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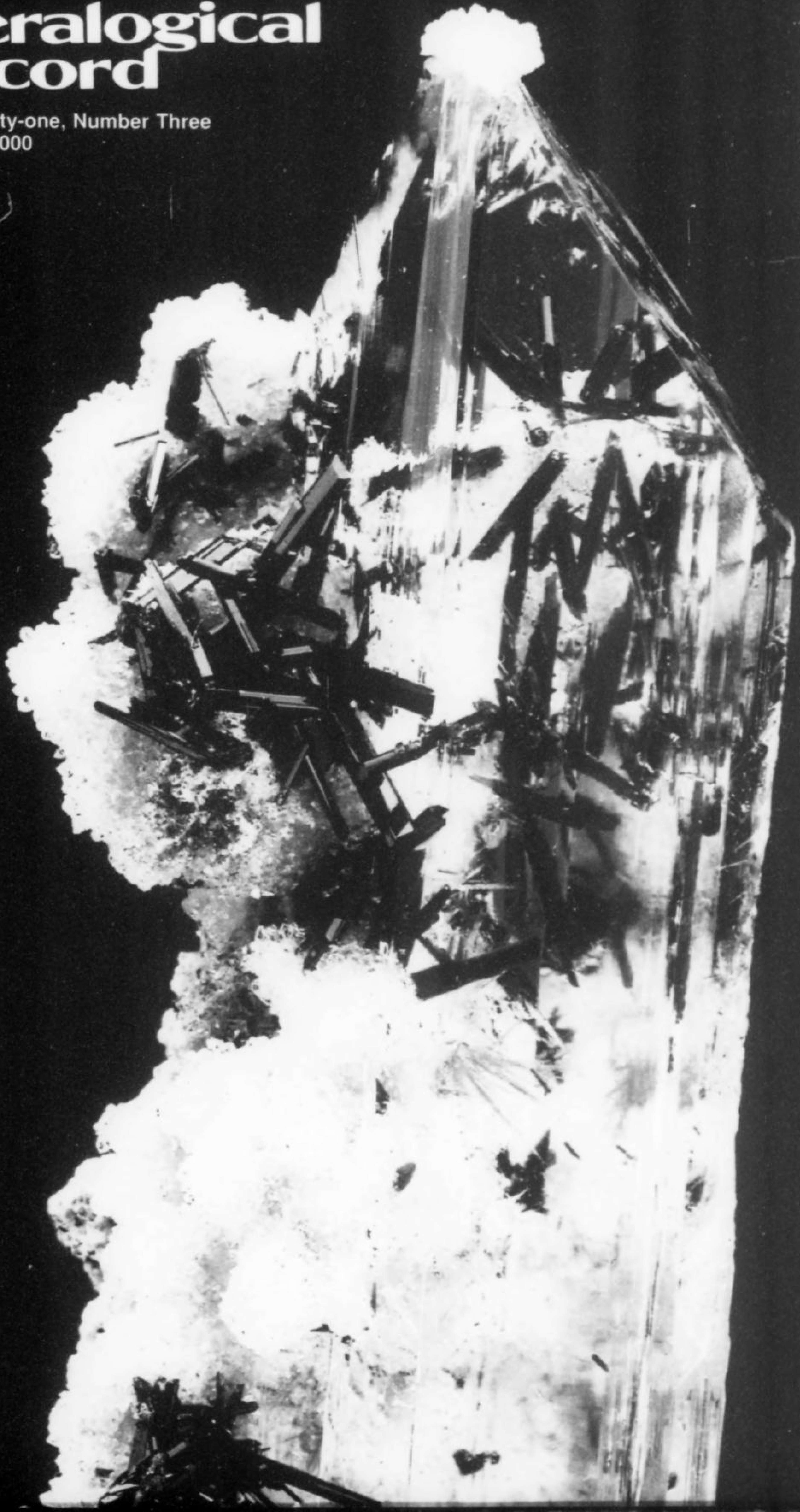

THE MINERALOGICAL RECORD

Articles

Columns

COVER: ATACAMITE in GYPSUM, 6.8 cm, from the Lily mine, Ica, Peru. Irv Brown collection; Jeff Scovil photo.

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notes from the EDITOR

NOTICES

Died, Cynthia Peat, 74, accomplished amateur mineralogist, collector and long-time Canadian subscription agent for *The Mineralogical Record*; in Toronto, of multiple myeloma. Cynthia was born in Henley-on-Thames, England, in 1925, and lived in Kent during and shortly after World War II. She served as a Wireless Operator and Radar Mechanic in the (British) Women's Auxiliary Air Force from 1943 to 1947, and married Jim Peat in 1948. They subsequently emigrated to Canada with their two sons in 1957.

Cynthia first developed an interest in minerals during a visit to a Maine mineral shop in 1960; she soon became an avid collector, and involved the entire family in collecting trips. She learned more about minerals working as an assistant to the well-known Toronto mineral dealer Prosper Williams during the 1960's, receiving her payment in the form of specimens. She spoke fondly of opening consignments from Tsumeb, and unwrapping one treasure after another.

Still hungry for knowledge, Cynthia approached the Mineralogy Department of the Royal Ontario Museum and asked for a job. Though funds were short, as usual, she was taken on and served the Department for over 20 years, cleaning and cataloging specimens, learning to use the analytical equipment, and ultimately becoming an X-ray technician. Those were exciting times at the R.O.M.; an extensive array of rare and unknown minerals was being discovered in the Yukon and at Mont Saint-Hilaire, Quebec.

Jim Peat retired in 1986, and Cynthia stayed on at the R.O.M. as part-time manager of the mineral exchange collection.

Perhaps because most minerals from Mont Saint-Hilaire are tiny, Cynthia became a micromounter. Following her first visit to that famous quarry in the mid-1960's, she missed few opportunities to collect there, and in time became extremely knowledgeable about the minerals from this unique occurrence. She was generous with specimens, making many rare Mont Saint-Hilaire microminerals available to others at the annual Canadian Micro Mineral Association conferences and workshops.

Many people will miss her generosity, her knowledge, her friendliness and her willingness to help.

Tony Steede

CALL FOR PAPERS

The 22nd annual FM-TGMS-MSA Mineralogical Symposium will be held on February 10, 2001 at the Tucson Gem and Mineral Show in the Tucson Convention Center. The topic of the symposium will be **The Minerals of Russia**—which is also the show theme for 2001. Papers on descriptive mineralogy, paragenesis, classic and new Russian localities, and other subjects pertinent to Russian mineralogy are welcome. An audience of enthusiastic amateur and professional mineralogists and geologists is expected.

Those wanting to present a paper at the Symposium must submit a 200 to 300-word abstract, **by September 10, 2000**, to Raymond W. Grant, Mesa Community College, 1833 W. Southern Avenue, Mesa, AZ 85202. Tel: (480) 461-7008, Fax: (480) 461-7234, e-mail: rwgrant@mail.mc.maricopa.edu.

Presentations will be 20 minutes in length, followed by a short question-and-answer period. Abstracts will be published in *The Mineralogical Record*.

RARE SULFOSALTS FROM THE VAN SILVER MINE

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In British Columbia the Silver Tunnel of the Van Silver mine has produced hundreds of rare and beautiful crystal specimens of lead and silver antimony sulfides, including fizelyite crystals which are among the best in the world. The ore at Van Silver comes from a hydrothermal lead-zinc-silver vein system, which contains significant antimony. Diaphorite and fizelyite were first observed in Canada at the Van Silver mine, and it is the second reported occurrence in Canada for semseyite, miargyrite and pyrostilpnite.

INTRODUCTION

The identifications of the rare minerals reported here are based predominantly on X-ray powder diffraction and electron microprobe analyses performed at the Geological Survey of Canada. Additional chemical analyses (atomic absorption) were performed at Chemex Labs Ltd., Vancouver. Bart Cannon (Cannon Microprobe, Seattle, Washington, USA) provided some preliminary microprobe work.

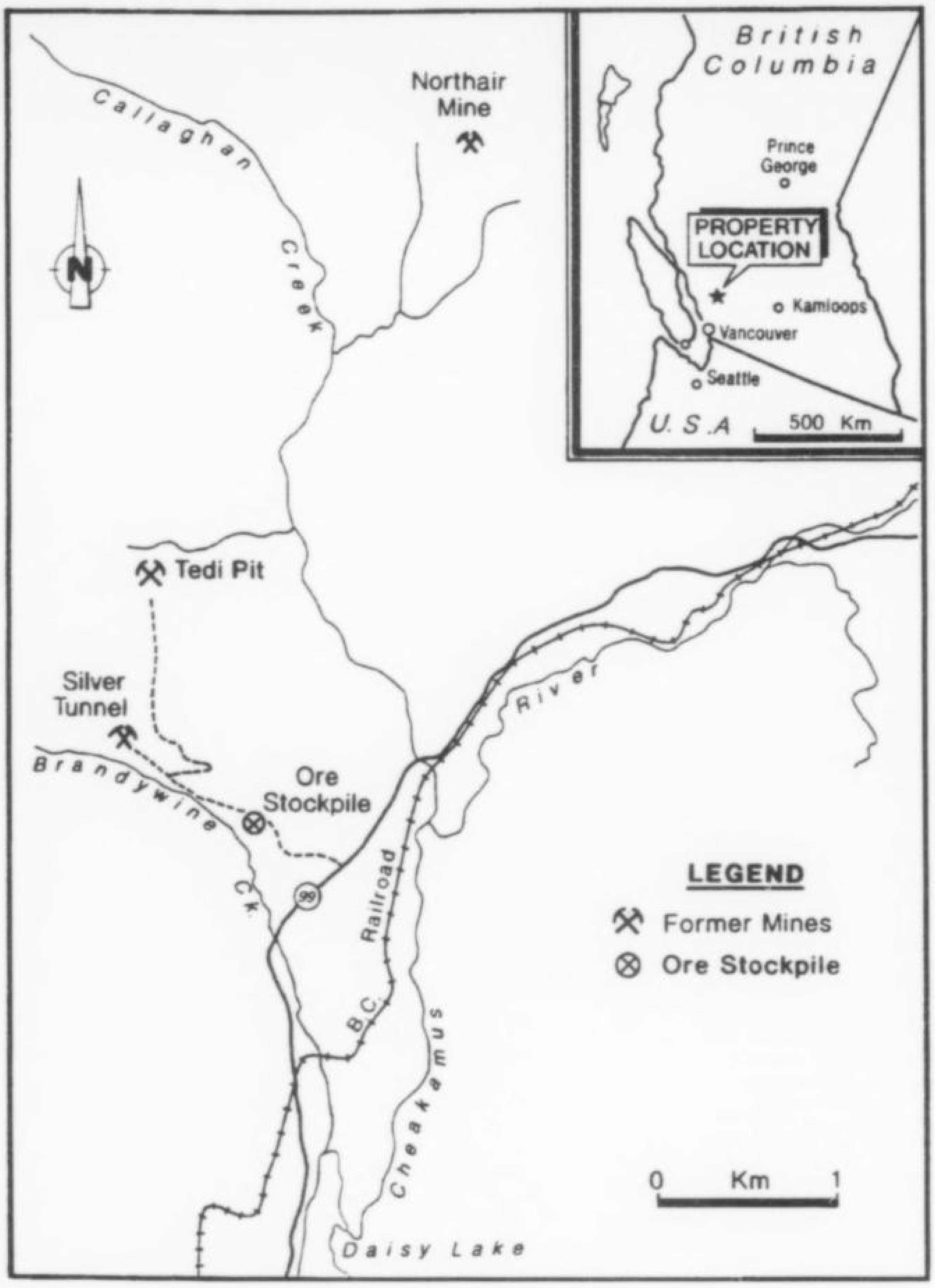


Figure 1. **Location of the Silver Tunnel and the ore stockpile of the Van Silver mine.**

The Van Silver mine (Fig. 1) is located west of Highway 99 on a tributary of Brandywine Creek, 105 km north of Vancouver, British Columbia. Brandywine Creek is a tributary of the Cheakamus River, which drains a large mountainous area. The region is renowned for its scenery, lakes, alpine meadows, glaciers, and excellent skiing at Whistler and Blackcomb Mountains, 20 km to the north.

Silver-bearing ore was produced during underground mining from the Silver Tunnel adit, which lies at the 685-meter elevation on Snow Creek. The Silver Tunnel is now inaccessible due to caving; however, silver minerals are found on the waste dump, ore stockpile, and occasionally in a small open cut above the tunnel. The best collecting area at this time is the ore stockpile at the abandoned mill site, which is situated along the Brandywine Creek road 1.0 km east of the adit at a point 1.0 km northwest of Highway 99. During the colder months the region is covered by a meter or more of snow, restricting mineral collecting to June through September.

The silver ore in the stockpile was mined by Van Silver Explorations Ltd. from the Silver Tunnel. The fresh rhyodacite host rock is pale in color but soon turns black on exposed surfaces. Mixed with the ore in the stockpile are large fragments of a green chlorite-sericite schist from the nearby Main Zone pit, which, apart from a showing of linarite, contains little of mineralogical interest.

Inside the ore stockpile the creamy white rhyodacite weathers to a glutenous gray-white montmorillonite clay, streaked with dark, crumbling crystals of sulfide minerals. Nothing of mineralogical interest has been recovered from the clay. Lumps of quartz-rich rhyodacite and quartz nodules within the clay have maintained their integrity. When the nodules are broken, one commonly finds a carbonate lining. Leaching out the carbonate with hydrochloric acid occasionally yields euhedral microcrystals of sulfide and sulfosalt minerals perched on lustrous quartz crystals. The best sulfosalt specimens come from galena veins in the quartz-rich rhyodacite. These veins average a few millimeters in width, but range up to several centimeters in length. Careful splitting along the sulfide veinlets exposes vugs containing small crystals of quartz, galena, pyrite, sphalerite and the suite of rare sulfosalts described in this paper. Crystal sizes range from tenths to several millimeters. In spite of the crystal size, this decrepit little stockpile has produced some of the most spectacular crystals of lead and silver sulfosalts found anywhere in the world.

When the suite of crystallized species in the vugs is carefully examined, a remarkable story unfolds. From the simple observation that if mineral A overgrows mineral B, then mineral A was deposited after mineral B, the paragenetic sequence of the minerals at the Van Silver deposit can be worked out. This is unusual because most sulfosalt deposits result from repeated, overlapping mineralizing episodes at varying temperatures and places in the mine. The usual result is that the paragenetic sequence can be established only for individual specimens, the sequence varying from one specimen to another, causing some confusion. However, the small size of the Van Silver deposit and the simplicity of the vein system allowed the sulfosalts to crystallize one at a time in the same sequence throughout the zone.

Figure 2. **View toward Whistler on Highway 99. The dirt road on the left, where the power lines cross Highway 99, leads directly to the ore pile from the Silver Tunnel. Ray Hill photo.**

Figure 3. **The ore stockpile in 1992. Although the fast-growing alder are taking over the stockpile, it is still one of the few wheelchair-accessible mineral collecting localities in British Columbia. Ray Hill photo.**

HISTORY

Early British exploration of the area began with the building of the 1859 Gold Rush trail, passing about 50 km north of the Van Silver deposit. This trail provided access to the Cariboo gold fields of central British Columbia. The Squamish trail, which connected the Gold Rush trail to tidewater on Burrard Inlet, was constructed from 1873 to 1877 and passed less than 10 km from the Van Silver deposit. As prospectors discovered mineral showings and the great timber potential of the area was recognized, a railroad, then called the Pacific Great Eastern, was built along this route from Vancouver to access central British Columbia. This railroad, now known as British Columbia Rail, was completed in 1914 and, along with the completion of Highway 99 in the 1960's, opened the area to development and recreation.

The Van Silver mine was first prospected and staked as the Blue Jack Group in 1923 by A. E. Snow. In the 1930's small hand-sorted, high-grade ore shipments were made by Blue Jack Mines Inc., but the remote location and lack of reserves prevented mine development (British Columbia Minister of Mines, 1923–1936). There has been only one other producing mine in the immediate area, the Northair gold mine, which in the 1980's produced copper-lead-zinc concentrates that contained over 30,000 kilograms of silver and 5,670 kilograms of gold (Hewitt, 1991).

In 1967 Van Silver Explorations Ltd. acquired the property and, in the mid 1970's, built a small concentrator with a capacity of 100 tonnes per day. In 1977, the only year of operation, Van Silver Explorations Ltd. milled 8,067 tonnes of ore from which they

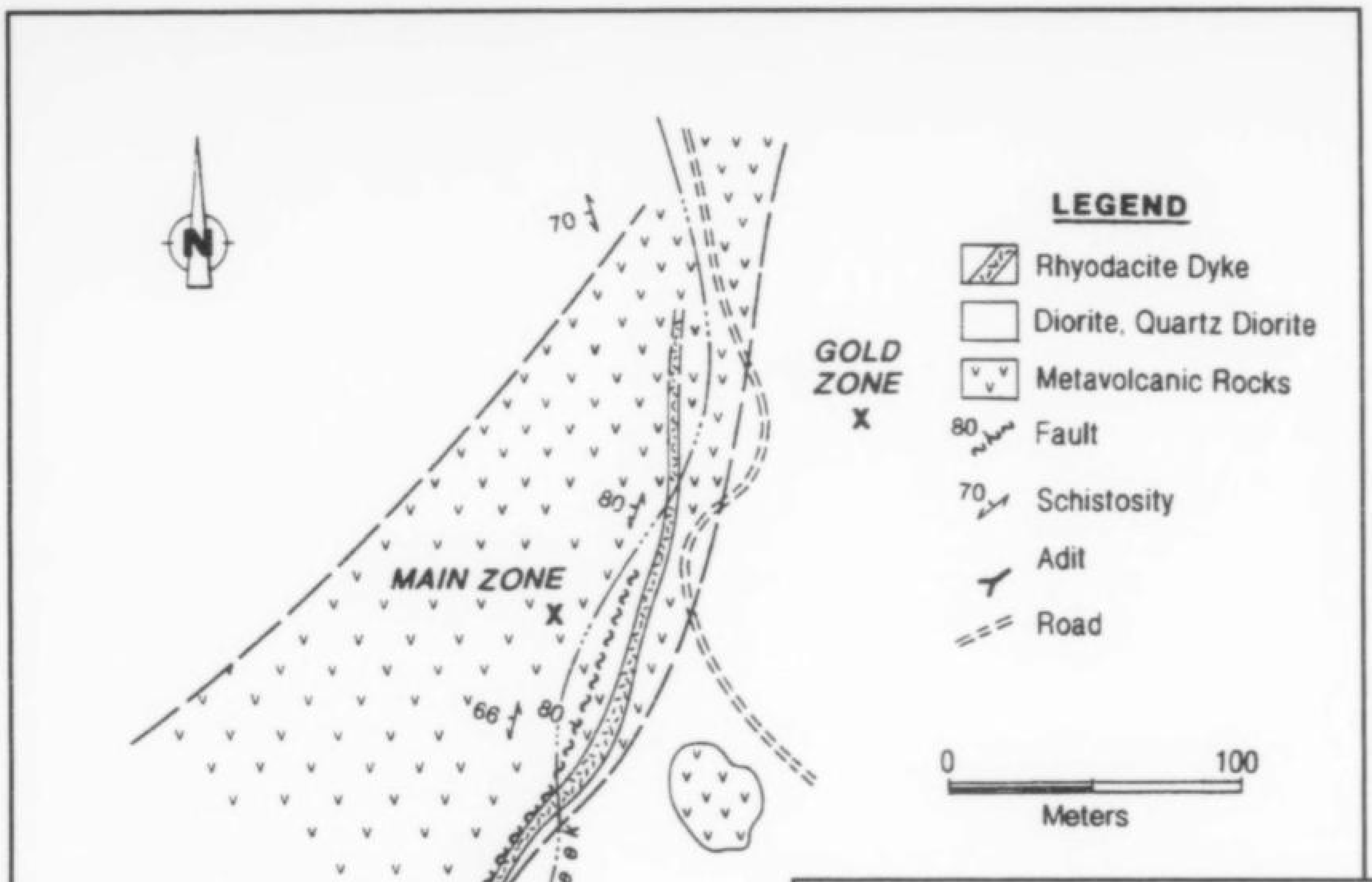


Figure 4. **The geology of the Van Silver mine, modified from Osborne (1976). The adit is the Silver Tunnel and the road to it has mostly caved into Brandywine Creek.**

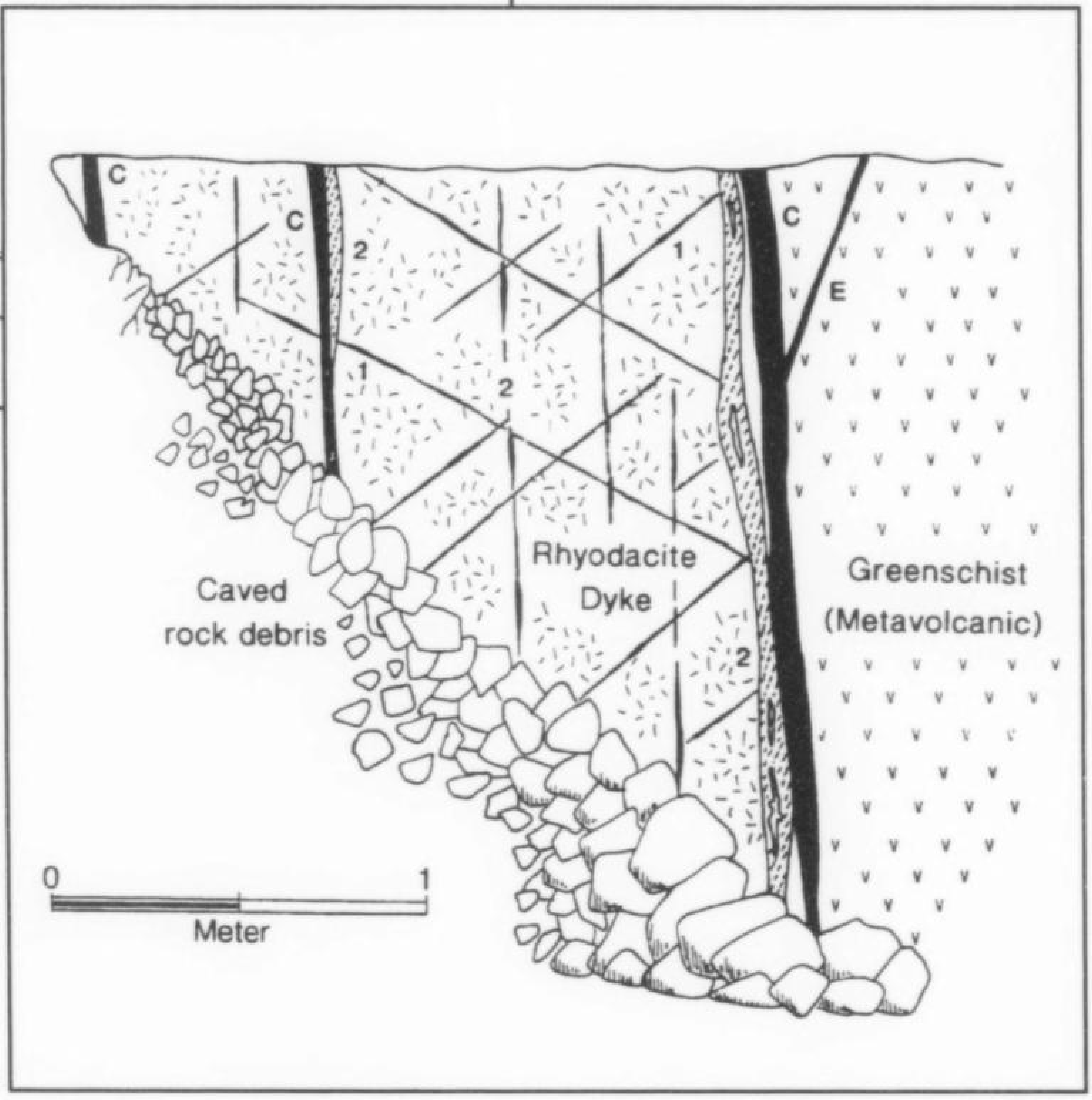


Figure 5. **Mineralized rhyodacite dike, No. 1 Crosscut, south face, Silver Tunnel. Notations (E,1,2) refer to stages of veins. Dark linear features (C) are clay-altered gouge zones (after Soregaroli, 1966).**

recovered 1.38 kg of gold and 157.5 kg of silver contained in base metal concentrate (British Columbia Minister of Mines and Petroleum Resources 1974–1978).

In 1966 one of the authors (AES), during the course of a property evaluation for a Canadian mining company, collected and later identified diaphorite and miargyrite from the Silver Tunnel. Lloyd Twaites in 1973 collected sulfides from near the mill. In 1978, Ty Balacko first collected samples from the ore stockpile and, with thorough microscopic examination, observed diaphorite and pyrostilpnite. Ty Balacko has provided almost all of the "unknowns" for this study. In recent years, serious collecting and analytical work has been done collectively.

The property is now held by La Rock Mines Ltd. of Vancouver. Collectors should obtain permission from the owners in Vancouver before removing material.

GEOLOGY

The Van Silver property and surrounding area are characterized by north to northwest-trending roof pendants of volcanic and volcano-sedimentary rocks floating in a sea of dioritic and quartz dioritic rocks of the Coast Plutonic Complex. The Coast Plutonic Complex and included roof pendants form the backbone of the Coast Mountains, a northwest-trending mountain range stretching for several hundred kilometers along the coast of British Columbia.

Many base metal and precious metal showings are hosted in roof pendants within the Coast Mountains. Several such showings,

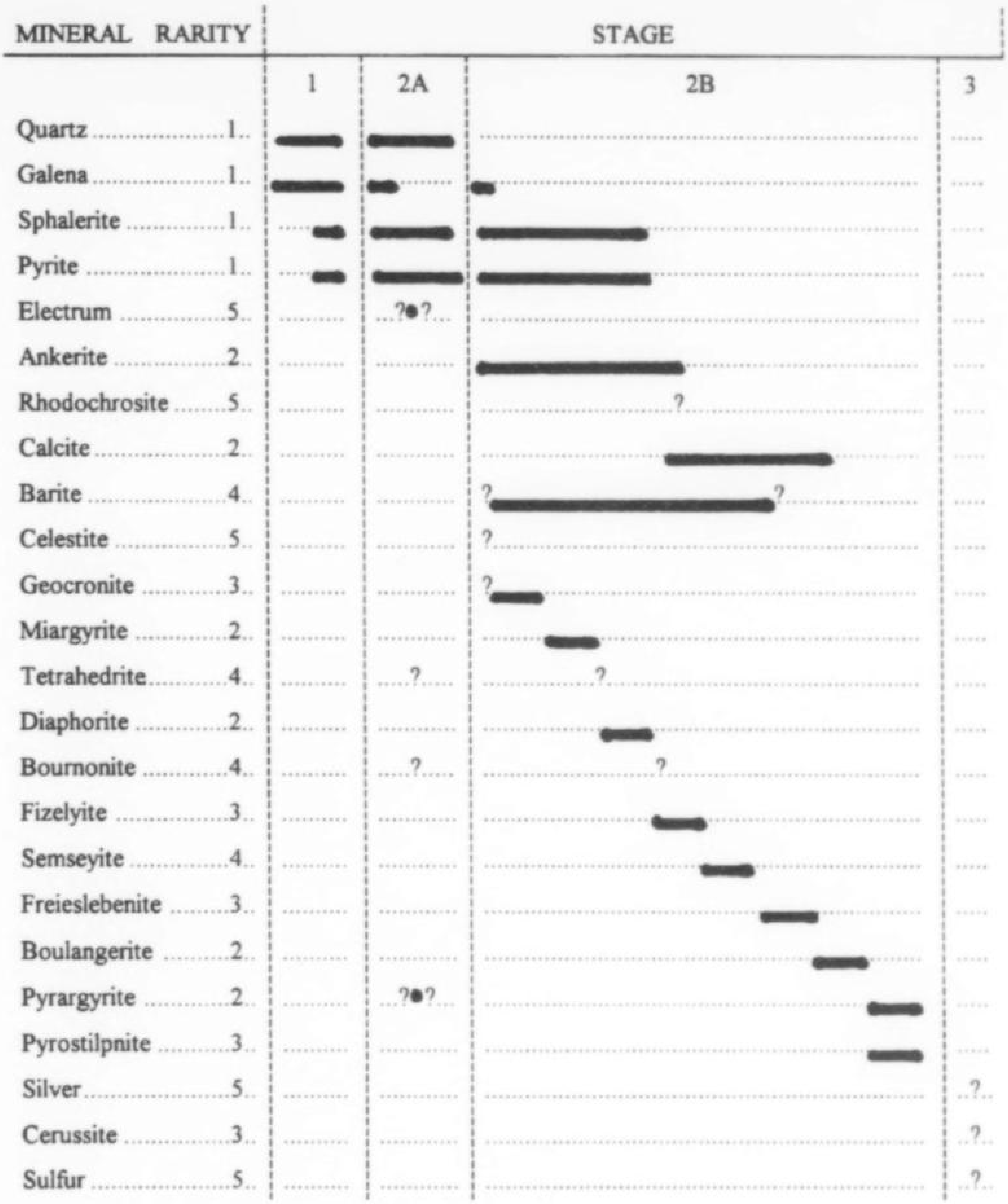


***Figure 6.* The sequence of mineralization at Van Silver. Rarity is on a five-point scale with 5 the most rare. The "?" are estimates for rare minerals seen on a few specimens with few associations. The timing is purely relative and the length of the deposition bars reflects this.**

including the Van Silver mine, are hosted in greenstones of the Callaghan Creek pendant. This pendant is composed largely of andesitic flows and equivalent fragmental rocks, accompanied by argillites, conglomerates and minor limestone (now marble) which have been assigned to the Lower Cretaceous Gambier Group by Woodsworth (1977). Regional greenschist metamorphism has imposed a weak to strong foliation on the volcanic and plutonic rocks. Intensely altered and schistose andesitic rocks are favored sites for faulting and for the emplacement of rhyodacite and basaltic dikes. Late Tertiary basaltic to rhyodacitic flows and pyroclastic rocks fill major valleys and cap mountain peaks in the area. Pleistocene alpine glaciation carved deep valleys, some of which are partially filled by Pleistocene olivine basalt flows.

Silver Tunnel Deposit

Where observed, the silver and base metal-bearing quartz veins which form the Silver Tunnel deposit are confined to a rhyodacite dike which has been intruded into greenschists near the contact of the Gambier Group and quartz diorites of the Coast Plutonic Complex (Fig. 4). The contact between the greenschists and rhyodacite dikes is especially favorable for fault development which is reflected as intensely clay-altered gouge zones. Where the alteration is extreme, much of the dike has been transformed into a creamy tan to gray, soft plastic mud. Less altered areas of the dike are more competent. Alteration is fracture controlled and, in areas of widely spaced fractures, nodules of silica-altered rhyodacite remain as hard, rounded masses in the softer rock.

Where mined, the rhyodacite dike has an average thickness of about 2 meters and has been traced by surface and underground exposures and by diamond drilling for a strike length of about 500 meters. The dike strikes generally northerly with a steep westerly dip; this gives the surface trace of the dike a northeasterly trend as the elevation increases to the north. The west contact of the dike is faulted and both the dike and the greenschist are intensely altered to clay, resulting in very unstable ground conditions in the tunnel. Continued mining in this unstable ground resulted in total collapse of the adit and closure of the mine.

Figure 5 is a sketch of the mineralized dike in the No. 1 crosscut as mapped by Soregaroli (1966). This mineralization in the tunnel has been traced northward for over 30 meters and is terminated at

Brandywine Creek to the south. Base and precious metals are confined largely to this altered rhyodacite dike.

Diamond drilling has intersected the silver mineralization at a depth of about 20 meters below the Silver Tunnel. A later tunnel was excavated at this elevation, but nothing of economic significance was encountered and bad ground conditions again forced abandonment.

Barren quartz veins were observed within the greenschist in the Silver Tunnel. Such barren veins containing chlorite or carbonate patches occur throughout the region and are unrelated to the mineralizing episode.

Metallic minerals within the deposit are confined to two distinct stages of veins as observed in the Silver Tunnel:

Stage 1: quartz-pyrite-sphalerite-galena veins

Stage 2: quartz-carbonate-barite-sphalerite-galena-sulfosalt veins.

Stage-1 veins form a network of narrow 0.5 to 1.0 cm veins which dip about 20 to 30 degrees westerly and 30 to 35 degrees easterly. Such veins only occur within the dike.

Stage-2 veins, where the silver sulfosalts occur, generally strike and dip parallel to the observed dike contact. Thicknesses range from 1.0 mm to 10 cm. Distribution of minerals in the veins is irregular with a patchy occurrence of vugs. Stage-2 veins distinctly cut stage-1 veins as shown in Figure 5.

Paragenesis

The simplicity of the ore veins at the Van Silver deposit has led to a remarkably consistent depositional sequence. Microscopic examination of hundreds of specimens recovered from the ore stockpile has revealed two mineralizing episodes in the *stage-2* veins, which are designated *stage 2a* and *stage 2b*, as well as a third mineralizing episode, *stage 3*. Geological features corresponding to stage 3 were not identified in the Silver Tunnel. The observed specimens were all recovered from the ore stockpile and stage 3 may well represent secondary enrichment occurring *in* the stockpile. Figure 6 summarizes the observed paragenetic sequence.

A vein opening a few square centimeters in area may contain euhedral crystals of several species ranging in size from submillimeter to a few millimeters. The close association of lustrous, black sulfosalts on white quartz or carbonate make spectacular micromounts. A few thousand specimens of millimeter-sized crystals of sulfosalts and their associates have been collected by the authors. Sufficient material has now been examined to allow a statistically significant assessment of the relative abundance of species (Fig. 6).

Stage 1

The earliest stage of mineral emplacement in the Silver Tunnel is characterized by quartz, galena, sphalerite and pyrite. Sulfosalts have not been observed in stage-1 veins. Galena is almost universally overgrown with quartz, sphalerite or pyrite. Virtually all of the exposed galena shows dissolution textures, and is coated with cerussite, probably from alteration during stage-3 activity. Pyrite forms millimeter-size cubes with pyritohedral modifications and striations. The pyrite commonly has an iridescent tarnish and makes good micromounts when perched on the lustrous, clear, Dauphiné-twinned quartz crystals. Sphalerite occurs rarely as sharp, lustrous, millimeter-size yellow-brown tetrahedra with lively, yellow-brown internal reflections. Some colorless tetrahedral sphalerite with a black rind is easily mistaken for tetrahedrite.

Stage 2

Some millimeter-size quartz crystals contain bright red pyrargyrite inclusions. Vugs contain gemmy red pyrargyrite crystals up to several millimeters long; rarely centimeter-size anhedral crystals of pyrargyrite are enclosed in the galena, pyrite and sphalerite, indicating an early deposition for this pyrargyrite. On rare specimens the euhedral pyrargyrite crystals are overgrown by pyrite or sphalerite. Much of the early pyrargyrite is decrepit and vugs exist that are barren except for pyrargyrite inclusions in quartz. Other early stage-2 sulfosalts are not found on pyrargyrite. These observations suggest the possibility of two episodes of mineralization in the stage-2 veins.

Stage 2a corresponds to the deposition of a second generation of galena and the first silver mineralization. After galena was deposited in the stage-2 veins, and while the sphalerite and pyrite were still being deposited, the first pyrargyrite crystallized. Electrum and possibly bournonite are associated with this early pyrargyrite.

One specimen with a stage-2a assemblage has an indistinct millimeter-size group of wires of electrum perched on a pyrargyrite crystal. The electrum looks like silver with a yellow tarnish, but is unaffected by a drop of concentrated nitric acid. Analysis of one grain of electrum, found in polished section, yielded 62% gold and 36% silver. Presumably the gold values in the mine concentrates came from electrum. Another single specimen containing galena, bournonite crystals on pyrite and sphalerite crystals on pyrargyrite crystals suggests that some of the bournonite is from stage 2a.

Only the vugs that were protected from dissolving solutions preserve the stage-2a mineralization and these are rare. Once the stage-2a minerals were dissolved, the metal-rich solutions remained in the stage-2 veins and probably cooled slowly. Thus in stage 2b the sulfosalts precipitated from the cooling solution a single phase at a time, giving the remarkable depositional sequence shown in Figure 6.

The carbonate gangue appears at the onset of stage 2b and occurs on nothing later than boulangerite. Initially the carbonate was exclusively ankerite. Fizelyite is the last mineral to simultaneously deposit with ankerite. Calcite then becomes the only carbonate, depositing with semseyite, freieslebenite and boulangerite.

Ankerite occurs as sometimes lustrous, white to beige rhombohedra up to 4 mm across. The rhombohedra are simple and may be stacked with a dozen or more crystals in parallel growth to more than a centimeter in size. Manganese predominates over magnesium. Rhodochrosite is known only from a single specimen with pink cleavages tending to yellowish flattened rhombohedra, closely resembling calcite. Calcite occurs as unimpressive white to yellowish flattened rhombohedra (nailhead spar) up to 3 mm in diameter. There are substantial amounts of iron and manganese in the calcite.

The few barite specimens recovered make this mineral difficult to place in the paragenetic sequence. A single blue celestite of unknown paragenesis has also been recovered. Geocronite occurs on barite. Freieslebenite is the last mineral that has been observed to crystallize on barite. Barite occurs as transparent to white, sometimes zoned, tabular crystals up to a centimeter in size. It is probable that barite and ankerite mark the beginning of stage-2b mineralization.

Galena occurs as crude to sharp octahedra up to a millimeter in size. In some vugs lined with quartz and ankerite, lustrous galena octahedra have precipitated exclusively on the ankerite. Galena octahedra are rare and occur only on gangue minerals, suggesting a deposition at the onset of stage 2b.

Stage 3

Cerussite, sulfur and silver of stage 3 may have formed by the action of ground water in the ore stockpile. White cerussite crystals are found on bournonite and galena as sub-millimeter acicular crystals. Scarce sub-millimeter silver wires have also been found. A short time after collection, a growth of acanthite appears on the wires. A few sub-millimeter, resinous, globular sulfur crystals have been observed, and could be the excreta of bacteria in the ore stockpile.

RARE SULFOSALTS OF STAGE 2B

During stage-2b deposition, nine antimony sulfides were sequentially crystallized, one after the other with essentially no overlap. Of the many hundreds of specimens examined, less than six specimens showed convincing evidence of overlap. Although there often is more than one habit of a particular antimony-bearing sulfide, such variations do not occur in the same vug. The only common evidence of two simultaneously deposited antimony-bearing sulfides occurs at the end of the sequence where pyrargyrite and pyrostilpnite are found growing on each other. This probably reflects a fluctuating crystallization temperature near the transition temperature (192°C) of these dimorphic minerals.

Stage-2b rare sulfide and sulfosalt minerals are described below in their order of deposition from earliest to latest:

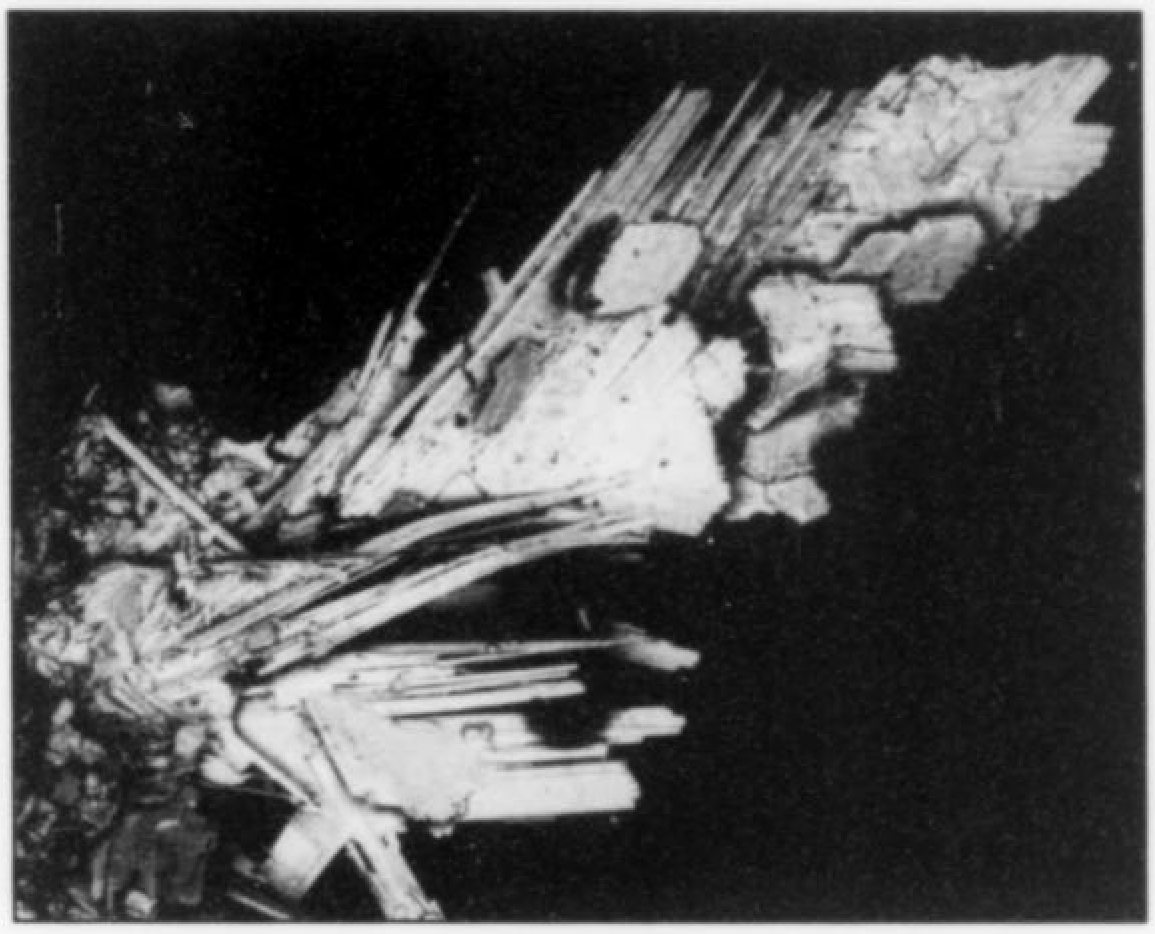


***Figure 7.* Geocronite crystal group, 0.6 mm in length. Geological Survey of Canada specimen A-88-15-6 and photo.**

Geocronite $Pb_{14}(Sb,As)_6S_{23}$

Geocronite is highly variable in habit, but invariably pseudohexagonally twinned. It occurs in parallel stacks and rosettes to 1 mm in diameter, black in color and generally lustrous. Geocronite often forms isolated crystal groups on ankerite and quartz and rarely on barite, yet it has been observed overgrown by miargyrite and later minerals. On some rosettes of pseudohexagonal plates, a spike of geocronite extends from the twin boundary in the plate and tiny spikelets of 0.1-mm length grow from the main spike at an angle of about 60° in the plane of the plate. Striations at 60° and 120° on the platelets, as in Figure 7, distinguish the mineral. The geocronite from this locality contains about 3% arsenic by weight.

Miargyrite $AgSbS_2$

Miargyrite occurs as complex, blocky, lustrous, intergrown crystals with dark red internal reflections. Crystals are commonly in the 1–3 mm range and reach a maximum size of 5 mm. The complex crystals are difficult to visually orient. Figure 8 is a typical example. Generally miargyrite is associated with galena. Miargyrite is one of the earliest minerals and is commonly overgrown with diaphorite and later minerals. A single specimen which has a miargyrite crystal perched on a diaphorite is the only evidence of their overlap. The dark red internal reflections, blocky habit and dark pink-red streak distinguish miargyrite. Miargyrite from the Van Silver deposit contains about 0.3% arsenic by weight.

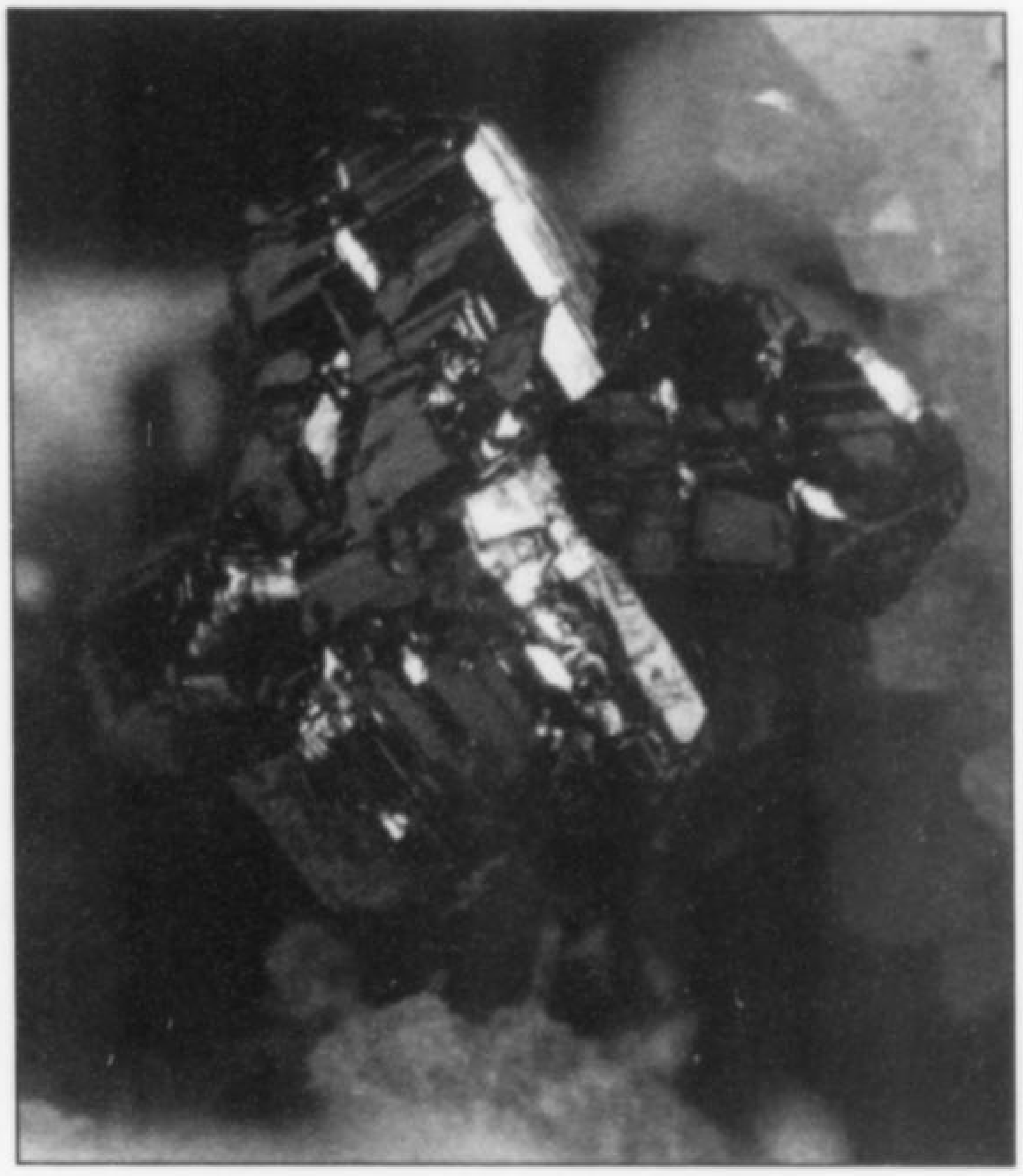


***Figure 8.* Miargyrite crystals in a 1.8-mm group. Ty Balacko specimen; Ed Montgomery photo.**

Tetrahedrite $(Cu,Fe)_{12}(Sb,As)_4S_{13}$

Tetrahedrite from Van Silver contains 20 weight % silver, 5 weight % zinc, just over 1 weight % iron, and less than 1 weight % arsenic. It occurs as sharp, lustrous black tetrahedra to 1 mm in size, sometimes with trapezohedral modifications, and is usually observed on quartz, pyrite and sphalerite. This is consistent with stage-2a deposition. A single specimen with a tetrahedrite tetrahedron perched on a miargyrite crystal is the only convincing evidence of stage-2b deposition. This almost pure antimony-end-member tetrahedrite shows slightly darker internal red reflections than does the pure arsenic member from Binnental, Switzerland. The red reflections and lack of cleavage distinguish tetrahedrite from sphalerite.

Diaphorite $Pb_2Ag_3Sb_3S_8$

Diaphorite occurs as dull to brilliant, black, prismatic crystals, commonly 1–2 mm in length and about 0.5 mm in width. Rarely the crystals reach 5 mm along the *c* axis. The occasional blue tarnish and frequent dullness may result from post-mining weathering in the ore stockpile. Prism faces generally are striated parallel to the prism or *c* axis, as can be seen in Figure 9. Fine striations are not due to repeated twinning, because even on heavily striated crystals, which may be almost round in cross section, all the terminal faces can be mirror smooth. There may only be two or three prism forms: {hk0}, {100}, and possibly {010}. At least half a dozen crystal forms are represented on the terminations. Every crystal has at least three terminal forms with at least two of them being {0kl}, {h0l} or {hkl}. Each of these forms has faces that make obtuse angles with the prism axis and it is this presence of two distinct sets of obtuse angles that distinguishes diaphorite. The complex terminations and obtuse angles permit a visual distinction

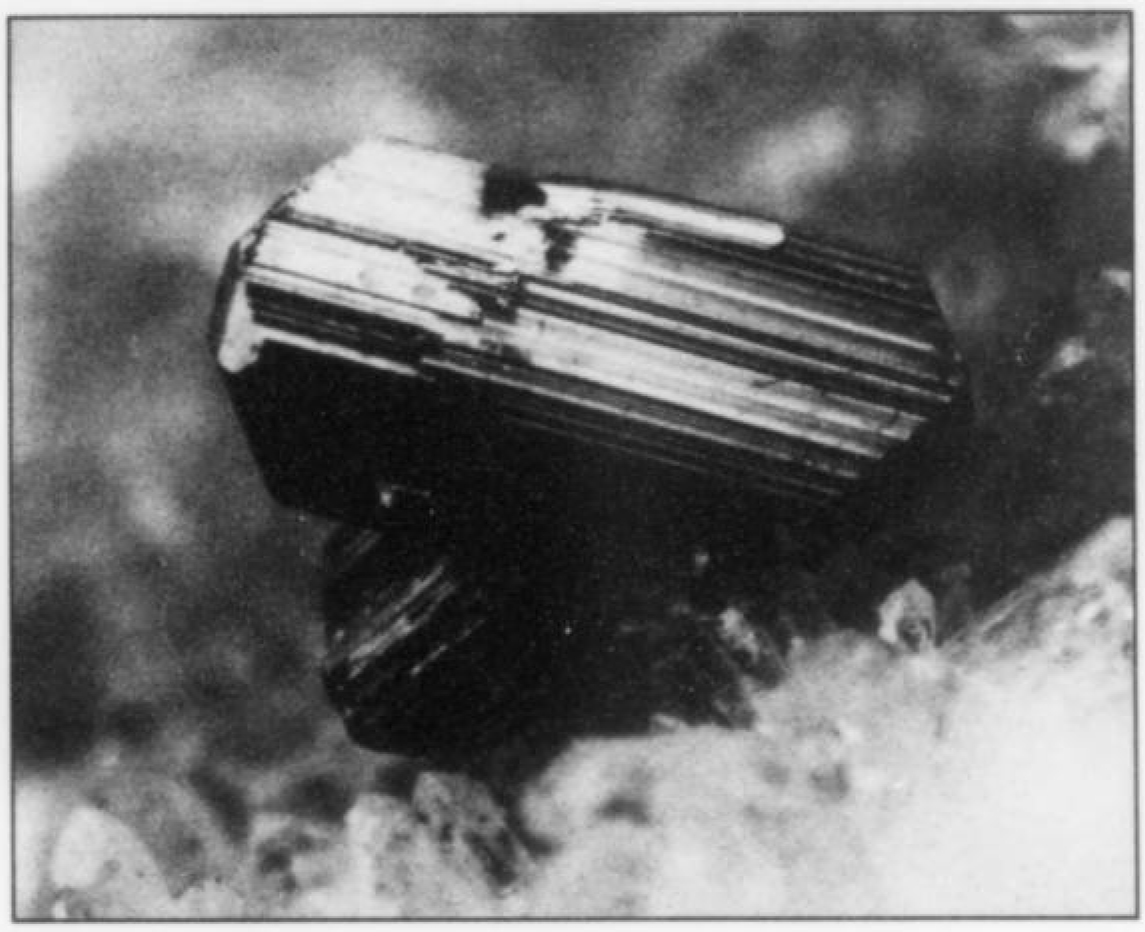
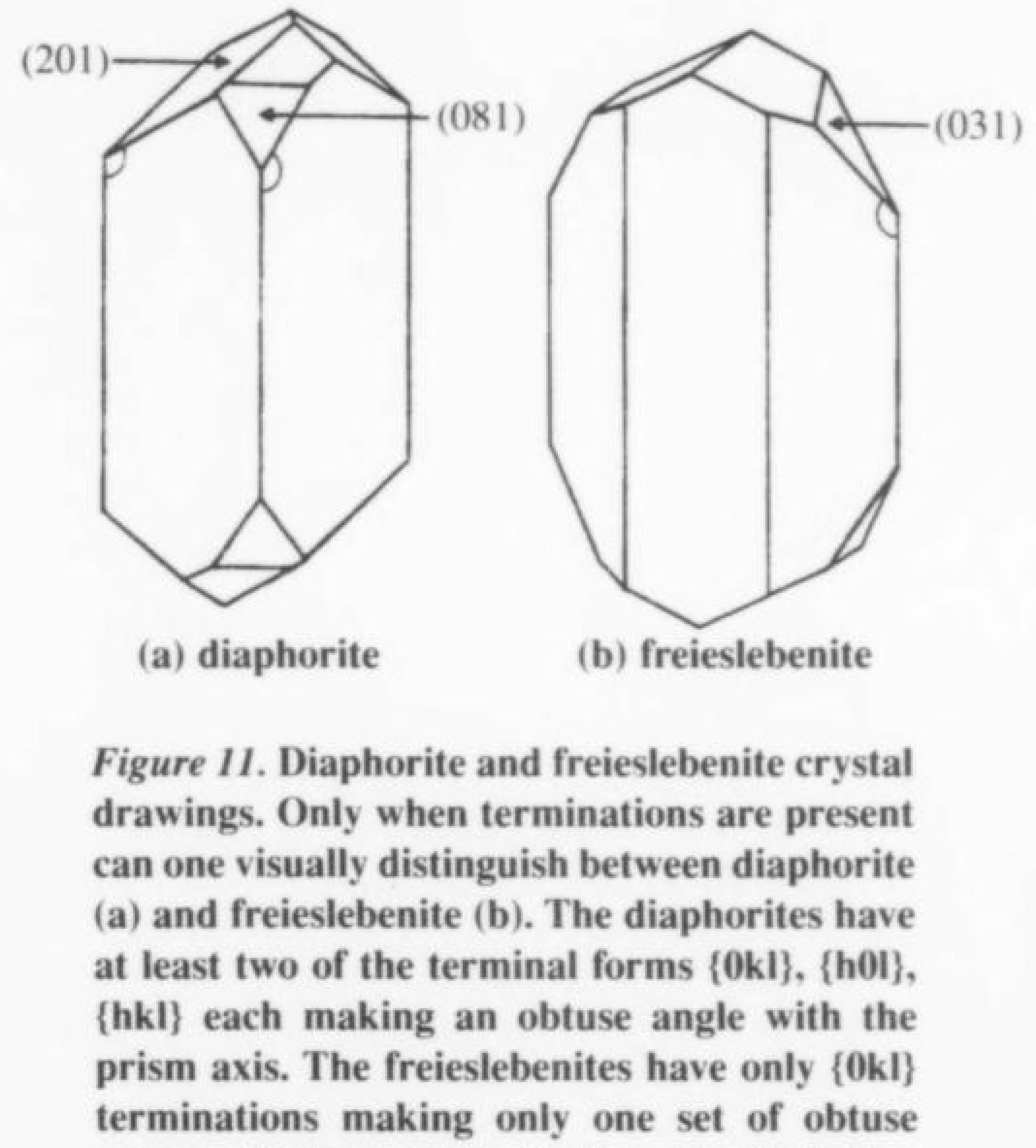


Figure 9. **Doubly terminated diaphorite crystal, 1.8 mm long. Ty Balacko specimen; Ed Montgomery photo.**



(a) diaphorite **(b) freieslebenite**

Figure 11. **Diaphorite and freieslebenite crystal drawings. Only when terminations are present can one visually distinguish between diaphorite (a) and freieslebenite (b). The diaphorites have at least two of the terminal forms {0kl}, {h0l}, {hkl} each making an obtuse angle with the prism axis. The freieslebenites have only {0kl} terminations making only one set of obtuse angles with the prism axis. Here the (201) face and the (081) face in diaphorite (a) provide the two sets of obtuse angles. In the freieslebenite (b) the (031) face gives one obtuse angle. (Crystals drawn with Shape.)**

between diaphorite and the rarer freieslebenite, which has a simpler termination as shown in Figure 11. The absence of internal reflections combined with the prismatic habit and black color of diaphorite distinguish it from the other minerals. Intergrown diaphorite crystals are common and some of these appear to represent two types of twins. One is a V-twin with the angle between the two prism axes being about 25°. The other twin has the two prism axes parallel with a re-entrant angle of about 90°.

Diaphorite occurs most frequently in galena-rich veins. Intimate intergrowths with the other sulfide minerals frequently occur and one often observes an isolated intergrowth of diaphorite and another sulfide. Some individual crystals of diaphorite are perched on colorless quartz crystals, similar to such material from Morey, Nevada (Williams, 1968).

Figure 10. **Diaphorite crystals to 2.3 mm. Ty Balacko specimen; Ed Montgomery photo.**

Bournonite $PbCuSbS_3$

Bournonite occurs as dull to lustrous, steel-gray, tabular crystals and cog-wheel twins up to 3 mm in size. Although it is the only steel-gray mineral lacking cleavage at Van Silver, it is recognized most frequently by its characteristic crystal habit. Bournonite occurs with both stage-2a and stage-2b associations, generally on quartz, pyrite, sphalerite and galena. The only evidence for placing bournonite in the stage-2b sequence is a single specimen with a bournonite crystal overgrowth on a diaphorite crystal. There is less than 1% arsenic by weight in the bournonite.

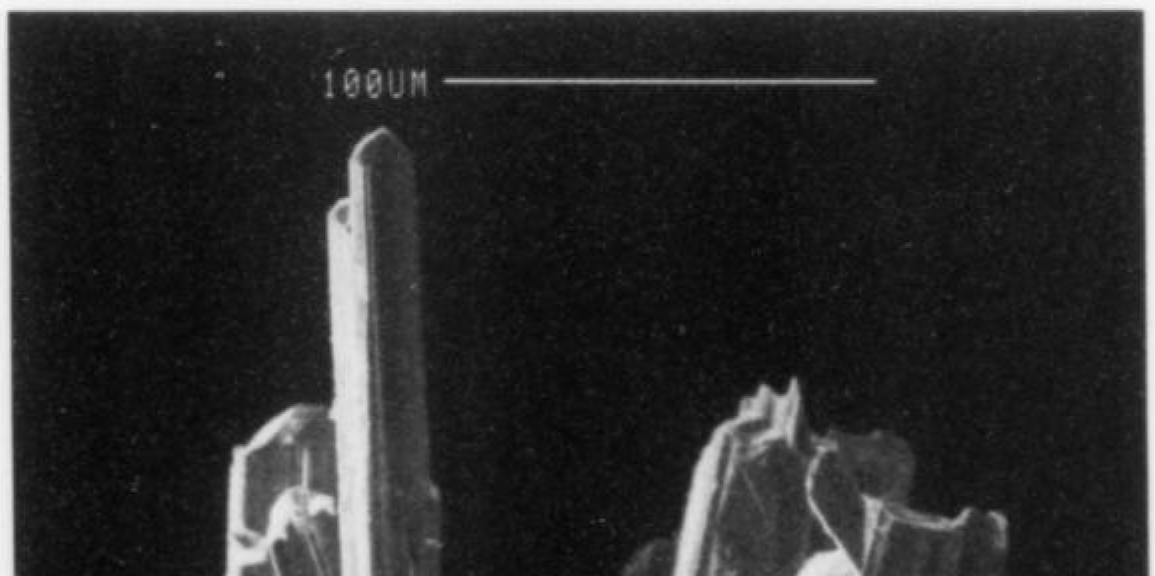


Figure 12. **Fizelyite terminated crystal, 0.075 mm wide. Geological Survey of Canada specimen A-88-15-8A and photo.**

Fizelyite $Pb_{14}Ag_5Sb_{21}S_{48}$?

The lustrous gray-black fizelyite is highly variable in habit. It ranges from lathe-like to prismatic to a ropy form of intergrown prisms. The crystals are striated parallel to the prism axis and often show some curvature. Occasionally they have good terminations as in Figure 12. The average crystal length is 0.5 mm, but crystals up to 4 mm have been found. Individual single crystals are known; however, radiating groups, as in Figure 12, are more common. Some millimeter-size sprays of fizelyite covered with 0.1-mm freieslebenite crystals have been recovered.

The presence of boulangerite with silver minerals is often an indicator of nearby fizelyite. Fizelyite crystals have been found growing on both miargyrite and diaphorite crystals. One specimen shows fizelyite overgrowing semseyite, yet in another part of the vug semseyite occurs on fizelyite, the only evidence of their co-deposition. The gray-black color and lathe-like habit are diagnostic of fizelyite.

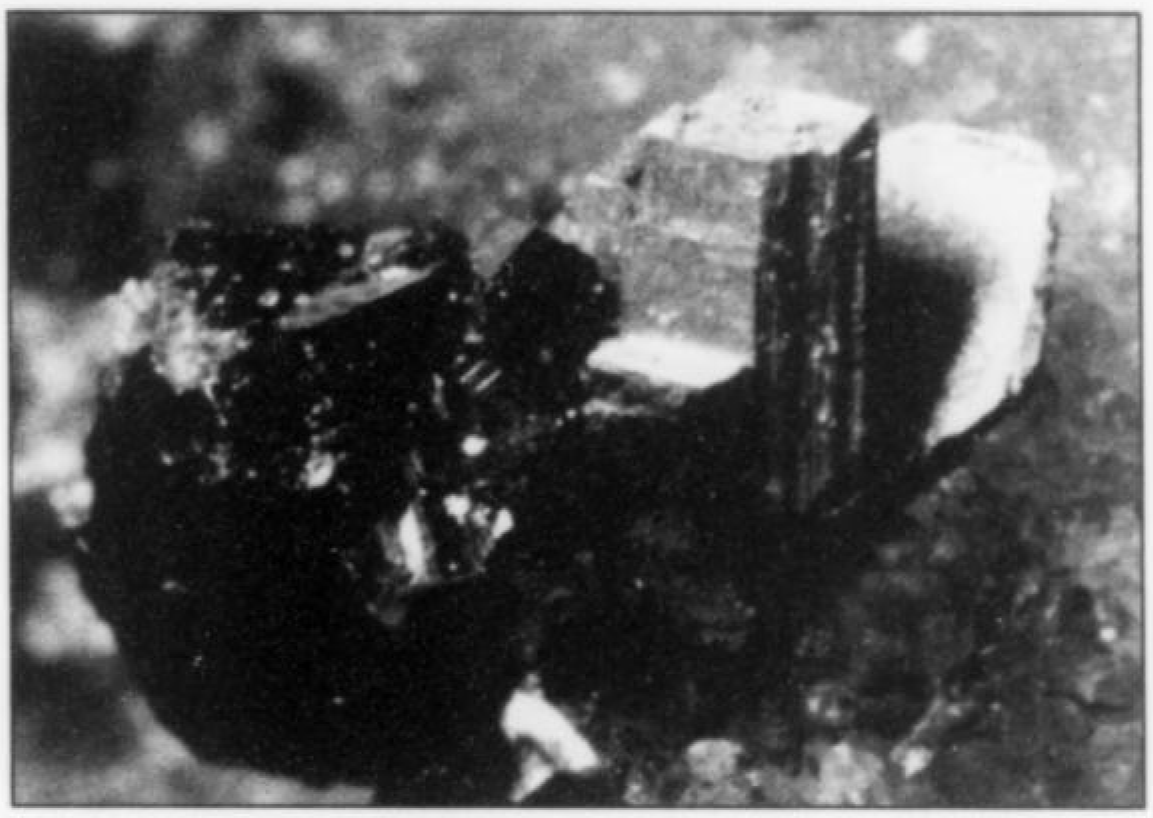


Figure 13. **Semseyite crystal group, 1.8 mm, on miargyrite and pyrite. Ty Balacko specimen; Ed Montgomery photo.**

Figure 14. **Doubly terminated freieslebenite crystal, 0.9 mm long. Ty Balacko specimen, Ed Montgomery photo.**

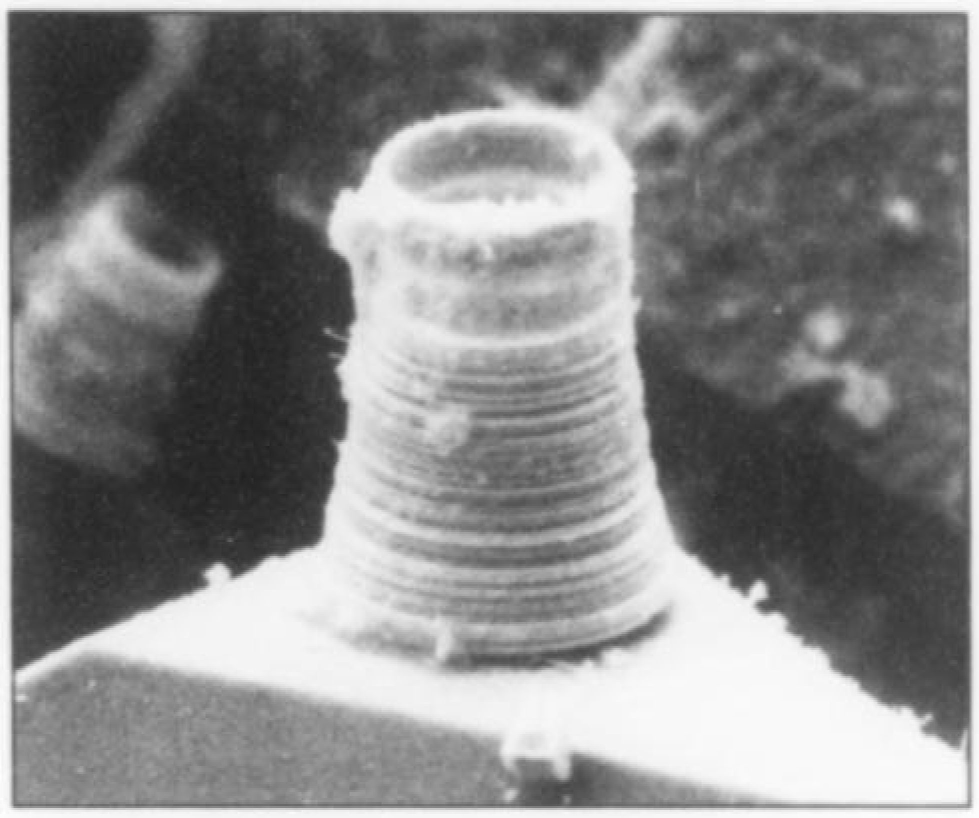


Figure 15. **Boulangerite coil, 0.1 mm in length, on clear quartz. Don Howard specimen and photo.**

Semseyite $Pb_9Sb_8S_{21}$

At the Van Silver deposit semseyite occurs as tabular gray crystals up to 3 mm in size, often in parallel growth. A cockscomb habit with parallel stackings of the gray platy crystals is typical; Figure 13 shows the beginnings of such a cockscomb. Semseyite has been observed in co-deposition with fizelyite and on calcite. More frequently it appears on quartz, pyrite and sphalerite. Semseyite is the only gray, platy, cleavable mineral present, and is most easily recognized by its crystal habit.

Freieslebenite $AgPbSbS_3$

Freieslebenite is found in bright black wedge-shaped prisms up to 1 mm long, 0.5 mm wide and about 0.25 mm thick. Figure 14 shows a typical freieslebenite crystal. There are at least two prism forms and all the prism faces are striated parallel to the *c* axis. The striations probably arise from an alternating growth of {100} and {110} or {hk0} forms. The terminal faces are only of the form {0kl} and rarely two will be seen on a single crystal. Occasionally the terminal faces are striated parallel to the shortest or *a* axis, probably indicating an alternating growth of the two terminal forms. Since the terminal forms {0kl} are parallel to the shortest axis, they make only one set of obtuse angles with the prism axis as shown in Figure 11. All black prismatic crystals from Van Silver submitted for X-ray analysis (with at least two of {hkl}, {0kl) or {h0l} termination) have been identified as diaphorite and all those with only {0kl} terminations have been identified as freieslebenite.

In the absence of good crystals it is impossible to distinguish between freieslebenite and diaphorite except by microprobe or X-ray analysis. The tiny black wedge-shaped prisms are characteristic of freieslebenite.

Boulangerite $Pb_5Sb_4S_{11}$

Boulangerite occurs as loose, matted, lustrous tufts up to 1 cm in length. It sometimes has altered to purplish brown mats reminiscent of some uncleaned Romanian specimens. Boulangerite frequently is found with silver minerals and occasionally is the only sulfide in a quartz-lined vug. No great antimony-bearing sulfosalt locality is complete without crystal rings, and Figure 15 shows a stack of them. All the "feather ore" analyzed from Van Silver has proven to be boulangerite.

Pyrargyrite Ag_3SbS_3

Pyrargyrite occurs as red, gemmy, hexagonal prisms up to 5 mm in length. It is one of the latest minerals to crystallize in stage 2b and has been observed as overgrowths on most of the other minerals of this stage. The internal red reflections and red streak of pyrargyrite are paler than those of miargyrite. Pyrargyrite from the Van Silver deposit contains less than 1% arsenic by weight.

Pyrostilpnite Ag_3SbS_3

Pyrostilpnite occurs as tiny orange prisms with an average length of 0.1 mm, but reaching lengths up to 0.6 mm. Early in this study the authors thought pyrostilpnite to be extremely rare; however, when material was examined under the microscope at 80× it was seen to be common. Pyrostilpnite, one of the last minerals to crystallize, has been observed on most other minerals. Often it grows from cracks in sphalerite as in Figure 16. The crystals are commonly simple prisms, though some intergrown crystals may be V-twins. Rarely one finds composite crystals that somewhat resemble the sheaf-like habit found in Saxony and Bohemia. The bright orange color and gemminess immediately identify pyrostilpnite. As in pyrargyrite, the pyrostilpnite contains less than 1% arsenic by weight.

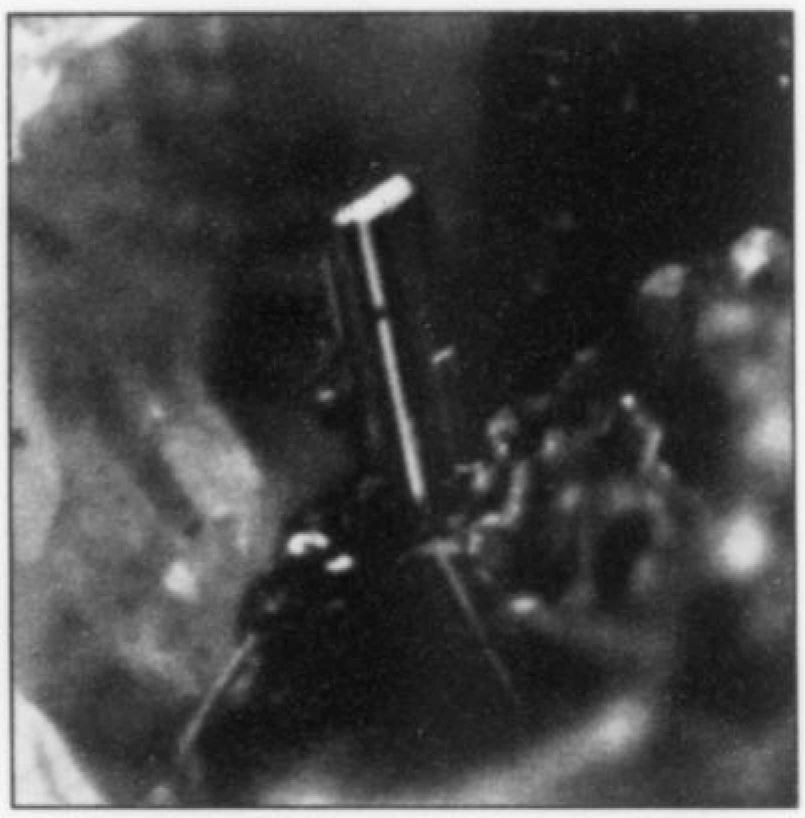


Figure 16. **Pyrostilpnite crystal, 0.3 mm long, on sphalerite. Ty Balacko specimen, Ed Montgomery photo.**

DISCUSSION

Unfortunately most of the stage-2b minerals are so rare that there is little published information on their thermodynamic properties (Craig and Scott, 1974). However, the deposition sequence at the Van Silver deposit is consistent with the extensive work of Hoda and Chang (1975). On the basis of their laboratory studies it would appear that crystallization of stage-2b minerals bournonite and tetrahedrite requires a temperature in the range 450°–350°C. Geocronite, the first sulfosalt to crystallize in stage 2b, also forms in the 400°C range. Notably the geocronite had the highest arsenic value at 3 weight %. Hoda and Chang (1975) found that, in the 350° to 250°C range, miargyrite, diaphorite, fizelyite, semseyite, freieslebenite and boulangerite crystallized sequentially, and in the 250° to 180°C range pyrargyrite and pyrostilpnite precipitated. This is consistent with overall sequence of crystallization observed at the Van Silver mine. It is hoped that this report of such a clean and simple natural system might stimulate further laboratory studies.

Isotope studies of ^{34}S in the sulfosalts could confirm a lowering temperature as their precipitating mechanism. Fluid inclusion work and isotope studies of stage-2a and -2b pyrargyrite could confirm the two separate mineralizing episodes inferred here. Relative abundances of ^{13}C, ^{18}O and ^{34}S in coexisting carbonates and sulfates would provide additional information on temperature and pH constraints in deposition.

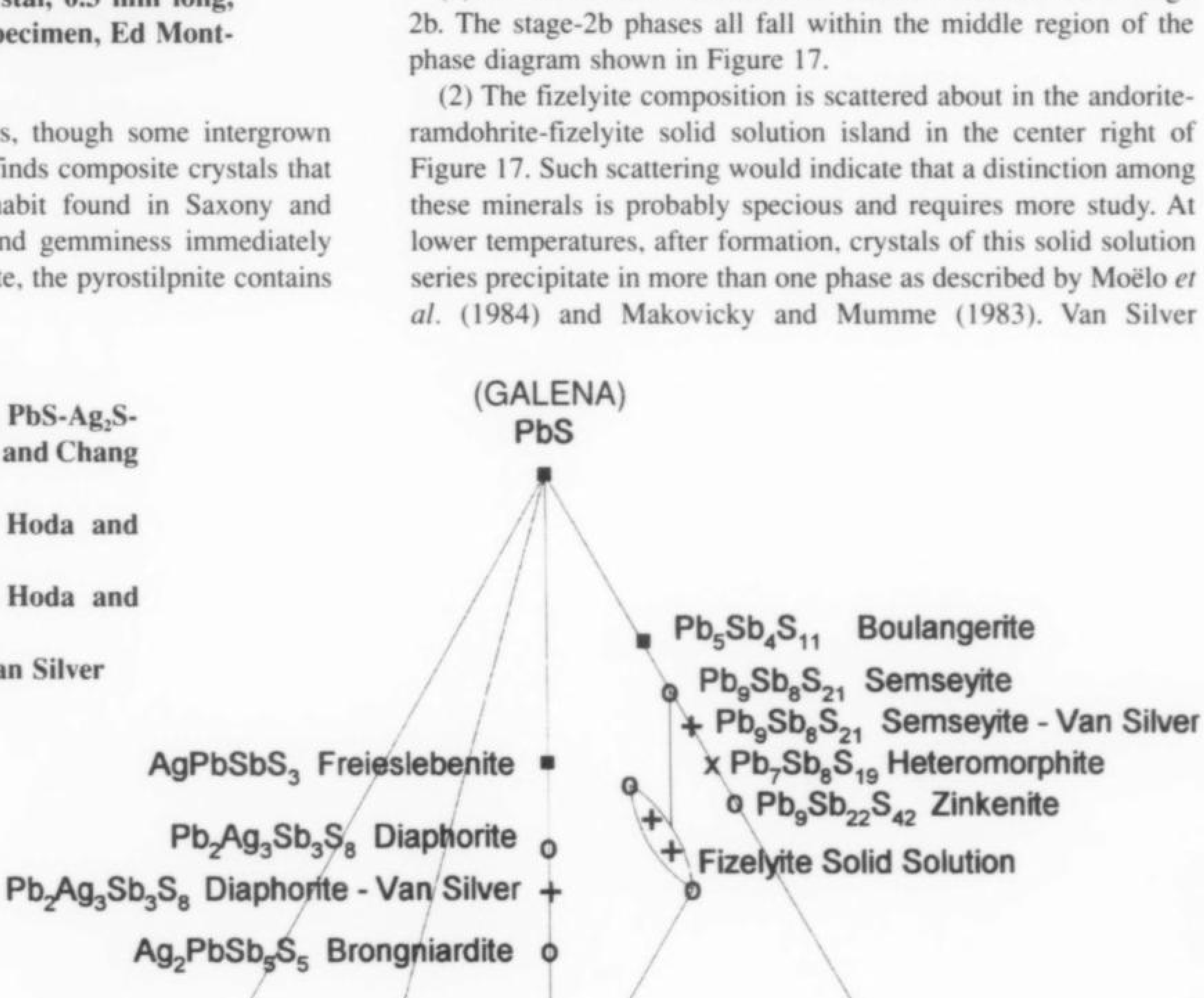
Figure 17 is a phase diagram taken from Hoda and Chang (1975) for the ternary system PbS-Ag_2S-Sb_2S_3 at 300°C. The compositions of the sulfosalts from the Van Silver deposit are plotted on the diagram. Four points are worthy of note:

(1) At Van Silver no acanthite or stibnite was observed in stage 2b. The stage-2b phases all fall within the middle region of the phase diagram shown in Figure 17.

(2) The fizelyite composition is scattered about in the andorite-ramdohrite-fizelyite solid solution island in the center right of Figure 17. Such scattering would indicate that a distinction among these minerals is probably specious and requires more study. At lower temperatures, after formation, crystals of this solid solution series precipitate in more than one phase as described by Moëlo *et al.* (1984) and Makovicky and Mumme (1983). Van Silver

Figure 17. **Phase Diagram of the PbS-Ag_2S-Sb_2S_3 at 300°C. Modified after Hoda and Chang (1975).**

■ = composition observed by Hoda and Chang and at Van Silver
○ = composition observed by Hoda and Chang
+ = composition observed at Van Silver
× = not observed



"fizelyites" have such two phase intergrowths; however, there are untwinned single-phase portions which may be suitable for a reliable crystal structure determination.

(3) Semseyite from Van Silver is uniformly low in lead, but apparently not low enough to become heteromorphite, as can be seen in Figure 17. This mineral has a semseyite-like appearance and produces a semseyite X-ray powder pattern.

(4) On the join between galena and miargyrite, one has, near the middle, the solid solution line between diaphorite and brongniardite. *Brongniardite* (Mozgova *et al.*, 1989), not an I.M.A-approved mineral species, has the end-member composition $PbAg_2Sb_5S_5$. The Van Silver diaphorites plot about a quarter of the way down this solution series. The difference in crystal chemistry between the two minerals needs to be determined. Most Van Silver diaphorites are untwinned and may be well-suited for crystal structure analysis.

ACKNOWLEDGMENTS

We are very grateful to Mr. M. Lavasseur for generously permitting access to the Van Silver workings throughout our long study. It is a pleasure to thank John Dagenais for drawing the sulfur specimens to our attention, and Mark Mauthner of University of British Columbia for the electron microprobe analyses for sulfur and celestite. We would also like to thank Don Harris and Andy Roberts at the Geological Survey of Canada for all the other electron probe analysis and X-ray diffraction identifications, respectively. Valuable editing and suggestions provided by George Robinson greatly improved the text. One of us (RW) would like to thank the Joint Professional Development Committee at U.C.F.V. for release from teaching duties to complete this work.

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The Brownley Hill mine is situated about 4 km east of the market town of Alston in the historic lead mining district of Alston Moor. It has recently produced exceptional specimens of the rare mineral alstonite, which was first discovered at the mine in the 1830's, and is also well known for galena, fluorite, millerite, sphalerite and rare supergene species such as brianyoungite and bottinoite.

INTRODUCTION

The mineral deposits which lie beneath the Pennine Hills of Northern England have been mined for centuries and are known to collectors worldwide for fine specimens of fluorite, barite and witherite. The ancient lead mining district of Alston Moor, which lies on the northwestern edge of the North Pennines, has also furnished exceptional examples of two mineralogical rarities: the barium-calcium carbonates alstonite and barytocalcite.

Almost all early British mineralogical texts contain references to Alston or Alston Moor ("Aldstone Moor" in some very early volumes) and most 19th-century collections in museums worldwide have specimens from the area. The early importance of the Alston mines as producers of mineral specimens is illustrated by the fact that calcite and fluorite are figured in Rashleigh (1797: p. 41 and p. 33) and calcite is figured in Sowerby (1809: p. 35).

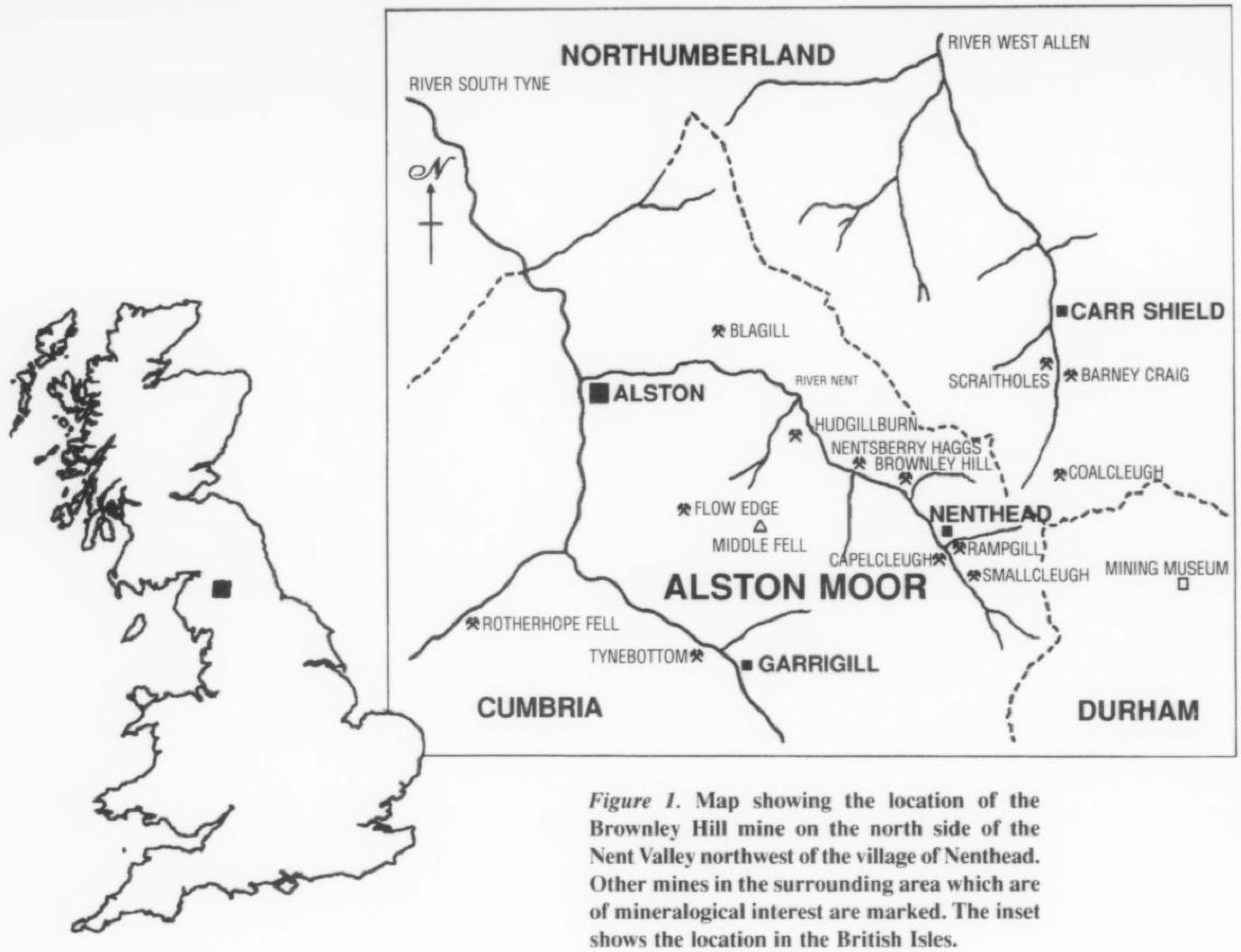

***Figure 1.* Map showing the location of the Brownley Hill mine on the north side of the Nent Valley northwest of the village of Nenthead. Other mines in the surrounding area which are of mineralogical interest are marked. The inset shows the location in the British Isles.**

Unfortunately, these and many other early specimens lack specific locality data.[1] The absence of locality data is compounded in the case of the Brownley Hill mine, as specimens with a detailed label often give the locality as "Bromley Hill" (with the word *mine* missing entirely). This early misspelling, which has been perpetuated in some mineralogical texts, causes confusion, and it is perhaps partly for this reason that the locality is not particularly well known to collectors worldwide.

The Brownley Hill mine is situated on the northern edge of Alston Moor, about 1 km to the west of the village of Nenthead (Fig. 1). It is one of a number of mines which exploited veins on the north side of the Nent Valley. Many of these are well known as mineral localities. The Blagill mine, about 6 km northwest of Nenthead, produced good barytocalcite (and has the unusual distinction of being the only locality in the world where that mineral was mined as an ore). The Nentsberry Haggs mine, situated immediately northwest of the Brownley Hill mine and connected to it underground, produced exceptionally fine barytocalcite and witherite as well as cabinet specimens of alstonite, barite, galena and sphalerite. The Smallcleugh mine, southeast of Nenthead, is well-known to British collectors for well-crystallized galena and sphalerite. Further southwest, the Rotherhope Fell mine is the only locality on Alston Moor known to have produced *outstanding* fluorite specimens (although good specimens may have came from a number of other mines in the area). Most of the fine fluorite for which the north Pennines are famous originated in the mines at Weardale, further to the east.

In mineralogical terms, the Brownley Hill mine is particularly notable for the rare mineral alstonite, which was originally described from the workings in the mid-1830's. Nineteenth century specimens are common in collections worldwide, but these have been surpassed in terms of crystal size and quality by those collected during the last decade. As well as alstonite, the Brownley Hill mine has produced good cabinet specimens of fluorite, calcite, sphalerite and galena, and a number of species which are rare or locally unusual. In 1993 a new mineral, brianyoungite, was described from the mine, making it one of the few British type localities for more than one species.

HISTORY

The historical description provided here is based largely on the work of Raistrick and Jennings (1965), whose account remains the most comprehensive review of the development of the lead mining industry in the north of England. It is supplemented by Pettus

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[1] It is worthwhile recording, however, that some specimens labelled Alston Moor have their origins far outside its boundaries. The authors have seen "Alston Moor" specimens in museum collections, which came from as far away as Weardale, the Caldbeck Fells, and the mines in Northumberland. This is possibly due to the fact that specimens were purchased from dealers in Alston, who were vague about localities, either deliberately to protect their sources, or because their customers were not as sophisticated as is the case nowadays.

Figure 2. **The adit entrance to the Bloomsberry Horse Level, begun sometime prior to 1789 to give access to the ground at the level of the Great Limestone. The photo shows the level as it stood in the late 1970's before the stone walling was removed and replaced by a metal gate. Richard Bird collection.**

(1670), who describes the early period of mining on Alston Moor, by Wallace (1861, 1890), and by a number of more recent accounts which make specific reference to the Brownley Hill mine including Smith (1923), Dunham, (1948, 1990), Critchley (1984) and Fairbairn (1993). Since there are few references to any specific mines prior to about 1700, a general account of mining is provided to that date.

The first documentary evidence of mining on Alston Moor dates from 1130 A.D. Accounts of up to £40 annually for the rent of the mines suggest they were well-developed at the time. Mines were worked throughout the 12th century, falling steadily into arrears which amounted to more than £2,000 by 1226. The area must have remained productive, however, since the King brought miners in, and was active in securing protection and liberties for them. There is little evidence of activity in the 14th century, but by the 15th century renewed Crown interest had led to the development of the Fletcheras mine on Alston Moor, which remained productive for four more centuries.

In 1611, when a large part of the manor of Alston passed to the Hylton family, a survey reported the mines were nearing exhaustion. They were purchased in 1629 by the Earl of Derwentwater and remained in the possession of the Earls of Derwentwater until 1715, when the family lent support to the Jacobite rebellion. Defeat followed, and the estates were confiscated by the Crown and passed to the Greenwich Hospital for Seamen. At first the Commissioners of the Hospital decided to run some of the mines on their own account, but they quickly found a better arrangement was to lease the mines, most of which were taken by the London Lead Company.[2]

The first record of the Brownley Hill mine is at the general letting of mine leases by the Commissioners of the Greenwich Hospital in 1735. The mine was thought to be worthless and was not taken at this time, although it was said that it had been worked previously in the Slate Sills by Alderman Ridley. The mine was leased briefly to Thomas Westgarth in 1748 and the London Lead Company acquired the lease in 1751. Although some ore was

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[2] The London Lead Company was formed in 1692 as "The Governor and Company for Smelting Down Lead with Pittcoale and Seacole." It was also known as the Quaker Company. It was responsible for most of the developments in lead mining and smelting on Alston Moor between 1730 and 1880.

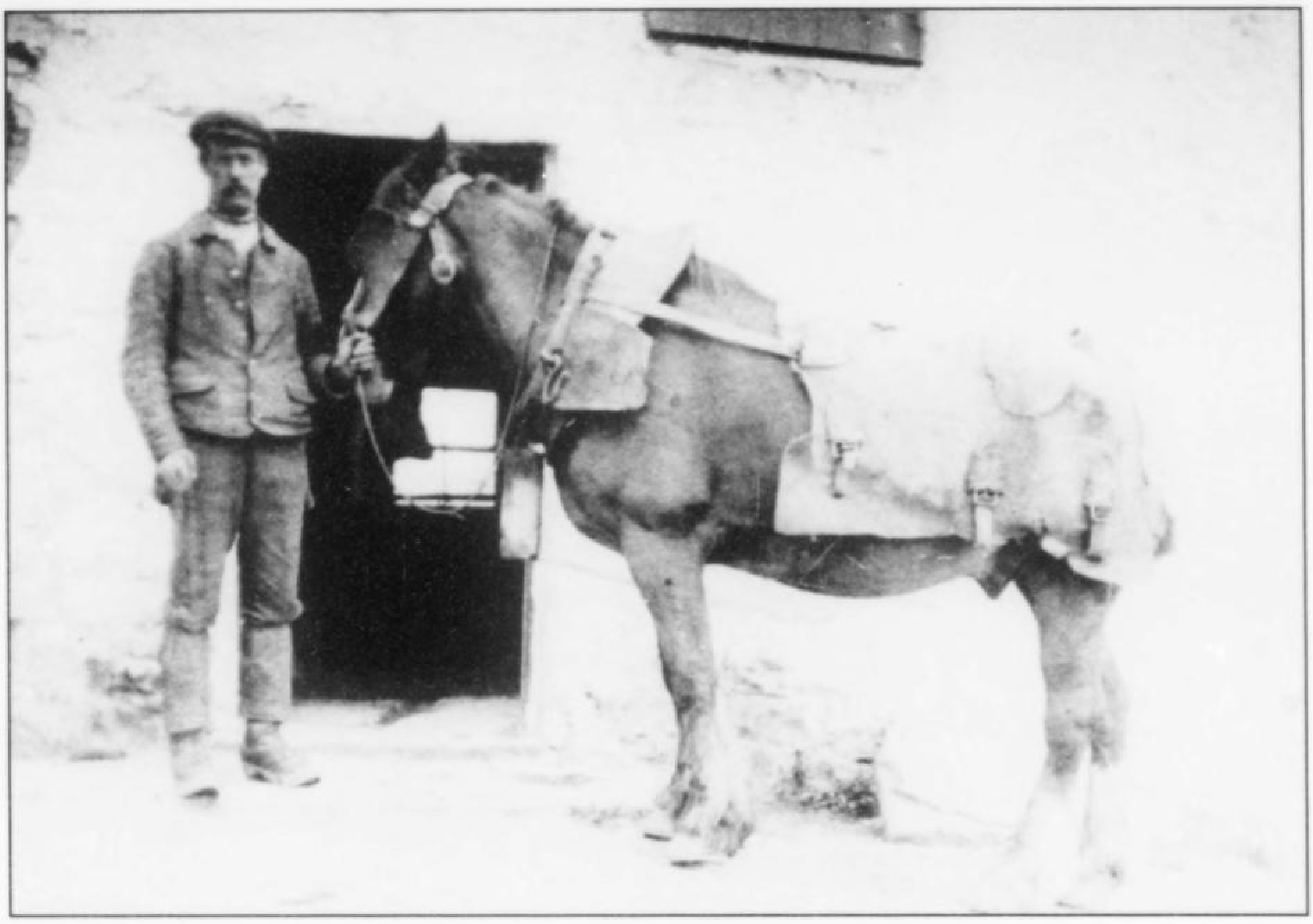

***Figure 3.* An undated photo of a miner with one of the horses used to tram the ore from the Brownley Hill mine. From the photographic archive at Beamish, The North of England Open Air Museum.**

produced, the London Lead Company relinquished its lease in 1765, and the Brownley Hill mine became one of the few major independent workings in the area.

A large quantity of ore was raised by William Armstrong and William Hutchinson, the next lessees, who worked the mine between 1765 and 1795. The ore was purchased by the London Lead Company who owned the smelters, and still made a good profit on the refined lead.

By 1789 drifting on the Brownley Hill vein had reached the county boundary (also the sett boundary), more than 1 km from the mine entrance (manuscript plan in the Lindsay Greenbank collection). This drivage was almost certainly on the Brownley Hill High Level, which was cut in the shale at the top of the Great Limestone. The high level was replaced as the main access to the mine over the next few decades by the Bloomsberry Horse Level, a long crosscut from the river Nent near to its junction with Gudham Gill. The Bloomsberry Horse Level eventually drained the whole of the mine, and gave easy access to the ground at and above the level of the Great Limestone. The importance of the level can be judged by the fact that the Brownley Hill mine is sometimes known (occasionally even on mineral specimen labels) by the alternative name *Bloomsberry mine*.

The Brownley Hill Company took the lease in 1795 and benefited both from the Bloomsberry Horse Level, which gave easy access to the veins, and from the high price of lead during the Napoleonic Wars. For a time the company did very well, but by 1816 they had given up as the amount of ore raised did not pay development costs. By this time many of the rich orebodies were worked out and much of the ore that was raised during the remainder of the century was recovered by reworking old ground.

Jacob Walton, Thomas Shaw and Partners, who subsequently took the mine, decided as a policy to lease liberal "bargains" to teams of miners for periods of up to a year. The employment of men by means of bargains was the norm at the time; payment would be based on an amount of level driven, or an amount of ore won from a piece of ground, or some combination of the two. Bargains were traditionally made for a period of a month, but by letting the ground for periods of up to a year at relatively generous rates, production of a large amount of ore from the old workings was made economic. Indeed, the Brownley Hill mine was one of the more productive mines on Alston Moor for most of the period it was worked by Jacob and later John Walton. Annual returns of a few hundred tons of lead ore rose to more than a thousand tons in the mid-1850's, and then returned to previous levels.

When the Brownley Hill Mining Company took the lease in 1874, the ground had been explored very thoroughly for lead, and increasing reliance was placed on zinc production. The Nenthead and Tynedale Lead and Zinc Company, the next lessee, produced both lead and zinc between 1891 and 1894, but not profitably—the decline which had begun in the 1870's following the collapse in world lead prices was by now irreversible. In all, the Brownley Hill mine produced a little over 10,000 tons of refined lead and 1,000 tons of zinc ore for the period between 1845 to 1894 for which statistics are available (Burt *et al.*, 1982).

The final period of working was undertaken by the Vieille Montagne Zinc Company of Belgium, whose name is seen on the mine abandonment plans. The Vieille Montagne Zinc Company reworked many of the mines on Alston Moor for zinc in the first part of this century, and produced some ore from the Brownley Hill mine (John Lawson, personal communication). The Nenthead mines were interconnected at the level of the Great Limestone by this time (Fig. 4), and some of the Brownley Hill levels were also

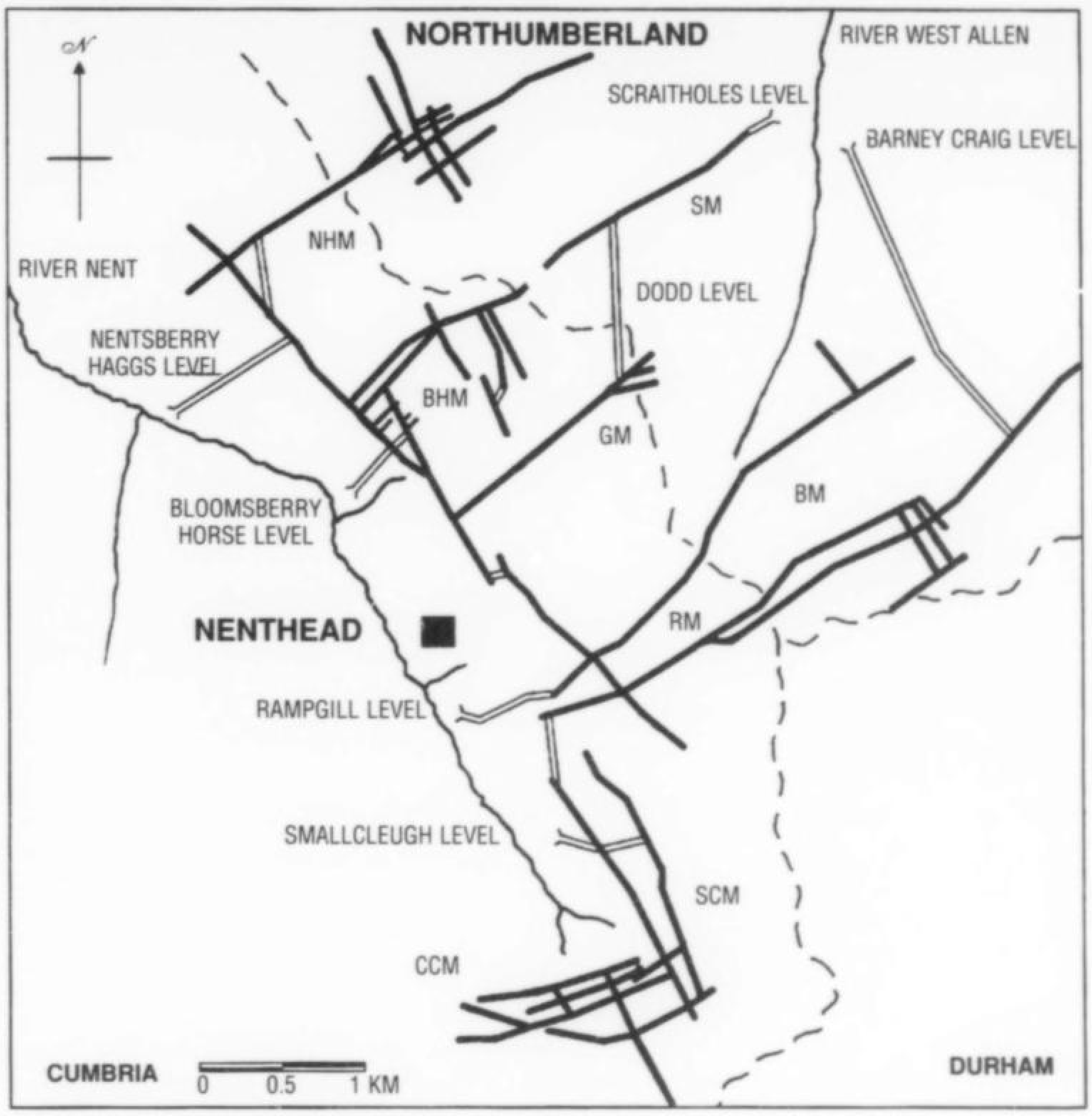

Figure 4. **Simplified plan showing the mineral veins (black) and crosscuts at the level of the Great Limestone on the northwest side of the Nent Valley. The Brownley Hill mine, accessed via the Bloomsberry Horse Level, is one of a number of mines, initially separate, which were interconnected by the end of the 19th century. Abbreviations are BM Barneycraig mine; BHM Brownley Hill mine; CCM Capelclough mine; GM Gudhamgill mine; NHM Nentsberry Haggs mine; RM Rampgill mine; SM Scraitholes mine; SCM Smallcleugh mine.**

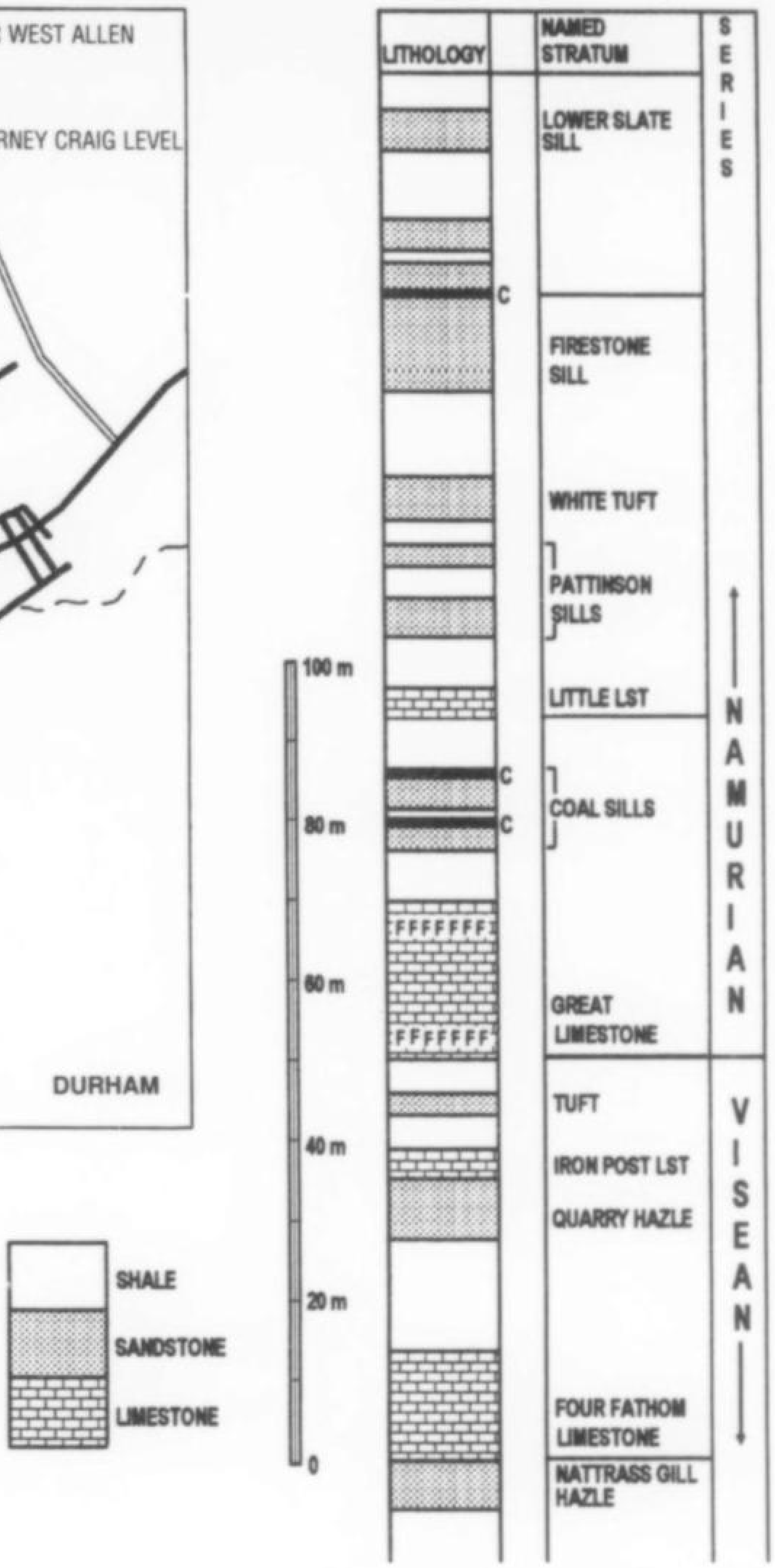

Figure 5. **The sedimentary sequence at the Brownley Hill mine, based on a section drawn by the Vieille Montagne Company. The term "*sill*" as used by the lead miners commonly refers to a sandstone and does not have its modern geological connotation. The bases of the four major cyclothems present are indicated by the black horizontal lines in the "named stratum" column (Johnson and Nudds, 1996). Use of the symbol "F" indicates the approximate horizons in the Great Limestone where metasomatic flats occur.**

opened to serve as haulageways for ore from adjoining mines. A final six-month trial was made in 1936, but the orebody was not rich enough to pay costs and the company turned its attentions elsewhere.

GEOLOGY

The Pennine Hills run north-south from the Derbyshire to the Scottish border and are often described as the backbone of England. They form an area of moorland plateau which is steeply dissected by the east-west river valleys known as the Dales. Most of the moorland is given over to hill farming or grouse shooting, while the valleys, which are more intensively farmed, shelter scattered settlements. The mines, once essential to the economic survival of the Dales communities, are almost gone. A handful of small workings, principally for fluorite, still survive in Derbyshire and the north Pennines but most have succumbed either to periodic falls in commodity prices or to the constraints imposed by development in an area of outstanding natural beauty.

The north Pennines are made up of alternating beds of carbonate and siliclastic rock of Carboniferous age, most of which lie horizontally or nearly so. These unconformably overlie older clastic volcanic rocks which were intruded in the Caledonian Orogeny by the Weardale Granite. The principal rock types exposed at surface are limestone, shale and sandstone. They crop out on the sides of the fells in a rhythmic succession, which repeats regularly through the strata, and gives the Dales country its characteristic appearance, with limestone scarps rising in steps up the fellsides.

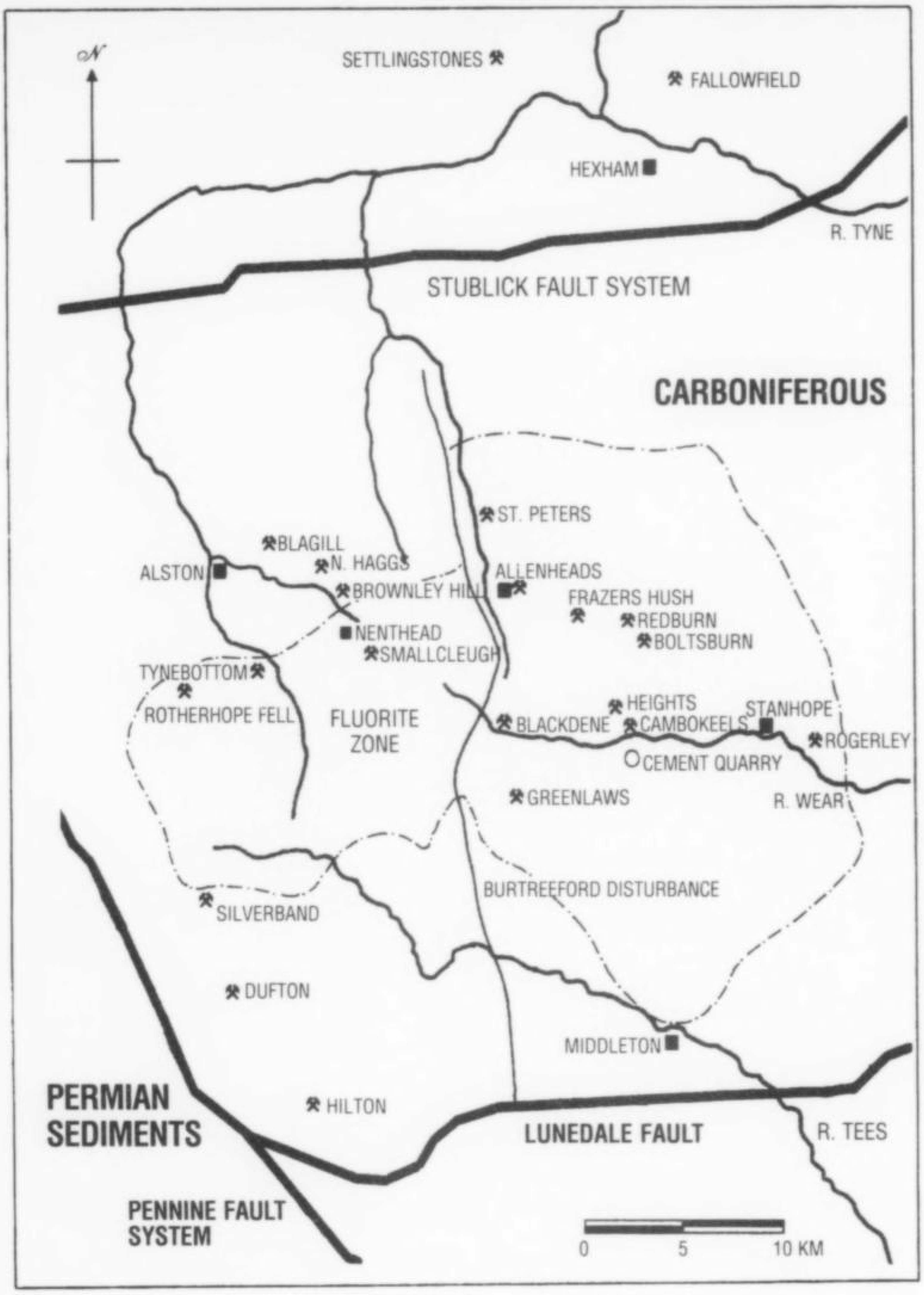

Figure 6. **A simple geological map of the north Pennine Orefield, showing the Alston Block, bounded in the west by the Pennine Fault system and in the south by the Lunedale Fault. The Burtreeford Disturbance is a complex fault structure which divides the orefield in two. The approximate outcrop of the fluorite zone, in the central part of the orefield, is indicated by light shading. A number of the localities of interest to specimen mineralogists are marked.**

Each complete unit in the rock succession is known as a cyclothem. Measured from the base of one limestone to the base of the next, each cyclothem represents a few million years of geological time, in which depositional conditions changed from the warm clear-water marine conditions in which the limestones formed, to the more turbid deltaic and lagoonal environments in which the sandstones and shales were deposited. Coal seams are present at the top of some of the cyclothems and represent a further change to terrestrial swamp-like conditions.

The sedimentary sequence is intruded by the Whin Sill Dolerite, and a number of other minor igneous bodies. The Whin Sill is thought to be of late Silesian age (295 million years) (Fitch and Miller, 1964). It is of importance as a control of mineralization in parts of the orefield, thus providing an upper boundary for the age of the deposits.

The rock succession on Alston Moor was first described in a scientific manner by Westgarth Forster (1809), who recognized that the strata were laterally continuous over a wide area. This and the later accounts of Sopwith (1833) and Wallace (1861) were based on information gleaned from centuries of lead mining. Knowledge of the sedimentary stratigraphy was important to the miners, since the orebodies are stratabound. It was largely for this reason that the companies working on Alston Moor drew up detailed sections of the strata (Fig. 5).

Biostratigraphical studies, based on the macrofossil faunas of the sedimentary strata, began around the turn of the century (e.g. Garwood, 1907, 1912; Smith, 1910), and these largely reinforced the conclusions of the earlier lithological studies. It is now clear that the strata on Alston Moor belong to the Viséan and Namurian Series of the Carboniferous. The stratigraphic studies which established the relative ages of the individual beds are summarized by Dunham (1948) in a classic *Geological Survey Memoir* which describes the geology and mineralogy of the whole of the orefield. This has recently been revised and updated to conform with modern geological nomenclature (Dunham, 1990).

Primary Mineralization

The mineral deposits of the North Pennine Orefield are of the Mississippi Valley type (MVT). The orebodies are stratabound, and consist primarily of fissure veins in the harder beds (limestone, sandstone and dolerite) and metasomatic replacements in the limestones. The fissure veins, which occupy dilatation fractures on faults, tend to lie vertically or nearly so, and die out in the softer shales. The metasomatic replacement flats are associated with vein

Figure 7. Stone-arched passages in the flat workings. The scarcity of timber meant that most of the passages in the Nenthead mines were stone arched. Waste rock, known locally as "deads," is stacked on top. Photo from the Richard Bird collection.

mineralization in the limestones; they form when the limestone wallrock around the vein is replaced by a mixture of sulfide and gangue minerals and, as their name suggests, tend to lie horizontally or nearly so.

The orefield has been studied extensively, the most up-to-date and comprehensive accounts of the primary mineralogy and ore genesis being due to Dunham (1990) and Ixer and Vaughan (1993). Fluid inclusion studies show the minerals in both the vein and flat deposits crystallized from low-temperature metal-rich brines but the precise origin of the mineralizing solutions has not been determined. The age of the mineralization is also the subject of debate. It seems most likely that deposition began sometime soon after the cooling of the Whin Sill (at about 295 million years) and continued into Permian times (Dunham, 1990). Gentle doming of the Alston Block at this time produced the fractures in the rocks which acted as conduits for the brines and the open fissures in the harder beds in which the vein minerals were deposited. A simple geological map showing the main structures of the orefield, with some localities of particular interest to collectors identified, is given in Figure 6.

Most of the ore at the Brownley Hill mine was won from veins and replacement flats in the Great Limestone. This limestone stratum forms the base of the Namurian and is one of the thickest in the north Pennines (at about 20 meters at Brownley Hill mine) (Fig. 5). It is the most important lead-bearing bed in the district. The Tuft, a shaley sandstone, and the Quarry Hazle, a sandstone, underlie the Great Limestone. Examination of *in situ* exposures shows that veins in these strata hosted some ore. Dickinson (1901) suggests that the Four Fathom Limestone, beneath the Quarry Hazle, also contained rich lead ore, but the workings at this level are flooded and we have been unable to verify this. Ore was produced from the beds above the Great Limestone, up to the Slate Sills, during the early period of mine working, however, records from this period are scanty and none of the workings are accessible. It seems unlikely that any of the upper workings was significant in comparison to those in the Great Limestone.

The workings in the Great Limestone at Brownley Hill mine are below the zone of supergene alteration. Nonetheless, a significant number of supergene species occur. These appear to have been produced almost exclusively by post-mining oxidation processes.

Figure 8. **The adit entrance to the Brownley Hill mine as it stood in May 1997. The area worked by the mine stretches upward and to the left of Gudham Gill, with the sett boundary on the horizon.**

Mineral Zonation

A zonal distribution of gangue minerals within the Alston Block of the North Pennine Orefield has long been recognized (Dunham, 1934, 1937, 1990). The mines in the central area of the orefield (which include the famous Weardale fluorite localities) typically have a fluorite gangue. The barium minerals, barite and witherite, are the dominant gangue minerals on the periphery. The position of the fluorite zone (Fig. 6) is closely correlated with the subcrop of the Weardale Granite (although the intrusion of the granite predates the mineralization) and fluid inclusion studies show that orebodies within the fluorite zone were generally deposited at a higher temperature than those in the barium zone.

The outer margin of the fluorite zone and the inner margin of the barium zone cross Alston Moor but are not coincident. A zinc-rich intermediate zone in which quartz, ankerite and calcite are the principal gangue minerals is present. The workings of the Brownley Hill mine lie for the most part within this zinc-rich intermediate zone, but also contain assemblages characteristic of both the fluorite zone and the barium zone. This makes the mine one of the most mineralogically diverse in the orefield.

COLLECTORS and COLLECTING

The north Pennines have a tradition of mineral collecting which dates back more than two centuries. Specimens from the Victorian period are common in museums worldwide. The miners would bring home "spar" to sell to collectors and dealers, and managers would generally turn a blind eye to what was considered a traditional perquisite of the job. Collecting was certainly worthwhile; Nall (1888) notes that even a small specimen of alstonite might fetch as much as 5 pounds, more than a miner would earn in a month!

There were professional mineral dealers in Alston for most of the 19th century, and it is to them that we owe many of the fine north-of-England specimens seen in collections today. The most productive period was between 1820 and 1850, coinciding with extensive mining in the local area and the developing Victorian obsession with collecting (Mick Cooper, personal communication). Alstonite specimens were certainly collected from the Brownley Hill mine in the 1830's, when James Johnson and Thomas Thomson first described the species.[3] Thomson (1837) records "[alstonite specimens] came into my hands in the year 1834, being in a collection exposed here for sale by a mineral dealer from Alston," and he was certainly aware that some of these specimens were from the Brownley Hill mine. Alstonite was included in a specimen display made by John Cowper, the Alston mineral dealer, at the Great Exhibition of 1851 in London (Mick

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[3] Given its low lead content it seems possible that the vein in the alstonite area was worked for specimens rather than ore. An old cache of specimens, presumably left by the miners, was uncovered during exploration in the late 1980's.

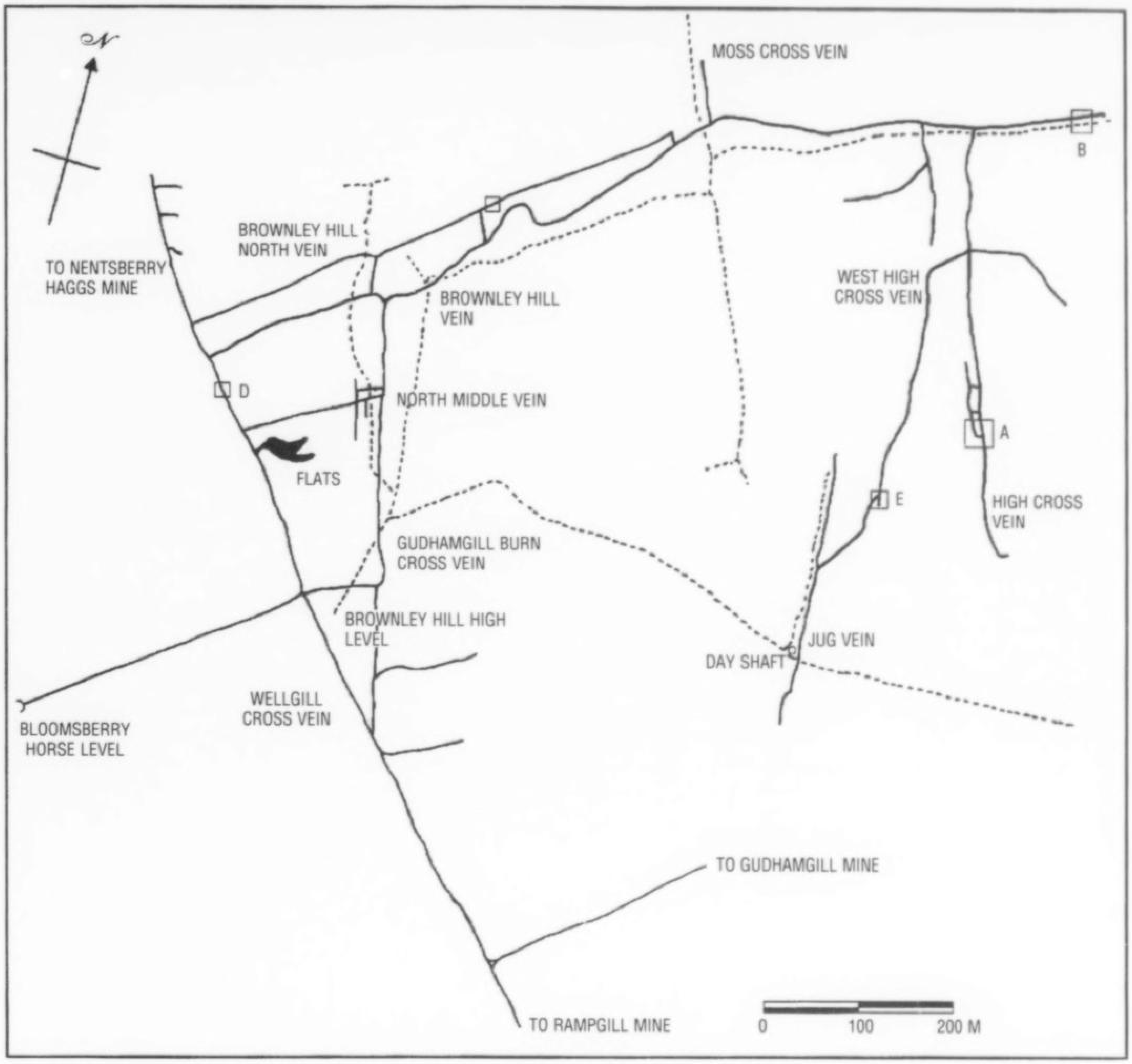

***Figure 9.* Simplified sketch of the Brownley Hill mine workings, modified from the Vieille Montagne Company abandonment plan. The levels at the base of the Great Limestone (accessed via the Bloomsberry Horse Level) are indicated by continuous lines; the earlier higher levels are indicated by dotted lines. Areas of particular mineralogical interest are: (A) Holmes' Rise on the High Cross vein, cotype locality for alstonite. (B) Large quartz cavity on the Brownley Hill vein, with harmotome and copper secondaries. (C) Nickel-rich area on the Brownley Hill North vein with bottinoite, ullmanite and bournonite. (D) Level walls on the Wellgill Cross vein with secondary Cu and Zn minerals and the type locality for brianyoungite. (E) Thomson's Rise on the West High Cross vein, the strontianite area.**

Cooper, personal communication), and there are a number of Cowper alstonite specimens in the Natural History Museum, London.

The scale of specimen dealing in late 19th-century Alston can be judged from an account of a collecting trip in 1889 (a time when mining was in decline), written by the American dealer Charles Pennypacker (Pennypacker, 1904). Arriving in the town of Alston, Pennypacker spent several days with Patrick Gilmore, a junk dealer with "a warehouse full of specimens." William Jefferis, another American collector/dealer who visited Alston after Pennypacker, wrote "the set out of specimens in that old warehouse was so intoxicating that fifty English sovereigns disappeared in short order" (Cooper, 1990).

A magnificent suite of minerals from the mines around Nenthead, including many self-collected specimens, was assembled by Sir Arthur Russell in the first half of this century (the Russell collection is now in the Natural History Museum, London). The Russell collection contains a very fine series of Brownley Hill alstonite specimens, all of which were "old-timers" by the time Russell acquired them. In field collecting terms, however, the Brownley Hill mine appears to have received comparatively little attention from Russell and his contemporaries. Indeed it was considered to be a minor locality for sphalerite and galena by many British collectors until recently. This is perhaps because the horse level was blocked well before High Cross vein, denying access to the more interesting areas of the mine.

The first serious attempt to rediscover the area where the alstonite was originally found in the mine was made in the 1970's by a team of collectors led by the Cornish mineral dealer Richard Barstow (the Barstow collection is now in the Plymouth Museum). Barstow descended an air shaft into the Brownley Hill High level, and from there made his way into the workings on West High Cross vein (Lindsay Greenbank, personal communication). Unfortunately, exploration of the workings in this area did not reveal alstonite, and the search was eventually abandoned. The type locality was finally rediscovered in the late 1980's (using the same air shaft descended by Barstow) by north-of-England mineral dealer Lindsay Greenbank. Shortly afterwards, mine explorers clearing the Bloomsberry Horse Level broke through to the High Cross vein, allowing easier access to the workings in that area. For a short period of time specimens from the mine (particularly alstonite, but also fluorite, calcite and galena) were common at mineral shows in Britain.

SITE DESCRIPTION

The mine workings are accessible via the Bloomsberry Horse Level, a crosscut which begins in Gudham Gill (grid reference NY 7762 4465) and leads onto the Wellgill Cross vein. The labyrinthine workings which radiate from this point, extend several kilometers into the hill. Many of the passages cut in the shale beds below the Great Limestone are in a collapsed or dangerous state. Nevertheless the mine has been explored by mining historians and is well-known to collectors. In common with many of the other Nenthead mines, it contains some superbly constructed stone-arched passages but there is little else of historical significance. Descriptions and surveys can be found in Fairbairn (1993) and Critchley (1984).

Nothing of consequence remains at the surface. The mine dump, which has been bulldozed, is resisting attempts to return it to meadowland; it is not generally productive of mineral specimens. A reconstruction of a 19th-century lead mining operation can be visited at the Killhope Lead Mining Museum about 5 km to the east. Even closer at hand, just west of Nenthead, are the remains of the Rampgill and Smallcleugh mines. A grant from the Heritage Lottery Fund was recently awarded to preserve the surface features which remain here, and a visitor center run by the North Pennines Heritage Trust has recently opened. It is still possible, therefore, to gain an impression of the workings of a large 19th-century Pennine lead mine.

The current collecting situation appears to be that responsible private collectors are allowed access to the Nenthead mines, but commercial collecting is not allowed (Anon., 1996). The interiors of the Smallcleugh mine and Carr's Level are designated as Sites of Special Scientific Interest, and collecting is more restricted there. People intending to visit any of the underground workings are advised to leave details with the warden at the visitor center in Nenthead.

MINERALS

The descriptions provided below are based partly on accounts in the mineralogical literature, and partly on specimens collected in the field over a period of many years. Identifications have been made at the Universities of Leeds and Manchester, mostly by X-ray diffraction. Species confirmed by X-ray diffraction during this study include alstonite, anglesite, ankerite, aragonite, barytocalcite, barite, brochantite, epsomite, harmotome, hydromagnesite, jarosite, marcasite, melanterite, millerite, serpierite, siderite, sulfur and witherite. Qualitative analyses by SEM EDAX have been used to support the identifications where appropriate.

Since the workings are complex, and contain many kilometers of drifts and adits, the descriptions given below should be read in conjunction with the simplified mine plan (Fig. 9).

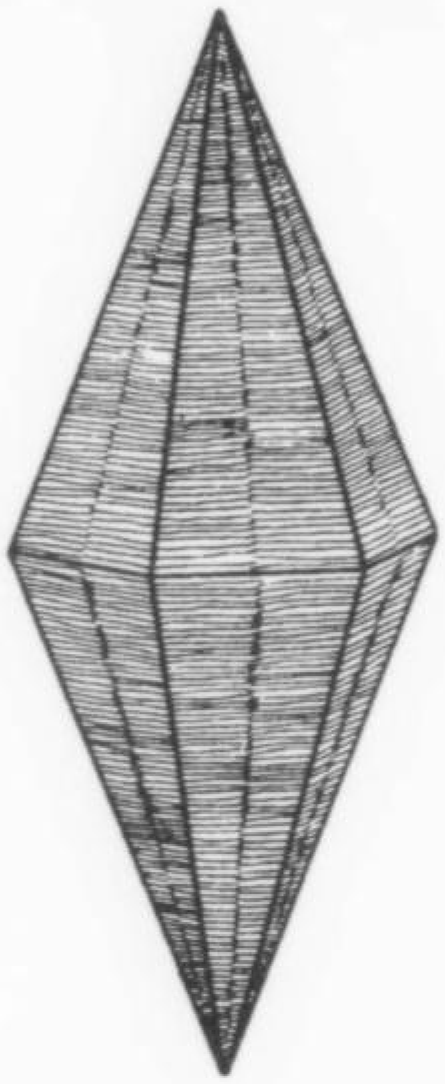

***Figure 10.* Alstonite crystal sketch showing the pseudohexagonal pyramidal crystal habit with weak horizontal strations characteristic of old-time specimens. Modified from Palache *et al.* (1951).**

Alstonite $BaCa(CO_3)_2$

Alstonite was first described as a variety of barytocalcite, based on specimens from Brownley Hill mine, Cumbria and the Fallowfield mine, Northumberland, by James Johnston (1835). It was independently described in the same year, as "bicalcareo-carbonate of barytes" by Thomas Thomson, who had purchased specimens in 1834 from "Mr. Cowper . . . a mineral dealer from Alsten Muir" (Thomson, 1835). Further publications in which the scientists criticized each other's analyses followed (Johnson, 1837; Thomson, 1837), although with hindsight we can see that Johnston's analyses were the more accurate.

Alstonite was at first given the name *bromlite* (Thomson, 1837) after the cotype locality, which is written Bromley (= Brownley) Hill in some early references. The first use of *alstonite*, which is the currently accepted species name, is due to Breithaupt (1841). The Brownley Hill mine and the Fallowfield mine are considered the cotype localities for the mineral (Clark *et al.*, 1995).

Nineteenth-century alstonite specimens from the Brownley Hill mine are reasonably common in museum collections. Old-time specimens typically show white pseudohexagonal alstonite pyramids associated with thin hexagonal calcite plates on a matrix of white calcite and pink barite. As previously noted, the information on accompanying labels is often imprecise, giving the locality simply as "*Alston*" or "*Alston Moor.*" Unfortunately, not all specimens so labeled are from the Brownley Hill mine, this designation occasionally also applying to the Fallowfield mine, which also produced alstonite in the mid-19th century. Specimens from the two mines are relatively easy to distinguish: alstonite from the Brownley Hill mine is typically associated with thin hexagonal calcite crystals and contains pink barite in the matrix, whereas

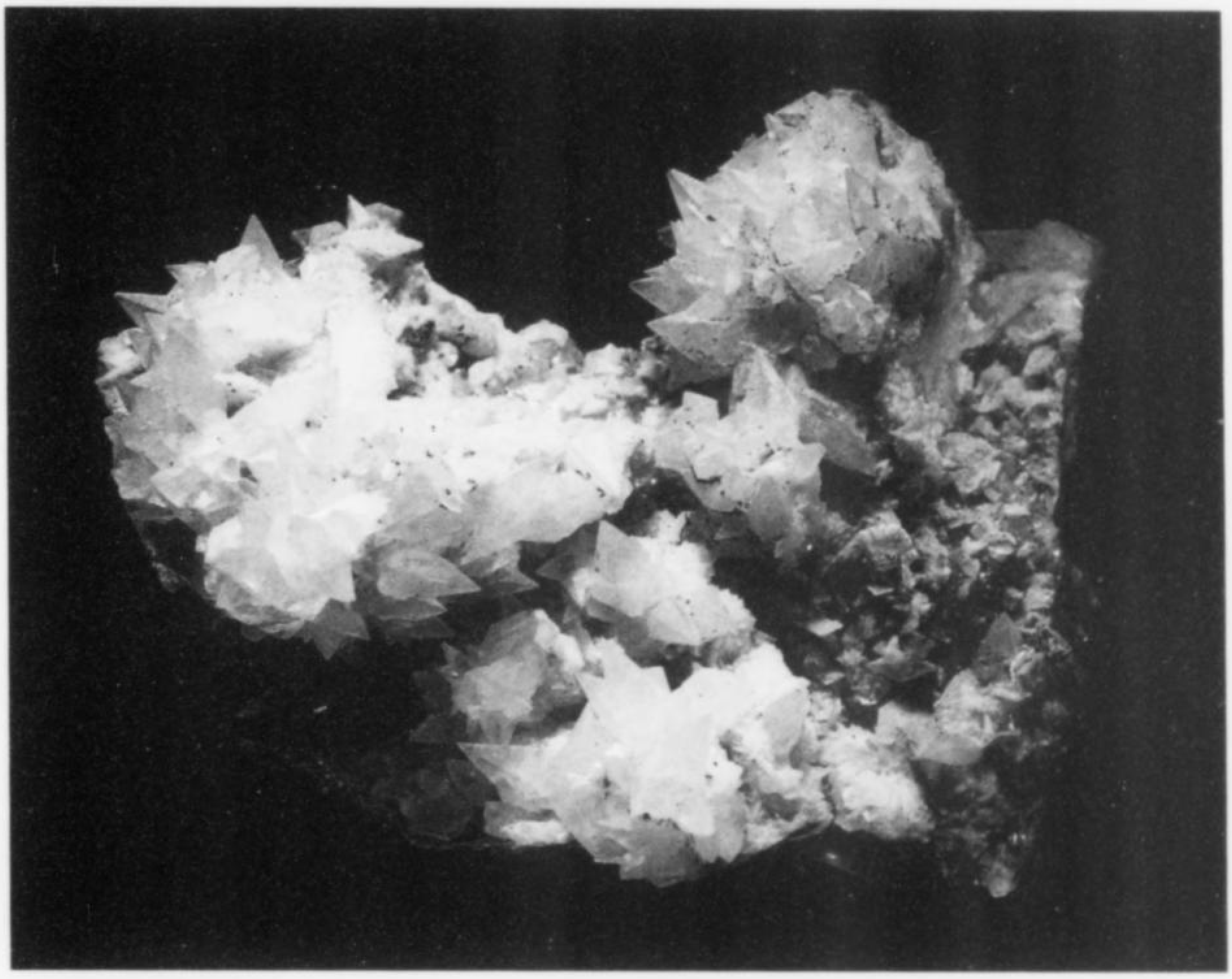

Figure 11. White pseudohexagonal alstonite pyramids to 6 mm, with white calcite plates and pale brown ankerite. This crystal habit and appearance of this specimen is typical of old-time alstonite. David McCallum collection; David Green photo.

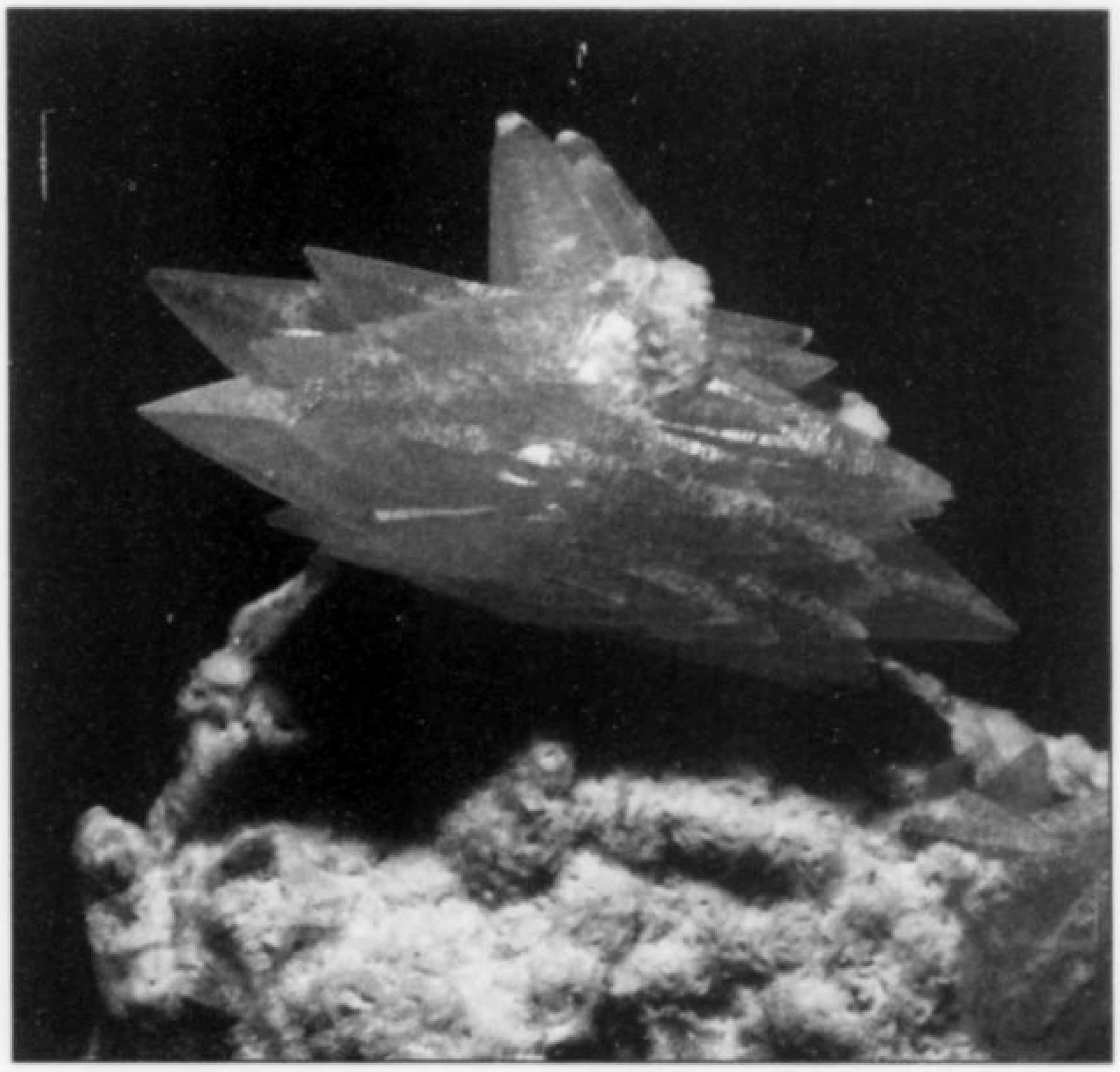

Figure 12. Acute pseudohexagonal alstonite in a large, doubly terminated group of parallel crystals (2.5 cm across) on calcite. Anonymous collection; David Green photo.

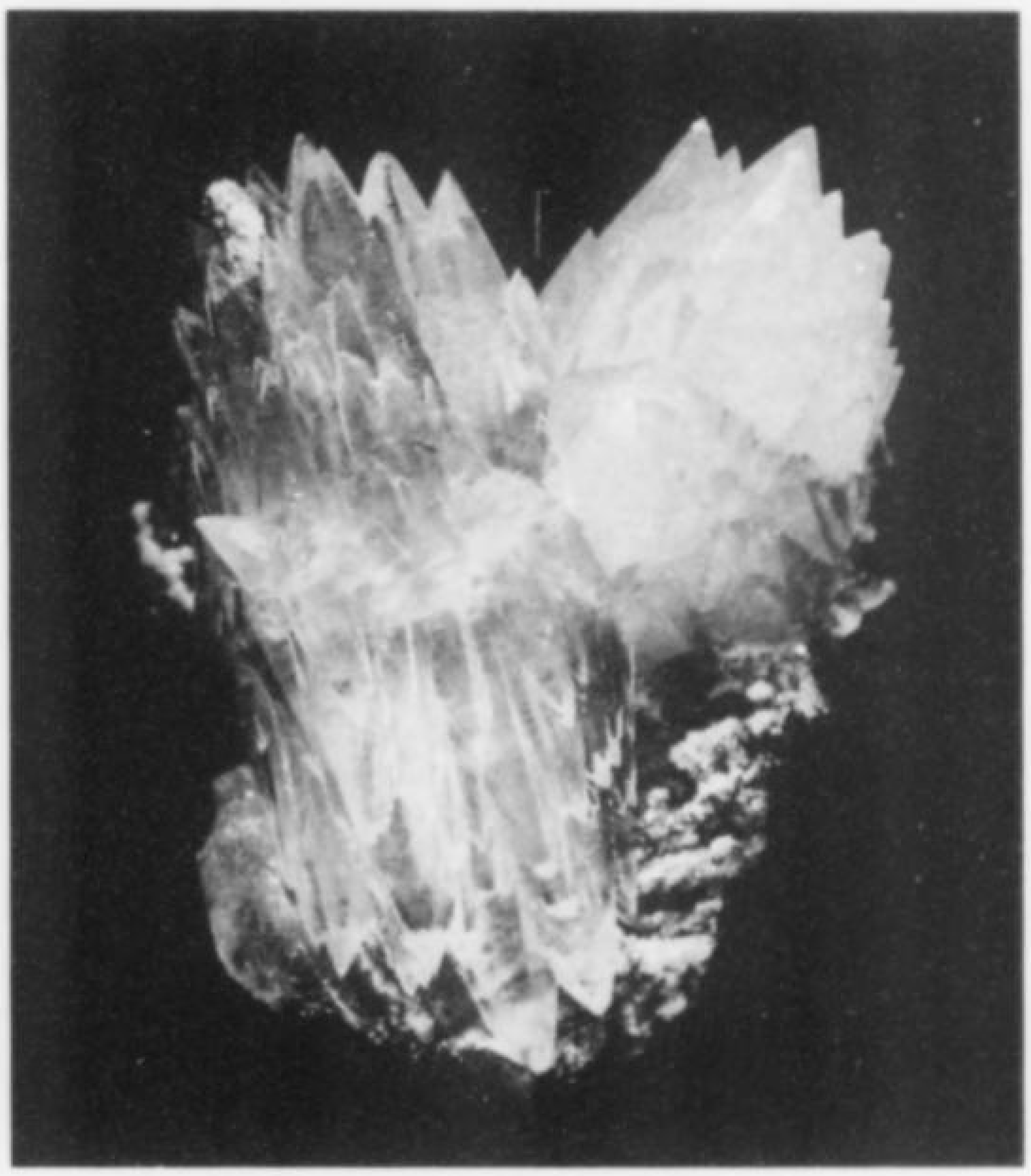

Figure 13. Translucent thumbnail alstonite crystal group, the largest crystal 2.5 cm in length. Anonymous collection; David Green photo.

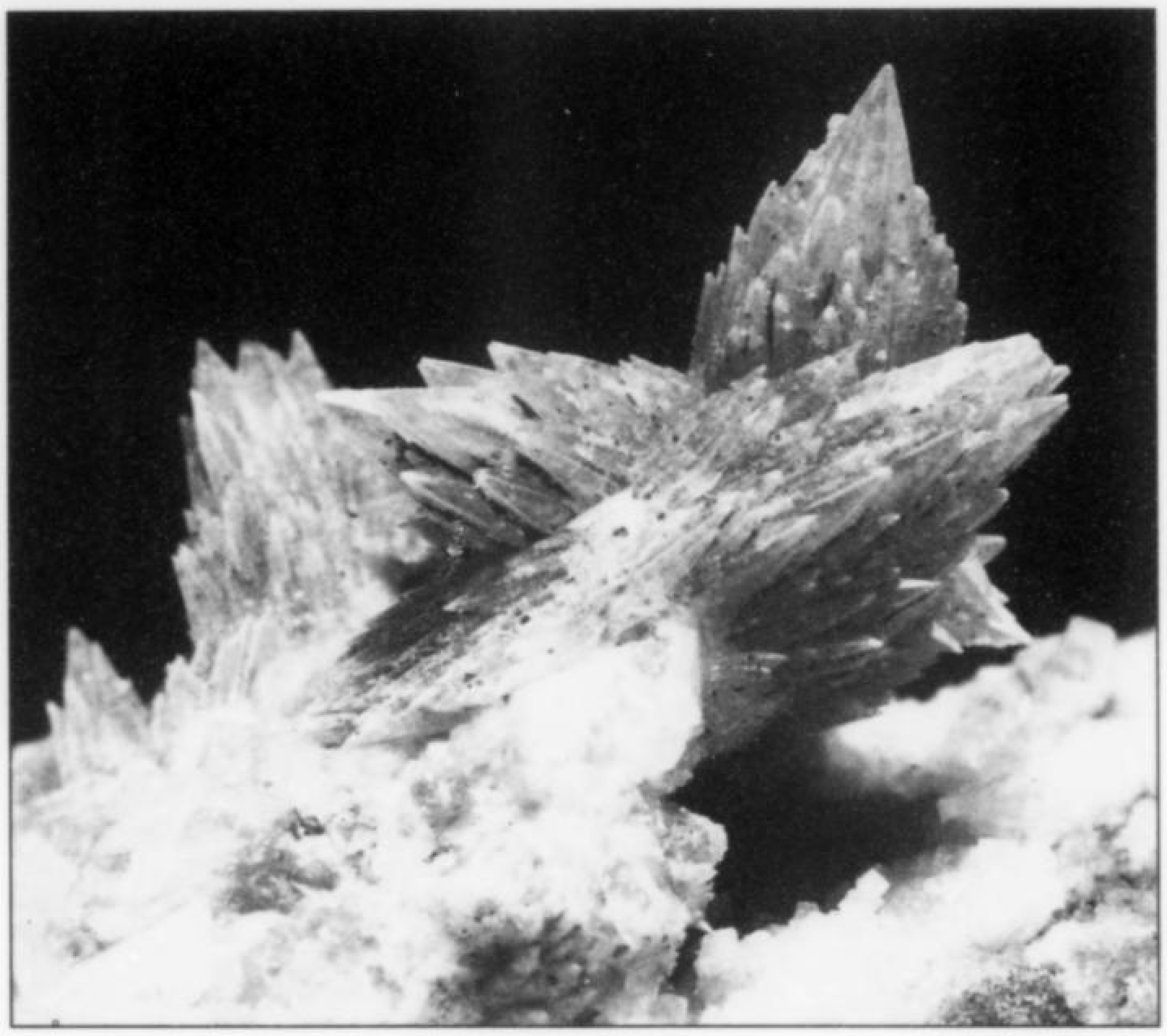

Figure 14. **Pink (light-sensitive) alstonite crystal group, the largest crystal 1.5 cm in length. All of the pink alstonite specimens were collected from a thick sandstone bed below the Great Limestone. Mike Wood collection; David Green photo.**

alstonite from the Fallowfield mine is commonly accompanied by large pseudohexagonal witherite pyramids.

It was long suspected that the Brownley Hill alstonite specimens originated from Jug vein, although the exact whereabouts of the type area was not recorded. Recent exploration has shown that the type area is in fact on High Cross vein between Holmes' rise and Richardson's rise (Young *et al.*, 1990) (this is marked as area A in Fig. 9).

In addition to the classic old-time habit, crystals of other distinct habits, not previously recorded, also occur in this area. While it is wholly within the Great Limestone, High Cross vein has a simple structure: vertical walls contain a fissure vein up to 30 cm wide, composed primarily of barite and calcite deposited in a symmetrical crustiform sequence. Alstonite of the classic old-time habit occurs as a late-stage primary mineral in calcite-lined cavities up to 1.5 meters in length, in the central portion of the vein. As the vein is followed downward, the eastern wall enters a thin sandstone, while the western wall remains in the Great Limestone. At this level, the vein structure becomes more complex, containing angular wallrock clasts net-veined by calcite, which are in turn overgrown by a sulfide-rich vein fill consisting primarily of galena, pyrite and calcite. Cavities within this assemblage host a suite of late-stage primary minerals, including lustrous, translucent, parallel groups of acute bipyramidal alstonite crystals, exceptionally to 2.5 cm. The vein is unproductive in the shaly strata below the sandstone and is represented by a discontinuous series of calcite lenses. A massive sandstone is encountered below the shale. Alstonite is present at this horizon as translucent pink crystals, exceptionally to 1.5 cm, associated with calcite and ankerite (these were noted by Moore, 1996). The pink color fades quickly in sunlight, and since the specimens do not recover their color, they should be kept in darkness.

Anglesite $PbSO_4$

Anglesite is rare, occurring as lustrous, transparent, blocky crystals to about 1 mm in cavities in galena. It is almost always accompanied by sulfur.

Ankerite $Ca(Fe,Mg,Mn)(CO_3)_2$

Ankerite is abundant in the north Pennine orefield, particularly in the replacement flat deposits, where it is often the most common primary carbonate. A complete series between ankerite and dolomite exists, with compositions near to dolomite tending to exhibit curved crystal faces, and flatter crystal faces indicating substantial iron content tending toward ankerite (Dunham, 1990). However, crystals from different areas of the Brownley Hill mine, in different mineral assemblages and with different crystal habits (both flat and curved faces), were examined by X-ray diffraction during this study, and all proved to be ankerite. Ankerite is ubiquitous in both the vein and replacement flat type deposits. It commonly lines cavities where it is found as white, brown, cream, red, and yellow rhombic crystals to about 1 cm associated with all of the common primary minerals.

Aragonite $CaCO_3$

Aragonite occurs uncommonly as radiating masses of white acicular crystals, to about 2 mm. It post-dates all of the major primary carbonates and may be post-mining in origin.

Barite $BaSO_4$

Barite occurs in two isolated areas of the workings. It is the dominant primary mineral at Holmes' rise on the High Cross vein, where it occurs as a massive white to pink vein filling to about 30 cm wide. It also occurs sporadically along the West High Cross vein near the top of the Great Limestone, again as a massive vein filling. Tabular crystals, sometimes aggregated into cockscomb forms, can be found in both areas, but collector-quality specimens are rare. Examination of surface dumps suggests that barite is a common primary vein mineral in old workings above the Great Limestone.

Barytocalcite $BaCa(CO_3)_2$

Barytocalcite was first reported from the surface dumps of the Brownley Hill workings by Young (1985a), but specimens have not been located *in situ* despite extensive searches. Barytocalcite was

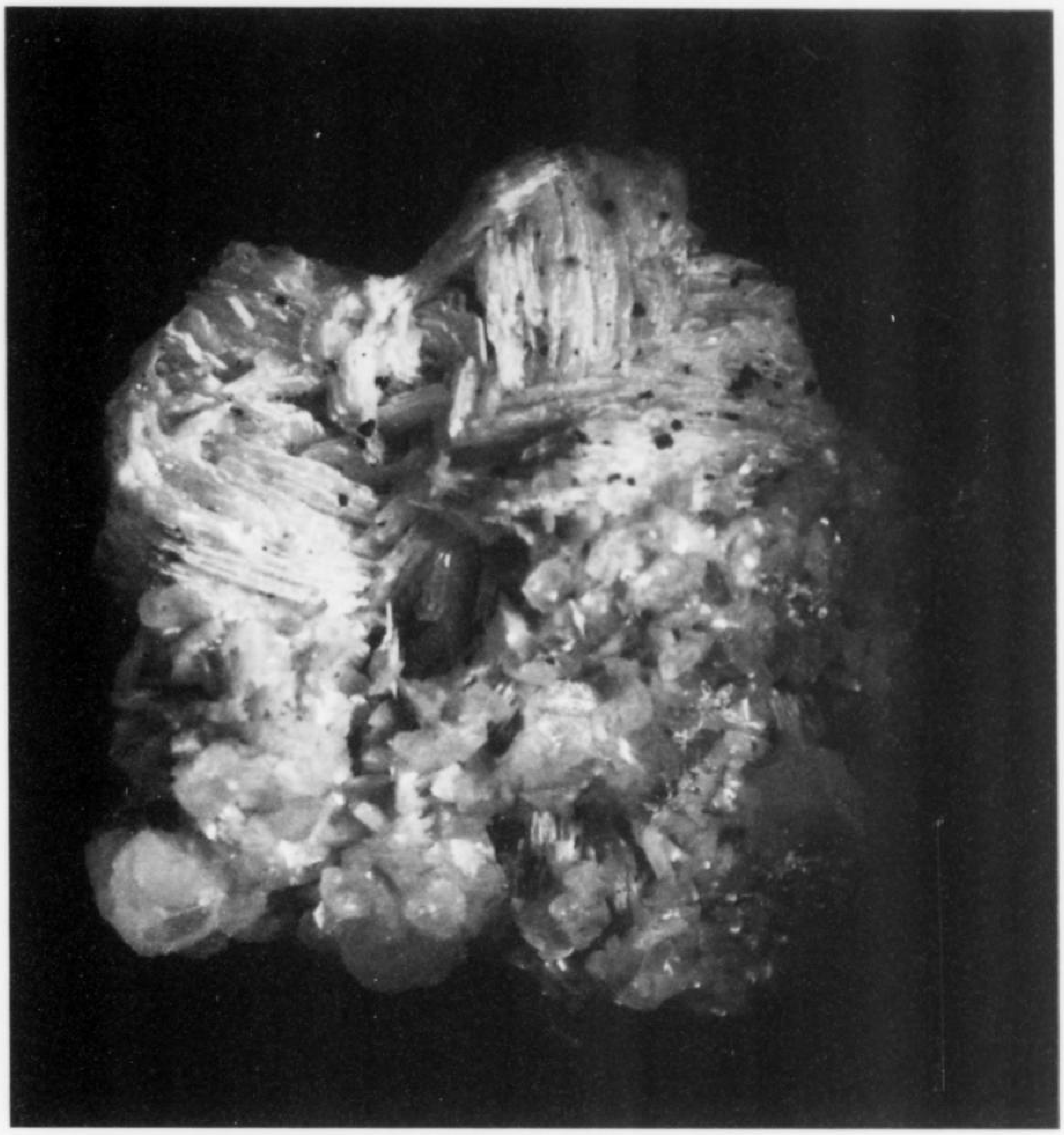

Figure 15. **White tabular barite with minor chalcopyrite crystallized on the upper half of this 7 x 7 cm specimen with well-crystallized, pearly, pale brown ankerite and yellow-brown calcite on the lower half. John and Robert Lawson collection; David Green photo.**

subsequently reported in minute traces associated with nail-head calcite from the area around Holmes' rise on High Cross vein (Young *et al.*, 1990). Detailed examination of specimens from Holmes' rise shows that barytocalcite occurs as an epitaxial overgrowth of minute prismatic crystals which are oriented parallel to the *c*-axes of nail-head calcite crystals. It is commonly associated with alstonite.

Despite the large number of localities in the northern Pennine orefield where barytocalcite or alstonite occur, a close association of the two polymorphs has not hitherto been recorded. Both species crystallized following calcite, late in the primary paragenesis, and while it is difficult to be certain, a few specimens seem to indicate barytocalcite is earlier than alstonite.

Bottinoite $Ni(H_2O)_6[Sb(OH)_6]_2$

The mineral which became known as bottinote was discovered at Brownley Hill mine in 1982 (Steve Rust, personal communication). Preliminary research at the Natural History Museum, London, showed the pale blue phase on galena to be a new species containing both nickel and antimony, however, only a small number of specimens were available, making full characterization difficult. Further progress was not made until 1990, when the unknown phase was found to be identical to a new mineral from the Bottino mine, Italy, which was subsequently named bottinoite (Bonazzi *et al.*, 1992).

The occurrence of bottinoite at the Brownley Hill mine is described by Clark and Rust (1993), who report that it was found on Tatters String, a minor vein between the Brownley Hill vein and the Brownley Hill North vein. A subsequent tape and compass survey of the complex workings in this area has shown that the occurrence is in fact on the Brownley Hill North vein, in backfilled stope workings in the Great Limestone, 10 meters above the horse level and 40 meters north of the crosscut from the Brownley Hill vein (area C in Fig. 9).

Bottinoite is restricted to a single cylindrical cavity (about 1 meter deep and 15 cm in diameter), elongated horizontally, situated parallel to the vein. Pale blue to greenish aggregates of thin, tabular, curved crystals, exceptionally to 3 mm, occur on slightly oxidized cuboctahedral galena associated with cerussite, sulfur, quartz, ullmannite and dolomite. In common with other worldwide occurrences, it is likely that this bottinoite formed by the oxidation of ullmannite.

Bournonite $PbCuSbS_3$

Bournonite is recorded by Clark and Rust (1993) from the area of the mine where bottinoite was discovered.

Brochantite $Cu_4SO_4(OH)_6$

Rounded green brochantite crystals to about 0.5 mm occur rarely with serpierite and harmotome in the quartz lining of a large cavity on the Brownley Hill vein. In common with the other secondary copper minerals at this locality, brochantite appears to have formed as a result of the post-mining oxidation of chalcopyrite.

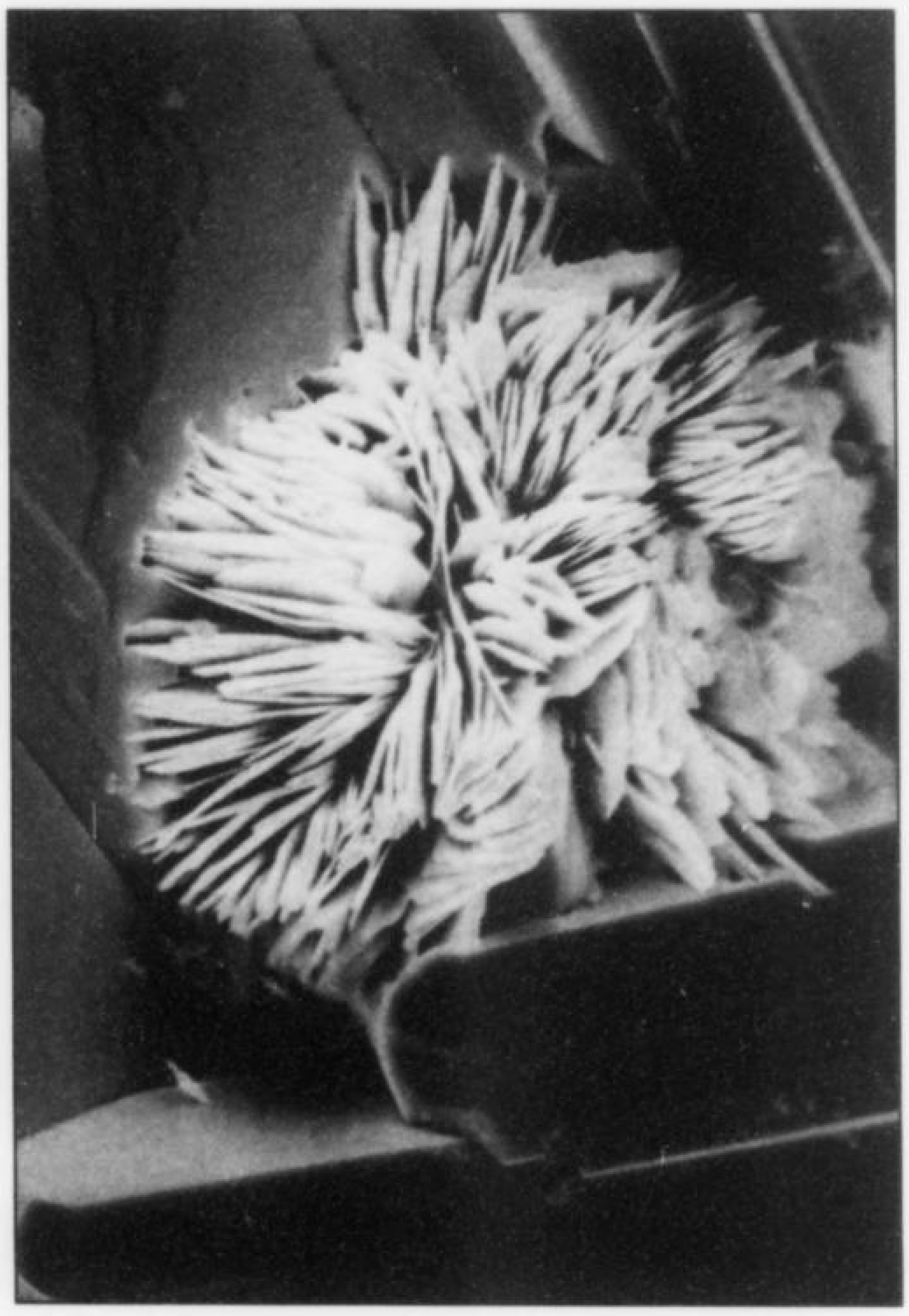

Figure 16. **SEM image showing a rossetiform aggregate of thin, platey brianyoungite crystals 100 µm across. Royal Museum of Scotland photo courtesy of Alec Livingstone.**

Brianyoungite $Zn_3(CO_3SO_4)(OH)_4$

The Brownley Hill mine is the type locality for the recently-described basic zinc carbonate sulphate *brianyoungite* (Livingstone and Champness, 1993). The mineral is named for Brian Young (1947–), a prolific author on the mineralogy of the British Isles and well known field mineralogist.

Brianyoungite occurs as white rosettes of thin bladed crystals, typically 1–2 µm thick and less than 0.1 mm in length. The type specimens were collected from the wall of the level on the Wellgill Cross vein between the North Middle vein and the Brownley Hill vein (area D in Fig. 5), where brianyoungite occurs associated with gypsum, goethite, smithsonite and the zinc-dominant ktenasite. They are preserved in the collection of the Royal Museum of Scotland, Edinburgh. Brianyoungite almost certainly formed by post-mining oxidation of the overlying zinc-rich orebody.

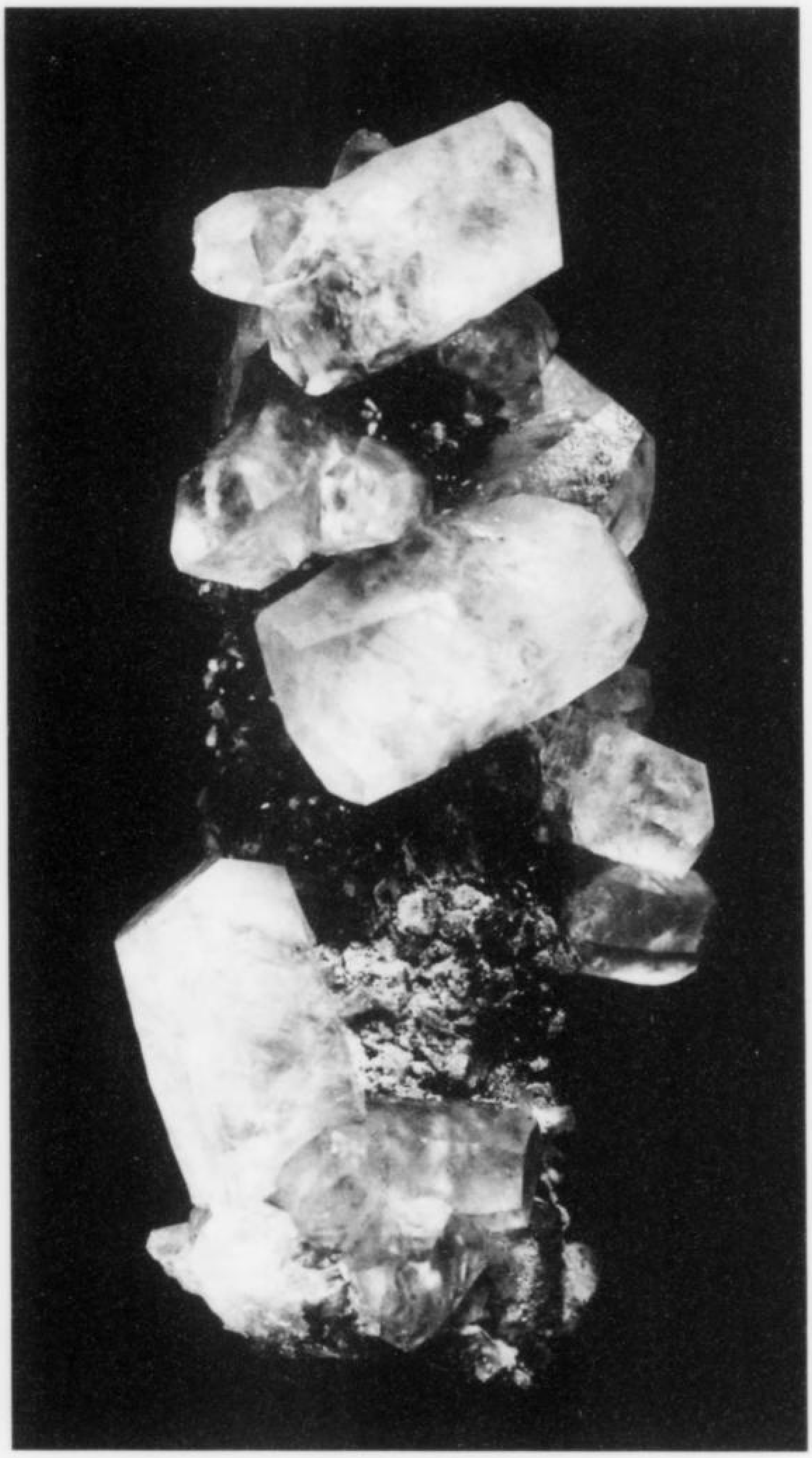

Figure 17. **A siliceous stalactite 5 cm in length covered in pale yellowish brown translucent calcite crystals. Anonymous collection; David Green photo.**

Calcite $CaCO_3$

Calcite crystals are common at many of the mines on Alston Moor (see for example, Greg and Lettsom, 1858) and are figured both by Rashleigh (1797) and Sowerby (1809). Although the Brownley Hill mine is not specifically mentioned, it is likely that at least some old-time specimens come from this locality. Calcite occurs as colorless to white, yellow or brown crystals with nail-head terminations, some of which are prismatic in habit, while others form as thin plates often stacked parallel to the *c*-axis. The crystals do not generally exceed 3 cm.

Cerussite $PbCO_3$

Small, white, acicular cerussite crystals in association with bottinoite and sulfur are reported by Clark and Rust (1993).

Figure 18. **A transparent yellow fluorite cube 2 cm on edge from the workings on the Jug Vein. David McCallum collection; David Green photo.**

Chalcopyrite $CuFeS_2$

Chalcopyrite is relatively uncommon at the mine, occurring as complex brass-yellow to brown tarnished crystals usually to about 0.5 mm, but exceptionally to 3 mm. It is commonly associated with ankerite, barite, calcite or fluorite and is sometimes coated by minute spherules of bright green malachite.

Dolomite $CaMg(CO_3)_2$

Dolomite is recorded by a number of authors (e.g. Dunham, 1990; Clark and Rust, 1993). All specimens examined during this study proved to be ankerite. Dolomite *sensu stricto* appears to be rare; it is certainly less abundant than ankerite.

Epsomite $MgSO_4 \cdot 7H_2O$

Fine hair-like epsomite crystals, some reaching 10 cm in length, occur alone or with gypsum, as post-mining efflorescences on the walls of the levels.

Erythrite $Co_3(AsO_4)_2 \cdot 8H_2O$

Minute, bright pink spherules associated with sphalerite, ankerite and quartz on a specimen from the Brownley Hill vein were shown to contain only Co and As (by SEM EDAX); they are almost certainly erythrite (Mike Rothwell, personal communication).

Fluorite CaF_2

Fluorite was first recorded in the Great Limestone at the Brownley Hill mine by Forster (1821) and old-time specimens similar in appearance to those recently collected from Brownley Hill mine are present in some 19th-century collections. Unfortunately, these are almost always labeled "*Alston Moor,*" and since a number of nearby mines produced similar fluorite specimens it is not generally possible to be sure of provenance.

Fluorite is common at the High Flat Horizon (near the top of the Great Limestone) on the Jug Vein, and is a minor component of the mineral assemblage at the south end of the West High Cross vein, but occurs nowhere else in the mine. Cavities several meters deep lined with crystalline fluorite are common in the Jug vein, and the miners would undoubtedly have collected specimens to sell to collectors and dealers. Typically, the crystals are translucent pale yellow to amber cubes to about 3 cm with numerous offset faces; they occasionally incline toward apple-green or colorless. In common with most other north Pennine localities, the Brownley Hill mine fluorite fluoresces a bright blue-violet. It is commonly associated with ankerite, and more rarely with chalcopyrite, sphalerite, galena, quartz or calcite.

***Figure 19.* Cuboctahedral galena crystals to 1.6 cm, with black sphalerite, on white quartz. From the flats on the Middle Vein. Peter Briscoe collection; David Green photo.**

Galena PbS

For the majority of its life, Brownley Hill mine was worked solely for lead. Galena is the only significant lead ore, and is common in both the vein and flat deposits. Cavities containing crystalline specimens are relatively common. The crystals usually display distorted cube and octahedron forms, with numerous offset faces. Specimens must have been produced in the 19th century; Greg and Lettsom (1858) noted "large cubic crystals at Brownly Hill." Good specimens are uncommon, perhaps the best being from the large flat deposits on the Middle vein, where cuboctahedral crystals, exceptionally to 10 cm, are found with ankerite, quartz and sphalerite.

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

Goethite is recorded by Livingstone and Champness (1993) as part of the post-mining assemblage which includes brianyoungite and secondary copper and zinc minerals.

Gypsum $CaSO_4 \cdot 2H_2O$

Drusy crystalline gypsum crusts commonly encrust the level walls. Specimens tend to be very delicate and rarely survive extraction; they are best left *in situ*.

Harmotome $(BaK)_{1-2}(Si,Al)_8O_{16} \cdot 6H_2O$

The occurrence of zeolites in the North Pennine Orefield is reviewed by Young *et al.* (1991), who show that in almost all cases their formation is related to hydrothermal events associated with the emplacement of the Whin Sill. At the Brownley Hill mine, however, harmotome is a late-stage primary vein mineral (D. I. Green and J. R. Nudds, in preparation).

Harmotome occurs as colorless to white prismatic crystals, with characteristic cross-shaped terminations, rarely exceeding 1 mm, in a large quartz-lined cavity on the Brownley Hill vein (area B in Fig. 9). Voids between different generations of white pyramidal quartz crystals, which make up the lining of the cavity, contain a diverse mineral suite including harmotome, calcite, gypsum and several secondary copper minerals. On most specimens the harmotome is corroded and partly replaced by barite.

Hydromagnesite $Mg_5(CO_3)_4(OH)_2 \cdot 4H_2O$

Hydromagnesite is typically found in veinlets in serpentinites, and its occurrence in Mississippi Valley type deposits is unusual. White hydromagnesite spherules to about 0.4 mm in diameter are found richly encrusting alstonite crystals in cavities within the sulfide-rich vein filling at Holmes' rise on the High Cross vein. Hydromagnesite is the last in a complex series of carbonates to crystallize in the cavities in which it occurs. This might indicate the presence of a late-stage remnant hydrothermal solution rich in magnesium. Alternatively, it may have formed by recent alteration of dolomite-ankerite as noted in Palache *et al.* (1951).

Hydrozincite $Zn_5(CO_3)_2(OH)_6$

Hydrozincite occurs as a component of the white encrustations on the mine walls produced by post-mining oxidation of sphalerite.

Jarosite $KFe_3^{3+}(SO_4)_2(OH)_6$

Yellow earthy jarosite is common in the shale beds both above and below the Great Limestone. It appears to form by the post-mining oxidation of pyrite.

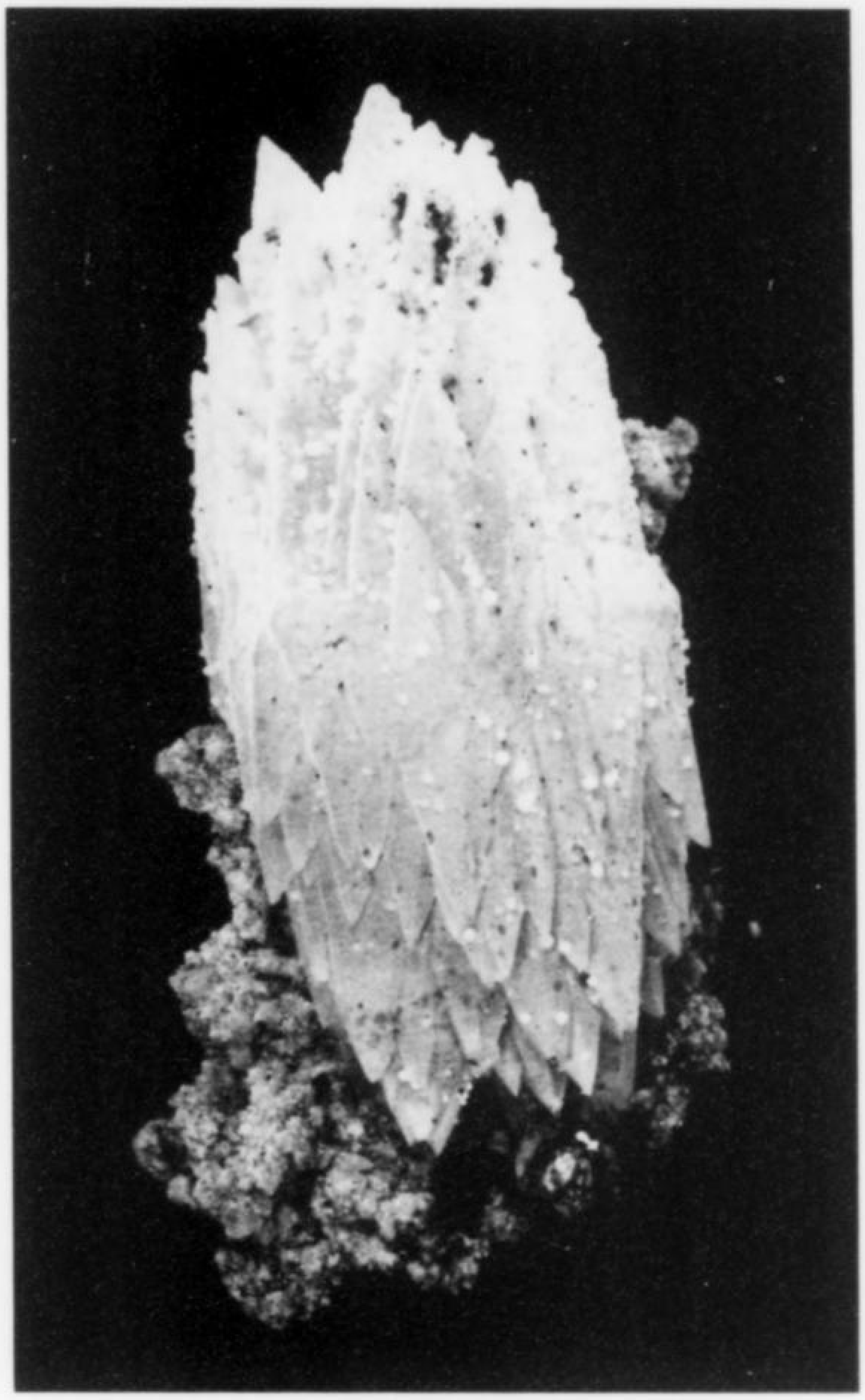

Figure 20. **Hydromagnesite spherules to 0.4 mm encrusting alstonite. Anonymous collection; David Green photo.**

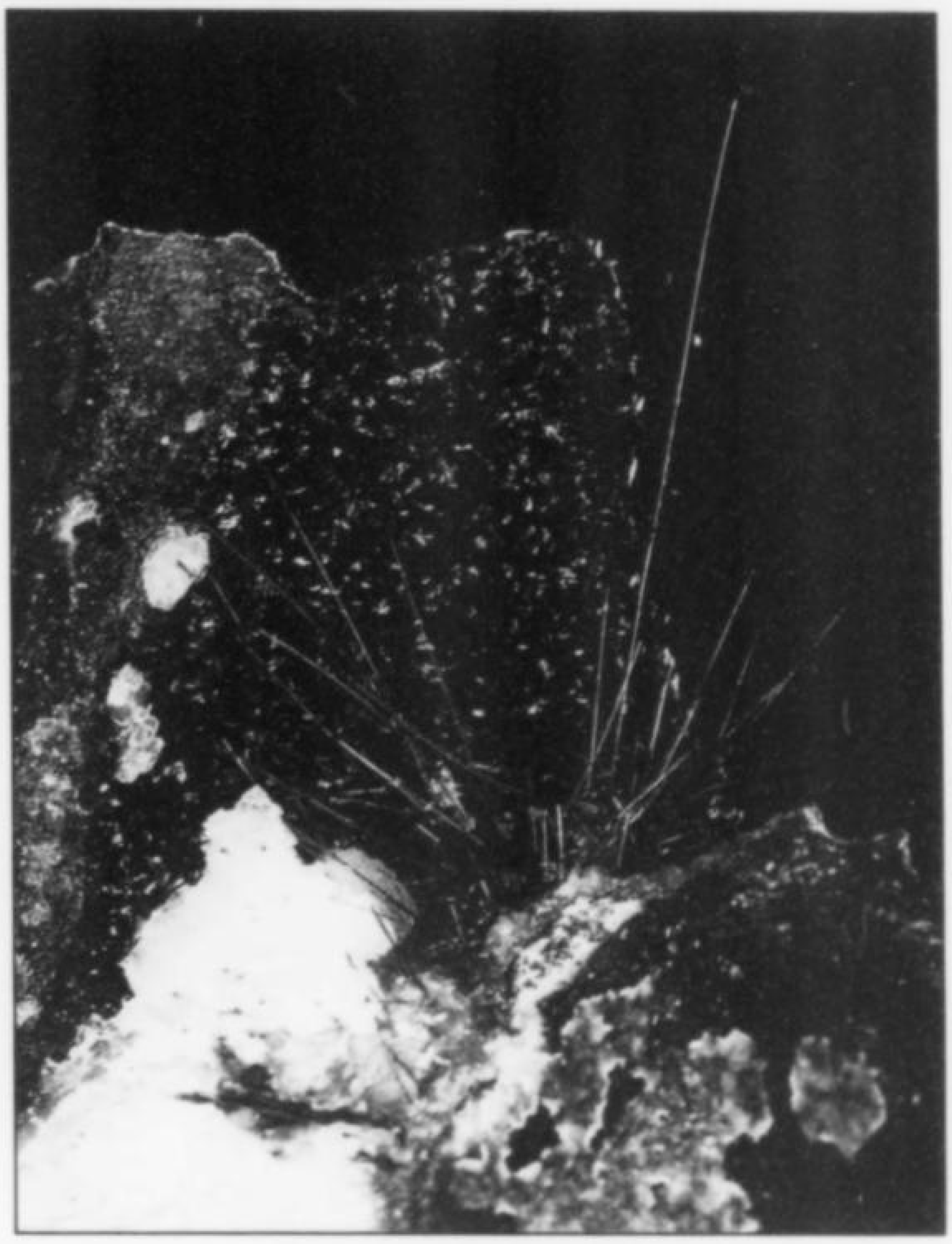

Figure 21. **Bright metallic millerite crystals to 2.5 cm against a background of dark brown siderite. Specimen from the West High Cross vein. David McCallum collection; David Green photo.**

Ktenasite-analog $(Zn,Cu)_5(SO_4)_2(OH)_6 \cdot 6H_2O$

Blue to blue-green grains of the zinc-dominant analog of ktenasite to 0.3 mm are reported by Livingstone (1991). They are almost certainly post-mining in origin.

Malachite $Cu_2CO_3(OH)_2$

Green malachite spherules are found on tarnished brassy chalcopyrite. As with other supergene species, it is rare and probably recent in origin.

Marcasite FeS_2

Marcasite crystals to about 1 mm occur in cavities in the sulfide-rich vein material at the base of the Great Limestone at Holmes' rise.

Melanterite $FeSO_4 \cdot 7H_2O$

Melanterite occurs as pale blue masses of curved capillary crystals, commonly associated with jarosite and gypsum. It typically occurs in shale and appears to have formed by post-mining oxidation of pyrite.

Millerite NiS

Millerite is rare in the Pennine orefields. At the Brownley Hill mine it occurs on High Cross vein and on West High Cross vein, where it is restricted stratigraphically to the sandstone bed just below the Great Limestone (Green and McCallum, 1993). The best specimens show bright brassy yellow acicular crystals to 2.5 cm filling cavities lined with calcite, siderite and ankerite. Galena, pyrite and an unidentified, possibly amorphous, green oxidation product are common associates. Millerite does not occur in veins in which sphalerite is abundant.

Pyrite FeS_2

Pyrite is widespread throughout the Brownley Hill workings. Tarnished crystals to about 1.5 cm, showing cube and pyritohedron forms, occur in the sulfide-rich alstonite assemblage at Holmes' rise. Pyrite crystals speared by acicular millerite are found on specimens from the West High Cross vein, and highly elongated crystals occasionally occur on the same specimens. Distorted cubic crystals occur on silicified limestone in the large replacement flats on the Middle vein.

Quartz SiO_2

Quartz commonly forms drusy crusts of pyramidal crystals in cavities in both the vein and replacement flat deposits. Specimens richly covered in milky white pyramidal crystals, some to 5 cm, are not uncommon. Macrocrystals of quartz are absent from those areas of the mine where barium minerals dominate.

Serpierite $Ca(Cu,Zn)_4(SO_4)_2(OH)_6 \cdot 3H_2O$

Serpierite occurs with harmotome, gypsum, and rarely with brochantite in fractures in the quartz lining of a large cavity on Brownley Hill vein (area B in Fig. 5). The aggregates of blue lath-like crystals reach about 2 mm, and appear to have been produced by post-mining oxidation of chalcopyrite.

Sphalerite ZnS

Sphalerite is extremely common. The large replacement flats on the Middle vein have long been known to British collectors as a source of specimens. Good specimens typically show lustrous black crystals to about 5 mm richly encrusting silicified limestone, with galena, quartz or ankerite as occasional associates. Cavities containing crystals to 2 cm are common throughout the mine, but the larger crystals tend to be dull. Small, transparent, red to red-brown crystals of "ruby blende" occur on several veins.

Siderite $FeCO_3$

Siderite occurs as interlocking crusts of opaque, dark brown to black, dull to lustrous, curved crystals. It is commonly found encrusting galena.

Smithsonite $ZnCO_3$

Smithsonite is noted by Livingstone and Champness (1993) as an associate of brianyoungite. In spite of the abundance in the workings, it is very rare. It is one of the very few species not found by the authors in this study.

Strontianite $SrCO_3$

Strontianite is rare in the north Pennines (see Young, 1985b). It was first reported from the Brownley Hill mine as white to pale green divergent sprays of acicular crystals to 5 mm in cavities in barite with calcite and ankerite (Wood, 1991). The few specimens discovered were collected from the top of the Great Limestone near Thomson's rise at the southern end of West High Cross vein (area E in Fig. 9).

Sulfur S

Sulfur was first recorded on partly oxidized galena with bottinoite and cerussite by Clark and Rust (1993). It is usually found associated with secondary lead minerals, most commonly anglesite, as rounded yellow to yellow-green crystals to about 0.5 mm.

Ullmannite NiSbS

Ullmanite occurs as cubic, metallic gray crystals on galena in a cavity on the Brownley Hill North vein, where it is associated with bottinoite, cerussite, and sulfur (Clark and Rust, 1993).

Witherite $BaCO_3$

The first description of witherite from the Brownley Hill mine is by Thomson (1835), who purchased a specimen with ". . . very large six-sided prisms terminated by low six-sided pyramids." The accompanying chemical analysis can be interpreted as witherite with some barite contamination. Pseudohexagonal witherite crystals to 3 cm, with flat pyramidal terminations (as described by Thomson), are occasionally present on old-time Brownley Hill alstonite specimens (Lindsay Greenbank, personal communication).

Witherite is restricted to the barium-rich area of the High Cross vein north of Holmes' rise. In addition to the old-time habit described above, it occurs in the brecciated sulfide-rich vein at the base of the Great Limestone, as sharp, lustrous, pseudohexagonal bipyramids typically to about 2 mm, but exceptionally reaching 1 cm. Alstonite, calcite, hydromagnesite, galena, pyrite and marcasite are common associates.

CONCLUSIONS

The Brownley Hill mine is one of the most mineralogically diverse in the north Pennines. It has provided exceptional examples of the rare mineral alstonite, and also galena, sphalerite, calcite and fluorite specimens without which no north-of-England collection would be complete. Recent fieldwork has revealed a surprisingly diverse supergene mineral suite, including a number of species such as bottinoite, brianyoungite and a ktenasite analog which are very rare. This has been complemented by the discovery of a suite of primary minerals which are uncommon in the Mississippi Valley type deposits of the north Pennines including bournonite, millerite, strontianite, ullmannite, and (perhaps) hydromagnesite.

Mineralization which belongs to both the fluorite zone and to the barium zone is exposed in the Brownley Hill mine, but most of the workings are within the ankerite-dominated intermediate zone. This accident of geography is largely responsible for the occurrence's mineralogical diversity. It is interesting to note, however, that many of the more unusual primary minerals occur near the transitions between the gangue mineral zones. Thus the alstonite area near Holmes' rise on the High Cross vein, which also hosts the uncommon primary minerals barytocalcite and hydromagnesite, is immediately south of the point where an ankerite-dominated vein assemblage gives way to a barium-dominated assemblage. The strontianite occurrence on the West High Cross vein is in a similar transitional position.

The occurrence of millerite on the West High Cross vein and the High Cross vein is unusual in that it is stratigraphically restricted (to the shaley sandstones just below the Great Limestone). Detailed examination of the veins both above and below this horizon failed to produce other specimens. Alstonite in its more unusual crystal habits is similarly restricted.

The supergene mineral suite at Brownley Hill mine is surprisingly diverse. Since all of the accessible workings are below the zone of natural supergene alteration, most of the supergene species, including the unusual zinc carbonate-sulfate brianyoungite for which Brownley Hill mine is the type locality, are thought to be post-mining in origin.

A few specimens from the Brownley Hill mine can be found in most British museums and in many other museums worldwide which hold 19th-century mineral collections. A large number of specimens from the mine (acquired post-1992), including alstonite and examples of many of the unusual species described above, are preserved in the Manchester Museum collections.

The Brownley Hill mine is one of the classic north-of-England mineral localities. It has produced a suite of minerals which includes almost all of the species for which the Mississippi Valley type deposits of the North Pennine Orefield are famous. Its reputation as a locality of international importance rests largely on alstonite specimens, which have been produced since the 1830's, and which include probably the finest specimens with the largest crystals of any locality worldwide. The quality of the specimens collected recently can be judged by the reaction of a knowledgeable dealer in North-of-England minerals, not usually given to superlatives: "so there is such a thing as an aesthetic alstonite!"

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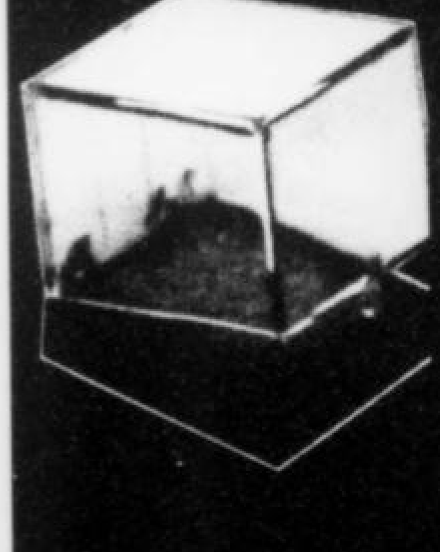

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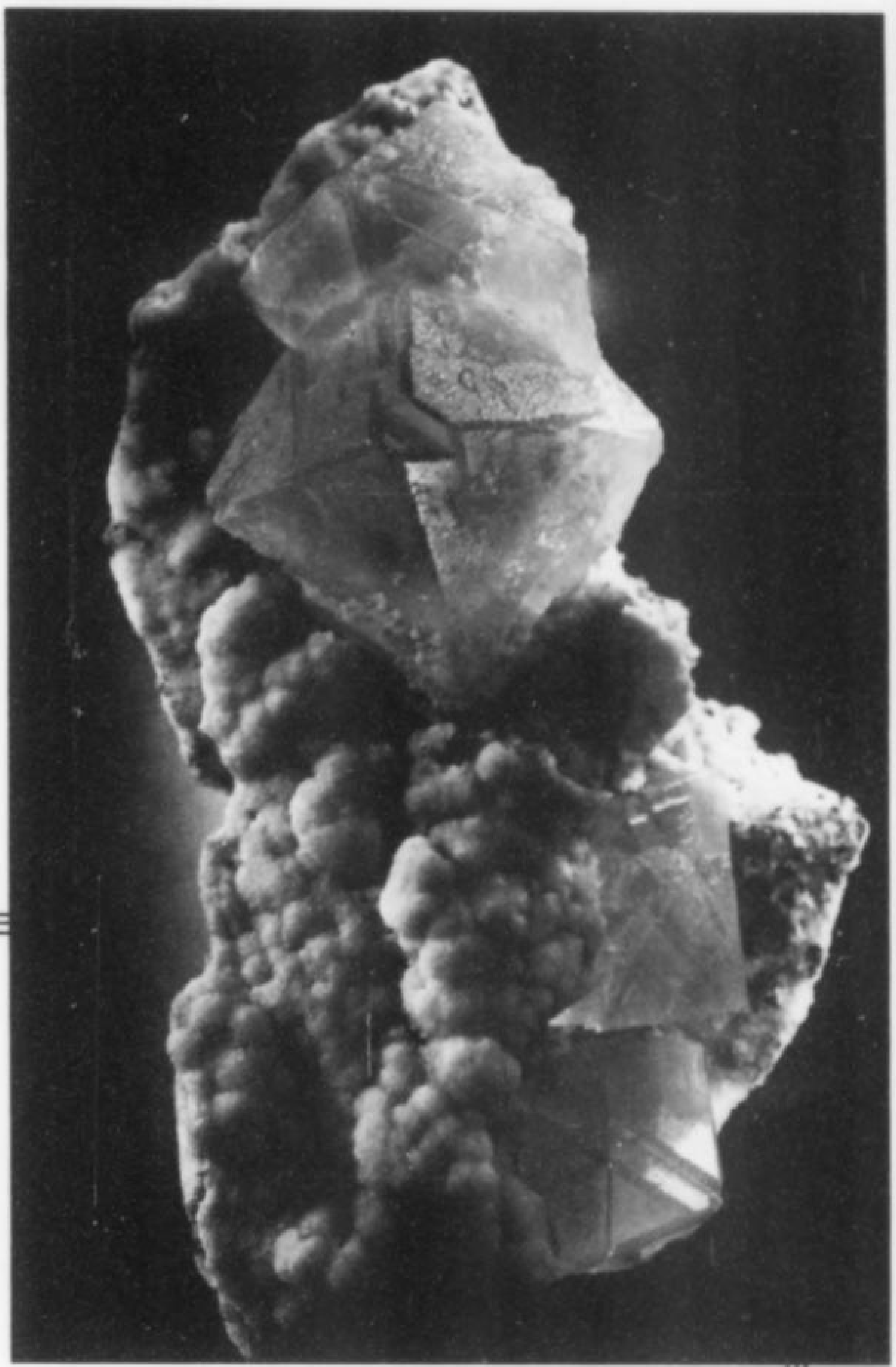

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ARAKIITE

◆

A NEW ZN-BEARING HEMATOLITE-LIKE MINERAL FROM LÅNGBAN, VÄRMLAND, SWEDEN

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ABSTRACT

Arakiite, idealized as $(Zn,Mn^{2+})(Mn^{2+},Mg)_{12}(Fe^{3+},Al)_2(As^{3+}O_3)(As^{5+}O_4)_2(OH)_{23}$, is monoclinic, space group *Cc*, with unit-cell parameters refined from powder data: $a = 14.248(8)$, $b = 8.228(4)$, $c = 24.23(1)$ Å, $\beta = 93.62(3)°$, $V = 2843(2)$ Å^3, $a:b:c = 1.7316:1:2.9445$, Z = 4. The strongest seven reflections in the X-ray powder-diffraction pattern are $[d(\text{Å})(I)(hkl)]$: 12.07 (100) (002); 6.046 (100) (004); 4.040 (90) (006); 3.148 (30) ($\bar{4}04$, $\bar{1}17$); 3.030 (70) (224); 2.411 (40) (424, $\bar{5}15$); 1.552 (70) (640, $\bar{3}51$). The mineral was found on a museum specimen, previously labeled as dixenite, from Långban, Värmland, Sweden, and occurs on one surface as red-brown to orange-brown aggregates of micaceous plates. Associated minerals are calcite and very minor magnussonite, and the bulk of the specimen is specular hematite. Arakiite is megascopically indistinguishable from either hematolite or dixenite and possesses the following physical properties: streak is pale brown; lustre is resinous to submetallic; diaphaneity is opaque (masses) to translucent (thin edges); non-fluorescent; hardness is estimated at 3–4; cleavage is {001} perfect; tenacity is brittle; fracture is uneven, almost subconchoidal; calculated density is 3.41 g/cm^3 (for empirical formula and unit-cell parameters derived from crystal structure). Arakiite is biaxial negative, $\alpha = 1.723(4)$, $\beta = 1.744(2)$, $\gamma = 1.750(2)$; 2*V* (meas.) = 44(3)° (extinction), = 40(10)° (direct), 2*V* (calc.) = 56°; dispersion $r > v$ medium; orientation is Y = *b* and X ^ *c* = +4° (in β obtuse). There is no evidence of pleochroism. The crystal structure shows that manganese occurs as Mn^{2+}, iron occurs as Fe^{3+} and arsenic occurs as both As^{3+} and As^{5+} in a 1:2 ratio. Averaged electron-microprobe analyses yielded ZnO = 4.48, MnO = 34.32, MgO = 12.76, Fe_2O_3 = 6.76, Al_2O_3 = 2.25, As_2O_3 = 6.56, As_2O_5 = 15.84, H_2O (calculated assuming stoichiometry) = [13.74], total = 96.71 weight %, corresponding to $(Zn_{0.83}Mn^{2+}_{0.17})_{\Sigma1.00}(Mn^{2+}_{7.12}Mg_{4.77})_{\Sigma11.89}(Fe^{3+}_{1.28}Al_{0.67})_{\Sigma1.95}(As^{3+}O_3)_{1.00}(As^{5+}O_4)_{2.08}(OH)_{22.99}$, based on 34 (O+OH) anions. (OH) was confirmed by both infrared spectroscopy and crystal-structure analysis. The mineral name is for Dr. Takaharu Araki (1929–) for his numerous crystal-structure contributions to the science of mineralogy.

INTRODUCTION

Arakiite, ideally $(Zn,Mn^{2+})(Mn^{2+},Mg)_{12}(Fe^{3+},Al)_2(As^{3+}O_3)(As^{5+}O_4)_2(OH)_{23}$, is a newly recognized mineral species from Långban, Sweden. The specimen on which the new mineral occurs was acquired by one of us (M.N.F.) on exchange from the late John Fuller of The Natural History Museum, London, UK, in September 1985. It is a portion of a larger specimen (BM1921, 310) which was labeled as dixenite from Långban, Värmland, Sweden, and was initially acquired by the museum in 1921 from Mr. C. Wendler who had provided them with a number of Långban samples in the early 1920's. The misidentification is certainly legitimate; arakiite is megascopically indistinguishable from dixenite and hematolite. All three minerals occur at Långban as thin foliated reddish-colored masses on ore-bearing matrix. Routine X-ray powder-diffraction study indicated that the mineral is not identical to dixenite or hematolite. Further study using modern mineralogical techniques showed it to be a new mineral, the description of which is reported here. The crystal structure most closely resembles that of hematolite (Moore and Araki, 1978) rather than that of dixenite (Araki and Moore, 1981) and has been dealt with in a separate publication (Cooper and Hawthorne, 1999).

The mineral is named for Dr. Takaharu Araki (b. 1929), formerly of the Department of the Geophysical Sciences, University of Chicago, Chicago, Illinois, for his numerous crystal-structure

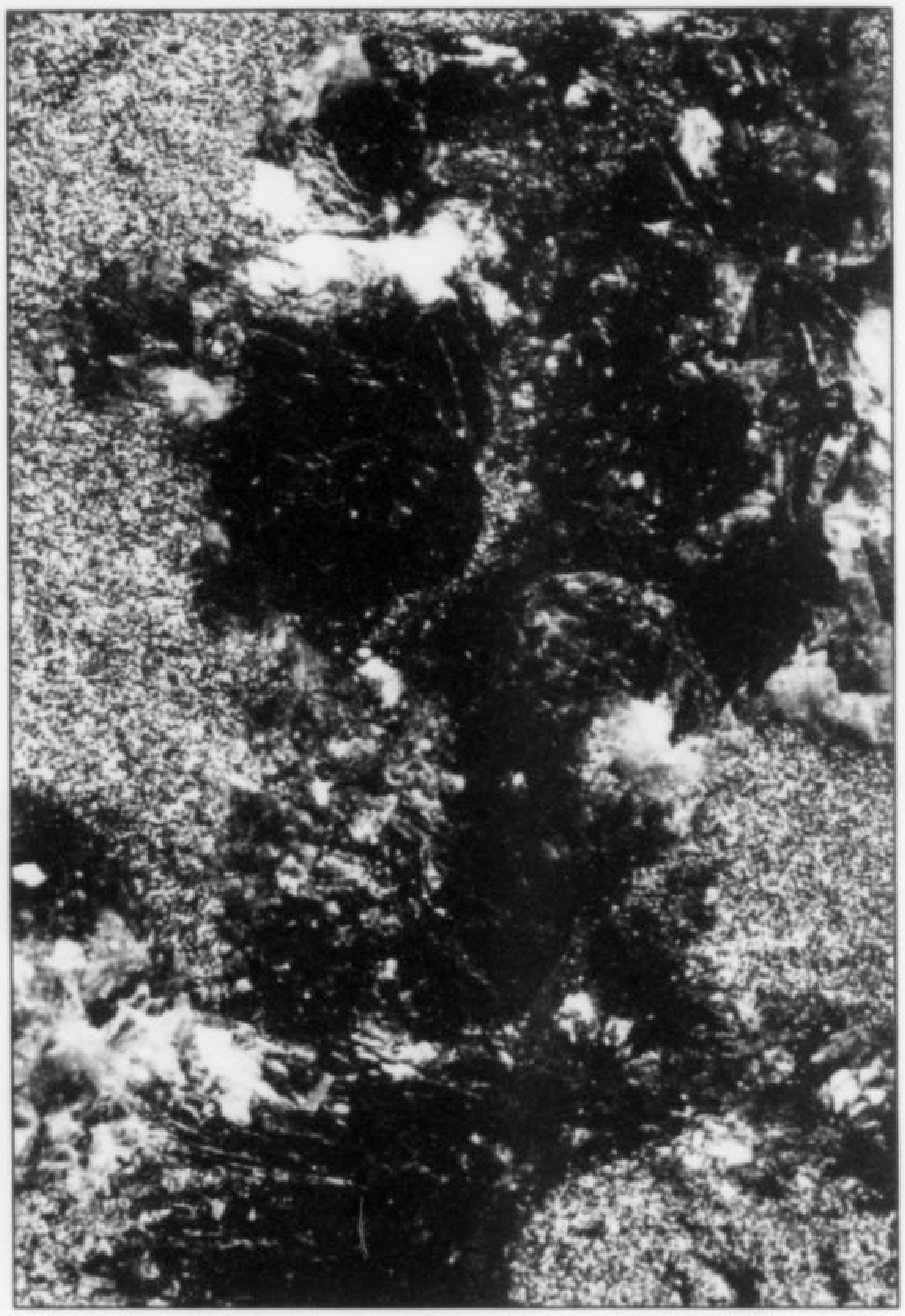

Figure 1. **Arakiite foliated masses on specular hematite. Longest field of view is approximately 15 mm.**

contributions to the science of mineralogy. Dr. Araki, in close collaboration with Professor Paul Moore, solved the structures of many complex P-bearing and As-bearing phases, including those of hematolite and dixenite. The mineral and mineral name have been approved by the Commission on New Minerals and Mineral Names, I.M.A. The specimen used for this study now resides within the Harvard Mineralogical Museum, Cambridge, Massachusetts, and has been assigned the catalog number 134608. Additional material is preserved at The Natural History Museum, London, UK, as BM1921, 310.

SPECIMEN DESCRIPTION

The single sample used for this study measures 15 x 20 x 18 mm and consists principally of massive fine-grained specular hematite. Arakiite is only found on one surface where it occurs as aggregates of micaceous plates over an area of approximately 15 x 10 mm. A color photograph of essentially the complete arakiite aggregate is presented in Figure 1. Associated minerals are colorless anhedral calcite and tiny blue-green anhedral grains of magnussonite. We have no detailed information about the site of origin within the mine.

PHYSICAL and OPTICAL PROPERTIES

Arakiite is red-brown to orange-brown with a pale-brown streak. The lustre is resinous to submetallic, and masses are opaque whereas thin edges of grains are translucent. The mineral is predominantly anhedral and mica-like with no obvious forms; it has a perfect {001} cleavage. The tenacity is brittle, fracture uneven, almost subconchoidal, and the hardness is estimated at 3 to 4, considering that it is easily scratched by a needle. There is no evidence of fluorescence under either longwave or shortwave ultraviolet radiation. Density could not be measured because of the meager quantity of pure material; the calculated density is 3.41 g/cm^3 (based on the empirical formula and unit-cell parameters determined from the crystal-structure study). Twinning was neither observed megascopically nor in the subsequent X-ray single-crystal and crystal-structure studies.

Spindle-stage optical measurements at 590 nm indicate that the mineral is biaxial negative with $\alpha = 1.723(4)$, $\beta = 1.744(2)$, $\gamma = 1.750(2)$; $2V$ (measured by extinction method) = 44(3)°, $2V$ (measured directly) = 40(10)°, $2V$ (calculated) = 56°. The discrepancy between measured and calculated $2V$ is attributable to uneven extinction related to the "curved" nature of the plates. The dispersion is $r > v$ medium, and no pleochroism was observed. The optical orientation is $Y = b$, $X \wedge c = +4°$ (in β obtuse).

X-RAY DIFFRACTION

Arakiite is monoclinic, space group *Cc*, with unit-cell parameters refined from powder data: $a = 14.248(8)$, $b = 8.228(4)$, $c = 24.23(1)$ Å, $\beta = 93.62(3)°$, $V = 2843(2)$ Å^3, and $a{:}b{:}c = 1.7316{:}1{:}2.9445$. Cell parameters derived from the crystal-structure study (Cooper and Hawthorne, 1999) are: $a = 14.236(2)$, $b = 8.206(1)$, $c = 24.225(4)$ Å, $\beta = 93.52(1)°$, $V = 2824.0(7)$ Å^3, and $a{:}b{:}c = 1.7348{:}1{:}2.9521$.

A fully indexed X-ray powder-diffraction pattern is presented in Table 1. If one considers the whole pattern, the data are unique. However, strong $00l$ reflections at 12.07, 6.046, 4.040 and the strong reflection at I.552 Å are comparable, in both intensity and spacing, to those diffraction lines published for both hematolite and dixenite and, additionally, to the unnamed Fe^{3+} analogue of hematolite (Dunn and Peacor, 1983) and to the unnamed Långban arsenate of Roberts and Dunn (1988). Studies are in progress on the latter two; suffice to say at this time that neither is crystallographically nor chemically identical to arakiite. All known members of this "family" of structures can be readily differentiated by routine X-ray powder-diffraction film methods, including 57.3 mm cameras.

CHEMISTRY

A thin cleavage plate of arakiite was analyzed with a Cameca SX-50 electron microprobe, using an operating voltage of 15 kV, a beam current of 20 nA, a beam 5 µm in diameter, and a counting time of 20 s on a peak and 10 s on background. The plate was selected from an area on the sample adjacent to that from which the cleavage plate used for the crystal-structure analysis was picked; it was fixed to the surface of a plexiglass disk and then carbon coated prior to analysis. Probe standards are as follows: cobaltite (As); gahnite (Zn); spessartine (Mn); forsterite (Mg); fayalite (Fe); kyanite (Al). An energy-dispersion scan indicated the absence of any other elements with atomic number greater than 9 except those reported here. The following elements were sought but not detected: Na, Ca, K, Ti, V, Cr, Cu, Si, P, S, F. Data were corrected using the PAP procedure of Pouchou and Pichoir (1984, 1985). The valence states for Mn and Fe and the number of O atoms, were determined by crystal-structure analysis prior to the final interpretation of the electron-microprobe results. The paucity of pure material prevented quantitative determination of H_2O. However, the presence of H as (OH) was confirmed both by crystal-structure analysis and powder infrared-absorption study; the formula was therefore calculated to give 23 (OH). The average of thirteen determinations and ranges and standard deviations are given in

***Table 1*. X-ray powder-diffraction data for arakiite.**

$I_{est.}$	dÅ$_{(meas.)}$	dÅ$_{(calc.)}$	*hkl*
100	12.07	12.089	002
100	6.046	6.045	004
10	5.463	5.422	$\bar{1}13$
20	5.262	5.255	113
15	4.764	4.756	$\bar{2}04$
30	4.119	4.114	020
90	4.040	4.030	006
10	3.952	3.943	115
5	3.822	3.826	312
10	3.648	3.664	023
5	3.572	3.561	220
5	3.496	3.487	$\bar{3}14$
20	3.404	3.415	206
		3.401	024
5	3.317	3.314	314
10	3.223	3.219	$\bar{3}15$
30	3.148	3.152	$\bar{4}04$
		3.147	$\bar{1}17$
70	3.030	3.026	224
5b	2.862	2.879	026
		2.847	$\bar{2}08$
5	2.799	2.801	316
5	2.749	2.753	$\bar{4}06$
10	2.700	2.693	130
20	2.631	2.635	$\bar{1}32$
5	2.594	2.599	422
		2.597	$\bar{5}13$
5	2.546	2.545	133
20	2.498	2.502	$\bar{4}24$
40	2.411	2.415	424
		2.411	$\bar{5}15$
15	2.372	2.370	$\bar{3}31$
15	2.338	2.341	$\bar{2}28$
		2.341	135
10b	2.291	2.292	515
		2.288	$\bar{4}26$
5b	2.237	2.234	408
		2.234	$\bar{3}34$
5b	2.157	2.161	604
		2.158	$\bar{3}35$
5	2.106	2.112	137
		2.105	335
		2.102	$\bar{6}06$
20b	2.065	2.062	517
10	2.017	2.017	$\bar{6}23$
5	1.905	1.907	$20\underline{12}$
20	1.859	1.857	429
15	1.810	1.810	608
		1.810	$\bar{1}3\underline{10}$
5	1.777	1.778	$\bar{2}2\underline{12}$
20	1.748	1.747	$51\underline{10}$
5	1.661	1.660	$\bar{5}1\underline{12}$
5	1.619	1.621	538
20	1.573	1.574	$\bar{2}2\underline{14}$
70	1.552	1.553	640
		1.553	$\bar{3}51$

114.6 mm Debye-Scherrer powder camera
Cu radiation, Ni filter (λ Cu$K\alpha$ = 1.54178 Å)
Intensities estimated visually; b = broad line
Not corrected for shrinkage and no internal standard
Indexed with a = 14.248, b = 8.228, c = 24.23 Å, β = 93.62°

***Table 2*. Compositional data for arakiite.**

	Weight %	*Range*	*Standard deviation*
ZnO	4.48	4.00–4.74	0.19
MnO	34.32	33.84–34.95	0.34
MgO	12.76	12.27–13.47	0.34
Fe_2O_3	6.76	6.32–7.16	0.27
Al_2O_3	2.25	2.02–2.47	0.14
As_2O_5	15.84	{23.00–24.2[1]}	0.38
As_2O_3	6.56		
H_2O[2]	[13.74][2]		
Total	96.71		

[1] Total As calculated as As_2O_5, then partitioned as $As^{5+}_2O_5$ and $As^{3+}_2O_3$ in a 2:1 ratio as determined from the crystal structure.
[2] Calculated assuming the formula derived from crystal-structure analysis.

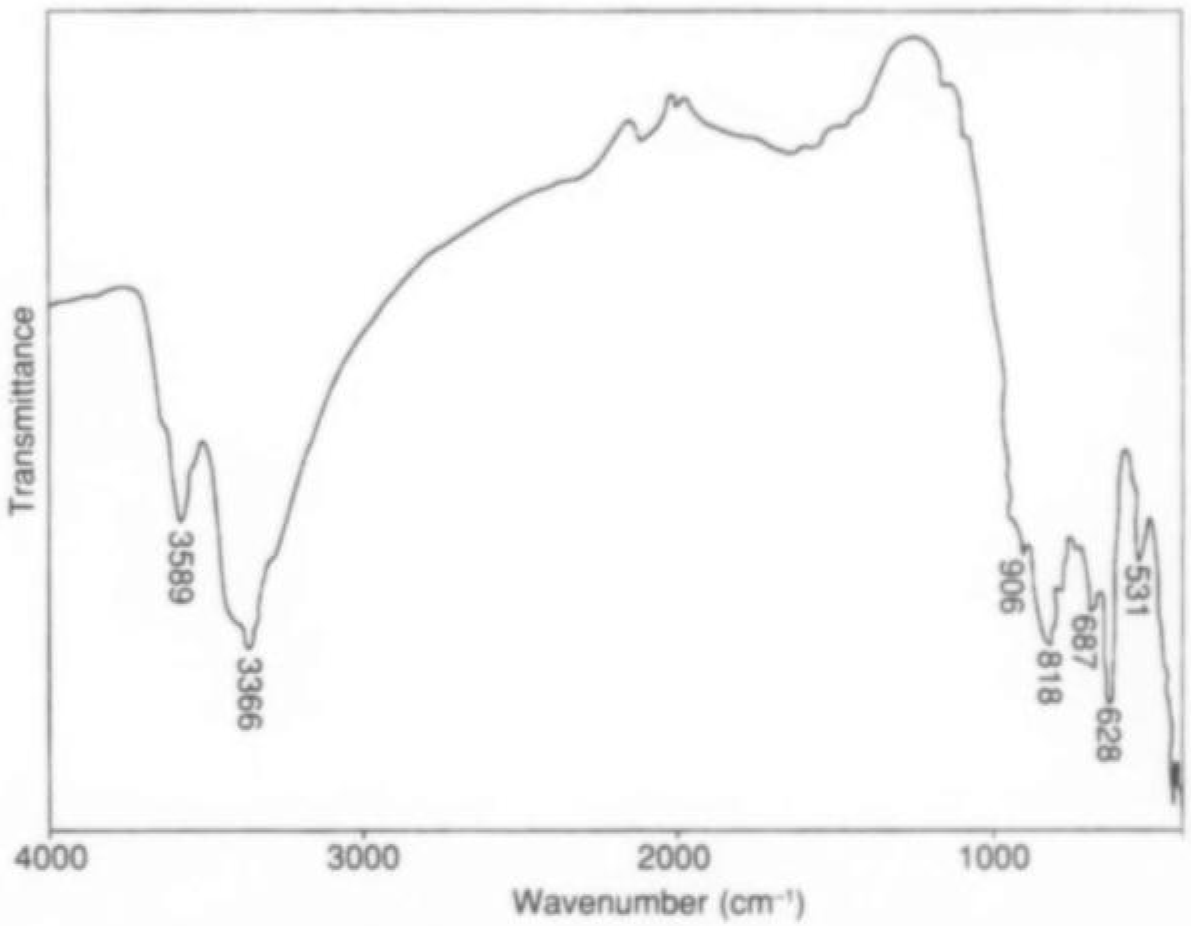

***Figure 2*. Infrared-absorption spectrum for arakiite.**

Table 2. Arsenic was initially quantified as As_2O_5, then partitioned as $As^{5+}_2O_5$ and $As^{3+}_2O_3$, in a 2:1 ratio as observed in the structural study. With 34 anions [O + (OH)], the empirical formula for arakiite is $(Zn_{0.83}Mn^{2+}_{0.17})_{\Sigma 1.00}(Mn^{2+}_{7.12}Mg_{4.77})_{\Sigma 11.89}(Fe^{3+}_{1.28}Al_{0.67})_{\Sigma 1.95}(As^{3+}O_3)_{1.00}(As^{5+}O_4)_{2.08}(OH)_{22.99}$. The idealized formula is $(Zn,Mn^{2+})(Mn^{2+},Mg)_{12}(Fe^{3+},Al)_2(As^{3+}O_3)(As^{5+}O_4)_2(OH)_{23}$ and the end-member formula is $ZnMn^{2+}_{12}Fe^{3+}_2(As^{3+}O_3)(As^{5+}O_4)(OH)_{23}$. Zinc is the key element which differentiates arakiite from hematolite. Both minerals have structures that are based on five close-packed repeat layers. Four of the five layers are topologically identical and only differ in cation ordering. The single distinctive layer involves tetrahedrally coordinated (Zn/Mn^{2+}) in arakiite versus octahedrally coordinated (Mn^{2+}) in hematolite. Full details of the structural similarities and differences between arakiite and hematolite have been published by Cooper and Hawthorne, 1999.

INFRARED-ABSORPTION STUDY

The equipment and procedures for acquiring the infrared-absorption spectrum for arakiite are identical to those used to obtain the spectrum of mcalpineite (Roberts *et al.*, 1994) and are not repeated here. The spectrum (Fig. 2) clearly shows absorption bands for (OH). Strong to medium-strong bands at 3366 and 3589 cm^{-1} are due to O-H stretching in the hydroxyl groups.

ACKNOWLEDGMENTS

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MINERAL STORIES

The Giant Chloritoid

by Wendell E. Wilson

Mineral shows can get long, especially for dealers who have to spend hour after hour in their booth or their motel-room shop. Sometimes, just to pass the time, they challenge each other, test each other, or work some other kind of mineralogical mischief against each other . . . all in fun, of course.

The following incident took place at the Denver Show in 1998, in the Holiday Inn (Marty Zinn's *Colorado Mineral and Fossil Show*). It revolved around a remarkable specimen brought to the show by dealer Herb Obodda: a single, hexagonal-tabular, silver-dollar-size crystal of blackish-green chloritoid, probably the largest such in the world. It was certainly unlike anything I had ever seen.

Another mineral dealer, Danny Trinchillo, had been chatting with Herb in his room; Danny allowed that, having been a mineral dealer for some years now, he (Danny) was getting pretty good at identifying minerals. In fact, Danny felt quite confident of his ability, and of how unlikely it was now that he could be fooled or surprised, at least for very long.

Herb reached for the giant chloritoid, kept in a closed, cotton-lined box about the size of a cigarette pack, held shut with a rubber band.

"I've got a really good specimen right here," said Herb. "Do you think you could identify it?"

"Well," said Danny, "I might have to check a book or two but, sure, I could identify it."

"Okay," said Herb, "but let's make it interesting. If you correctly identify it, I'll sell it to you for $1500, which is half of what I was going to ask for it. But if you *can't* identify it within 60 minutes, you owe me $1500 cash. What do you say?"

Danny thought about this for a minute; being a sporting (and confident) fellow, he said okay.

Herb handed the box over to Danny; Danny opened it and took out the specimen. He had never seen anything like it. Oh-oh.

Leaving the specimen with Herb, Danny rushed out of the room to search for reference works. Out in the hallway he bumped into an exemplary one: Marcus Origlieri, a brilliant young college student with an encyclopedic knowledge of mineralogy.

"What is that big, green, hexagonal crystal plate in Herb's room?" asked Danny.

Marcus sensed some fun here because (a) Danny seemed a little desperate, and (b) for some reason, Herb wasn't telling Danny what the specimen was.

"Well . . ." said Marcus, "What's it worth to you?"

"Hundred dollars?" said Danny, pulling out a hundred dollar bill and sticking it in Marcus's hand.

"Chloritoid," said Marcus.

"Hah!" said Danny.

Back in Herb's room moments later, Danny correctly identified the specimen and walked off with his prize, still owing Herb $1500.

The next morning in the hotel restaurant, some people including Joel Bartsch (curator at the Houston Museum), Dave Wilber (curator for the Freilich Collection) and others were sitting around a table sipping their coffee and waiting for breakfast. Enter Danny, who came over and proudly related his little victory to everyone. As they all chatted, the box with the crystal in it was passed around for all to admire.

The specimen was finally passed to Joel Bartsch, who studied it a moment, then noticed that no one was really paying attention to him at that moment. On a mischievous impulse he palmed the crystal, then replaced the lid on the box, secured the empty box with the rubber band, and casually passed it back to Danny.

Danny gave the box a little shake and heard the expected faint rattle from inside, assuring himself that the crystal was still there. (Actually it was only the stiff cardboard label doing the rattling, but Danny failed to realize this.) He slipped the box into his pocket.

Joel was now wondering what to do with the pilfered crystal. As Dave Wilber looked the other way in conversation, Joel slipped the world's largest chloritoid crystal *into* Dave's coffee cup!

Dave periodically sipped from his cup, unawares; whenever it seemed the coffee level was getting so low that the crystal would soon become visible, he would always reach for the coffee pot and refill his cup, much to Joel's relief!

Good thing chloritoid is not soluble in hot water, or (worse yet) soluble and *toxic*. But, being a silicate, it rested inertly in the hot coffee.

Finally Danny prepared to leave and Joel figured it was time to resolve the situation.

"You know, I'll bet that's not the only chloritoid crystal that nice," said Joel. "If I were to find one that good, if I just pulled one out of Dave's coffee cup, for example, could I keep it?"

Danny frowned. He felt the box in his pocket and gave it a little rattle, just to be sure. Mystified, he finally said, "Sure, yeah, you could keep it."

Delicately, Joel reached a thumb and forefinger into Dave Wilber's coffee and, to the wonderment of all, came up with the chloritoid crystal!

Danny, incredulous, opened his box and found only the cotton and the cardboard label inside. He'd been had, fair and square, and he knew it. Being a good sport, he conceded ownership to Joel.

Joel, of course, had no intention of taking unfair advantage of Danny. So he graciously donated the crystal back to Herb, in lieu of the $1500 owed by Danny. Even Marcus gave Danny his hundred dollars back. And so, in the end, everything was as it had started out: Herb had the giant chloritoid back, and no one owed money to anyone.

The crystal itself, still the finest known example of its species, was shortly thereafter acquired by Dave Wilber for the Freilich Collection. After Dave nearly swallowed it with his coffee, I guess Herb decided he deserved first chance to buy it.

Surprise Crystals

by Art Smith

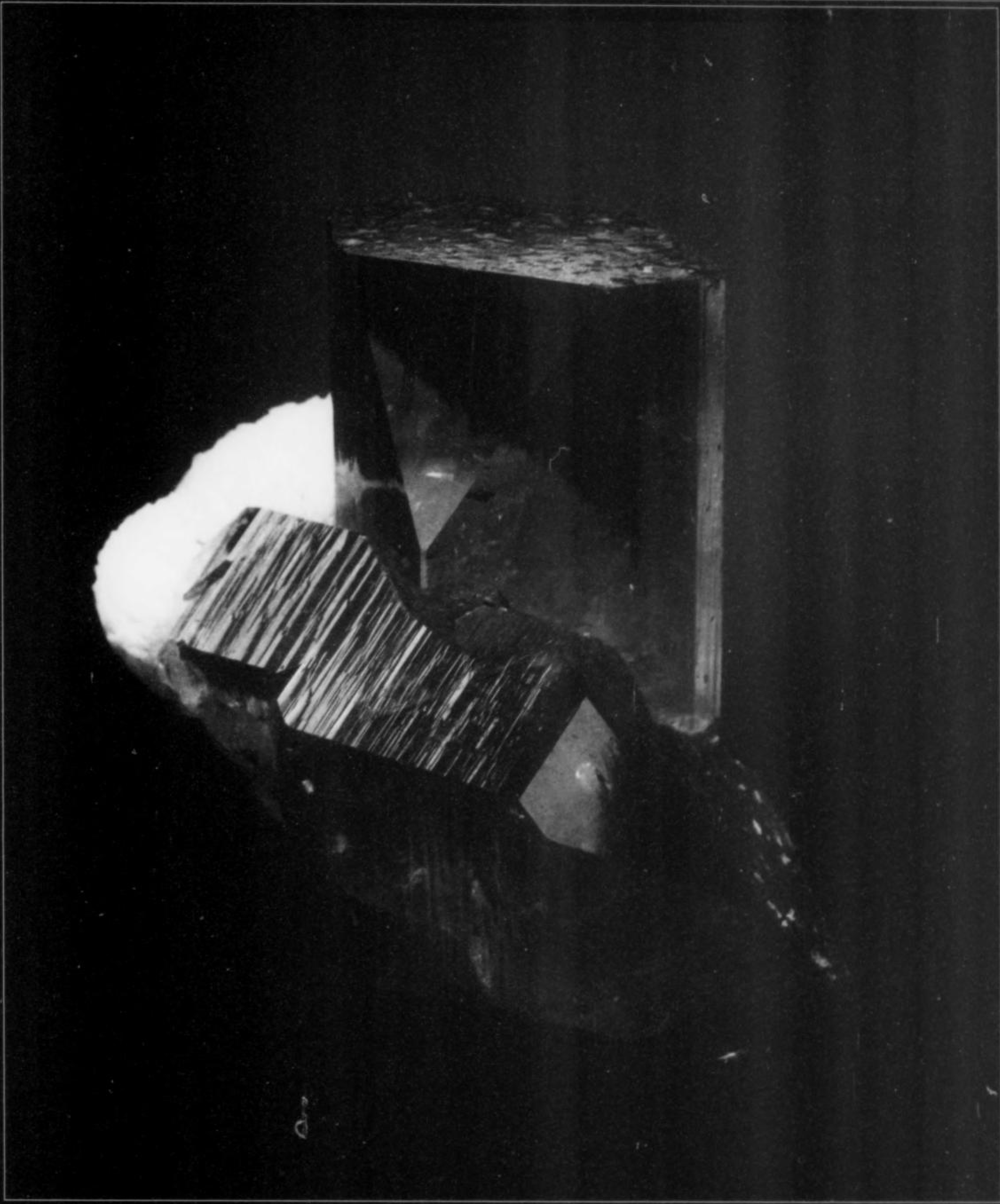
In the early 1970's I was introduced to the Red Mountain Pass area between Ouray and Silverton in the San Juan Mountains of southwestern Colorado by Tom Rosemeyer. We collected at the National Belle mine, situated at the former town of Red Mountain. Lustrous, well-formed microcrystals of enargite occur in small vugs with limpid quartz crystals, dickite and pyrite. At that time numerous specimens could be easily collected from the lower dumps.

After a few collecting trips I had trimmed out enough material for my collection plus additional material for swapping. The untrimmed surplus was labeled and confined to a flat in the garage. Flats like this start on the top of the stack but, if not retrieved, soon end up on the bottom. Evidently this flat reached the bottom and stayed there for a while.

The National Belle matrix is not very stable in the humid climate of Houston, Texas. Ten years later, when I finally needed more micro material, the flats on top were removed. The flat containing the National Belle specimens still had a front but the rest had completely deteriorated, and the specimens were sitting in a mixture of partly disintegrated paper, boric acid (to kill roaches), and mouse and roach droppings. As I blew the crud off one specimen I noticed some tiny, bright blue crystals and some larger bright white sprays in some cavities. There was nothing like them in my collection. How did I miss seeing them? I rushed them to my microscope.

By the time I had examined the third specimen containing these crystals I had come to the realization that they had formed during storage and had not been there before. I had grown my own crystals! My initial euphoria quickly faded and I realized they were not truly minerals. I procrastinated a little about their fate. Should they be analyzed? No, they are not really what I am interested in. So the whole lot was chucked without even one going into my collection.

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.*



Topaz on Quartz, Gilgit, Pakistan. 6.8 cm

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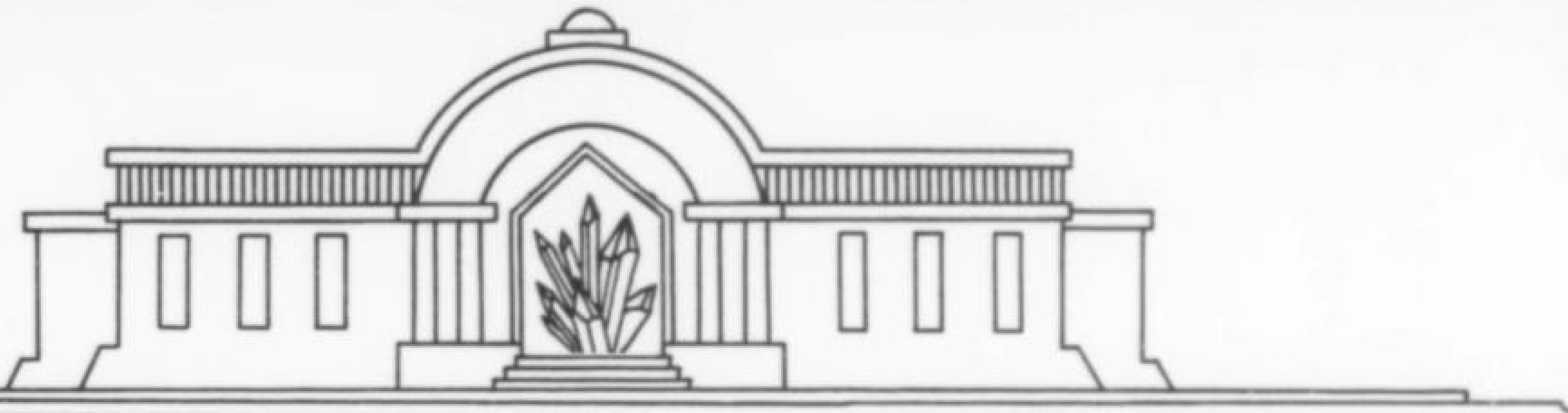

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Fax: (505) 835-6333
Associate Curator: Robert Eveleth
Tel: (505) 835-5325
E-mail: beveleth@gis.nmt.edu
New Mexico Tech,
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Specialties: New Mexico minerals, mining artifacts, worldwide minerals

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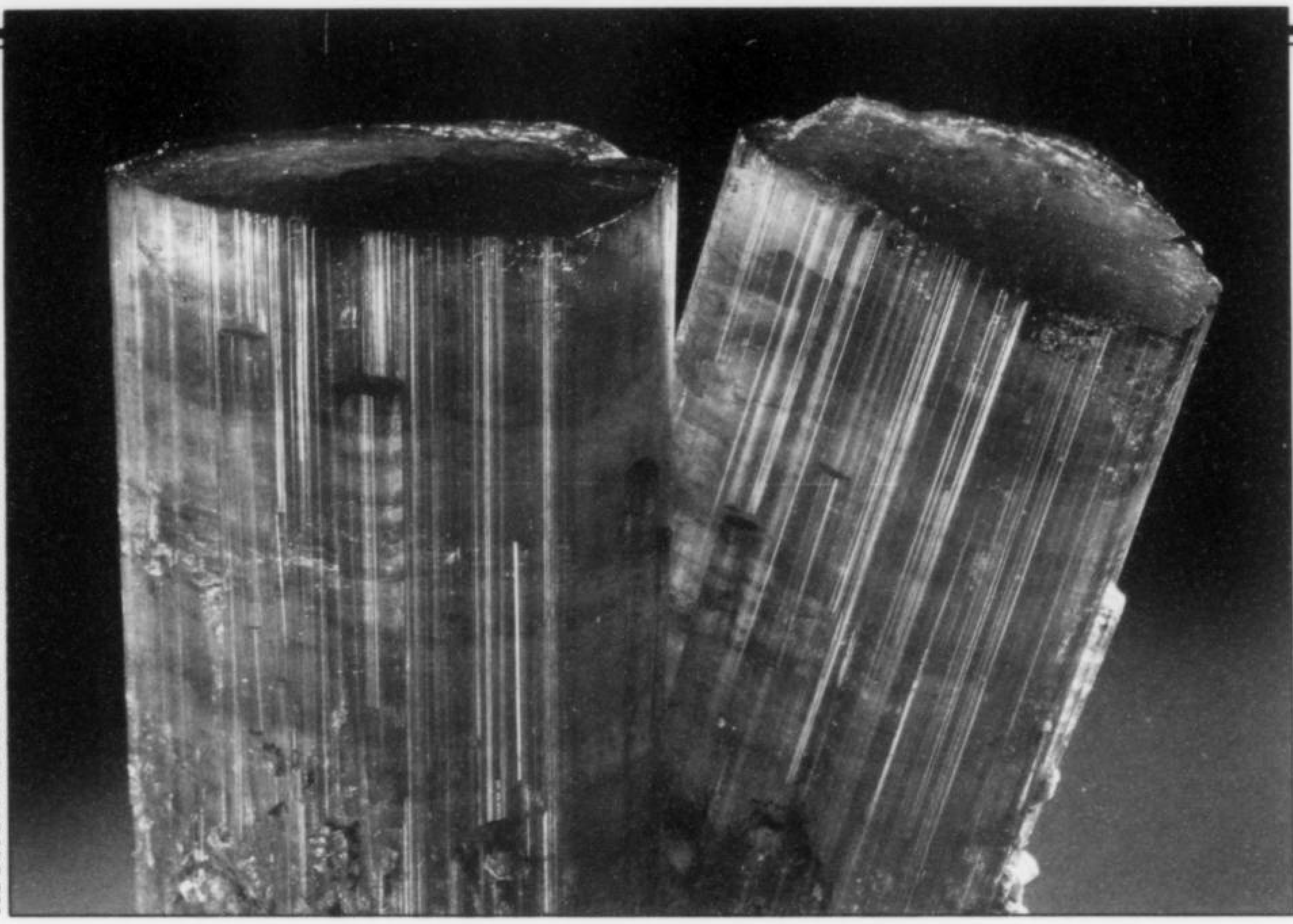

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Specimen=16.5 cm

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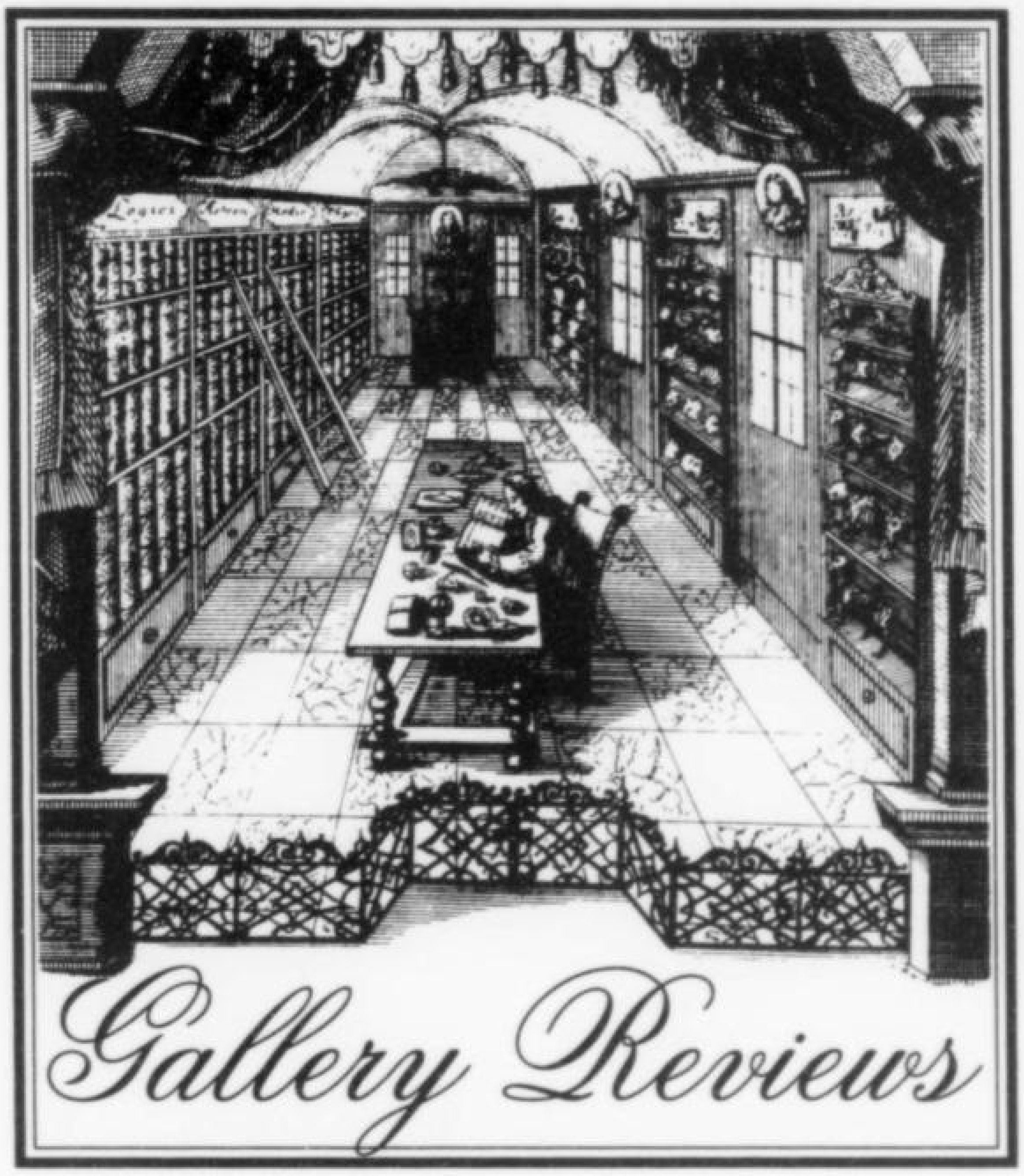


The Smithsonian's Janet Annenberg Hooker Hall of Geology, Gems and Minerals

by **John S. White**

This quite new mineral and gem gallery (opened September 1997) merits many compliments. Before proceeding with those, however, an admission is in order, in the interests of full disclosure. The reader must be told that I have long been associated with the Smithsonian and was, in fact, curator-in-charge of its mineral and gem collections when I retired in 1991. All I can say against the possible charge of bias is that I have done my best to produce a review that is fair and balanced. In fact, it is not based solely upon my own reactions. I have purposely invited comments from numerous friends who have also critically assessed this gallery; most, but not all, of them are involved with minerals either professionally or as collectors. With the exception of a relatively minor number of specific criticisms, the overall reaction has been enthusiastically positive.

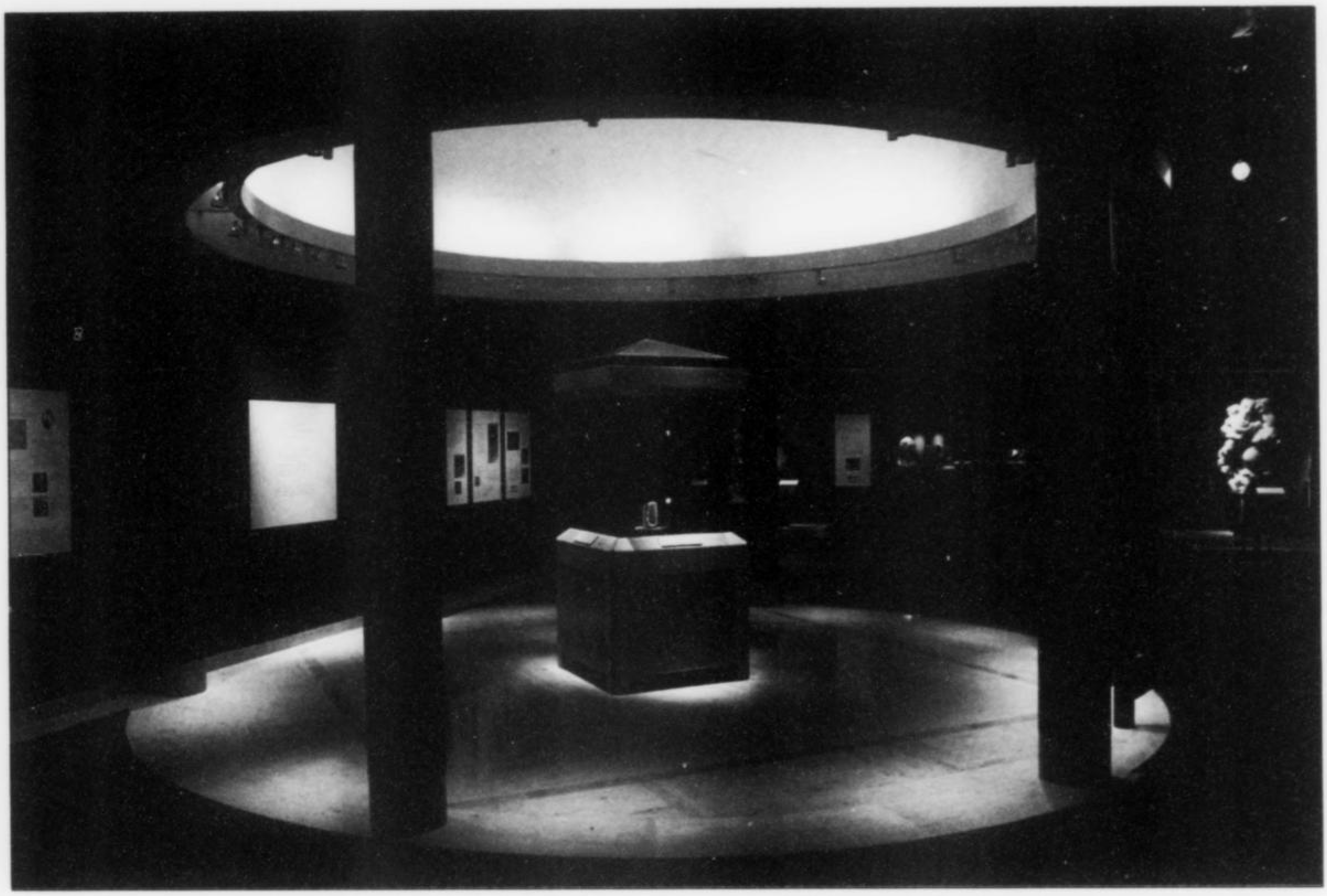
Conflicts having been addressed, let us now enter the *Janet Annenberg Hooker Halls,* named for a philanthropist who had earlier donated many exceptional pieces of jewelry featuring extraordinary gemstones, and who more recently contributed major financial support for the creation of this exhibit. The first room off of the rotunda is the *Harry Winston Gallery,* named for the famous New York gem dealer whose research foundation also contributed funds toward its construction. This large room was designed to accommodate the immense crowds which come primarily to see the Hope Diamond. It is a light and airy room, and I found it welcoming, although others found it a waste of space. The world's most famous diamond sits in an elegant freestanding display case near the center of this large space, enabling far more visitors to view it at one time than was possible before. The Hope shares this room with four very large and mostly dramatic natural history objects that are decorative (three out of the four, at least) and intended to be suggestive of what lies beyond. These are the "Tucson Ring" meteorite, a sandstone concretion from France which is quite wonderful, an immense sheet of natural copper from Michigan, and a perfectly meaningless large group of mediocre, badly damaged quartz crystals from near Karibib, Namibia, for which the museum is alleged to have paid approximately $60,000! Vastly superior quartz specimens can be obtained in Brazil for as little as a few thousand dollars. A minor design problem made itself apparent here and that is the labeling of all five objects. The labels are made of highly reflective ceramic (designed to resist wear) of a light tan color upon which the information is printed in coffee (with cream)-colored type so there is not enough contrast. With spotlights reflecting off of these labels, they are difficult to read.

From this area the visitor may venture either left, thus entering the geology and meteorites gallery, or right, where one finds a roomful of gems, beyond which begins the mineral gallery. I chose the course to the right; the geology and meteorites portion will not be covered in this review, even though after a cursory examination it appears excellent.

The gems room, or "Treasures from the National Collection," is an inviting, relatively large and square space done up very much like an upscale jewelry store, and most effective it is, except that the very first pair of objects encountered, a necklace and a bracelet, hardly qualify as "treasures," at least by Smithsonian standards. Their presence in this exhibit presents a riddle, the answer to which is likely more political than pertinent. Next to these anomalies, however, we see the real stuff: in squarish wall case after squarish wall case, some ten in all, are wonderful gemstones, mostly set in exquisite jewelry. The cases are appropriately uncrowded, each having only a small number of objects in it. This is made possible because the greater part of the faceted gems in the collection is distributed among the minerals in the next room. Especially gratifying is the fiber-optic lighting used for these cases: the best lighting of gems that I can ever recall seeing in a museum. The ends of the light fixtures are visible to the viewer because they are very close to the objects, but what they do for the beauty of the gems is so astounding that one appreciates, rather than objects to, their presence. They are in no way offensive, to me, at least. Here, superb lighting is accompanied by excellent labeling, very easy to read and not overly wordy. Each case is titled, with names like: *Celebrity Gems, Rubies and Sapphires, Stars and Cat's Eyes, Jade* (just four exquisite pieces), *Emeralds and Aquamarines, Diamonds,* and *Janet Annenberg Hooker Gems* (the latter all donated by the woman for whom the gallery has been named). In the center of the room is a large peninsula-case containing two immense gem-quality topaz crystals, some interesting and very large faceted topaz objects, and the Smithsonian's exceptional flawless quartz sphere (12.9 inches or 32.7 cm in diameter). These few oversized objects provide a fine contrast to the jewelry and gems.

Buoyed-up from the sheer *grandeur* of the "Treasures" room one turns with high expectations to the next portion of the gallery, the minerals. No one is apt to be disappointed, at least so far as the visual impact upon entering this, the largest and longest continuous section, is concerned. On the left is a large floor-to-ceiling three-dimensional hologram of the crystal structure of halite, a very effective device for giving the visitor a sense of looking inside an immensely magnified crystal. To the right are a modest number of introductory crystallography cases with explanations of crystal structure and symmetry—just about the right amount. The subject is introduced, but not belabored.

From this point on are primarily mineral specimens and cut stones upon which to feast one's eyes. Down the center are a series of island cases, the largest of which is floor-to-ceiling. The others are clusters of simple geometric bases with glass tops in which are displayed small numbers of mostly large, mostly flashy specimens.



Harry Winston Gallery. The Hope Diamond is in the free-standing case in the center.

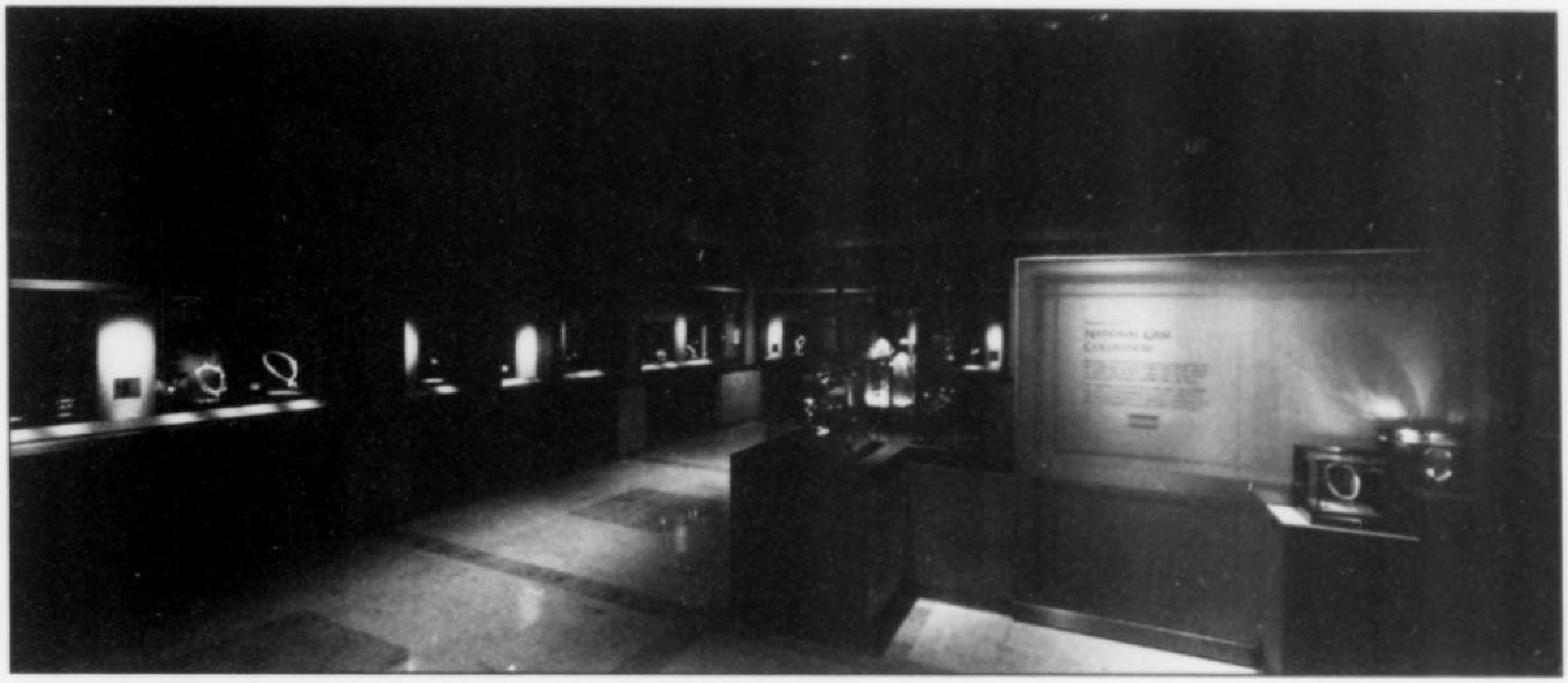
Along the sides of this long corridor are continuous floor-to-ceiling cases containing a higher density of specimens grouped according to some particular common thread or theme. These wall cases are divided into a series of "alcoves" by angular cases which break up the monotony, providing distinct units for separating different topics. The overall strategy in this part of the gallery is to offer the visitor something like a "fast track" and a "slower track." The former occupies the center of the corridor and focuses on larger, more spectacular specimens with little or no text to slow anyone down. This was done with the folks in mind who just breeze through the place, glancing here and there at specimens that may happen to catch their eye. The slower track on either side is intended for those who wish to stay longer and perhaps learn more. One can debate the effectiveness of this scheme, but I feel that it probably works better than any other I have observed. Overall the Smithsonian has done a very good job in developing it.

For those who take the time to notice, the slightly didactic cases down either side of the hall are arranged as follows. On the right are a series of displays relating to crystal shapes; and on the left a series relating to mineral colors. These are nicely done and include such groupings as: *The Many Faces of Crystals, One Mineral/Many Shapes* (pyrite, then calcite, then wulfenite), *Mineral Rainbow, Colored by Copper, Colored by Impurities, One Mineral/Different Impurities* (beryl, then fluorite), and *One Family Many Colors* (garnets).

Next, on the right side, one finds a series of alcoves given over to mineral chemistry, at least in that the minerals are grouped as (1) silicates, (2) phosphates, arsenates, vanadates, sulfates and halides, (3) carbonates, borates and oxides, and (4) sulfides, sulfosalts and native elements. I think I would have reversed the order. The large island case in the middle of the floor relates to the side cases and contains much of the same sort of thematic presentation, first *From Two Elements*, referring to the diversity of minerals that contain the elements silicon and oxygen. This is, unfortunately, a bit misleading because all of the examples are silicate minerals containing other elements in addition to silicon and oxygen and therefore are composed of three or more elements. The rest of the case is filled with quartz and silicate minerals, grouped under the headings *All One Mineral* (quartz), *Silicate Family*, and *Diversity—Quartz*.

On the opposite wall the next set of alcoves deals with specific mineral groupings, the names of which are: *Multicolored Minerals* (trichroic minerals such as the kunzite variety of spodumene and tanzanite, the gem zoisite), *Amazing Gems* (feldspars, then optical effects in agate, then "alexandrite"), then *Stars and Cat's Eyes*, then *Opal*, then *Diamond*, then *Calcite*, and then *Rare Minerals*. Other individual units include groups of specimens selected to illustrate topics such as the minerals of Tsumeb, the traprock minerals of India, geodes, inclusions in crystals, crystal growth, pegmatite minerals and new acquisitions. There are others, but those mentioned are probably sufficient to allow the reader of this review to derive some sense of how the whole thing is organized.

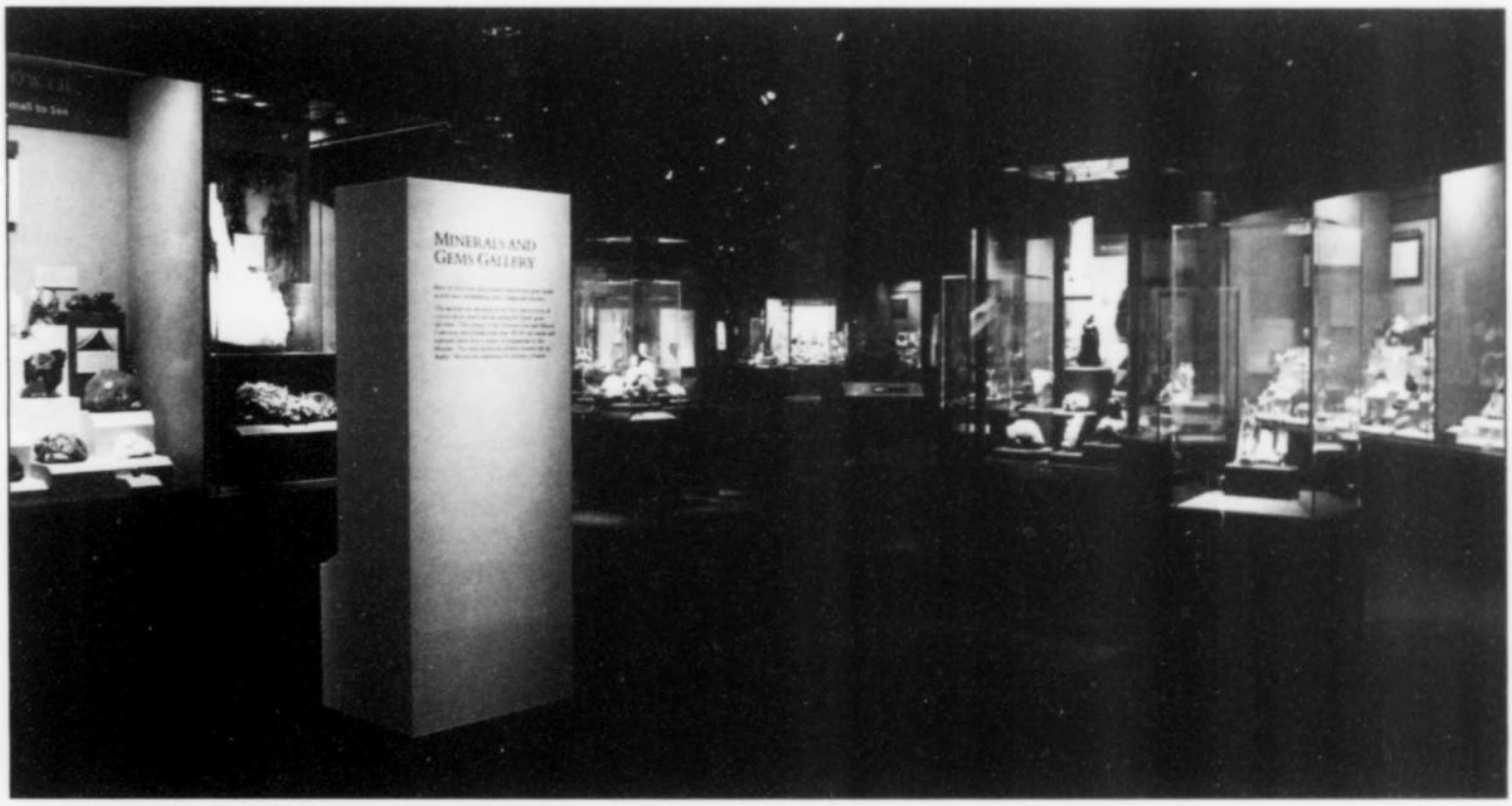
At the very end of this particular segment of the exhibit one finds a high concentration of crystals of what are largely gem minerals, with many faceted gems of the same species dispersed among them, plus a reconstructed Herkimer (New York) quartz pocket (representing an extraordinary collecting effort by John Medici and his sons and an outstanding reassembly by the Smithsonian, but positioned too low for most viewers), and a reconstructed and



The National Gem Collection portion of the new exhibit hall.

somewhat idealized pegmatite gem pocket (the best of these that I have seen). Off to the side, appearing almost as an afterthought and in far too much darkness, are three of the finest gem elbaite matrix specimens one could ever hope to see, two from California and one from Brazil, all lined up in a row. These really should have greater prominence, as they are truly stunning specimens.

Midway through the hall is a video screen that displays a continuous short narrated film explaining why rubies are red. It is well-done and relatively unobtrusive, and is the only such audio-visual device employed in the entire gallery, thank you! There are, however, three computer-interactive stations in the new hall, two in the mineral section and another further along (plus some more in the unreviewed geology hall). On one of these you can manipulate virtual mineral crystals in three dimensions to learn about symmetry elements. Another deals with pegmatites and includes an animation about how pegmatites form, a video on pegmatite mining, and a virtual image of the recreated pegmatite pocket in the hall, which can be explored in detail. The third one, called "Mining a Car," is in the last section and allows the visitor to discover the many minerals needed to produce the materials used in building a typical automobile. Reaction from the non-collector of minerals is that the first two are pretty weak and could easily have been omitted. But they probably do not tie up traffic too much as they are not all that captivating, so they won't detain visitors for very



A portion of the Minerals and Gems Gallery, so-named because gems are dispersed throughout among the mineral specimens.

long. "Mining a Car" is better. On the downside for all of them is that they tend to break down from time and time and appear to represent a maintenance problem for the audio-visual people. My own philosophy with respect to the use of interactives is that their number should be inversely proportional to the excellence of the collection drawn upon for the exhibit. In other words, they are a reasonable substitute when fine specimens are lacking.

For my taste, the minerals portion of the hall is breathtaking. The lighting, with a few exceptions, is excellent. The hall itself is a bit on the dark side but there are so many display cases that the ambient light on the floor is just about right. I do not like halls that are *too* dark. Most of the specimens are quite adequately illuminated through the use of unobtrusive spotlights in the ceiling for the island cases, while the wall cases are lighted internally, using a combination of spot and projector-type tungsten metal halide lights and filtered fluorescent tubes "for uniform case wash." I was never aware of any unfortunate "shadowing" where I came between the spotlights and the objects in the island cases. Some fiber optics are used for special effects but they are minimal in number.

The extraordinary richness of the collection is never in doubt for, apart from the spectaculars in the small island cases, there are 60 individual thematic display units in this section over a length of 133 feet, and each is filled with unbelievable crystals and gemstones; some sparsely occupied, but most containing just about the right number of specimens so that they do not appear too crowded. Most of the minerals simply sit on flat surfaces. Those that need support are held up by unobtrusive metal claws attached to rods inserted into holes in the base. The lateral cases have groups of tiered blocks of different elevations. A specimen sits on top of each of these and its label information is printed onto the block nearby. Those on the right are painted a light off-white color and the label type is dark, making it very easy to read. Unfortunately, this has been reversed on the other side: dark gray base-paint with light-colored type, making these much more difficult to read.

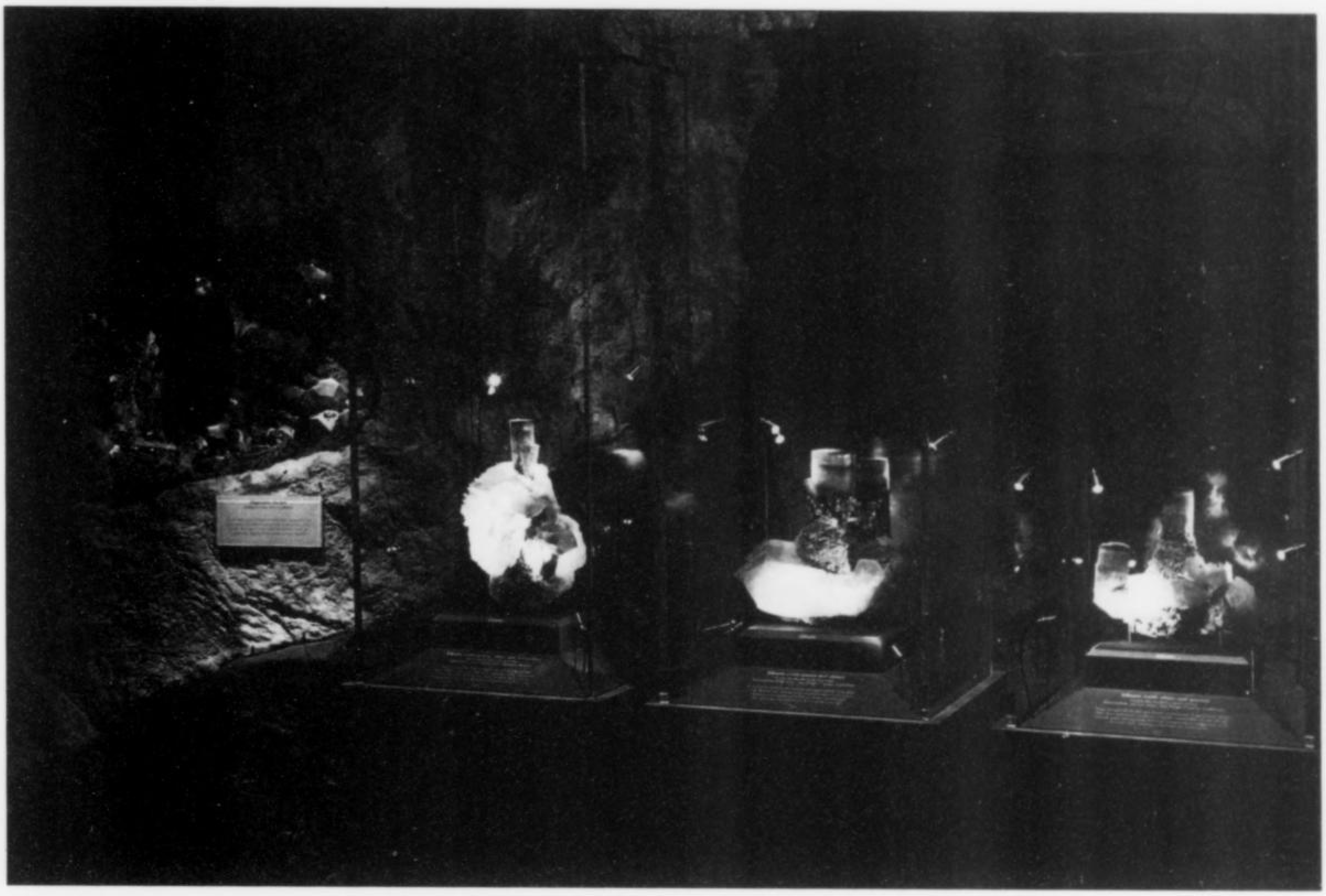
There is still another room beyond this one. Here, in the *Mines Gallery*, the museum has attempted to create a sense of being underground in a mine, complete with the sound of dripping water. Financial support for this gallery was provided by "Member Companies of the National Mining Association," as stated on a mounted plaque. Within the various tunnel branches are window display cases featuring suites of superb minerals that have been found in the United States mines represented here, which are: the Fletcher mine, Vibernum, Missouri; the Morefield mine, Amelia County, Virginia; the Copper Queen mine, Bisbee, Arizona; and the Sterling Hill mine, Ogdensburg, New Jersey. The minerals for the latter mine, as might be expected, are the remarkably fluorescent ones for which this mine is famous, and this display well-satisfies the needs of those who expect to find fluorescence illustrated in a museum. The museum's exceptional gold specimens are also found here, all in one case, but somewhat underlit. Their brilliance seems diminished, as they do not appear as spectacular now as in their former home, a large and brightly-lit vaultlike display case. Just the same, this final portion of the mineral gallery is most effective and admirably executed.

The Minerals and Gems Gallery; the gold case is seen in the distance.

The visitor may then continue on in essentially the same direction to enter the *Rocks Gallery*, the beginning of the geology hall but not, as mentioned, covered in this review.

Let me be unequivocal about this: I really love this mineral gallery! I can think of no other that I have seen that I would rank close to it, with the possible exception of the American Museum in New York, but I have not been back there for a very long time so it is difficult to compare them. One might well argue that, with such a superb collection as the Smithsonian has, it would be hard for the gallery to fail, and there is some truth in that idea. However, fine minerals or not, the educational level of the not too ambitious script is exactly where I feel it should be. Throughout the gallery there are lots of teasers, little educational "sound bites," but no long and tedious, overly esoteric, text. Therefore, from just about every perspective that matters (themes, specimen selection, labeling, lighting and dramatics) the gallery is an overwhelming success. Merely standing at the beginning of the minerals section and letting your eyes take in as much of the hall as you can see, is a stimulating experience. Colorful and sparkly crystals beckon to you the entire length of the hall. They invite you in and promise visual gratification. It is a little like one's fantasy of what a crystal-lined cavity in rock might look like.

All of this is not to say that there are not some unfortunate problems. I wish this were not so, but it is; yet all should be easily correctable. I hope that the museum will be able to attend to many of these shortcomings in due course. One terrible reality about



Three wonderful elbaite specimens all in a row!

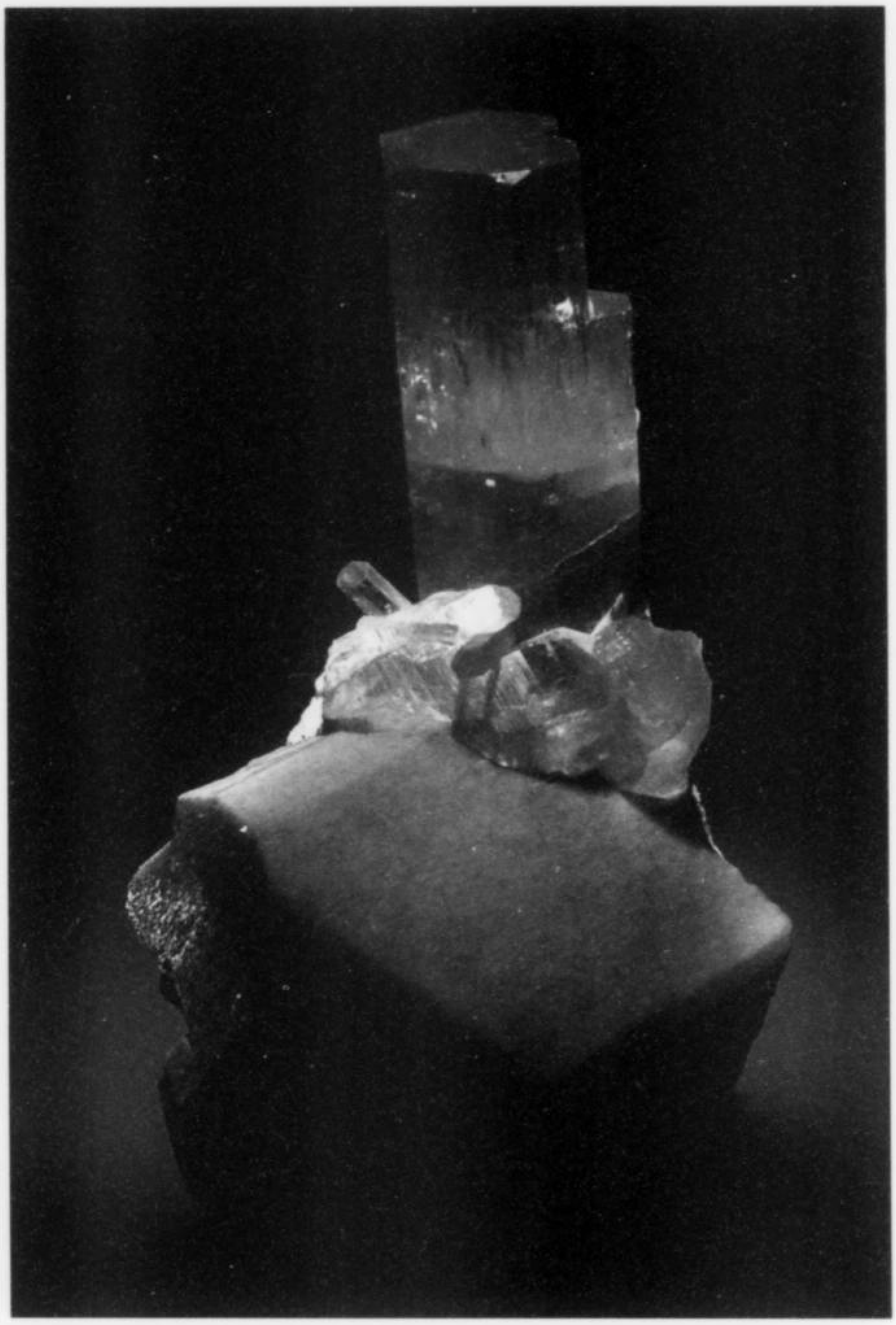
large institutions is that they usually do not have the flexibility to *instantly* (by that I mean in a few months) revise newly opened galleries when problems are first identified. Perhaps this is something that should be anticipated when new galleries are being planned, and should be budgeted for. In this case, those who can attend to these matters are now committed to other projects and will not be available for change-making in the mineral gallery for quite a while, probably years.

The most serious problems are maintenance ones: excessive dust entering unsealed cases and the frequent burning out of light bulbs, plus overcrowding of the hall by visitors. The maintenance problems demand daily attention and, due to the extreme value of the objects displayed and the fact that the cases must be opened in order to service the lights, the responsibility for maintenance must, therefore, fall to mineralogy staff members who can be trusted to enter the cases. A very real fear is that sometime in the future this regular attention will diminish or, worse, will be delegated to museum maintenance staff who should not be given access to the objects in the exhibit. It is indeed unfortunate that the design did not do more to minimize the development of this potentially disastrous situation.

Overattendance is also a big nuisance. The mixed blessing that the Smithsonian lives with is that its great popularity brings in huge numbers of visitors, something that museums welcome, but the big crowds are not easily accommodated in the narrow and linear exhibition halls. There is nothing, really, that can be done about this short of replacing the building, and that is unlikely to happen. If you want to be able to fully appreciate the most that this gallery has to offer, plan to arrive as early as possible (10:00 a.m.) before the place fills up.

Lesser problems observed include such things as objects in some display cases, and even entire cases that are not adequately lighted. In particular I noted the trichroic spodumene (kunzite) from Brazil wherein, regrettably, only two of its exceptional three colors can be discerned, and the trichroic gem zoisites (tanzanites) which are so abominably lighted that their rich colors cannot even be guessed at. The "What's New" case, with six specimens that are supposed to be newly acquired, suffers from poor lighting as well. Actually the pieces aren't all that new and they are, with perhaps one exception, so mediocre that it is probably just as well that they are sitting in semi-darkness. It seems to me that new acquisitions ought to be showcased; they should be considered "bragging pieces" and ought to be especially well-illuminated, and they should also truly be current. If a museum decides to incorporate a "New Acquisitions" display unit in its gallery, then it should be prepared to update it regularly. One of the Smithsonian's "new" acquisitions in this case is an indifferent calcite twin from the prolific Rudnyy (or Rudnii), Kazakhstan, locality. There must be a thousand collectors who own better examples!

Another problem for the average viewer is that many specimens feature two or more quite prominent minerals, yet the labels will name just one. If both are named, such as the blue topaz crystal under a blanket of lepidolite, the viewer has no way of knowing which is topaz and which is lepidolite. A slab of charoite, for example, contains four prominent minerals, so how does the viewer know that charoite is the purple one? This problem occurs with far too many specimens and should have been anticipated. In the cases along the sides of the gallery where minerals are on rows of blocks of varying heights, there is no break of any kind to help one to distinguish various chemical groupings, so there is a lot of



Beryl with microcline, Shigar Valley, Dasu, Northern Area, Pakistan; 23 cm.

spillover. Thus, one finds arsenopyrite, kermesite, krennerite and others under the heading Native Elements. This same sort of spillover problem arises with the halides/sulfates/phosphates and vanadates, where species that do not belong to a certain chemical group are positioned under that group's label. In the quartz varieties case the sardonyx cabochons are obviously dyed, yet the label does not so state. One freestanding case contains two superb spodumene crystals, a green one from Brazil and a pink one from California. The identifying information for both has been printed on one label, but there is no way the visitor can match these with the appropriate crystals.

The artist who did sketches to supplement some topics could have used closer supervision. There are, for example, a number of drawings of basic crystal forms, but these are often so distorted that at least one-third of them do not closely resemble the forms they are supposed to represent. The worst is a hexagonal tablet, very thin, that is labeled a "trigonal prism"! The natural crystals that are intended to accompany this drawing are vanadinite, a mineral that does not produce trigonal forms. The drawing of a "tetragonal prism," which is actually the combination of a prism plus the pinacoid, looks exactly like a gypsum crystal which is, of course, monoclinic. I also found a drawing of a pair of Japan-law twinned quartz crystals but, for some reason, the pair are enantiomorphs; that is, one is a left-handed crystal and the other is a right-handed crystal. Now, this is not impossible, but it is an extremely rare phenomenon and one which I am certain the artist did not intend to draw. Further, the angle of the twin is shown as 84°, while the actual Japan-law twin angle is 84°33′ which is enough of a difference to matter. In the same case about twinning, there is a quartz "gwendel" [*sic*] and a pair of microcline specimens, one of which is a Carlsbad twin and the other a Manebach twin, yet the labels state that they are both Carlsbad. The purpose, I am quite sure, for selecting this pair was to illustrate the two common twin-laws of feldspar. Still another mistake in this case: there is a label which reads "the calcite specimen below," yet there are eight calcite specimens beneath this label.

There is a case dealing with inclusions of one mineral in another, and among the examples is a section of a quartz crystal from Brazil with black inclusions of "elbaite." Actually they are schorl. Another quartz crystal, this from Mexico, is stated to contain rutile; but the inclusions are hematite. Opposite this is a matrix specimen of topaz that has been repaired so sloppily that great gobs of glue are visible at the base of one topaz and some red material is incorporated into the glue, looking like the most amateurish repair job I have ever seen.

There are altogether too many errors; but many of these are, admittedly, often of a more technical nature and most are problems that the "great unwashed" will be totally unaware of, or indifferent to. Still, I think they should be mentioned because they do detract from an otherwise extraordinary effort—some credit for which must, in all fairness, be given to the excellence of the Smithsonian's remarkable mineral and gem collection.

Comparison with the Former Gallery

Just a few comments here will note some of the things that have changed and others that have not since the minerals and gems exhibit was redesigned. Of course, the character of the new gallery and the lighting are altogether different, and vastly better, in my opinion. The older one, like almost every other everywhere in the world, followed a very sterile format, the meaning of which was largely lost on the public. The minerals were arranged by chemistry throughout, beginning with the native elements, then sulfides, etc. This meant absolutely nothing to most of the visitors, and today you will see that the more progressive institutions have abandoned this format altogether. This arrangement did lead to the display of a greater diversity of species, however, because it created space that had to be filled and there were only so many specimens of the more dramatic crystallized minerals that could be used. The elimination of many of the rarer species from the current exhibit is something that nettles some mineral collectors, mostly locals, but they must remember that the exhibit was not created with them in mind. They constitute an infinitesimal portion of the target population so their desire to find specimens of minerals that simply are not very interesting to look at cannot be allowed to dictate specimen selection.

In the old gallery there were approximately 3,300 specimens on display, including 2,300 minerals and 1,000 gems. Included in the former were more different species than we see now, but there is no count of how many there actually were. Today, there are 2,450 specimens, including 548 gems. Approximately 600 species are represented, which is quite good coverage.

The area of the new gallery is almost exactly the same as the old, approximately 9,000 sq. feet. Its configuration is dictated by the long and narrow space it occupies and that, of course, has not changed either, except for the Winston Gallery where the Hope Diamond now sits. This is new floor space created through innovative reconstruction of what used to be open space between galleries.

Estimating costs is always difficult and the usual practice is to include only those that would not otherwise be incurred, such as staff salaries, which includes all of those people permanently employed by the museum who participated in the effort in some capacity. There are usually modifications to the building as well, and these probably ought not to be included either. A pared-down estimate for just the mineral, gem and mine portions of the new gallery cannot be established but the entire Hall of Geology, Gems and Minerals is estimated to have cost about $18 million, some $11 million having been raised from donations and another $3 million representing "gifts in kind," such as computer interaction with accompanying hardware and software.

Compromises

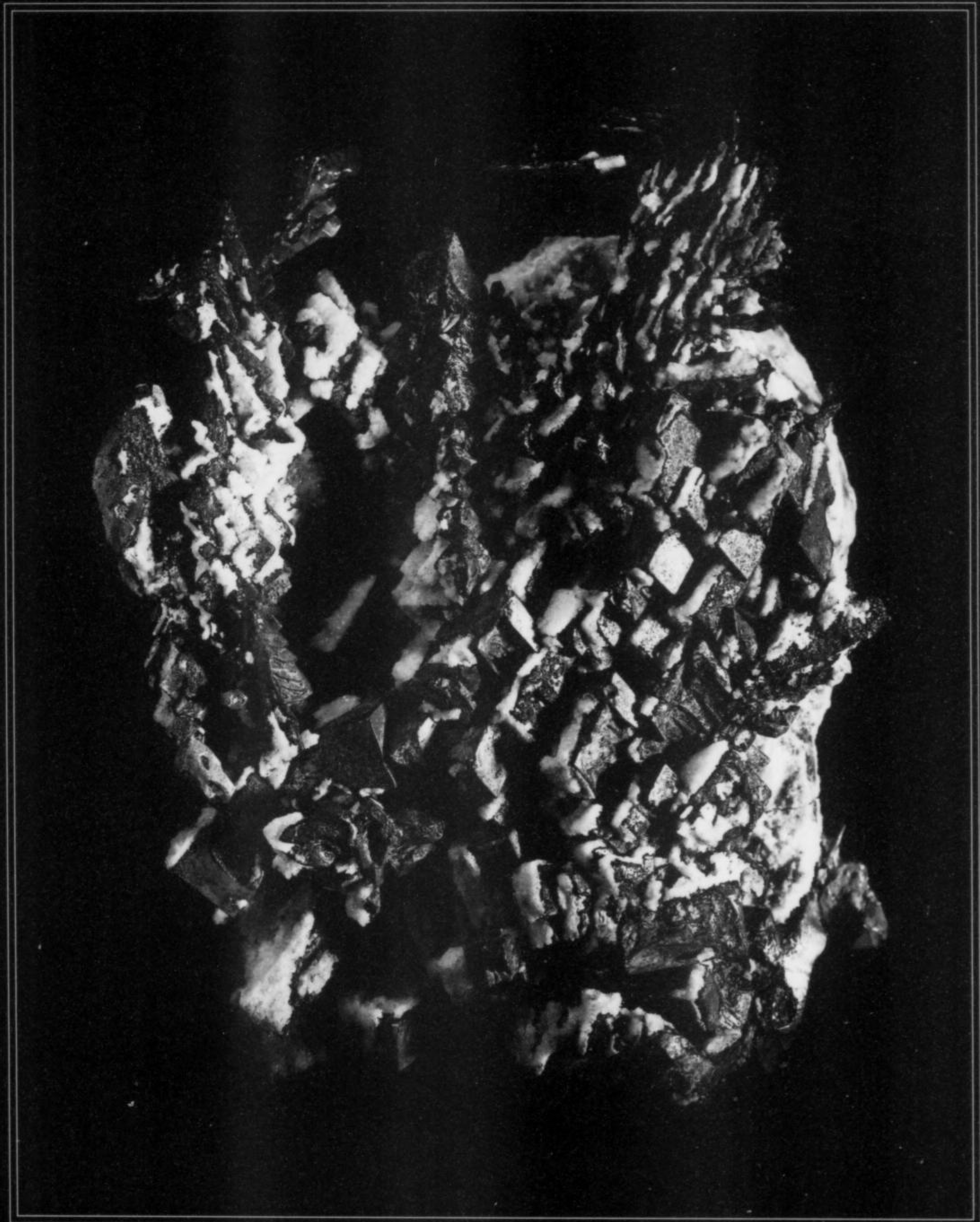
Any effort of this magnitude requires extensive compromise. It would be ludicrous to believe that the curator, or the director, can get everything that he or she wants. Working within a budget is just one of the many limitations imposed on any such enterprise. In addition, there may be severe restrictions on the inventive use of space when the space, from the start, is long and narrow and cannot be changed. With many museums, weak collections impose harsh compromises. Happily, this is not the case at the Smithsonian.

Today museums must be mindful of concessions that must be made for handicapped visitors. These can force all sorts of limitations on innovation. The elevation of cases and positioning of labels, along with type-size on labels, are all pretty much dictated by the access requirements of the handicapped. When type-size is increased, labels either must be made larger or the information placed on them abbreviated.

Footnote

Finally, one thing that I did not find anywhere in the new gallery, and this is not surprising because I don't recall seeing it in any other mineral/gem gallery either, are prominently posted signs telling interested visitors how they might obtain additional information about minerals, essentially a "hot line" for the curious. How nice and how reasonable it would be if, after having been stimulated by what was just seen in the displays, a fired-up visitor could find an address or a telephone number or a website that could be used to obtain some information about (1) literature, (2) hobby organizations, (3) collecting, or otherwise acquiring specimens, and such. Responding to such inquiries could be a very worthwhile task for a museum volunteer, so that this activity need not become a time-devouring nightmare for the professional staff. At the very least, the responses could be supplied via recorded messages.

All photos courtesy of the U.S. National Museum of Natural History, Smithsonian Institution.



COPPER, 4 inches, Phoenix mine, Michigan. From Larry Conklin (1971); ex-AMNH specimen; illustrated in Arthur Court's book.

Clara and Steve Smale

COLLECTORS

∞

PHOTO BY STEVE SMALE

What's New in Minerals

Tucson Show 2000

by Tom Moore

[Feb. 1–14]

As the new millennium opens, and no apocalyptic misfortunes have so far kicked in (unless you count certain presidential candidates), it is a pleasure to note that in the mineral world our greatest show has come over the cusp unchanged and undiminished: it is still great, and still a playland of fun and plenty for everyone. Marty Zinn's hotel show has expanded into big white tents between the Executive and Ramada Inns; the Main Show's mineral dealers, formerly situated on the leeward side of the hall, have switched to starboard, exchanging places with the gem/lapidary dealers; there is still the background buzz of grousing by customers that "there's nothing much new here," and by some dealers of the slack time in business between the opening of the hotel show and the Main Show. But I can think of no significant qualitative changes to report on, which is the best of millennial news! (And, by the by, my broken foot is completely back up to speed, and I do mean this literally: hotel staffers could have clocked me at warp speed as I covered the corridor distance between, say, a nice stilbite and a nicer stibnite.)

I'll forego further introductory expostulation, because there is a great deal to report on. Not that the show exactly brimmed with dramatic new knockout discoveries, but there did seem to be a near-record number of interesting mineral offerings, both of the brand new kind and of things coming into their second or third reincarnation.

The first item up, as it happens, *is* a dramatic knockout discovery: probably the finest large **topaz** specimens ever found in North America. In earlier show reports I have mentioned Harvey Gordon's preliminary work on the pegmatites of the Zapot claim, near Hawthorne, Mineral County, Nevada. (And see the July–August 1999 issue with an article on the claim, published *before* the big topaz discovery.) Until recently the Zapot claim has been modestly productive of greenish blue microcline ("amazonite"), smoky quartz, and blue topaz specimens. The big breakthrough for Harvey and his crew came on October 28, 1999, when the "Trick or Treat Pocket" was opened; eventually it yielded about 100 large topaz specimens, with bluish gray to greenish blue to aquamarine-blue, sharp, highly lustrous, gemmy crystals. The three biggest measure 24 cm, 21 cm, and 15 cm across the tops; they are wedge-terminated and thick, with gemminess filling the better parts of their interiors, and they protrude from massive white feldspar matrix. Smaller sizes of this wonderful gem topaz, down to thumbnails, are available from *Harvey Gordon Minerals* (500 Ballentyne Way, Reno, NV 89502). Nor are the specimens of Zapot Claim **smoky quartz** at all shabby: single, thick, part-gemmy prisms, some with cathedral growth patterns, reaching 40 cm high. The Zapot topaz showcase at the Main Show, with several of the biggest and best matrix specimens, was a real attention-grabber, holding its own even against the Freilich Collection cases (see later) next door.

Partners Greg Ferdock and Scott Kleine of *Great Basin Minerals* (3895 Lisa Ct., #C, Reno, NV 89503-1125) have brought out some new Nevada **barite**, found five weeks ago at the Dee gold mine, just 4 miles north of the now-famous Barrick Meikle mine, Elko County. The Dee mine barites are fatter and more wedgy than the Barrick Meikle habit, and more orange. They are transparent, but not nearly as lustrous or as generally impressive as the Barrick Meikle specimens. The Dee crystals, which can reach 5 cm on edge, form solid clusters on a pale brown spongy limestone matrix up to 30 cm across. There was quite a generous lot of this material at the Great Basin room in the Executive Inn, and more specimens had already reached a few other dealers around the show.

But Casey and Jane Jones of *Geoprime* (120 E. Colorado Blvd., Monrovia, CA 91016) were not to be outdone in the Nevada barite department—nor in the Nevada stibnite department. This room in the InnSuites featured the products of the (take a deep breath) Anglogolds Jerritt Canyon Joint Venture Murray mine, near Elko, Elko County, where there was a good strike of **stibnite** a year and a half ago, but an even better strike last October, the stibnite this time accompanied by what the Joneses were familiarly calling "sugarcube" barite. The stibnite clusters from both mining epochs are some of the best ever found in the U.S., with lustrous prisms to 30 cm long, in shaggy clusters in jumbo sizes. The barite "sugarcubes" are equant pseudorhombs to 2.5 cm, solidly covered, and sugar-sparkling, with quartz microcrystal coatings. These make a beautiful contrast with the metallic black stibnite spears which they perch on, encrust or are impaled by. About 100 excellent miniature and cabinet-sized specimens were collected, and the Joneses plan to return soon for more.

You have already heard about the final Nevada item: the terrific strike of brilliantly lustrous clusters of **orpiment** crystals, with sharp individuals reaching 2 or 3 cm, on black shaly matrix, from Cut 62 of the Twin Creeks mine, Humboldt County. We owe these to the miracle-workers of Bryan Lees' *Collector's Edge* mining crew, who extracted them last summer; when Wendell Wilson reported on them from Denver the specimens were not yet for sale. In Tucson they were: an amazing abundance of them, both in an InnSuites room and at the Collector's Edge stand at the Main Show. The smaller ones were refreshingly inexpensive for world-class specimens of a beautiful mineral: $25 or $50 could buy an outstanding thumbnail. Specimen sizes ranged from there up to 35 cm across. Bryan assures us that we need not worry unduly that the orpiment will deteriorate; he will tell you about his expert preparation and stabilization techniques, as well as about the locality generally, and his diggings there, in a forthcoming article.

Several flats of miniature and cabinet-sized specimens of **magnetite**, and of the unusual combination of magnetite and **fluorapatite** were offered by John Seibel of Seibel Minerals (P.O. Box 95, Tehachapi, CA 93581), who dug them last October from

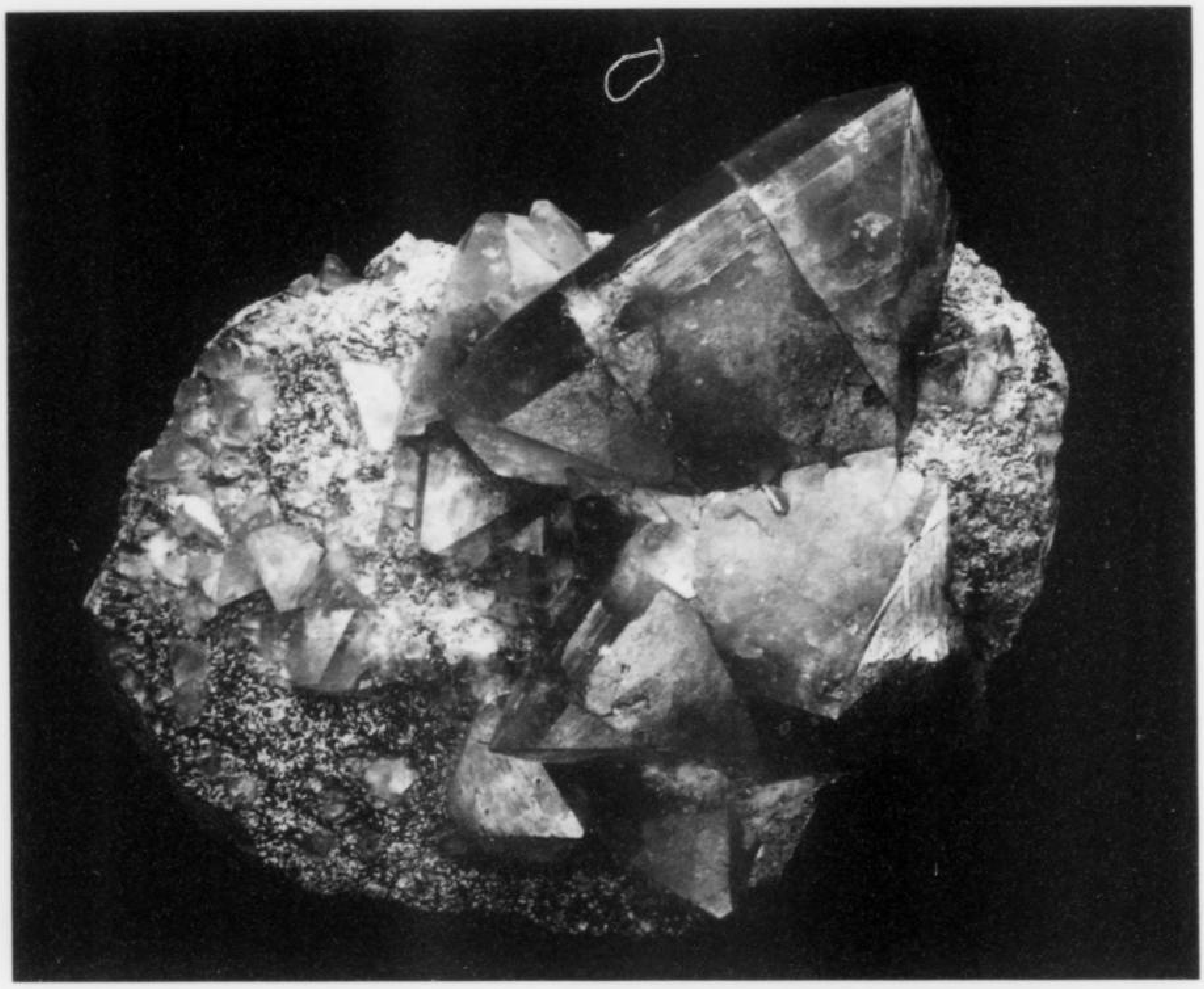


Figure 1. **Topaz crystal group, 48.5 cm, from the Zapot claim, Hawthorne, Nevada. Harvey Gordon specimen; Jeff Scovil photo.**

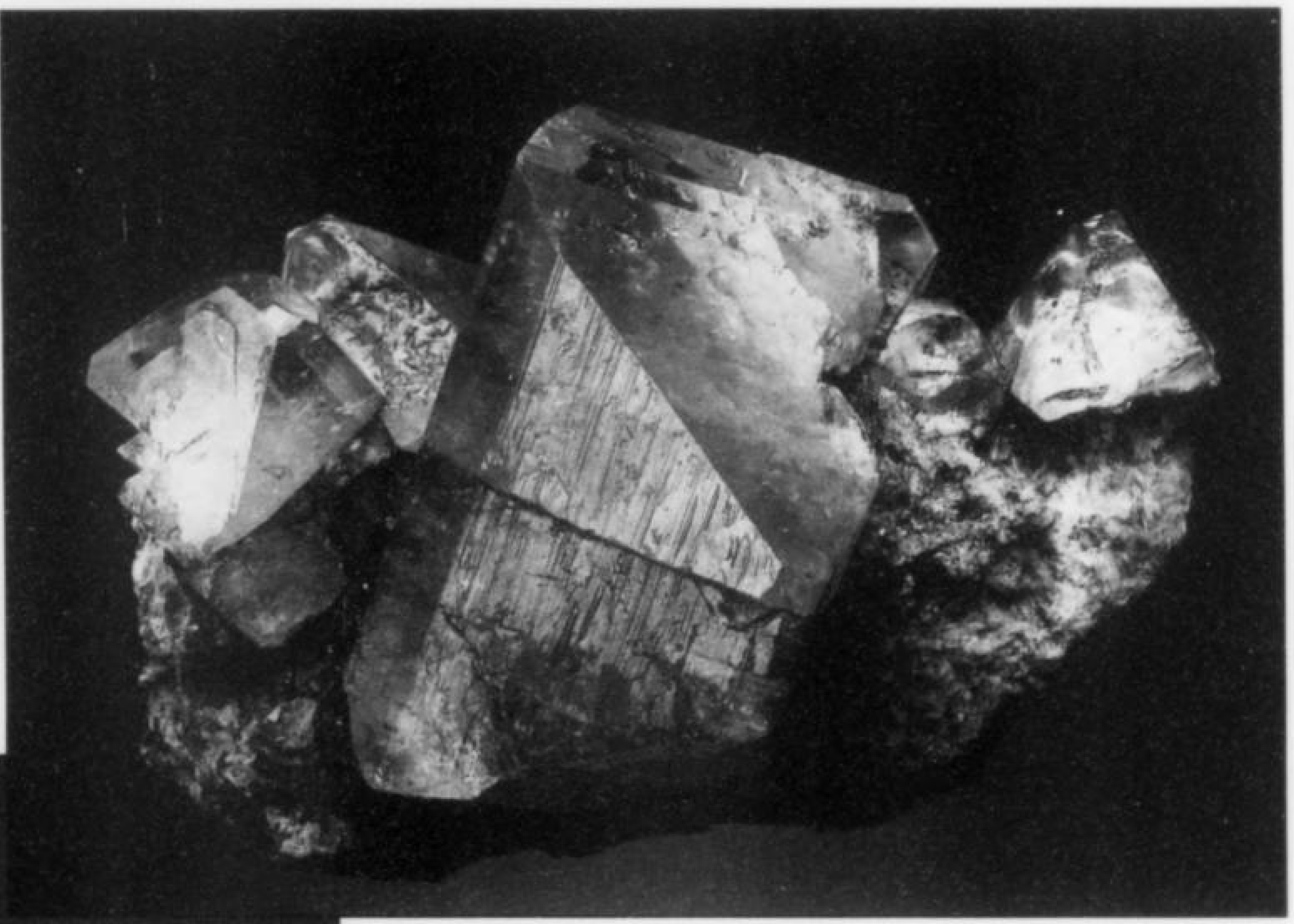


Figure 2. **Topaz crystal group, 13.3 cm, from the Zapot claim, Hawthorne, Nevada. Harvey Gordon specimen now in the collection of the Natural History Museum of Los Angeles County; Jeff Scovil photo.**

Figure 3. **Topaz with smoky quartz, 4.1 cm, from the Zapot claim, Hawthorne, Nevada. Harvey Gordon specimen; Jeff Scovil photo.**

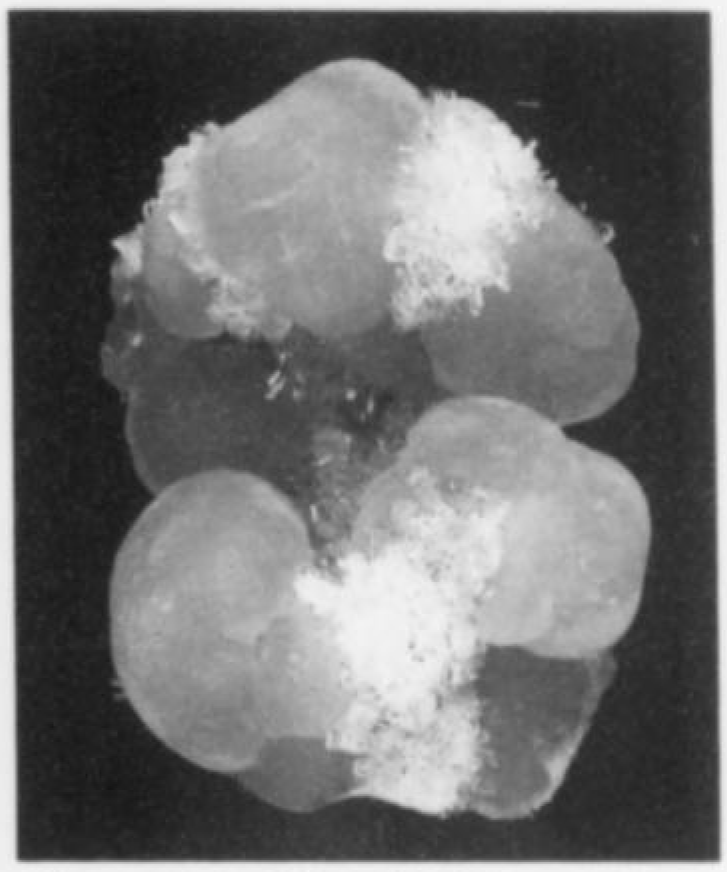


Figure 5. Smithsonite, 7.5 cm, from the San Antonio mine, Santa Eulalia, Chihuahua, Mexico. Kerith Graeber collection; Jeff Scovil photo.

Figure 4. (above) Barite crystal cluster, 8.6 cm, from the Dee mine, Humboldt County, Nevada. Geoprime specimen; Jeff Scovil photo.

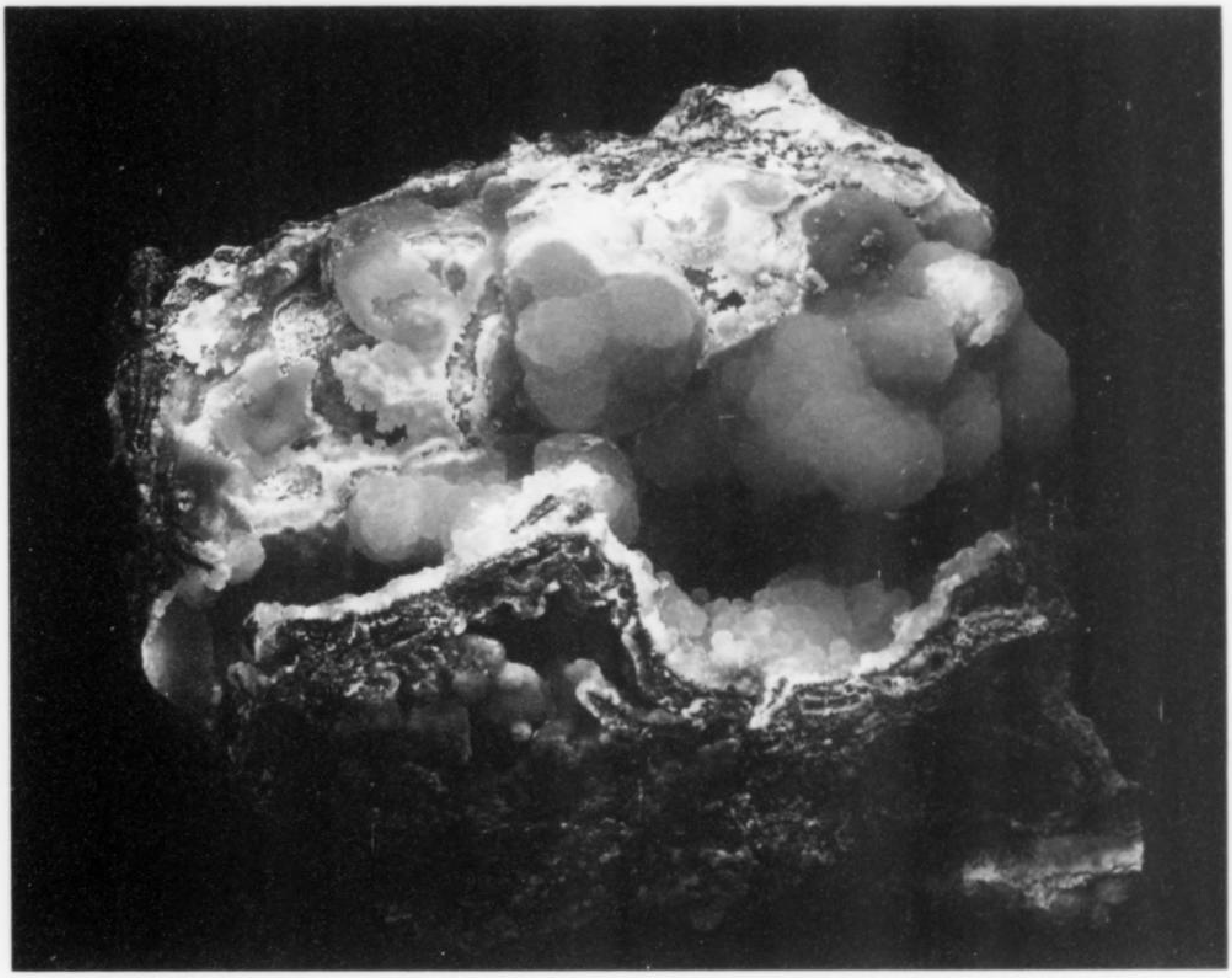


Figure 6. Smithsonite, 27 cm, from the San Antonio mine, Santa Eulalia, Chihuahua, Mexico. Peter Megaw collection; Jeff Scovil photo.

pockets in granite near Cedar City, Iron County, Utah. The magnetite octahedrons are sharp and very black with slightly curved, scalloped faces and bright luster; individuals reach 4.5 cm on edge, and they intergrow very nicely, with plenty of spaces to show crystal edges, in heavy, hunky groups. John also had many flats of loose, pale yellow, gemmy (though internally crazed) fluorapatite prisms with pyramidal terminations. The really elite specimens, though, are the ones on which the two species come together, with yellow apatite crystals rising from a jumble of magnetite; the very best of these, measuring 4 x 5 x 12 cm, went for $600.

Coming to Colorado, as I do now, is inevitably to revisit the Sweet Home mine, and the indefatigable *Collector's Edge* mining crew. Graham Sutton, the new mine manager, had a pocket named after him ("Graham's Pocket"), which was hit in December 1998, and which produced a fabulous **rhodochrosite** specimen displayed at the Main Show (see later). The best pocket of 1999 came in late September: an 18 x 20-inch vug called "Steve's Pocket," after marketer Steve Behling. These and other smaller, recent pockets have tended to yield deep gemmy red rhodochrosite crystals with preferential face-coatings of purple **fluorite** crystals, for a fine aesthetic effect. A bit more Sweet Home mine skinny: after its start-up in May 1999, the mine went on *year-round* working status; i.e. mining continued through the winter and is ongoing now (Tucson showtime), and after a brief pause in March/April 2000, it will reopen in May. The gorgeous new rhodochrosites at the *Collector's Edge* stand at the Main Show seemed adequately to explain why the work here is getting more intensive all the time—pretty good for a once highly speculative "specimen mine" which was to have been worked for only five seasons (1991–1996).

There are two bits of rare-zeolite news from Alaska. For one, late 1999 saw the collecting of many very fine large specimens of **barrerite** from Rocky Pass, Kuiu Island, Alaska. Barrerite is a sodium-rich member of the stilbite group, and the snow-white, slightly brown-stained sharp crystal blades and sheaves (individual blades reaching 3 cm) look just like stilbite. They form solid groups to 10 cm across, or cluster in seams in gray-green weathered basalt. A 1997 paper in *The Canadian Mineralogist* (Vol. 35, pp. 691–698) confirms that this material is indeed barrerite, for which Kuiu Island is only the second (and easily the better) world occurrence. There were three specimen sources in Tucson: the claim owner, Istvan Toth, had about a dozen cabinet-sized pieces at the Days Inn, while more and better ones reposed at the Executive Inn with Jordi Fabre and with Hungarian dealer Andras Lelkes (Hercegprimas u. 11, 1051 Budapest, Hungary).

Speaking of Alaska, my old college buddy Doug Toland has recently moved from Alaska to Idaho, but before doing so he collected something he would like the world to know more about: very fine crystals of **yugawaralite**, from an outcrop along the Chena Hot Springs Road, near Fairbanks. These were *not* available in Tucson, but a few northwesterners have specimens, and to inquire about them you may contact Doug at his woodsy retreat at 667 Meadow View Road, Sagle, ID 83860. The yugawaralite crystals are not quite the equals of the recent ones from India, but are probably second best in the world: very sharp, transparent and colorless toothy blades to 2 cm sitting up on a white quartzite matrix. Unfortunately they are often solidly coated with microcrystals of quartz, but specimens wherein the yugawaralite blades "show prism" (you know, like "showing leg") are very appealing. Specimen sizes are mostly thumbnail and miniature, Doug tells me.

The last American news is from my own corner of the country, New England, which still does corner the market on world-class **babingtonite** crystals. From Springfield I reported that Rocko Rosenblatt of *Rocko Minerals* (Box 3A Route 3, Margaretville, NY 12455) had a few nice thumbnails of babingtonite on prehnite, recently collected at the revived Lane quarry, Westfield, Massachusetts. He had a few more in Tucson, and rumors flew of extraordinarily fine, large/sharp/lustrous black crystals, although I saw only one of these (in the keeping of Rob Lavinsky). Further rumors had it that the Roncari quarry near East Granby, Connecticut had also lately turned out world-class babingtonite. I was unable to track down any of these "killers," although the mid-grade ones at Rocko's, all thumbnails, were still very nice to look at: sharp, slightly rough-surfaced, black terminated prisms to about 1.25 cm long, sitting nicely on little spheroids of brownish green prehnite. The Roncari quarry is known for its very fine datolite crystals, but this is a first for babingtonite from this place. Oh yes, from the Lane quarry, Rocko also had ten miniatures with lustrous, very deep blackish green **epidote** in drusy coatings over quartz crystals and quartz/anhydrite casts. These sparkly little specimens were acid-etched out of calcite vein fillings, and were collected just this past winter (hence not seen in Springfield).

Several dealers offered mostly small, modest specimens of the pale green reniform **smithsonite** now coming from Level 8 of the San Antonio mine, Santa Eulalia, Chihuahua, Mexico. These are glistening little distorted droplets, with hemimorphite in tiny bladed crystals, and also in more glistening white droplets, on a matrix of iron-stained massive smithsonite. But much more rarely, the smithsonite here is blue, and then it looks almost exactly like Kelly mine, New Mexico, smithsonite at its best, and makes lovely specimens up to 35 cm across. Dave Bunk (1441 W. 46th Ave., Unit #8, Denver, CO 80211) brought together three different lots of the blue stuff, all dug within the last six months, and was offering about 100 pieces at his Main Show Stand.

Further, Dave gets an honorable mention for repeating his last year's shelf of exquisite small specimens of **silver minerals** from Mexico, and for yet another flamboyant single-shelf performance: about 50 superlative specimens of **galena** in all sizes, some from hot contemporary localities like Dalnegorsk and the Madan district, Bulgaria, and some from old hallowed places like Neudorf, Germany; Leadhills, Scotland; and Phoenixville, Pennsylvania.

Thomas Gary Nagin of *Crystals Springs Mining* (P.O. Box 40, Royal, AR 71968) had a showroom in the InnSuites lobby all full of **quartz**, of course; but the most interesting shelves held perhaps 175 specimens in all sizes from a new strike of Japan-law twins at the Pampa Blanca mine, Ica Department, Peru—dug within the last six months. The twins are all very sharp, with varying re-entrant angles, slightly milky to clear within but with an appealing frostiness of surface luster on many. The biggest individual twin I saw is 6 cm across the wingtips. There are many loose thumbnail twins for which the best word, I'm afraid, is "cute," but there are also amazing large groups with twins thrown together at all angles; one stunning 15 x 30-cm cluster is topped by a 1.5 x 5 x 5-cm twin ($8500). The matrix, when present (rarely), is an altered greenish-grayish white rock. I'd guess that this is the best, most abundant new find of Japan-twinned quartz from anywhere in a good long while.

Another new Peruvian find was being offered at the Executive Inn by Dr. Jaroslav Hyršl (Heverova 222, CZ-280 00 Kolin 4, Czech Republic). Here were about 10 miniatures and small cabinet-sized specimens of **tennantite** pseudomorphs after enargite, dug last September at the Julcani mine, Huancavelica. The crystals, which reach 7 cm high but are mostly around 2 or 3 cm, are sharp, excellent representations of the enargite form, except that they are now tennantite: broken ones reveal mealy, chewed-out-looking interiors where alteration was still under way, under the solid, bright metallic gray-black skins. The matrix, when present, consists of translucent subhedral gray-white barite crystals.

And speaking of Peruvian **barite**, Scott Werschky of *Global Mineral Resources* (30 High Ridge Court, Reno, NV 89511) had a couple of flats of excellent miniatures and thumbnails of lustrous milky white barite, in thin, stepped, compound bladed crystals to 2 cm, on black sulfide matrixes, from the Huanzala mine, Dos de Mayo Province, Huanuco Department. I vaguely remembered reading of these in the Peru Issue, but Scott's were the first I'd seen, and they are beautiful little specimens (which must be why I bought a thumbnail: only $15).

Just last month (January 2000), a small pocket in the Urupuca mine, Minas Gerais, Brazil, gave up about 100 specimens of what is probably the prettiest **lepidolite** I've ever seen; a few pieces were being offered in the Executive Inn by Paulo and Fabiano Vasconcelas (Rue Alfonso Pena, 3053, Governador Valadares, Minas Gerais, Brazil). From a matrix of pale green parallel bladed crystals of cleavelandite, with garnishes of quartz and gemmy green elbaite crystals, rise dense forests of brilliant purplish pink lepidolite, the "trees" being compound prisms which fan a bit at the tops, where offset hexagonal pinacoid terminations show nicely. These few specimens, from about 3 to 12 cm, are beautiful things, with interlocked bright lilac lepidolite featherdusters glittering all over them.

Luiz Menezes (Rue Esmeralda, 534, Belo Horizonte 30410-080, Brazil) had the scoop on last October's new strike of **stokesite** at the Urucum mine, Galileia, Minas Gerais. We've known this occurrence in the form of loose, single thumbnail-sized spheres of tiny pinkish-grayish brown stokesite crystals, but the new specimens are much larger; indeed some are on matrix, up to 10 x 12 cm, of greenish cleavelandite with multiple stokesite spheres sitting in solution cavities. There are also loose clusters of spheres to 4 cm, and in some of the spheres the usual rough coating of cookeite or lepidolite is absent, so that colorless transparent stokesite crystals to 2 mm may be seen.

Edson Endrigo of *Valadares Minerals* (new address: Rua Dr. Jesuino Maciel 1358, Sao Paulo, Brazil) informed me that, yes, the Urucum mine is open and mining gems again: hence the new-improved stokesites, and hence too Edson's hundreds of thumbnails and miniatures of **kunzite spodumene**, in loose, typically etched crystals with rippled surfaces but total gemminess and a gorgeous lilac color. Edson says that he's seen newly dug, sharp, euhedral kunzite crystals a meter long from the Urucum mine.

Carlos Barbosa had about 20 specimens from a new find of **variscite** at an aluminum prospect pit near Itumbiari, Goias. Very oddly, these are shiny, 5-mm to 1-cm *spheres* of microcrystals of variscite, and they are a bright emerald green, presumably from trace chromium. They sit in vugs in a hard grayish chalcedony; some brown iron staining in localized spots on the little green spheres actually helps the aesthetic effect.

Finally from Brazil, I must mention two fine, lustrous floater crystals of **emerald** (long prisms and flat basal faces + tiny pyramids), from the Brumado mine, Bahia, lurking in one of the flats that Brad Van Scriver let me paw through in the Executive Inn room of Heliodor (P.O. Box 10, 19921 Prague 9, Czech Republic). The crystals are both 1.5 x 1.5 x 3.5 cm, internally somewhat crazed and clouded but a winning pale to deep green. Other dealers had more of these beautiful crystals.

Readers will have learned by now, from the January-February issue, about the major fluorite-mining project recently undertaken at the Rogerley mine, Weardale, County Durham, England, by an American consortium called UK Mining Ventures; Wendell Wilson mentioned the subject in his Denver report. At his Main Show stand, Cal Graeber, a member of the group, was selling some of the hundreds and hundreds of green fluorite specimens which came out of a series of pockets hit in June and July 1999. These pockets produced, Cal says, about 1800 pieces, from toenails to 2-foot plates, with classic sea-green penetration-twin fluorite cubes to 3.5 cm on a matrix of quartzite-replaced limestone. Also included are dull gray octrahedral **galena** crystals to 1 cm. None of the fluorites so far, unfortunately, come up in color or luster to the best of the old-timers from this place; Cal showed me an abundance of "almost" ones at the Main Show, while Bill Pogue showed an equal abundance of medium-range ones in the Executive Inn room of *Pegmatite Mining Specialists* (P.O. Box 989, Del Mar, CA 92014). Flats of specimens placed anywhere near this room's exposure to the sunlight began visibly to come alive with the glamorous/ghostly blue fluorescence for which this fluorite is noted. More work is planned for next summer at the locality.

Jordi Fabre had, as usual, some new things from Spain. One of these was "kongsbergite"—the varietal name some people give to native **silver** when it gets sufficiently high in mercury; these pieces have been found to contain 10% Hg. Jordi's 50 or so thumbnails and miniatures were found in September 1999 at a barite quarry called the Roza de Santa Matilde, Herrerías, Almería. The specimens are pretty, but alarmingly delicate, with bright webworks of filiform silver rising from small matrixes of a brick-red jasper and/or white barite. Jordi says that microcrystalline **chlorargyrite** is interspersed also, helping, we hope, to hold these lacy little structures together.

Jordi also had 10 specimens, from 5 x 6 up to 10 x 10 cm, of flattish plates with mounds of **prehnite** in very lustrous, greenish gray spherical aggregates over quartz, with tiny acicular colorless crystals of **clinozoisite** sometimes showing on the undersides of the plates. These pieces were taken in February 1999 from "a pocket as big as a truck" in a granite quarry at La Cabrera, near Madrid. They are an odd color for prehnite, and very attractive.

The Van Scrivers of *Heliodor* (see under Brumado emerald) have just scored a buying coup: they are now the proud owners and offerers of the former private collection of Pierre Choulat of Chamonix, France—all fine French Alpine material of famous sorts. For example, there is a great variety of habits of **quartz**, in many miniatures and thumbnails, from the Mt. Blanc area: groups of amethystine-tinged bipyramids, or smoky gwindels, or dreamy little fadens. Also there are fine cabinet-sized specimens of smoky quartz, including some gwindels, to 10 cm across, and there are a few pink octahedral **fluorite** crystals, from 1 cm to 3.5 cm, with the smaller, more richly pink ones sitting on clear or smoky quartz crystals. Also from the same collection there are a few beautiful groups of very thin (almost "needle") prisms of clear quartz from the classic La Gardette mine, Isére—these bristling specimens to 9 cm across.

Approaching the stand of Francois Lietard (*Minerive*) at the Main Show, I was expecting his usual exclusive focus on contemporary finds from the Himalayas, and indeed *most* of his stock was of this type. But as a Frenchman he seemed proud to be showing off also a hoard of 35 very fine specimens of **pyromorphite** from the Les Farges mine, Ussel, France. This mine operated only between about 1975 and 1980, so the world-class pyromorphites from here are already classics. Ussel pyromorphite is known for its playful quirkiness in the color department; even on the same specimen, crystals of different generations may range from a vivid medium apple-green, to dark green, to lustrous greenish brown, to duller brown. Francois had samples of nearly all such combinations, and even a few of the cherished "polka dot" specimens, with mustard-yellow tips on green-brown prisms. The fat, convex barrels with terminal hoppering can get to 1.5 cm; the matrix is a gossany quartz/limonite and/or white barite. Francois' specimens ran from thumbnails up to 20 cm long, and they were, in all, the best lot of this material I've seen since I lived in Europe during the mine's brief heyday.

In the Executive Inn, mining engineer Peter Tutt (Polsumer Str. 1, 45894 Gelsenkirchen, Germany) was offering a couple of flats of what he called "black" **fluorite**, collected last year, just before final closing of the old Markus Röhling silver mine, Annaberg, Obersachsen, Germany. Actually it isn't black, although at first glance it looks that way, because of a very, very dark purple surface zone on the amber-brown crystals. The specimens consist of plates, from 4.5 to 20 cm across, of interlocked simple sharp cubes, uniformly around 2 cm on edge, over massive fluorite. They are blackly attractive, unusual fluorite specimens, and a good miniature runs around $100.

From Italy this year comes a new **barite** occurrence—how much barite can you stand in a single report?—in a small open-pit mine near Carbonia, Sardinia. The barite crystals are very stout and wedge-terminated, to 5 cm, and of a lovely transparent yellow-orange color, nicely glassy and clean and bright; they make jumbled groups on massive barite/calcite matrix to 25 cm across. About 30 such cabinet specimens are available: the last which are likely to be collected, according to Riccardo Prato of *Gemmologi Gia* (Via del Piatti, 2, 20132 Milano, Italy).

From Switzerland this year comes a major replenishment of the

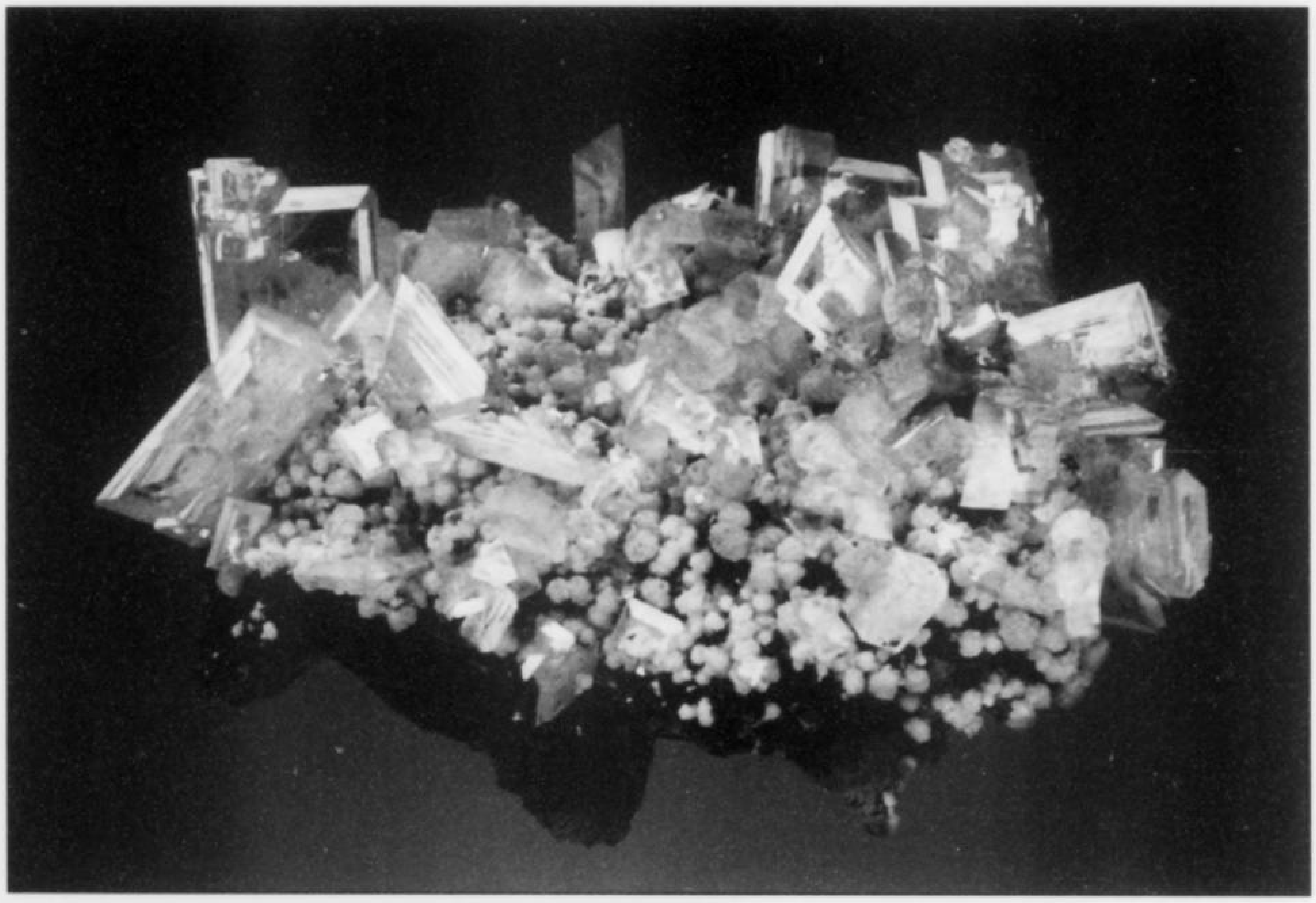
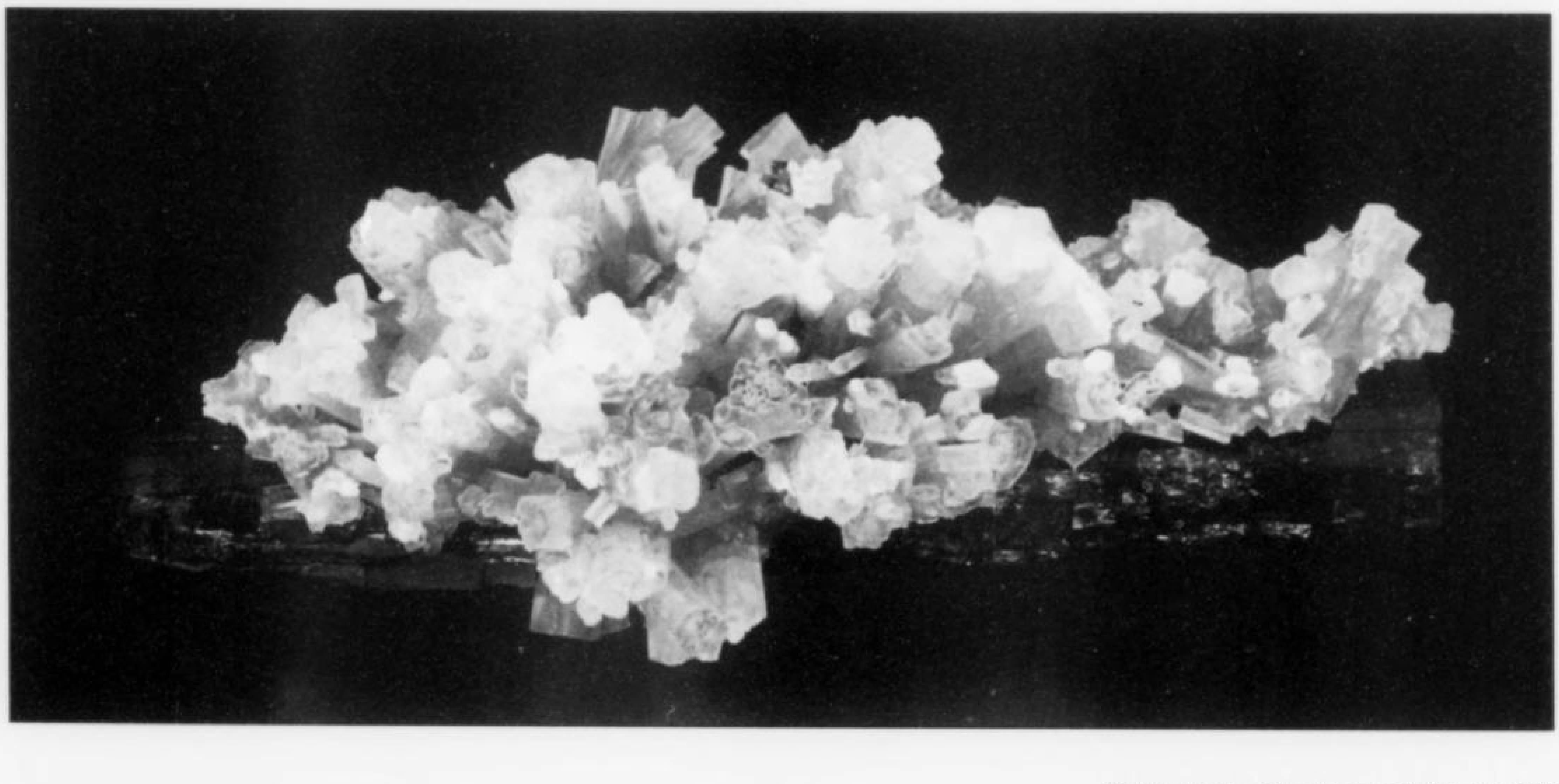


Figure 7. Wulfenite with mimetite, 5.3 cm, from the El Potosi mine, Santa Eulalia, Chihuahua, Mexico. Peter Megaw collection; Jeff Scovil photo.

Figure 8. Creedite, 5.5 cm, from the San Antonio mine, Santa Eulalia, Chihuahua, Mexico. Peter Megaw collection; Jeff Scovil photo.

Figure 9. Lepidolite crystals on an elbaite crystal, 8 cm, from the Urupuca mine, Minas Gerais, Brazil. Jürgen Tron collection; Jeff Scovil photo.



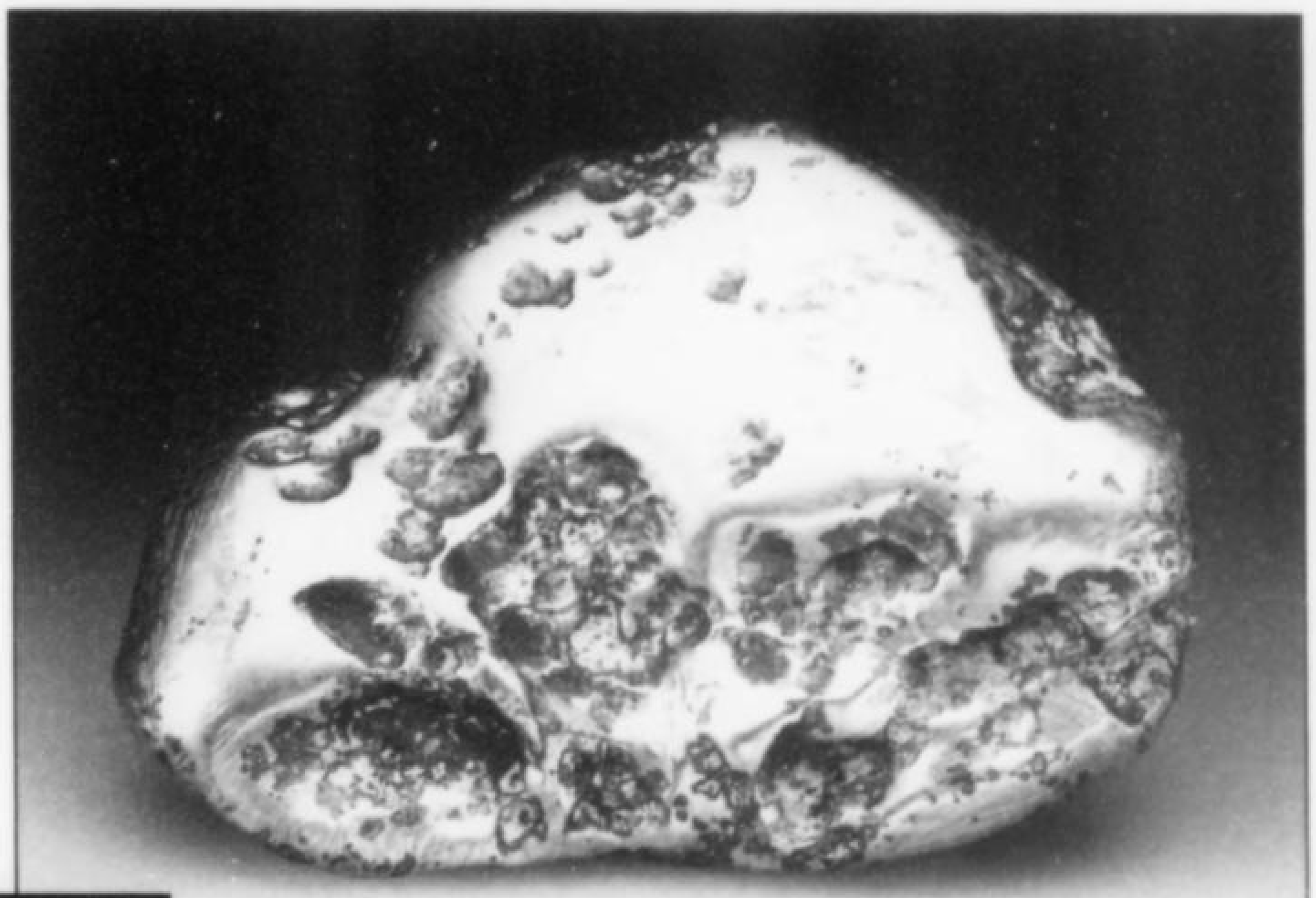
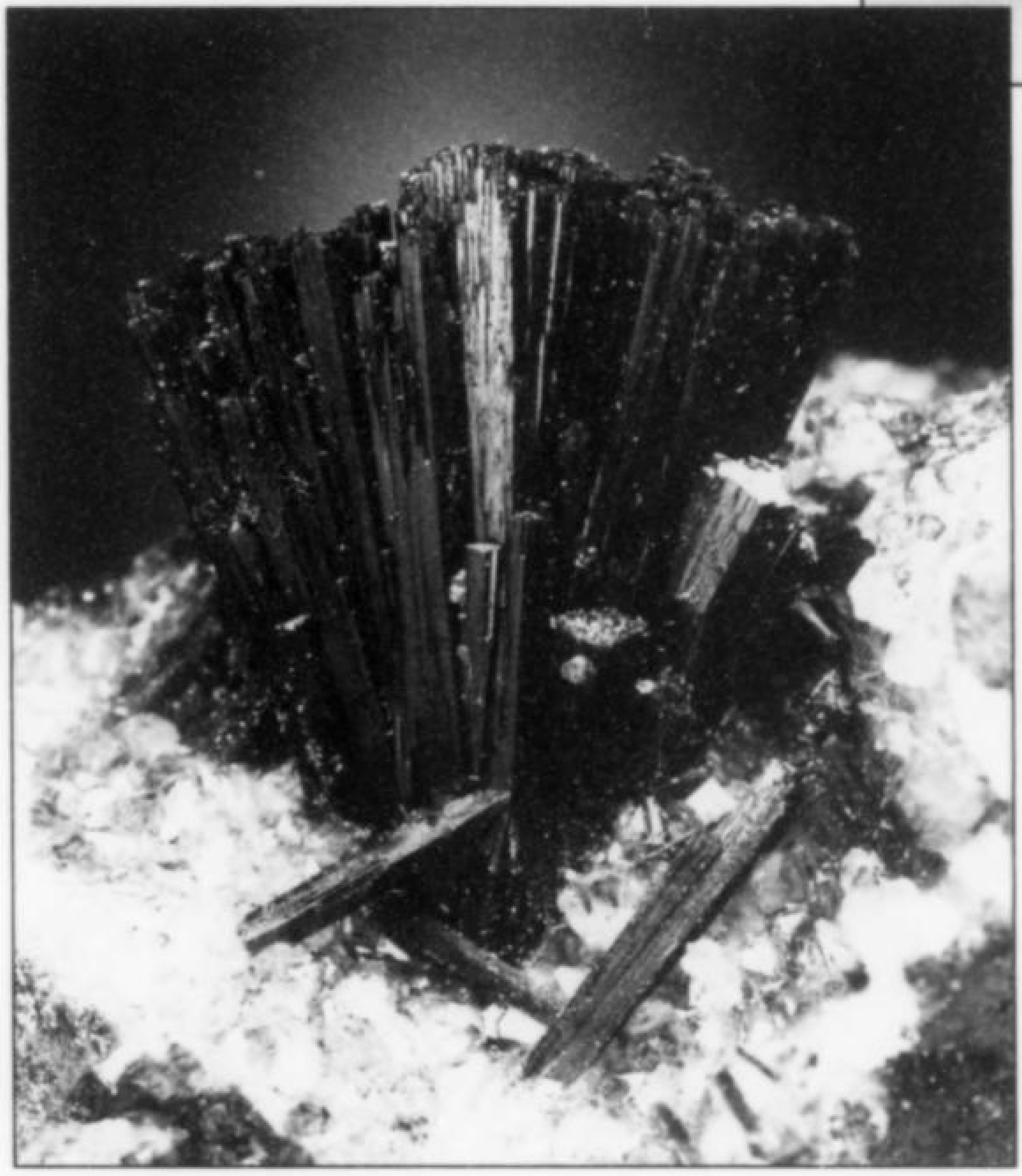


Figure 10. **Bismuth nugget, 12 cm, from Rio Vilace, La Paz, Bolivia. Mikon Mineralien specimen; Jeff Scovil photo.**

Figure 11. **Malachite crystal group (non-pseudomorphous), 2.7 cm, from Kalengwa, Zambia. E. N. Stoetzel specimen; Jeff Scovil photo.**



sparse stock of fine specimens of **cafarsite** lately seen at diverse dealerships. The dozen small specimens offered this time by *Heliodor* are first-rate crystal examples of this rare arsenate species, whose only significant occurrence is in clefts on Monte Cervandonne (if you are on the south, Italian side of the mountain) or Mt. Cherbadung (if you are on the north, Swiss side). It seems that in the summer of 1999, a lucky/skillful Strahler broke into an ice-filled pocket on the Swiss side (the precise locality, as given by the conscientious labelers of Heliodor, is Wannigletscher, Cherbadung, Binntal, Canton Valais, Switzerland), where he found a handful of loose, very sharp single crystals and small crystal clusters. These have smooth faces, crisp edges, a rich chocolate-brown color, and a complexity of isometric forms, though on the largest crystals the octahedron predominates. Most of the single cafarsite crystals at Heliodor are at least two-thirds complete, and range from 1.5 to 2 cm; these cost around $150, while a 3.5-cm cluster is $750. I would suggest that such prices are reasonable, if not low, for top representatives of a rare, and even fairly attractive, Alpine species.

Figure 12. **Chrysoberyl twin, 6.5 cm, from Rakwana, Sri Lanka. Dave Bunk specimen; Jeff Scovil photo.**

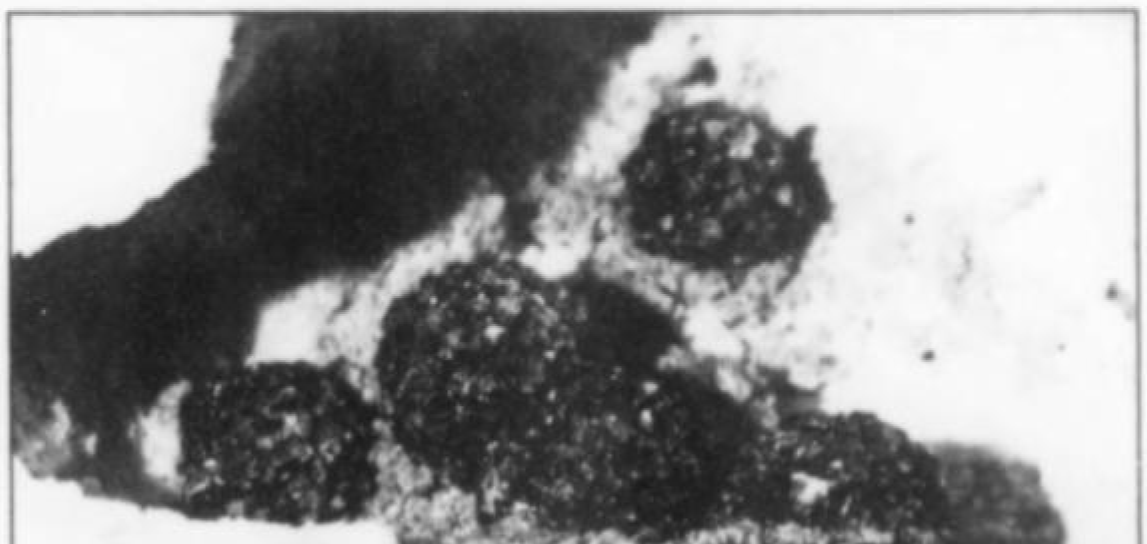


Figure 13. **Variscite in spherical clusters to 5 mm, from Itumbiara, Goias, Brazil. Carlos Barbosa specimen; Jeff Scovil photo.**

More modestly, Andre Gorsatt found, last July, a few smoky gray, pearly-translucent to transparent, twin crystals of **dolomite**, as thumbnail-size floaters, on the Turbenalp, Binntal, Valais. Good dolomite is rare from Switzerland, and a 2.5-cm twin (like the one I bought) is a bargain at $20. Andre could be found again in the "Swiss" room I went on so long about last year; the dealership is *Swiss Minerals* (CH-3996 Binn-Imfeld, Switzerland).

Leaving Europe, we pause briefly at the old classic locality called Zöptau (Czechs actually call it Sobotína), in Moravia, central Czech Republic; and to see what is new/old from there we pause at the Main Show stand of Petr Korbel's *Eastern Minerals* (Vysokoskolska 488/8, 165 00 Praha 6 - Suchdol, Czech Republic). Mineralized clefts of the Alpine type at Zöptau have long been known for fine **epidote** specimens, with minor albite, apatite, and prehnite; the locality has been reworked recently, and although no superlative epidote crystals have yet been found, Petr had a few very presentable ones, loose thumbnail-sized prisms and little clusters, of a pistachio-green color and high luster, although there's considerable fracturing of the crystals, and many terminations are missing. But, yes, someone is out there working on the old place, and who knows what they'll come up with tomorrow?

You can count on Dudley Blauwet of *Mountain Minerals International* to have a lot of scrumptious little gem crystals, usually from the Himalayas, although sometimes, like fellow Himalayas-man Francois Lietard, he surprises you with just-as-goodies from elsewhere too. The most impressive things at Dudley's Main Show stand this year, I thought, were from the Merelani mine, Tanzania, yes, "the tanzanite place." There were, of course, several ravishing thumbnail gem crystals of **tanzanite**, but more unusual were his three toenail clusters of **grossular**. These sharp dodecahedrons to 1.3 cm have a distinctive pale green color and are vividly lustrous and totally gemmy, piling up in brilliant loose groups. Rob Lavinsky of the Arkenstone also had several superb specimens. Blauwet also had equally brilliant and gemmy 2.5-cm **diopside** crystals from the Merelani, pale apple-green: one loose single, and one implanted on a silvery gray matrix of graphite.

Gilbert Gauthier, at the Main Show, had about 30 shining loose thumbnail-sized **cassiterite** specimens, in a style he was calling "quadruple twins": the fine morphological points escaped me, but it appears as if single blocky crystals grew on each of the four faces of a pseudo-octahedron, rising to make a roughly square shape. Just as unusual is the locality: the Kirengo mine, Rwanda, where, Gilbert said, Mr. Gordon Complain, an engineer at the mine, collected these specimens around 1970. They would be top-class cassiterites if their edges were not conspicuously abraded from their many years of adventures.

Top-class, though, is the word for the two specimens of "primary" **malachite** from the Kalengwa mine, Zambia, being shown in the Executive Inn by Norbert Stötzel (Am Johannesseifen 19, 57076 Siegen, Germany). The larger specimen is a 10-cm massive chalcocite/cuprite matrix, with 4-cm lush green fans of parallel malachite crystals rising at many points; sadly, though, there is much damage to the fans. The killer is the smaller piece: a 4 x 4-cm matrix with a large open cavity, lined with quartz crystals, from which rises an undamaged 2.7-cm malachite spray of stunning aspect. Norbert said that a German collector took these specimens out two years ago, from this long-abandoned copper prospect somewhere in the Zambian bush; I hope he has sold the smaller piece to a major collection, as it is arguably one of the world's very best malachites.

Bryan Lees' mining crew last year launched a major assault on the Namibian pegmatites of Mile 72, Swakopmund, which are the source of those legendary blue **jeremeyevite** crystals. As of September 1999, Bryan's crew had completely dug out the pancake-shaped pegmatite pods and the small dikes from which the blue jeremeyevites once came, and had found dozens of jeremeyevite crystals. Unfortunately these are a wan pale yellow, very thin, singly terminated at best, and without much luster, though they are semi-gemmy. The longest crystal is about 4 cm long and 5 mm wide and thick; the majority are in 1.5 to 2-cm length range. Rob Lavinsky, who bought them, would like you to know that when they are cleaned a bit more they will be available through *The Virtual Show* and "in person" at Denver. I can't say they're very impressive to look at, but they are from a classic locality for one of the rarest of rare/desirable species. Rob Lavinsky, by the way, is honcho of *The Arkenstone* (P.O. Box 948627, La Jolla, CA 92037), while his partner, John Veevaert, owns *Trinity Mineral Company* (P.O. Box 2182, Weaverville, CA 96093-2182); together they run *The Virtual Show* (john@the-virtualshow.com). These guys have a very sophisticated and decidedly "coming" mineral operation; they are selling large numbers of specimens over the internet, not just for themselves and collector consignees, but also for other dealers. Oftentimes they advertise specimens on the net which are at that moment *also* for sale in some other dealer's room, so the home shopper can compete directly with the show-goer!

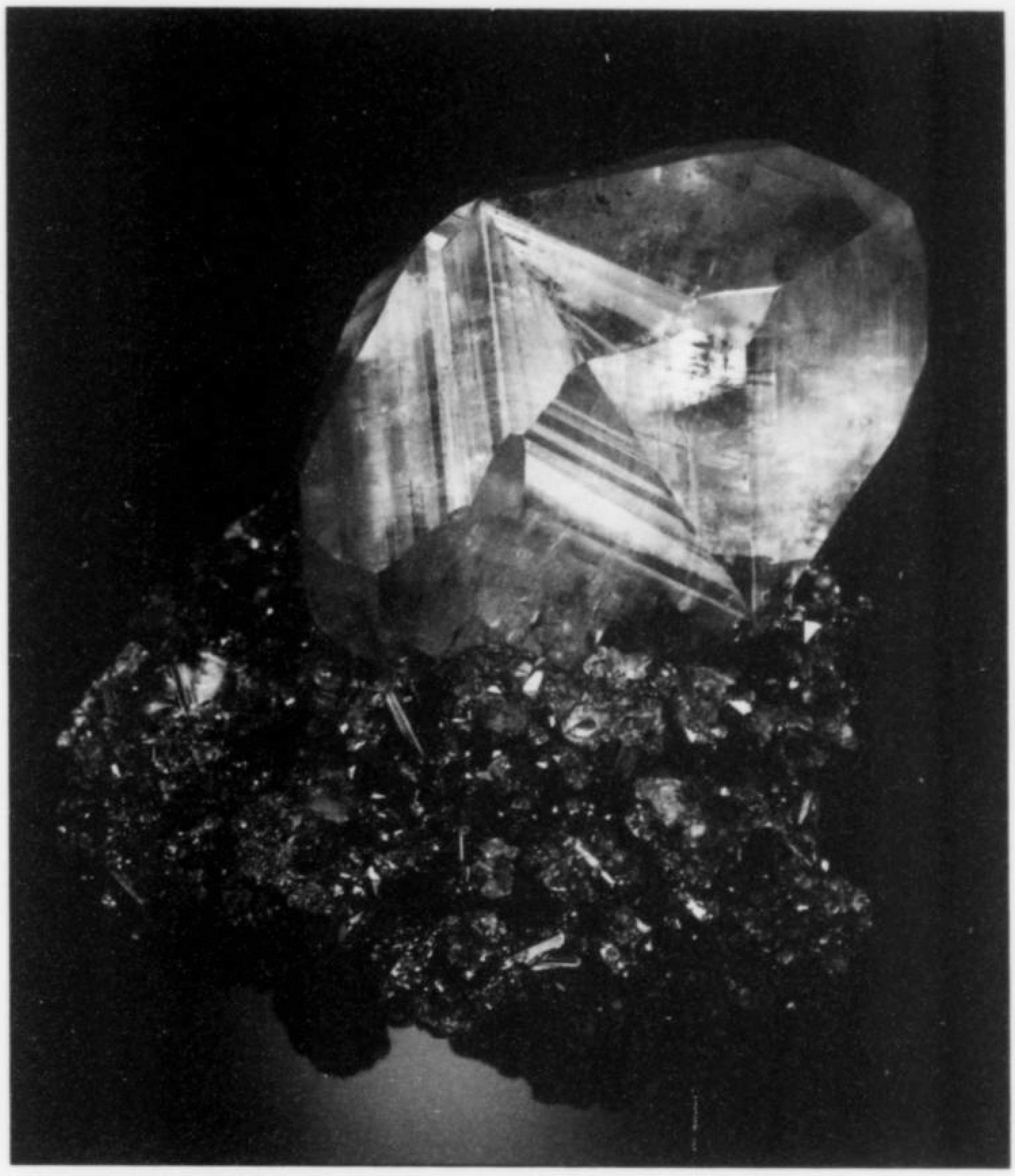
From Springfield I described the handsome new **schorl** crystals now beginning to come from the "Erongo Mountains," Namibia, and there were more in Tucson, both in the smaller sizes and up to 15-cm lustrous black subparallel fan-groups of terminated crystals. Rocko (again) had some, but the best were with Clive Queit (Box 1014, Fourways, 2055 Republic of South Africa). Clive also had a few nice, lustrous, greenish blue, gemmy, loose **aquamarine** crystals from this place.

The friendly Italians at *Gemmologi Gia* (see under Sardinian barite) also had about 20 fine **chrysoberyl** specimens found recently at Anzakobe, Madagascar—and a copy of a recent *Lapis* article about the find. These are bright yellow-green fishtail twins, tightly compact and not gemmy, but lustrous and of sharp, clean form, in miniature to small-cabinet sizes.

And everyone should be informed that many of the very large, very yellow and lustrous, very attractive crystals from Madagascar that heretofore have been called "rhodizite" have now been shown to be **londonite**, a new species which is the cesium analog of rhodizite, i.e. $(Cs,K)Al_4Be_4(B,Be)_{12}O_{28}$. According to Skip Simmons, a co-author of the IMA-approved but as yet unpublished formal description (who gave permission for us to mention the name), some of the crystals are rhodizite and some are londonite; some are white and some are yellow, but color does not correlate with composition. The most attractive specimens have shining yellow dodecahedrons to 4 cm embedded in a pegmatite vein material containing schorl, reddish purple tourmaline and quartz.

Václav Budina of *KARP Minerals* (P.O. Box 54, 272 80 Kladno, Czech Republic) had some mineralogical news from, of all places, Iran. Last summer, he told me, some Czechs brought out a good supply of unusual **hematite** specimens from an iron mine on Hormuz Island, and he had samples to prove it, in the KARP room at the Executive Inn. The hematite crystals are mostly loose, horizontally striated hexagonal prisms with wavy faces (think corundum), black, with a medium-bright submetallic luster, all from 1.5 to 2.5 cm high. Also there are a few thumbnail and small-miniature groups of more conventional modified rhombohedrons of hematite: they are not especially remarkable-looking. More investigations are planned.

Much more exciting to look at are the new **rutile** specimens from Mount Kapudzhuk in Azerbaijan, reportedly quite near the Armenian border. Wendell Wilson provided the first notice of these (and a photograph) in his Denver report, and I'm pleased to say that specimens of the material were quite plentiful around the show.



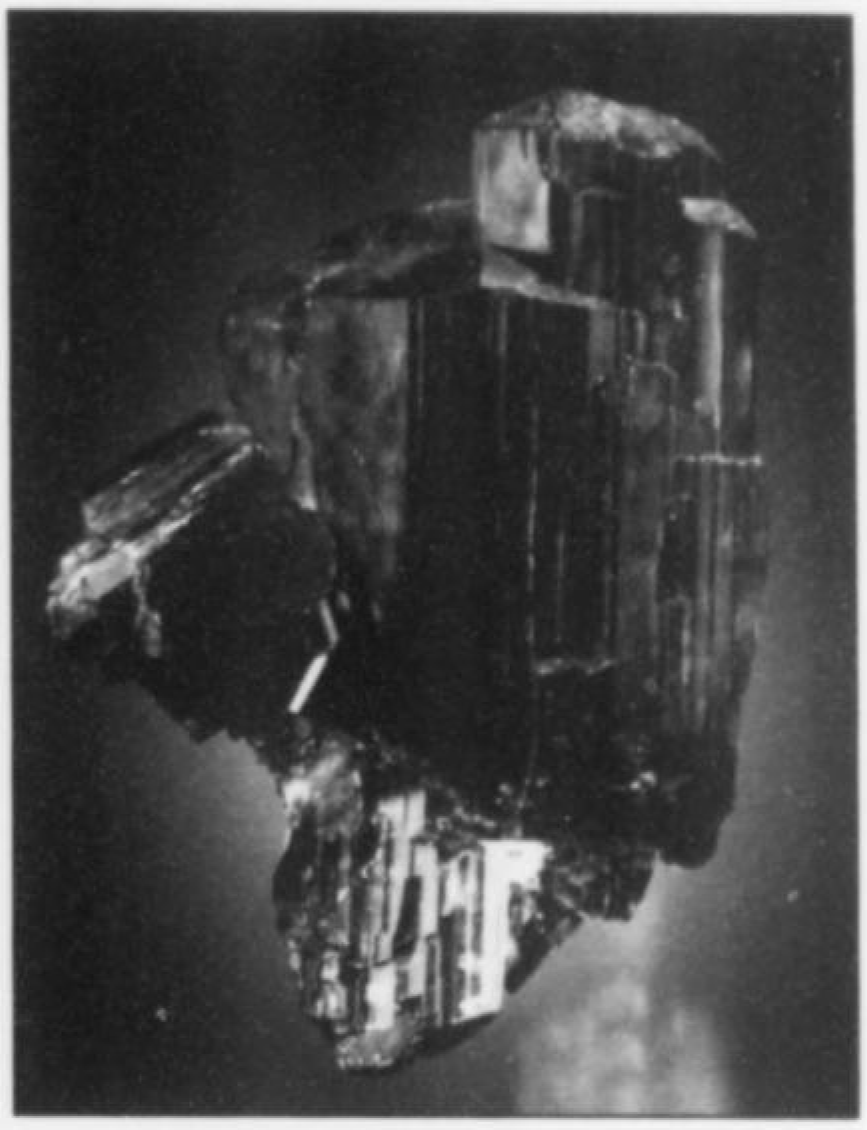


Figure 15. Clinoenstatite crystals, 3 cm, from near Astore, Nanga Parbat area, Chilas, Pakistan. Herb Obodda specimen; Jeff Scovil photo.

Figure 14. Calcite on stibnite, 7.1 cm, from Lantian, Guangxi, China. Brown and Wilensky specimen; Jeff Scovil photo.

Figure 16. Fluorapophyllite on quartz crystals, 10.1 cm, from Hunan, China. Brown and Wilensky specimen; Jeff Scovil photo.

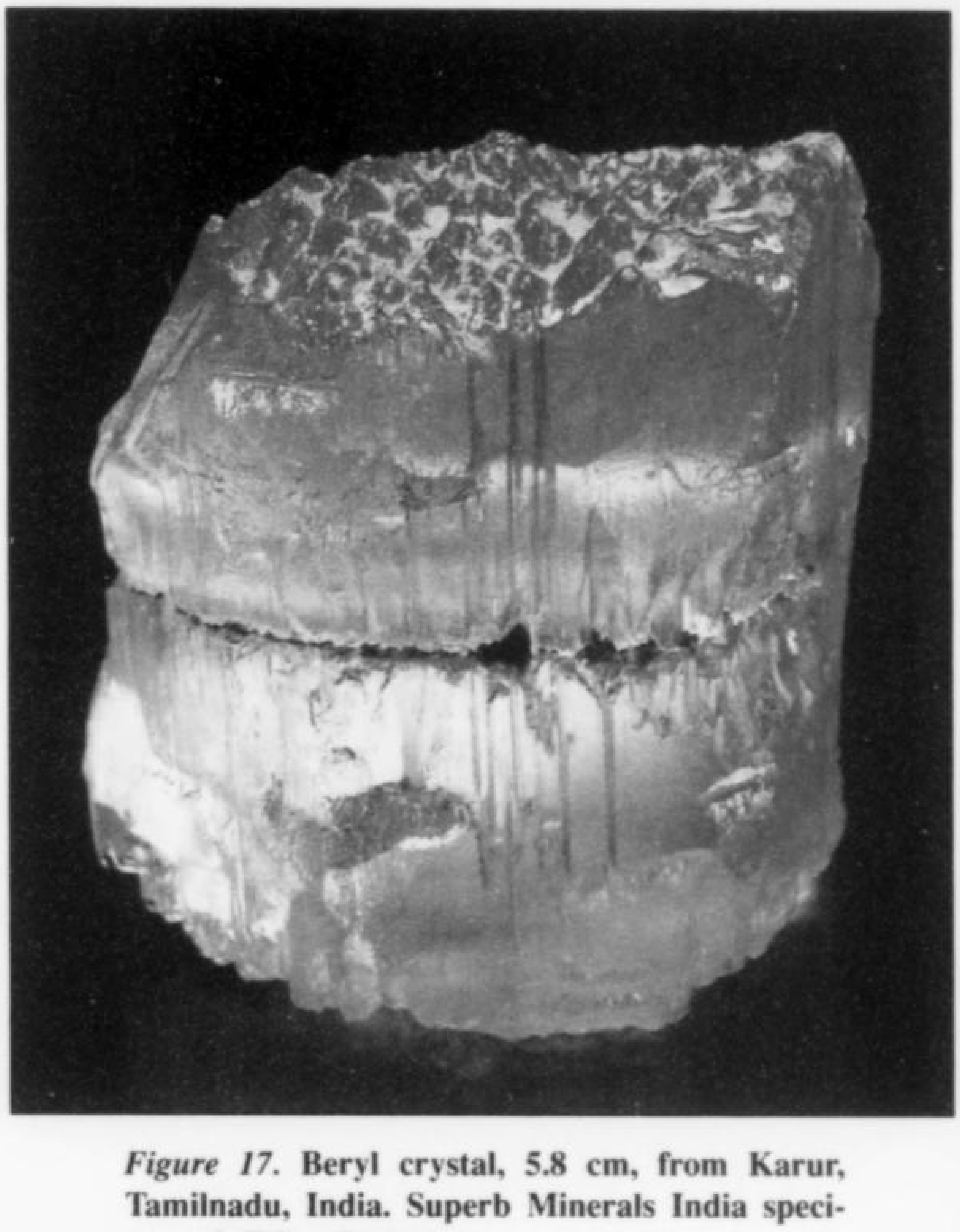


Figure 17. Beryl crystal, 5.8 cm, from Karur, Tamilnadu, India. Superb Minerals India specimen; Jeff Scovil photo.

These are, at their best, dramatically fine rutile specimens, with brilliant, blocky, complex bright crystals to 3 cm sitting loosely on white quartz matrix with iron-stained milky quartz crystals. Except for the quartz association, these rutile crystals would strongly resemble those of Graves Mountain, Georgia—which is saying a lot for their quality. Among the dealers who had them in Tucson were KARP, John Attard, Gemmologia Gia, and Michel Jouty (in his new hideout in the Frontier Hotel), but there were many others.

On to Russia. In the Executive Inn room of the *Urals Geological Museum* I found none other than Dr. Evgeni Burlakov, whose two recent *Mineralogical Record* articles on the Puiva and Dodo mines I translated from their German versions in *Lapis*. We were glad to meet, and I was glad to know what to look for in his offerings of some recently dug specimens from both mines. The only species significantly represented was **titanite**, but in some fine pieces from both the Puiva and Dodo mines. The Dodo titanites (thumbnails and miniatures) are lustrous, sharp, translucent yellow-brown cyclic twins; in the matrix miniatures these twins reach 1.5 cm, and densely coat scaly gray-green amphibolite, while the thumbnails are floater twins of the same size, with flaring wings. Perhaps more scientifically interesting are the large matrix plates from the Puiva mine: same scaly amphibolite, but in pieces to 15 cm across, all studded with sharp, chlorite-dusted titanite twins to 1 cm, with tiny sharp gray calcite rhombs. Some of the other Puiva pieces show tight mounds of intergrown titanites over smoky quartz crystals.

Back again in the *KARP* room we find the show's only offering (that I noticed) of significant numbers of **sperrylite** specimens from the now-famous locality of Talnakh, near Noril'sk, Siberia. Word is that mining is ending now at this extraordinary platinum deposit, so we may soon see even fewer such specimens; even this lot, the KARP folks said, was collected more than two years ago. Familiar, by now, is the amazingly bright metallic luster of these sharp, complex, tin-white platinum arsenide crystals embedded in mineralogically complex, heavy, dense sulfide matrix. The KARP selection consisted of about a dozen thumbnails and miniatures, with the sperrylite crystals (5 mm to 1 cm) in varying states of completeness, and, stashed away in a drawer, a wonderful 4 x 4 x 9-cm iridescent matrix with a complete 2.2 cm sperrylite crystal, among many others arrayed along the top.

On the way out of the KARP room at last, let's pause to admire the new **pyrite** thumbnails from the Nikolay mine, Dalnegorsk: sharp, bright, lightly striated pyritohedrons to 1 cm that sit up, or nestle and hide, in a very peculiar matrix, of a gray-green, finely stalactiform calcite that looks like a cluster of little mud pillars such as are created by tunnelling insects. These are most odd-looking pyrite specimens—good for your Dalnegorsk suite—and the best of the thumbnails only runs around $25.

A major new find has just come out of Pakistan, escorted by Herb Obodda (P.O. Box 51, Short Hills, NJ 07078), who had 12 specimens at his Main Show stand. It is the rare pyroxene species **clinoenstatite**, from Astore, Nanga Parbat Area near Chilas, Pakistan, and it is very good-looking for a pyroxene: deep blackish green, resembling epidote, in thin-bladed to blocky, sharp crystals to 3 cm long. These crystals have light vertical striations, crisp monoclinic angles at the terminations, and a *very* bright glassy overall luster. Specimens ranged in size from a couple of thumbnails up to a 6 x 12-cm cluster. All were pricey, but these are certainly the world's best (maybe even the world's only presentable) crystal specimens of the species.

Upon wandering, one night, into the Executive Inn room occupied by Rob Lavinsky and John Veevaert's *Virtual Show*, I had a real learning experience about **kunzite spodumene**—and saw a couple of terrific kunzite crystals too. One of these monsters was 3.5 x 7 x 19 cm, the other 6 x 11 x 32 cm! They are both from Kunar, Nuristan, Afghanistan, and they both have typical kunzite form, and are gem-clear—except that their color is a fairly rich aquamarine-*blue* (or rather, pleochroic in blue, with the deeper shade down the *c* axis). According to John Veevaert, some Afghan kunzites actually emerge from the ground in this color, but a few days of sunlight turn them to the familiar lilac-pink hue. The darker the final pink, the more likely it is that they started out blue. The Virtual Guys, thus, have been careful to keep these two giant crystals out of sunlight, to see how long it takes them to change color anyway, or whether they *will* do so.

An attractive habit of **apophyllite** was found in a single pocket in the Mohodari quarry, Nasik, India, in September 1999, and specimens were on hand in the Executive Inn room of Dr. Arvind Bhale of *Earth Science International* (Yasham 166/1+2+3, Aundh Gaon, Pune 411 007, Maharashtra, India). The apophyllite crystals are "cubes," i.e. pseudocubes, some with "octahedral" truncations: they average about 2.5 cm across, and come either as perfect, loose floater singles or in great clusters and stacks.

The biggest piece is a 15 x 20-cm matrix with 3.5-cm crystals piled up on a deep bed of glistening greenish white natrolite prisms. Some of the crystals have colorless/transparent areas, but mostly their interiors look as if someone was sick in them—with great roiling clouds of a mottled gray-green-pink material. Scientifically speaking these inclusions are finely divided chlorite, chloritoid, montmorillonite and hematite, but they truly look barfy; and yet the specimens are oddly beautiful. About 30 pieces in all were available.

On a much more dignified note, as befits great gem crystals: a pegmatite near the town of Karur, Tamil Nadu State, southern India has yielded (so far) three magnificent crystals of **aquamarine beryl** having a choice deep blue gemminess throughout the interiors. One (singly terminated) crystal is the size of a forearm; the others are 5 x 5 and 3 x 4 cm; the big one was already "gone," but I was proudly shown the other two by K. C. Pandey of *Superb Minerals (India) Pvt. Ltd.* (Shyam Castle, Brahgiri, Nashik Road, Nashik-422 101, Maharashtra, India). Apparently these were very recently dug at Karur, already known as the source of fine large plates of deep purple amethyst crystals.

I got myself a nifty thumbnail specimen of a ruby **spinel** crystal pertly perched on matrix, from Pein Pyit, Myanmar (Burma). These spinels were widespread around the show, and I highly recommend them for their richly deep red, sharp octahedral crystals, especially when these sit on white marble matrixes (loose crystals are easy to find, good matrix-placed ones much harder). The crystals come in sizes up to 4 cm, and in a range of color (red to purple) and gemminess.

Sri Lanka excels this year, not so much for the usual gem crystals of this and that, as for very sharp, very black, blocky **pargasite** crystals embedded in vein calcite, from Kolonne, near Embilipitiya. **Forsterite** also occurs here, in sharp, greenish brownish black blades, sometimes several centimeters long; also the locality yields sharp black octahedrons of iron-rich **spinel**. Jaroslav Hyršl had the best of this suite of minerals, in several miniature and toenail-sized pieces.

Matters Chinese will take up considerable space this time, as great things continue to be discovered in China, and then to pour onto the market. One can easily lose track of all the colors, forms, habits, associations, etc. of Chinese fluorite and calcite alone. Many others of the new Chinese occurrences represent strikingly beautiful species-associations, and everyone, from the seekers after "decorator" specimens to the more mineralogical devotees of very large, very beautiful pieces are having a Chinese field day, every day, these days. Surely the best place to start is the InnSuites room where Debbie Meng of *Debbie Meng's Minerals* (P.O. Box 8393, Monterey, CA 93943) held court again this year. As I missed the Denver Show, I missed the further appearance there of the new Chinese **pyromorphite** of which I caught a whiff in Springfield. But Debbie and plenty of other dealers had wonderful specimens of this pyromorphite in Tucson; Debbie says that it comes from an old lead mine in Jiangxi Province. In color and luster this material closely resembles the best of the recent Spanish pyromorphite, i.e., it is bright yellow-green; the crystals are prisms and spindles, generally around 1 cm, scattered all over an iron-stained white quartz. According to Debbie, more than 1000 pieces, in all sizes and qualities, have come out in the past year.

Then there are the wondrously beautiful **calcite/stibnite** specimens from somewhere near the town of Lan Tan, Guangxi Province, which were widely available around the show this year. The calcite crystals are lustrous, complex, rounded, butterscotch-orange and gemmy, all a-glitter with a myriad of little faces, and they can reach 5 cm across. Their matrix consists of massive stibnite with quartz, with brilliant stibnite needles rising from underneath and penetrating/surrounding the calcites. Debbie has heard of some stibnite crystals from this occurrence "thick as chopsticks." Together the metallic black stibnite and lustrous butterscotch calcite make a stunning combination, sometimes in huge cabinet-size specimens.

Just as stunning are the **quartz/hematite** combinations from somewhere in Jiangxi Province: Mike Bergmann had the best at the Main Show, but these too were liberally scattered about. They are sprays of thin-prismatic clear quartz with individuals sticking out porcupine-wise all over; an earlier quartz generation is colorless (its crystals often broken off), but a later generation is coated (rarely, included) with bright red hematite dust. The dusting is not enough to affect light transmission, only to render the quartz crystals a transparent brickish-crimson red, especially near their tips. Further, around the bases where the quartz crystals meet are very thin jet-black plates of hematite grouped in rosettes clustered in undulant waves covering the massive hematite matrix.

I first reported on the lustrous, transparent, whitish brown **cassiterite** crystals from Ximeng, Yunnan Province in 1998 (from Denver), when I saw them at Ken and Rosemary Roberts' stand. As *Roberts Minerals* is (sadly) now out of business (Ken's working for Bryan Lees these days), Debbie Meng has repossessed what was left of the Roberts stock of these beauteous cassiterite crystals, and added more. The specimens are mostly cyclic twins, either as sharp little floaters or on a gray-white matrix with quartz; the twinned clusters may reach 3 cm.

Just next door to Debbie Meng's room, another Chinese dealer, Dr. Liu of *AAA Liu's Minerals* (Französische Allee 24, 72072 Tübingen, Germany), had still more transparent cassiterites from Yunnan, as well as some major large Lushi mine stibnite groups; sharp black **stannite** crystals to 1 cm with arsenopyrite; and a lot *more* Chinese stuff. But Michel Jouty was the one with the three champion (of those I saw) Lushi mine **stibnites**, the biggest a group easily a foot and a half across and a foot high, of highest luster and very little damage, with thick, terminated spears sticking out all over.

Although I've raved on and on about prolific China, it's only coincidental, really, that this next item also comes from there: it is a meteorite, and a very odd sort of meteorite at that, labeled "octahedrite," from a fall in 1516 A.D. in "Nantan County," China. Although "What's New in Minerals" rarely makes note of meteorites (because they are rocks), this one is remarkable, as its fragments actually resemble crude octahedral crystals, and are the closest things a collector is likely to get to natural crystals of iron. The distorted, rough-surfaced, lustrous metallic gray-white "octahedrons" are 4 to 5 cm on edge, in singles and groups of two or three. What happened, it seems, is that the meteorite shattered during its fall through the atmosphere, cleaving along its internal crystal domain boundaries. Larry Venezia (115 Coleridge St., East Boston, MA 02128) had a dozen pieces of this strange material in his room at the InnSuites—together with a flyer quoting venerable Chinese archives which say that in May of the eleventh year of the reign of the Emperor Zhengde, "stars fell down from a northwest direction . . . waving like snakes and dragons, bright as lightning; then they disappeared in seconds."

A classic locality in Japan comes up next, with the welcome news that it isn't so "classic," i.e. dead, as we have thought. The dealership of *Oherikosha Inc.* (Post No. 603-8376, Kinugasa, Kyoto, Japan) had a small tablefull of excellent, sharp, clear Japan-law twin crystals of **quartz** from the type locality for such twins: Narushima, Nagasaki, Japan. At $10 or $20 or $50 apiece these were among the show's best bargains: all between 2 and 2.5 cm except for four toenails. Most of them have fairly deep re-entrant angles, for distinct V shapes, and a few also have simple untwinned quartz prisms growing out at angles to the flat front faces of twins, for a nice effect. The Japanese gentleman in the room said that these specimens were quite recently found in diggings in veins in a sandstone on a mountainside—and any good field collector might go, presumably, and find more.

Australian collector Dehne McLaughlin (5 Tenth Avenue, West Moonah, Tasmania, Australia 7009) showed up at the InnSuites with, among other things, a generous lot of **molybdenite** from Wolfram Camp, Dimbulah, North Queensland, the lot mined in 1982. Thick, subhedral molybdenite rosettes to 6 cm cover massive white milky quartz in medium to large cabinet-size specimens, with the bright metallic gray, rose-like clusters of MoS_2 standing out prominently. On some specimens, crude faces of native **bismuth** crystals to 3 cm spear up into the huge molybdenite plates.

This final item caused quite a buzz around the hotel show, and no wonder, for it is a marvelously vivid red, utterly gemmy **cuprite**, brought out in 1996, during the last days of mining at the Red Dome mine, Chillagoe, about 130 km west of Cairns, Queensland. Troy Cluss of the dealership of *Euhedra* (55 Hawksbury Rd., Westmead 2145, New South Wales, Australia) had a spread of thumbnails, plus three specimens between 5 x 5 and 7 x 7 cm: heavy masses of solid red cuprite with sharp crystals to 4 cm along the tops. The disadvantage is that they are tightly packed and rather mashed up, so that very few faces of individual crystals can show, and there is, besides, considerable damage. However, the color is a virtually insane deep red, the gemmy transparency is total, and the adamantine luster is high. *Great Basin Minerals* had three good thumbnails of the same material (with the same advantages and disadvantages). Word is that if gold prices go up enough, the waste piles of this old gold mine may be processed, and in such a case, more good cuprites like these might appear. Also, Troy Cluss showed me some **azurite** in large, rich blue blades (always contacted, never terminated), and some miniatures with water-clear calcite crystals to 4 cm, from the same place.

The Main Show's theme this year was **Brazilian minerals**, and a great many exhibit cases took the viewer on dream trips to fabulous gem pegmatite fields. Three cases showed just a single Brazilian specimen: first, a pellucid gemmy blue topaz crystal from the Xanda mine, 40 cm or so across the termination (American Museum of Natural History); next, a portable-TV-sized Itatiaia "cranberry" elbaite/albite/quartz (John Lucking, Gene Meieran and Wayne Thompson); finally, an old and equally gargantuan cluster of green elbaite on quartz from the Cruzeiro mine (Natural History Museum of Los Angeles County). A wide, deep, ethereally lighted case full of giant gem crystal specimens from Brazil was Gene and Roz Meieran's dazzling contribution. And then there was the

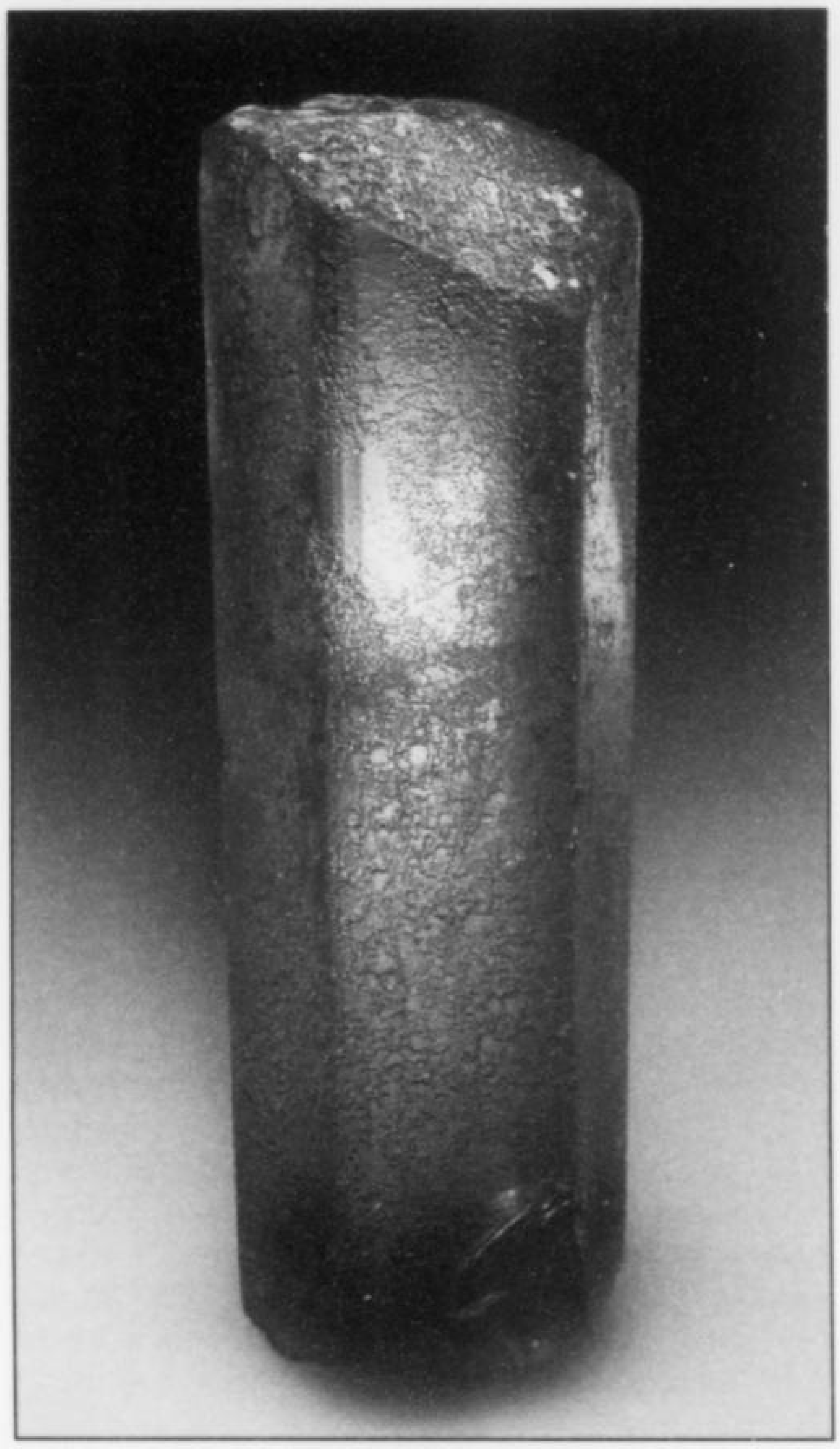


Figure 19. **Amethyst crystal cluster, 5.8 cm, from Karur, Tamilnadu, India. Carolyn Manchester collection; Jeff Scovil photo.**

Figure 18. **Beryl crystal, 15.6 cm, from Karur, Tamilnadu, India. Brown and Wilensky specimen; Jeff Scovil photo.**

Figure 20. **Londonite crystal, 1.8 cm, from Antsongombato, Mahaiza region, Madagascar. Jeff and Gloria's Minerals specimen; Wendell Wilson photo.**

erudite case on the minerals of Rio Grande do Sul, with geology, photos, specimens and faceted gems, by the Mineralogical Museum of Bonn; and the case showing Rio Grande do Sul calcites, by Victor Yount. Let's not forget two cases chockfull of Brazilian thumbnails, these respectively by Ron Pellar and Sharon Cisneros. Then there came illustrious Brazilian cases by illustrious institutions, all full of great things, of course, and worthy of much more than this mere listing: the Houston Museum of Natural Science, the Cranbrook Institute, the French Museum of Natural History, the Smithsonian (with the "Van Allen Belt" rose quartz!), the Carnegie Museum, Harvard, the Royal Ontario Museum . . . and others.

Beyond Brazil, as it were, lay riches in a parade of assorted topics. These included Bisbee Minerals (Phelps Dodge—two cases); Arizona Minerals (Les and Paula Presmyk); Prehnite (Henry and Patsy Schmidt); Minerals of the Northern Pennines (Manchester Museum, England—with superlative classic English fluorites, good photos, text, and a map of mine locales); Ural Gems (Urals Geological Museum—fine alexandrites, corundums and emeralds); the Keith and Mauna Proctor Collection (two wonder-full cases); Minerals of the N'Chwaning and Wessels mines (Treasure Chest, South Africa); Worldwide Pyrite (a donor case assembled by the University of Arizona Mineral Museum); Self-Collected [terrific!] Specimens (Wolfgang Mueller); Mexico cases by Blue Sky Mining and Top-Gem Minerals; Tsumeb Smithsonite (Bill and Diana Dameron); more Tsumeb minerals (Marshall Sussman); Arizona Quartz Collected by Bill & Carol & Rick & Alyce (Tucson Gem and Mineral Society); Calcite Pseudomorphs (Cincinnati Museum of Natural History); Twinning in Minerals (Kay Robertson); Southern African Thumbnails (Bruce Cairncross); Minerals From Mogok (American Museum of Natural History); and a small but heart-felt case by Jim Bleess memorializing the late Luis Leite.

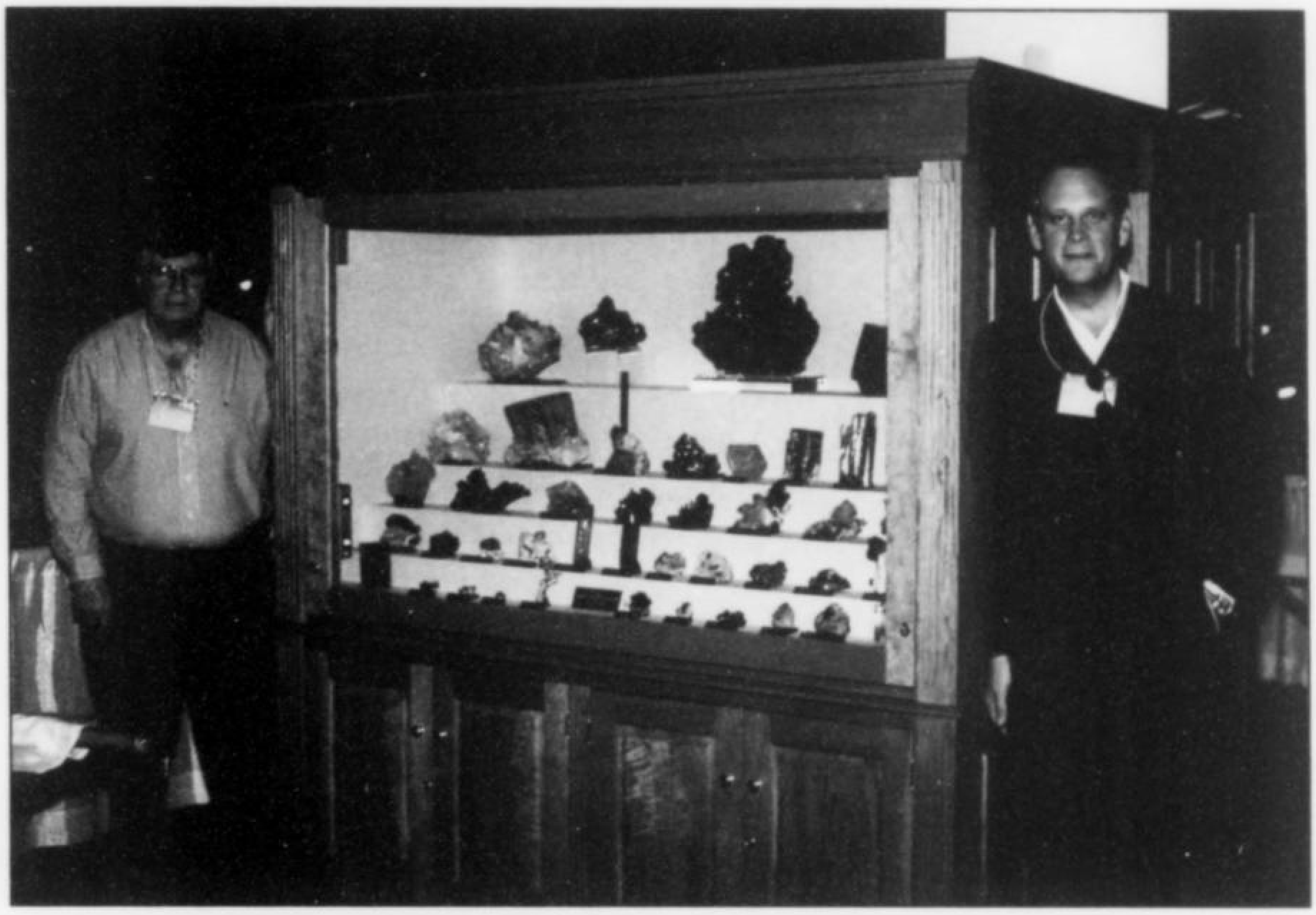


Figure 21. **Dave Wilber and Joe Freilich beside one of the two Freilich Collection cases (Tucson Show); Jeff Scovil photo.**

Figure 22. **Keith Proctor Collection case (Tucson Show); Jeff Scovil photo.**

Bryan Lees' *Collector's Edge* dealership/mining company put in three cases of special note. One was packed with newly collected orpiment specimens from the Twin Creeks mine, Nevada, even better than most for sale back at the *Collector's Edge* stand. In a second case there regally stood, all alone, "The Ice Dragon," a single foot-high aquamarine from Pedra Azul, Brazil, naturally etched and hollowed out in fantastic, surrealistic forms. In a third case reposed the best rhodochrosite specimen from the December 1998 "Graham's Pocket" at the Sweet Home mine, with deepest red gemmy rhombohedrons to 5 cm on edge, preferentially dusted with purple fluorite crystals, all in a circular, somewhat concave plate. Wondering why Bryan's crew had not *named* this tremendous piece, as it had named earlier ones, Tom Gressman suggested calling it "The Fruit Bowl." Since Bryan has—tentatively—approved this, let me, seizing the moment, suggest that "The Ice Dragon" aquamarine might be renamed "The Lava Lamp," in deference to those of us Senior Collectors who respond fondly to '60's connotations.

It must be said, though, that a single exhibitor quite dominated the show floor this year. Two large, back-to-back, opposite-facing cases contained 145 specimens (yes, I counted them) from the Joe Freilich Collection—the same great contemporary collection, assembled and curated by Dave Wilber, and featured in the January–February Special Issue of this magazine. The two big, glass-fronted cherrywood cases were themselves noteworthy: products of *Williams Mineral Company* (R.R. 1, Box 77, Dutch Hollow Road, Rio, WV 26755), a firm that promises in its brochure to custom-build collection cases just this handsome, for any sort of collector . . . and the Freilich cases made for the best kind of advertising. The lighting in the cases was carefully tuned to match the exact color of daylight, and was softened (some thought too much) in its intensity so as to avoid glare.

Readers who look again at the photos of Freilich specimens which filled the January–February issue may be assured that every piece looked *at least* that good in person. Every single one of these 145 pieces, whether pictured in the Special Issue or not, is a masterpiece of its kind. One of the two cases, crowned by a gigantic, lush Bisbee azurite plate, seemed nevertheless to center on a Peruvian pyrite, this crystal cluster itself crowned by a 4-cm modified octahedron so brilliantly mirror-faced and lustrous that it made my teeth ache (some say that this is the finest pyrite specimen in existence). The other case featured seven step-shelves of specimens, from large-cabinet size down to the winsome small-thumbnail corkscrew of Dzhezkazgan silver shown in the issue. Such a wide range of sizes was really not an aesthetic problem, since colors, shapes, lusters etc. were so harmoniously arranged (Dave Wilber said he devoted the better part of two days to the arrangement). Besides, as soon as the eye fixed on *any* one piece, mesmerization was apt to set in, and all surroundings, including the continuously milling crowds, went away.

Of course I can't reproduce the whole thing in print, i.e. set out to describe every piece, but I'll "label" a few I especially liked which were *not* pictured in the issue: arsenopyrite/stannite from China (12 x 12 cm); ilvaite/quartz from Dalnegorsk (12 x 15 cm); hambergite from Afghanistan (a transparent blade 7 cm high); childrenite from Afghanistan (a perfect, loose 4.5-cm twin); arsenic from Germany (a smooth, perfect sphere 3.5 cm in diameter); moschellandsbergite from Germany (many crystals to 1 cm covering a 7-cm matrix); silver from Michigan (an electric-white arborescent tree 12 cm high); elbaite from Afghanistan (an 8 x 10 x 12 cm blue-pink polished-treestump lookalike on matrix). Finally, it seemed that either Joe Freilich, Dave Wilber, or both were more or less constantly on hand to chat in the friendliest way with whomever wanted to do so—from "how did they cut that one?" tourists to all the ranking dealers, collectors, and curators, many of this group stopping by often to relive their roles in placing specimens in the collection. Perhaps it was by hanging out awhile in this traffic of expert voices, of pleasure and praise, that I got the feeling that no single collection ever presented at any Tucson Show had had quite the same general impact that this one was having.

Well, you had to be there. If you were (and I speak of the Tucson Show in general), you were lucky, and if you weren't, I do hope you'll make it next year.

Barcelona Show 1999

by Miguel Calvo

[November 5–7]

The Barcelona Show is Spain's most important annual mineral bourse, where news of local and international mineral discoveries reaches the Spanish collecting community. This year there were 74 dealers, most of them from Spain but also from other European countries.

The most interesting find from Spain this year is the native **silver** from Herrerías, Almería province. The exact locality (according to the labels) is "Roza de Santa Matilde," apparently a surface occurrence overlooked by the miners of a century ago; it was found accidentally by local collectors digging for barite. Jordi Fabre obtained two large lots. The first of these, found in 1999, consists of silver in sheets filling fractures in a hard, brecciated limestone. The second lot is characterized by arborescent masses of tiny crystals scattered through a soft argillaceous matrix; the dull gray specimens contain 10% mercury, and consequently have sometimes been labeled with the old varietal name, "kongsbergite."

Jordi Fabre also had some interesting specimens of **calcite** from the La Florida mine in Cantabria, Spain. These were dug some years ago by a group of collectors who found a single, very large crystal-lined geode which yielded about a hundred specimens. The pieces consist of an underlying compact crust of dolomite crystals with large, gemmy, morphologically complex (and probably twinned) calcite crystals which are nearly "round" due to the abundance of forms. The best specimens remain in the collections of the original collectors, but many second-level pieces have been sold.

Lorenzo Morales had some eye-catching **gypsum** specimens found shortly before the show at an alabaster quarry near Quinto de Ebro, Zaragoza province. The habit is identical to that of the well-known specimens found some years ago at nearby quarries in Fuentes de Ebro. The main difference with regard to the new specimens is crystal size: up to 32 cm (over a foot) long and 12 cm wide, with many crystals over 20 cm. As might be expected, the jumbo-size crystals are less transparent, lustrous and perfectly formed than the earlier smaller crystals.

Also coming out in large sizes are **fluorite** specimens found in 1999 at a small prospect named "La Viesca" in the La Collada area of Asturias province, Spain. Jose Manuel Jurado of Barcelona had specimens with cubic crystals up to 20 cm on edge. The color is pale violet and the luster is frosty, which is typical of fluorite from this area.

Joan Abella had some **silver** specimens from the Balcoll mine at Falset, Tarragona province, Spain. These appeared for the first time at the 1998 Barcelona Show.

A company called *Baikal Geo* from Madrid had many specimens from pegmatites found in granite quarries at La Cabrera in the Bustarviejo area, Madrid province. Included were **laumontite** crystals to 4 cm, in clusters lacking matrix, large plates of botryoidal **prehnite** from the Castilla quarry, and up to 1-cm tufts of **bavenite** on feldspar crystals from the Los Gallegos quarry. *Baikal Geo* also had specimens of **plumbogummite** in blue crusts with **wulfenite** microcrystals, from the La Montañesa mine, Navalagamella, Madrid province.

The finest **prehnite** from the La Cabrera area turned up in the trunk of Juan Peña's car: bright green plates to 15 cm across, some with scattered lenticular calcite crystals. He also had **clinozoisite** tufts with calcite crystals from the same locality, and **pyromorphite** from last year's discovery at the San Andres mine. Also in his stock were colorful (but unfortunately unstable) fine crystals of the iron sulfates **voltaite**, **coquimbite** and **botryogen**. In addition, **rhomboclase** was found as stalactitic clusters; all of these came from abandoned workings in the Alfredo pit of the Rio Tinto mine, Huelva province, Spain.

Javier Saura had his usual selection of fine **barite** specimens from the La Union mine, Cartagena area. This year the Victoria and Teresita mines also produced specimens. In addition to these, he also had attractive **calcite** crystals with tabular, bluish, waterclear crystals of barite or celestine found just before the show at the Parajola mine near Algameca, also in the La Union mine area.

The grayish rhombohedral **magnesite** crystals from the Eugui quarries, Navarra, have been famous for many years but are found only rarely. This year, Pedro Echevarría of Pamplona obtained a nice lot of specimens, consisting of the typical rhombs on magnesite rock matrix.

From localities outside of Spain perhaps the most interesting find was epitaxial **freibergite** on **enargite** from the San Genaro mine at Huancavelica, Peru. Jordi Fabre had these, as well as Japan-law **quartz** twins from Cerro Ullpace, Castrovirreyna, Peru.

FM The Friends of Mineralogy, Inc.

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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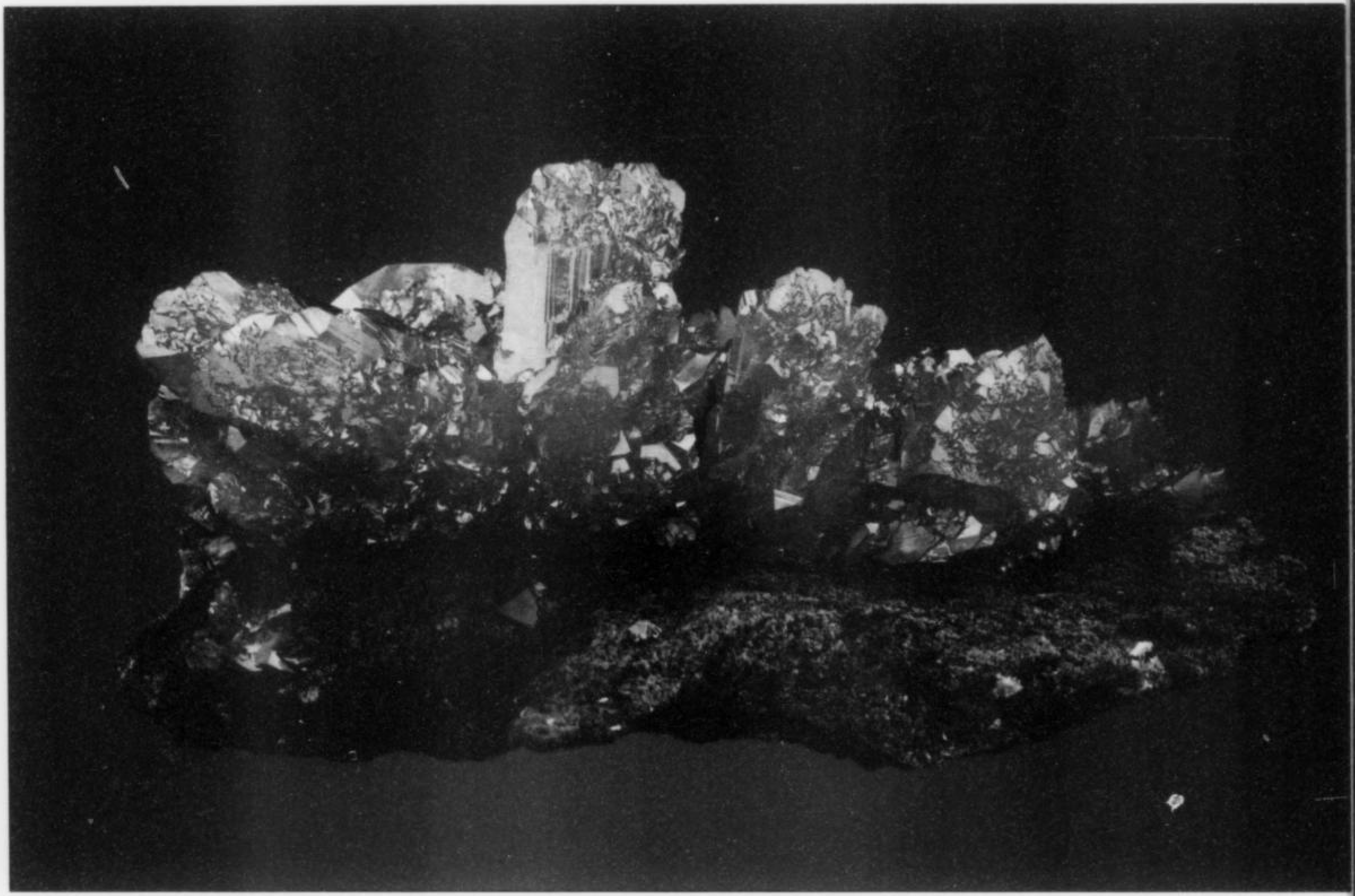
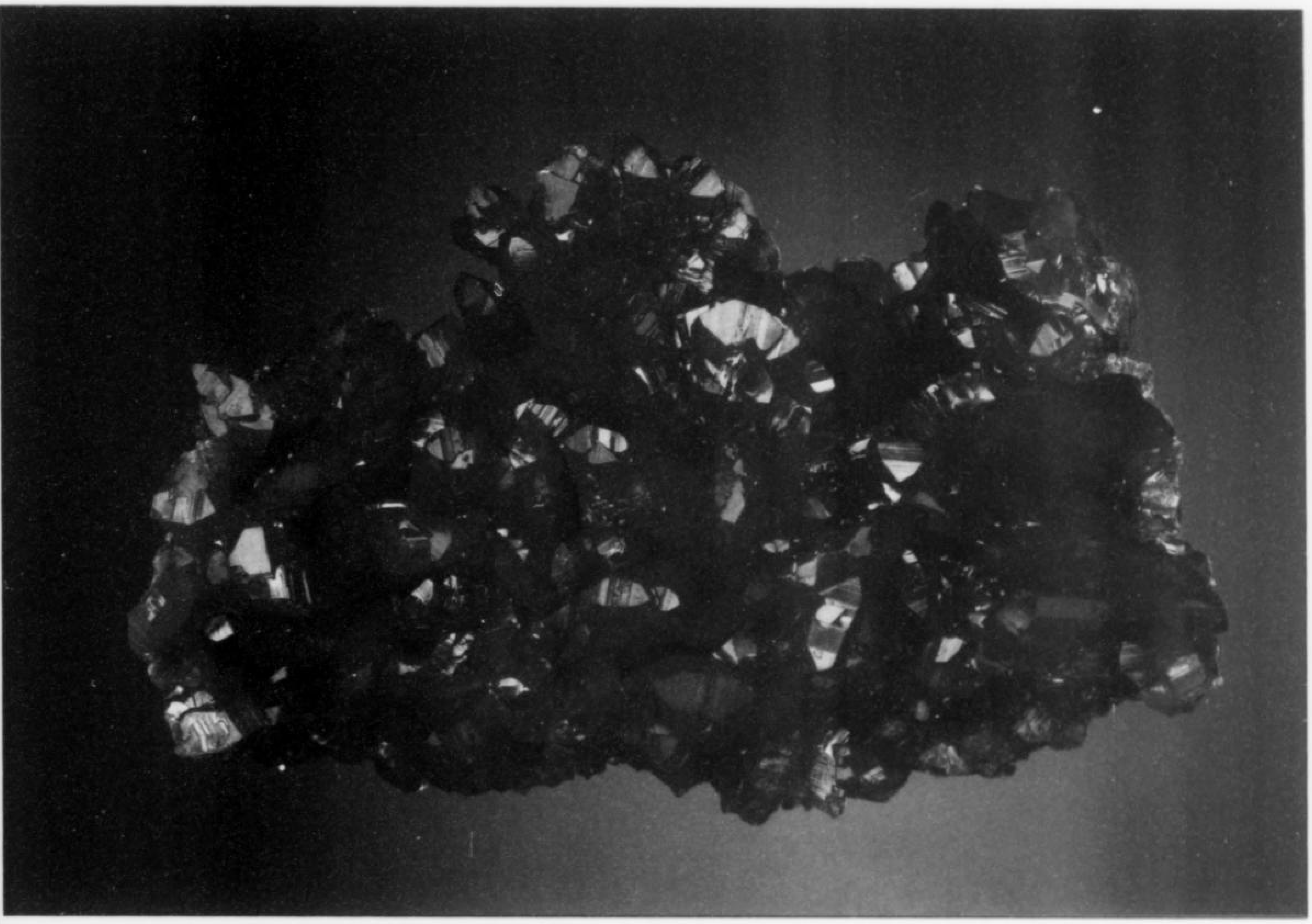
Tucson TGMS-MSA-FM Symposium 2001

The twenty-second annual Mineralogical Symposium will be held on February 10, 2001 at the Tucson Gem and Mineral Show. It is cosponsored by Friends of Mineralogy, the Tucson Gem and Mineral Society, and the Mineralogical Society of America. The topic of the symposium is **Minerals of Russia**—the Tucson Show's theme for 2001. Papers on descriptive mineralogy, paragenesis, classic and new locations and related subjects about the minerals of Russia are welcome. An audience of amateur and professional mineralogists and geologists is expected.

Anyone wanting to present a paper should submit a 200 to 300-word abstract to Raymond W. Grant, Mesa Community College, 1833 W. Southern Avenue, Mesa, AZ 85202; Tel: (480) 461-7008; Fax: (480) 461-7234; e-mail: rwgrant@mail.mc.maricopa.edu.

Presentations will be twenty minutes in length, followed by a period for questions. Abstracts must be submitted by September 10, 2000. The abstracts will be published in the January/February 2001 issue of *The Mineralogical Record*.





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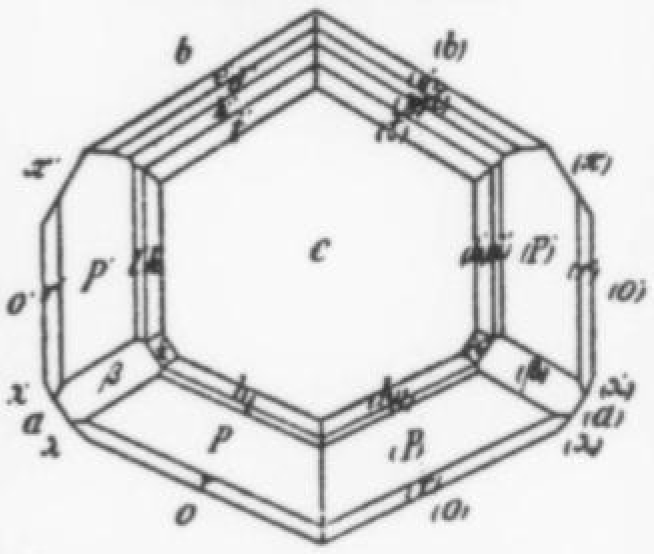

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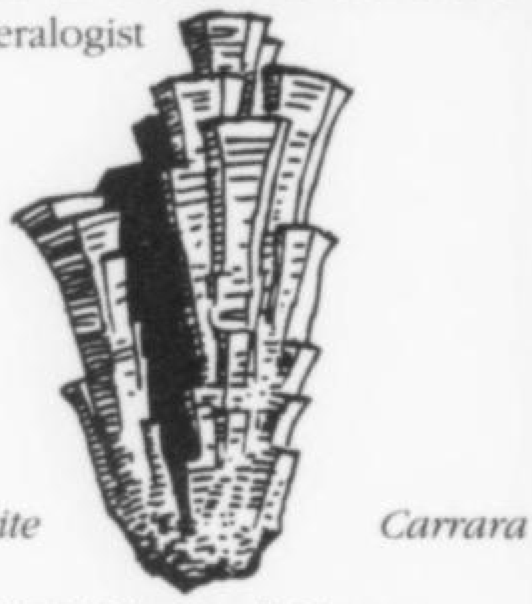

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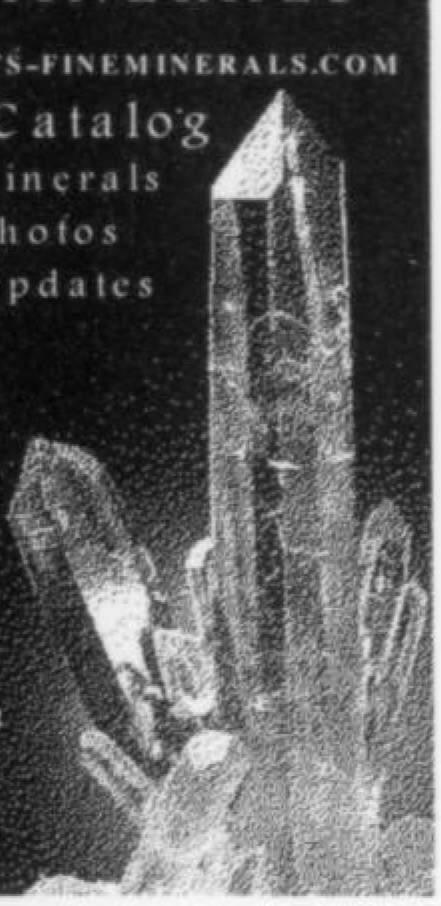

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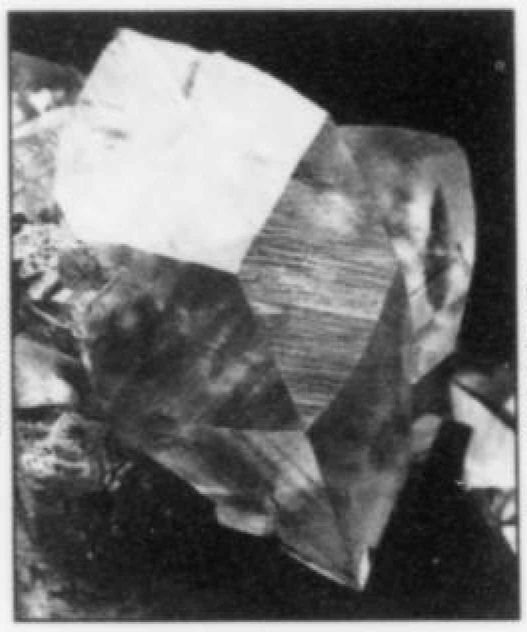

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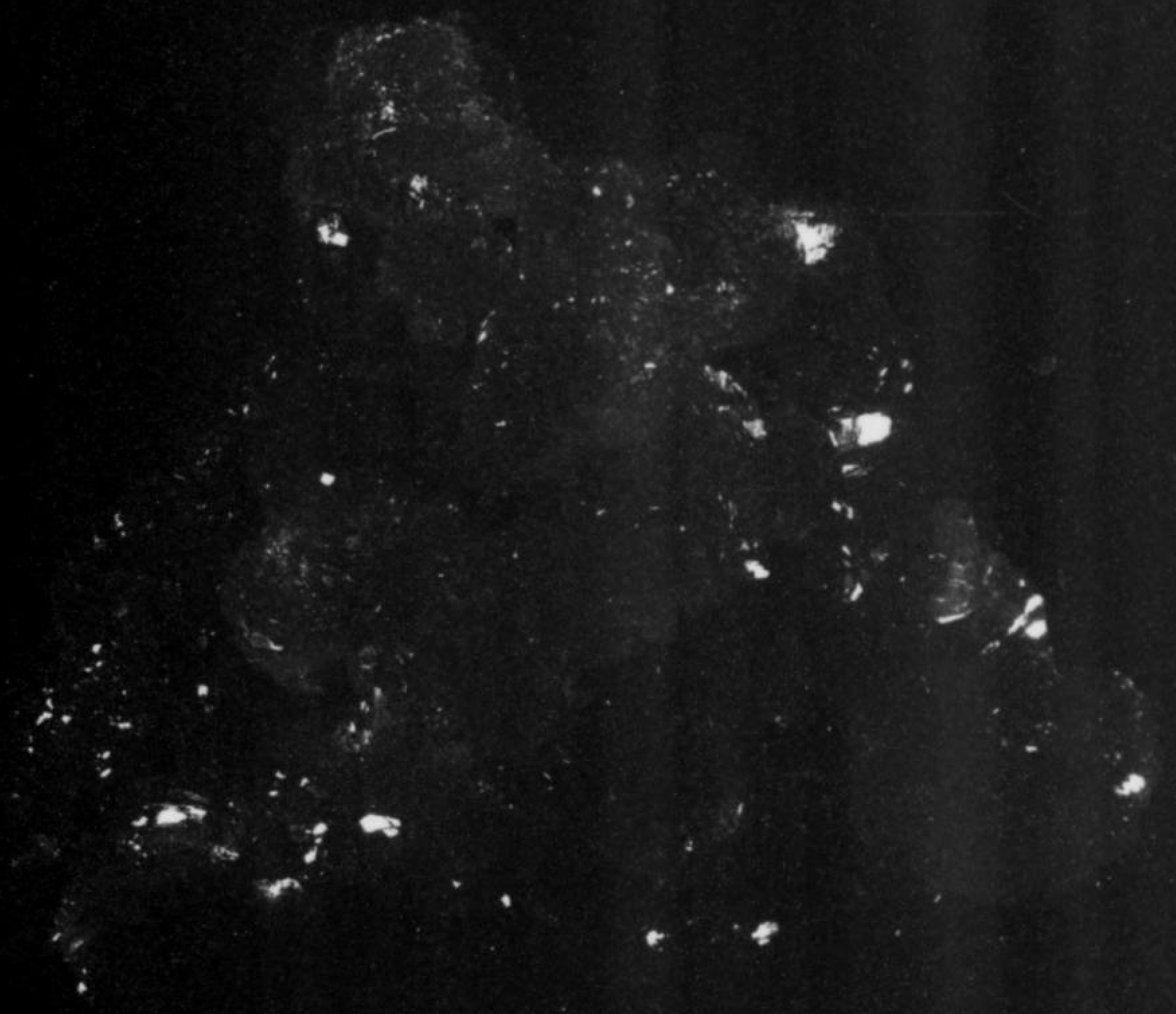

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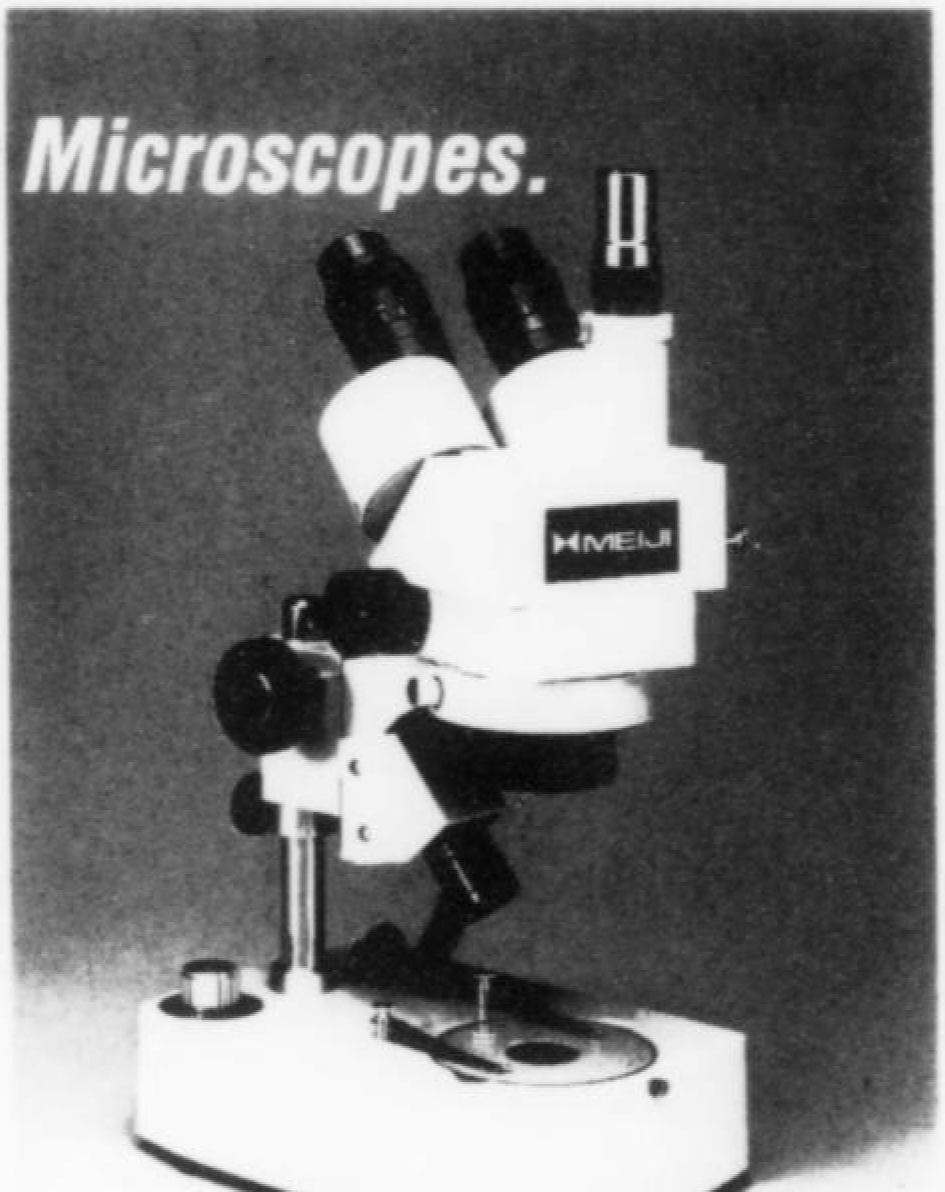

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