. R. Hickey and associates, operated under the name of the Mex-Tex Mining Company. Work done by this concern consisted of road building and the excavation of a few open cuts (Williams *et al.*, 1964). In early 1950, two men named Erwin and Bishop from

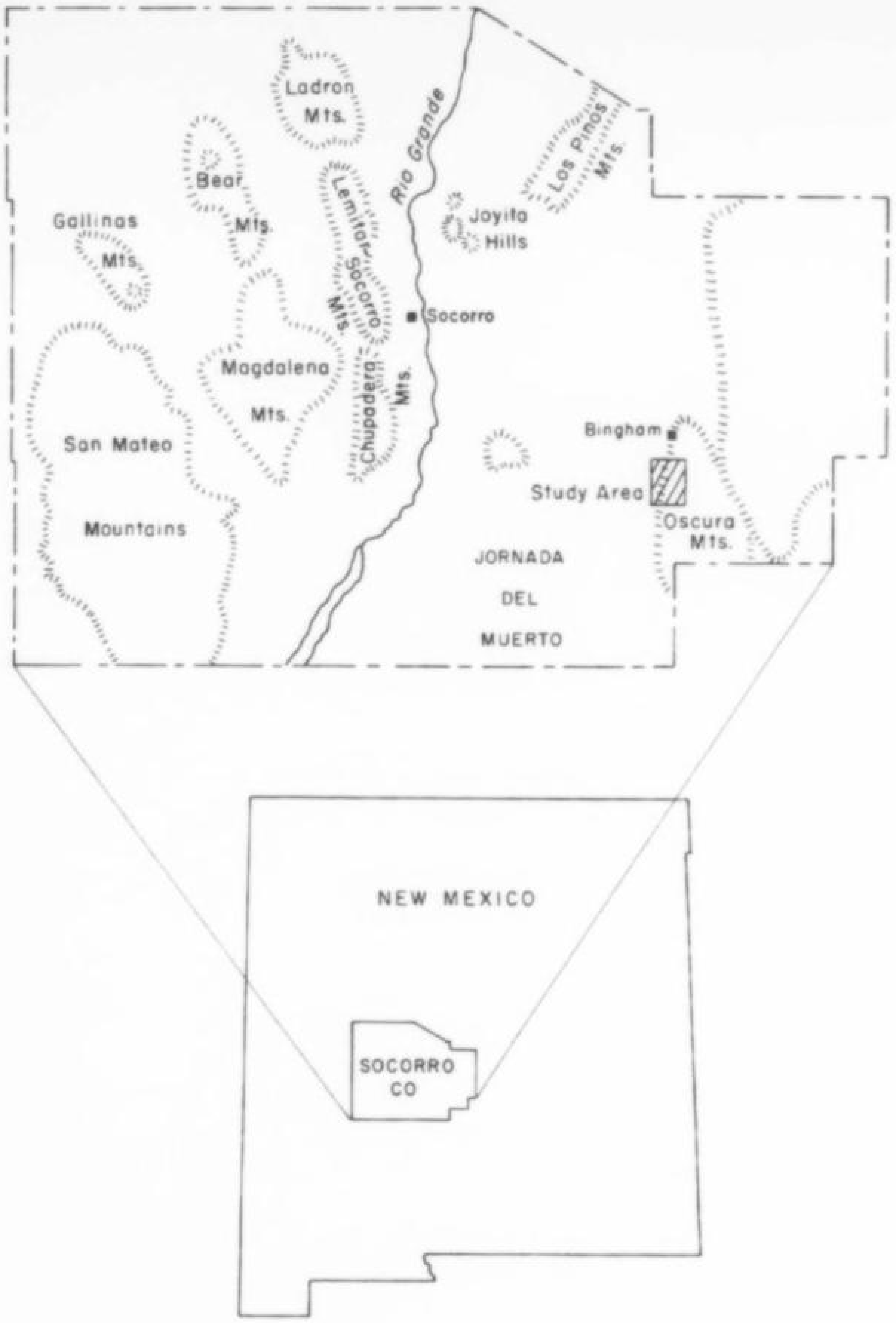


Figure 1. **Location map of Hansonburg mining district, Bingham, New Mexico.**

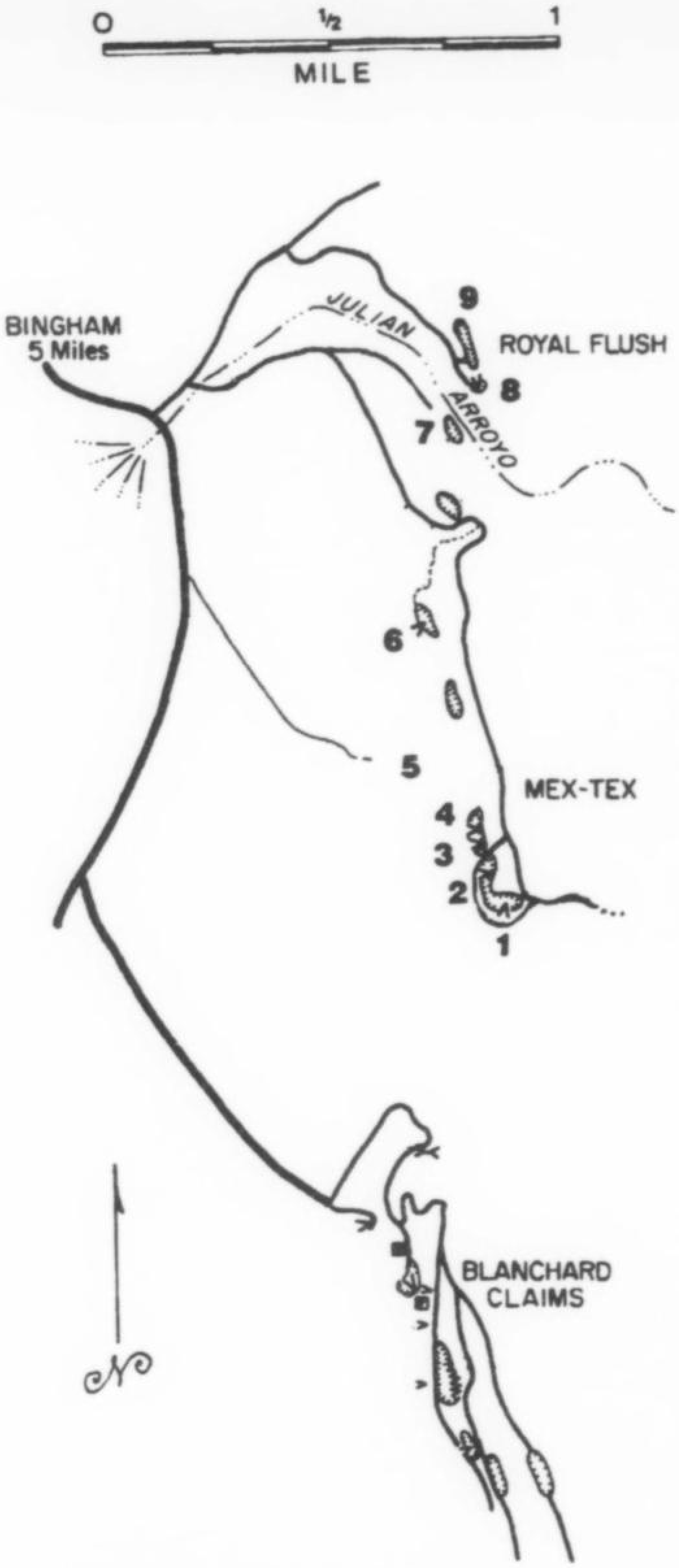


Figure 2. **Mines in the Mex-Tex group, Hansonburg district, New Mexico: (1) Unnamed adit, (2) Upper Mex-Tex mine, also known as the Julian Malacite (sic) mine, (3) Byrd tunnel and open pit (caved), (4) Snake Pit mine (partially caved), (5) Hickey No. 1 mine, (6) Ora mine, (7) Downey stope, also known as the Desert Rose mine and the Mountain Canyon mine, (8) Royal Flush mine, south pit, (9) Royal Flush mine, north pit.**

Houston, Texas, who had control of the Royal Flush claims, purchased the Mex-Tex group but retained the name Mex-Tex Mining Company. They completed construction of a 200-ton-per-day barite mill near San Antonio, New Mexico (about 30 miles west of the mine). From late 1950 through 1958, the company produced 34,056 tons of barite. The Atomic Mineral Corporation purchased the Mex-Tex property in July of 1959, and it was then operated by a lessee, Galber, Inc., of Carlsbad (Lee Downey, president and general manager). In 1959 and 1960, the company produced 812 tons of barite (Williams *et al.*, 1964). In the early 1960's, Galber Inc. mined and explored the Mex-Tex and other adjoining properties and shipped several carloads of lead concentrate by truck and rail to the ASARCO smelter in El Paso, Texas, 220 miles to the south (Kottlowski, 1979). Mining activity at the Mex-Tex mine virtually ceased thereafter. Total recorded production of barite in New Mexico up to and including 1962 was 36,118 tons, mined in nine of the state's 32 counties. However, 96.5% of the total had been obtained from a single deposit, the Mex-Tex mine (Williams *et al.*, 1964).

From 1964 to 1987, the ownership of the Mex-Tex mine is not clear. The Sunshine Mining Company which held claims at the nearby Blanchard mine most likely also held claims at the Mex-Tex group of mines in the mid to late 1960's. A series of corporations including Basic Earth Science Systems, Inc., Hansonburg Mines Inc., and Western General Resources, Inc., exercised control in the 1970's to 1983. In 1983, however, Western General Resources, Inc., did not complete the required annual assessment work and the property reverted to public domain. From 1983 to 1987 the entire Hansonburg district remained open to claim.

In May of 1987, the Mex-Tex mine was relocated as two claims (Dean Alexander and Ginger-Brandy) by one of the authors (TM) and Robert Dickie of Albuquerque, whose intention was to operate the mine for the production of mineral specimens. Since that time, the claims have been operated exclusively for the production of mineral specimens for collectors.

MINE WORKINGS

A number of adits, trenches, open cuts and stopes comprise the Mex-Tex claims. Figure 2 identifies the significant locations at which noteworthy mineral occurrences have been identified. The unnamed adit (no. 1, Fig. 2) at the extreme south end of the Mex-Tex group is a short (27 feet) adit that runs north toward the Upper Mex-Tex mine. The Upper Mex-Tex mine (no. 2, Fig. 2) contains the principal mine workings in the area. "Upper" refers to its position at the highest elevation. The Byrd tunnel (no. 3, Fig. 2) lies in the trench northwest of the Upper Mex-Tex; it is collapsed and inaccessible. The Snake Pit mine (no. 4, Fig. 2) also lies in this trench and is only partially accessible due to continuing collapses which make collecting extremely hazardous. The Hickey No. 1 mine (no. 5, Fig. 2) and the Ora mine (no. 6, Fig. 2) are adits situated lower in elevation than the "Upper" workings, and can be considered the "Lower" Mex-Tex mines.

Events in the recent history of the mine have substantially changed the opportunity for collecting minerals. The Upper Mex-Tex mine (Fig. 3) in 1964 was an adit-stope, 350 feet long containing several ore pillars for roof support. From the back of the adit and the top of the stopes to the surface, only 20 to 30 feet of rock existed. At some point between 1964 and 1987, two major collapses of the adit occurred. The first collapse, according to the recollection of Sam Jones, the caretaker at the time, occurred around 1972 and involved the section from 20 feet to the 100-foot mark. A larger section from the 210 foot mark to the 350 foot mark at the end of the adit collapsed at a later unknown date. Fortunately, there was (as far as we know) no one in the mine during these events. Entering the middle portion of the adit at that time required entering the portal, climbing up to the collapsed portion of the adit, crossing over the debris and then climbing down into the stope at the far end. This situation existed until February of 1991, when another major collapse occurred near the far end. This area was the site of a large stope with a 20-foot ceiling and is the location of several major pockets which produced some of the most significant fluorite, galena and barite specimens for which the Mex-Tex mine is well known. Popping and cracking noises with occasional minor rock falls had been noticed by the claim owners and other collectors for several years before this collapse, so the calamity was not totally unexpected. Currently, the only remaining open areas at the Upper Mex-Tex mine are near the opening and the 190 to 210-foot section.

It was not long after this event that tragedy struck in the vicinity of the Mex-Tex mine. In September of 1993, a group of German and Swiss mineral collectors on a guided collecting tour of the area signed in at the Blanchard Rock Shop for fee-basis surface collecting at the nearby Blanchard mine. Underground collecting was strictly forbidden. They proceeded instead to the Mex-Tex mine. Two of the group (a father and an adult son) separated from the others and entered the Ora mine (an unclaimed property) at the north end of the Mex-Tex mine area. They were only a short distance inside the adit, as they had no lights, when the rock slab the younger collector was retrieving specimens from came loose and he was crushed to death. His father also received injuries when the boulder dropped. This incident resulted in closure of the entire mining district by the Bureau of Land Management (BLM), except to claim owners and local ranchers. The area was closed from September 1993 to April 1995. In the fall of 1994, the Ora mine was claimed by Eddie DeLucca of Orogrande, New Mexico. He proceeded to completely secure the entrance to the mine using rebar and metal plate, thus blocking unauthorized access and providing the security that was previously lacking. With this measure in effect, the BLM lifted the restrictions previously imposed. The Mex-Tex mine properties currently remain under mining claim and fee-basis mineral collecting is not permitted.

MINERALS

A list of the minerals from the Hansonburg district was published by Taggart *et al.* (1989). Some of the minerals occurring at the Mex-Tex mine (coronadite, crandallite, creedite, libethenite, plumbogummite, tsumebite and turquoise) have not been found at the Blanchard mine or elsewhere in the district. Conversely, a number of species occurring at the Blanchard mine (antlerite, cinnabar, hydrozincite, sulfur, mottramite, otavite, and cuprite) have not been found at the Mex-Tex mine. This listing will include only those species that have been reliably reported from the Mex-Tex mine by competent observers or that have been confirmed by the authors through personal observation. Most of the less common species identifications have been confirmed by microprobe analysis or X-ray diffraction.

Anglesite $PbSO_4$

Anglesite is generally found as an oxidation product of galena. It occurs throughout the mine as concentric gray bands around galena "eyes" and as small, gemmy, spear-shaped crystals up to about 2 mm on and in galena.

Aurichalcite $(Zn,Cu^{2+})_5(CO_3)_2(OH)_6$

Aurichalcite is uncommon at the Mex-Tex mine. It does occur sparingly throughout the area as small, pale blue tufts and sprays in the vicinity of altered chalcopyrite crystals.

Azurite $Cu_3^{2+}(CO_3)_2(OH)_2$

Azurite was found during a May–June 1996 dig about 10 feet in front of the Upper Mex-Tex adit while searching for linarite and spangolite specimens. The crystals are small (0.5 mm), in bladed aggregates in association with malachite and chrysocolla. Only a very small amount of material was recovered.

Barite $BaSO_4$

Barite is found throughout the area, often in large crystals. It is always colorless to white and transparent to sub-translucent. Single crystals may reach 20 cm or larger; they are often found in large pods and intergrown groups of crystals.

Brochantite $Cu_4^{2+}(SO_4)(OH)_6$

Brochantite is common in all areas of the mine, usually in small amounts. Bright grass-green acicular crystals typically associated with linarite occur in the Upper Mex-Tex area. More commonly, brochantite is found as drusy crusts of very small crystals and as coatings on the silicified limestone. Particularly fine specimens associated with spangolite were recovered during the May–June 1996 dig just south of the adit portal.

Calcite $CaCO_3$

Large scalenohedral calcite crystals up to 10 cm have been collected from vugs in the limestone above the ore zone in the Upper Mex-Tex mine. These crystals are always included with goethite and are consequently sub-translucent. A secondary crust of white calcite which fluoresces green coats some of these

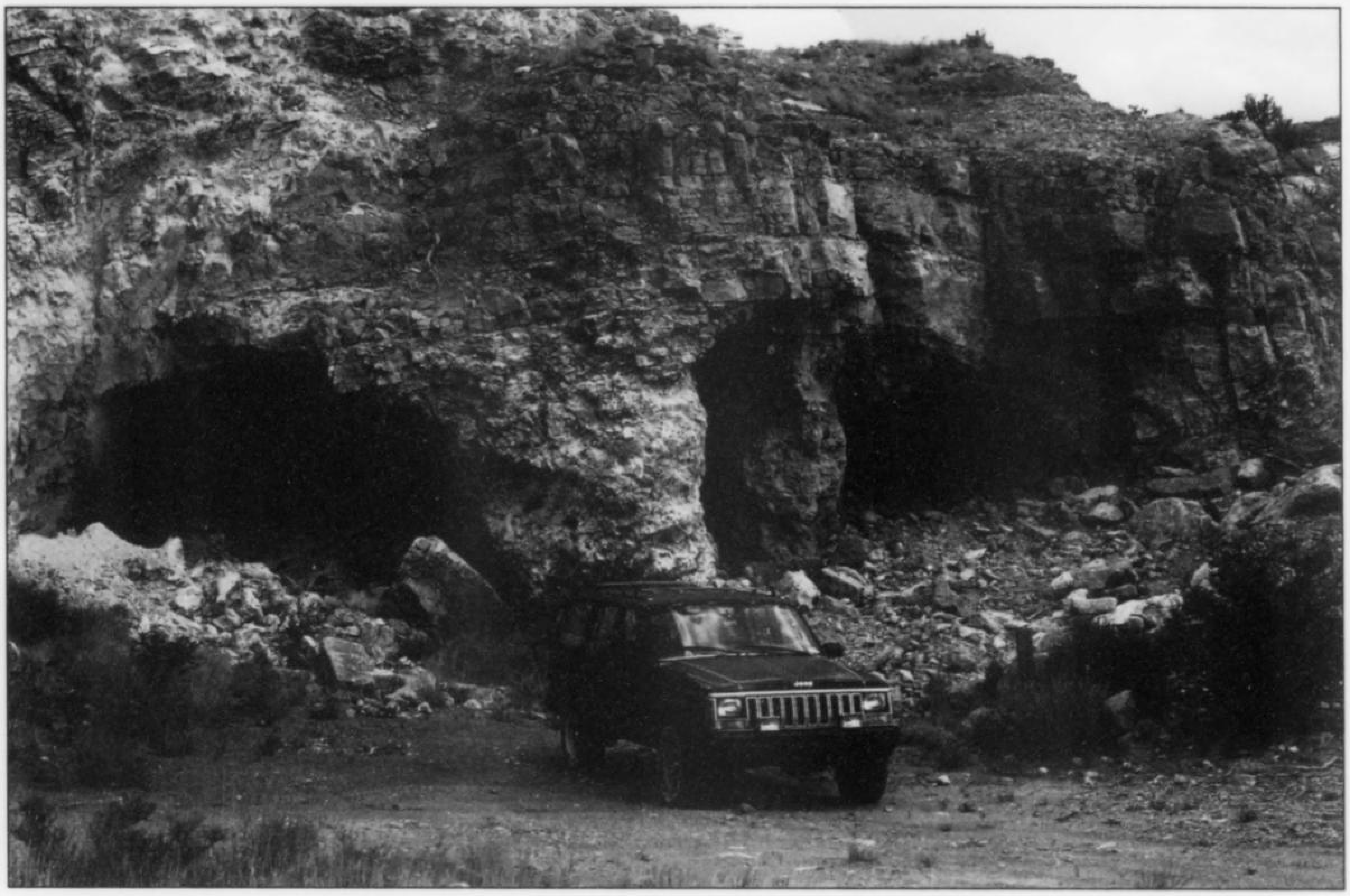


Figure 3. **Upper Mex-Tex mine, looking southeast, in May 1997.**

crystals. Elsewhere in the mine, calcite is usually found as white *papierspath* ("paper-thin spar") crystals and as travertine.

Caledonite $Pb_5Cu_2(CO_3)(SO_4)_3(OH)_6$

Caledonite has been reported by Bringe *et al.* (1992) from the Snake Pit mine but has not been confirmed by the authors.

Cerussite $PbCO_3$

Cerussite is virtually always found as an oxidation product of galena, in association with anglesite. Galena initially alters to anglesite and then to cerussite; most galena has a coating of drusy cerussite crystals on the surface. Crystals larger than a few mm are unknown from the Mex-Tex mine. The crystals are always colorless to gray and may be transparent to translucent. Most of the galena at the Mex-Tex mine has been partially or completely altered to anglesite and cerussite.

Chalcopyrite $CuFeS_2$

Chalcopyrite has occasionally been found as 1.5-cm disphenoidal crystals that have been partially or completely altered to goethite and/or malachite. These crystals are sometimes dusted with small murdochite crystals and make attractive specimens.

Chrysocolla $(Cu^{2+},Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$

Chrysocolla is found in numerous areas throughout the mine as sky-blue crusts and coatings on the silicified rock. This material is friable and not suitable for lapidary purposes. It has also formed as an alteration product of many of the uncommon to rare species (spangolite, brochantite, creedite). Unfortunately, these alteration specimens, although quite attractive when collected, often lose water in time, became cracked and turn a drab olive-green.

Corkite $PbFe_3^{3+}(PO_4)(SO_4)(OH)_6$

Corkite has been found in a very few specimens at the Upper Mex-Tex mine near the adit entrance, in association with other phosphate minerals and brochantite. Bright yellow spherical aggre-

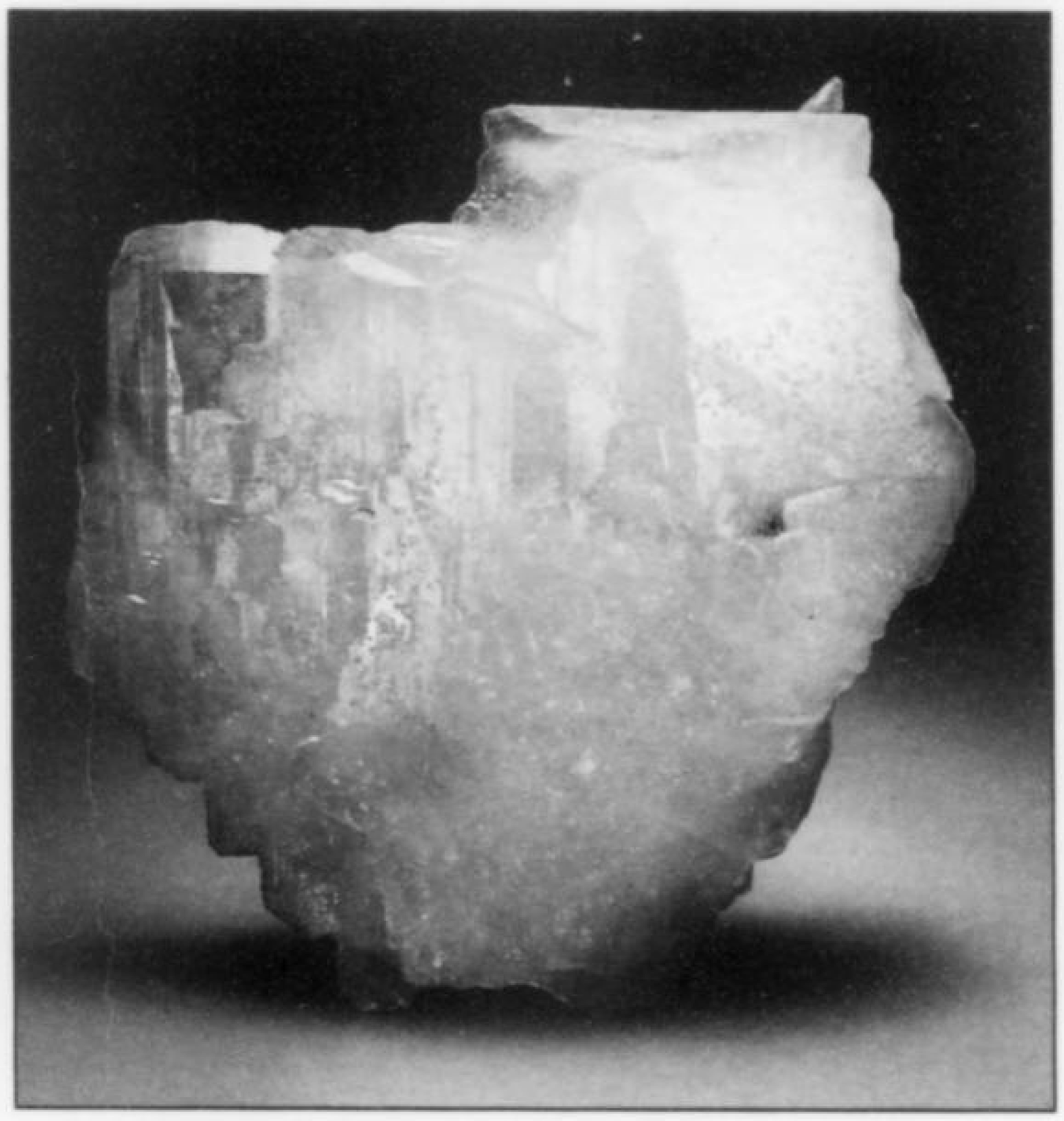


Figure 4. **Barite, 15 cm, from the Upper Mex-Tex mine. T. Massis collection; Jeff Scovil photo.**

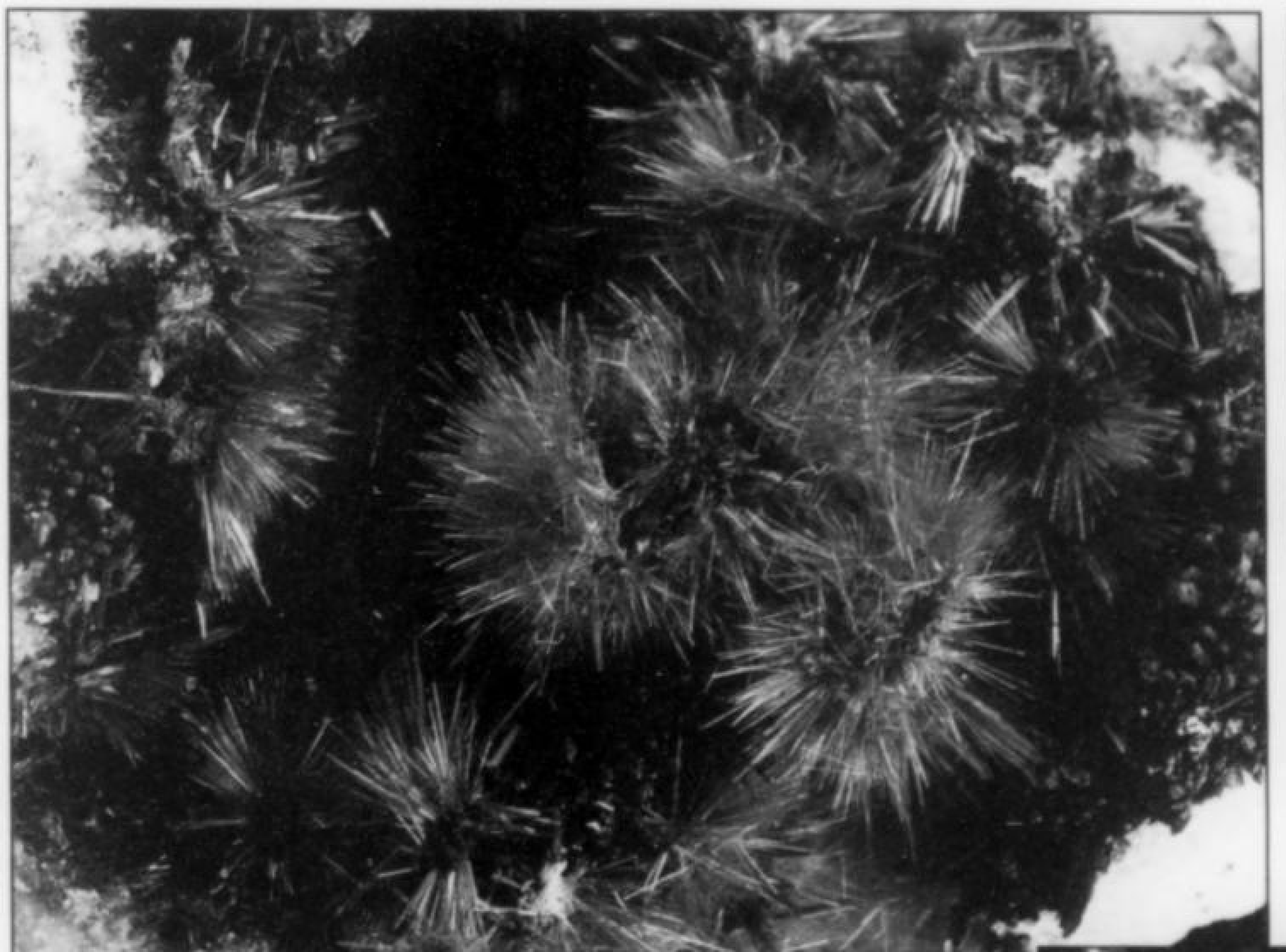
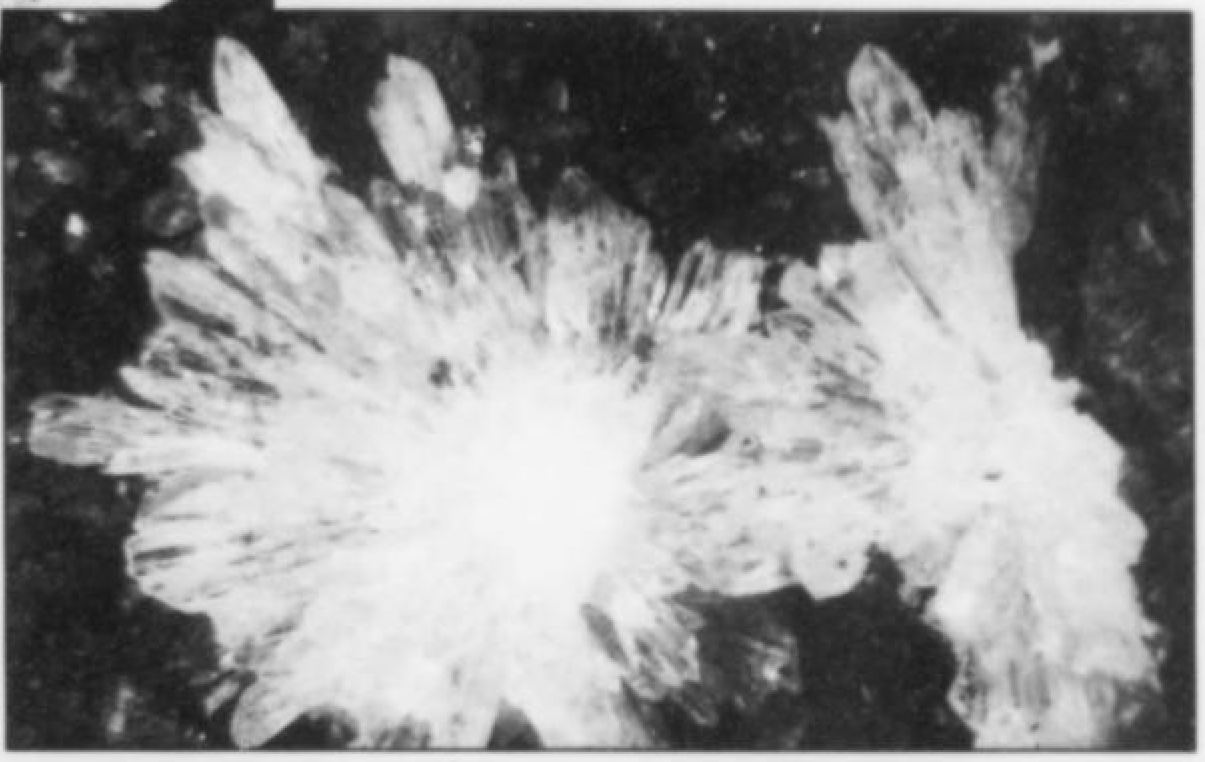


Figure 5. **Brochantite group, 3.5 cm across, from the Upper Mex-Tex mine. R. S. DeMark collection; Jeff Scovil photo.**

Figure 6. **Cyanotrichite sprays, 1 cm, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.**

Figure 7. **Corkite with green brochantite, 1.2 cm across, from the Upper Tex-Mex mine. R. S. DeMark collection; Arnold Hampson photo.**

Figure 8. **Creedite sprays with blue-green spangolite crystals, 1 cm across, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.**



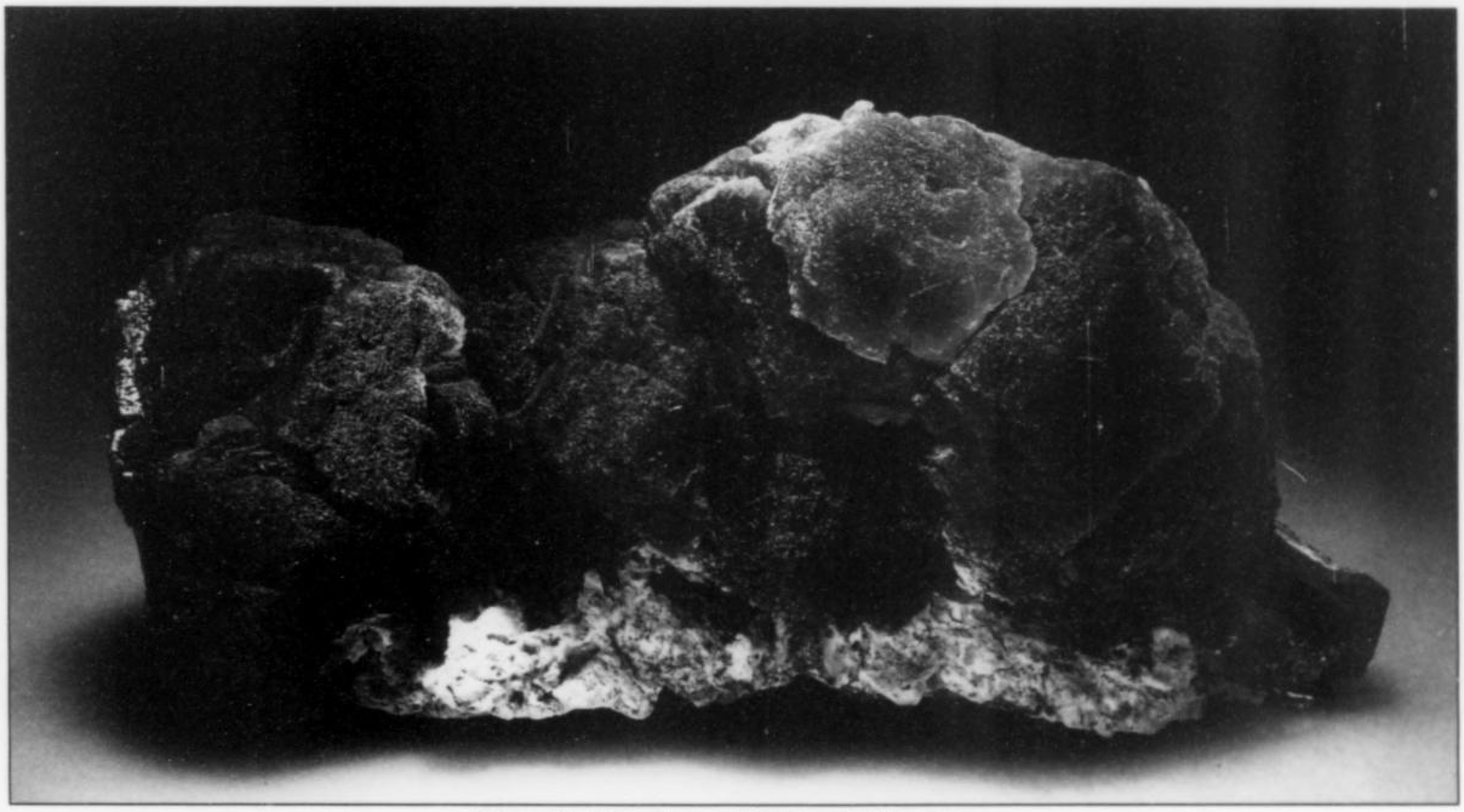


Figure 9. **Fluorite crystal group with galena, 17.8 cm, from the Upper Mex-Tex mine. T. Massis collection; Jeff Scovil photo.**

gates of bladed crystals up to 2 mm across were found coating quartz crystals and on brochantite needles. Aggregates of very small, green, blocky crystals were also found in this area. Identification was accomplished by microprobe analysis (Paul Hlava, personal communication, 1997).

Coronadite $Pb(Mn^{4+},Mn^{2+})_8O_{16}$

Coronadite was found in the Snake Pit adit by the authors as brownish black spheres and botryoidal masses in association with tabular, yellow wulfenite crystals. Scrutinyite and plattnerite were also found in close association, along with an undetermined clay mineral, possibly dickite. Coronadite was identified by microprobe analysis (Hlava, personal communication, 1992).

Crandallite $CaAl_3(PO_4)_2(OH)_5 H_2O$

Crandallite has been found at the Upper Mex-Tex mine associated with turquoise, libethenite and plumbogummite, as botryoidal white crusts and small spheres. There appears to be a gradational transition from crandallite (which is white) to plumbogummite (which can be gray to blue). Identification was by microprobe analysis (Hlava, personal communication, 1992).

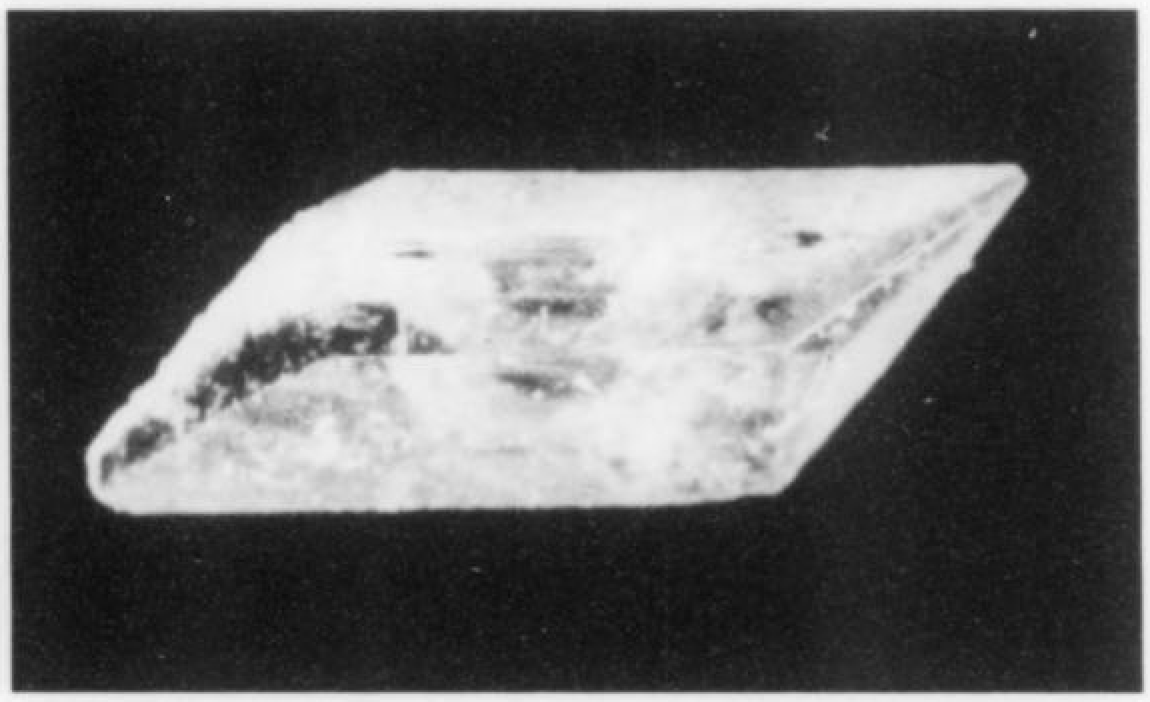


Figure 10. **Creedite crystal, colorless, 5 mm, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.**

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

Creedite has been found as noteworthy specimens in the Upper Mex-Tex mine. Specimens of creedite purported to be from the Mex-Tex mine had been cited (Taggart *et al.*, 1989), but it wasn't until 1991 that Tom Massis reported finding *in-situ* creedite. Crystals up to 1 cm were recovered from the far end of the Upper Mex-Tex adit/stope. They are generally white to colorless and translucent and were simple, monoclinic, prismatic crystals. They are associated with brochantite and some are partially altered to chrysocolla. In May 1995, a second occurrence was discovered at the opening of the upper Mex-Tex adit. Transparent, colorless sprays and individual crystals were found nestled with spangolite crystals in very attractive specimens. The largest sprays approach 1 cm while individual crystals are 2–4 mm.

Cyanotrichite $Cu_4^{2+}Al_2(SO_4)(OH)_{12}\cdot 2H_2O$

Although cyanotrichite had been described as occurring at the Mex-Tex mine (Taggart *et al.*, 1989), it had not been observed by the authors until excellent specimens were recovered from south of the Upper Mex-Tex adit portal during the May–June 1996 dig. Sky-blue sprays up to 3 cm were found in a small pocket associated with bright green brochantite sprays and lustrous spangolite. Unfortunately, only a few specimens were recovered.

Dickite $Al_2Si_2O_5(OH)_4$

Dickite has been reported as common throughout the Hansonburg district, as small coatings and masses with the appearance of white to cream-colored popcorn (Taggart *et al.*, 1989). Specimens of coronadite from the Snake Pit mine occur with crystals of what appears to be a clay mineral. These are cream colored, hexagonal platelets close to 1 mm in size. Further work will be required to identify this mineral.

Fluorite CaF_2

Fluorite from the Mex-Tex mine graces collections around the world. It has always been a favorite of collectors due to the variety of colors and habits that can be found. Ranging from pastel greens, purples and blues to darker blues, the color is striking and demands attention. Additionally, the hexoctahedron and tetrahexahedron forms, while rare in most areas, are quite common at the Mex-Tex. The cube remains the most common form but stepped growth and combinations with other forms enhance even this simple form. Always transparent to translucent, the crystals often make aesthetic specimens, especially when associated with galena and barite and occasionally with brochantite and linarite.

Fluorite is ubiquitous at the Mex-Tex, but several spectacular pockets were found at the far end of the Upper Mex-Tex adit/stope. One of these was the "4th of July" pocket, named for its discovery date in 1988 by one of the authors (TM). It was approximately 10 feet long by 4 feet high and produced more than 100 individual specimens of spectacular fluorite and galena. Unfortunately, this section of the mine was lost to collecting during the February, 1991 collapse.

The Ora mine has also produced a large number of fluorite specimens. Large plates up to 45 cm with purple, complex fluorite crystals to 10 cm associated with galena and sprinkled with small wulfenite crystals are probably the finest specimens from this adit. Specimen production from this mine has declined since the September 1993 accident.

Figure 11. **Fluorite crystal group, colorless, 10.2 cm, from the 4th of July pocket, Upper Mex-Tex mine. T. Massis collection; Jeff Scovil photo.**

Galena PbS

Mined as ore along with barite, galena is found throughout all areas of the mine. It is inevitably altered, at least on the surface, to anglesite/cerussite. The cube is the predominant form although some crystals are modified by small octahedral faces. Crystals exceeding 5 cm are not uncommon and some reach 10 cm. Superb specimens intergrown with fluorite were recovered from the stope at the far end of the Upper Mex-Tex adit.

Goethite $Fe^{3+}O(OH)$

No significant specimens of goethite have been found but the mineral is common as "limonite" alterations of pyrite and chalcopyrite in minor amounts in numerous areas of the mine.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum is much less abundant at the Mex-Tex mine in comparison to the nearby Blanchard mine. When found, it is usually a colorless, transparent glaze coating either the host silicified limestone or occasionally the fluorite and other minerals.

Hemimorphite $Zn_4Si_2O_7(OH)_2H_2O$

Hemimorphite has been reported from the Upper Mex-Tex mine in a number of small pockets above the 4th of July pocket (TM) and also from the Snake Pit mine by Bringe *et al.* (1992). It occurs as aggregates of 1 mm, colorless, prismatic crystals on quartz crystals and fluorite.

Jarosite $K_2Fe_6^{3+}(SO_4)_4(OH)_{12}$

Rarely found in recognizable crystals, jarosite has been confirmed in very small (0.05 mm), platy, yellow-brown crystals from the Upper Mex-Tex mine. Identification was confirmed by microprobe analysis (Hlava, personal communication, 1986). Thin, yellow to brown coatings and crusts elsewhere around the mine are also most likely jarosite.

Libethenite $Cu_2^{2+}(PO_4)(OH)$

Previous reports of libethenite at the Mex-Tex mine were based on a single specimen in the collection of Tim Hanson (Taggart *et al.*, 1989). Precise location information, however, was never available. In September of 1991, one of the authors (TM) discovered the location of the elusive libethenite to be near the opening of the Upper Mex-Tex adit. Bright, grass-green spheres and spherical crystal aggregates were found in association with plumbogummite, turquoise and crandallite. The spheres average about 1 mm in diameter.

During a June 1995 exploratory dig in the same vicinity, another remarkable find was made. Sprays of bright olive-green libethenite crystals were again found but this time tsumebite, pseudomalachite and pyromorphite were found in addition to plumbogummite and crandallite. The sprays of prismatic crystals are more open in this occurrence and the individual crystals are distinct and larger than those in the September 1991 find.

Linarite $PbCu^{2+}(SO_4)(OH)_2$

Always one of the most sought after minerals at the Mex-Tex mine, linarite has been found throughout the area. The best specimens have been recovered from the upper Mex-Tex adit. A single unattached 2.5-cm crystal formerly in the collection of Jerry Simmons is reputed to have come from the Mex-Tex mine in the 1950's but unfortunately confirmation is not available. Specimens collected in recent years have usually consisted of bright sky-blue drusy crusts on galena, fluorite and barite, and coating vugs in the host rock. The frequent association with brochantite often provides for spectacular specimens.

Malachite $Cu_2^{2+}(CO_3)(OH)_2$

Often very difficult to distinguish from the ubiquitous brochantite, malachite generally has a darker green color and is more inclined to be found in spheres. Effervescence in acid is an easy way to distinguish malachite from brochantite. A short adit at the southernmost end of the Upper Mex-Tex workings has produced attractive specimens.

Murdochite $PbCu_6^{2+}O_{8-x}(Cl,Br)_{2x}$

Sprinklings of minute (1 mm or less) lustrous murdochite crystals are found in some areas, usually associated with plattnerite and often scrutinyite. The crystals are dominantly cubic in habit, sometimes modified by the octahedron. They are usually found where oxidation of chalcopyrite and galena crystals has occurred. Attractive specimens of drusy quartz dusted with brilliant black murdochite crystals have been found in the unnamed adit at the southernmost end of the Mex-Tex group. Some specimens with countless murdochite crystals covering the quartz exceed 60 cm in diameter.

Plattnerite PbO_2

Plattnerite is found as 1-mm prismatic black crystals throughout the mine, usually on or near altered galena crystals. Scrutinyite may be associated as well as murdochite. Spectacular specimens of galena completely coated by plattnerite crystals were recovered from the stope at the far end of the Upper Mex-Tex adit.

Plumbogummite $PbAl_3(PO_4)_2(OH)_5 \cdot H_2O$

Plumbogummite was initially identified in a specimen provided by Tim Hanson (Taggart *et al.*, 1989); precise location information was not immediately available, but was later determined to be the same as that described under libethenite. Plumbogummite occurs as botryoidal coatings or crusts that are glassy, with a distinctive robin's egg-blue color which grades into gray. Associated minerals are libethenite, crandallite, turquoise and tsumebite.

Pseudomalachite $Cu_5^{2+}(PO_4)_2(OH)_4$

Pseudomalachite has been tentatively identified from the Mex-Tex mine by microprobe analysis (Hlava, personal communication, 1995) and by physical properties. It occurs rarely with the other phosphates described in this article at the entrance to the Upper Mex-Tex adit, where it is found predominantly as grass-green, glassy spheres (less than 1 mm) perched on quartz crystals. Some of it is in the form of coarsely crystalline aggregates and some is in good crystals. The crystals are short blades less than 1 mm in length, with rounded terminations.

Psilomelane Hard manganese oxide

Black dendrites and thin films and crusts of "psilomelane" coat some of the silicified limestone drusy quartz in the area. This material is assumed to be at least partially psilomelane.

Pyromorphite $Pb_5(PO_4)_3Cl$

Pyromorphite is less common than the other phosphates and is easily overlooked. It occurs in colorless to gray crystals no larger than 1 mm, in association with the other phosphates. The habit is prismatic with minor pyramidal faces and terminated by the pinacoid.

Quartz SiO_2

Although quartz crystals are ubiquitous in all areas of the Mex-Tex mine, exceptional specimens are noteworthy primarily from the Upper Mex-Tex mine and in the vicinity of the unnamed adit at the south end of the workings. Amethystine and smoky-tipped crystals were commonly found in the Upper Mex-Tex prior to the 1991 collapse of the stope. These are in some cases dusted with murdochite crystals. The unnamed adit contains large plates of white to very slightly smoky crystals, some of which also have murdochite crystals in association. Crystals are dominated by the

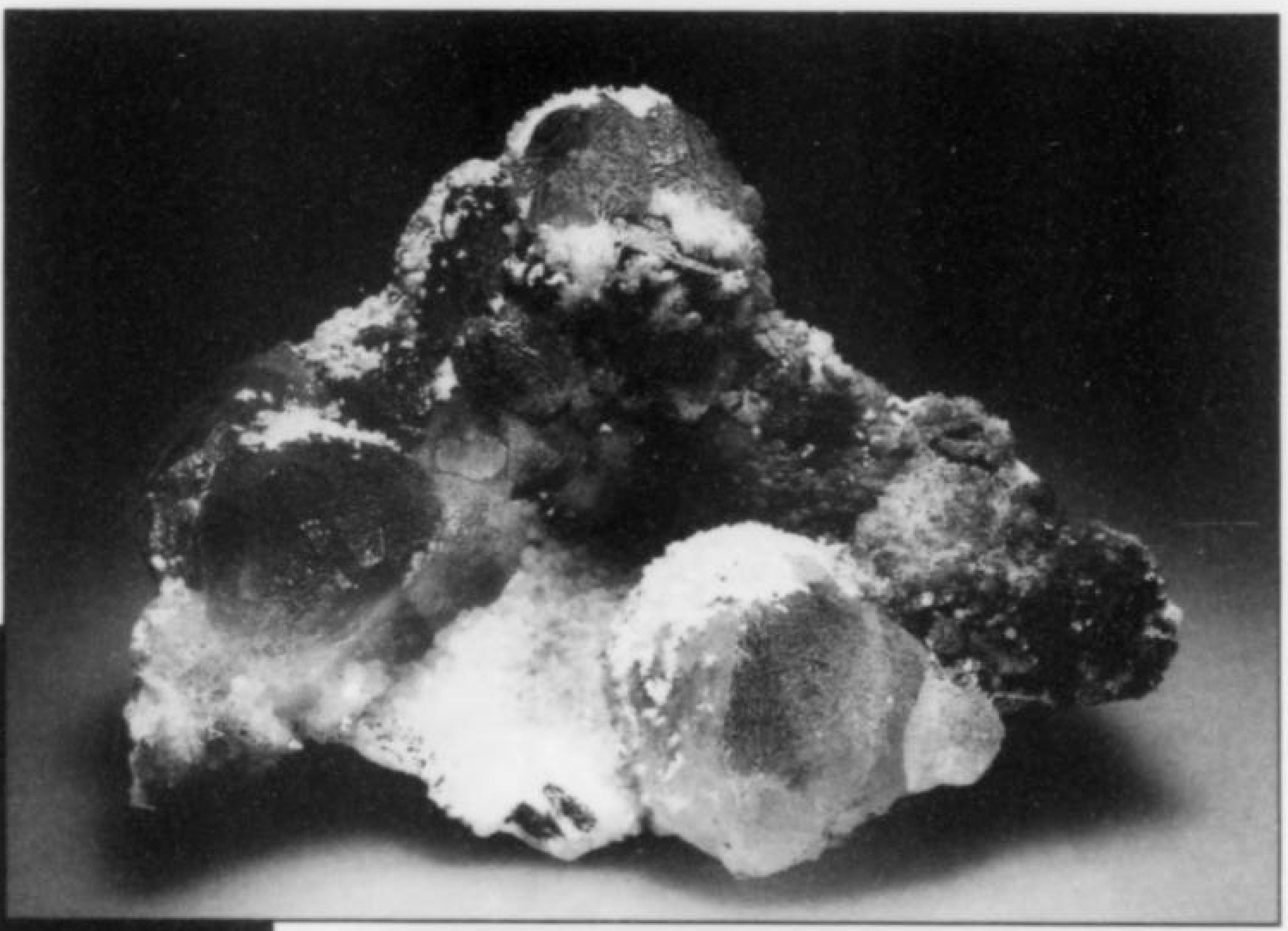


Figure 12. **Fluorite crystal group with quartz, 13.1 cm, from the 4th of July pocket, Upper Mex-Tex mine. T. Massis collection; Jeff Scovil photo.**

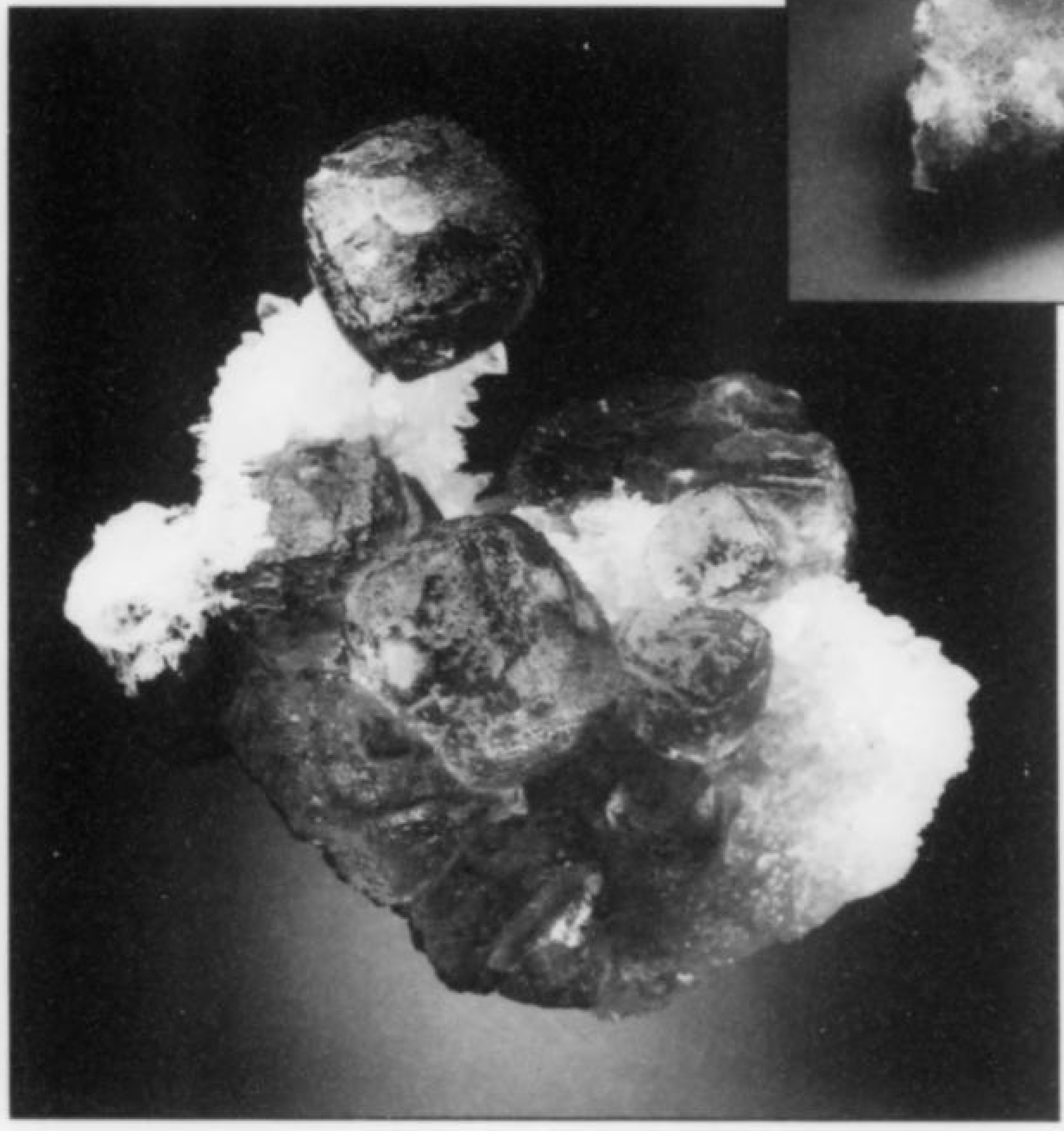


Figure 13. **Fluorite crystal group, 4.3 cm, showing hexoctahedral development, from the Upper Mex-Tex mine. T. Massis collection; Jeff Scovil photo.**

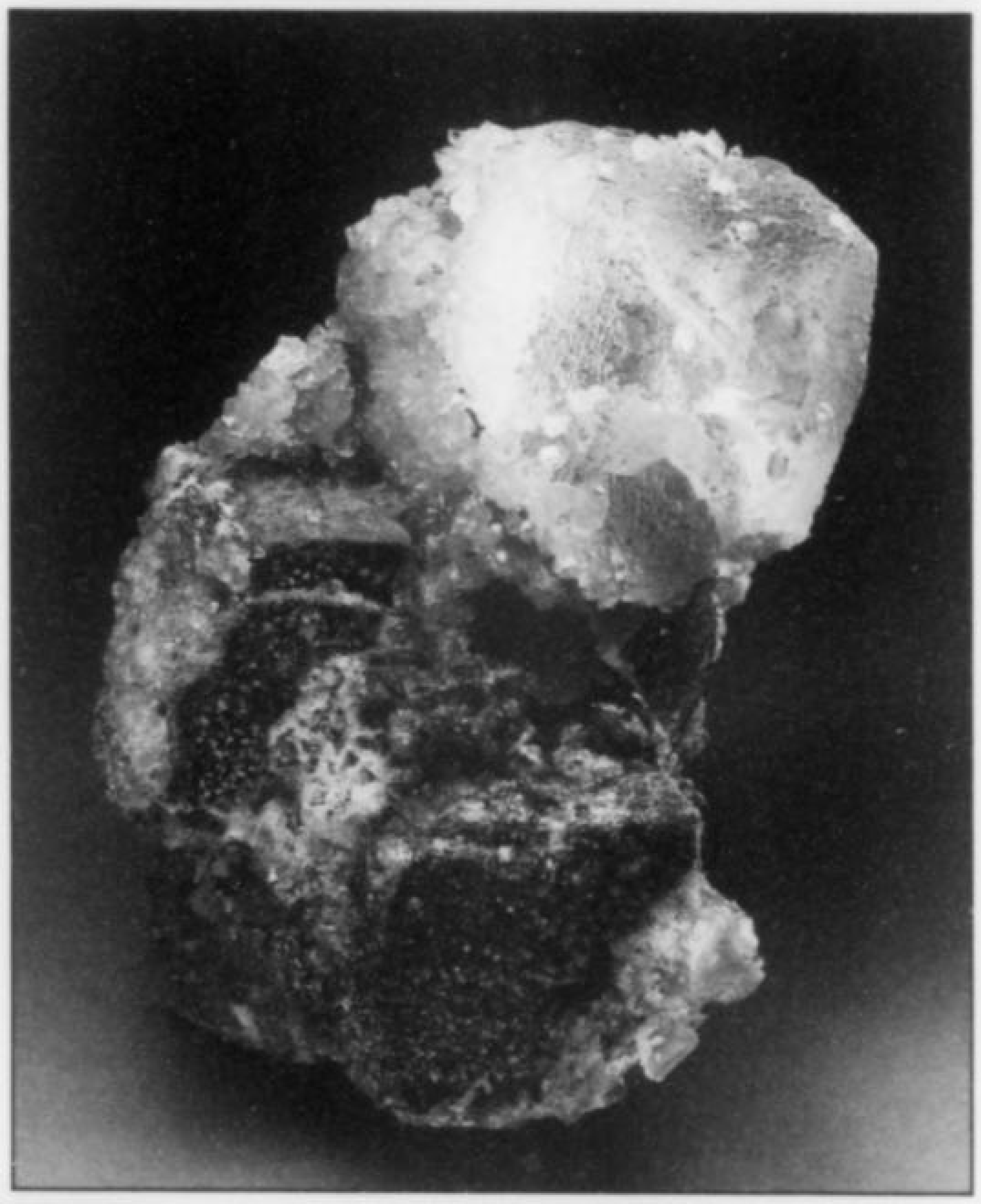


Figure 14. **Galena crystals with quartz and fluorite, 11 cm, from the Upper Mex-Tex mine. R. S. DeMark collection; Jeff Scovil photo.**

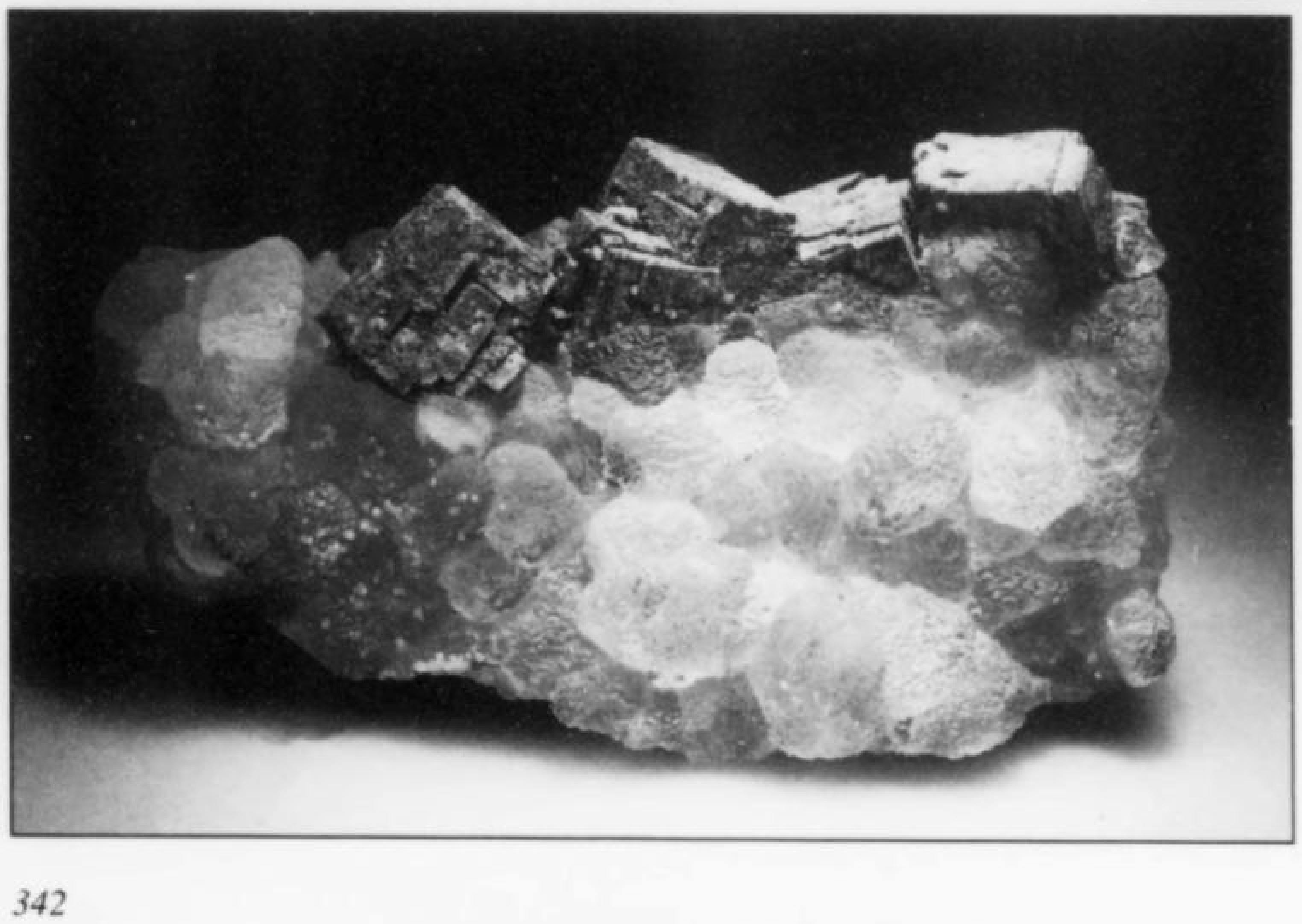


Figure 15. **Galena crystals on fluorite, 30.2 cm, from the 4th of July pocket, Upper Mex-Tex mine. T. Massis collection; Jeff Scovil photo.**

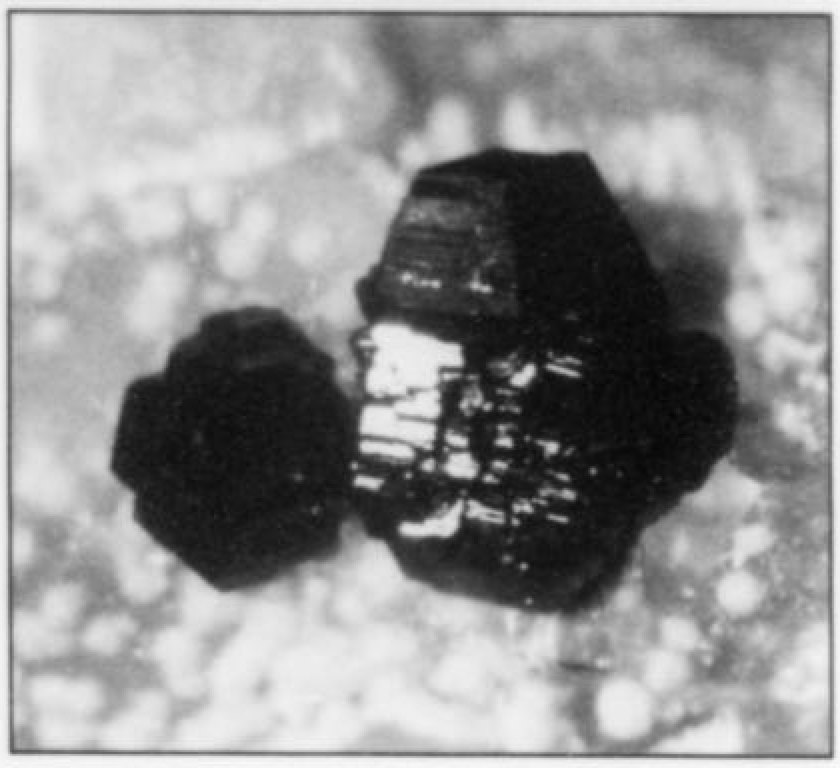


Figure 16. **Spangolite crystals to 1 mm, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.**

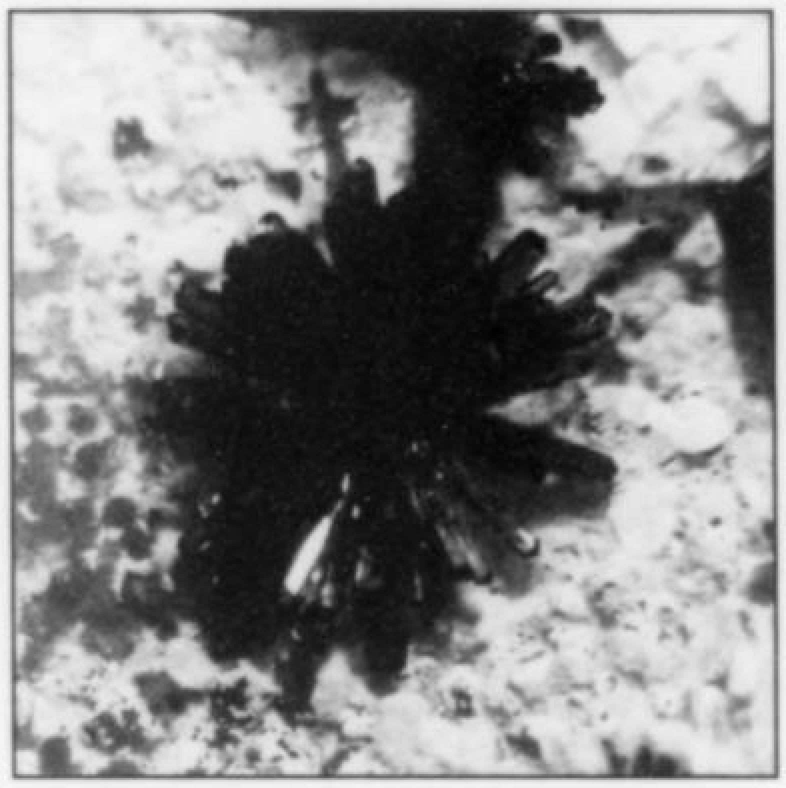


Figure 17. Libethenite crystal sprays, 2.5 mm, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.

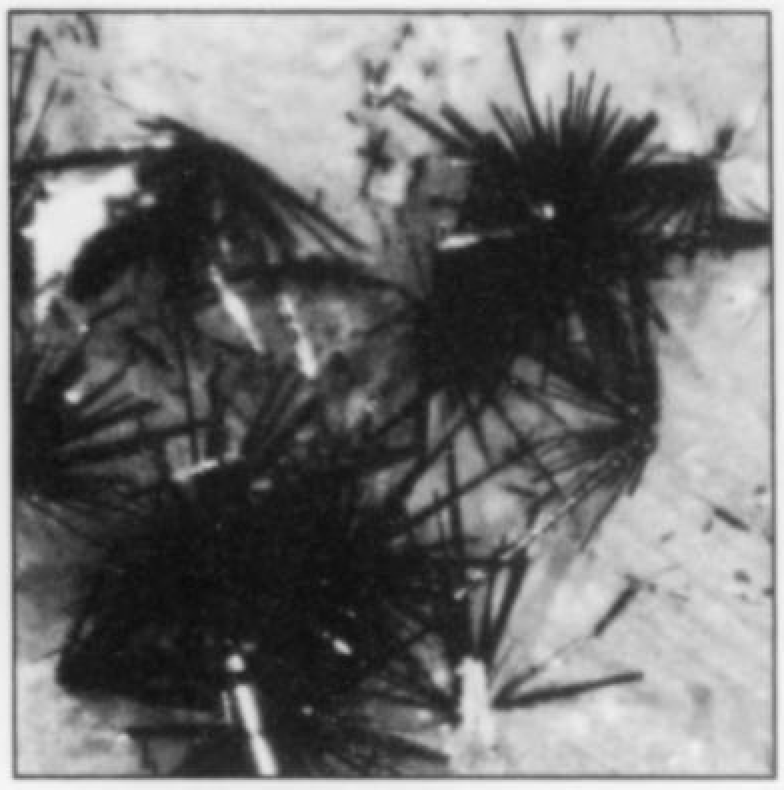


Figure 18. Plattnerite crystal sprays on quartz, 1.5 cm across, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.

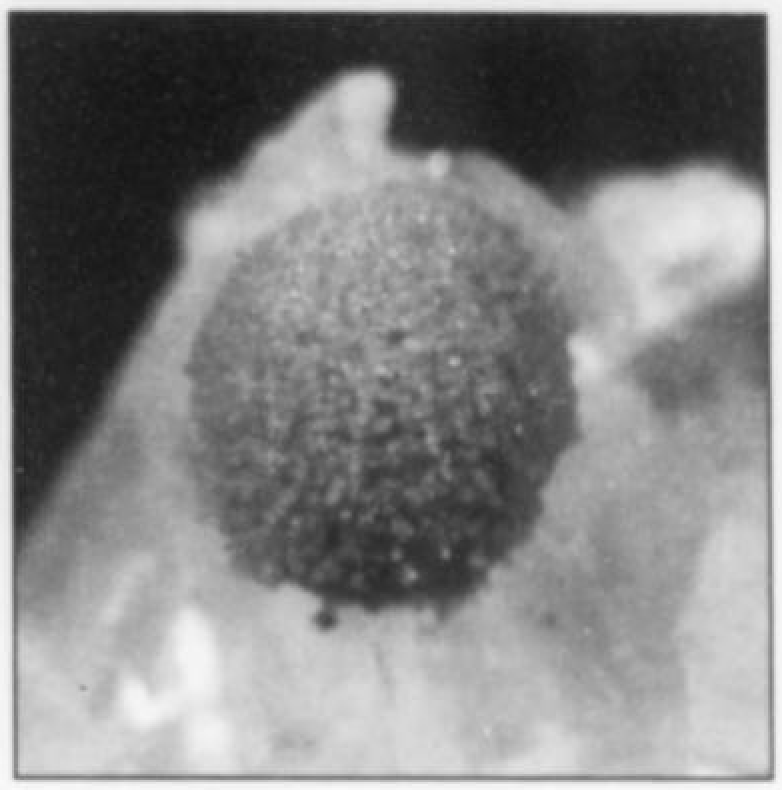


Figure 19. Turquoise crystal spherule, 1.2 mm, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.

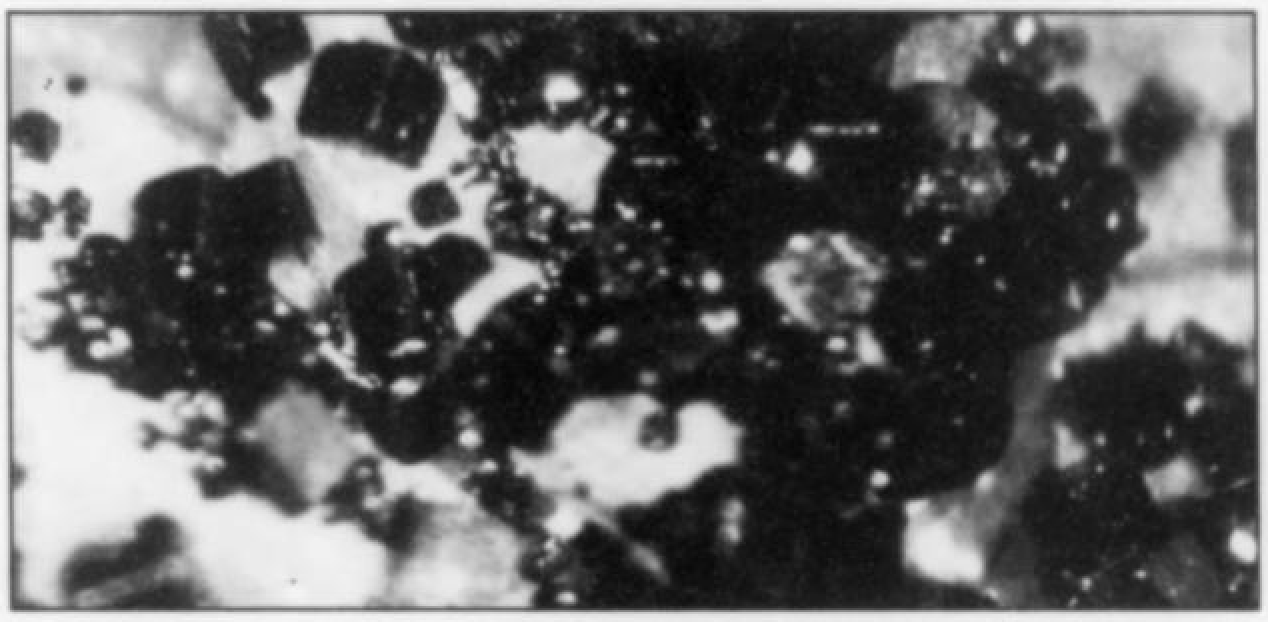


Figure 20. Murdochite crystals on quartz, 1 cm across, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.

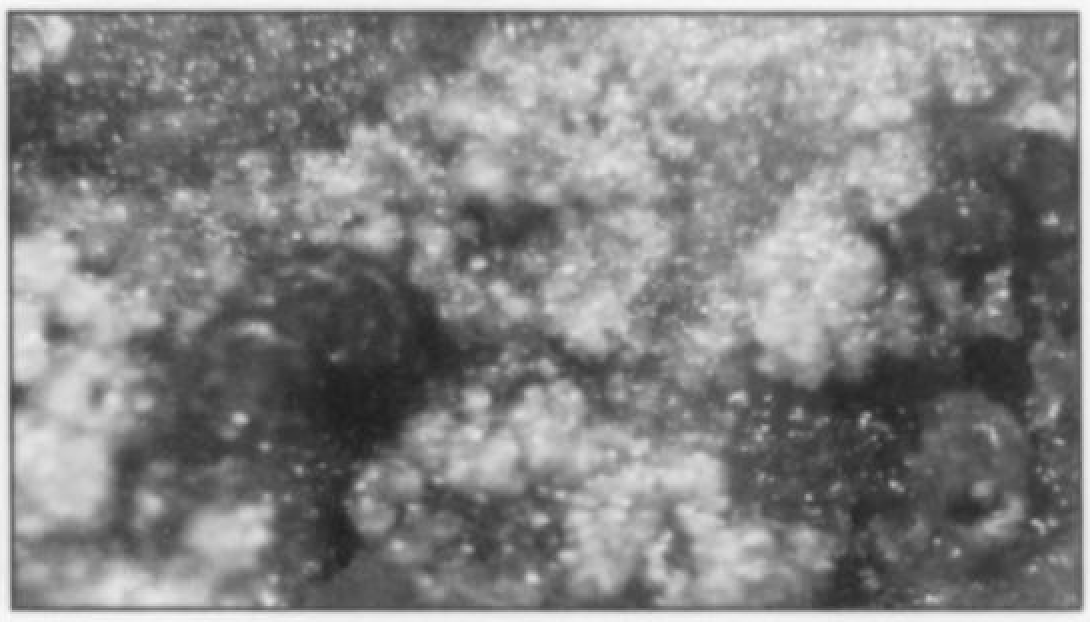


Figure 21. Plumbogummite with botryoidal green libethenite, 1.5 cm across, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.

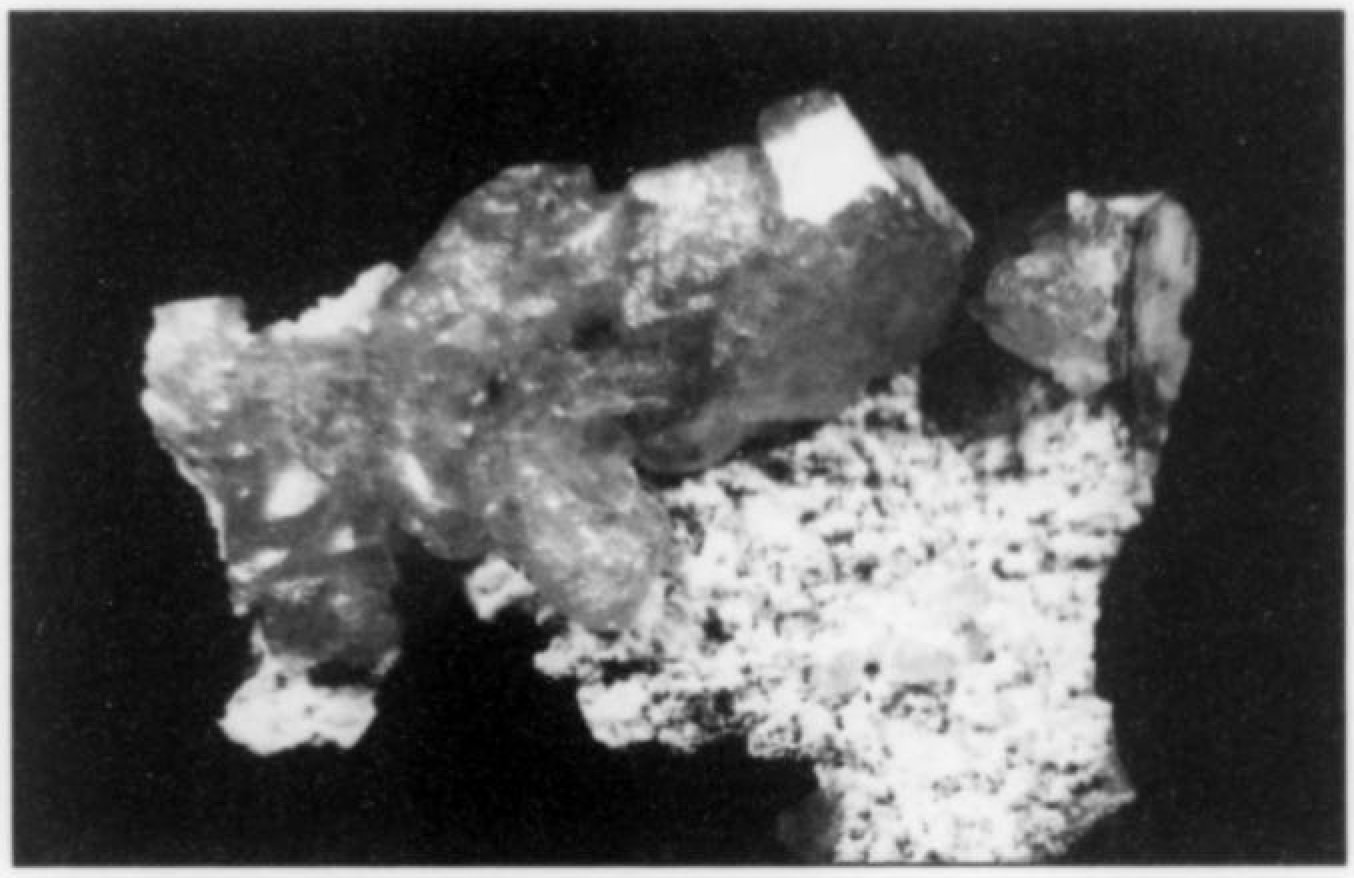


Figure 22. Wulfenite crystal group, 1 cm, from the Hickey #1 mine. R. S. DeMark collection; Arnold Hampson photo.

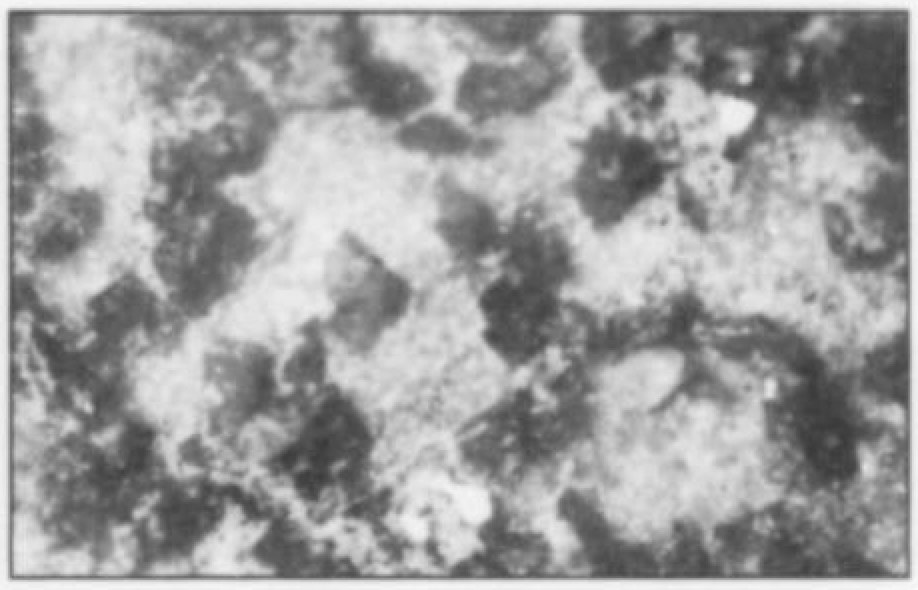


Figure 23. Tsumebite crystals on matrix, 1.5 cm across, from the Upper Mex-Tex mine. R. S. DeMark collection; Arnold Hampson photo.

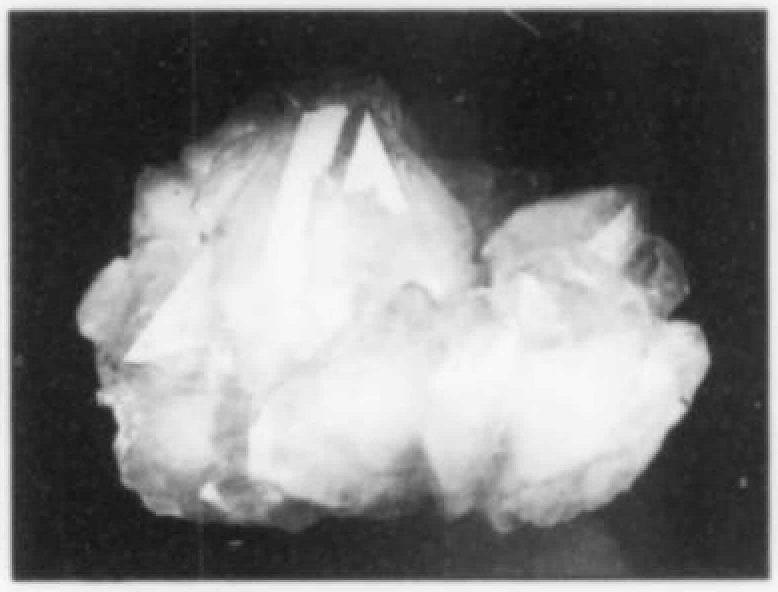


Figure 24. Pale amethystine quartz, 7.6 cm, from the Upper Mex-Tex mine. R. S. DeMark collection; Jeff Scovil photo.

rhombohedral faces with minor prism faces, and are usually less than 3 cm across.

A pleasant surprise during the June 1995 dig was the discovery of a large amount of pale amethyst immediately south of the unnamed adit and just below the surface. This was by far the finest amethyst ever found at the Mex-Tex mine, and dozens of flats of specimens were recovered. Elsewhere, quartz can be found associated with fluorite, barite and galena in attractive specimens.

Rosasite $(Cu^{2+},Zn)_2(CO_3)(OH)_2$

Rosasite has been found sparingly as turquoise-blue, 0.5-mm spheres on oxidized galena specimens in association with oxidized chalcopyrite crystals.

Scrutinyite PbO_2

Scrutinyite, a rare polymorph of PbO_2, has been found only in the Snake Pit adit. Finely crystalline aggregates of reddish, micaceous crystals occur coating quartz crystals. Scrutinyite has also been found as alteration coatings on galena crystals. Typical associations include plattnerite, coronadite and wulfenite.

Spangolite $Cu_6^{2+}Al(SO_4)(OH)_{12}Cl\cdot 3H_2O$

One of the rarest and most attractive minerals at the Mex-Tex mine, spangolite is the target of many collectors. The Upper Mex-Tex adit/stope has produced the finest specimens. Early finds usually produced aesthetic specimens in association with bright green brochantite and sometimes linarite. In June of 1995, superb specimens intergrown with individual crystals and sprays of creedite astounded the claim owners during their summer dig. Crystals are generally 2 mm or less, although larger crystals have been reported. The pedion, pyramid, and hexagonal prism combine to form generally barrel-shaped crystals that are a delight to micromineral collectors.

Tsumebite $Pb_2Cu(PO_4)(SO_4)(OH)$

Although a single specimen of tsumebite of unknown origin from the Hansonburg district was positively identified by Taggart and Foord (1979), no corroborating specimens had been located until June of 1995. This discovery occurred while recovering specimens of libethenite, plumbogummite and other minerals from an exploratory dig by the claim owners near the opening of the Upper Mex-Tex adit. The crystals are tabular, commonly twinned or in aggregates, with individual crystals less than 0.5 mm. They are transparent to translucent and vary in color from a sea-green to apple-green. They are most commonly associated with libethenite and plumbogummite but may also be found with spangolite and brochantite. Identification was confirmed by microprobe analysis (Hlava, personal communication, 1995).

Wulfenite $PbMoO_4$

The best wulfenite from the Hansonburg district has come from the Mex-Tex mine property. The Ora mine, the Hickey #1 mine, and the Snake Pit adit have all produced excellent specimens. Crystals from the Ora mine are tabular to blocky and range in color from straw-yellow to orange. Crystals from 1 to 3 mm commonly coat drusy quartz specimens. Crystals from the Hickey #1 mine may reach close to 1 cm and are usually tabular. The color is typically a yellow-green to butterscotch and the crystals are sometimes markedly color-zoned parallel to the prism faces. Wulfenite from the Snake Pit adit is always associated with coronadite and is always tabular in habit. Crystals are transparent and range in color from yellow to yellow-orange.

CONCLUSION

Specimens from the Mex-Tex mine that were mined prior to the early 1960's are exceedingly rare. The most active years of mining at the Mex-Tex mine saw virtually no production of specimens, despite the fact that the most heavily mineralized zones were mined and fabulous specimens were undoubtedly exposed. It has only been since 1987 that a large number of specimens have been recovered and made available to collectors. This was made possible when the Mex-Tex mine was claimed by mineral collectors solely interested in the minerals as specimens.

With the recent collapses within the adit, much of what might have been forthcoming is once again unobtainable. There is hope, however! During 1995 and 1996, near-surface pockets and mineralized zones have produced outstanding specimens of spangolite, brochantite, amethyst, creedite and other uncommon species that equal or exceed the best previously known from the Mex-Tex mine. Future digs may very well produce more high-quality specimens.

Limited access to collect at the Mex-Tex mine is possible with prior written permission of the claim owners. Individuals showing up at Bingham without prior correspondence will not be allowed to collect. A caretaker on site is authorized by the claim owners to restrict unauthorized collecting.

ACKNOWLEDGMENTS

We would like to thank Dr. Peter J. Modreski of the U.S. Geological Survey in Denver, Colorado, for suggested improvements to this article, and Paul F. Hlava with Sandia National Laboratory in Albuquerque, New Mexico, for his unending help in identifying unknown New Mexico mineral species using microprobe analysis. Many thanks also to Dr. Judith L. DeMark for help in the preparation of this article.

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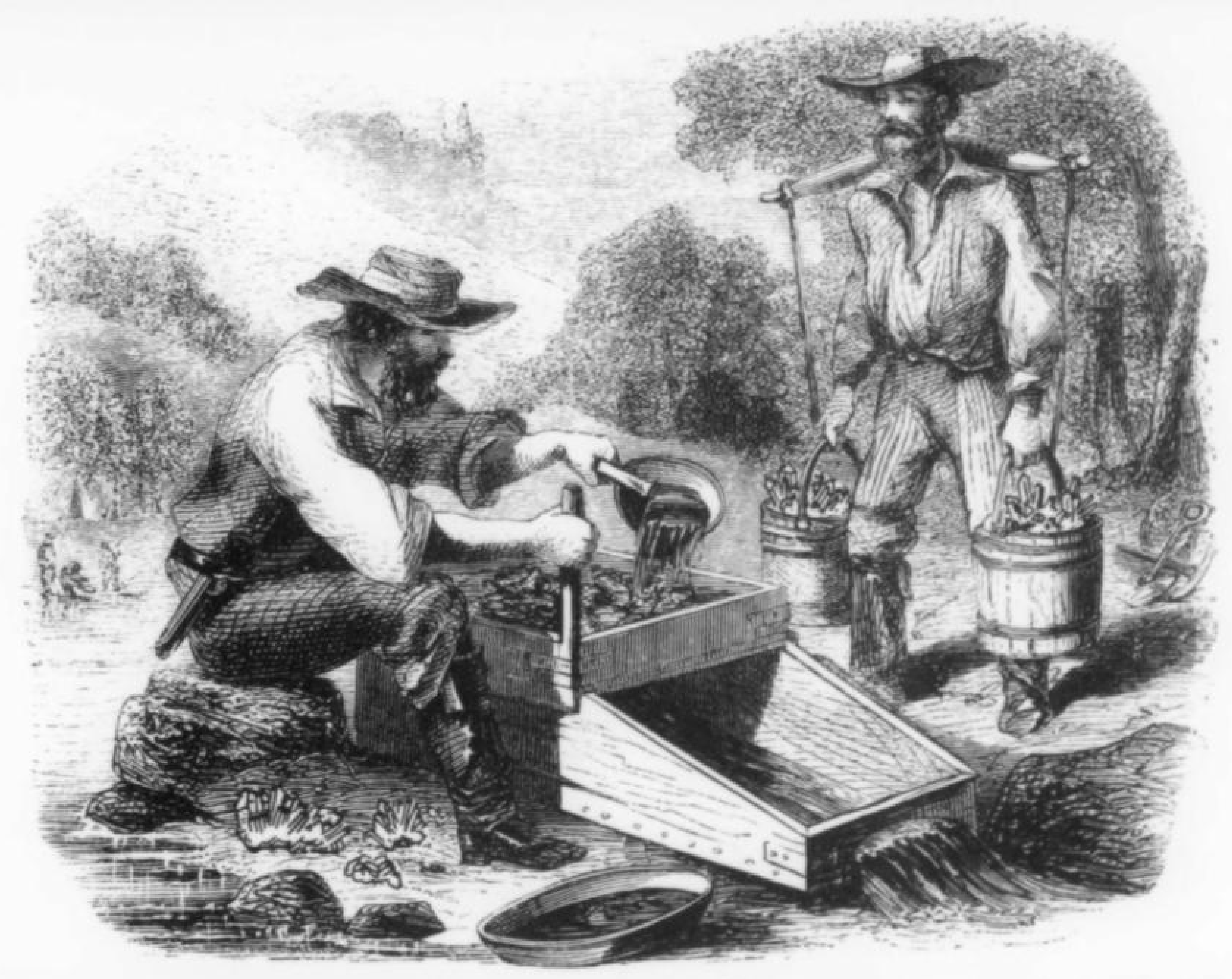

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Topaz, Ouro Preto, Brazil, 8.9 cm

Famous Mineral Localities:

THE SAPUCAIA PEGMATITE

MINAS GERAIS, BRAZIL

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The Sapucaia pegmatite is famous as the type locality for six phosphate species: barbosalite, faheyite, frondelite, lipscombite, moraesite and tavorite. It also contains a secondary uranium suite. It should not, however, be confused with the first Brazilian source of fine crystallized rose quartz, the nearby Berilo Branco mine, which has often been given the Sapucaia name.

LOCATION

The Sapucaia pegmatite is located about 50 km east-southeast of Governador Valadares, in the municipio of Galileia, Rio Doce basin, Minas Gerais, Brazil. Access is easy, first by the paved highway 33.5 km from Governador Valadares toward Mantena to the village of Saõ Vitor, and from there on the paved road toward Galiléia for 22.1 km. From that point take the turn-off north for 9 km toward the town of Sapucaia do Norte, intersecting a 1.8-km road that leads to the entrance of the mine property. From the entrance a 3.2-km service road leads to the steep-sided open pit. The mine is situated at coordinates 239E and 7910N on the Itabirinha de Mantena map, 1:100,000, SE-24-Y-A-V, IBGE (1979).

GEOLOGY

The deposit is in the Paraíba Group, Lower Precambrian in age (ca. 1,980 million years old). Here cupolas and pegmatites were

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later emplaced following the intrusion of a granitic batholith into a mica schist complex called the São Tomé Formation. The intrusion has been dated at 550-600 m.y. near Galiléia (Barbosa *et al.*, 1966). More than 150 pegmatite bodies have been worked in the area for minerals such as amblygonite, brazilianite, beryl (as beryllium ore and as gem-grade heliodor, aquamarine and morganite), columbite-tantalite, colorless and smoky quartz, spodumene (as lithium ore and as gem-grade kunzite), and gem-quality tourmaline.

The pegmatite body is well-zoned and oval-shaped in outcrop (40 x 100 meters), the long axis being oriented north-northwest. An irregular open pit with near-vertical sides 40 meters high surrounds the prominent free-standing core zone.

The central part of the zoned pegmatite, where open-pit mining once exploited beryl, is composed essentially of giant-size perthite masses containing numerous books of pale muscovite, an irregular framework of quartz, several elongated and fluted masses of industrial-grade beryl, large laths of white weathered spodumene to more than 2 meters in length, and (branching) vein-like masses of triphylite to several tons in weight. Albite, montebrasite, muscovite, quartz, tourmaline, sphalerite and other sulfides occur intergrown with the unaltered triphylite.

Hydrothermal fluids generated within the pegmatite produced a wide variety of secondary minerals in the form of spherulitic masses, fibers, needles and well-formed crystals in cavities within

Figure 1. **Location map.**

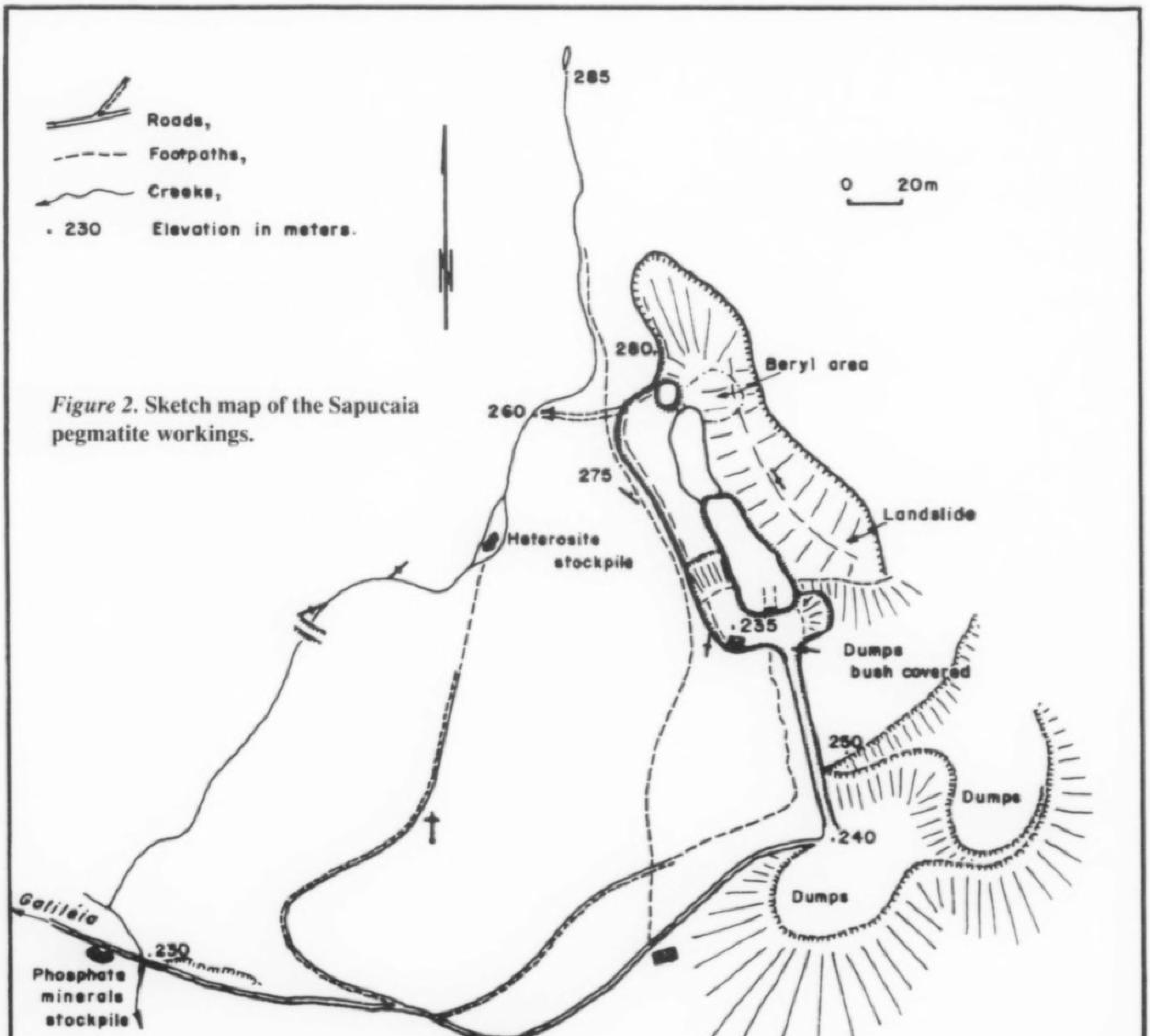


Figure 2. **Sketch map of the Sapucaia pegmatite workings.**

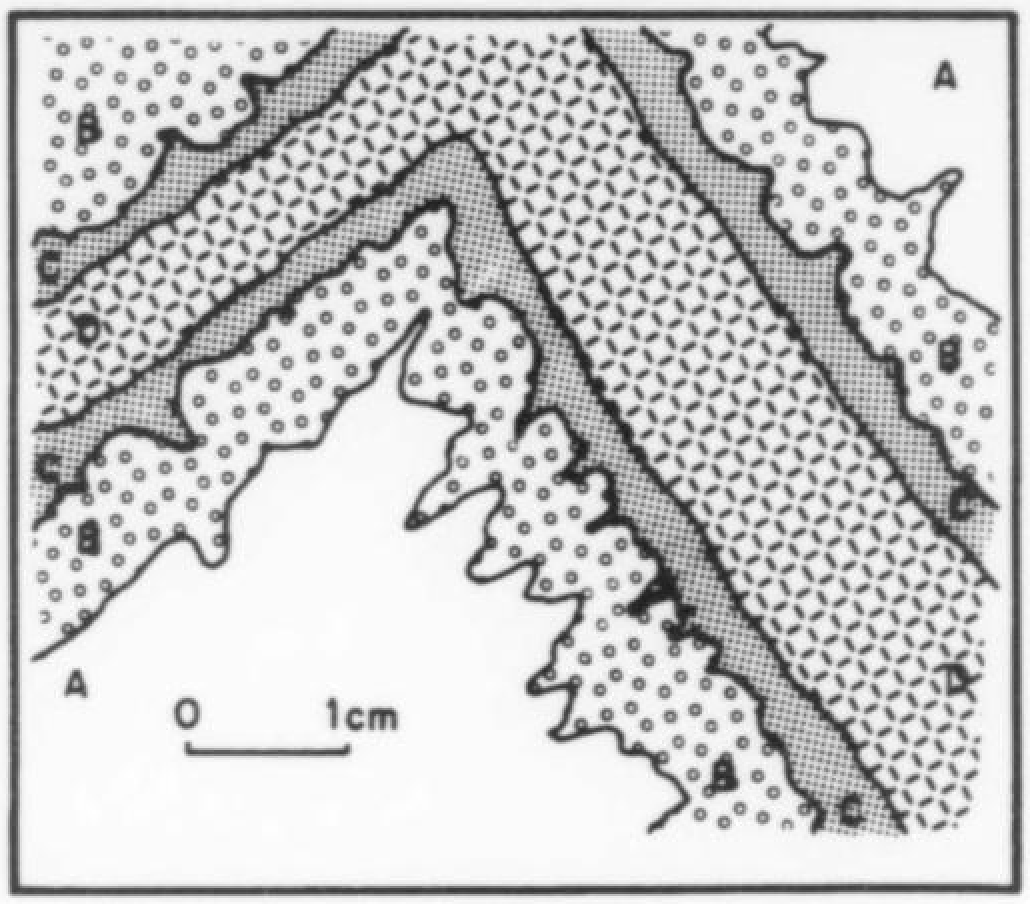


Figure 3. **Idealized sketch showing zones of secondary minerals developed along fractures in triphylite. A-unaltered triphylite; B-porous, altered triphylite with cavities containing colorless hureaulite, crystalline aggregates of blue vivianite, and crystalline aggregates of black barbosalite; C-fine-grained blue-green zone containing essentially black barbosalite, yellow tavorite, and intermediate alteration products; D-massive purple heterosite with some brown ferrisicklerite. (After Lindberg and Pecora, 1955).**

or adjacent to beryl, muscovite, quartz, triphylite and other minerals. The alteration of triphylite results in the formation of heterosite and many other phosphate minerals, arranged in a crude zoning around the triphylite masses. The unaltered triphylite cores are separated from a massive heterosite-ferrisicklerite zone by a porous, altered triphylite zone with sponge-like cavities containing terminated crystals of hureaulite, crystalline aggregates of blue vivianite, bladed blackish green barbosalite, and yellow earthy tavorite.

The dumps south of the pit contain many tons of discarded phosphate material. Phosphates can also be collected along a small, nearly dry creek which runs west of the mine and crosses the access road (see map). Large phosphate pebbles and boulders are often exposed in the creek bed after heavy rains; these are generally massive triphylite or frondelite, with or without alteration minerals, or heterosite sometimes showing good crystals.

The wall rock enclosing the pegmatite body is a vertically dipping biotite schist with staurolite porphyroblasts. The staurolite crystals reach 3 cm in size and are twinned at right angles; they are plentiful in the soil along the access road.

HISTORY

The Sapucaia pegmatite was probably discovered sometime in the 1920's or 30's, but was not actively mined until World War II. It was one of many deposits in the Minas Gerais mica belt to be investigated during the war years (1942–1945) by joint field parties of the U.S. Geological Survey and the Brazilian National Department of Mineral Production (D.N.P.M.). The mine became a substantial producer of industrial beryl and mica. W. T. Pecora of the U.S.G.S. and A. L. de M. Barbosa of the D.N.P.M. studied and mapped the Sapucaia pegmatite. They reported (Pecora *et al.*, 1950) that the central zone contained "irregular bodies of triphylite, which were altered partly by hydrothermal solutions during consolidation of the pegmatite, and partly by surficial waters during weathering. Both agencies have resulted in a complex assortment of rare phosphate minerals."

A suite of specimens collected by Pecora and Barbosa during the course of their field work at Sapucaia was turned over to M. L. Lindberg in 1948 for complete identification and description. During 1950-1953 additional specimens were contributed by E. R. Swoboda, R. Greenwood, S. Anderson and E. I. Brown. Seven new mineral species were described from this material: *lipscombite* (Lindberg, 1962), *frondelite* (Lindberg, 1949), *faheyite* (Lindberg and Murata, 1953), *moraesite* (Lindberg *et al.*, 1953), *tavorite* and *barbosalite* (Lindberg and Pecora, 1954a), and *avelinoite* (Lindberg and Pecora, 1954b). Avelinoite was later found to be identical with cyrilovite (Strunz, 1956; Lindberg, 1957a), but the other six still stand as valid species. Summing up their work on Sapucaia phosphates, Lindberg and Pecora (1958) listed their apatite, bermanite, childrenite, gordonite, heterosite, hureaulite, leucophosphite, lipscombite, metastrengite (= phosphosiderite), montebrasite, roscherite, saleeite, strengite, triphylite, variscite and vivianite as having been positively identified, in addition to the new species. More recently the list has been expanded to include jahnsite (Moore and Ito, 1978a), arrojadite (Moore and Ito, 1979), dufrenite and one unidentified zinc phosphate (Hirson, 1965) having lower refractive indices than the zincian rockbridgeite of Lindberg and Frondel, 1950), a kidwellite-like mineral (Moore and Ito, 1978b) and johnsomervilleite (Araki and Moore, 1981).

After a period of abandonment during the 1960's and early 70's, some small pits were excavated in 1975–1977 into the northeastern side of the core; a beryl-rich zone with coralloid blue vivianite-stained triphylite in feldspar was discovered. Similar excavations on the west side of the core encountered plentiful secondary phosphates (mainly mitridatite, variscite and phosphosiderite with johnsomervilleite) in feldspar boxworks.

During the summer of 1978, following heavy rains, the weathered schist wallrock forming the eastern side of the pit collapsed, partially burying the workings.

Reworking of the dumps for feldspar in 1980 allowed the recovery of many blocks of phosphate minerals. During the summer of 1982 a forest fire uncovered old phosphate stockpiles near the access road close to the ford (fine frondelite and heterosite and excellent phosphosiderite). According to the miners, this stockpile had been set aside decades earlier specifically for examination by Professor Charles Palache of Harvard, who unfortunately never returned to claim it (Wendell Wilson, personal communication).

Heavy rains in 1986 flooded the southwestern portion of pit, and further landslides buried deeper the eastern side of the workings.

In 1990 the workings were leased by Enio Deniculi, a local contractor previously involved in mining the phosphate-rich Boa Vista pegmatite (Cassedanne and Cassedanne, 1981). His new excavations, for recovery of K-feldspar, advanced toward the johnsomervilleite-rich zone in the southwestern portion of the pit. The current lessee of the property is O. J. M. de Moura, from owner Isaura Mouria Sebastiana Bothelho. Because of heavy rains during the summer of 1998, the excavations remain flooded and the service road is still washed out in two places.

Near the access road a small north-south trending pegmatite was prospected a few years ago. It yielded schorl, garnet, columbite-tantalite, arsenopyrite, scorodite and rare beryl.

Figure 4. Adit entrance on the northwest side of the mine (Richard V. Gaines standing nearby), 1973. Photo by Wendell E. Wilson.

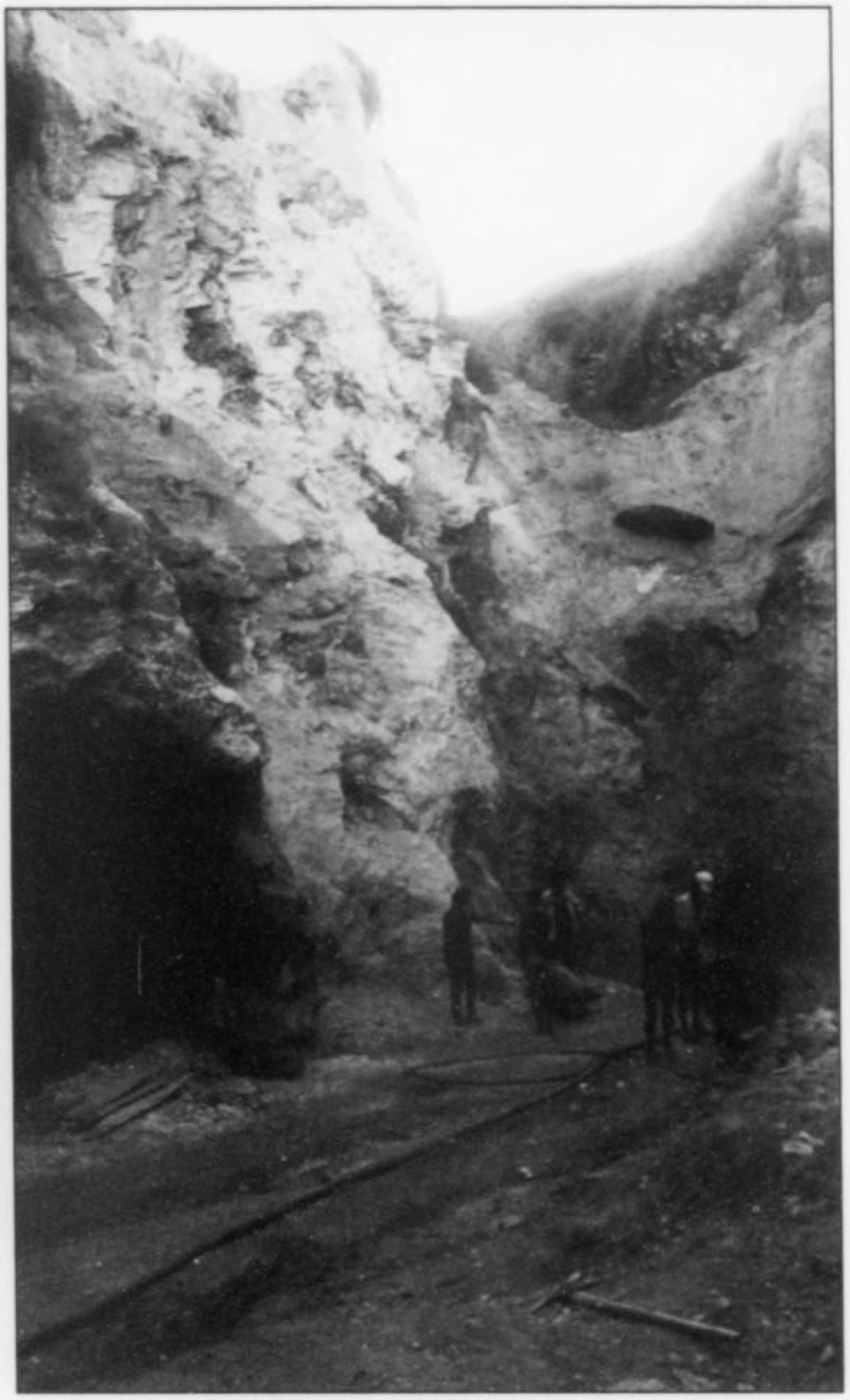


Figure 5. Workings along the pegmatite core in the southwestern part of the mine (1985).

Figure 6. Flooded interior of the mine, in the beryl area, 1973, prior to the collapse of the northeast wall of the pit. Photo by Wendell E. Wilson.

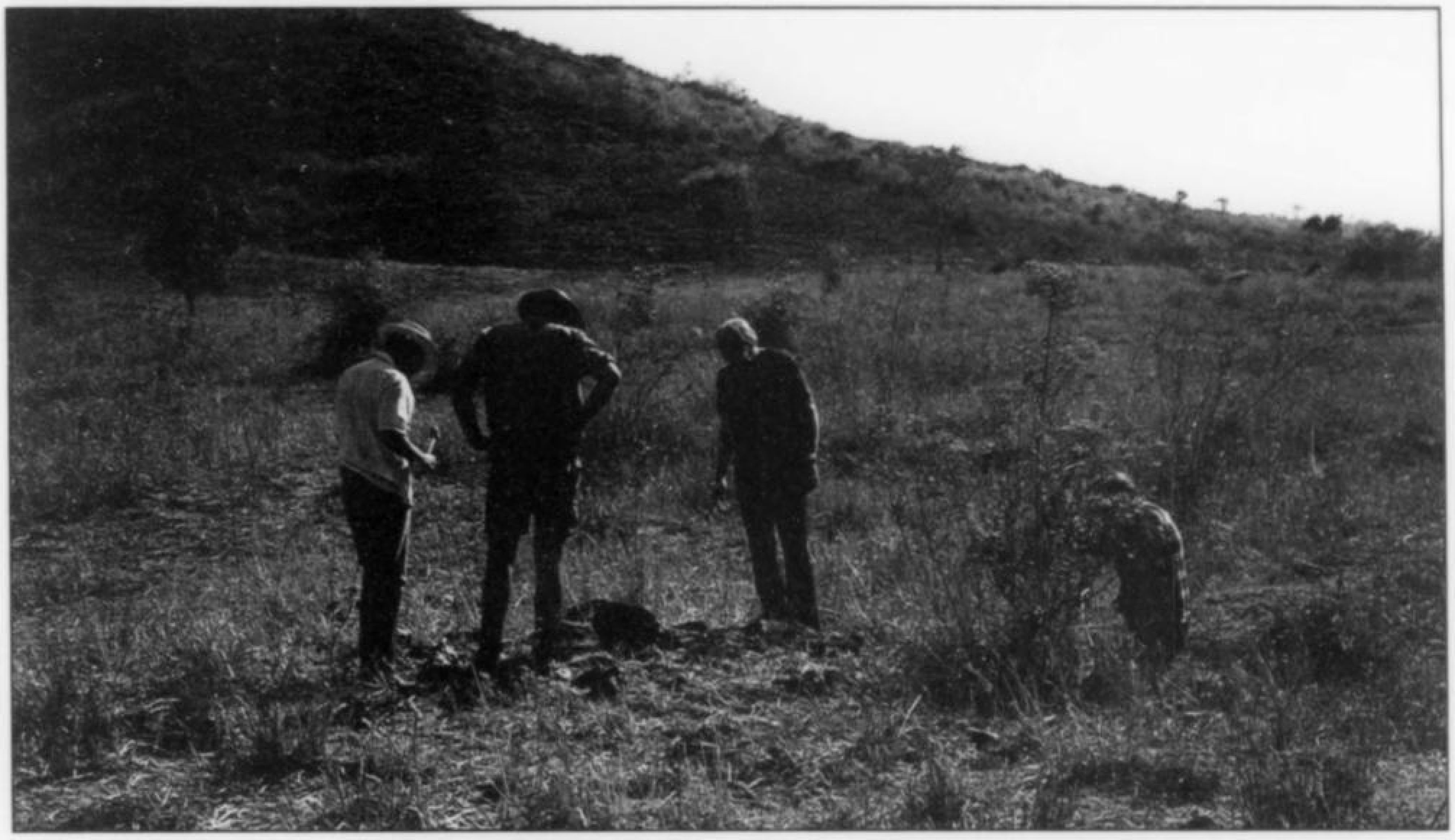


Figure 7. **Phosphate stockpile near the Sapucaia mine, 1973. Photo by Wendell E. Wilson.**

Figure 8. **Collecting phosphates in the flooded area of the pit, 1973. Photo by Wendell E. Wilson.**

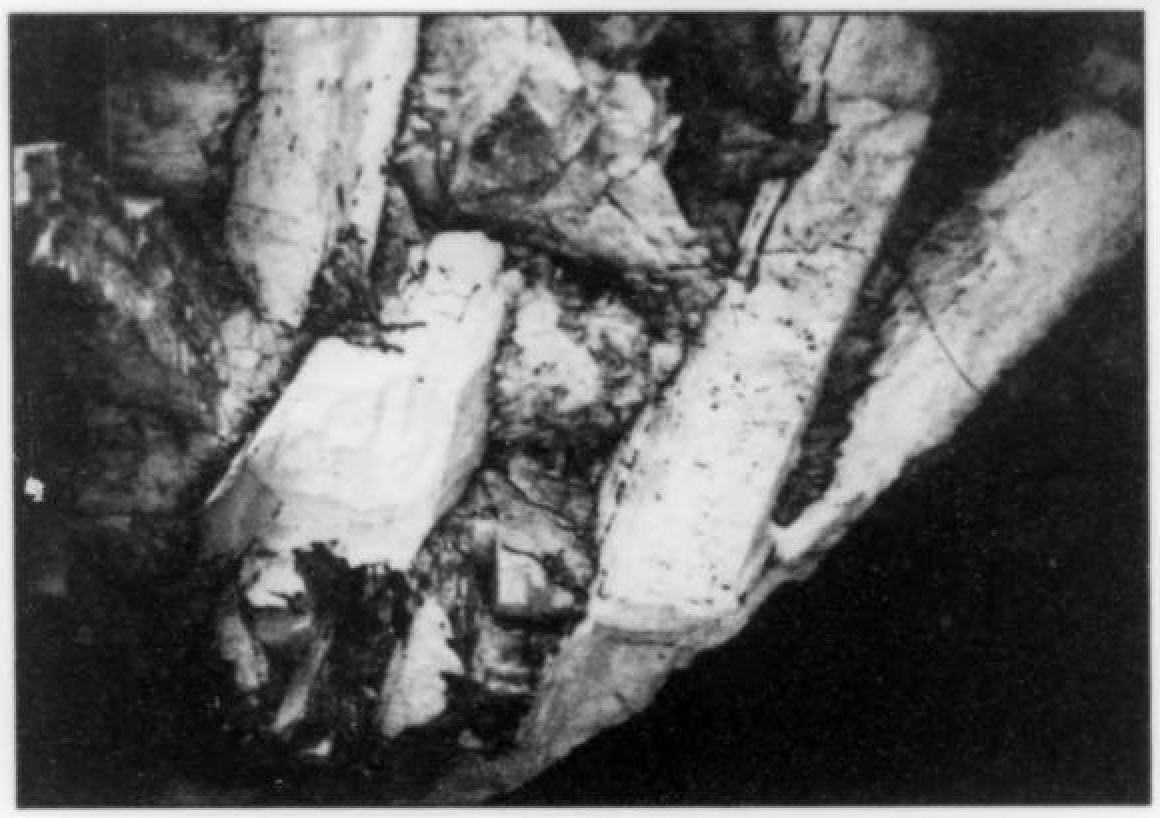


Figure 9. **Spodumene laths in an old adit caved in front of the access trench (1975). The largest lath is 1.8 meters in length.**

MINERALOGY

Principal Assemblages

A detailed study of the phosphate mineral associations present in hundreds of specimens has revealed three principal assemblages (determined in part by Lindberg and Pecora, 1958, and completed here):

Triphylite assemblage

The triphylite assemblage occurs as fracture fillings and replacements in massive triphylite. Vein deposition of montebrasite, pyrite, quartz, sphalerite, tourmaline and zircon coexists with replacements of triphylite (usually along cleavages) by heterosite, barbosalite, frondelite, jahnsite, phosphosiderite, rockbridgeite, tavorite and manganese oxides.

Frondelite assemblage

The frondelite assemblage consists of residual heterosite,

***Table 1.* Chemical analyses of selected phosphate minerals from the Sapucaia mine.**

	Arrojadite	*Barbosalite*	*Cyrilovite*	*Faheyite*	*Frondelite*	*Hureaulite*	*Johnsomervilleite*	*Leucophosphite*	*Lipscombite*	*Montebrasite*	*Moraesite*	*Roscherite*	*Tavorite*	*Triphylite*	*Triphylite*
Al_2O_3	2.23	—	1.36	0.10	1.31	—	—	0.25	—	35.50	none	—	—	—	—
BaO	1.5	—	—	—	—	—	—	—	—	—	—	—	—	—	—
BeO	—	—	—	7.26	—	—	—	—	—	—	25.28	12.58	—	—	—
CaO	2.57	—	0.10	—	0.002	—	11.24	—	—	—	—	7.60	—	—	9.52
FeO	17.6	13.10	none	none	none	18.02	16.52	none	3.75	—	—	6.26	2.39	29.58	26.94
Fe_2O_3	1.7	41.65	47.87	21.42	48.85	—	5.23	41.02	50.45	0.28	0.11	13.36	42.57	—	—
K_2O	0.58	—	0.63	trace	0.12	—	—	10.93	—	—	—	—	—	—	—
Li_2O	0.70	—	—	—	—	—	—	—	—	10.11	—	—	7.64	9.33	—
MgO	6.78	—	—	1.14	0.20	1.73	5.73	—	—	—	—	—	—	1.12	—
MnO	14.6	2.82	0.99	5.99	7.74	27.57	8.53	—	7.91	—	—	10.04	1.47	14.55	10.15
Mn_2O_3	—	—	—	none	1.75	—	—	0.57	—	—	—	—	—	—	—
Na_2O	4.54	—	4.70	0.84	0.98	—	6.11	0.53	—	0.14	—	—	—	0.08	—
PbO	4.42	—	—	—	—	—	—	—	—	—	—	—	—	—	—
SrO	0.34	—	—	—	—	—	—	—	—	—	—	—	—	—	—
U_3O_8	—	—	—	—	—	—	0.15	—	—	—	—	—	—	—	—
ZnO	0.2	—	—	—	—	0.14	—	—	—	—	—	—	—	—	—
F	—	—	—	trace	—	—	none	—	—	—	—	—	—	—	—
H_2O	n.d.	4.93	14.45	14.90	7.52	12.46	1.70	11.20	4.45	5.70	39.80	11.56	6.16	0.20	—
P_2O_5	40.6	37.50	29.06	38.11	31.28	39.37	42.30	34.71	33.37	48.14	34.76	37.60	39.78	45.16	42.83
SiO_2	none	—	—	—	—	—	—	—	—	—	—	—	—	—	—
insol.	—	—	1.4	9.44	0.32	—	2.55	0.45	—	—	0.30	0.80	—	—	0.75
Density	—	3.5-3.6	3.08	2.66	—	3.21	3.35	2.95	3.66	3.01	1.8	2.93	3.28	3.52	—
Total	98.35	100*	100.20	99.20	100.07	99.29	100.06	99.66	99.93	99.87	100.25	99.80	100.01	100.02	**
Ref.	Moore & Ito 1979	Lindb. & Pecora 1955	?	Lindb. & Murata 1953	Lindb. 1949	Lindb. & Pecora 1955	Casse. & Casse. 1985	Lindb. 1957b	Lindb. 1962	?	Lindb. et al. 1953	Lindb. 1958	Lindb. & Pecora 1955	Lindb. & Pecora 1958	Casse. & Casse. unpubl.

* Calculated to 100.
** Partial analysis

montebrasite and triphylite enclosed by frondelite; massive replacement of frondelite by cyrilovite, cryptomelane and leucophosphite; and fracture coatings in frondelite of bermanite, cyrilovite, goethite, leucophosphite, lipscombite, mitridatite, moraesite, opal, phosphosiderite, rockbridgeite, variscite and manganese oxides.

Silicate assemblage

The silicate assemblage consists of altered albite as a host for apatite, hureaulite, goethite, gordonite, leucophosphite, phosphosiderite, rockbridgeite, saleeite, tourmaline and variscite; altered beryl as host for faheyite, moraesite, roscherite and variscite, and muscovite hosting replacements and vug fillings of apatite, bermanite, childrenite, faheyite, frondelite, montebrasite, roscherite and variscite.

Minerals

Arrojadite $KNa_4CaMn_4^{2+}Fe_{10}^{2+}Al(PO_4)_{12}(OH,F)_2$

Arrojadite occurs at Sapucaia as small, bottle-green to yellowish green patches in vivianite-stained triphylite that was common in the beryl-rich zone (worked 1975–1977). For a chemical analysis see Table 1.

Arsenopyrite FeAsS

Arsenopyrite, sometimes in association with pyrite, is common as subhedral crystals to 1 mm in barbosalite.

Augelite $Al_2(PO_4)(OH)_3$

Augelite occurs very rarely as thin veinlets in frondelite, sometimes in association with vivianite.

Autunite $Ca(UO_2)_2(PO_4)_2 \cdot 10\text{–}12H_2O$

Autunite occurs rarely at Sapucaia, as small crystals perched on (or enclosed in) variscite, and as fissure coatings in albite near johnsomervilleite crystal groups.

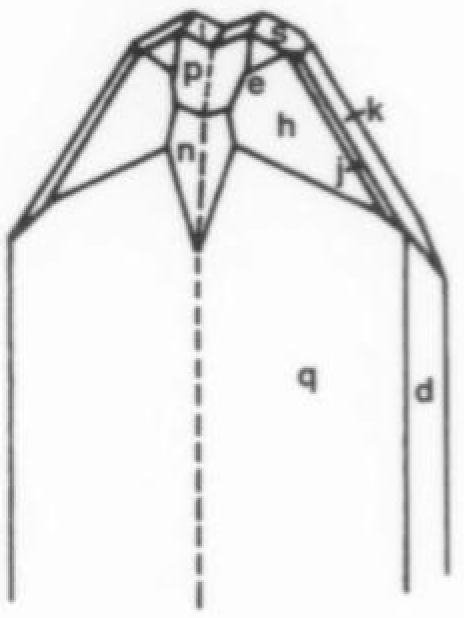


***Figure 10.* Barbosalite crystal drawing of a crystal twinned on (001), Sapucaia (Lindberg-Smith, 1969).**

Barbosalite $Fe^{2+}Fe_2^{3+}(PO_4)_2(OH)_2$

Sapucaia is the type locality for barbosalite, where it occurs mainly as a very fine-grained, dark blue-green layer at the boundary between heterosite and porous triphylite. The contact with heterosite is well-defined, but with the porous triphylite the transition is more gradual, locally extending irregularly or along cleavage cracks into the unaltered triphylite. Tavorite is commonly found mixed with barbosalite. The layer ranges from a few millimeters to about 1 cm in width.

In cavities barbosalite occurs as earthy, massive material surrounding hureaulite crystals, and also as a thin coating of very small crystals on hureaulite crystals. Larger jet-black crystals are also known, usually in twins with both members of the twin equally and symmetrically developed (Lindberg and Christ, 1959; Lindberg-Smith, 1969), and as square crystal aggregate composed of four coplanar crystals meeting at a point, at 90° to each other, with hureaulite crystals in vugs in triphylite. Cavities near heterosite contain the most barbosalite. The contacts between hureaulite and barbosalite are sharp, suggesting little or no reaction or replacement. For a chemical analysis see Table 1.

Berlinite $AlPO_4$

Irregular veinlets of white coarse-grained berlinite occur intersecting frondelite (R. V. Gaines, personal communication). A very few small, white to yellowish white berlinite balls have been found in vugs in altered frondelite.

Bermanite $Mn^{2+}Mn_2^{3+}(PO_4)_2(OH)_2{\cdot}4H_2O$

Bermanite occurs as reddish brown to terra cotta-red crystals and aggregates lining vugs in frondelite and spongy feldspar. Phosphosiderite, strunzite and variscite are in some cases associated. Spectrographic analysis by Lindberg and Pecora (1958) showed that manganese is the major metallic cation, and iron is minor. Oily looking brown bermanite also surrounds and transects johnsomervilite aggregates. Altered bermanite turns yellowish and earthy.

Beryl $Be_3Al_2Si_6O_{18}$

Crude, opaque crystals of industrial-grade beryl to 1 meter in length, and large masses of white to bluish and pale yellowish beryl were mined at Sapucaia during the war years and shortly thereafter. Some additional beryl was recovered during the years 1975–1977. Good, transparent to translucent prisms of yellowish brown to greenish brown beryl 1–10 cm in length and small fragments of aquamarine have also been found, some of them embedded in phosphate minerals. Most beryl crystals at Sapucaia are hydrothermally altered and have multicolumnar terminations.

Biotite $K(Mg,Fe^{2+})_3(Al,Fe^{3+})Si_3O_{10}(OH,F)_2$

Biotite occurs at Sapucaia as laths to 10 cm in the outer zone of the pegmatite body, and as plentiful, narrow, bladed crystals with triphylite.

Cacoxenite $(Fe^{3+},Al)_{25}(PO_4)_{17}O_6(OH)_{12}{\cdot}75H_2O$

Cacoxenite occurs rarely as lustrous, pale yellow, hourglass-shaped acicular bundles a few tenths of a millimeter in length, in vugs in feldspar.

Childrenite $Fe^{2+}Al(PO_4)(OH)_2{\cdot}H_2O$

Childrenite occurs at Sapucaia as pale honey-colored crystals associated with roscherite in pockets in muscovite, and with phosphosiderite and variscite in albite made vesicular as a result of triphylite leaching. The indices of refraction suggest that Sapucaia childrenite is of near end-member composition in the childrenite-eosphorite series (Lindberg and Pecora, 1958). In some specimens cyrilovite crystals occur perched on childrenite bearing a thin limonite film.

Clays

Brownish colored clays (mineral species undetermined) admixed with iron hydroxides occur commonly at Sapucaia as crusts (banded and unbanded) in frondelite vugs and in cavities in gossan boulders.

Cryptomelane $K(Mn^{+4},Mn^{2+})_8O_{16}$

Cryptomelane occurs as black patches and fine dendrites among the phosphate minerals, feldspars and quartz. It is also found as mammillary crusts, blebs and small stalactites in vugs in frondelite and in gossan boulders. Good, large coralloid growths, and minute spheroids occur, the spheroids perched on variscite and jahnsite crystals.

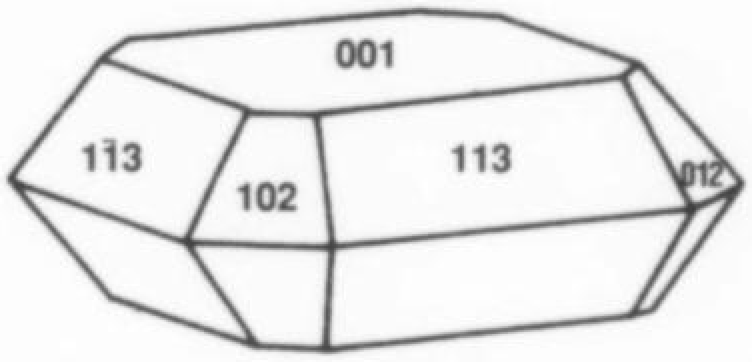


Figure 11. **Cyrilovite crystal drawing, Sapucaia (Lindberg, 1957).**

Cyrilovite $NaFe_3^{3+}(PO_4)_2(OH)_4{\cdot}2H_2O$

A Sapucaia mineral at first thought to be a new species was described and named *avelinoite* by Lindberg and Pecora (1954b) but was later found to be identical with cyrilovite (Strunz, 1956; Lindberg, 1957a). It forms crystal aggregates and coatings that range in color from bright yellow to pale yellow, greenish yellow, yellow-orange, brownish yellow and honey-yellow. In the altered zone surrounding frondelite it occurs associated with phosphosiderite, jahnsite and leucophosphite. In some cases cyrilovite coats variscite crystals or occurs in association with saleeite blades in spongy feldspar. Individual crystals vary in size but are usually under 0.1 mm; many are intergrown. The crystals are squat and tend to lie on the basal pinacoid. Dominant forms include {001}, {113} and {012} (Lindberg and Pecora, 1954b; Lindberg, 1957a). For a chemical analysis see Table 1. Some crystals are Pb-rich, as revealed by recent semi-quantitative X-ray fluorescence analysis. Cyrilovite becomes earthy and pale yellow upon alteration.

Dufrenite $Ca_{0.5}Fe_6(PO_4)_4(OH)_6{\cdot}2H_2O$

Hirson (1965) reported the presence of dufrenite in association with heterosite as an alteration product of triphylite but gave no further description.

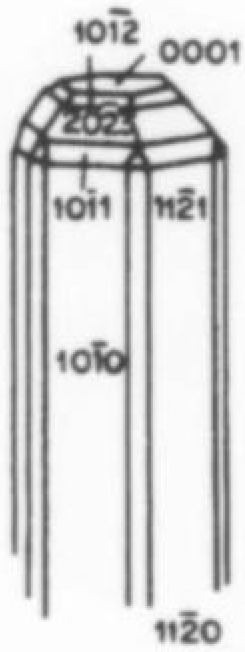


Figure 12. **Faheyite crystal drawing, Sapucaia (Lindberg and Murata, 1953).**

Faheyite $(Mn^{2+},Mg)Fe_2^{3+}Be_2(PO_4)_4{\cdot}6H_2O$

Sapucaia is the type locality for faheyite (Lindberg and Murata, 1953), where it occurs as matted and radiating groups and masses of acicular, white to bluish white and brownish white fibers coating

Figure 13. Typical suite of secondary phosphate minerals derived from the alteration of triphylite. From bottom to top: heterosite (dark purple), tavorite (yellowish), barbosalite (dark green) and hureaulite (flesh colored). The sample is 14.5 cm across.

Figure 14. A translucent, yellowish green beryl crystal recovered prior to 1968. The specimen is 9.5 in length.

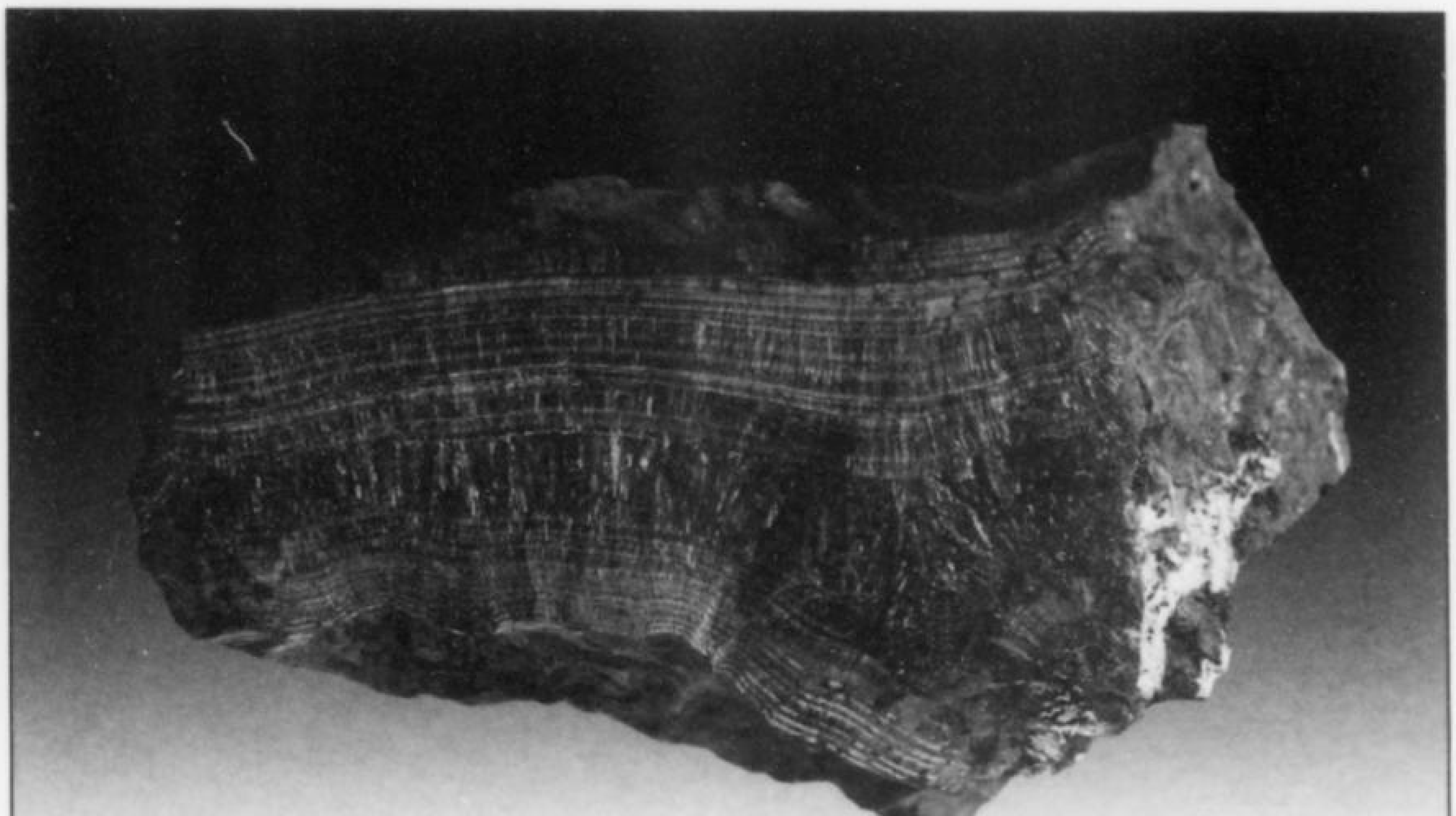


Figure 15. Typical banded acicular frondelite specimen, 19.5 across.

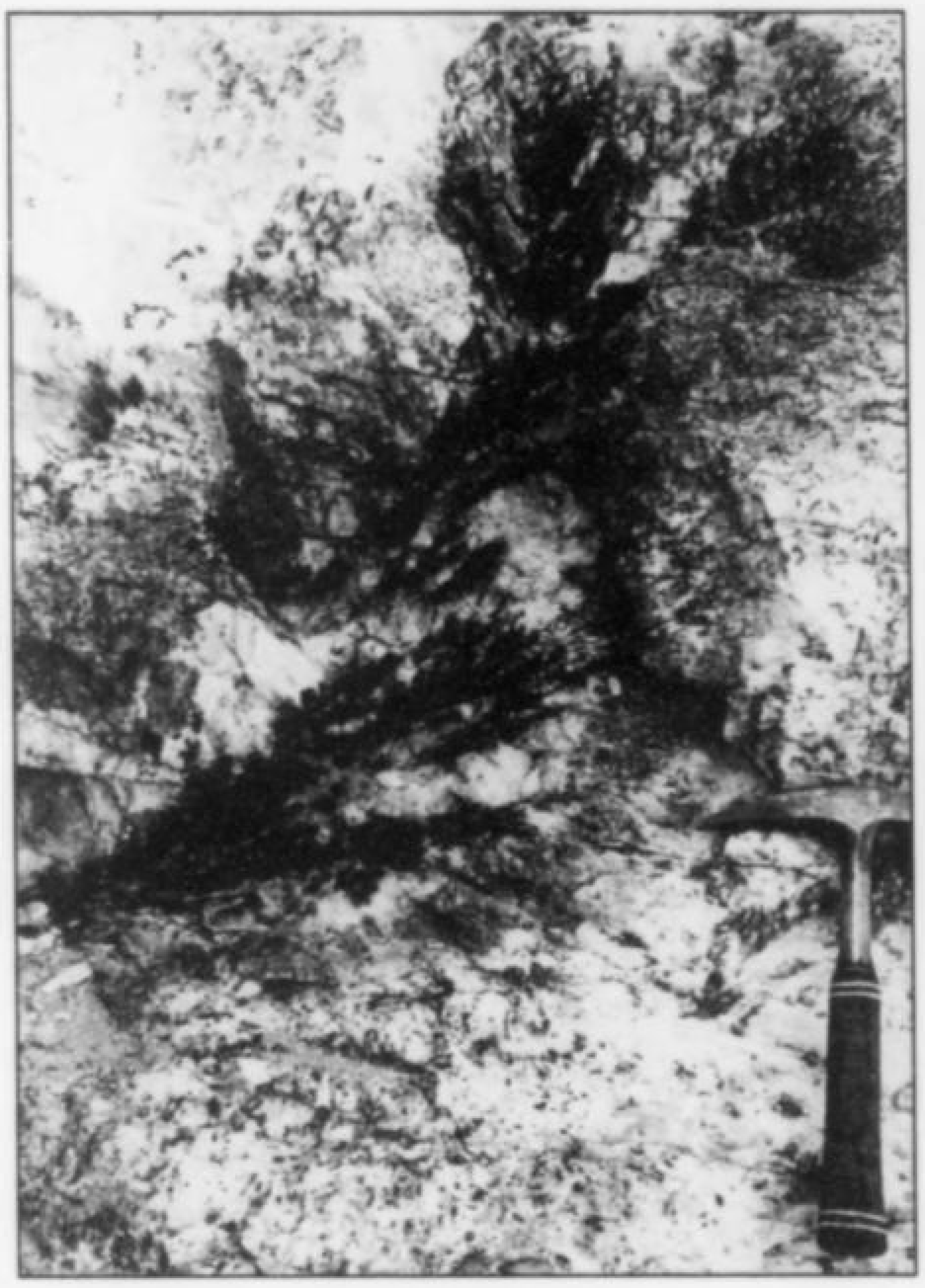


Figure 16. Coralloid johnsomervilleite in place in the western side of the open pit (1977).

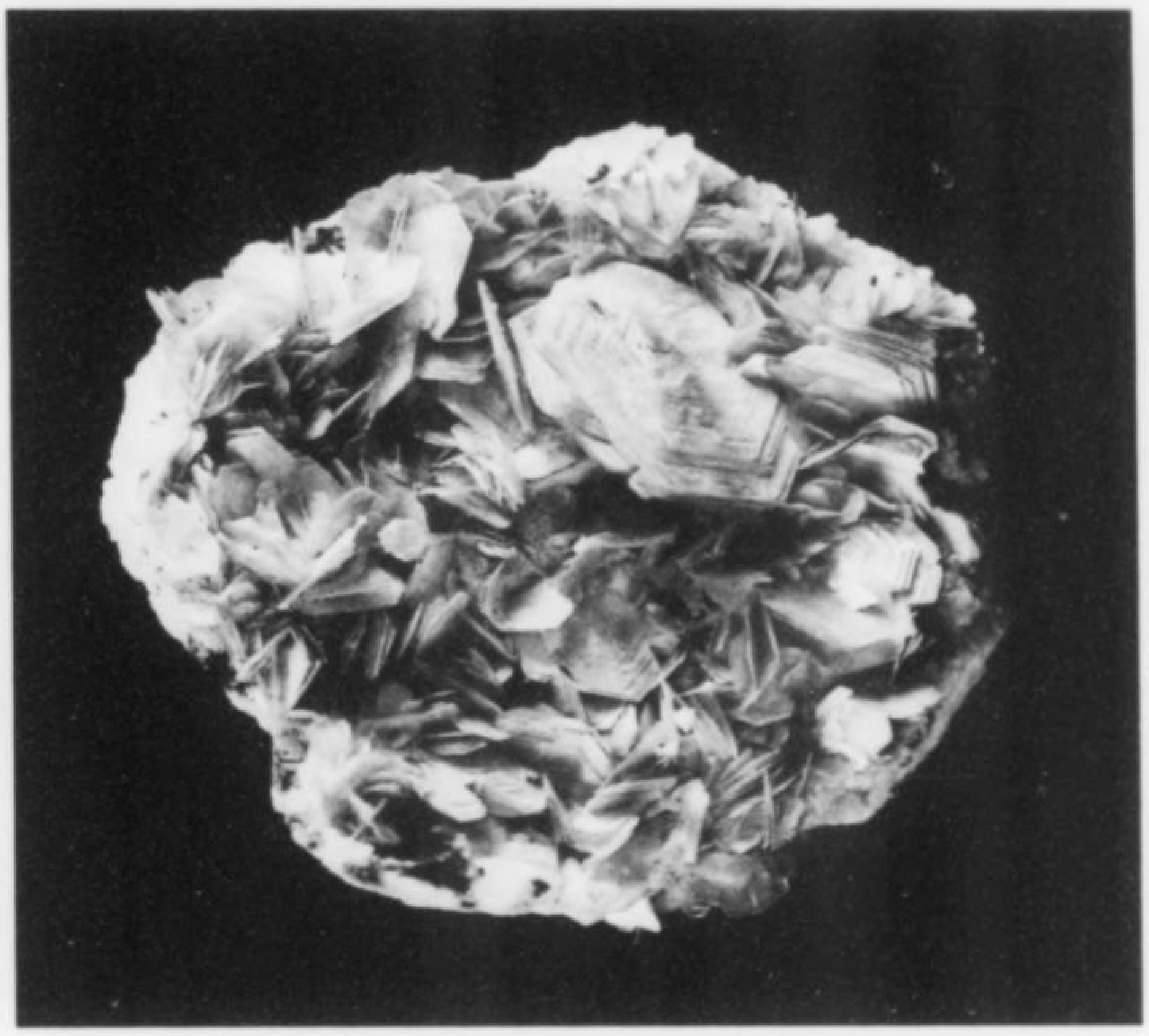


Figure 17. Small muscovite crystal group from a vug. The sample is 6.5 cm wide.

Figure 18. Group of heterosite crystals, pseudomorph after triphylite. The sample is 23 in height and was collected during 1987 in the creek west of the mine.

Figure 20. Phosphosiderite (blue) on weathered triphylite; the sample is 7.5 cm wide.

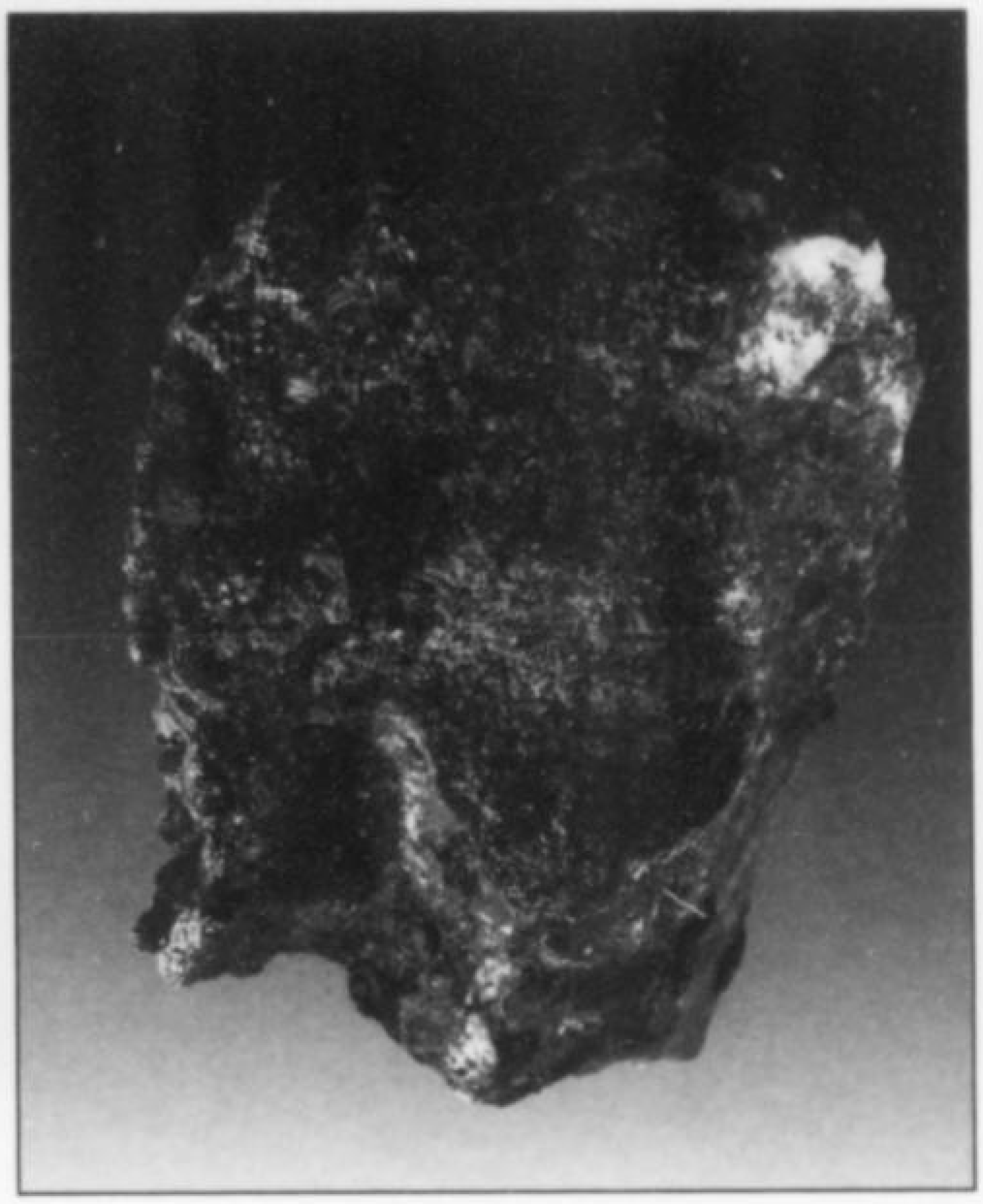


Figure 19. Hureaulite crystals in vuggy, highly altered triphylite. The sample is 7 cm across.

roscherite, frondelite, variscite and quartz (Lindberg and Pecora, 1958). It has also been found as tufted fibers in pockets in muscovite. Botryoidal masses of fibrous faheyite completely enclose euhedral quartz crystals and cover the surfaces of muscovite sheets. Flat rosettes of fibers occur between sheets of muscovite. Tufts of fibers have been found on crystals of variscite and on botryoidal frondelite or between frondelite layers. Individual faheyite fibers average about 0.08 mm in length and 0.01 mm in diameter. They grow perpendicular to the surface of host minerals and, under strong magnification, show pyramidal termination faces (Lindberg, 1964). For a chemical analysis see Table 1.

Feldspars

Giant pink perthite crystals occur in the core zone, but virtually none are of collector quality. White blades of *cleavelandite* albite line some vugs in the southwestern part of the pegmatite body. Near phosphates, pale olive-green and brown-stained feldspar, associated with quartz and/or variscite, occur as irregular veinlets cutting large heterosite and frondelite blocks. Large spongy masses of feldspar that remained following triphylite leaching provided the best sites for the crystallization of good secondary phosphates.

Ferrisicklerite $Li(Fe^{3+},Mn^{2+})PO_4$

Compact to micaceous masses of ferrisicklerite form irregular replacements of heterosite along fissures. The brown streak and lack of cleavage are characteristic.

Fluorapatite $Ca_5(PO_4)_3F$

Pale greenish blue fluorapatite crystals occur at Sapucaia in association with saleeite in vugs, and scattered on albite. A spectrographic analysis (Lindberg and Pecora, 1958) shows 1 to 5% manganese. Small, white crystals of fluorapatite occur with roscherite and also in quartz-variscite-monterasite veins cutting muscovite. Yellowish bottle-green apatite patches up to several centimeters in size have been found scattered in the blue vivianite-stained triphylite.

Frondelite $Mn^{2+}Fe_4^{3+}(PO_4)_3(OH)_5$

Sapucaia is the type locality for frondelite (Lindberg, 1949), where it occurs mainly in large, brown, botryoidal, banded or drusy, radially fibrous masses up to 30 kg in weight. These masses form the substrate or matrix for many other phosphate species, either as cavity linings or layered vein fillings. The individual acicular crystal domains, either evenly colored or color-zoned along the axis of elongation, reach 8 cm in length. Color varies from ochre-yellow to red-brown, orange and greenish brown. Small sprays of limonite-stained needles associated with tavorite have been found in cavities in albite; and minute, lustrous, doubly terminated crystals have been found in association with crystals of cyrilovite, phosphosiderite and leucophosphite in vugs in large, fibrous-botryoidal frondelite masses. Crystal forms include {100}, {010}, {110} and {101} (Lindberg, 1960). For a chemical analysis see Table 1.

The first stage of frondelite alteration is a partial replacement by mitridatite. The end product is a spongy, vuggy or earthy limonite mass or "gossan."

In addition to the brown frondelite described above (MnO 7.74; FeO none; Fe_2O_3 48.85 weight %), a dull green frondelite (MnO 5.54; FeO 7.70; Fe_2O_3 41.93 weight %) also occurs at Sapucaia in fibrous masses and thin plates between muscovite sheets.

Goethite $Fe^{3+}O(OH)$

Mammillary goethite is found in the gossan material as brown, radially fibrous masses alternating with thin, earthy bands.

Gordonite $MgAl_2(PO_4)_2(OH)_2 \cdot 8H_2O$

Gordonite occurs in colorless vitreous crystals, usually tabular, in some cases diamond-shaped, and as crusts with leucophosphite, saleeite and fluorapatite in albite vugs. Gordonite has also been found in buff-colored crystals associated with variscite and phosphosiderite. Refractive indices and spectrographic data suggest that ferric iron substitutes for some of the aluminum in the formula (Lindberg and Pecora, 1958).

Gummite secondary uranium oxides

Very thin, pale yellow to orange patches (to 1 cm) of undifferentiated uranium oxides occur locally in feldspar fissures.

Heterosite $Fe^{3+}PO_4$

Heterosite occurs at Sapucaia as a brownish crust and as massive crystalline blocks to 30 kg in weight. The blocks show a good cleavage and a purple color when broken. Compositionally it is close to end-member composition in the series with purpurite, containing 33.98% Fe_2O_3 and only 9.79 weight % MnO_2+Mn_2O_3 (Lindberg and Pecora, 1958).

Heterosite is found associated with triphylite, from which it altered by oxidation of iron and manganese. Lithium leached into the local environment probably leads to the formation of tavorite. Black, dense seams cutting heterosite have been found to contain ferrisicklerite, lithiophorite, cryptomelane, γMnO_2 and perhaps other intimately intergrown manganese oxides with veinlets of quartz and/or variscite.

Good heterosite crystals to more than 10 cm and heterosite crystal groups (pseudomorphs after triphylite) have occasionally been collected in the creek west of the mine.

Hureaulite $Mn_5^{2+}(PO_4)_2[PO_3(OH)]_2 \cdot 4H_2O$

Hureaulite occurs as transparent to translucent, colorless to salmon-pink crystals in vugs in altered triphylite blocks with unoxidized green frondelite. Single crystals have also been found in vugs in feldspar. In triphylite, the hureaulite often forms prolate nodules having a spongy or reticulated texture, the cavities having been lined with microcrystal crusts of amblygonite, barbosalite, rockbridgeite, tavorite and vivianite. The single crystals of hureaulite, up to several millimeters in size, vary from equant to elongated and are sometimes doubly terminated. Minute opaque inclusions produce a mottled aspect. Clusters of such crystals are also known. Weathering causes a color change to pale yellow and then to earthy orange. For a chemical analysis see Table 1.

Hydroxylherderite $CaBe(PO_4)(OH)$

Svizero (1976) reported pale greenish yellow "herderite" (= hydroxylherderite) crystals and complex twins to several millimeters in size. Dominant forms are {110}, {012}, {102}, {123}, {100} and {010}.

Jahnsite-(CaMnFe) $CaMn^{2+}Fe_2^{2+}Fe_2^{3+}(PO_4)_4(OH)_2 \cdot 8H_2O$

Jahnsite is somewhat common at Sapucaia, occurring as tiny, flattened, elongated, waxy yellow crystals in frondelite cavities, and as small rosettes in feldspar vugs. The crystals are striated parallel to the axis of elongation. Associated species include bermanite, hureaulite, frondelite and strunzite. Jahnsite also partially replaces johnsomervilleite to form an irregular, earthy yellow rim.

Johnsomervilleite $Na_2Ca(Mg,Fe^{2+},Mn)_7(PO_4)_6$

Johnsomervilleite is abundant at Sapucaia, as coralloid growths to several tens of centimeters in size, in pink feldspar and albite. It also forms arborescent, parallel columns of spheroids 1–2 cm in diameter. The johnsomervilleite groups form the outermost zone around other early phosphates, and are typically surrounded by an iron hydroxide halo. Myrmekitic intergrowths of johnsomervilleite with quartz and feldspar are associated with cyrilovite, jahnsite and phosphosiderite. Johnsomervilleite is dark gray to pitch-black, with a conchoidal to splintery fracture and no cleavage. Thermoluminescent but non-fluorescent, the mineral is easily soluble in acids. Sapucaia johnsomervilleite is Ca-rich and partially oxidized (see Table 1) (Cassedanne and Cassedanne, 1985; Livingston, 1980).

Kaolinite $Al_2Si_2O_5(OH)_4$

Kaolinite is abundant as a chalky, pale yellowish white alteration product of feldspars, forming botryoidal crusts lining feldspar vugs.

Kidwellite (?) $NaFe_9^{3+}(PO_4)_6(OH)_{10}\cdot 5H_2O$

Moore and Ito (1978b) report a silky white mineral replacing rockbridgeite at Sapucaia which gives a powder diffraction pattern closely resembling the pattern of kidwellite (except for some relative intensities and a line at 13.89 Å).

Laueite $Mn^{2+}Fe_2^{3+}(PO_4)_2(OH)_2\cdot 8H_2O$

Laueite occurs at Sapucaia as very pale yellow crusts, minute needles and small, distorted crystals associated with phosphosiderite and hureaulite in vugs in altered frondelite.

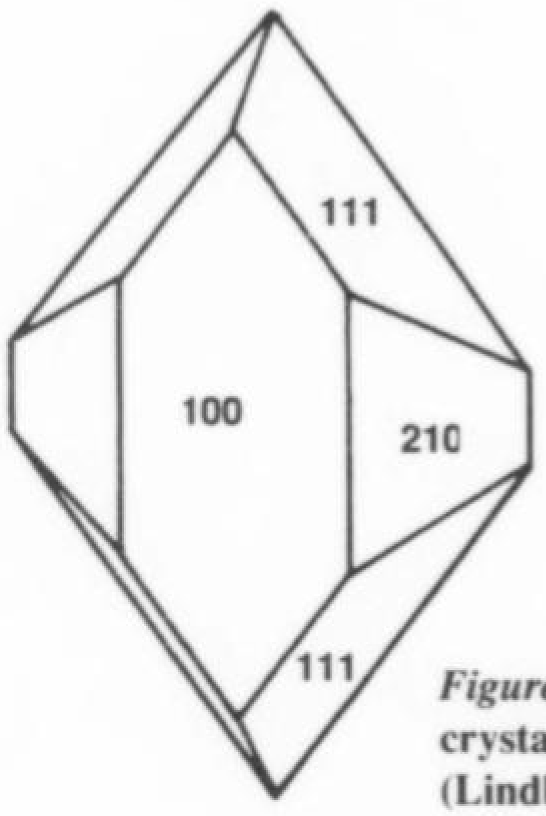


Figure 21. **Leucophosphite crystal drawing, Sapucaia (Lindberg, 1957).**

Leucophosphite $KFe_2^{3+}(PO_4)_2(OH)\cdot 2H_2O$

Aluminum-bearing leucophosphite occurs at Sapucaia as pink spherules, thin crusts and flat, fan-shaped aggregates of radiating crystals. Locally these crystals are intergrown with saleeite. Crystals are found in albite vugs and perched on dark-colored secondary phosphate minerals and frondelite.

Leucophosphite lacking aluminum occurs sparingly as minute, doubly terminated, buff-colored, diamond-shaped plates and rosettes in close association with cyrilovite, phosphosiderite and manganese oxides lining vugs in frondelite. The frondelite is usually partially altered, the masses of fibers forming a loose network coated with crusts of interstitial cyrilovite and minor leucophosphite. The leucophosphite crystals frequently contain a few radiating fibers of residual frondelite. For a chemical analysis see Table 1.

Leucophosphite from Sapucaia was the first known inorganic occurrence of the mineral (the earlier recognized occurrences being derived from bird and bat guano) and the first known natural source of well-defined crystals.

Limonite undifferentiated hydrous iron oxides

Hard, earthy yellow ochre with a variable amount of admixed impurities is common in vugs in weathered minerals, mainly in frondelite. Limonite also replaces or coats frondelite fibers.

Lipscombite $(Fe^{2+},Mn)Fe_2^{3+}(PO_4)_2(OH)_2$

Sapucaia is the type locality for lipscombite, where it occurs as black to olive-green, fine-grained masses and crystal aggregates of high luster, intimately intergrown with cyrilovite and phosphosiderite in frondelite vugs. The deep greenish blue-black color renders even small fragments opaque. The analysis by Lindberg (1962) shows significant substitution of divalent manganese for divalent iron (see Table 1). Lipscombite is apparently limited at Sapucaia to an alkali-altered oxidized zone in frondelite containing cyrilovite. Barbosalite, which is structurally related to lipscombite, is apparently restricted at Sapucaia to triphylite and heterosite assemblages.

Litihiophorite $(Al,Li)Mn^{+4}O_2(OH)_2$

Lithiophorite in attractive specimens is rare at Sapucaia, occurring as display-quality coralloid growths in vugs in altered phosphates, mainly triphylite. However, lithiophorite is fairly common as an admixture with other manganese oxides in seams cutting heterosite.

Löllingite $FeAs_2$

Löllingite occurs at Sapucaia as bladed crystals to several centimeters in length, sometimes in parallel growth, in albite.

Magnetite $Fe^{2+}Fe_2^{3+}O_4$

Magnetite occurs as small, rare blebs perched on tavorite in vugs in albite.

Mitridatite $Ca_6(H_2O)_6[Fe_9^{3+}O_6(PO_4)_9]\cdot 3H_2O$

Mitridatite occurs at Sapucaia as mamillary to spongy crusts of coalescent globules that are composed of small, soft, bright needles or earthy masses. The color ranges from olive-green to dull dark green, in some cases with a yellowish hue. It is found coating weathered heterosite or frondelite (which it replaces locally) and in feldspar vugs.

Monazite-(Ce) $(Ce,La,Nd,Th)PO_4$

Monazite-(Ce) occurs as small, rounded honey-yellow to orange crystals a few millimeters in size, in feldspar.

Montebrasite $LiAl(PO_4)(OH,F)$

Massive white or translucent intergrowths of quartz and montebrasite form veinlets in triphylite, heterosite, frondelite muscovite and albite. Large crystals of montebrasite show well-formed faces or sawtooth edges indicative of some resorption. For a chemical analysis see Table 1.

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

Montmorillonite clay occurs as earthy white masses replacing spodumene and cut by thin, bright veinlets of sericite.

Moraesite $Be_2(PO_4)(OH)\cdot 4H_2O$

Sapucaia is the type locality for moraesite (Lindberg *et al.*, 1953), where it occurs as tufted or radial aggregates forming fibrous coatings and spherulitic masses. The individual acicular crystals are pale rose to colorless and milky to transparent, forming on the walls of vugs in or near beryl, and on the surface of albite, quartz and muscovite. Moraesite occurs commonly on botryoidal frondelite, and may include unaltered fragments of beryl. On free surfaces, crystals of moraesite form a fragile and delicate assortment of needles grading into velvety crusts with a coarse fibrous structure. The crystals are minute, singly terminated, acicular laths

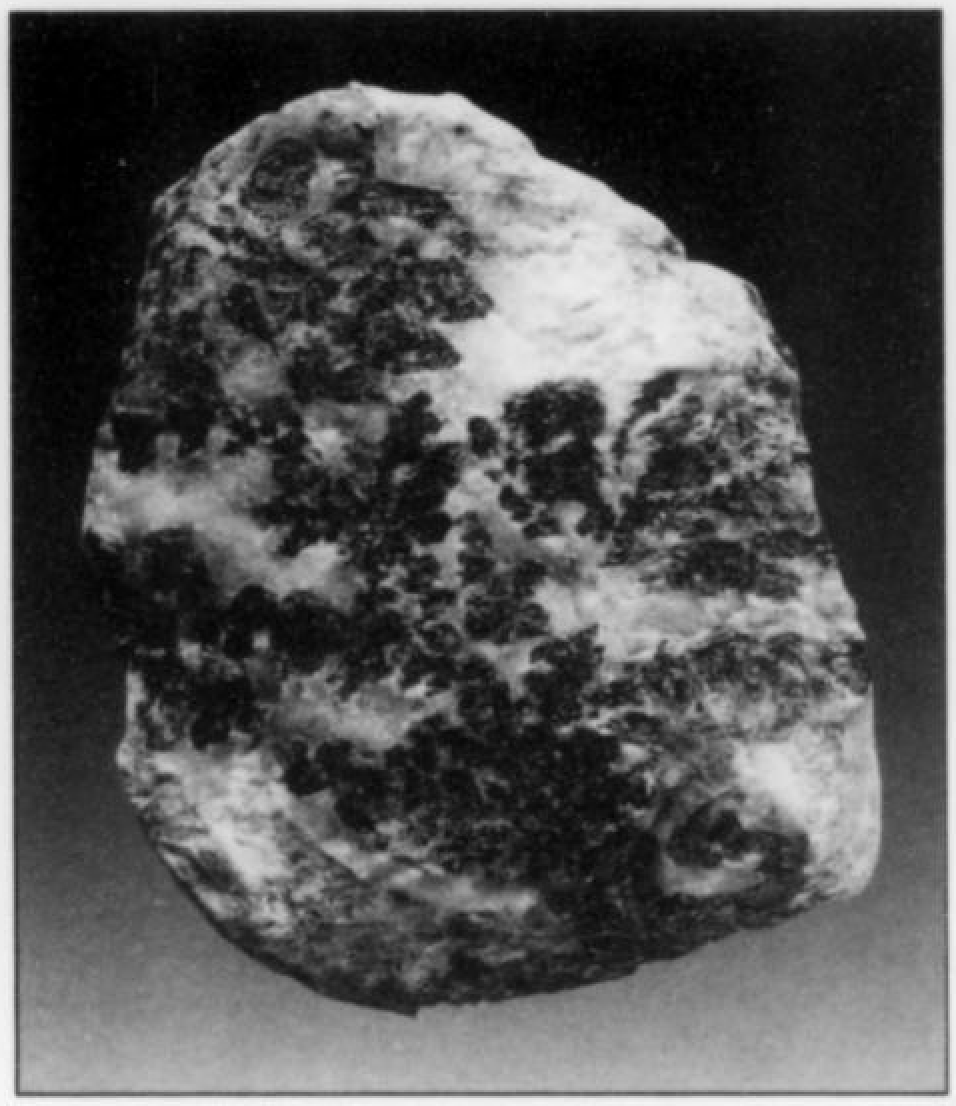


Figure 22. **Coralloid triphylite in feldspar, 9 cm in length.**

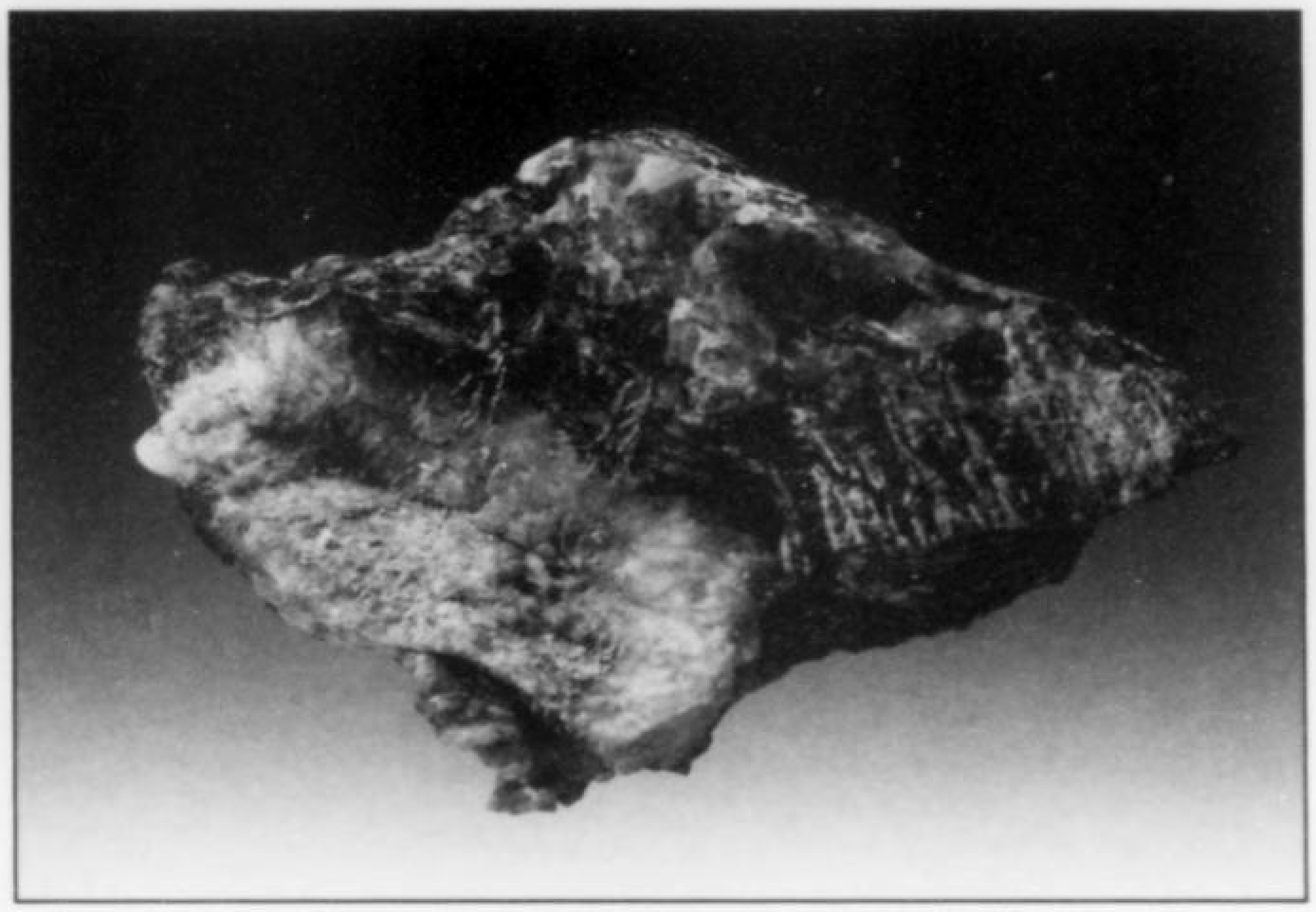


Figure 23. **A good specimen of rutherfordine collected during 1986; 8 cm in length.**

Figure 24. **Fine, large moraesite specimen, 7.5 cm across.**

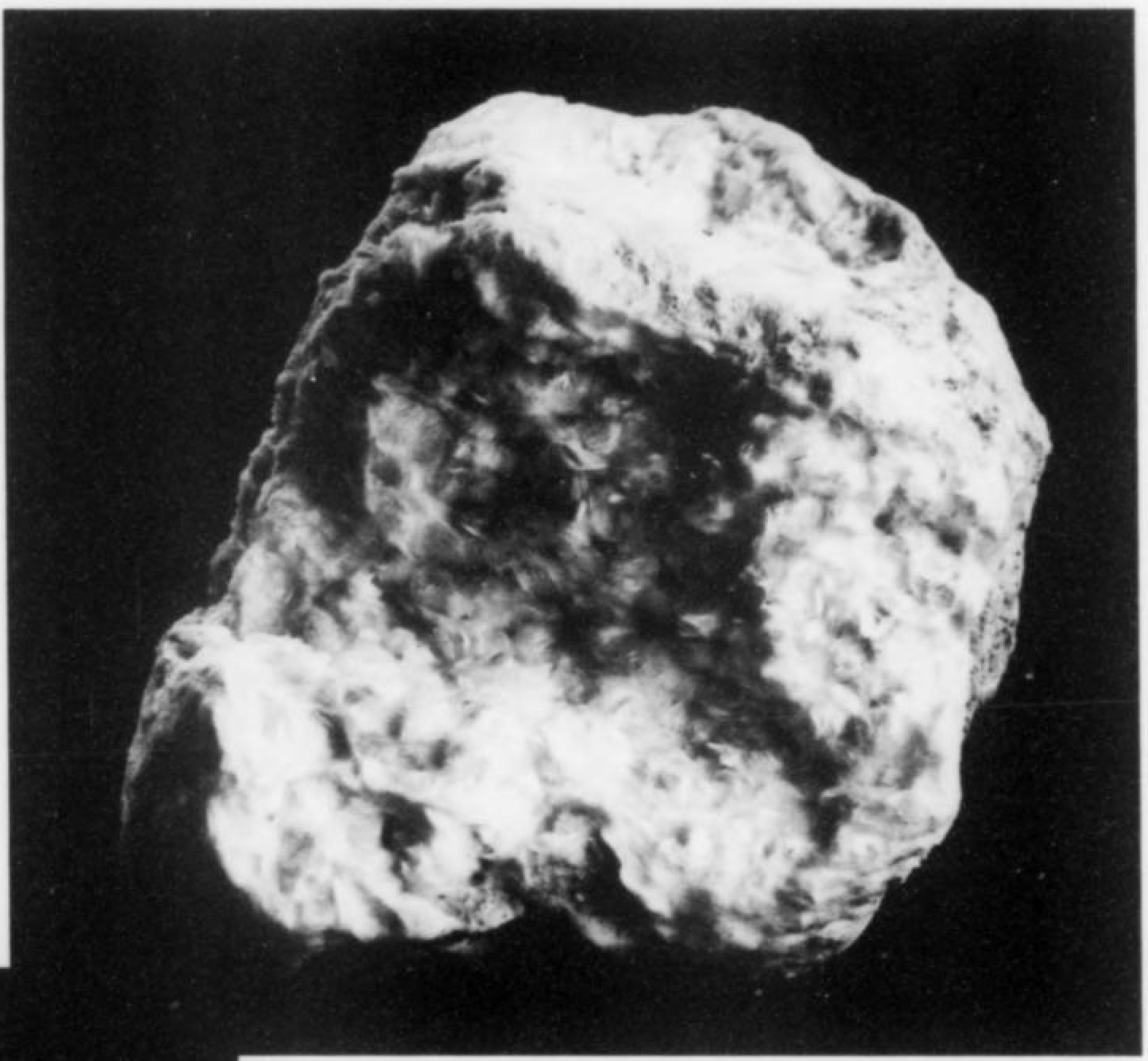
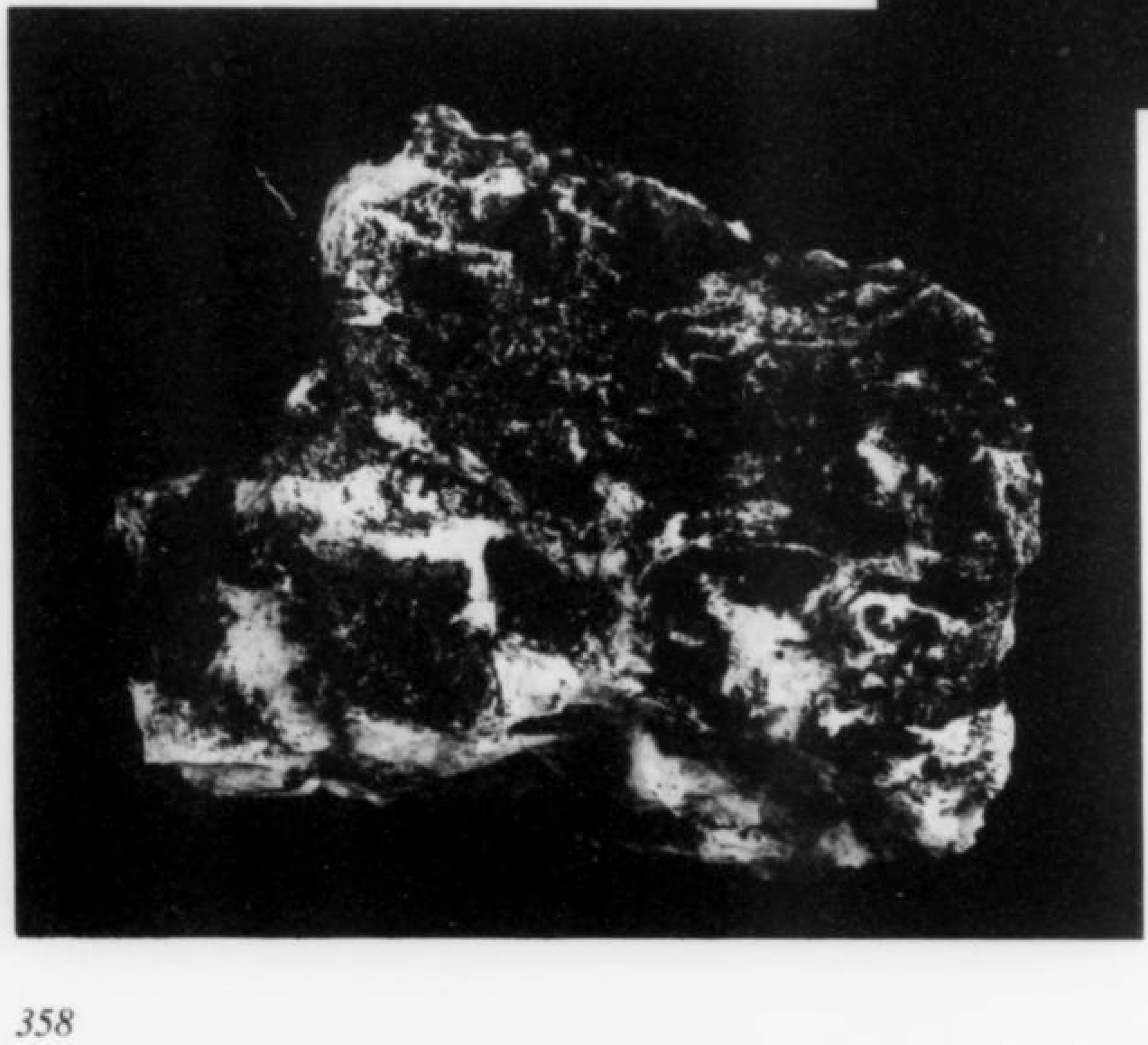


Figure 25. **Manganoan variscite (red) on vuggy feldspar. The specimen is 6.5 cm in width.**



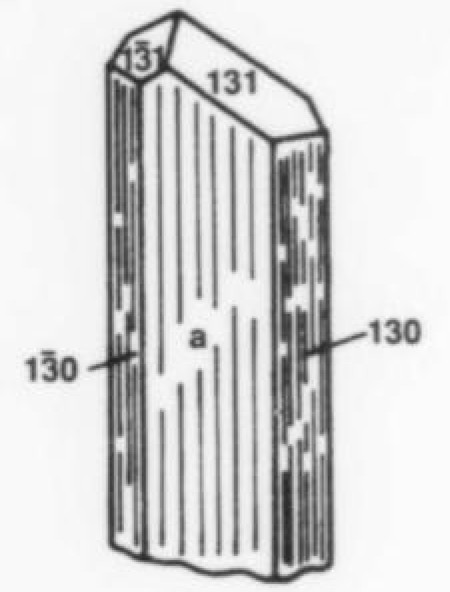


Figure 26. **Moraesite crystal drawing, Sapucaia (Lindberg *et al.*, 1953).**

elongated parallel to the *c* axis and tabular parallel to the orthopinacoid (100). Forms present include {100} and {130}, with equivalent pyramid faces {131} and $\{1\bar{3}1\}$ unequally developed. Some samples have a pale brown coating of iron oxides. For a chemical analysis see Table 1.

Muscovite $KAl_2(Si_3Al)O_{10}(OH,F)_2$

Well-formed groups of small, pale, water-green muscovite occur in vugs in albite. Most muscovite at Sapucaia, however, is pale grey in color, frequently fish-tail twinned, forming large sheets and books to several tens of centimeters in size. Fine, silky-bright sericite, delicately banded by iron oxides, occurs in veins cutting milky quartz northeast of the pegmatite core.

Nontronite $Na_{0.3}Fe^{3+}_2(Si,Al)_4O_{10}(OH)_2 \cdot nH_2O$

Nontronite occurs as irregular spots or patches associated with biotite and schorl.

Opal $SiO_2 \cdot nH_2O$

Hyaline opal occurs as attractive, thin crusts in frondelite cavities and as a coating on some crystals of phosphosiderite.

Phosphosiderite $Fe^{3+}PO_4 \cdot 2H_2O$

Stubby, buff-colored crystals and lavender blades of phosphosiderite occur in frondelite vugs and as lavender encrustations on frondelite, heterosite, hureaulite and vuggy albite. Phosphosiderite, jahnsite, rockbridgeite, strengite, variscite, iron oxides and skeletal quartz form a closely knit assemblage. The composition of Sapucaia phosphosiderite (as indicated by indices of refraction) is somewhat variable but is always high in iron (Lindberg and Pecora, 1958). Phosphosiderite also occurs as thin veinlets following cleavage directions in lightly altered heterosite.

Phosphuranylite $Ca(UO_2)_3(PO_4)_2(OH)_2 \cdot 6H_2O$

Svizero (1976) reported the presence of phosphuranylite at Sapucaia but gave no description.

Pyrite FeS_2

Pyrite occurs in veinlets and scattered anhedral crystals and crystal aggregates surrounding euhedral quartz in triphylite. Crystals with striated faces are found with barbosalite in the alteration layers around triphylite masses. Minute pyrite crystals, sometimes in dendritic groups, have been found perched on hureaulite in albite vugs.

Quartz SiO_2

Quartz is common at Sapucaia, as the principal constituent of the massive quartz core of the pegmatite, and also as fine crystals. Singly and doubly terminated crystals of colorless to pale smoky quartz more than 10 cm in size have been found in vugs, sometimes with muscovite and frequently in close association with *cleavelandite* albite. Veinlets of milky to transparent quartz cut phosphates, especially triphylite, frondelite and heterosite. Pale gray to white mammillary crusts and small stalactites of chalcedony are found in frondelite vugs and gossan boulders.

Rockbridgeite $(Fe^{2+},Mn^{2+})Fe^{3+}_4(PO_4)_3(OH)_5$

Rockbridgeite occurs at Sapucaia as dark green botryoidal crusts, small clusters and sprays composed of radial fibers in albite vugs and in cavities in weathered frondelite. Dull green acicular crystals of rockbridgeite represent a later generation of formation. Hureaulite crystals sometimes occur perched on rockbridgeite.

Roscherite $Ca(Mn^{2+},Fe^{2+})_2Be_3(PO_4)_3(OH)_3$

Roscherite occurs disseminated in the smaller interstices between muscovite books, as individual brown to reddish brown prismatic crystals to 1 mm, as crystal aggregates and as fine-grained sericite-like powdery masses. It is closely associated with frondelite, variscite and tufts of faheyite. In larger vugs roscherite forms a structureless groundmass enclosing euhedral quartz crystals. Locally, open spaces in such vugs may be lined with a fibrous layer of frondelite. Roscherite has also been found sparsely admixed with frondelite, in association with multicolored beryl (as brown staining in the cleavage planes and as surrounding granular crusts). Crystal forms include {100}, {010}, {111}, $\{\bar{1}11\}$, {102}, {201}, {101}, $\{20\bar{1}\}$ and {301}. For a chemical analysis see Table 1.

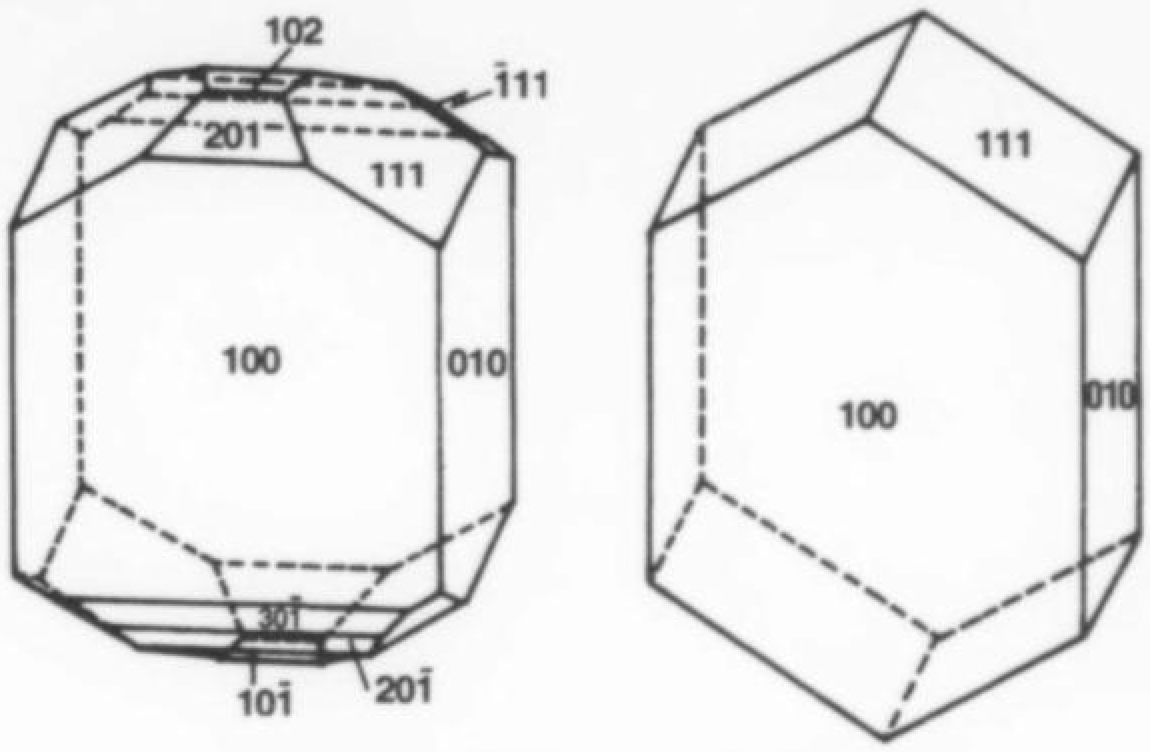


Figure 27. **Roscherite crystal drawings, Sapucaia (Lindberg, 1958).**

Rutherfordine $UO_2(CO_3)$

A few specimens of rutherfordine were found in 1986 in the dump near the entrance to the mine. It is pale yellow to orange and forms earthy masses and small, parallel or slightly divergent groups of prismatic rods to 1.2 cm in length. The rods are pseudomorphs after an unknown mineral. Rutherfordine occurs in gray, iron-stained quartz fissures and along cleavage planes in feldspar.

Sabugalite $HAl(UO_2)_4(PO_4)_4 \cdot 16H_2O$

Following a landslide in 1979 in the southeast portion of the workings, sabugalite was found scattered over the fallen debris. It is very rare, occurring as square plates to several millimeters and as crystalline crusts in vugs in gossan.

Saleeite $Mg(UO_2)_2(PO_4)_2 \cdot 10H_2O$

Saleeite has been found at Sapucaia as square, tabular, lemon-yellow to greenish yellow crystals with micaceous cleavage. The individual crystals and groups occur in vugs and seams in albite and frondelite. Some crystals are perched on hureaulite and on variscite rosettes. Good specimens were recovered in 1980 during clearing of the southwest portion of the workings.

Siderite $Fe^{2+}CO_3$

Siderite has been found filling vugs in albite. It is porous and pale brown where massive, but lustrous scalenohedral and rhombohedral microcrystals suitable for micromounting have been recovered as well.

Sphalerite $(Zn,Fe)S$

Iron-rich sphalerite forms anhedral nodules to several centimeters in quartz and feldspars situated near phosphates.

Spodumene $LiAlSi_2O_6$

Spodumene is abundant near the pegmatite core as giant, white, earthy, weathered laths to 2 meters in length.

Strengite $Fe^{3+}PO_4 \cdot 2H_2O$

Strengite forms a vitreous coating on green frondelite, and also white blebby crystals in vugs in the frondelite. Strengite (in contrast to its dimorph, phosphosiderite) is apparently limited in occurrence to partially oxidized environments where phosphatic iron is of mixed valences and where hureaulite and sulfides are present. Observed crystal forms include {001}, {201} and {101} (Lindberg and Pecora, 1958).

Strunzite $Mn^{2+}Fe_2^{3+}(PO_4)_2(OH)_2 \cdot 6H_2O$

Strunzite occurs at Sapucaia as thin crusts of very soft, bright yellow needles in vugs in green frondelite. Very rare, pale, silky fibers to 7 mm have also been found in albite vugs.

Tavorite $LiFe^{3+}(PO_4)(OH)$

Sapucaia is the type locality for tavorite (Lindberg and Pecora, 1955). It occurs principally as greenish yellow, fine-grained, discontinuous veinlets up to 5 mm thick and several square centimeters in area, at or near the contact between heterosite and barbosalite. It is also found as a microscopic network veining heterosite, ferrisicklerite and barbosalite. Scattered flakes of tavorite can be found sparsely distributed along cleavage cracks in triphylite. Tavorite ultimately replaces barbosalite and hureaulite. Viviante occurs in association, along with rare magnetite blebs perched on tavorite. For a chemical analysis see Table 1.

Tourmaline complex borosilicate

Dark, striated prisms to 20 cm of an unidentified tourmaline species showing three-faced pyramidal terminations have occasionally been found in K-feldspar of the pegmatite core. Schorl is common as small, brownish to black, translucent crystals scattered in triphylite masses, feldspars and johnsomervilleite, and as veinlets in feldspar and frondelite.

Triphylite $LiFe^{2+}PO_2$

Large crystalline masses of triphylite up to 50 kg in weight occur as the primary phosphate from which many of the secondary minerals have been derived. Unweathered triphylite is translucent, olive-green to gray-green or brownish yellow, and shows a conchoidal fracture. For a chemical analysis see Table 1.

Weathering of triphylite is frequently evident as a partial replacement by vivianite begins to take place along cleavages and fissures (turning the specimen pale blue), and as a surficial crust. As weathering advances, triphylite develops a vuggy texture. Cavities become filled with barbosalite, rockbridgeite, variscite, hureaulite, phosphosiderite and tavorite.

Biotite, muscovite, dark brown tourmaline, beryl and transparent to translucent quartz crystals are the associates of unaltered triphylite. Some pyrite also occurs near contacts with feldspars.

A later generation of triphylite occurs as dendritic to coralloid or fish-bone aggregates intergrown in feldspar. Some golden-brown altered biotite is usually present as well. For a partial chemical analysis see Table 1.

Variscite $(Al,Fe^{3+})PO_4 \cdot 2H_2O$

Manganian and ferrian variscite occurs at Sapucaia as single crystals, aggregates and spherulitic masses in pockets in muscovite and frondelite. It also forms crusts in albite vugs and may replace beryl crystals. Variscite forms squat crystals with curved faces, showing phantoms of varying composition. Forms {001} and {011} tend to be concavely curved, and {010} tends to be convex. The crystals are a brilliant raspberry-red in color, the intensity varying with the manganese content (0.04% to 2.46%). Fe_2O_3 ranges from 12.09 to 18.28 weight %. The indices of refraction also vary with the degree of iron and manganese substitution (Lindberg and Pecora, 1958). Peach blossom-pink and crimson to pale purple, radiating globules to 1 mm occur in vuggy feldspars and weathered johnsomervilleite, and sometimes perched on bermanite, jahnsite, mitridatite and strunzite or covered by phosphosiderite and manganese oxides. A wet chemical analysis gives $(Al_{0.828}Fe^{3+}_{0.106}Mn_{0.066})PO_4 \cdot 1.9H_2O$ (Cassedanne and Cassedanne, in press).

Vivianite $Fe_3^{2+}(PO_4)_2 \cdot 8H_2O$

Vivianite occurs as lustrous, translucent, bluish green to dark blue plates along triphylite and feldspar cleavage planes, as dendritic seams invading massive triphylite, and as veinlets in pink K-feldspar and johnsomervilleite. The crystals are very attractive and suitable for micromounting. Some specimens showing hureaulite crystals perched on viviante crystals have also been recovered.

Earthy, pale blue to pale purple altered vivianite replaces triphylite, cyrilovite and johnsomervilleite. Its bluish color lends a bluish cast to gray-green triphylite. Lindberg and Pecora (1958) provide a chemical analysis.

Xenotime-(Y) YPO_4

Xenotime-(Y) occurs as small, orange, bipyramidal crystals scattered in feldspar.

Zircon $ZrSiO_4$

Zircon is found as small, brown, stout, euhedral crystals scattered in feldspars, triphylite masses and johnsomervilleite.

ACKNOWLEDGMENTS

Our thanks to Paul B. Moore, Abraham Rosenzweig, Carlos Vasconcelos and Richard V. Gaines for reviewing the manuscript.

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(continued on page 365)

Famous Mineral Localities:

LAVRA BERILO BRANCO

THE ORIGINAL "SAPUCAIA" ROSE QUARTZ OCCURRENCE MINAS GERAIS, BRAZIL

Wendell E. Wilson
The Mineralogical Record
4631 Paseo Tubutama
Tucson, Arizona 85750

In 1959–1960 a spectacular pocket of large rose quartz crystal clusters was discovered at a small, obscure Brazilian pegmatite. Excepting a few small, pale crystals from Maine, this find was the first known occurrence of well-crystallized rose quartz.

INTRODUCTION

Crystallized rose quartz from Brazil is known today from a number of famous localities, including the Lavra da Ilha (Cassedanne and Cassedanne, 1973), the nearby Lavra do Ademar (Cassedanne and Cassedanne, 1980), and Alto da Pitora (Cassedanne and Alves, 1990).* The first such occurrence, however, was discovered at a small prospect called Lavra Berilo Branco ("White Beryl mine"), but known to the world as the "Sapucaia mine," probably because of its close proximity to the small town of Sapucaia do Norte. This choice of a popular name was unfortunate, because another mine just a few kilometers to the south had been given the name "Sapucaia" during the 1940's and was already famous as a source of rare phosphates (Cassedanne and Baptista, this issue). Consequently the two localities became confused, and would have remained so had it not been for the good memory of Mr. Constantino Vasconcelos, a long-time Brazilian mineral dealer who was active in the 1950's–1960's, and who communicated his knowledge for inclusion in this article.

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*Additional localities include Caraibas (= Mariano Dias) near the town of Rubilita; Valdete, near Coronel Murta, with pyrite and purple apatite; Lomoeiro, previously famous for topaz and other gem species, where a rose quartz crystal pocket was found in July 1989; Morro Redondo, formerly famous for gem tourmaline, where crowns of rose quartz crystals to 25 cm were found around 1990; Laranjeira, in a tourmaline-rich eluvium found in December 1989 about 2 km north-northeast of the Ademar pegamtite; and Giraú in the upper Piauí Creek area, where a few tens of kilograms of fine rose quartz clusters and crowns with gem-grade green and blue tourmaline were found. (See Cassedanne, 1991.)

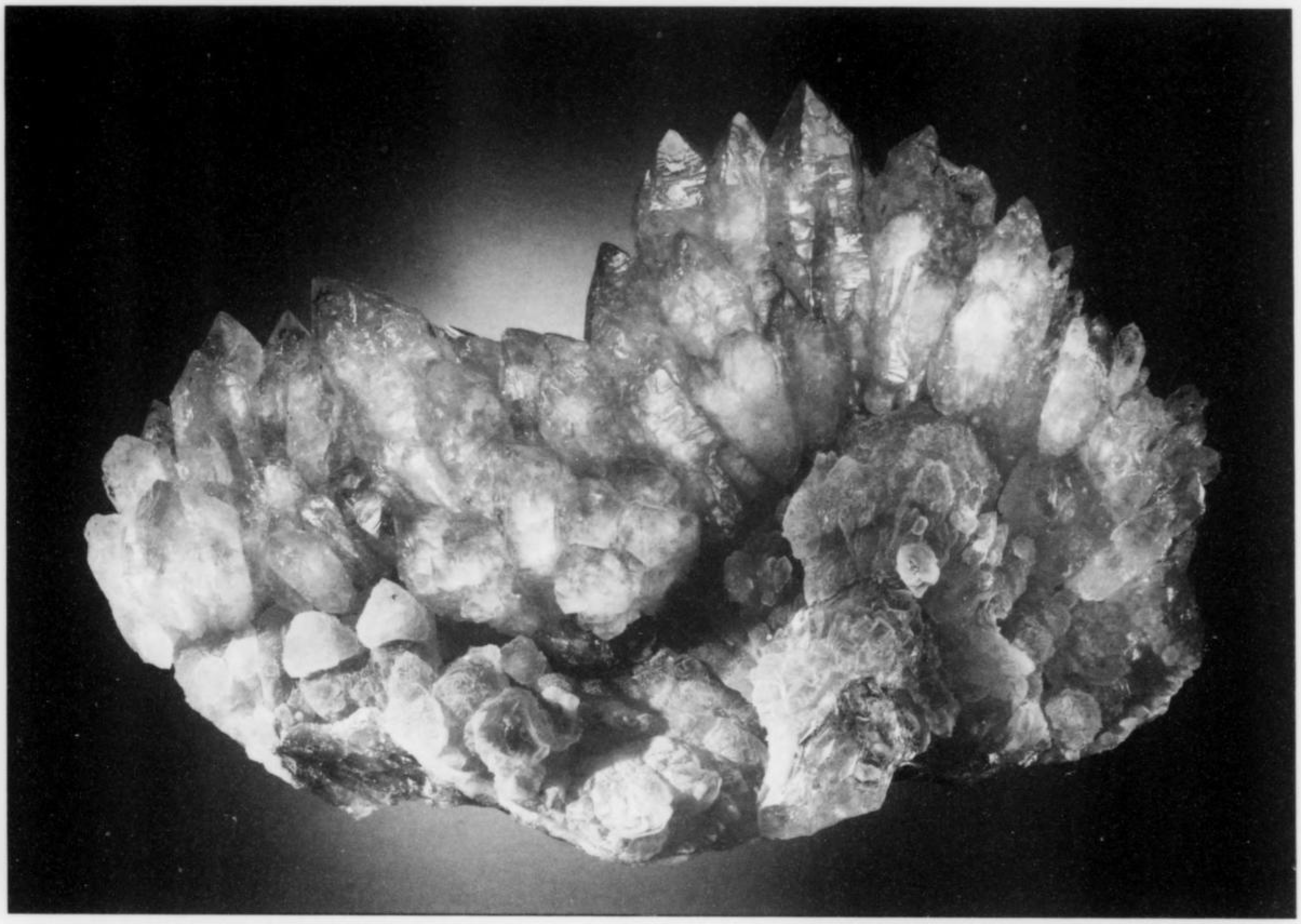

Figure 1. **Rose quartz group, 16.5 cm, from the William Larson collection. Photo by Harold**

Figure 2. **Rose quartz crystal cluster, 14 cm, from the Canadian Museum of Nature collection. Photo by Jeff Scovil.**

Figure 3. **Rhombohedron faces of rose quartz crystals showing "terraced" surface features. William Larson collection; photo by Harold and Erica Van Pelt.**

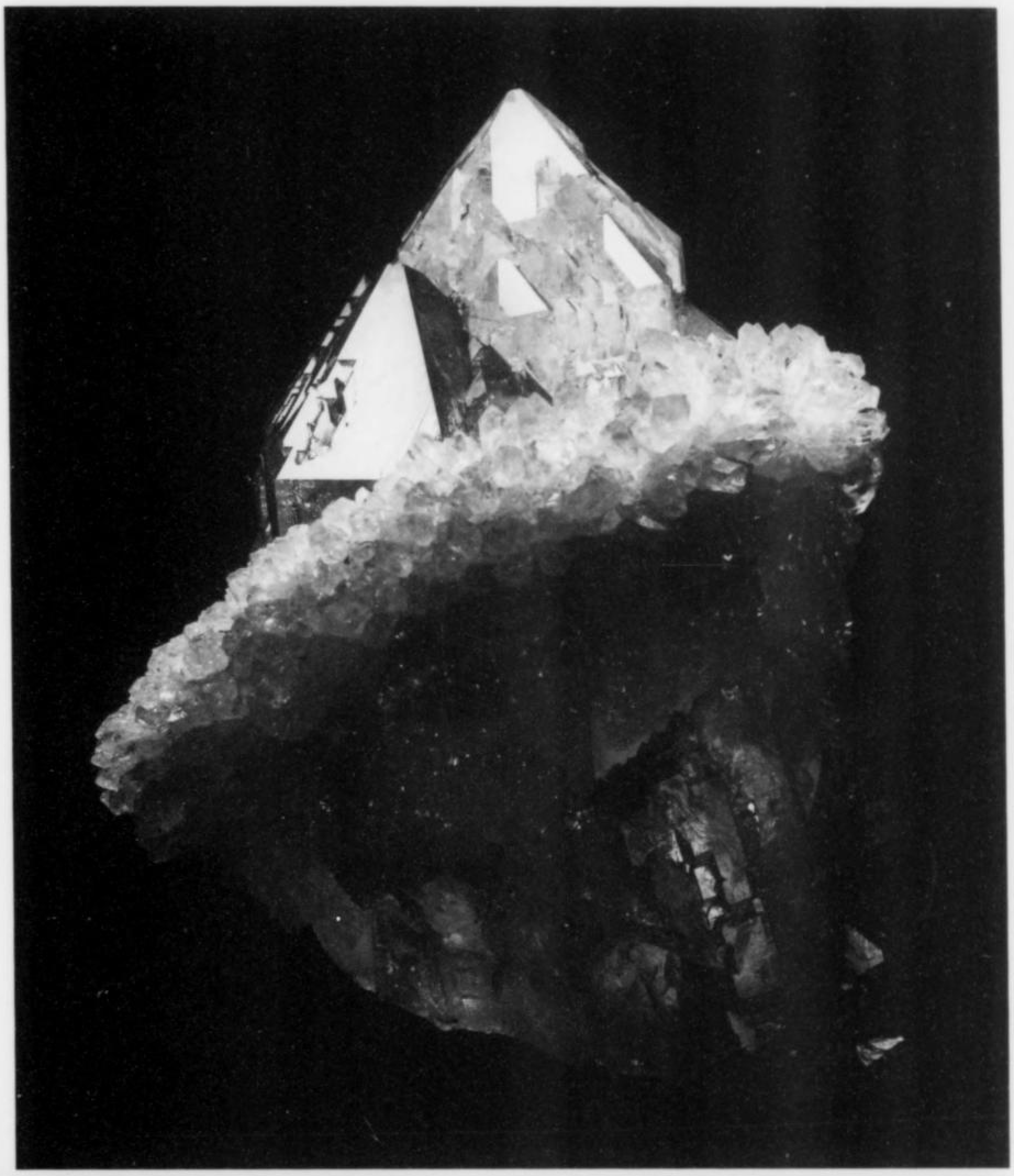

Figure 4. **The famous "Van Allen Belt" rose quartz specimen, 25 cm, now in the Smithsonian Institution. Photo by Harold and Erica Van Pelt.**

Figure 5. **Rose quartz crystals on pale smoky quartz, 10 cm, from the F. John Barlow collection. Photo by Harold and Erica Van Pelt.**

Figure 6. **Rose quartz cluster, 6.9 cm, from the Douglas Miller collection. Photo by Wendell E. Wilson.**

***Figure 7.* Location map showing the Berilo Branco, Sapucaia and Pitora pegmatite locations.**

LOCATION

Lavra Berilo Branco, the "Sapucaia" rose quartz mine, is located approximately 8 km south of the town of Divino das Laranjeiras and about 3 km east-southeast of the town of Sapucaia do Norte (at map coordinates 7914N x 238E). The Sapucaia phosphate/mica mine is located about 5 km farther south (coordinates 7910N x 239E), and the Pitora rose quartz occurrence is another 10 km south from there (at 7900N x 240E). Access is via a dirt road proceeding eastward from Sapucaia do Norte, past the fazenda (farm) Bela Vista and on down to the Rio Laranjeiras, just north of the retiro da fazenda Laranjeiras.

GEOLOGY

The Berilo Branco pegmatite is situated within the Lower Precambrian Paraíba Group. The intrusion of a granitic batholith into the São Tome mica schist complex about 600 m.y. ago was accompanied in its late phase by the emplacement of dozens of pegmatite veins in the Conselheiro Pena area.

Unfortunately the Berilo Branco pegmatite has never been mapped, and the extent of its working is currently unknown. For more information on the general area see Pecora *et al.* (1950).

The Berilo Branco pegmatite is identical to many others in the area; it is a granitic pegmatite with replacement zones, containing the usual quartz, K-feldspar, muscovite and albite with accessory white beryl (prismatic to flattened) gem-grade tourmaline and rose quartz (Dilermando Rodrigues, personal communication, 1999).

In the immediate area surrounding the Berilo Branco pegmatite are several other noteworthy occurrences including the Frente Boca de Fogo mine (fine beryl), the Boca Rica mine (good rockbridgeite and hureaulite crystals) and the Fazenda Campo Alegre (where 3 tons of large heliodor crystals up to 80 kg each were found).

HISTORY

The Conselheiro Pena area was known to contain at least 66 mica-producing pegmatites as of 1950 (Pecora *et al.*, 1950). The Sapucaia and the Berilo Branco were among these, though the latter was considered minor. The Sapucaia phosphate mine, also called the Sapucaia Velha ("Old Sapucaia"), and the Sapucaia do Norte ("North Sapucaia," after the nearby town), is actually several kilometers farther from the town of Sapucaia do Norte than the Berilo Branco. (Edgar Miranda, a former owner of the Sapucaia mine, confirms that no crystallized rose quartz has ever been found there.)

The owner of the Berilo Branco property in 1959 was Sebastião Ferreira (also known as "Sebastiãn do Odete"); he was working it for mica and other minerals. In early 1959 his miners on the site (Fio Ferreiro, José Gama, João Eduardo, Paulinho Maritaca, a man named Nasario, and several others) began to encounter small pockets containing small crystals and clusters of rose quartz. Specimens soon reached the dealers in Governador Valadares and Teofilo Otoni, the commercial distribution points for minerals in that part of Minas Gerais.

The specimens were such a surprise that rumors immediately sprang up suggesting that (a) the crystals were actually man-made, or (b) the crystals were natural but the color was fugitive and would fade with exposure to sunlight (Bancroft, 1973). These speculations were ultimately disproven, as more specimens came to light in the following months.

Pockets of smoky quartz appeared first, and as the pockets grew larger, so did the crystals. Small clusters of very pale pink quartz went almost unnoticed at first. Next a zone of large muscovite sheets and stocky quartz prisms was uncovered, behind which the main rose quartz pocket was found. The vug measured 10 to 16 cm across and perhaps 32 cm (about a foot) tall, but it extended for more than 5 meters (over 16 feet!). The rose quartz in this pocket was deeply colored, in wonderful sprays, fans and rings overgrown on large, blocky crystals of pale smoky quartz (Bancroft, 1984). Of the several rose quartz occurrences now known in Brazil, the "Sapucaia" (Berilo Branco) specimens ultimately proved to be the finest in color, luster and aesthetics.

The first American mineral dealer on the scene following the big discovery was Peter Bancroft, who purchased four major lots: from Franscelino Horta in Rio de Janeiro; Paulo Nercessian in Belo Horizonte; a dealer known simply as Nacimiento in Governador Valadares; and an unnamed dealer in Teofilo Otoni. The four lots together totalled nearly 200 specimens, including 50 major pieces from 10 x 10 cm and up in size. He traded most of these specimens off to various American and European collectors and dealers over the next several years. Although the now-famous Smithsonian specimen known today as "The Van Allen Belt" was not among Bancroft's specimens, he obtained at least a dozen that were close to it in size and quality (P. Bancroft, personal communication).

Excitement grew as the specimens reached the American market. Larry Conklin's ad in the May-June 1961 *Rocks & Minerals* offered a 3 x $4\frac{1}{2}$-inch rose quartz crystal "stalactite" for $75. Ron Romanella, through his "Commercial Mineral Corp.," also offered specimens in his ads (May-June 1962; November-December 1962), as did Shale's (November-December 1962). The locality was not well known yet, and was given simply as "Brazil" or "Espirito Santo" (the border of which is a few kilometers from the Berilo Branco mine) and even "Itibiaria, Bahia," which may be a separate occurrence, or just a misspelling of Ibituruna, the mountain overlooking Governador Valadares in Minas Gerais.

A superb specimen consisting of a large, blocky, pale smoky/citrine, 25-cm quartz crystal circumscribed by a ring of gorgeous pink quartz crystals (the whole specimen weighing over 10 pounds) was imported to the U.S. by the mineral and gem dealer Donald Parser. Named "The Van Allen Belt," it was subsequently purchased by Fred Kennedy of Rochester, Minnesota, who donated it to the Smithsonian Institution. The specimen was pictured on the cover of *Lapidary Journal* in August of 1963, wherein it was pronounced to be the "finest example of rose quartz crystals in the world," worth at that time $9,500.

After the mine closed around 1960 or 1961, it was occasionally reworked by garimpieros until 1973, when a new discovery of rose quartz was made. The find, however, proved to be of small extent. Dilermando Rodrigues (a dealer in Governador Valadares and owner of the famous Urucum pegmatite) remembers selling a very fine specimen from this pocket to the American dealers Milton and Hilde Sklar (Oceanside Gem Imports); it consists of a terminated, dark red rubellite crystal 15 x 1.2 cm, surrounded by a beautiful ring of bright pink rose quartz crystals. Rare individual specimens of rose quartz, tourmaline and beryl continued to be found at the mine for some years thereafter, but since 1991 the mine has been totally abandoned, caved and overgrown with vegetation. The owner of the property is Mr. Romulo Tavares of Governador Valadares.

MINERALS

Quartz SiO_2

With the passage of time, some specimens of Brazilian rose quartz can become separated from their locality data, especially the earliest such specimens which may not have come with much information in the first place. The specimens from the three main localities ("Sapucaia," Lavra da Ilha and Alto da Pitora) *can* be visually distinguished, however, if the collector knows what to look for.

Rose quartz crystals from the original find at the "Sapucaia" (Berilo Branco) pegmatite are generally the most lustrous, with bright, vitreous, almost greasy-looking faces. Most characteristic is the presence of "terraced" rhombohedron faces showing irregular, minutely stepped levels in rather swirling patterns. Associated species other than a pale yellowish smoky quartz and muscovite are generally lacking.

Lavra da Ilha rose quartz specimens are of somewhat lower luster with flat, unterraced rhombohedron faces. The color is often less intense. Accompanying minerals such a roscherite and eosphorite are highly characteristic of this occurrence.

Alto da Pitora rose quartz crystals and clusters may be large and spectacular, but tend to have the poorest luster, actually frosty in many cases, though in isolated areas they may be bright. The surface is not smooth, but often appears to be a composite of multiple semi-parallel rhombohedrons with multiple tiny termination points. Prism faces are often deeply striated.

The overall habit of "Sapucaia" (Berilo Branco) rose quartz is typically lavish clusters, fans, sprays and rings, similar to habits found at the other two major localities. The rose quartz was clearly deposited as a final quartz stage following the formation of the large smoky/citrine crystals. Exquisitely beautiful specimens to more than 25 cm were recovered from the principal pocket.

ACKNOWLEDGMENTS

This article could not have been prepared without the generous detective work and help of the late Richard V. Gaines, R. R. Romario Ribeiro of the DNPM (Brazilian National Department of Mineral Production), Constantino Vasconcelos of *Vasconcelos Ltda.* in Governador Valadares, Dilermando Rodrigues de Melo and their associates. Abraham Rosenzweig, Jacques Cassedanne and Paul B. Moore reviewed the manuscript at different stages and offered helpful suggestions.

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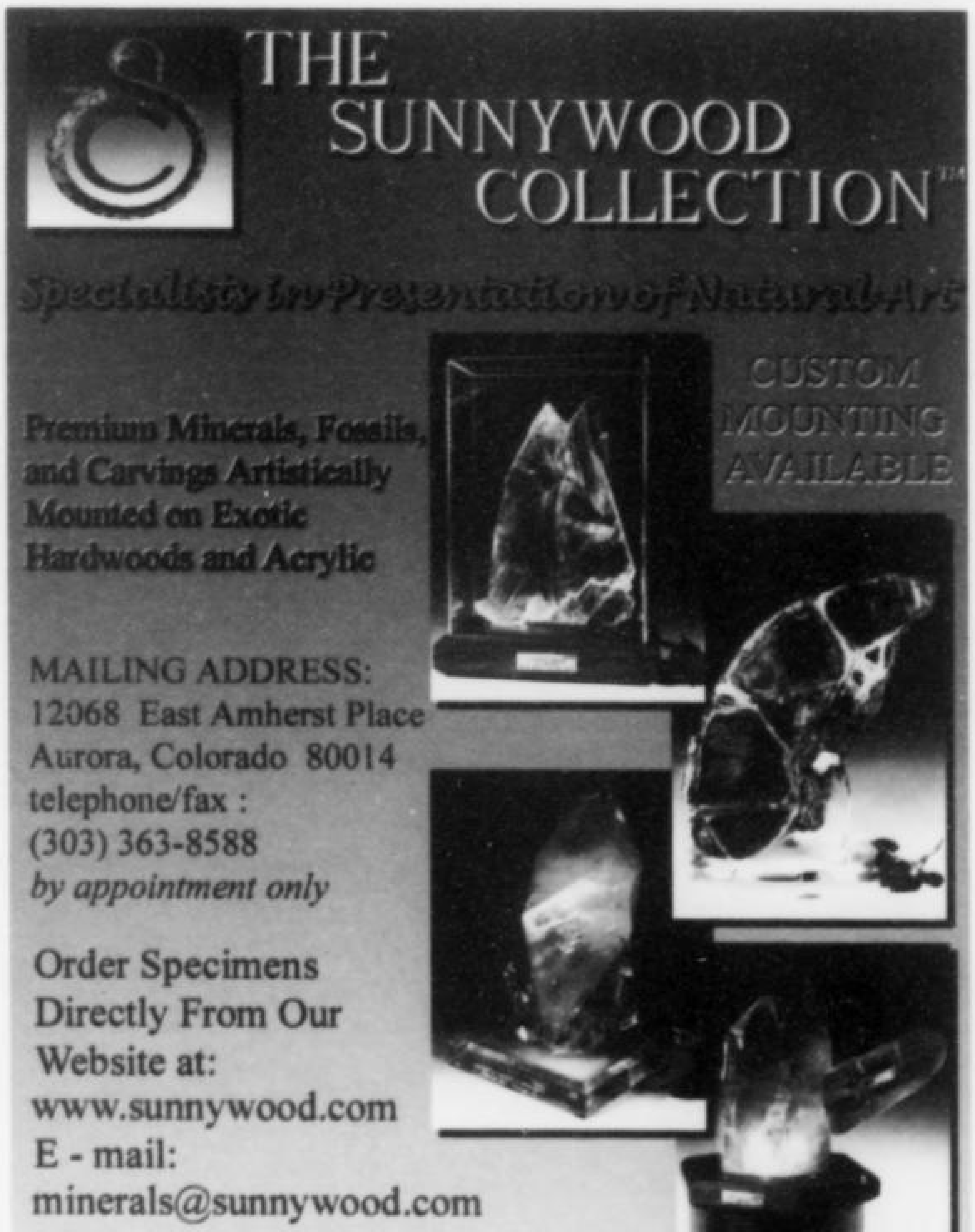

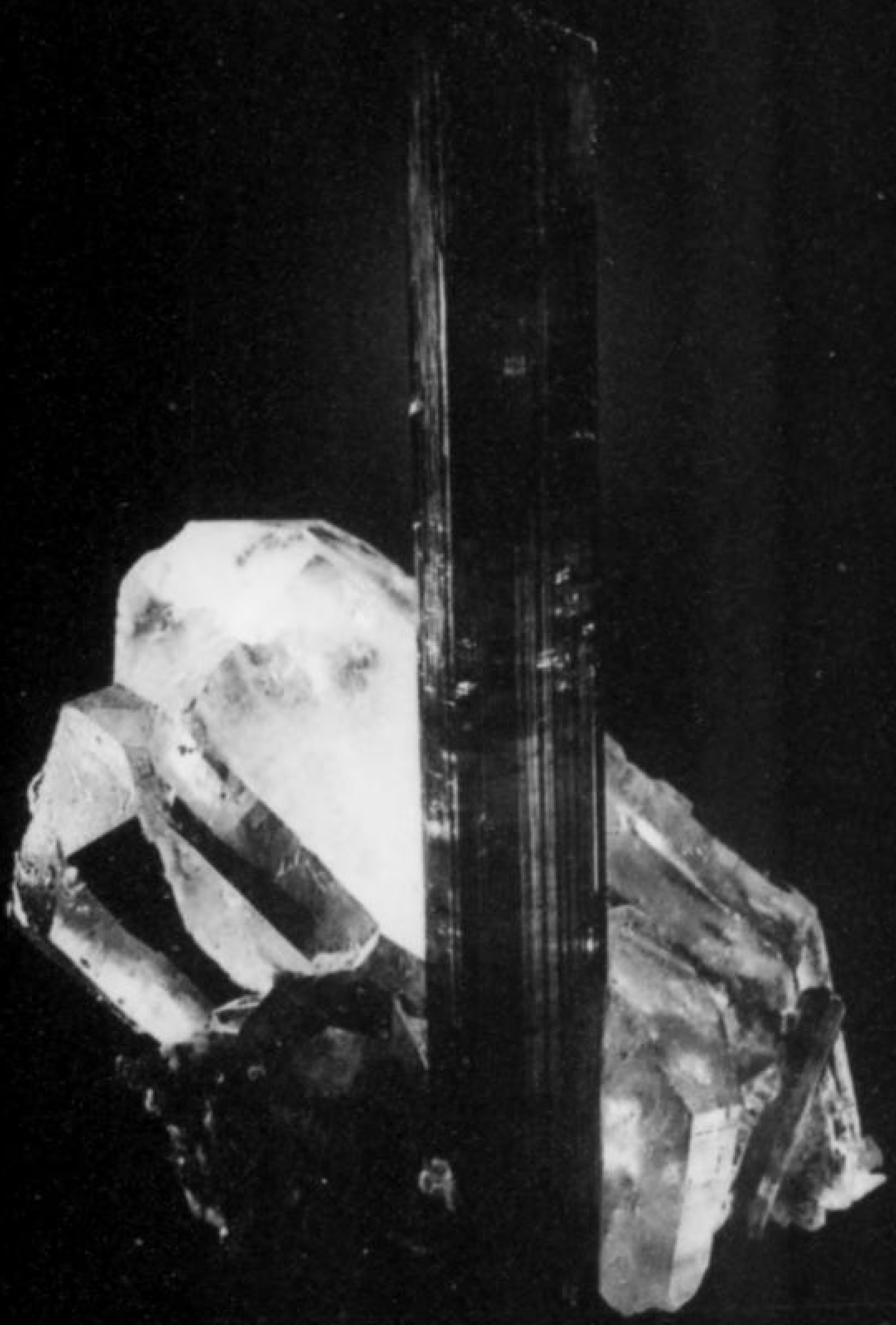

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INTRODUCTION

I was a young Mining Engineer in 1964, working for U.S. Borax at the Boron Open Pit in Boron, California. U.S. Borax also owned a large potash mine east of Carlsbad, New Mexico. They had need of a mining engineer, and as the mine was nearly played out it was hard to find a short-term outsider. Consequently, I was transferred to Carlsbad for fifteen months in 1964–65.

Collecting was in my blood, but Carlsbad was not a crystal collector's heaven. I did manage to find a partially caved, once flooded section of the mine with secondary halite and sylvite on red potash ore. Collecting this helped to preserve my sanity. But it was not quite enough for me, so I began asking if crystals were ever found in the other mines of the district.

Rumors finally reached me of a natural halite pocket in the adjacent Potash Corporation of America (PCA) mine. I tracked this down to a delightful individual, Mr. Armando Perrini. Mr. Perrini was the General Mine Foreman for PCA. After several visits to his home, I was rewarded with this tale, several color pictures taken of the crystal cave, and a fine, golden, 12-cm halite cube.

Unfortunately, I was never able to finagle a trip into the pocket. The PCA people said the section was caving, and it was too

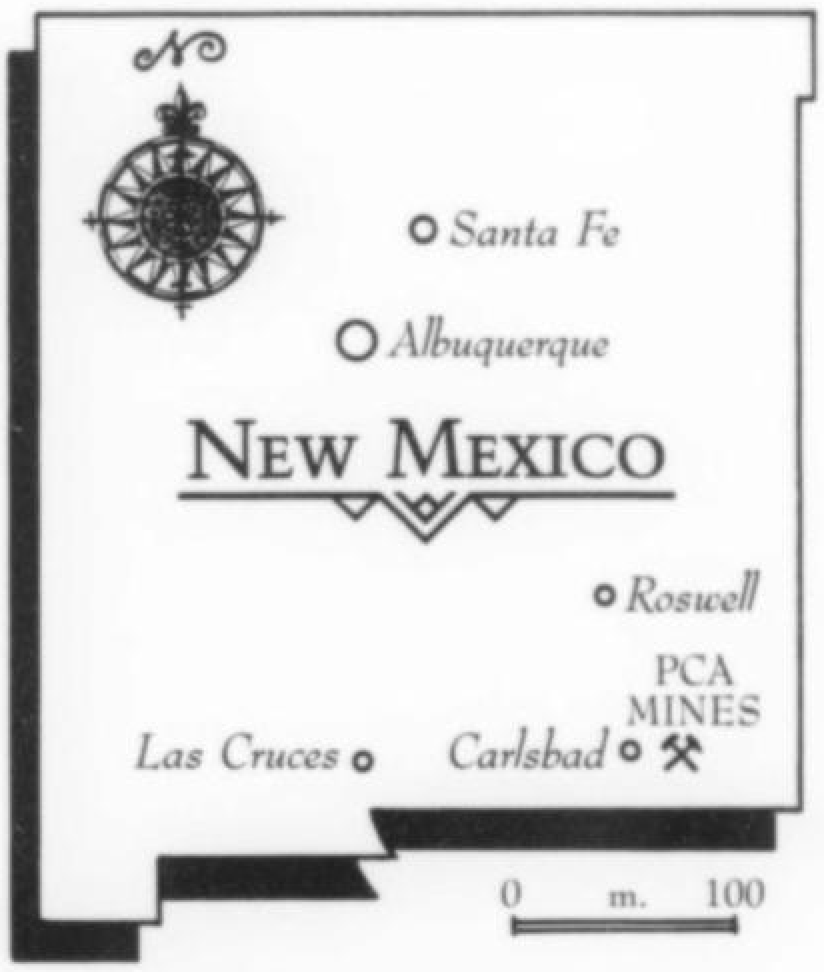

***Figure 1*. Location map.**

Figure 2. **An unidentified mine foreman sits among the halite crystals in the first cave that was found 15–30 feet above the orebody at the PCA mine, Carlsbad, New Mexico. April 10, 1962.**

Figure 3. **Armando Perrini, General Mine Foreman, looks at a halite crystal, April 10, 1962.**

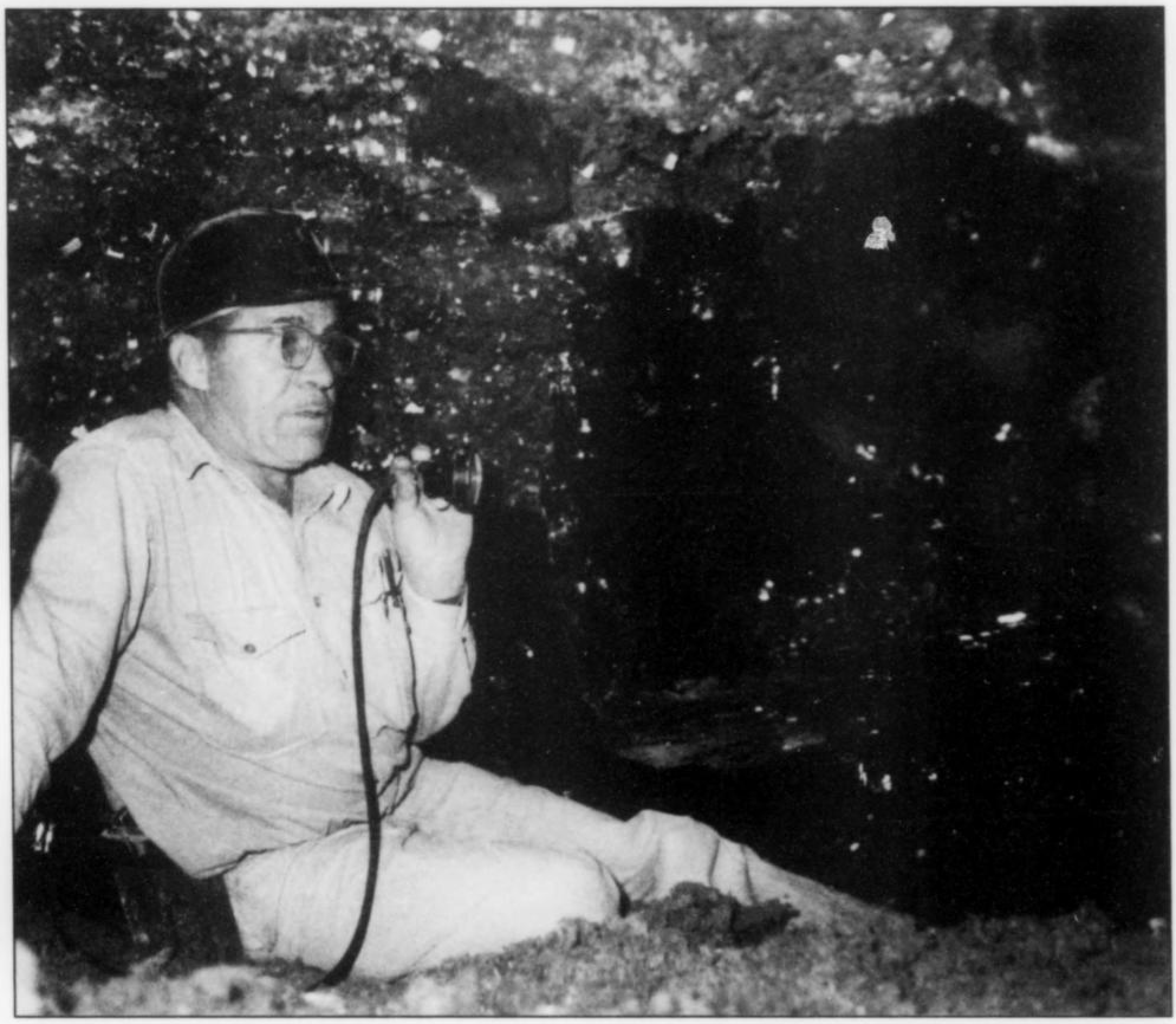

Figure 4. **Bill Baumann, Mine Foreman, observes a ceiling-to-floor mass of golden halite. The reddish material on the floor is polyhalite. April 10, 1962.**

Figure 5. **Bill Baumann with some of the big halite crystals, April 10, 1962.**

dangerous. Later experience indicated the real reason was corporate competition. PCA, at the time, was an unusually "closed" mine to outsiders, particularly direct competitors, and my employer, U.S. Borax, fit that description well.

GEOLOGY

The potash* deposits of New Mexico were formed in the great saline deposits of the Permian Basin. This basin, a dried embayment of ancient Permian seas, has a total salt bed thickness of 1000 to 3500 meters. It is composed of alternating layers of halite, clay, anhydrite, gypsum, sylvite, polyhalite, and locally abundant carnallite, langbeinite, and lesser salts. Repeated sequences attest to continued desiccation of seas with numerous fluctuations and interruptions.

The richest potash beds occur toward the bottom of subbasins on the edge of the main basin. The richest deposit was termed #1 Bed, now lying at roughly 330 meters depth. It was a series of large pods, separated from one another but stratigraphically equivalent. A typical pod was 1 to 5 kilometers across and 1 to 5 meters thick. There was little faulting and folding of the beds, only gentle undulations. One or more mines worked each pod. As the high-grade #1 Bed was depleted, new mines were developed on overlying beds of lower grade sylvite and langbeinite.

Typical ore ran about one-third potassium chloride (sylvite), two thirds sodium chloride (halite), and roughly 1% clay, hematite and other insolubles. Ubiquitous hematite gave the ore a brick-red color. Radiation from the radioactive K^{40} isotope caused nearby halite to turn blue, so the red ore was speckled with small blue halite crystals. On rare occasions, near the fringe of an orebody, massive halite crystals formed, yielding beautiful large blue cleavages. These were much rarer than in similar, more folded European potash deposits.

THE CARLSBAD POCKETS

The mines at Carlsbad are worked by room-and-pillar or longwall mining methods. One aspect of mining was the presence of low-volume, but highly pressurized gas in thin seams a few meters above #1 Bed. This gas, a combination of air and carbon dioxide, exerted a strong downward pressure on mine openings, particularly at intersections and large open rooms formed by longwall mining. This gas pressure was believed to contribute to roof falls. All the mines in the district working #1 Bed routinely drilled small-diameter holes into the ceiling to a depth of 10 meters or so to vent this gas and relieve the pressure.

Armando Perrini described how one of these holes exposed a remarkable crystal pocket in the northwest corner of the PCA mine in April 1962. About 6 meters above the ceiling, the drill hit a thin polyhalite bed, then broke into a large cavity, and brine rushed out. The flow stopped after a few hours.

Mr. Perrini, in his capacity of General Mine Foreman, had a raise driven to see what was there. The raise broke into the first of two large crystal pockets. The pocket covered an area roughly 100 meters across, although most of that was merely a crack. The open portion was up to a meter high, and could be crawled into for roughly 20 meters.

The ceiling of this pocket was covered with polyhalite and huge, clear, sharp cubes of golden yellow halite. Many crystals reached down to the floor. The crystal size ranged from 1 to 100 cm on an edge! The floor was covered with a crystalline polyhalite crust and a few halite crystals. Perrini and his assistants took a series of color photographs in the pocket (shown here). A few, mostly smaller crystals were removed from the pocket and have been preserved in museums and collections. These photos may be all that remains to document the huge crystals, though they cannot capture their true beauty and transparency. The crystals, glowing in the light from the miners' head lamps, must have been a lovely sight.

Shortly afterward, a second crystal cave was found 40 meters north of the first. The floor of this cave was covered with drying mud. The ceiling was covered with even *larger* cubes, some estimated to weight 3 or 4 tons! There were also three large sylvite cubes 12 to 15 cm in size in this pocket. They were clear and colorless, as opposed to the golden yellow halite crystals. Perrini had at least one of the sylvites in his collection. I do not know if anything other than the sylvite crystals were collected, or if photos of these huge halites were taken.

Only a few people, mostly PCA personnel, were allowed into the caves. I transferred back to Boron in 1965, and Mr. Perrini died a year or so later. Do the caves still exist, and are they accessible? I do not know. However, I did talk to a young geologist from New Mexico about a year ago, and I told him this tale. He said he had been on a field trip to the mine, and he thought the caves were still there. But he could be referring to some later caves. Perhaps this article will trigger some interest in pursuing the matter. As can be seen from the photographs, the crystal groups are huge but wonderful—worth saving in some museum.

ACKNOWLEDGMENTS

Thanks go to the late Armando Perrini for his efforts to expose these caves, and save for posterity the photos and a few crystals from a remarkable find. Mr. Perrini was not a serious collector, but had a true miner's love of the beauty of nature. We should never forget that most of the mineral specimens now existing came from miners such as he.

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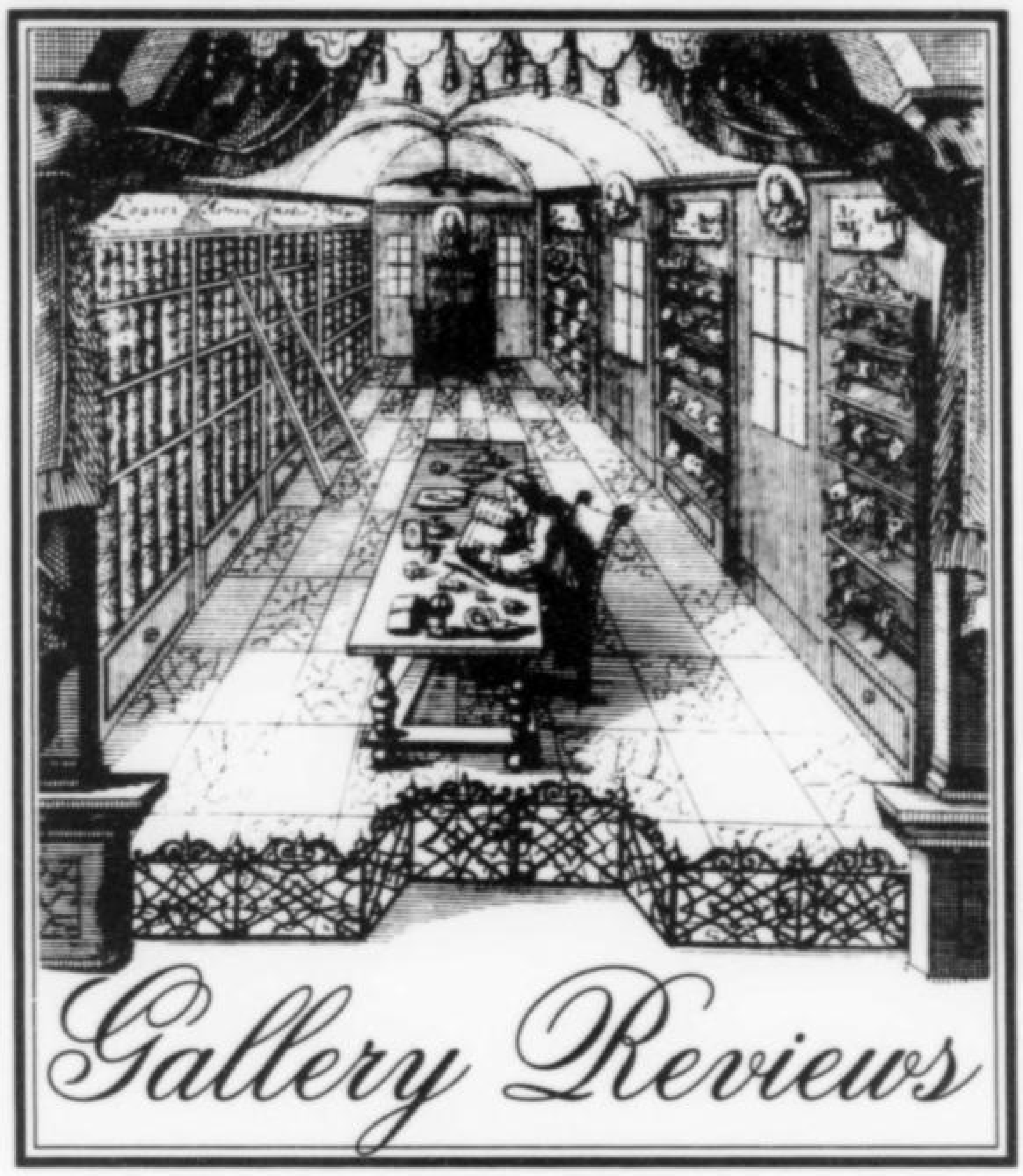
*"Potash," strictly speaking, refers only to potassium carbonate, but potassium *ore* of any kind is generally referred to as "potash."



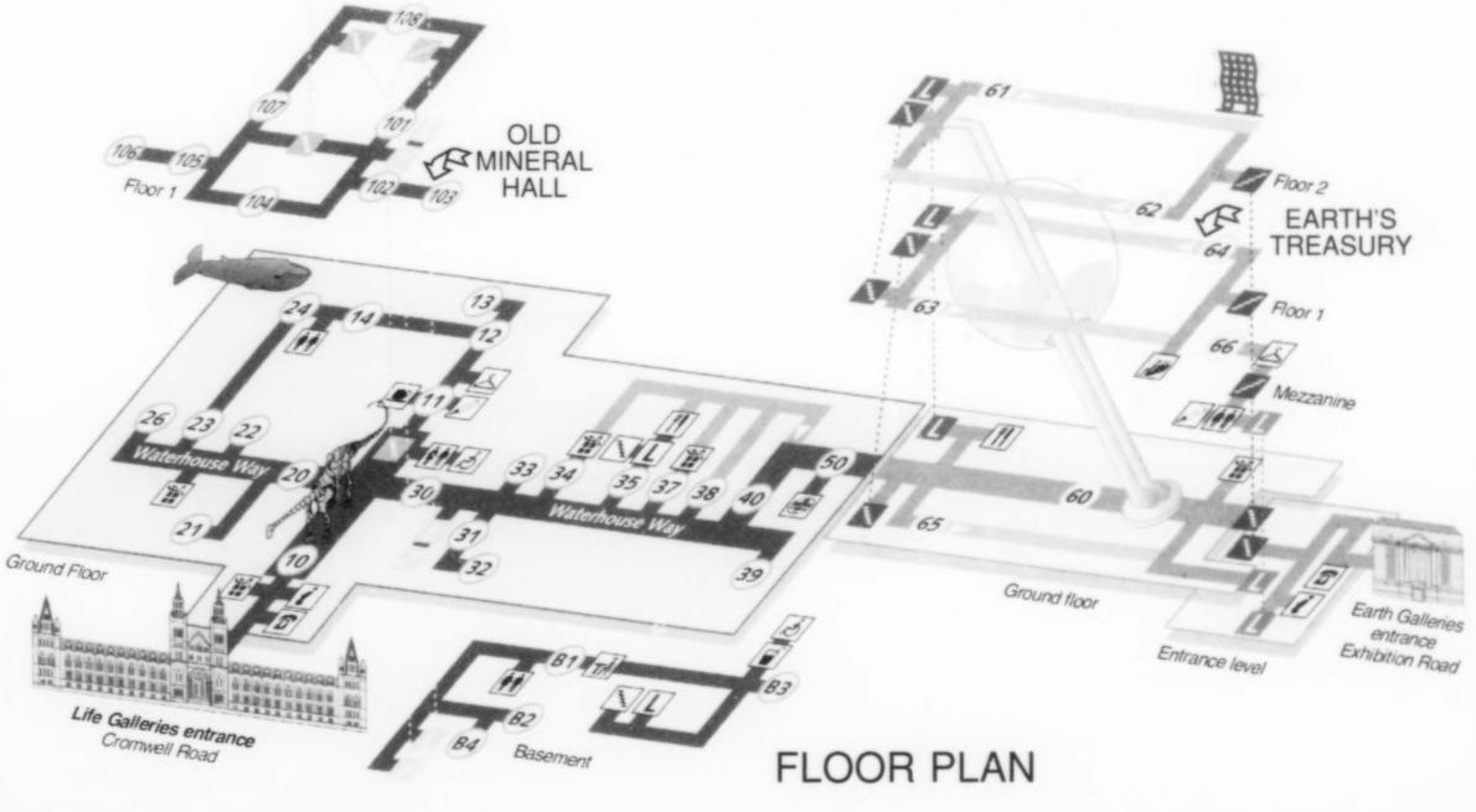
The New Mineral and Gem Gallery at the British Museum

by **John S. White**

In 1985, the two museums just around the corner from each other, the Geological Museum and the British Museum (Natural History), were merged into one. They had somewhat overlapping exhibits in the earth sciences, but the dominant mineral specimen display was in the huge gallery of the latter museum, an antique yet widely revered facility relying upon daylight alone and boasting about 10,000 displayed specimens of at least 1500 different mineral species (Burchard and Bode, 1986). The Geological Museum, on the other hand, presented more geologically oriented exhibits, including British geology and ore deposits, but also a rather diverse and extensive gemstone collection, "one of the finest in the world" (Burchard and Bode, 1986). In 1973, the Geological Museum opened *Story of the Earth*, an innovative thematic display stressing geological processes in a most dramatic fashion wherein specimens were, for the most part, replaced by working models and educational gimmickry.

Combining these adjacent museums led to the evolution of a new overall exhibition scheme in which the British Museum (NH) would eventually house only the "Life Galleries" and its neighbor would house the "Earth Galleries" (see diagram), and collectively the two buildings would henceforth be known as The Natural History Museum, "the finest museum of nature in the world." The old Geological Museum was altered altogether, with "Earth Galleries" spread over three different floors, tied together by an escalator which rises in a huge, nearly empty, atrium from the ground floor and deposits visitors on the third floor (Floor 2 in Britishese), where one finds geology exhibitions entitled *The power within* and *Restless surface*. The second floor ("Floor 1"), not accessible via the escalator, contains two exhibitions as well, *From the beginning* and *Earth's treasury*, the latter having just opened in July, 1998. In spite of the fact that the terms "minerals" and "gems" are virtually nowhere to be found in the building, and the word "mineral" appears just once in the museum's brochure, it is here in *Earth's treasury* that minerals and gems can be found and it is this portion of the exhibition that is the focus of my review. Please note that the "ologies" are now *passé*, so that terms such as mineralogy, geology and paleontology cannot be found anywhere. These apparently frightening terms are thought to intimidate the masses expected to fill these halls.

Upon arriving at the beginning of *Earth's treasury*, the first case one encounters is a bit of a mystery. It is contained within the wall, as are most of the display cases in this gallery, and it is about a foot wide and perhaps six feet tall, with the base at about chest level for an adult. It is subdivided into compartments by vertical and



FLOOR PLAN

Figure 1. **The RTZ Atrium (named for Rio Tinto Zinc, its sponsor) with its three-story escalator which passes through a "squeaking, creaking, clanking, groaning globe (when it is working)" (Sharpe, Howe and Howells, 1998). It actually looks better in this photograph because the photo was taken using a time exposure which gives the sphere a more surrealistic appearance. Photo courtesy of The Natural History Museum.**

horizontal panels and within each compartment is parked a specimen. This is an odd mix of things and is supposed to represent the sorts of natural objects that a beginning collector might possess, at least this is my interpretation of the meaning of the cryptic text alongside this case (although the highly valuable matrix blue topaz from Russia, among other things, is hardly something one would find in a novice's collection). Just below each specimen is a handwritten label giving only the object's name, no locality, and these labels look very much like an afterthought. Peculiarly, they do not identify the objects nearest them, but instead refer to the ones on the shelves below, some distance from the labels, and awfully confusing. Those toward the top of the case are difficult to see, despite my being relatively tall, as they are perhaps nine feet high. The lighting comes from high up and is quite inadequate but I dismissed this, assuming that it was because the sense of the case was supposed to be more important than the individual specimens.

The next case, also inserted in the wall, contains but two specimens, a wonderful group of chrysoberyl crystals and a large faceted chrysoberyl "alexandrite." This case was designed so that the nature of the light alternately changes and with this the specimens are supposed to change their color from green to red to green, etc. Unfortunately, their colors never really change. The gem had turned itself on its pedestal about 90° so that the table faced to the left, but I was told that when it faced forward the color change was apparent.

It was at this point that I turned away from this case and took in the entire hall for the first time. It is dark . . . depressingly dark. There seems to be metal everywhere, heavy metal. There is steel in every direction and what isn't steel is gray or black, most of it highly reflective. Nothing jumps out at you. Nothing seems particularly inviting, compelling you to examine it because of its color or form. It is one long dark tunnel. Perhaps this dark corridor is supposed to suggest a mine but, as executed, I felt more like I was on a battleship than in a mine. I will confess to a bias and that is I do not like overly dark exhibit halls. They depress, rather than excite.

Just beyond this window case is the only example in the gallery of the use of a mechanical device as an educational tool, however it is no longer working properly. It features (featured) a very elaborate steel Rube Goldberg–like construction in which a revolving screw was to have raised a ball to the top of the case, setting it off on a downward course where it was to trigger the illumination of different elements of a display of the physical properties of minerals. The ball rolling along steel rods, it seems, made too much noise so it had to be removed even though the screw still turns and the lights go on in succession, albeit not really long enough for a novice to grasp the meanings of each of the properties illustrated. The device's metal construction is massive steel throughout and it seems completely out of place with the mineral specimens that appear in this failed display.

At this point I began to feel more than a little uneasy. On the right was a floor to ceiling vertical window within which was blackness. After a while a faint light appeared and some of the objects (mineral specimens) within the case began to fluoresce, but only weakly except for the few Franklin things. The case is narrow, perhaps more than 10 feet deep, and can be viewed from either end. The case label is within the case so that the text can be read only when the incandescent light briefly comes on, thus one is compelled to try to read it very quickly while also examining the specimens quickly before all is plunged into darkness again. The weakness of the fluorescence is due, I believe, to the ultraviolet light sources having been placed too far from the specimens. Amazingly, some specimens do not fluoresce at all and that is because they are not fluorescent! Included is, I was told, the museum's best large Frizington barite and a fine group of amethyst crystals. Why are these and others here? Your guess is as good as mine. The specimens stand on gray-painted heavy metal stanchions that are of differing heights, each of which looks strong enough to support a house yet is the base for a single specimen, one of which is but a small gypsum. All across the floor of this case are pieces of gray shale standing on their edges, helping to add to the depressing drabness of the entire case.

After working my way around this monstrosity (there can be no other word for it), I saw a bank of slanted cases along the righthand wall which extends for a long distance. These are about waist high (for me), much too high for many a child. All of these cases are only a couple of inches deep in the front and this, remarkably, is where the mini-spotlights, the only lights in the case, are housed. Of course, this means that the light does not play down upon the objects in the case but flows across them essentially horizontally. The backs of the cases are higher, perhaps six or eight inches, and on these surfaces are panels with label information and modest text

Figure 2. **One of the introductory displays. Much of the light is from the flash used for the photograph, but not all of the annoying reflections can be so attributed. The lighting of the specimens in the lower right is typical of the type of lighting which characterizes most of the gallery. Photo courtesy of The Natural History Museum.**

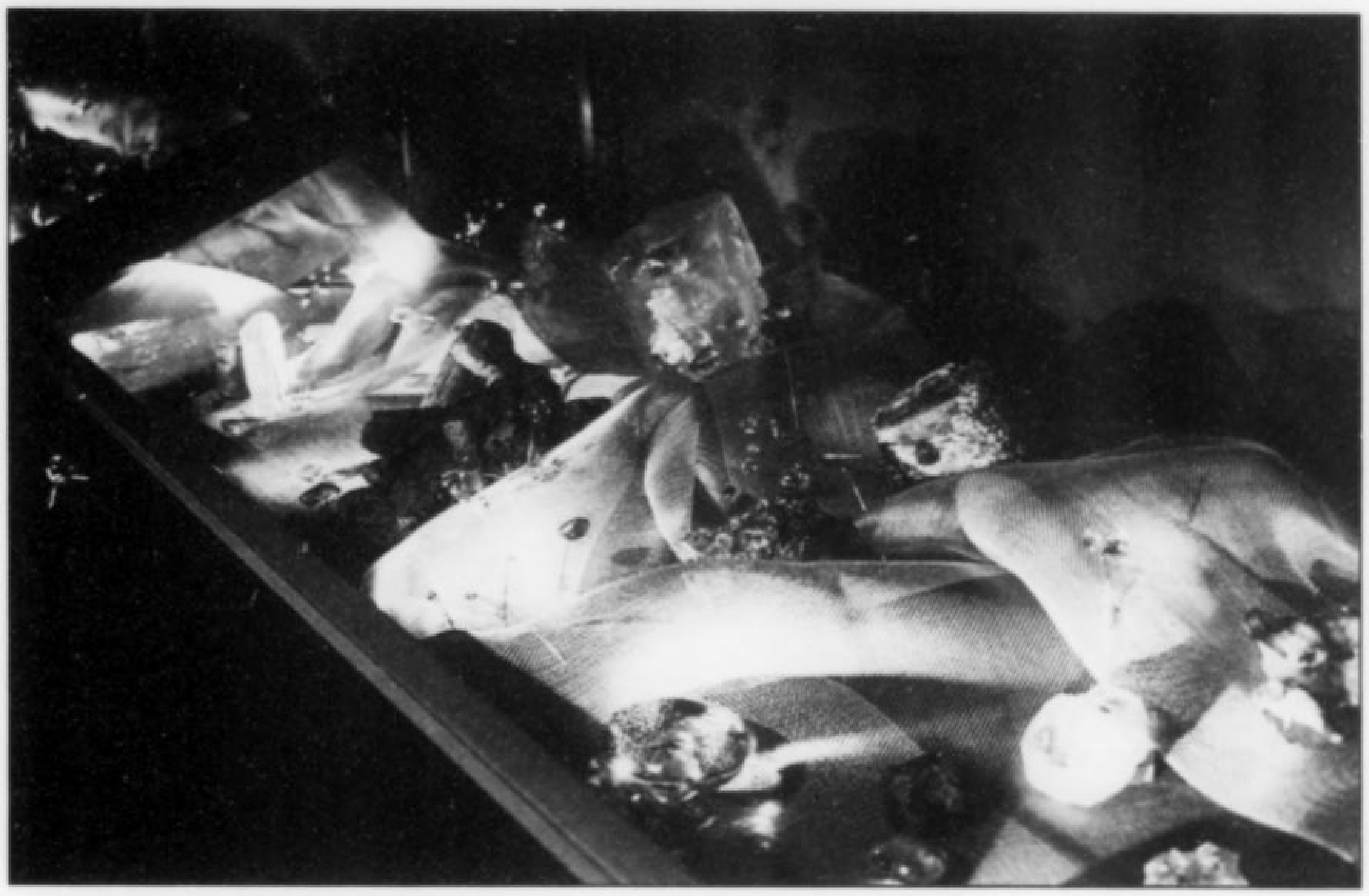


Figure 3. **One of the bizarre uses of metal screen in which is found a jumble of faceted gems and crystals. Note the absence of both labels and adequate lighting. Photo courtesy of The Natural History Museum.**

screened onto them. This is a startlingly inept arrangement. The lights strike the objects in the front of the case, and these objects cast shadows on those behind; altogether many of these objects cast shadows on the labels in the very back of the cases, making them extremely difficult to read. Some of the objects within these cases are in total darkness! The labels, in general, are keyed to tiny numbers placed among the objects in the case, and these are also difficult to read. There are numbers for most specimens, but in some cases there are only a few numbers, and the visitor is left to try to relate label information to specimens that are unnumbered, at least those that can be seen and/or read.

There are, I believe, about 22 of these cases mounted along the right wall, separated slightly into two groups of eleven. The "topics" for the first group are: Gemstones: color and cut; The Collectors: Charles Pain; The Collectors: Arthur Herbert Church and Charles R. Matthews; Collectors gems (2 cases); Tourmaline; Topaz/Zircon/Peridot; Garnet/Spinel/Chrysoberyl; Simulants & Fakes/Synthetic and Industrial Diamonds; The Collectors: Sir Arthur Russell (2 cases); and The Collectors: Frederick Noel Ashcroft. The second set includes Organic Gems; Metal Ores; Tsumeb: a natural plumbing accident; Rare Earth Elements; Minerals for the Chemical Industry; Minerals that Harm; Slates and Tiles; Clays and Clay Minerals; Agates and Other Silicas; and Quartz and Opal. Believe it or not, this bizarre assembly was described in a published review of this gallery as "a huge continuous case with gems and minerals in a *systematic* (emphasis added) arrangement" (Sharpe, Howe and Howells, 1998). I would love to have the authors of that review explain what is systematic about this odd gathering of gemstones, asbestos and slate.

But that is the least of the problems with these cases. As mentioned, they are about waist-high for me, so many children will not be able to see into them at all. They are all similarly dark and heavily shadowed so that numbers and labels are very difficult to read. Perhaps in order not to exclude shorter visitors altogether, mirrors hover over these cases so that if one looks up one can see the reflected image of their interiors, a fact that isn't terribly gratifying because viewing the underlit and shadowed objects this way effectively places them at more than twice the distance from the eye and reverses all of the labels. These cases alone have been recycled from the old Geological Museum, having been "polished up and given a bit of late 1990's stainless steel trim, in the dim light they pass as new" (Pearman, 1998). Ironically, the specimens that they formerly contained, even though less spectacular on average, could be much better seen and appreciated than those that presently occupy these spaces.

The first of these cases is stunning, but in a way not anticipated by the designer, I am certain. It is so bad that it makes one want to turn around and go home. It is filled with perhaps hundreds of faceted gems. Attached to each is a sort of clip with a long (about 3 inches) gold-plated(!) wire filament sticking out from the bottom of the gem. Attached near the end of each wire is a small plastic label which contains, I was told, the catalog number of the piece, for museum accounting only. Originally, these wisps of wire were to have been inserted into some sort of base in order to make the gems stand up with their tables more or less facing the viewer. The plastic labels were to have been placed below the supporting surface and not seen. However, it was discovered that this design was unworkable (I believe that the gems would have been too high for the lights to strike them) so the gems were simply laid out on the floor of the case with all of these metal tails sticking up in the air behind them with their plastic tags prominently displayed. It looks very much like someone just took a box of these gems with tails and dumped them in the case. None of the gems are oriented so that they can be viewed properly, and even if they were, the lighting and shadowing are so bad that the colors are largely suppressed and cannot in any way be appreciated. The same may be said for six or seven other cases in this series, all of which have their wire tails sticking up in the air.

Further along in this section is a case devoted to gems of the minerals chrysoberyl, spinel and garnet. The text and label information for the chrysoberyls appears at the left of the back panel, yet the chrysoberyls are on the right side of the case, and the opposite is true for the garnets. Meaningful information is very difficult to find. Garnets are described as "a group of silicate minerals of varying but distinct chemical capacities." Even though garnet species names are used, there is no attempt made to explain the terms "species" and "variety," the visitor is left to work that one out on his/her own. The tourmalines are treated differently than the garnets; only the group name "tourmaline" appears; none of the species names are given. There is no worthwhile chemical information presented anywhere.

Perhaps the best case in the hall (there has to be one that qualifies no matter how awful the entire thing is) is the one of which the museum seems to be most proud, "Minerals of the UK." There are not a lot of specimens in this case, but those that are present are superb indeed. The biggest problem with the case, however, is the lighting which somehow manages to wash out the colors of these extraordinary specimens. This is also a narrow walk-around case so that the specimens can be viewed from two sides. But the specimens are mostly oriented toward just one side, and the identifying numbers that are to be matched with the labels at the bottom of the case on both sides appear on the "front" side only!

It is bad enough that most of the labels and many of the identifying numbers are very difficult to read, but to make matters worse there are specimens in many of the cases that have *no* labels at all. Nothing! To the museum's credit, I noted very few labeling errors, but this sole commendation is overwhelmed by shortcomings of all sorts. It is appropriate that the staff refers to this gallery as a "permanent" exhibit because the possibility of upgrading or substituting has just about been precluded by the design. Individual specimens do not have individual labels. Rather, whole groups of specimens have numbers placed next to them so that the labels with corresponding numbers can be grouped and screened onto large panels placed in the back of or at the foot of the case. This means that changing just one specimen would require replacing the entire panel, not very practical, and not likely to happen. Furthermore, the outlandish design of many of the cases also precludes specimen replacement. These cases feature steel rods inserted into the backs of vertical cases, forming a regular geometric array. The specimens are squeezed in between these rods and, if necessary, those behind the specimen are shortened. This is perhaps the most inflexible display scheme one could devise, and it is not very pleasant to look at.

I could go on and on, but I am in danger of running out of negatives. There is not a single display element in this hall that does not warrant severe criticism. The designer appears not to have given a thought to maintenance, as most of the display cases are not sealed and some have great gaps between glass panels, thus allowing insidious dust to creep in with ease. Most of the lights are inside the cases so that when they require replacing, someone has to open these cases. Who does this? It is a lot to ask of the curatorial staff that they become bulb changers, yet the specimens are often both valuable and fragile, so the task should not be left to service personnel. This is a major problem but is one that could have been addressed in the design.

As one approaches the end of the hall, there are two prominent features guaranteed to anchor one's disgust with the entire effort. On the left is a large glass and steel wall which looks very much like an automat (the kind with hinged windows with food behind them). This is mostly empty, but a few specimens have been inserted including some large sheets of muscovite with interesting inclusions. The problem is that the lighting is poor and the area behind this case is dark so that the visitor is forced to view transparent muscovite sheets in front of a grey to black background. The glass is covered with what appear to be greasy streaks; it looks filthy. The other stunning feature is a huge gray monolith, a rectangular block about 8 feet across, 1 foot thick and perhaps 12 feet high, parked in what is undoubtedly the darkest portion of the entire hall. Screened onto the surface that faces the gallery are the names of all the mineral species known, I suppose, at the time it was designed. The names are printed in type that is about 1/3 inch high, sort of brown in color, and nearly impossible to read because the lights for this monstrosity play down from the ceiling and reflect off its steel surface. The fingerprints that are all over it, however, stand out clearly.

The gallery is flat-out depressing, and not just because of what high-tech run-amok design has created. It is depressing because a travesty has been made of what is (or was) arguably one of the finest exhibition collections ever assembled. The selection makes no sense, the order (or disorder) with which it is presented makes no sense, and the poor lighting and labeling utterly destroy what may have otherwise been inadvertently worthwhile. The glitz and glitter of all the glass and metal may briefly awe the visitor, but all too quickly any excitement stimulated by that first encounter is snuffed out by the dark and depressing reality of this senses-numbing cavern of mis-lit, disorganized and ill-labeled confusion. This gallery could very well serve as a model of what can happen when the inmates take over the asylum, when the wrong people are given absolute authority over curators, when design becomes more important than the objects around which a museum justifies its existence.

It would be unfair of me to leave the reader with the impression that everyone feels as I do. In fact, the designer of this abortion, David Bentheim, was lauded by *Design Week* (a journal?) for presenting specimens "in an original, informative and innovative way." This is a little like an automobile magazine lauding the design of a new car even though the car won't run and has never left the garage. The design may indeed be original and innovative, but informative is one adjective that very definitely does not apply. The gallery was reviewed for *The Geological Curator* by three people from the National Museums and Galleries of Wales (Sharpe, Howe and Howells, 1998). In a not altogether flattering commentary, they still managed to write such tripe as "with well thought out cases and lighting," and in reference to the "exhibitions" in *Earth's treasury* "they look good, with superb specimens, well-displayed." In fact, the cases lack any form of coherence and the lighting is simply appalling. The minerals and the gems should be the stars of the show, but they have been given less than second-class status. It may be that some of the metal and glass display units used in *Earth's treasury* could be effective in a modern up-scale jewelry store, but it must be remembered that jewelry stores do not traditionally label their inventory, so the inadequate and largely unreadable labels would not present a problem for them. They would never, however, attempt to sell gemstones of any sort without bathing them in the best light available. The lighting used in this gallery leaves most of the specimens with washed-out colors and often formless.

Sharpe, Howe and Howells (1998) conclude their review with the statement: "Despite the criticisms geologists and museum professionals might have about the new galleries and the way in which the NHM approaches exhibitions, the galleries will be popular with the public." This is a remarkable statement for, as museum people ought to know and should never lose sight of, the public tends to be acritical. The public tends to assume that museums know better than anybody what they are doing. This means that when new exhibitions are opened, the public will come, and they will appear to like what they see no matter how awful it may be. The director of The Natural History Museum may successfully delude himself into believing that good attendance is a ringing endorsement of content, but he needs to wake up. The principal objective should have been that of displaying as many fine mineral and gem specimens as is reasonable, in a manner in which the specimens can be fully appreciated, and some understanding of them can be derived through an intelligent interpretation. An in-house organ states that the "aim of the exhibition given to David (Bentheim, the designer)" by the NHM was to "encourage a sense of personal discovery for each visitor." I don't think that what was intended was to make each visitor feel like a miner, seeing the specimens as a miner might underground. My most memorable "personal discovery" was that I shall need a flashlight in order to appreciate the gems and minerals, should I ever return to this museum.

As noted in local newspaper coverage (Pearman, 1998) of the opening of *Earth's treasury*, "the public's love affair with museums and galleries is fickle; if new sensations are not provided at frequent intervals, visitor numbers can drop off alarmingly . . . ." It was an advantage, perhaps, in earlier times when museums did not have to scramble for visitors' dollars. Today's museums, unfortunately, have been forced into the revenue-gathering business so that attendance is now the measure of their "success," rather than faithful adherence to the core functions which make museums unique among all educational facilities and related media-based educational tools. The core functions, which accrue to museums alone, are the collecting, preserving and effective displaying of actual specimens.

In all of the literature that I have seen relating to this gallery, much is made over the fact that more than 3000 specimens are exhibited. This becomes a hollow claim when the lighting is so poor that the specimens cannot be properly appreciated and the labeling is so poor (or even absent) that many of these specimens cannot even be identified and those that can often require considerable effort. It is a harsh judgment indeed, but I do not believe that this exhibition is salvageable. In my opinion it ought to be torn out and completely replaced. It is far and away the worst of its kind that I have seen. And it did not come cheap. According to Sharpe, Howe and Howells (1998), over 8.5 million dollars was spent on exhibitions alone in the Earth Galleries, an average of about 1.5 million dollars per gallery, or something like $1600 per square meter, but one cannot assume that this gallery did not far exceed the average cost. Even though a complete disaster, it *looks* expensive.

My heart goes out to the curators, for whom *Earth's treasury* must be a terrible embarrassment; they cannot be pleased with any aspect of it. Visitors to the museum have been cheated as well, for they are deprived of seeing a superb mineral collection properly displayed. Many of the world's finest mineral specimens are here but one would be lucky to find them, let alone fully appreciate their importance. Curiously, the old mineral exhibit in the old British Museum (NH) building (which is still in place but its days are probably numbered), with only daylight to illuminate the minerals, shows its objects to far better advantage. Even on a cloudy day, the visitor can see the form and color of every specimen and can read the labels with ease. How refreshing!

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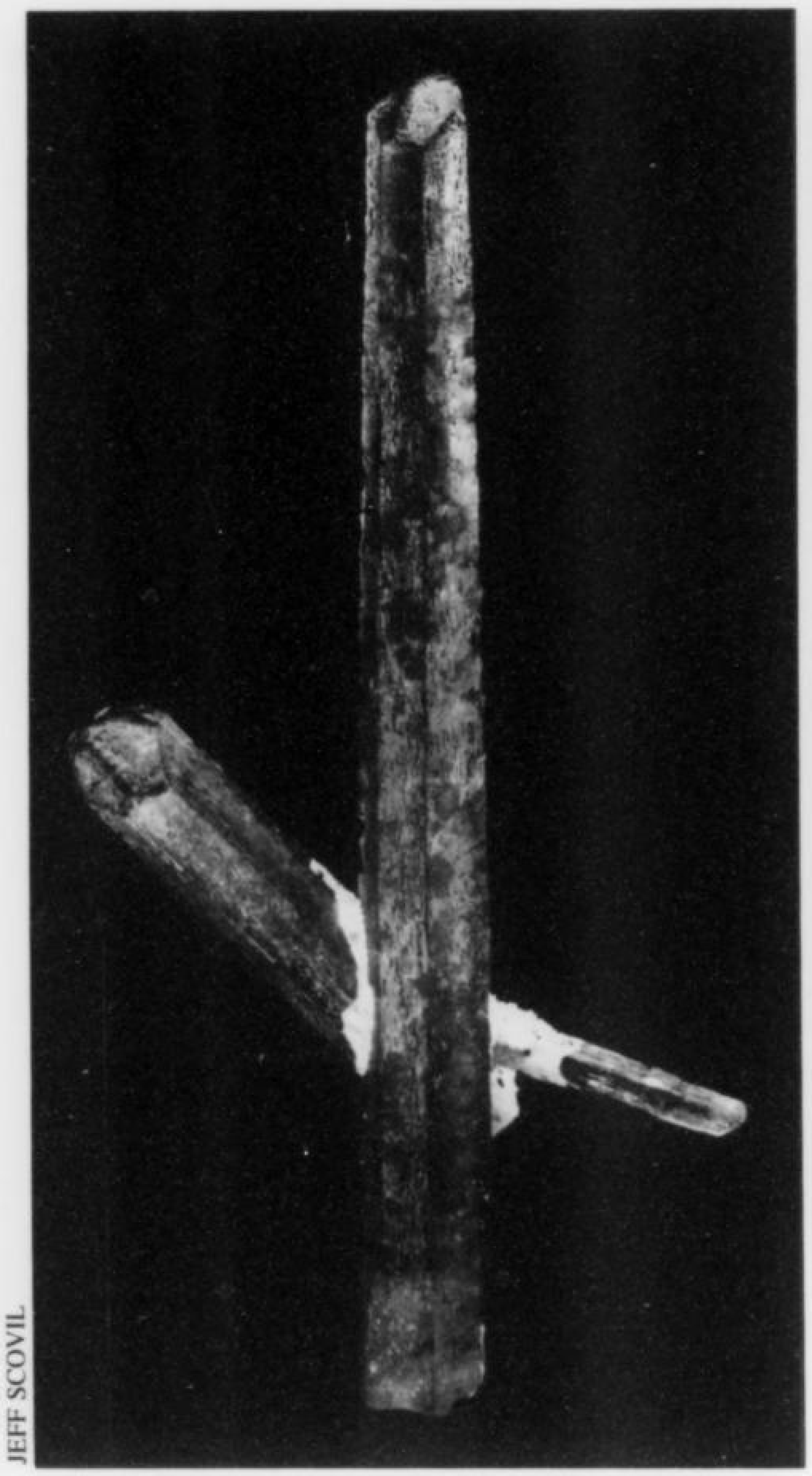
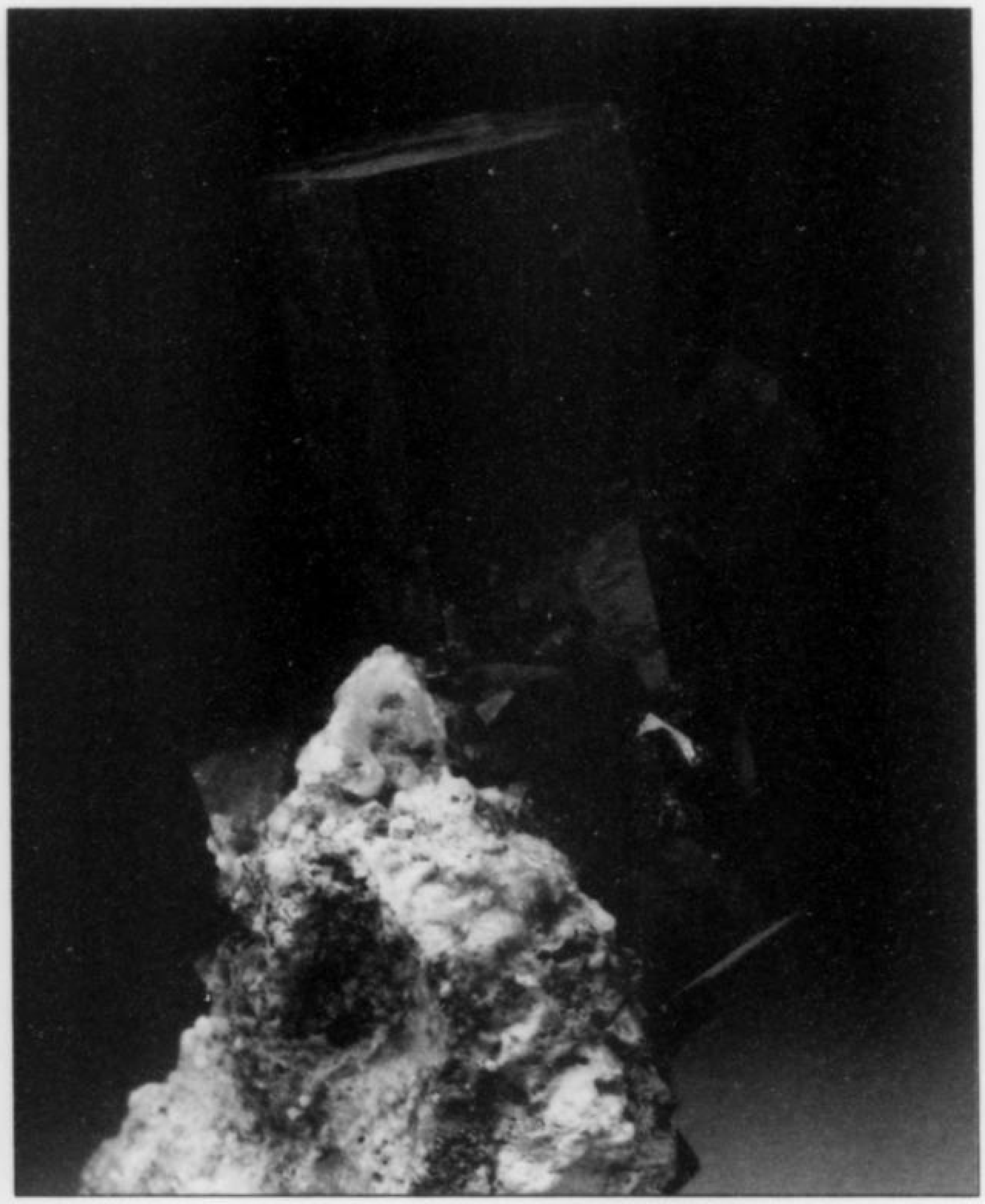


JEFF SCOVIL

JEREMEJEVITE
nr. Swakopmund,
Namibia
F. John Barlow Collection



JEFF SCOVIL

RED BERYL
Wah Wah Mountains,
Utah
F. John Barlow Collection

The Collector's Edge Minerals, Inc.

We have just acquired the F. John Barlow collection! This exquisite collection contains thousands of superb worldwide mineral specimens. Mr. Barlow's collection includes numerous mineral suites that reflect thirty years of devotion to the hobby. If you have any special wants regarding specimens in this collection, please contact us immediately.

We are interested in your collection, too. If you have fine minerals or a fine mineral collection and are interested in selling, please call us for a confidential meeting. We pay top prices for superb material.

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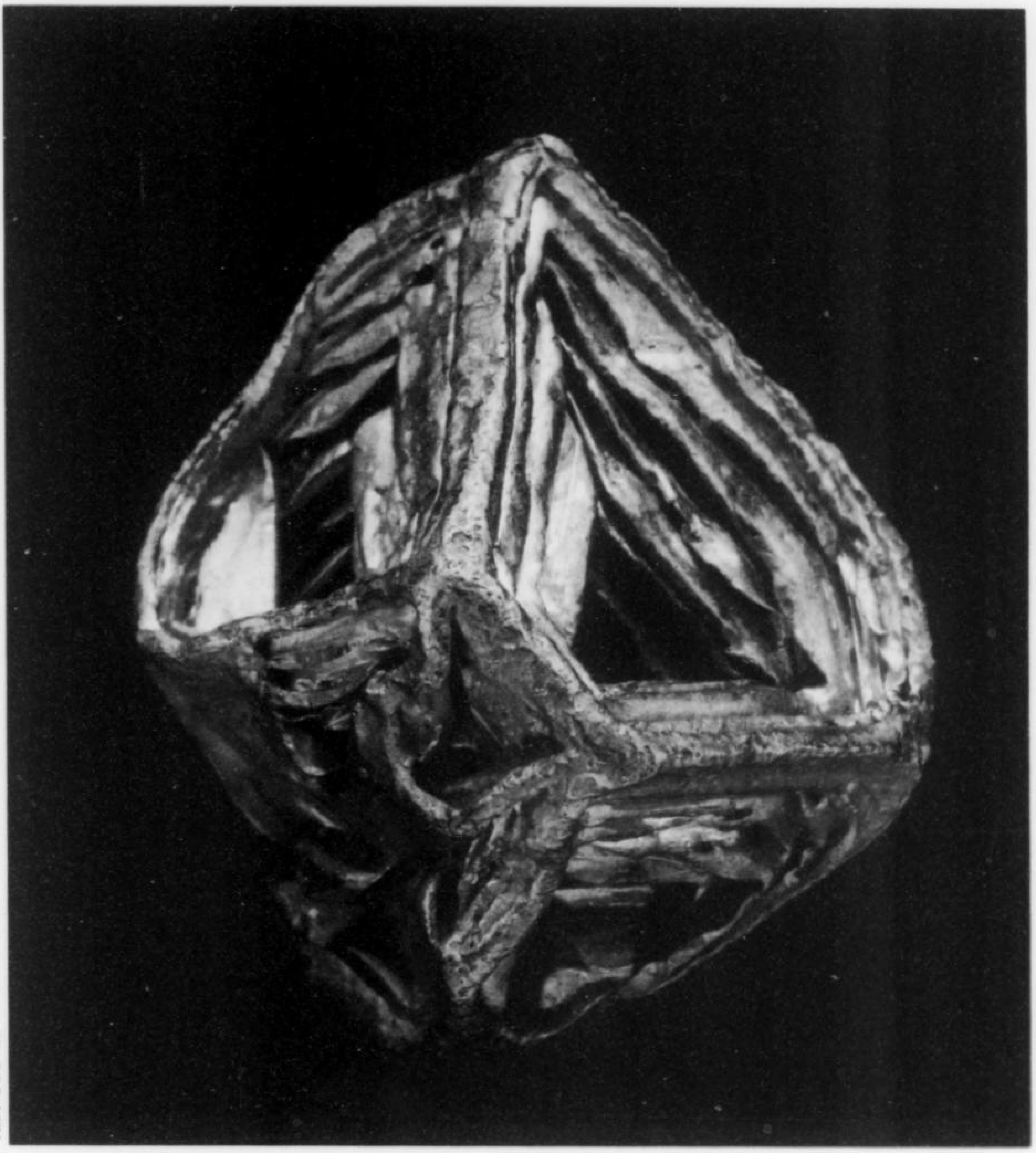

JEFF SCOVIL

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Zapata Field,
Venezuela
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MINERAL STORIES

A Remarkable Site

by Michele Dondi and Gianluca Puggioli

The summer of 1983 found us exploring the sunny and pebbly bed of Brasimone Creek in the Emilian Apennine Alps of northern Italy. The summer heat seemed to amplify the almost deafening screeches of the cicadas. For several hours we had been searching in vain for ophiolitic rocks containing millerite-vaesite-jamborite mineralization known to yield excellent micromounts.

Around noon, tired and discouraged, we sat down in the cool shadow cast across the creek bed by a small bridge. There we ate our mortadella sandwiches, and afterwards began absent-mindedly pitching stones into what remained of the stream not far away.

We had not bothered to examine the rocks where we were sitting; but at that moment I noticed that the rock I was about to throw was very strange. It looked like serpentine studded with green garnet crystals, very much like the demantoids from Val Malenco! A thrill ran down my spine! Had we stumbled onto an extraordinary locality?

Hastily I picked up another rock, this one having an unusual pink color just like the rhodonite-tinzenite assemblage from Val Graveglia in Liguria! I was absolutely flabbergasted. In the meantime Gianluca had found a pyrite-hematite specimen reminiscent of what we had seen recently on the Isle of Elba. And we noticed that near his foot was a scapolite specimen like those which are so characteristic of a valley in the Lombardy Alps!

These specimens, we soon realized, came from a small heap where someone had carelessly dumped out some wooden boxes that had been ruined by the high water level of the winter flood season. The contents were scattered over several meters around: vesuvianite (from Bellecombe, Aaosta Valley?), epidote (from Antronapiana, Ossola Valley?), zeolites (from Fassa Valley?), stibnite (from the Cetine mine in Tuscany?), galena and phosgenite (from Monteponi, Sardinia?), sulfur (from Sicily?), and so on. In just a few minutes we took a trip to some of the most famous mineral localities in Italy!

All of the specimens we recovered are miniature-size and perhaps a little weathered. None is particularly rare or exceptional, but they are all of good commercial quality. Who had disposed of them there? We never did find out.

Toward the end of that summer day we found, at the bottom of the heap, what we had sought in the beginning: some ophiolite specimens containing beautiful millerite-vaesite-jamborite microcrystals. But we're still trying to figure out exactly where they came from, since we never did find the outcrop.

The Quiet Collectors

by Al Ordway

It was sometime during the summer of 1964, when Bob Bartsch, a couple of his friends and I went to Rincon, California, to collect, with others, at the Mack mine. The Mack mine, which belonged to Mrs. Hall, was situated about 250 feet from her house. Her home is one of the oldest structures in the valley and is surrounded by a forest of beautiful cactus, succulents, and flowers of all colors.

Mrs. Hall enjoyed the serenity of her home, but did allow collecting by the occasional visitor, providing they worked *quietly*! The Mack Pegmatite had produced small, but excellent aquamarines. It was located on the gentle slope of a small knoll within a shallow ravine. The hanging wall of this pegmatite had been removed decades ago, leaving only the dense footwall with its myriad of empty vugs attesting to the bygone richness of this small pegmatite. Mining had ceased when the ground level of the ravine was reached.

It was our intent to probe a bit below this level because there was ample evidence of a continuous, but sparse pocket zone. Jonnie Springer was the first to meet us at the mine only a few minutes ahead of Josie Scripps. Josie was a friend of Mrs. Hall, and had informed her of our visit. Since Mrs. Hall was somewhat reclusive and seldom came out to the mine, an air compressor and appurtenances were brought in under the assumption that she wouldn't notice.

We parked on the road which was about 100 feet from and 15 feet higher than the mine. We drilled about a 6-foot hole at a low angle into and under the pegmatite. One stick of dynamite was all that was needed for cracking that portion of the pegmatite without damaging any vugs which might be near. This was to be a safe, *quiet* job, since one stick would produce only a small puff of dust and little noise. Certainly, it couldn't disturb Mrs. Hall.

The two friends of Bob were eager to be powdermen, so they carried the blasting material to the drill hole. Bob showed them what to do, then he came up to the road leaving the "powdermen" without supervision. Apparently, they didn't understand the instructions because (unknown to us) they proceeded to pack most of the drill hole with dynamite! The fuse was lit and we all stood at the side of our vehicles, anxiously waiting for the quiet "thump," signifying it was time to go in and dismantle the pegmatite in search of those beautiful beryls.

The dynamite ignited, and the concussion was immense! A large cloud of dust rose swiftly into the air, followed closely by the Mack pegmatite. We arched our backs and watched the larger chunks of rock as they gracefully crested and began their descent. Though we were thus far being pelted only by minuscule fragments, we saw the big *coup de grâce* headed our way! Panic ensued. Josie dove to get under her truck and I was on her back vying for the same narrow space. I didn't know where Jonnie or the others were, but I assumed they were heading for cover too.

As the fragments fell all around us, there was one loud "kachunk" and then silence. We all got out from our safe havens and just stood there in shock. We learned that the loud "kachunk" was caused by a large rock that hit the top of Jonnie's new Chevrolet station wagon. Josie broke out in hysterical laughter when she saw the depression on Jonnie's wagon. Jonnie didn't seem to share in this humor, as she glared at Bob and me. Though not discernible, her lips were saying, "you morons!"

We looked over at Mrs. Hall's house and saw that it was dusted white and had a scattering of minor rock fragments on the roof. We expected to be admonished by Mrs. Hall, but she was either oblivious as to what had happened or was too frightened to come out.

We checked the blast area and, though there remained workable pegmatite, the area we had planned to exploit was now a small crater. We rolled up the hose, packed up the tools and exited the property as quietly as we arrived.

The Magic Beans

by Art Smith

For Spring vacation in 1959, my friend Ed and I decided to load up his 1957 Buick with our large supply of Morgan County, Missouri, Buckshot mine barite crystal specimens and head south from Columbia. Our intent was to sell or trade them with the numerous rockshops in the Hot Springs, Arkansas area that I had scouted out the previous year.

Our first stop after a cold rainy overnight under a state park's picnic shelter was the Rush Creek zinc district of the northern Arkansas Ozarks. [Ed. note: See the article on the Rush Creek district in vol. 24, p. 285.] It was a clear, beautiful, early Spring day as we entered the Rush Valley and forded the creek. We spotted some open adits above us into the valley wall and pulled into the first shanty we saw to see if we needed permission to collect at them. The shanty belonged to a retired miner and was a typical Ozark classic with the chickens and other animals having as much right of access to the back door and the kitchen as people. His answer was friendly:

> Sure you can collect in them old mines. They have been abandoned for years, but people are doing some work in the Monty [Monte Cristo mine] down the valley and up Clabber Creek, so you probably won't get in there. If you jest want some rock samples and cryshtels, jest hep yerself to those over there." [He pointed to some shelves on the side of a shed lined with specimens.] I got some rosin jack, a little black jack, lots a spar, some crystal, even some yellow, brown and gray turkey fat and other rocks from these mines you can have.

We thanked him but said we would like to try to collect our own first. Leaving our car parked at his place we climbed up to the closest adit with our flash lights and collecting gear and prowled and collected a few specimens, which proved not to be an easy task. Perhaps it was knowing that there were some "easy pickins" down below, but our enthusiasm for collecting quickly dulled and so after a couple of hours we returned to see if the specimen offer was still open.

We were invited in for lunch, which was cooking in a large skillet and was generously shared with chickens and cats by a little flick of the fork he was stirring it with. We politely declined, citing a huge breakfast as the reason and casually mentioned that we could use a few of his specimens.

"Sure thing, hep yurselves," he said.

Not wanting to appear overly greedy we carefully and slowly examined the specimens of smithsonite, sphalerite, dolomite, calcite and some tiny quartz crystals on the shelves. Feeling something under my foot, I moved it and looked down on a large (over one inch), smooth and dark kidney-shaped seed. I picked it up and noticing others, gathered several and started to put them in my jacket pocket.

"Those are not for you to have!" jolted me back to reality and I figured Ed had selected some of his prize specimens from the wrong shelf. But, no, he was directing his comments at me. I removed my hand from my pocket and showed him the seeds I had picked up which by then I realized littered most of the ground.

"You cain't have them!" he said sternly. "Them is magic beans. You can have all the rocks you want but not them beans!"

I expected a smile but there was none. So the seeds were slowly dropped to the ground. I do not think there was a look of disappointment on my face, only shock, but the miner must have thought otherwise and conceded me one, and only one, of his magic beans. Ed did not even ask for one.

Eventually we made our selections of three or four specimens apiece. Carefully we packed up our specimens and the one magic bean and left, heading south to Hot Springs. If the bean was magic, it did not work for us on that trip. Maybe in trying to take so many, or in taking even one, we incurred the curse of the magic beans. I suspect so, because:

(1) The water in Rush Creek had risen from the night before and we got stuck right in the middle of it.

(2) The rock shops in the Hot Springs area did not want our barite crystals. "They look jest like cryshtel and we have plenty of that."

(3) We got chased out of the magnetite mine in Magnet Cove when we tried to collect there.

(4) The owners of the Crater of Diamonds mine wanted to charge us the full price of $3.50 to see their museum and dig for diamonds even though there was less than an hour until they closed. We offered fifty cents to see the museum but it was rejected and so we missed it.

(5) We spent most of a day searching but could not find the Avant wavellite locality.

(6) We ran out of the little money we had, and not because we bought a lot of specimens. We just did not have much.

(7) We both got bad cases of food poisoning from hamburger meat we bought in Murfreesboro, and had an extremely miserable night camping out, and a difficult day trying to make a rendezvous with some other collectors in Joplin, Missouri, which was several hundred miles away.

Need I go on? We did, however, make it back to Columbia safely and fully recovered. The Rush specimens from the miner are long gone, having been upgraded by better specimens, but somewhere in a small leather pouch in a drawer filled with other miscellaneous treasures I still have the magic bean.

Unorthodox Excavation Method

by Bob Fitton

Sometimes it happens that a fine specimen is unexpectedly discovered through an operation of entirely different intent. Here is an example:

One night, about 25 years ago, three friends and I arrived at the Fonda, New York, quartz crystal area in Herkimer County. We had a couple of sandwiches and some beer, then unrolled our sleeping bags and sacked out.

Upon awakening in the morning I walked from the camper to a nearby soil bank, where I was almost immediately rewarded with a large clear quartz crystal, which turned out to be the best find of the entire trip. This gem was unearthed through an inadvertent act of hydraulic mining during the execution of my personal morning routine.

Many years have passed, and this fine crystal still rests proudly in one of my specimen drawers, where its quality is still acknowledged by my companions of that long-ago field trip. But I have yet to see one of them pick it up for a closer examination.

Interesting Inclusions in Quartz

The *Amerindiad & Quartz* shop in Murray Hill, New York, had a nice neon sign in the window: "ROCKS MINERALES." Despite this promising facade, it seemed to have a puzzling lack of customers.

The mystery began to unravel in Little Rock, Arkansas, on December 4, 1993. It was there that U.S. Customs Special Agent Stephen Del Casino seized an unusual shipment of quartz crystal specimens from Colombia, which was on its way to the Murray Hill shop by way of Little Rock. Agent Del Casino did not say whether he was tipped off by the unlikely shipping of quartz *into* Arkansas (normally an exporter of that mineral), but apparently the transportation of quartz from Arkansas to New York had been expected to pass unnoticed there.

The problem was, Customs Agents found 13 kilograms (almost 27 pounds) of cocaine ingeniously concealed within hollowed out portions of the quartz specimens. The eight-month investigation had begun in Colombia and nabbed Luis Valladares, the alleged cocaine trafficker, in Little Rock. Valladares quickly made a deal with the agents to turn informer, and the Lexington Avenue mineral store (unaware of Valladares's arrest) was put under surveillance.

After removing the cocaine from the quartz, Customs Agents sent Valladares on to New York with the now empty specimens to close the sale with shop owners Francisco "Pancho" Aristizabal and Victor Gonzalez. On December 9 the "sting" was completed when Aristizabal and Gonzalez arrived to open their crates, were taken into custody, and were charged with conspiracy to possess and distribute cocaine. The hollowed out quartz specimens were presumably retained as evidence, but their later disposition is unknown.

The Chañarcillo Proustite Lot

by Terry Szenics

In late 1977 I was hired by a company in Teaneck, New Jersey, to take a trip to South America specifically to find and buy mineral specimens. This trip started in Santiago, Chile, a choice which came about in an interesting way. Sometime earlier, the late Mr. Paul Desautels, then of the U.S. National Museum, was advised of something very exciting: a collection of proustites from the famous Chañarcillo locality currently available for sale in Santiago. This information he passed on to the company's head office in Teaneck.

It was a very exciting time for me, as this was going to be my first true international experience in the mineral business, something that I had always wanted to do, and Chile was a country I always wanted to visit. I also spoke fluent Spanish.

The initial information from Chile was sketchy, but was so tantalizing that a trip to Santiago had to be made. January, 1977 found me on the streets of Santiago, in the sweltering heat of a South American summer. A day before I had left New York buried under two recent snowstorms that had delayed my trip for over a week. "Climate shock" (as opposed to culture shock), is the first thing an international traveler has to get used to. Yes, but it's a "dry heat" . . . just like Tucson in July.

I located the owner of this proustite collection at his office in downtown Santiago. Strangely, he wasn't anybody I might have expected. He was a fairly young man in his early 30's, and he was an electrical engineer. When I inquired about his career, he said, "you know, we here design and build high tension power lines, stuff like that." Besides, after talking to him awhile, I could see he wasn't a mineral collector and knew basically nothing of minerals. He seemed the least likely person to have a collection of such a classic and desirable item as Chañarcillo proustite. Perhaps it was an inheritance, I thought. I'd find out soon enough.

The young electrical engineer took me later that day to his house in the tony Santiago suburb of Providencia to see the collection. We went to his garage and there he pointed to a closed wooden box on the floor. With a grin I recognized the box immediately: it had "Cobra" stamped on the top, with typical metal reinforcing on all the edges. It was from the Atlas Copco Corporation and was the type box used to ship their then-widely popular "Cobra" gas-powered rock drills. I also owned a Cobra rock drill back in the States, which I used for mineral collecting.

Staring at the Cobra box while dancing on hot coals, I could only think to myself, "Wow, Martin Ehrmann only had a half dozen Vaux proustites to deal with; here I have a crateful!" There were visions in my head of holding the most classic of Chilean proustites: A single crystal prism a few inches long, with other steeply scalenohedral crystals growing from the sides, like a herculean club with spikes, all the while glowing an intense, gemmy, brilliant scarlet red. Well, a strong dose of reality was about to clobber me, just like any spiked club.

The specimens were all carefully wrapped and as we started unwrapping then, my heart sank. It was proustite all right: bright red smears and small blebs of proustite in pieces of typical vein rock from Chañarcillo: the well-known dense, black, carboniferous calcite rock, shot through with veinlets of white calcite. It was Chañarcillo proustite all right, but nothing more than ore samples at best! No clusters of crystals, no spiked clubs of crystals, no nothing. In fact, not one piece of the dozens and dozens of pieces in the box showed a crystal, not even a tiny vug with a micro proustite crystal.

Quite perturbed, I had to inform my host exactly what he had in his possession, a collection of ore samples. Proustite for sure, but material suited to fit in a square of a cardboard-boxed student collection, never a museum showcase. My host was astonished. He then pulled out a document from his briefcase. It was a letter from the School of Mines in Copiapó, Chile, on their letterhead, signed by one of the professors and stamped with seals and all nice and tidy and official. It was an appraisal of the collection as being a fine collection of Chañarcillo proustite worth $3,000 U.S. dollars. It was, of course, totally wrong.

I asked the engineer what experience in mineral specimen dealing this professor might have had. Though he may have been a good teacher, I told him I didn't think the professor knew anything about the business. Unfortunately, in this case, the engineer took the word of the prestigious School of Mines in Copiapó as gospel. The School has the best mineral collection in Chile, and if you wanted to know more about minerals, that would be the logical place to go for answers. Especially so if you had no contact with mineral dealers outside of Chile.

It escapes me how the young engineer got involved in this deal in the first place. He bought this collection from miners, and whether this document came with the collection, or was obtained later I didn't find out. It, in the end, looked like a case of simply the blind leading the blind. In the end it was all academic: I didn't want the box. If it was free, it wasn't worth the airfreight to New York. Later I sent a telex (remember telex with its long ribbon and millions of funny little holes? Those were the days before Fax not too long ago revolutionized the world of telecommunications) to the head office telling them sadly it was a bust.

Later on this same trip, I did visit the city of Copiapó in northern Chile and was able to get a little better idea of what happened. There was a small mining operation at the time nearby at Chañarcillo, not at the Dolores Tercera mine so famous for its crystallized proustite, but one of the other mines in the Chañarcillo complex. It was at a time when silver prices were a lot higher than today (today *not one* silver or lead-silver mine is working in Chile), so it was a bona-fide metal mining operation. Apparently there was a flurry of excitement as they found a small quantity of the famous proustite, or "rosicler de plata," its old name as it is still known in Chile.

In Copiapó I saw a few small lots of the same material with dealers. In any large quantity it would make a very nice commercial material for the U.S. market. From a famous occurrence, a rather pretty item showing bright red spots of proustite in a contrasty black and white matrix, as long as the price per kilo was most reasonable. There was never any quantity of this material available, and whatever prices they gave me in Copiapó had no basis in reality. In Copiapó they were quoting prices as if these ore samples were all well crystallized. The few vendors in Copiapó were acting as if proustite—any kind of proustite—was the breath of life itself, without any real experience in knowing the mineral specimen market or what constituted a fine specimen or its price.

What none of the people who had this ore-grade proustite could possibly know: just two months before my trip to Chile, I visited the U.S. National Museum in Washington, D.C., and there the curator of the mineral and gem collection, Paul Desautels, took me into a back room where he pulled opened a cabinet drawer to show me the world's finest proustites from the former Vaux Collection, all four or five of them. We both looked at them as if they were gods.

I never did see the electrical engineer again, nor ever found out what was the final disposition of his box of proustite samples. If there is a moral to this story, it is don't ever get involved in a business, any business, that you don't know intimately, and especially don't let anybody decide price for you. Let the buyer beware. And even if you do know a business or any subject, you still don't know everything. I have been collecting minerals most of my life and I still learn something new every day in the wondrous world of minerals, and the not-so-wondrous world of human beings.

Chañarcillo Proustite (Part II)

by Terry Szenics

After a brief stay in Santiago, Chile, as a specimen buyer, I left for the northern city of Copiapó. This was in late 1977.

Copiapó is the administrative capital of Atacama province, and a major center of the mining industry in Chile. For anybody interested in minerals and mining in Chile, Copiapó is the place to be. I was staying in a small, family-run hotel in the downtown area. The owner took an interest in what I was doing, namely looking for export-quality mineral specimens. He especially liked the idea that

I was going to be a long-term guest, spending possibly weeks in his hotel, so he had every reason to make my stay as interesting as possible. (By the way, like so much that has happened in a modern country like Chile, this little hotel has since been torn down, and a new modern multi-story hotel is now in its place, for ten times the price, of course, with no meals included.)

So one day the hotel owner introduced me to the editor of the local newspaper, *The Atacama*, with the idea that I place an ad. So, in the next edition of the paper, on the front page in bold letters was the earth-shaking blurb, "Norteamericano compra minerales" ("American buys minerals.") I had left it up to the editor to place the ad, and didn't know really what to expect. I thought it would be a nice, conservative classified ad in the back pages, but this front page splash was totally out of proportion and turned into a monster for me.

Very quickly the very few bona-fide mineral dealers in town came to visit me. (Since those years all those dealers have disappeared along with whatever mineral specimen business was once in Chile. Sad but true.) Then, as word got around, I started to get a procession of miners in right off the desert. Like patients all suddenly released from some very, very big hospital, they were coming to me now all in various stages of being cured, by alcohol. Most just carried in a few worthless ore samples to offer me. A few carried in nothing: they were only looking for some up-front cash with the "promise" to bring me "exactly what I was looking for" next time they came into town. (Ho! Ho! Ho!)

One particularly obnoxious miner had a bag of what looked like good and heavy chalcocite copper ore. He insisted it was "mineral de alta ley de uranio," or high-grade uranium ore. Because I was an American (shades of Fat Boy and Trinity Site) he figured I had to be only after uranium in Copiapó: looking for mineral specimens had to be only a smokescreen.

One day a man came in who looked more like a flea-market dealer than a miner. He brought me something that still haunts me to this very day. From his bag he pulled out a large, hideous lump of slag from the local smelter, replete with ropy, vitreous texture and air bubbles frozen in time. He had cut the base and at strategic points up and down the surface had drilled in holes at sharp angles. With a flair he proceeded to stick pens and pencils in the holes and voila!: he proudly held out to me the perfect gift for the office desk: your very own slag pen and pencil holder! (I didn't buy it.)

In a very short period of time I was getting disgusted fast. My dream of being the new up-and-coming Martin Ehrmann was eroding quickly between these Santiago-Copiapó bookends. Besides getting a few nice specimens from the dealers I met, I also had a few people come into the hotel offering me proustite. But this routine wore thin quickly, even though these people were thoroughly innocent.

They would take me to their homes, and in a back room we would go to an old-fashioned safe, open it up and take out a folded up piece of black corduroy or felt cloth. Carefully unwrapping the cloth as if it held cut diamonds, they would show me a mass of rough proustite ore, or a red proustite smear on matrix, all mined many years ago at Chañarcillo. Interesting as perhaps a historical item, but hardly worth it as a desirable mineral specimen. Everybody possessed the nonsensical routine of showing me the piece for exactly 10 seconds, then fearfully grabbing it out of my hands, to wrap it up again. They were convinced that, demon-like, proustite's fabulous red color would disappear after a few minutes in sunlight. Like a broken record, I had to tell them over and over again that, yes, proustite *does* lose its color, but only after *long periods* of time: years in fact in lighted areas, such as unprotected museum showcases. God knows over the years how much black cloth has been sold in Copiapó. That cloth merchant must still be laughing up his sleeve; these proustites were hardly worth protecting so well.

Then one day an attractive young woman in her 20's came to the hotel, hearing that I was in town buying minerals. She said her father had a proustite put away that he might want to sell. Already I was used to the red ore sample-black felt routine, but like a good mineral dealer, I had to check *every* lead, or I'd be derelict in my duty. Why be in Copiapó in the first place?

She took me to their home, only a few short blocks from the hotel. I had already walked by this house a number of times, not suspecting a thing. It was that crazy newspaper ad that brought this gal to my hotel. She introduced me to her father, and he went back to (of course, what else?) his big old safe in the back room. He brought out the customary folded-up wad of black cloth. This time when he unfolded it, out came a choicely crystallized mass of deep red proustite in matrix the size of a lady's fist! I just stared at it for a moment, and all the pain and suffering of the past month in Chile melted away. I just stared at it. It was fine, very fine, though not up to the Vaux Collection proustite standards. For the year of our Lord 1978, in the total length of the Republic of Chile, to actually *see* a finely crystallized proustite was a miracle in itself.

Though the actual sizes in cm are lost to me now over the years, the specimen had a number of steeply terminated prisms rising from the matrix, not too terribly tall they were, say up to 2 cm. There were smaller accessory crystals in the matrix itself, with crystals in the matrix growing out at right angles from the upright prisms; the start of the classic "herculean club" form that fascinates collectors so much. Later checking with a loupe, there was some black mineral in microcrystals on some of the proustite surfaces which I took to be sphalerite. Thinking back now, it seems totally a misidentification. I never did learn what that black mineral was. The only distraction was some slight scuffing on a few crystal surfaces but all in all, a very healthy proustite and handling it that day was a moment I never forgot.

I learned an important lesson that day: to really appreciate a fine mineral specimen as that proustite, you have to pay your dues and suffer a lot first. As a neophyte international mineral specimen dealer, this was the first really fine specimen I was handling. With a fine Chilean proustite, it was a very nice way to start.

(continued on page 392)

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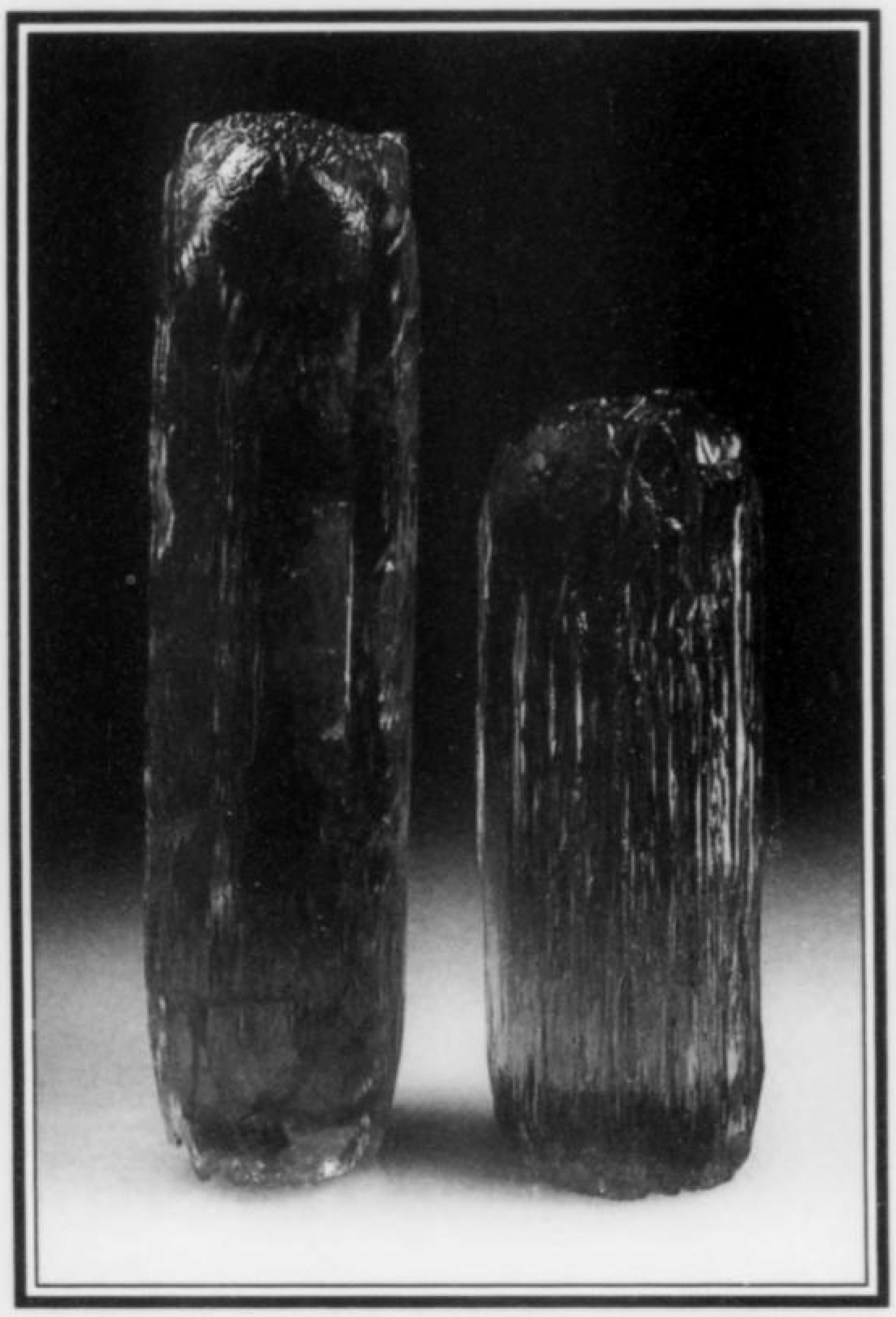

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PHOTO: AQUAMARINE, Jaqueto mine, Bahia, Brazil, 12.2 cm. Photo by Wendell E. Wilson.

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Museums listed alphabetically by city

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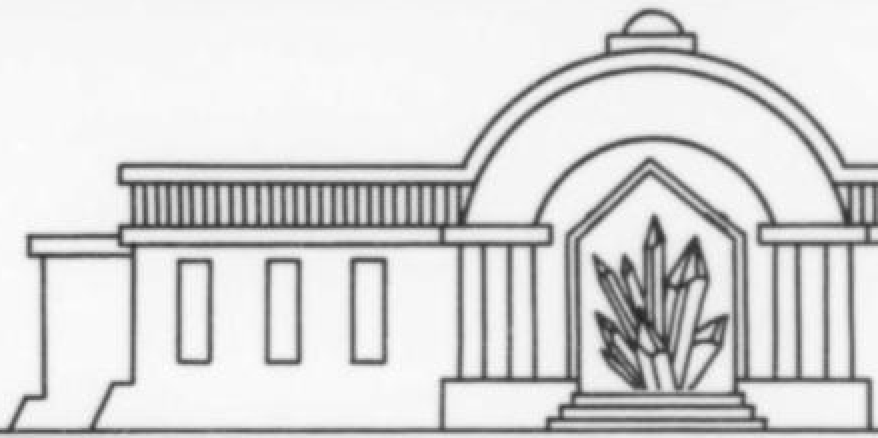

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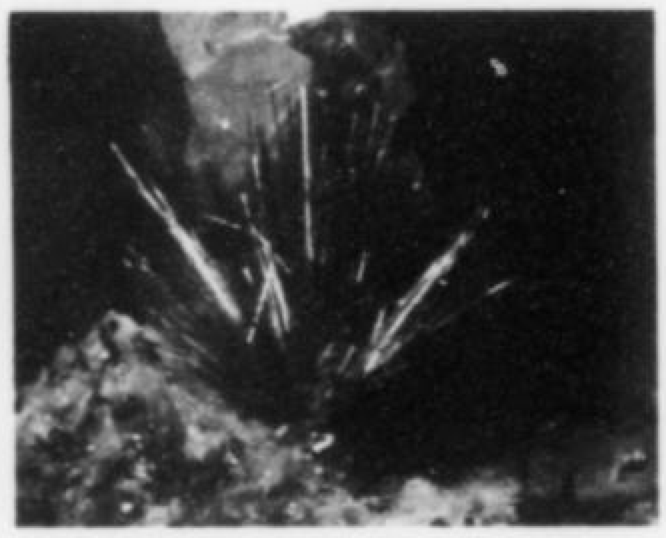

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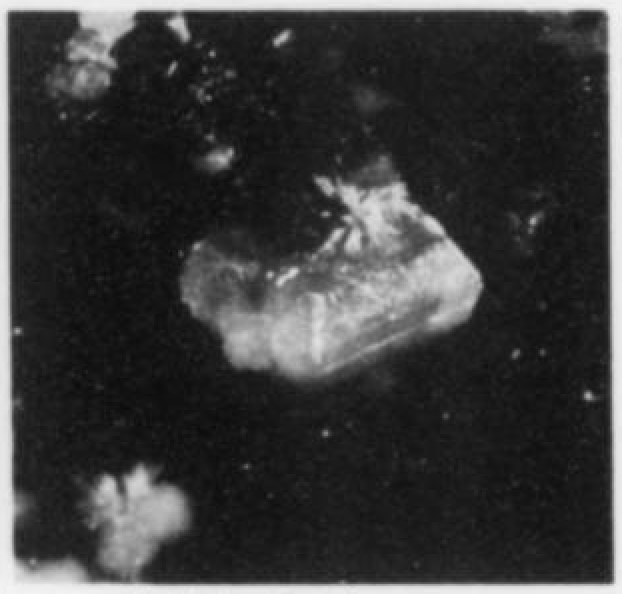

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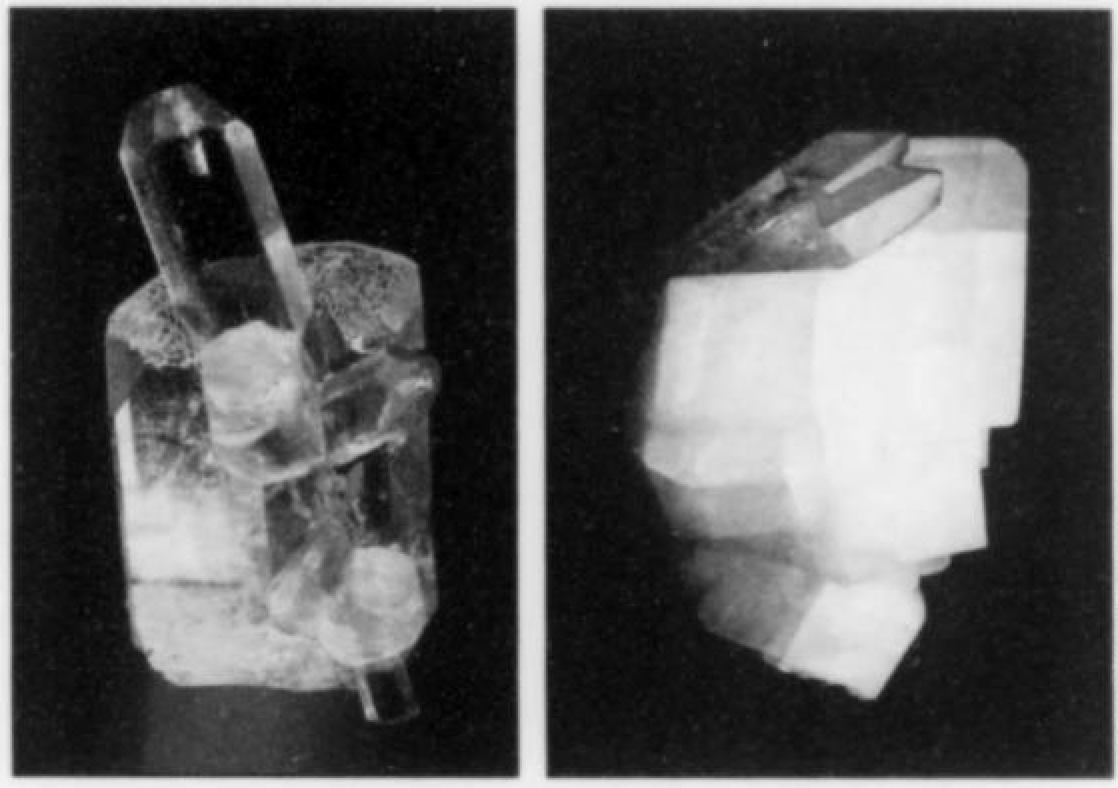

Mineral Stories *(continued from page 385)*

The moment came to get down to business and instinctively I felt I was going to be in a lot of trouble, considering what prices others were asking for proustite rubbish. Like I expected, the man gave me a price that was absurd: $15,000 U.S. I told him although it was a fine proustite, it was worth nowhere near that price. On that we parted, but we left the door open, that I should come back the next day or so. It was up to me now to come back with a counteroffer, and after thinking it over and over, all things considered, I came up with a price I could live with: $3,000 U.S. I didn't sleep well that night, for sure. Making a deal and getting that piece was all that occupied my mind in those hours.

When I came back to him and gave him my price, as expected, he said it would never do, but I could sense he really wanted to sell the specimen. The man was smarter than I originally thought. By throwing out the figure of $15,000 he was giving me a lot of room to trap myself, figuring I was a foreign collector who would pay high just to get any kind of the famous proustite in Chile. Of course it was the ad itself that an "American buyer of minerals" was in town that stimulated him to show it to me in the first place. I was pegged as a high-roller and that environment put me at a disadvantage. Over the following years I was involved in locating and buying other fine specimens in foreign countries where these one-of-a-kind specimens "come out of the woodwork." These individual deals can be especially trying and difficult, as opposed to the more predictable buying of freshly mined lots of commercial specimens in volume.

Well, I decided to stick to my guns and just tell him than $3,000 was all the piece was worth and that is what I'd pay, in cash. After thinking it over awhile, he came back with his final price: $3,500. It stunned me how quickly and sharply he came down it price: Figuring I'd pay $3,000, I'd probably pay somewhat more. In an effort to be diplomatic, I told him that we should split the difference between the two prices: $3,250 U.S. and after some hemming and hawing, he agreed to the final price of $3,250 U.S.

Thinking back today over those dealings, I can see now what dangerous ground I was walking on. Though $3,000-odd dollars was a tremendous sum to pay for a mineral specimen in Copiapó for that year, the piece was worth it, and much more. Today my instinct would be more to cut the deal *fast* at $3,500, "flash the cash" fast out of my pocket, and pay the man in Chilean pesos, U.S. dollars, or Borneo tribal stone money, however the man wanted it, and be off with the specimen just as fast. This man could have just as easily gotten tired of my haggling, telling me "no deal," deciding to wait for some future buyer. Fortunately for me, though, Copiapó was not the place that suffered a constant stream of foreign buyers, such as Lima, Perú, or Governador Valadares, Brazil. I was a novelty there in Copiapó for that space in time.

The problem was now to get him the money. Incredibly, as a buyer then I had nowhere near that amount of money on me. So I had to ask the New Jersey office to wire it to a bank in Santiago. I was looking at having to make a very long bus trip back to Santiago to pick up the funds, so I decided in my wide-eyed innocence to have the money wired from Santiago to a bank in La Serena, the largest city midway between Santiago and Copiapó. I didn't realize it could take longer with South American bank bureaucracy to get the money from Santiago to La Serena. A lot longer: the New York–Santiago transfer would happen instantly by comparison. Within a week though, I made the trip to La Serena and had to wait around all day at the bank for the funds, but the following day was back in Copiapó and finally paid for the proustite specimen. All the while I was running the great risk that the man might change his mind. But he kept his word, and that night in my hotel room I went through the routine of taking the specimen out of its box, examining it over and over again, then putting it back in the box again. This went on till the wee hours of the morning . . . . .

Before the end of my Chilean trip, the proustite specimen was safely shipped to New York along with other specimens. Shortly afterwards, when I was further north in Chile, I visited the famous Chuquicamata mine. It was something I'd hoped to do since childhood, but I found absolutely nothing in the way of minerals this mine is so famous for. I was about 20 years too late.

On the way back I stopped in the port city of Antofagasta. At the time there existed the regional office of the Geological Service of Chile, the equivalent of our U.S. Bureau of Mines in the United States. It was worth checking out, as some of the men who worked there might be mineral collectors or might at least know what mines were currently producing specimens in the area. After all, through their jobs these men were in constant contact with mines in the region. There were a couple of showcases at the office entrance with mostly mineral specimens of industrial nature; things like big pieces of raw sulphur, copper ore and the like. After handling that proustite in Copiapó, I just gave the cases a quick glance and walked in the door.

With one of the men there I got to talking, telling him I was traveling in Chile strictly looking to buy mineral specimens and asking him if he knew anybody in the Antofagasta area who had minerals for sale, old or new, good, bad or indifferent. He told me right off that if I was looking for specimens, I should be in Copiapó, not Antofagasta! Then he told me he had just heard there was recently in Copiapó a major proustite specimen being offered for sale. What? I thought to myself, there is *another* fine proustite there for sale?? He told me not to worry about it, as he heard it was just sold to a foreign buyer for $15,000 U.S. Then it hit me hard, so hard I winced. *That* was the proustite I just bought! It was just that the former owner was telling everybody I paid $15,000 for it, his original asking price!! The word spread fast in Chile, so much so that already this man across from me knew. When I asked who the seller might have been in Copiapó, I was given enough details, including the former owner's name.

I decided to just shut up in that office and keep my little secret to myself. It was best that *nobody* knew I was the buyer of that proustite, especially so now that this wild rumor that I paid such an astronomical price was spreading like a black cloud over me. Boy, news travels fast, doesn't it? Over the years starting with that first trip to Chile I learned *never* to talk about my business to unnecessary people while traveling in foreign countries, but I could never make *other people* stop talking about my business. Though Chile is a very civilized country, there was still the possibility a $15,000 price tag on my head might just fall on very wrong ears in a bar somewhere and I would be assaulted on the street or in my hotel room. This is especially true in dangerous places that produce mineral specimens and gems, places like Lima, Perú, or Nigeria.

I never did find much in Antofagasta, but the seafood was always excellent there. Now, after living in the capital of Santiago for a number of years and traveling and buying minerals in Chile off and on for over 20 years, I have never yet found another proustite of *any* quality, let alone anything like the one I bought in 1977.

Editor's Note: Everybody has a story they like to tell. If it has something to do with minerals, why not share it with other Mineralogical Record *readers? Just write it up (we'll help with the editing) and send it to* ***Lawrence H. Conklin****, 2 West 46th Street, New York, NY 10036, or* ***Wendell E. Wilson****, The Mineralogical Record, 4631 Paseo Tubutama, Tucson, AZ 85750.*

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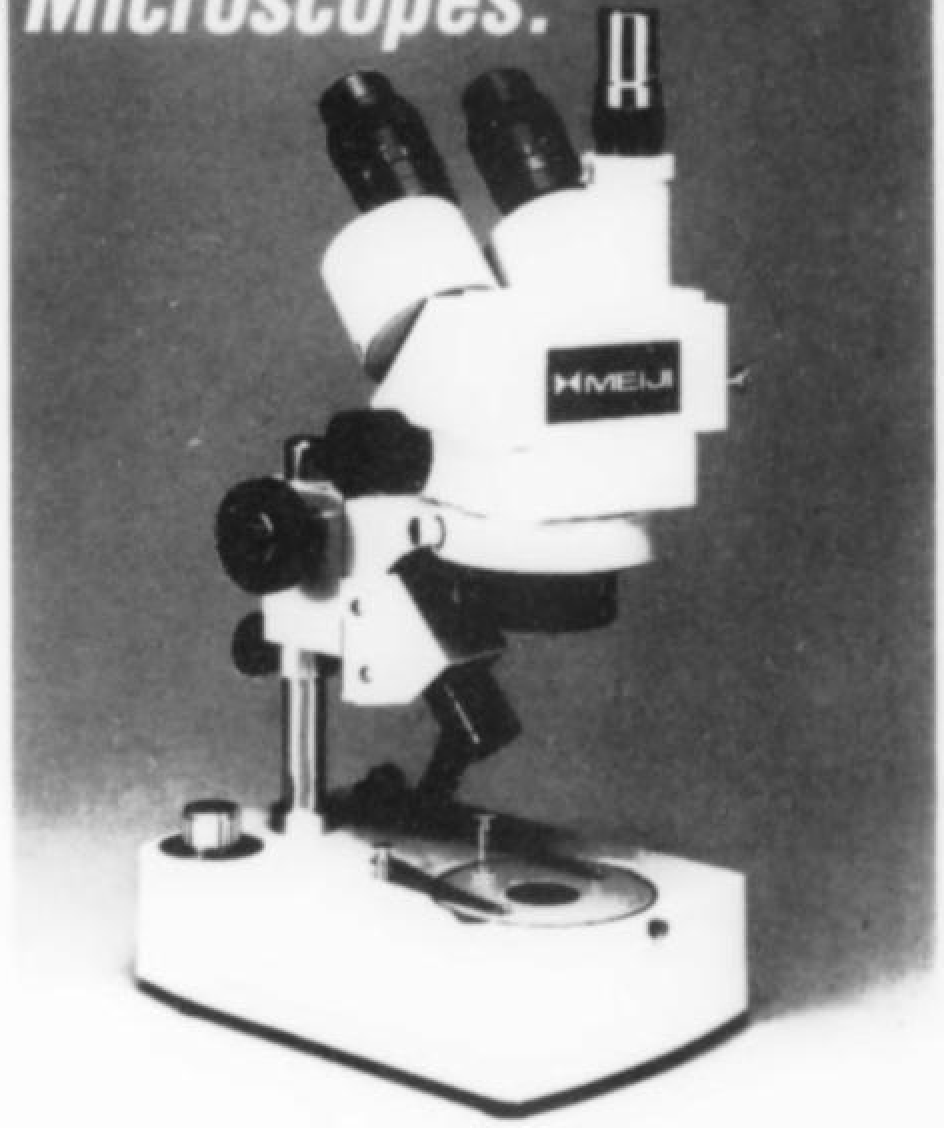

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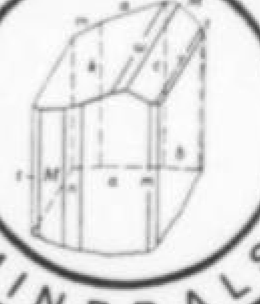

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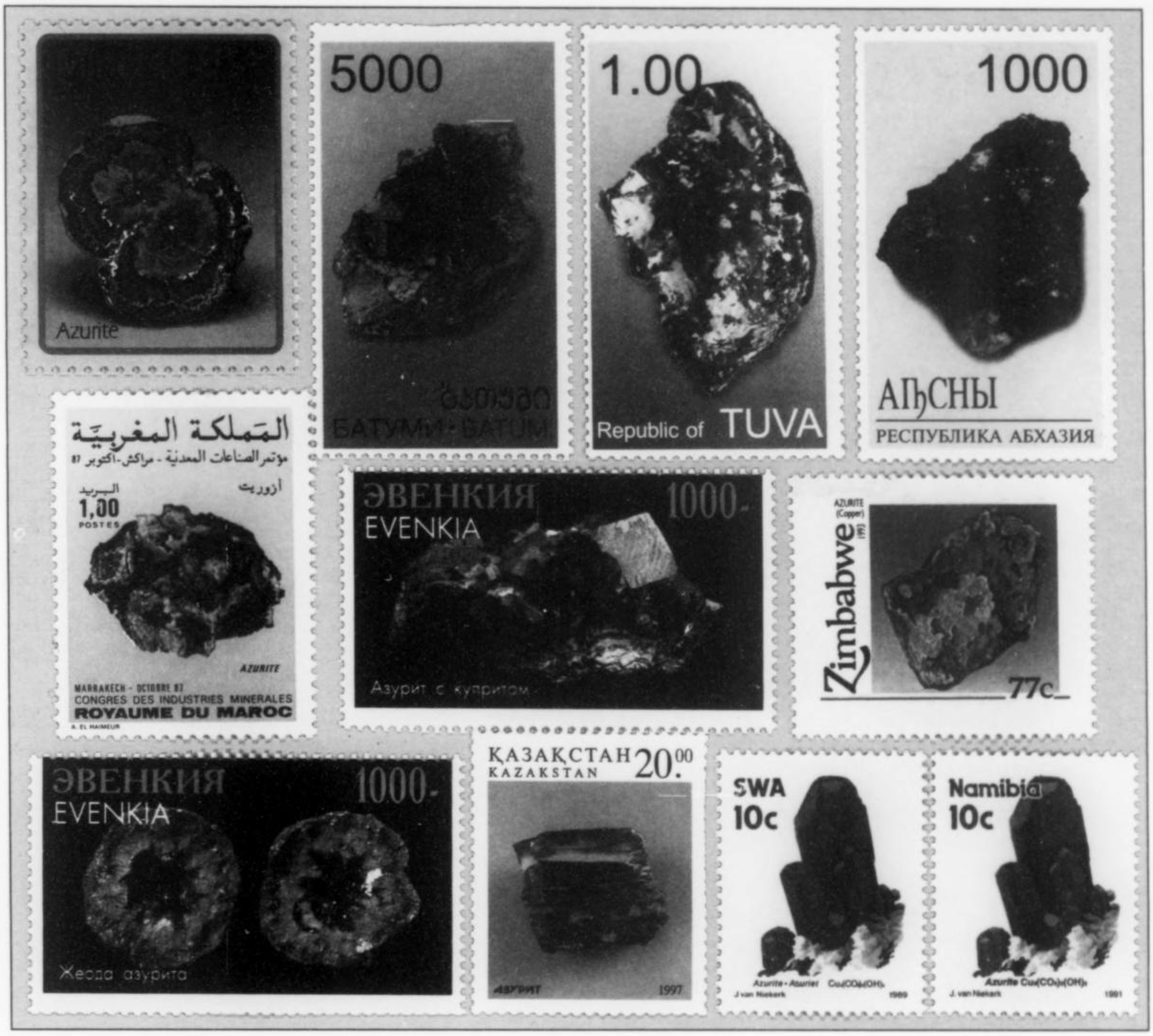

Letters

NAMING SPECIMENS

If anyone had ever told me that I would write a letter to the *Mineralogical Record* with a negative criticism, I would have said they were crazy. But I am, and here goes:

The Bolivian phosphophyllite article made me want to barf! Is the naming of mineral specimens by the "upper echelon" now the latest trend? Is it now posh to take the finest dozen or so specimens from a particular find and name each one after the person who was fortunate enough and wealthy enough to acquire it? Give me a break! If a woman acquires one of these specimens and later marries, does the specimen name change accordingly? Do these specimens come with adoption papers when they change hands? What happens in Bill Larson's case, where he owned two specimens? Will they be named after his two children? If I were the other people who loaned specimens for the article I would be outraged if my name was not also immortalized through attachment to my specimen.

I realize that we all want to leave our mark on society when we leave this life, but is this the way we're heading? If it is, I'm sure going to be disappointed in life; I seriously doubt that I will be able to acquire a specimen which can bear my name.

Yes, in the past some specimens have been recognized by such terminology. The "Roebling Apatite" comes to mind: it was one-of-a-kind and was retained by Roebling for many years. Today that is less likely; the way specimens change hands today, Lord only knows who owns the specimens pictured in an article by the time we receive the issue. Does each new owner get to rename it after himself? Or does it have to retain the name of its initial owner? Does a named specimen have an extra zero added to its price tag? I need to know these things so that we peons can stay up to snuff on the latest trends. (And why aren't the specimens named after the miner who found them? Weren't the miners the first owners?) [Ed. note: Some have been, e.g., the "Ed Over" Red Cloud wulfenites.]

I'm sorry if this letter sounds down right ridiculous; it is. That's my point. To name a specimen of any kind after its owner is down right ridiculous. Must we now go back and name all the great specimens in the world's collections?

Jealousy was never a part of the equation for me. Although my own collection may never win the McDole Trophy, every specimen I own is as important to me as the "Jones Phosphophyllite" is to Jones. When it comes to the thing nearest and dearest to my heart—minerals—your article pushed a button.

J. Roger Mitchell
Media, PA

I can tell! But I think you may be taking it all a bit too seriously. (My first clue was that your letter was typed all in capitals!) Specimens of the same species are sometimes referred to by their owners' names purely as a matter of convenience. After all, it's easier than trying to discuss "the 6-cm phosphophyllite, the 7-cm phosphophyllite, the 5-cm phosphophyllite, the 3.3-cm phosphophyllite" etc. There is nothing formal or permanent about it. Saying "the Jones' phosphophyllite" is simply easier than saying "the phosphophyllite that is owned by Jones."

Then again, maybe we're missing a bet here. Perhaps the International Mineralogical Association could be persuaded to establish a Committee on Specimen Names. Then, for a modest fee, a specimen could be formally registered as being named after its owner. We could name all *of our specimens after ourselves, and thereby add a zero onto the monetary value of each one! Meanwhile the IMA would make a fortune on fees. And the whole process would be egalitarian, and not prejudiced in favor of the wealthy; even a $1 specimen could be named after its owner! Sounds like a win-win proposition to me.* *Ed.*

FLAMBEAU MINE

First, I would like to sincerely thank the authors for assembling such an outstanding article on the minerals of the Flambeau mine (vol. 30, no. 2, March–April 1999). The mine and the minerals are unique, and the article chronicles the brief but interesting history of this world-class mineral locality. Both the geology and the specimen mineralogy are well documented.

The Flambeau mine illustrates the role of serendipity in collecting and preserving mineral specimens from a mine. The potential of the Flambeau deposit to become a world-class specimen producer was well known for nearly two decades by geologists and mineral collectors throughout the Midwest. When the orebody was drilled out in the early 1970's, the existence of crystallized minerals in the supergene ore was apparent. However, for more than a decade it appeared that the deposit would never be mined, so the issue of specimen recovery seemed moot. This situation changed in the late 1980's when Kennecott Minerals decided to obtain the necessary permits to bring the deposit into production.

When mining operations began in early 1993, a number of individuals in the Midwest approached the Flambeau Mining Company with various proposals to recover some of the crystallized minerals known to exist in the supergene ore. All of these proposals were rejected by the mining company, a common response by corporate management to requests of this type. When the senior authors (Casey Jones and Jane Koepp Jones) became aware of the mine's existence in late June 1994, mine management (and attitude) had recently changed, and the company was more receptive to specimen recovery. Thus, Casey and Jane were successful in obtaining a contract (for Burminco) where all others had failed because they quite serendipitously approached mine management at just the right moment. Timing, as they say, is everything. Therefore, the segment on "collecting history" in the article is, in my opinion, somewhat inaccurate. It reads as though the history of specimen recognition at Flambeau actually *began* with "geologists and miners on site picking up a pretty rock" followed by Casey and Jane seeing the pieces at the visitor center, recognizing the specimen potential, approaching mining management for a collecting contract and simply obtaining one (for Burminco). In truth, the potential of the Flambeau mine to be a "Wisconsin Tsumeb" was recognized long before Casey and Jane were even aware of the deposit.

That being said, the mineral collecting fraternity owes Kennecott Minerals and the Flambeau Mining Company an immeasurable debt of gratitude for allowing these beautiful mineral specimens to be recovered during mining operations. We also owe a debt of gratitude to Casey Jones and Jane Koepp Jones for an outstanding job of collecting these delicate minerals under challenging conditions.

Finally, a comment on the Flambeau mine azurites. As mentioned in the article, very few good azurite specimens were preserved from the mine, as most of the copper carbonate zone was mined out before collecting was permitted. Nevertheless, a few spectacular azurite groups were recovered and are still "around." Two years ago I saw a fantastic miniature group with individual crystals nearly $^3/_4$ inch across for sale at a Wisconsin mineral show. Pieces like this are quite rare. To Flambeau mine enthusiasts with a "good azurite" on their "must have" list, I would suggest getting in touch with some of the local rock and mineral clubs, shops, and mineral shows, and remembering above all that patience is a virtue.

Shawn M. Carlson
Crystal Falls, Michigan

YALE COLLECTION

Tom Moore did a wonderful job on the minerals and history of the Peabody Museum, Yale University (vol. 30, no. 2). I didn't even know they had a collection. Now, because of this colorful and affectionate article, I will certainly pay it a visit when I get the chance. I particularly liked his comparing the collection "to a lovably eccentric oldster, as variegated in rich experience and in wisdom as in liver spots and faintly foul odors." Nice photos, too, although one or two specimens from the Bisbee suite would have been nice to see.

Mark Hay
Phoenix, Arizona

BROKEN HILL BOOK

Bill Birch at the Museum of Victoria in Australia informs me that they supplied a defective e-mail address in their recent notice announcing the forthcoming second edition of the book on Broken Hill, New South Wales. The correct address is: <geocentr@pcpro.net.au>. Be sure to get on their mailing list so that you will receive ordering instructions as soon as the book is off the press. Ed.

SILVERMINES

I read with great interest your article on the Silvermines district, Ireland (vol. 30, no. 2). Mineralogical literature of this kind is rare for Ireland. I would like to update your readers on the current situation in the district:

The Shallee mine is currently being studied as the possible site for an interpretive center, including a mining museum and underground tours of the older workings. The Magcobar pit is at the center of an environmental controversy: the local citizenry would like to preserve and restore the natural landscape of the area, whereas the County authorities want to convert the open pit into a regional garbage disposal site.

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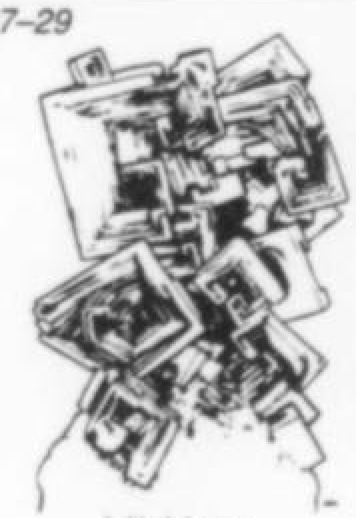
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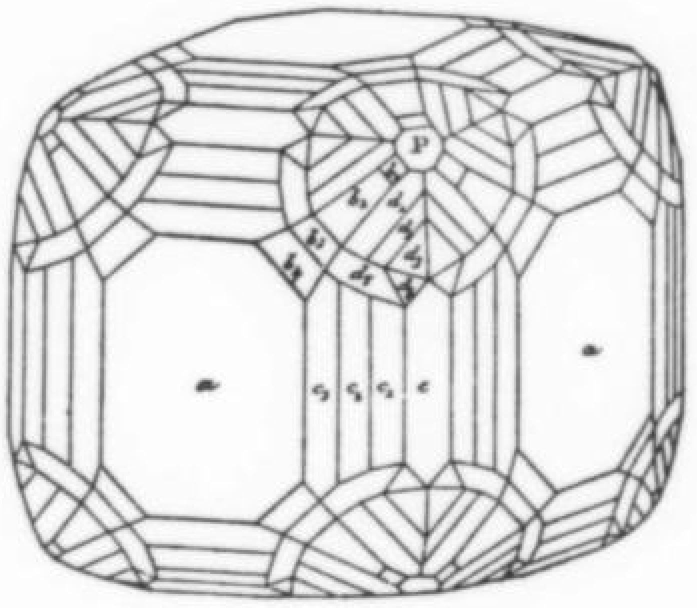

J. A. Mandarino
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New Minerals and Mineral Names
of the International Mineralogical Association
and
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Akimotoite Hexagonal

$(Mg,Fe)SiO_3$

Locality: From the Tenham chondritic meteorite (L6) which fell in 1879 in South Gregory, Queensland, Australia (Lat. 25°44′S, Long. 142°57′E). The mineral is present in the Acfer 040 chondrite also.

Occurrence: In a shock-metamorphosed meteorite. Other minerals in the Tenham meteorite are: "olivine" (probably forsterite), enstatite, clinoenstatite, diopside, plagioclase feldspar, (partly converted to glass), Fe-Ni alloy, and troilite. Ringwoodite, magnesian wüstite, iron, Fe-oxide, Fe-sulfide, and an unnamed silicate perovskite are present also.

General appearance: Very small grains of two types: (1) granular less than 0.4 microns and (2) columnar less than 1.4 microns.

Physical, chemical and crystallographic properties: Practically no physical and optical properties could be determined because of the small grain size. *Density:* 3.97 g/cm^3 (calculated). ***Crystallography:*** Trigonal, $R\bar{3}$, a 4.78, c 13.6 Å, V 269 Å^3, Z 6, $c{:}a$ = 2.8452. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** no data could be obtained. ***Chemical analytical data:*** Analytical electron microscopy gave: Na_2O 0.67, MgO 28.39, CaO 0.38, MnO 0.28, FeO 13.54, Al_2O_3 0.07, Cr_2O_3 0.16, SiO_2 56.35, TiO_2 0.17, Total 100.01 wt.%. Empirical formula: $(Mg_{0.75}Fe_{0.20}Na_{0.02}Ca_{0.01})_{\Sigma 0.98}Si_{1.00}O_{3.00}$. ***Relationship to other species:*** Dimorphous with enstatite and clinoenstatite. A member of the ilmenite group.

Name: For Dr. Syun-iti Akimoto (1925–), in honor of his great contributions to high-pressure research. ***Comments:*** IMA No. 97-044.

TOMIOKA, N. and FUJINO, K. (1999) Akimotoite, $(Mg,Fe)SiO_3$, a new silicate mineral of the ilmenite group in the Tenham chondrite. *American Mineralogist* **84**, 267–271.

Barquillite Tetragonal

$Cu_2(Cd,Fe)GeS_4$

Locality: The Fuentes Villanas mine, Barquilla deposit, near the village of Barquilla, in the southwest of Salamanca, Spain.

Occurrence: In the altered host rocks (impure limestones) adjacent to cassiterite-montebrasite-apatite-albite-quartz-mica veins. Associated minerals are: chalcopyrite, tetrahedrite, mawsonite, mohite, antimonpearceite, bornite, stannoidite, bismuth, and bismuthinite.

General appearance: Plates ranging from 20 to 50 microns and rosette-like aggregates of thin (less than 20 microns) platy crystals.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* megascopic color could not be observed. *Streak:* not observed. *Hardness:* VHN_{10} 180 to 300 kg/mm^2, Mohs 4 to 4½. *Tenacity:* not given. *Cleavage:* not given. *Fracture:* not given. *Density:* could not be determined, 4.53 g/cm^3 (calc.). ***Crystallography:*** Tetragonal, $I\bar{4}2m$ (by analogy with briartite), a 5.45, c 10.6 Å, V 314.8 Å^3, Z 2, $c{:}a$ = 1.9450. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 3.44 (10), 3.13 (10), 3.10 (100), 2.79 (10), 2.73 (10), 1.92 (80), 1.89 (70), 1.64 (60), 1.60 (20). ***Optical data:*** In reflected light: grey with a pale violet tint, very weak anisotropism, very weak bireflectance, very weak pleochroism. R & ^{im}R: (24.42, 10.79 %) 460nm, (23.29, 9.85 %) 540nm, (23.04, 9.59 %) 580nm, (23.46, 9.91 %) 660nm. ***Chemical analytical data:*** Means of thirty-four sets of electron microprobe data: Cu 30.67, Mn 0.43, Zn 0.09, Fe 2.20, Ag 0.26, Cd 20.38, Sn 0.17, Sb 0.09, Bi 0.16, Ge 14.99, Ga 0.05, S 29.42, Total 98.91 wt.%. Empirical formula: $(Cu_{2.10}Ag_{0.01})_{\Sigma 2.11}(Cd_{0.79}Fe_{0.17}Mn_{0.03}Zn_{0.01})_{\Sigma 1.00}(Ge_{0.90}Sn_{0.01})_{\Sigma 0.91}S_{3.98}$. ***Relationship to other species:*** A member of the stannite group; the cadmium-dominant analogue of briartite.

Name: For the locality, the village of Barquilla. ***Comments:*** IMA No. 96-050. The authors point out that single-crystal X-ray diffraction studies are needed to confirm the crystallographic data.

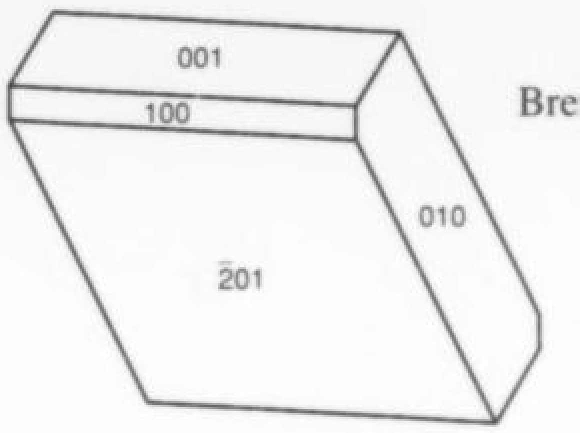
MURCIEGO, A., PASCUA, M.I., BABKINE, J., DUSAUSOY, Y., MEDENBACH, O., and BERNHARDT, H.-J. (1999) Barquillite, $Cu_2(Cd,Fe)GeS_4$, a new mineral from the Barquilla deposit, Salamanca, Spain. *European Journal of Mineralogy* **11**, 111–117.

Brendelite Monoclinic

$(Bi^{3+},Pb)_2(Fe^{3+},Fe^{2+})O_2(OH)(PO_4)$

Locality: The Güldener Falk mine, 3 km southwest of the center of Schneeberg, Saxony, Germany.

Occurrence: On the dumps of a mine worked for silver during the first half of the 16th century. Associated minerals are: eulytite,



Brendelite

bismutite, and bismutoferrite. Other minerals found on the dumps are: quartz, pyrite, marcasite, galena, sphalerite, silver, bismuth, arsenic, cobalt-nickel arsenides, bismuthinite, and acanthite. Other secondary minerals are: beudantite, beyerite, pucherite, petitjeanite, mixite, and a yet unnamed Bi-Fe-Co arsenate.

General appearance: Euhedral crystals up to 0.3 mm and crystal aggregates up to 3 mm.

Physical, chemical and crystallographic properties: *Luster:* vitreous to adamantine; the indices of refraction indicate adamantine. *Diaphaneity:* translucent. *Color:* black to dark brown. *Streak:* light brown. *Luminescence:* non-fluorescent. *Hardness:* VHN_{15} 300 kg/mm², Mohs 4½. *Tenacity:* not given. *Cleavage:* none observed. *Fracture:* none given. *Density:* could not be determined due to lack of material, 6.83 g/cm³ (calc.). ***Crystallography:*** Monoclinic, *C2/m*, *a* 12.278, *b* 3.815, *c* 6.899 Å, β 111.14°, *V* 301.4 Å³, Z2, *a:b:c* = 3.2183:1:1.8084. Morphology: forms observed {$\bar{2}01$}, {001}, {010}, and {100}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.726 (54), 3.372 (77), 3.322 (37), 3.217 (46), 3.011 (100), 2.863 (34), 2.750 (62). ***Optical data:*** Biaxial (-), α 2.06, β 2.15 (calc.), γ 2.19, 2V(meas.) 70°; no distinct dispersion was observed; pleochroism strong with X = light brown to brown, Y and Z = dark brown to opaque; Y nearly parallel to *a*, Z = *b*. ***Chemical analytical data:*** Two groups of electron microprobe data are given. The means of 15 sets are: FeO 3.12, PbO 26.08, Fe_2O_3 9.44, Bi_2O_3 47.10, P_2O_5 10.71, V_2O_5 0.24, As_2O_5 0.32, H_2O (1.46), Total (98.47) wt.%. Water was calculated to give O + OH = 7. Fe^{2+} and Fe^{3+} were determined by Mössbauer spectroscopy. Empirical formula: $(Bi_{1.27}Pb_{0.74})_{\Sigma 2.01}(Fe^{3+}_{0.74}Fe^{2+}_{0.27})_{\Sigma 1.01}O_{2.02}$-$(OH)_{1.02}[(PO_4)_{0.95}(AsO_4)_{0.02}(VO_4)_{0.02}]_{\Sigma 0.99}$. ***Relationship to other species:*** None apparent.

Name: For Christian Friedrich Brendel (1776–1861), director of the "Maschinendirektion," a bureau for construction, and responsible for application, construction, and monitoring of the machines used in the 19th century by the mining industry of Saxony. ***Comments:*** IMA No. 97-001. The subscripts in the empirical formula given here are slightly different from those given by the authors.

KRAUSE, W., BERNHARDT, H.-J., McCAMMON, C., and EFFENBERGER, H. (1998) Brendelite, $(Bi,Pb)_2Fe^{3+,2+}O_2(OH)$-$(PO_4)$, a new mineral from Schneeberg, Germany: description and crystal structure. *Mineralogy and Petrology* **63**, 263–277.

Chadwickite

Tetragonal

$H(UO_2)(AsO_3)$

Locality: The Sophia mine near Wittichen, Central Black Forest, Germany.

Occurrence: In granite. Associated minerals are: uraninite, metakahlerite, abernathyite, erythrite, pitticite, and another uranyl arsenite.

General appearance: Earthy and scaly crusts; also single grains (up to 20 µm).

Physical, chemical and crystallographic properties: *Luster:* dull. *Diaphaneity:* earthy to transparent. *Color:* yellow. *Streak:* yellow. *Luminescence:* non-fluorescent. *Hardness:* about 2. *Tenacity:* not given. *Cleavage:* {001} "more or less perfect." *Fracture:* uneven. *Density:* could not be determined but is greater than 4.03 g/cm³, 4.87 g/cm³ (calc.). ***Crystallography:*** Tetragonal, space group unknown, *a* 11.00, *c* 15.96 Å, *V* 1931 Å³, Z 14, *c:a* = 1.4509. Morphology: only {001} was observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 5.58 (8), 4.95 (10), 4.40 (6), 3.33 (8), 3.03 (6), 2.91 (5). ***Optical data:*** Uniaxial (-), ω 1.845, ε 1.750, pleochroism O = yellow, E = colorless. ***Chemical analytical data:*** Means of four sets of electron microprobe data: UO_3 73.0, As_2O_3 25.5, H_2O (1.5), Total (100.0) wt.%. Water was calculated by difference. Empirical formula: $H_{0.67}(UO_2)_{1.03}(AsO_3)_{1.04}$. ***Relationship to other species:*** None apparent.

Name: For the English physicist Sir James Chadwick (1891–1974). ***Comments:*** IMA No. 97-005.

WALENTA, K. (1998) Chadwickit, ein neues Uranylarsenit von Wittichen im Schwarzwald. *Aufschluss* **49**, 253–257.

Changoite

Monoclinic

$Na_2Zn(SO_4)_2 \cdot H_2O$

Locality: An old mining area about 2 kilometers west of the village of Sierra Gorda, northeast of Antofagasta, in the 2nd region, northern Chile.

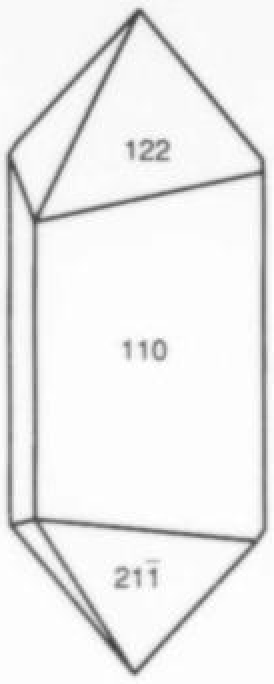
Occurrence: Associated minerals are: thenardite, gypsum, and paratacamite. Christelite and gordaite are also present at this locality.

General appearance: Seams of palisade-like anhedral crystals (up to 10 mm wide).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* Mohs between 2 and 3 with tendency towards 3. *Tenacity:* not given. *Cleavage:* not given. *Fracture:* not given. *Density:* 2.50 g/cm³ (meas.), 2.54 g/cm³ (calc.). *Other properties:* easily soluble in water. ***Crystallography:*** Monoclinic, $P2_1/a$, *a* 11.077, *b* 8.249, *c* 5.532 Å, β 100.18°, *V* 497.5 Å³, Z 2, *a:b:c* = 1.3428:1:0.6706. Morphology: no forms were observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.550 (58) (210), 4.245 (32) (20$\bar{1}$), 3.325 (25) (310), 3.289 (100) (220), 3.262 (35) (211), 3.245 (25) (12$\bar{1}$), 2.631 (27) (40$\bar{1}$). ***Optical data:*** Biaxial (-), α 1.507, β 1.512, γ 1.516, 2V(calc.) 83°. ***Chemical analytical data:*** Means of four sets of electron microprobe data: Na_2O 17.31, MgO 0.05, CaO 0.02, ZnO 20.62, SO_3 34.85, H_2O 18.99, Total 91.84 wt.%. Empirical formula: $Na_{2.32}(Zn_{1.05}Mg_{0.01})_{\Sigma 1.06}$-$(S_{0.90}O_{3.81})_{2.00} \cdot 4.37H_2O$. ***Relationship to other species:*** The zinc-dominant analogue of blödite and nickelblödite.

Name: For the changos, the early former inhabitants of northern Chile. ***Comments:*** IMA No. 97-041. The authors note that this locality is also the correct type locality for christelite and gordaite. The optical data are for synthetic $Na_2Zn(SO_4)_2 \cdot H_2O$.

SCHLÜTER, J., KLASKA, K.-H., and GEBHARD, G. (1999) Changoite, $Na_2Zn(SO_4)_2 \cdot H_2O$, the zinc analogue of blödite, a new mineral from Sierra Gorda, Antofagasta, Chile. *Neues Jahrbuch für Mineralogie, Monatshefte* **1999**, 97–103.



Clinocervantite

Clinocervantite

Monoclinic

$Sb^{3+}Sb^{5+}O_4$

Locality: The Cetine di Cotorniano mine, Siena, central Tuscany, Italy.

Occurrence: In cavities in a rock fragment. Associated minerals are: valentinite, tripuhyite, bindheimite, and rosiaite.

General appearance: Aggregates of prismatic crystals (up to 0.2 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous, but the indices of refraction indicate adamantine. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* uneven. *Density:* could not be determined, 6.72 g/cm^3 (calc.). **Crystallography:** Monoclinic, *C2/c*, *a* 12.061, *b* 4.836, *c* 5.383 Å, β 104.6°, *V* 303.83 Å^3, Z 4, *a:b:c* = 2.4940:1:1.1131. Morphology: forms {110}, {122}, and {211}. Twinning: on (100). **X-ray powder diffraction data:** 3.244 (VS) (111), 2.920 (M) (400), 2.877 (S) (31$\bar{1}$), 2.640 (W) (20$\bar{2}$), 1.851 (W) (420), 1.811 (W) (511), 1.783 (W) (22$\bar{2}$), 1.619 (M) (222, 71$\bar{1}$). **Optical data:** Biaxial (sign unknown), α′ 1.72, γ′ 2.10. **Chemical analytical data:** Nine electron microprobe analyses gave an Sb average value of 79.19 wt.%. This with the remainder as oxygen gives the empirical formula: $Sb_{2.00}O_{4.00}$. The ideal formula requires Sb_2O_3 47.40, Sb_2O_5 52.60, Total 100.00 wt.%. **Relationship to other species:** The monoclinic polymorph of cervantite.

Name: For the relationship to cervantite. **Comments:** IMA No. 97-017. The formula given in the title of the paper is rather misleading in that it implies that the two atoms of Sb have valences of 4+, whereas one has a valence of 3+ and the other has a valence of 5+. The crystal drawing in the paper does not appear to be in the standard orientation so it was redrawn for this abstract.

BASSO, R., LUCCHETTI, G., ZEFIRO, L., and PALENZONA, A. (1999) Clinocervantite, β-Sb_2O_4, the natural monoclinic polymorph of cervantite from the Cetine mine, Siena, Italy. *European Journal of Mineralogy* **11**, 95–100.

Cuboargyrite

Cubic

$AgSbS_2$

Locality: In the mining district on the Baberast near Haslach, Central Black Forest, Germany.

Occurrence: In a quartz-arsenopyrite hydrothermal assemblage. There are no other associated minerals.

General appearance: Anhedral grains (up to 0.5 mm).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* greyish black. *Streak:* black. *Hardness:* about 3. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* conchoidal. *Density:* could not be determined, 5.38 g/cm^3 (calc.). **Crystallography:** Cubic, *Fm3m*, *a* 5.65 Å, *V* 180.4 Å^3, Z 2. Morphology: no forms were observed. Twinning: none mentioned. **X-ray powder diffraction data:** 3.26 (90), 2.83 (100), 1.998 (80), 1.703 (60), 1.630 (50), 1.296 (20), 1.263 (30). **Optical data:** In reflected light: grey, isotropic. R: (34.18 %) 470nm, (34.88 %) 546nm, (34.72 %) 589nm, (34.26 %) 650nm. **Chemical analytical data:** Means of four sets of electron microprobe data: Ag 36.1, Sb 41.4, S 22.1, Total 99.6 wt.%. Empirical formula: $Ag_{0.98}Sb_{1.00}S_{2.02}$. **Relationship to other species:** The cubic polymorph of miargyrite.

Name: For the crystal system and silver content of the mineral and its relationship to miargyrite. **Comments:** IMA No. 97-004.

WALENTA, K. (1998) Cuboargyrite, ein neues Silbermineral aus dem Schwarzwald. *Lapis* **23(11)**, 21–23.

Grumiplucite

Monoclinic

$HgBi_2S_4$

Locality: The "Cavetta" tunnel in the Levigliani mine, Apuan Alps, Tuscany, Italy.

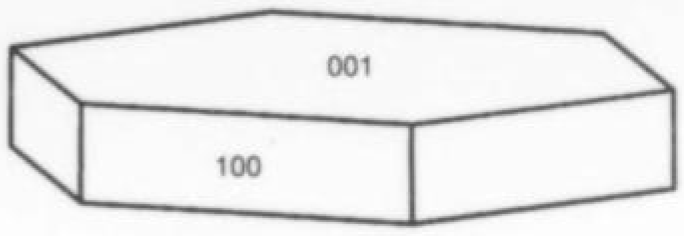
Occurrence: In quartz veins in a small mercury deposit. Associated minerals are: quartz, cinnabar, native mercury, pyrite, mercurian sphalerite, zincian metacinnabar, chalcopyrite, magnesian siderite, ferroan dolomite, and galena.

General appearance: Slender prismatic crystals 1 x 0.1 mm.

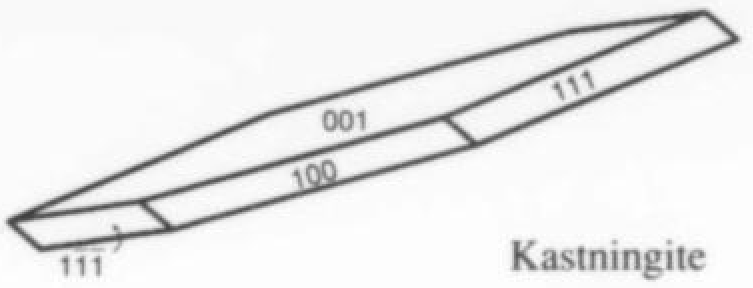
Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* grey-black. *Streak:* not given. *Hardness:* not determined. *Tenacity:* not given. *Cleavage:* {001} almost micaceous. *Fracture:* not given. *Density:* could not be measured, 6.94 g/cm^3 (calculated). **Crystallography:** Monoclinic, *C2/m*, *a* 14.185, *b* 4.071, *c* 13.995 Å, β 118.22°, *V* 710 Å^3, Z 4, *a:b:c* = 3.4844:1:3.4377. Morphology: no forms were observed. Twinning: ubiquitous on (001). **X-ray powder diffraction data:** 3.86 (m) (110), 3.55 (m) (111, $\bar{4}$02), 3.05 (s) ($\bar{3}$12, $\bar{1}$13), 2.914 (ms) ($\bar{3}$10), 2.865 (ms) (203, $\bar{3}$13), 2.644 (m) (311), 1.913 (m) ($\bar{5}$16), 1.805 (m) (404). **Optical data:** In reflected light: creamy white, distinct anisotropism, low bireflectance, nonpleochroic. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (35.7, 37.8; 23.2, 25.0 %) 470nm, (35.4, 37.5; 23.0, 25.0 %) 546nm, (34.9, 37.0; 22.0, 24.0 %) 589nm, (33.9, 35.8; 20.4, 22.7 %) 650nm. **Chemical analytical data:** Means of twelve sets of electron microprobe data: Hg 25.4, Bi 57.6, S 17.4, Total 100.4 wt.%. Empirical formula: $Hg_{0.94}Bi_{2.04}S_{4.02}$. **Relationship to other species:** None apparent.

Name: For the group of amateur mineralogists called *Gru*ppo *Mi*neralogico e *P*aleontologico *Luc*chese. The following statement is made by the authors: "The intention of the authors, in naming the new mineral grumiplucite, is to acknowledge amateur mineralogists all over the world for their contribution to the development of regional and systematic mineralogical studies, for providing specimens, and for invaluable field observations." **Comments:** IMA No. 97-021. The mineral was found by Luigi Pierotti, Ugo Quilici, and Moreno Romani.

ORLANDI, P., DINI, A., and OLMI, F. (1998) Grumiplucite, a new mercury–bismuth sulfosalt species from the Levigliani mine, Apuan Alps, Tuscany, Italy. *Canadian Mineralogist* **36**, 1321–1326.



Haggertyite



Kastningite

Haggertyite — Hexagonal

$Ba[Ti_5Fe^{2+}_4Fe^{3+}_2Mg]O_{19}$

Locality: The Prairie Creek lamproite, Crater of Diamonds State Park, near Murfreesboro, Pike County, Arkansas, U.S.A.

Occurrence: In reaction zones of small rounded mafic xenoliths in lamproite. Associated minerals are: "Ti-K richterite," diopside, "chrome-spinel," olivine (altered), ilmenite, jeppeite, and priderite.

General appearance: Isolated thin platelets (up to about 100 µm, but typically 30 to 70 µm) or in small groups.

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* megascopic color not given. *Streak:* not given. *Hardness:* VHN_{50} 500 kg/mm^2, Mohs 5. *Tenacity:* not given. *Cleavage:* not given. *Fracture:* irregular to conchoidal. *Density:* could not be determined, 4.74 g/cm^3 (calc.). ***Crystallography:*** Hexagonal, $P6_3/mmc$, a 5.9369, c 23.3445 Å, V 712.6 Å^3, Z 2, $c{:}a$ = 3.9321. Morphology: forms {001} and {100}. Twinning: none. ***X-ray powder diffraction data:*** 2.963 (44), 2.795 (90), 2.641 (100), 2.437 (46), 1.676 (37), 1.634 (47), 1.481 (47). ***Optical data:*** In reflected light: light grey, barely perceptible anisotropism, no bireflectance, nonpleochroic. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (16.9, 17.3; 5.13, 5.37 %) 470nm, (16.35, 16.8; 4.90, 5.19 %) 546nm, (16.3, 16.9; 4.92, 5.29 %) 589nm, (16.4, 17.1; 5.00, 5.42 %) 650nm. Indices of refraction calculated from the reflectance data are 2.30 and 2.33 at 590 nm. ***Chemical analytical data:*** Means of fifty-six sets of electron microprobe data: K_2O 1.40, MgO 2.7, MnO 0.80, FeO (total iron) 41.2, NiO 0.25, BaO 10.1, Cr_2O_3 1.4, TiO_2 39.1, Total 96.97 wt.%. The FeO was recalculated to Fe^{2+} and Fe^{3+} to give charge balance. Empirical formula: $(Ba_{0.68}K_{0.31})_{\Sigma 0.99}Ti_{5.05}Fe^{2+}_{3.91}Fe^{3+}_{2.01}Mg_{0.69}Cr_{0.19}Mn_{0.12}Ni_{0.03}O_{19}$. ***Relationship to other species:*** It is a member of the magnetoplumbite group.

Name: For Dr. Stephen E. Haggerty (1938–), Department of Geology, University of Massachusetts, Amherst, Massachusetts, U.S.A., for his contributions to the mineralogy and crystal chemistry of titanate minerals from the Earth's mantle. ***Comments:*** IMA No. 96-054. It is unfortunate that the editors of the journal decided not to publish the reflectance data for this mineral. Dr. Alan J. Criddle, who carried out the measurements, is thanked for supplying the data for this abstract. The crystal drawing given here is based on data in the description.

GREY, I. E., VELDE, D., and CRIDDLE, A. J. (1998) Haggertyite, a new magnetoplumbite-type titanate mineral from the Prairie Creek (Arkansas) lamproite. *American Mineralogist* **83**, 1323–1329.

Kastningite — Triclinic

$(Mn,Fe,Mg)Al_2(PO_4)_2(OH)_2 \cdot 8H_2O$

Locality: The "Silvergrube" quarry, Waidhaus, Upper Palatinate (Oberpfälzer Wald), Bavaria, Germany. The mineral also has been discovered at the Hagendorf-Süd deposit in Bavaria, Germany.

Occurrence: In a pegmatite. Associated minerals are: variscite and paravauxite in a matrix of quartz, albite, and mica. Other phosphate minerals in the pegmatite are: "apatite," rockbridgeite, triphylite, strengite, strunzite, keckite, beraunite, cacoxenite, and kingsmountite.

General appearance: Sprays of thin crystals (up to 2 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent to transparent. *Color:* colorless to white. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* soft. *Tenacity:* not given. *Cleavage:* not given. *Fracture:* not given. *Density:* 2.35 g/cm^3 (meas.), 2.38 g/cm^3 (calc.). ***Crystallography:*** Triclinic, $P\bar{1}$, a 7.0102, b 10.2050, c 10.5040 Å, α 71.82°, β 89.62°, γ 69.90°, V 666.19 Å^3, Z2, $a{:}b{:}c$ = 0.6872:1:1.0296. Morphology: forms {001}, {100}, {111}, and {$\bar{1}$11}; flattened on {001}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 9.917 (100) (001), 6.541 (36) (100, 110), 4.957 (50) (002), 3.312 (23) (211), 3.095 (28) ($\bar{1}$03), 3.001 (30) ($\bar{1}\bar{2}$2, 201), 2.558 (23) (024, 141), 1.653 (25) (006, 116). ***Optical data:*** Biaxial (-), α 1.5665, β 1.5740, γ 1.5815, 2V(meas.) 85.3°, 2V(calc.) 89.6°; dispersion not given; orientation not given. ***Chemical analytical data:*** Means of five sets of electron microprobe data: MgO 0.64, MnO 11.30, FeO 6.07, Al_2O_3 24.49, P_2O_5 37.96, H_2O (19.54), Total (100.00) wt.%. Water by difference. Empirical formula: $(Mn_{0.84}Fe_{0.45}Mg_{0.08})_{\Sigma 1.37}Al_{2.54}(PO_4)_{2.83}(OH)_{1.87} \cdot 4.80H_2O$. The ideal formula (with Mn:Fe = 0.667:0.333) requires: MnO 9.91, FeO 5.02, Al_2O_3 21.36, P_2O_5 29.74, H_2O 33.97, Total 100.00 wt.%. ***Relationship to other species:*** The aluminum-dominant analogue of stewartite.

Name: For Jürgen Kastning (1932–), Reinbeck bei Hamburg, Germany, who discovered the mineral. ***Comments:*** IMA No. 97-033. The crystal drawings in the paper are not in the standard orientation so a crystal has been redrawn here.

SCHLÜTER, J., KLASKA, K.-H., FRIESE, K., and ADIWIDJAJA, G. (1999) Kastningite, $(Mn,Fe,Mg)Al_2(PO_4)_2(OH)_2 \cdot 8H_2O$, a new phosphate mineral from Waidhaus, Bavaria, Germany. *Neues Jahrbuch für Mineralogie, Monatshefte* **1999**, 40–48.

Phosphovanadylite — Cubic

$(Ba,Ca,K,Na)_{0.66}[P_2(V^{4+},Al)_4(O,OH)_{16} \cdot 12H_2O$

Locality: Monsanto's Enoch Valley phosphate mine, Soda Springs, Caribou County, Idaho, U.S.A. (Lat. 42°53′N, Long. 111°25′W).

Occurrence: In sedimentary layers of the Meade Peak Member of the Permian Phosphoria Formation. The only associated mineral is sincosite.

General appearance: Drusy coatings of cubes (20 to 50 µm on edge).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* light greenish blue. *Streak:* very pale greenish blue. *Luminescence:* none mentioned. *Hardness:* could not be determined. *Tenacity:* not mentioned. *Cleavage:* could not be determined. *Fracture:* could not be determined. *Density:* 2.16 g/cm^3 (meas.), 2.13 g/cm^3 (calc.). ***Crystallography:*** Cubic, $I\bar{4}3m$, a 15.470 Å, V 3702.3 Å^3, Z 6.

Morphology: forms, only {100} was observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 10.8 (29), 7.73 (34), 3.164 (100), 2.827 (28), 2.738 (29), 2.582 (37), 2.445 (36). ***Optical data:*** Isotropic, n 1.566. ***Chemical analytical data:*** Means of six sets of electron microprobe data are expressed as: V 28.02, P 9.91, Al 1.97, Ca 1.31, Ba 8.28, Cd 0.09, Zn 0.34, Na 0.15, K 0.73, O 46.57, F 0.03, Total 97.13 wt.%. The empirical formula derived from these data (ignoring Zn and Cd) and the crystal structure analysis is: $(Ba_{0.38}Ca_{0.20}K_{0.06}Na_{0.02})_{\Sigma 0.66}$-$[P_{2.00}(V^{4+}_{3.44}Al_{0.46})_{\Sigma 3.90}O_{10.34}(OH)_{5.66}]\cdot 12.00H_2O$. In terms of oxide constituents, this requires: Na_2O 0.08, K_2O 0.36, CaO 1.42, BaO 7.37, Al_2O_3 2.97, VO_2 36.08, P_2O_5 17.95, H_2O 33.79, Total 100.00 wt.%. ***Relationship to other species:*** None apparent.

Name: For the chemical composition. ***Comments:*** IMA No. 96-037. No calculated density is given in the paper. The expression of analytical data as elements is strange for a mineral of this sort. The paper gives details of the crystal structure.

MEDRANO, M. J., EVANS, H. T., JR., WENK, H.-R., and PIPER, D. Z. (1998) Phosphovanadylite, a new vanadium phosphate mineral with a zeolite-type structure. *American Mineralogist* **83**, 889–895.

Pseudosinhalite

Monoclinic

$Mg_2Al_3B_2O_9(OH)$

Locality: The iron boron deposit of Tayozhnoye in the Aldan Shield, in the southern part of the Republic Sakha-Yakutia, Siberia, Russia (at approximately Lat. 58° N, Long. 125.5° E).

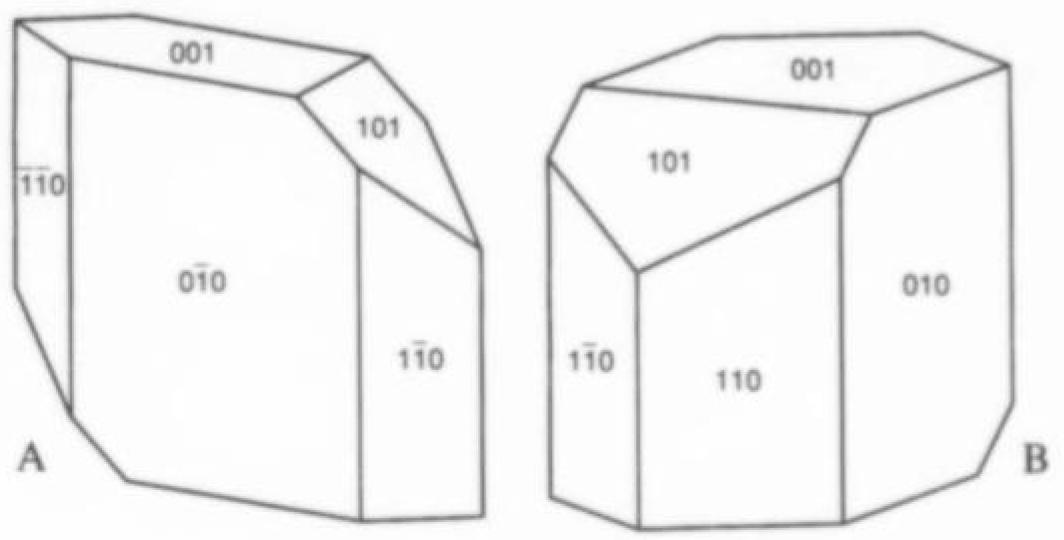
Occurrence: In an impure marble (sinhalite-bearing skarn). Associated minerals are: calcite, dolomite, forsterite, spinel, ludwigite, warwickite, suanite, szaibelyite, brucite, clinohumite, sinhalite, and hydrotalcite.

General appearance: Minute grains (less than 100 µm) replacing sinhalite.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* not given. *Cleavage:* none. *Fracture:* conchoidal. *Density:* could not be determined, 3.50 g/cm³ (calc.). ***Crystallography:*** Monoclinic, $P2_1/c$, *a* 7.49, *b* 4.33, *c* 9.85 Å, β 110.7°, *V* 299 Å³, Z 2, *a:b:c* = 1.7298:1:2.2748. Morphology: no forms were observed. Twinning: present on a micron scale. ***X-ray powder diffraction data:*** 3.21 (40), 2.61 (40), 2.14 (100), 2.102 (60), 1.625 (100), 1.607 (40), 1.399 (40). ***Optical data:*** Biaxial (-), α 1.691, β 1.713, γ 1.730, 2V(meas.) 80_, 2V(calc.) 82°; dispersion not observed; nonpleochroic; Z = *b*. ***Chemical analytical data:*** Means of fourteen sets of electron microprobe data: MgO 25.12, FeO 1.99, Al_2O_3 46.88, B_2O_3 (21.75), H_2O (2.81), Total (98.55) wt.%. Empirical formula: $(Mg_{2.00}Fe_{0.09})_{\Sigma 2.09}$-$Al_{2.94}B_{2.00}O_{9.00}(OH)_{1.00}$. ***Relationship to other species:*** The natural equivalent of the synthetic material.

Name: For the relationship to sinhalite. ***Comments:*** IMA No. 97-014. Because of the very fine-grained nature and rarity of the mineral, some data were taken from synthetic material described by Daniels *et al.* (1997).

SCHREYER, W., PERTSEV, N. N., MEDENBACH, O., BURCHARD, M., and DETTMAR, D. (1998) Pseudosinhalite: discovery of the hydrous MgAl-borate as a new mineral in the Tayozhnoye, Siberia, skarn deposit. *Contributions to Mineralogy and Petrology* **133**, 382–388. DANIELS, P., KROSSE, S., WERDING, G., and SCHREYER, W. (1997) "Pseudosinhalite" a new hydrous MgAl-borate: synthesis, phase characterization, crystal structure, and *PT*-stability. *Contributions to Mineralogy and Petrology* **128**, 261–271.



Scandiobabingtonite

Scandiobabingtonite

Triclinic

$Ca_2(Fe^{2+},Mn)ScSi_5O_{14}(OH)$

Locality: The Montecatini granite quarry near Baveno, Novara, Piedmont, Italy.

Occurrence: In a pegmatite cavity. Associated minerals are: orthoclase, quartz (smoky), albite, stilbite, fluorite, zinnwaldite, and babingtonite.

General appearance: Short, tabular crystals (submillimeter in size).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* pale grey-green. *Streak:* not given. *Luminescence:* not mentioned. *Hardness:* 6. *Tenacity:* brittle. *Cleavage:* {001} and $\{1\bar{1}0\}$ perfect. *Fracture:* not given. *Density:* 3.24 g/cm³ (meas.), 3.23 g/cm³ (calc.). ***Crystallography:*** Triclinic, *P*1 or $P\bar{1}$, *a* 7.536, *b* 11.734, *c* 6.748 Å, α 91.70°, β 93.86°, γ 104.53°, *V* 575.6 Å³, Z 2, *a:b:c* = 0.6422:1:0.5751. Morphology: forms {010}, {001}, {110}, $\{1\bar{1}0\}$, {101}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 11.37 (m), 3.48 (m), 3.14 (mS), 3.03 (m), 2.969 (S), 2.895 (S), 2.755 (mS). ***Optical data:*** Biaxial (+), α 1.686, β 1.694, γ 1.709, 2V(meas.) 64_, 2V(calc.) 73°; dispersion r > v, strong; pleochroism strong with colors from pink (Z′) to green (X′); X (φ = 42°, ρ = 47°), Y (φ = 146°, ρ = 75°), Z (φ = -250°, ρ = 47°). ***Chemical analytical data:*** Means of three sets of electron microprobe data: Na_2O 1.40, CaO 17.26, MnO 4.11, FeO 8.48, Sc_2O_3 11.32, Fe_2O_3 0.50, SiO_2 55.26, SnO_2 1.21, H_2O 1.63, Total 101.17 wt.%. Empirical formula: $Ca_{1.70}Na_{0.25})_{\Sigma 1.95}$-$(Fe^{2+}_{0.65}Mn_{0.32})_{\Sigma 0.97}(Sc_{0.91}Sn_{0.04}Fe^{3+}_{0.03})_{\Sigma 0.98}Si_{5.09}O_{14.00}(OH)_{1.00}$. ***Relationship to other species:*** It is the scandium-dominant analogue of babingtonite.

Name: For the chemical relationship to babingtonite. ***Comments:*** IMA No. 93-012. Two crystal drawings are given here based on data kindly provided by Prof. Orlandi. The crystal drawing in the paper (A) is not in the standard orientation so it has been redrawn here (B). Crystal A is rotated 90° about the *c*-axis with respect to crystal B.

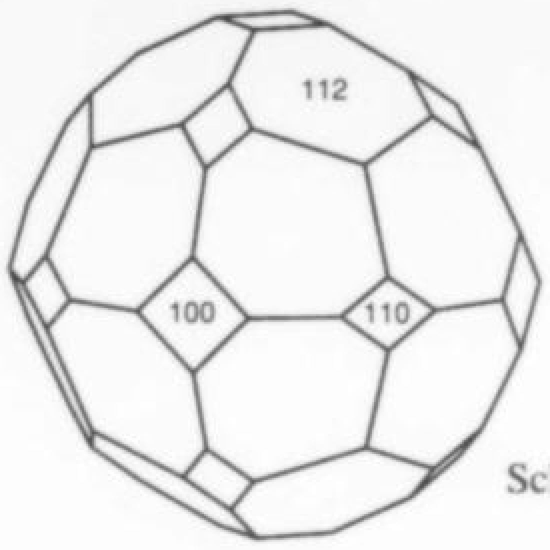
ORLANDI, P., PASERO, M., and VEZZALINI, G. (1998) Scandiobabingtonite, a new mineral from the Baveno pegmatite, Piedmont, Italy. *American Mineralogist* **83**, 1330–1334.

Schäferite

Cubic

$NaCa_2Mg_2(VO_4)_3$

Locality: The central part of the Bellberg volcano (Bellerberg on



Schäferite

older maps), near Mayen, Laacher See volcano area, Eifel, Germany.

Occurrence: In a fragment of a silicate-rich xenolith in leucite tephrite lava. Associated minerals are: magnesioferrite (on which schäferite is overgrown), sillimanite, quartz, enstatite, sanidine, cordierite, corundum, mullite, hematite, and augite.

General appearance: Small crystals (up to 0.15 mm in diameter) and crystal aggregates.

Physical, chemical and crystallographic properties: *Luster:* vitreous, but the index of refraction indicates adamantine. *Diaphaneity:* transparent. *Color:* orange-red. *Streak:* yellow. *Luminescence:* non-fluorescent. *Hardness:* approximately 5. *Tenacity:* not given. *Cleavage:* none. *Fracture:* conchoidal. *Density:* 3.40 g/cm³ (measured), 3.43 g/cm³ (calculated). ***Crystallography:*** Cubic, $Ia\bar{3}d$, *a* 12.427 Å, *V* 1919 Å³, Z 8. Morphology: forms {112}, {100}, and {110}. Twinning: none mentioned. ***X-ray powder diffraction data:*** 3.108 (44) (400), 2.779 (100) (420), 2.652 (20) (332), 2.535 (39) (422), 2.437 (15) (510), 1.793 (14) (444), 1.723 (26) (640), 1.662 (40) (642). ***Optical data:*** Isotropic, n 1.94. ***Chemical analytical data:*** Means of eleven sets of electron microprobe data: Na_2O 4.52, MgO 16.46, CaO 23.44, MnO 0.37, FeO 0.08, SiO_2 0.12, P_2O_5 0.23, As_2O_5 0.10, V_2O_5 53.95, Total 99.27 wt.%. Empirical formula: $(Na_{0.73}Ca_{0.09}Mg_{0.04}Mn_{0.03}Fe_{0.01})_{\Sigma 0.90}Ca_{2.00}Mg_{2.00}[(VO_4)_{2.96}(PO_4)_{0.02}(SiO_4)_{0.01}]_{\Sigma 2.99}$. ***Relationship to other species:*** A member of the garnet group.

Name: For Helmut Schäfer (1931–) who found the mineral. ***Comments:*** IMA No. 97-048. The idealized crystal drawing given here is based on the information given in the paper.

KRAUSE, W., BLAß, G., and EFFENBERGER, H. (1999) Schäferite, a new vanadium garnet from the Bellberg volcano, Eifel, Germany. *Neues Jahrbuch für Mineralogie, Monatshefte* **1999**, 123–134.

Thomasclarkite-(Y)

Monoclinic

$Na(Y,REE)(HCO_3)(OH)_3 \cdot 4H_2O$

Locality: In the southern corner of the Poudrette Quarry, Mont Saint-Hilaire, Rouville County, Quebec, Canada.

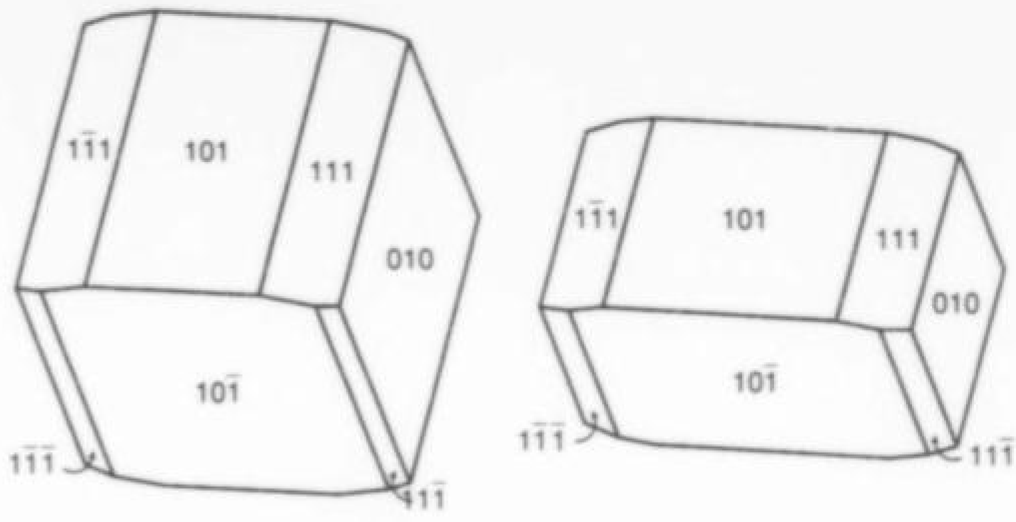
Occurrence: A late-stage hydrothermal phase in alkaline pegmatite dikes in nepheline syenite. Associated minerals are: aegirine, albite, analcime, ancylite-(Ce), astrophyllite, calcite, catapleiite, dawsonite, elpidite, epididymite, franconite, gaidonnayite, galena, genthelvite, microcline, molybdenite, natrolite, petersenite-(Ce), polylithionite, pyrochlore, rhodochrosite, rutile, sérandite, siderite, sphalerite, zircon, and an unidentified Na-REE carbonate.

General appearance: Individual pseudotetragonal crystals and groups of crystals (up to 2 mm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent to translucent. *Color:* white to yellow. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* Mohs 2 to 3. *Tenacity:* brittle. *Cleavage:* {010} perfect and a good {101} parting. *Fracture:* uneven. *Density:* 2.30 g/cm³ (meas.), 2.32 g/cm³ (calc.). ***Crystallography:*** Monoclinic (pseudotetragonal), *P*2, *a* 4.556, *b* 13.018, *c* 4.556 Å, β 90.15°, *V* 270.2 Å³, Z 1, *a*:*b*:*c* = 0.3500:1:0.3500. Morphology: forms are {010}, $\{0\bar{1}0\}$, {111}, $\{1\bar{1}1\}$, $\{\bar{1}11\}$, {101}, and $\{\bar{1}01\}$. Twinning: ubiquitous merohedral twinning on {101}. ***X-ray powder diffraction data:*** 12.97 (10) (010), 6.52 (3) (020), 4.57 (3) (100, 001), 4.32 (5) (110, 011), 3.223 (3) $(\bar{1}01, 101)$, 3.133 (5) $(\bar{1}11, 111)$, 2.593 (3) $(\bar{1}31, 131)$, 2.035 (3) (201, 102), 2.016 (4) (230, 032), 1.844 (3) 231, 132(). ***Optical data:*** Pseudo-uniaxial (-), ω 1.540, ε 1.40, some crystals show a small 2V of about 5°; nonpleochroic. ***Chemical analytical data:*** Means of two sets of electron microprobe data: Na_2O 6.72, CaO 0.33, Y_2O_3 14.52, La_2O_3 8.63, Ce_2O_3 17.11, Pr_2O_3 1.92, Nd_2O_3 5.63, Sm_2O_3 1.22, Gd_2O_3 1.22, Dy_2O_3 2.04, Er_2O_3 2.20, Yb_2O_3 1.32, CO_2 12.00, ThO_2 0.54, H_2O 26.60, F 0.17, sum 102.17, less O = F 0.07, Total 102.10 wt.%. Empirical formula: $(Na_{0.80}Ce_{0.18}Ca_{0.02})_{\Sigma 1.00}(Y_{0.48}La_{0.20}Ce_{0.21}Nd_{0.12}Pr_{0.04}Er_{0.04}Dy_{0.04}Sm_{0.03}Gd_{0.02}Yb_{0.02}Th_{0.01})_{\Sigma 1.21}(HCO_3)_{1.01}[(OH)_{3.98}F_{0.03}] \cdot 2.96H_2O$. ***Relationship to other species:*** None apparent.

Name: For Prof. Thomas Henry Clark (1893–1996) of McGill University. ***Comments:*** IMA No. 97-047. Details of the crystal structure are given in the paper. Mr. Lászlo Horváth provided the information for the crystal drawings which appear here.

GRICE, J. D. and GAULT, R. A. (1998) Thomasclarkite-(Y), a new sodium–rare-earth-element bicarbonate mineral species from Mont Saint-Hilaire, Quebec. *Canadian Mineralogist* **36**, 1293–1300.



Thomasclarkite-(Y)

Tsugaruite

Orthorhombic

$Pb_4As_2S_7$

Locality: Yunosawa mine, Ikarigascki-mura, Minami-Tsugaru-gun, Aomori Prefecture, Japan (Lat. 40°25′45″ N, Long. 140°36′ 54″ E).

Occurrence: In a thin barite veinlet in altered pumiceous pyroclastic rocks. Associated minerals are: barite, jordanite, and galena. Other minerals in similar veinlets in the deposit are: wurtzite, marcasite, gratonite, canfieldite, argentian tennantite-tetrahedrite series minerals, and mimetite.

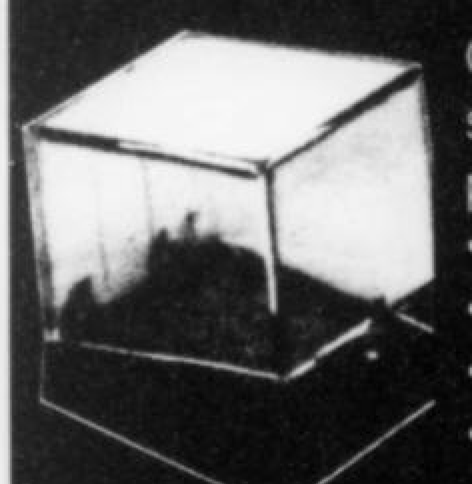
General appearance: Radiating groups of tabular crystals elongate on [001] and tabular on {010} (up to 0.04 x 2 mm).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* silvery lead-grey. *Streak:* lead-grey. *Hardness:* VHN_{25} 86.7 kg/mm², Mohs 2½ to 3. *Tenacity:* brittle. *Cleavage:* none observed. *Fracture:* uneven. *Density:* could not be determined, 6.83 g/cm³ (calc.). ***Crystal-***

lography: Orthorhombic, *Pnn*2 or *Pnnm*, *a* 15.179, *b* 38.195, *c* 8.0745 Å, *V* 4681.3 Å^3, Z 16, *a:b:c* = 0.3974:1:0.2114. Morphology: only {010} was observed. Twinning: none mentioned. ***X-ray powder diffraction data:*** 4.47 (30), 3.705 (34), 3.395 (100), 2.981 (26), 2.870 (34), 2.858 (25), 2.819 (53), 2.739 (48). ***Optical data:*** In reflected light: white with a greenish tint, weak to moderate anisotropism, weak bireflectance, weak pleochroism. R_1, R_2; $^{im}R_1$, $^{im}R_2$: (33.8, 34.0; 19.2, 19.4 %) 470nm, (31.8, 31.9; 18.2, 19.6 %) 546nm, (31.2, 31.3; 17.4, 19.3 %) 589nm, (30.4, 30.4; 16.3, 18.4 %) 650nm. ***Chemical analytical data:*** Means of seven sets of electron microprobe data: Pb 68.70, Tl 0.13, As 12.45, S 18.64, Total 99.92 wt.%. Empirical formula: $(Pb_{3.99}Tl_{0.01})_{\Sigma 4.00}As_{2.00}S_{7.00}$. ***Relationship to other species:*** None apparent.

Name: For the locality. ***Comments:*** IMA No. 97-010.

SHIMIZU, M., MIYAWAKI, R., KATO, A., MATSUBARA, S., MATSUYAMA, F., and KIYOTA, K. (1998) Tsugaruite, $Pb_4As_2S_7$, a new mineral species from the Yunosawa mine, Aomori Prefecture, Japan. *Mineralogical Magazine* **62(6)**, 793–799.



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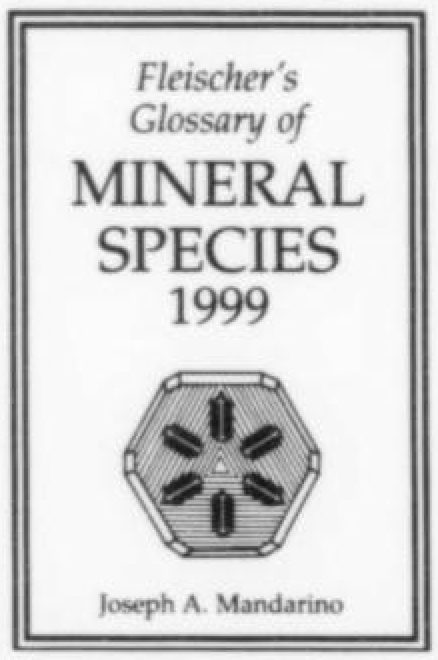

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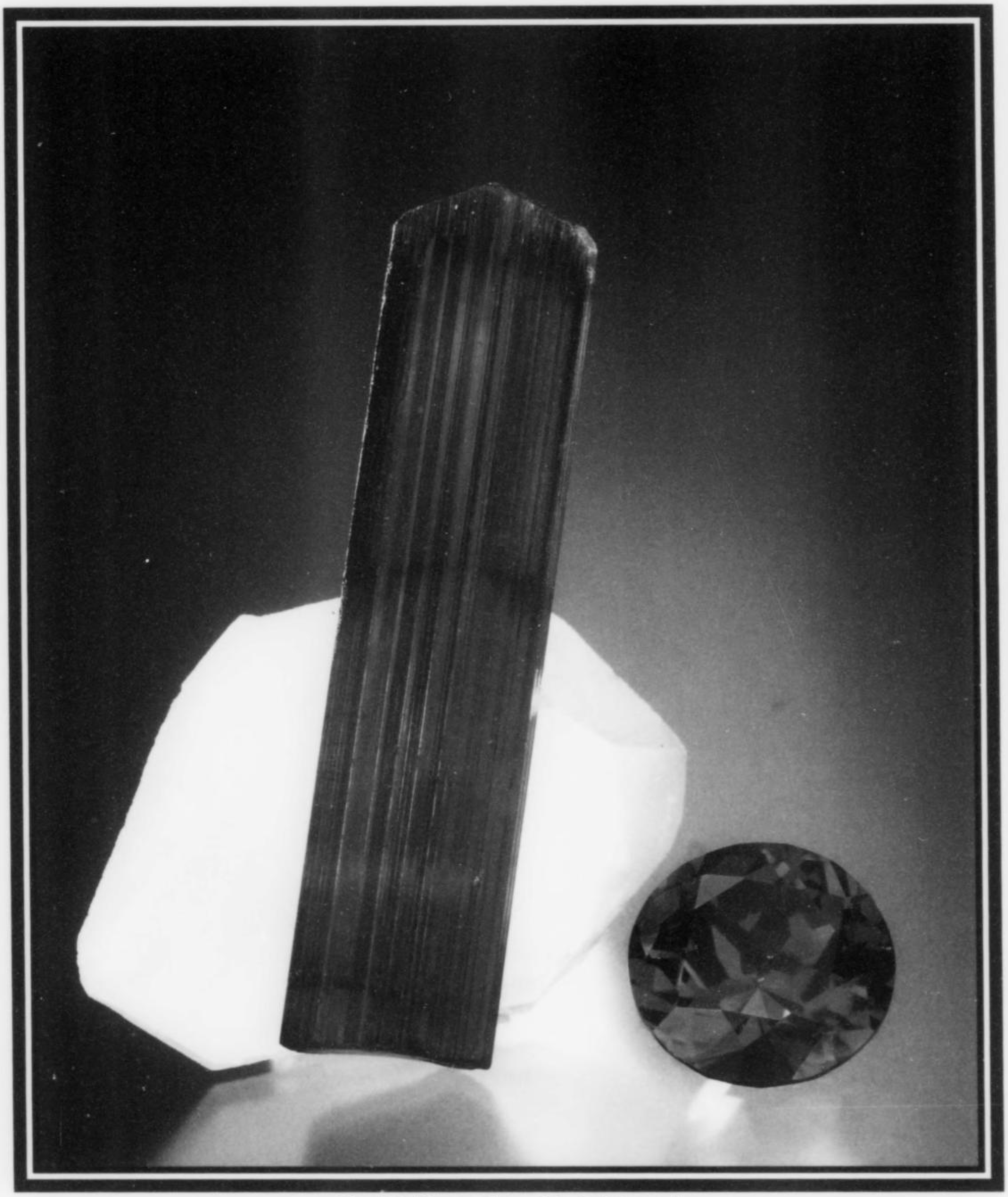

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