the Mineralogical Record

Volume Twenty-eight, Number Five
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PRINCIPLES OF GEOLOGY
C. LYELL VOL.
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THE MINERALOGICAL RECORD

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Articles

Columns

COVER: CASSITERITE twin, 5 cm, on matrix, from Yunan, China. Roberts Minerals specimen; Jeff Scovil photo.

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notes from the EDITOR

MINERAL CASES (VII)

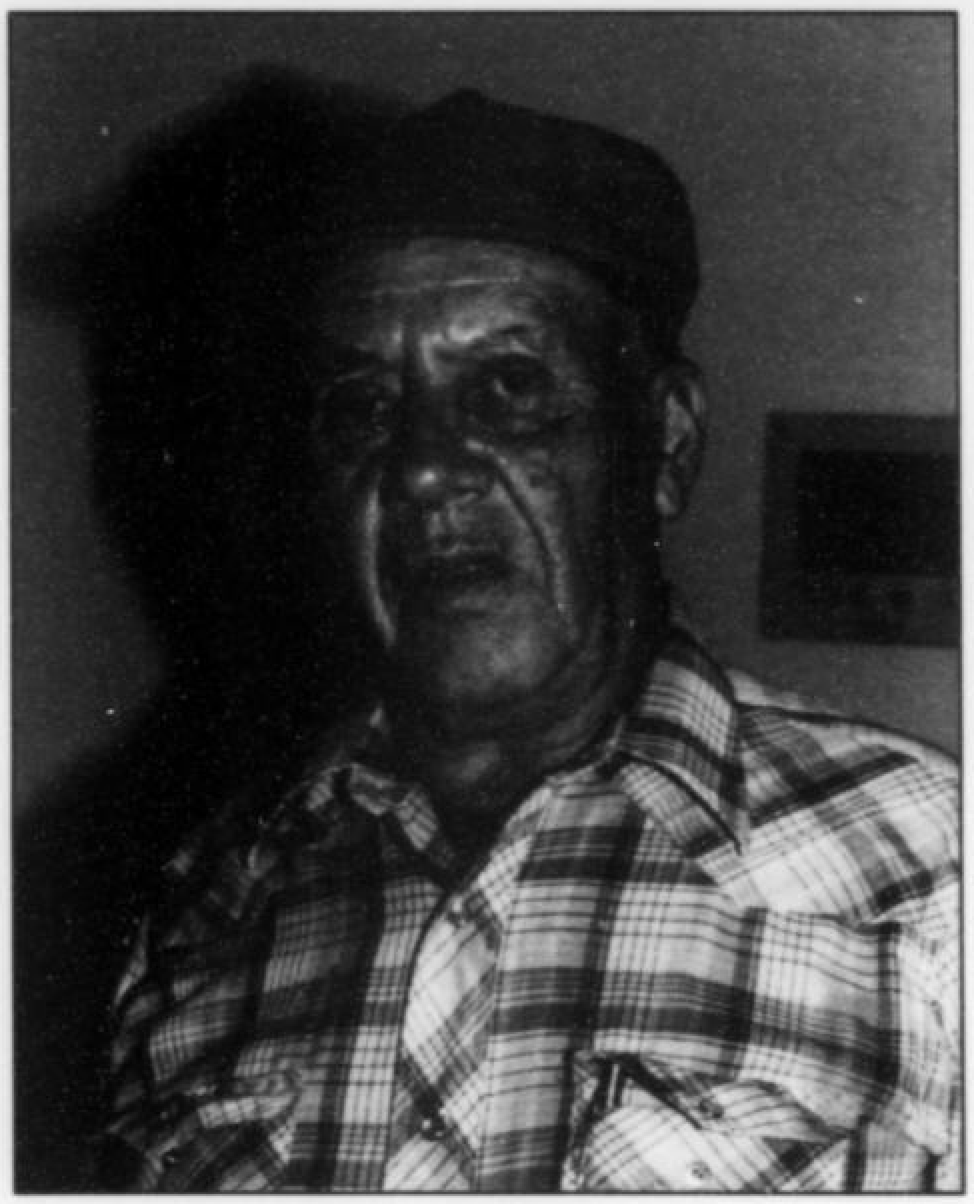
Our featured supplier of collector cabinetry this time is Steven J. Reutlinger, **Monadnock Mineral Display,** P.O. Box 39, Greenfield, NH 03047 (Tel: 603-547-3648). Steve is a member of the Keene, New Hampshire, mineral club and has a collection which includes many fluorites, especially from the William Wise mine in Westmoreland, New Hampshire. A woodworker since the age of 8, he operates a cabinetry shop specializing in custom kitchens and residential cabinetry. Lately, however, he has been doing a fair amount of work for mineral collectors, and has now developed a line of cabinets especially suited to that hobby. His catalog includes units with thumbnail storage drawers, open-shelf areas, and glass fronts, with or without built-in lighting. The cabinets, which start at $65 and go up to $850 or more, can be constructed of maple, oak, ash, red birch, cherry, mahogany, black walnut, bird's-eye maple, sassafrass, or other more exotic woods. The four-drawer thumbnail cabinet pictured here costs $275. A big floor-standing model with drawers behind cabinet doors is priced at $750. Of course, custom pieces can also be produced. Steve takes pride in creating workmanship of the highest quality, and would gladly share ideas with other woodworkers. Incidentally, he also produces a complete line of specimen display stands in standard and exotic hardwoods.

HIGH ON ANTIQUARIAN BOOKS

A report in the British medical journal *Lancet* has shown that the fungus which feeds on old book paper may be mildly hallucinogenic, and that the "fungal hallucinogens" may actually cause an "enhancement of enlightenment" in readers! This may explain the attraction of certain very old and rare mineral books which, viewed strictly on their technical merits, are really not very good. So, the next time you decide to spend some "quality time" with your own book collection, you just might want to shut off the ventillation.

NOTICES

Died, Tony Otero, 71, of Magdalena, New Mexico. Tony operated Tony's Rock Shop in Magdalena for 26 years, and was caretaker of the famous Kelly mine, Magdalena district (see vol. 20, no. 1, p. 13–24), for over 30 years while it was under the ownership of New Jersey Zinc and Gulf Western corporations. He collected underground frequently at the Kelly, discovering a fabulous, large seam of blue smithsonite in the 1970's. From 1994 until his death he was Mine Marshall at the Kelly under its new owner, Millenium Inc., and in 1994 made a second great strike with J. Blue Sheppard. The best specimen from the 1970's is probably "the Royal Kelly," now in the collection of Jim Duncan; the best piece from 1994 is "The Bubble" (see *Lapidary Journal*, December 1995), now in the Richard Rice Northwestern Museum of Minerals in Hillsboro, Oregon. Countless thousands of other fine Kelly mine specimens have also found their way into museums and private collections around the world, purchased from Tony at his shop or from his motel room at the old Desert Inn during the annual Tucson Gem & Mineral Show. His substantial personal collection was merged with specimens from the 1994 find and sold by Millenium Inc. during 1994 and 1995. Tony, a veteran of World War II (he was among the troops surrounded by enemy forces at the Battle of the Bulge), was buried in a special plot near the Kelly mine donated by J. Blue Sheppard.



Tony Otero
(1925–1997)
Photo taken at the Tucson
Show 1988 by Kent England.

Died, Julian Grier Blakely, 77, in Tucson. Julian Blakely was a long-time mineral collector, professional photographer and antiques afficionado. He lived for many years in Greenville, Mississippi, where he ran a successful photo supply and photography business.

In 1949, after a collecting trip to the Illinois fluorite district, he hit upon the idea of mass-producing attractive walnut specimen bases and lettering them in gold with species name and locality. Within a short time he was marketing them under the name of E.S.P. (Esthetic Specimen Presentation) Bases. Brown, walnut-grained plastic, soon replaced the expensive wood, and gold Old-English transfer lettering was supplied for elegant labeling. Blakely sold this product for many years, through ads under the name of *Blakely Mineral Gems* in *Lapidary Journal* and in early volumes of the *Mineralogical Record* (see his article, "Display specimens properly," in the August 1971 issue of *Lapidary Journal*, p. 684–687, 690–691, and his large ad in the *Mineralogical Record*, vol. 3, p. 285).

Around 1980 Blakely retired from the photography business and moved to Tucson, Arizona, where he served each year as a volunteer for the Mineralogical Record, running our silent auction at the Tucson Show, with the help of his wife Ruth (d. ca.1987). Still with plenty of energy to spare, he opened the Antique Mini-Mall on Grant Avenue as a "retirement business." His happy southern drawl and his gregarious personality made him many friends. He is survived by his fourth wife, Ellen, eight daughters, one son, and numerous grandchildren.

Died, Joe Cilen, 81, of Hawthorne, New Jersey. Joe was among the best known and best-loved mineral collectors in New Jersey; he was an active member of the Franklin-Ogdensburg Mineral Society, the North Jersey Mineral Society, and the Newark Mineral Society. He was also an avid gardener, growing prize-winning chrysanthemums. During more than 60 years of enthusiastic mineral collecting he assembled an enormous general collection of 20,000 catalogued mineral specimens, a species collection of 3,000 specimens, specialized collections of New Jersey traprock minerals, Långban minerals, and (of course) Franklin-Sterling Hill minerals, plus a major collection of mineral books and literature. (Most of the Franklin material has been sold at auction; the disposition of everything else is still, as of this writing, pending.) Joe was a valuable friend of mineralogy, competent, enthusiastic, good-natured and positive in his approach to all things; we can only hope that his example will live on among the generations that follow. ◆

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Assistant Curator: Lynn Heizler
Tel: (505) 835-5166
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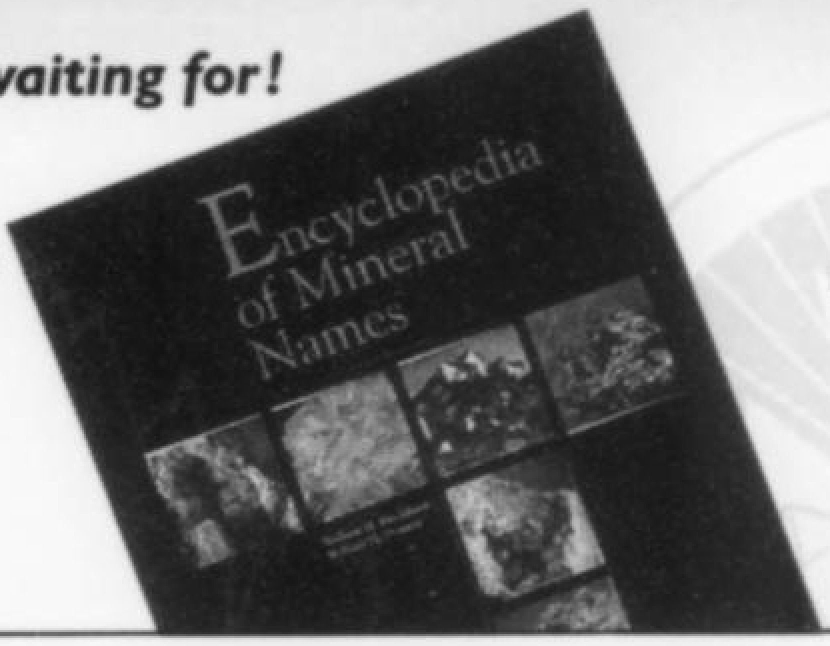

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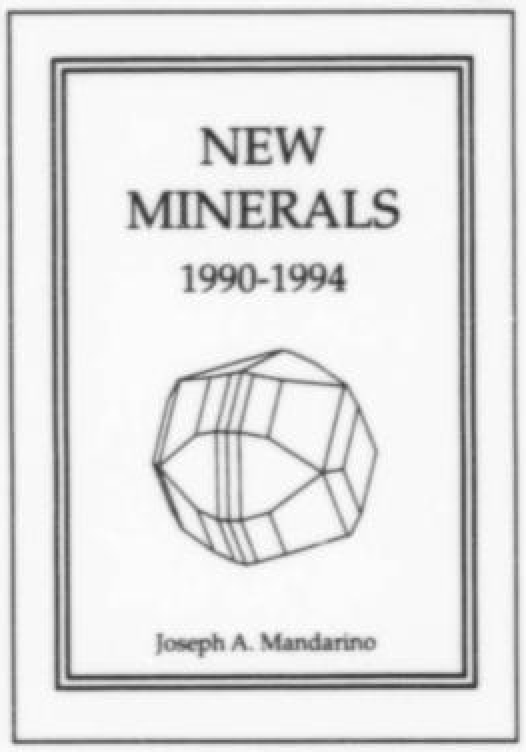

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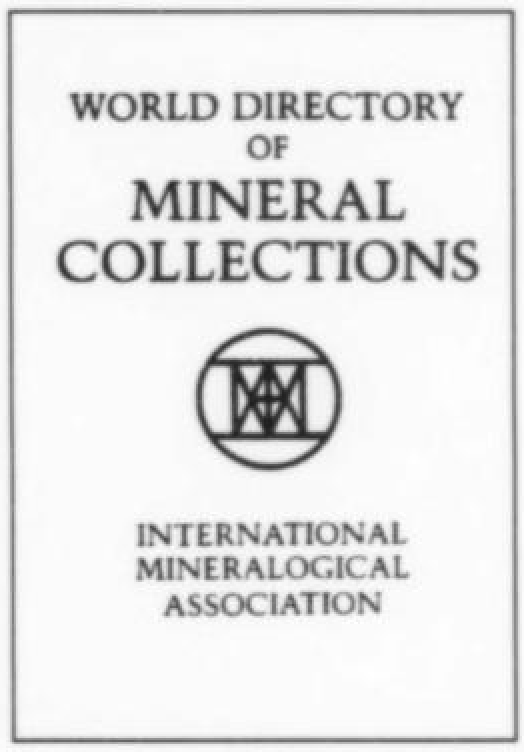

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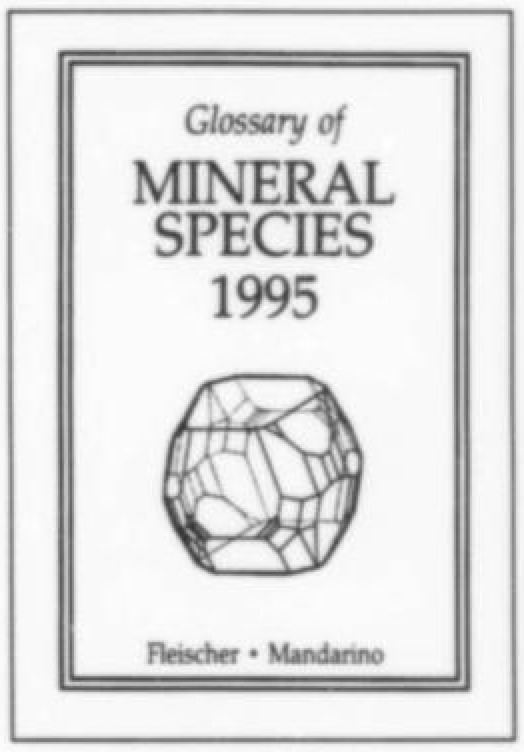

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LINCOLN COUNTY, KENTUCKY

Alan Goldstein
1607 Washington Blvd.
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Bill McKenzie
227 Southport Drive
Lexington, Kentucky 40503

Since 1964, a roadout in central Kentucky has been producing thousands of quartz geodes containing a variety of minerals including extraordinary specimens of millerite, jamborite (?) and unusual forms of pyrite.

INTRODUCTION

The Halls Gap geode locality is located along U.S. Highway 27, 7 km south of Stanford, Kentucky, near the community of Halls Gap (Fig. 1). It lies near the top of an escarpment known as Muldraugh Hill. In the development of the improved highway, road engineers serendipitously uncovered what is probably the best millerite geode horizon known in the world. Geodes from this roadcut have been a favorite among midwest collectors for years.

Discovered in 1964 by members of the Cincinnati Mineral Society (Medici, 1981), the locality has produced thousands of fine display specimens and many more study specimens. This article will examine the geology, stratigraphy, origins, and mineralogy of the locality as it relates to the formation of the geodes.

GEOLOGY

The Halls Gap millerite-bearing horizons are situated near the contact of the Halls Gap and Muldraugh members of the Borden Formation in east-central Kentucky. The units are exposed near the summit, known to geologists as Muldraugh Hill, which borders a section of Kentucky's Bluegrass region to the south and west. The Borden is apparently the result of deltaic conditions similar to those of the Borden siltstone in Illinois, as described by Swann *et al.* (1965) and Lineback (1966).

The Halls Gap occurrence lies near the apex of the Cincinnati Arch, a large anticlinal fold that runs generally in a north-south direction. It dips toward the east and west. The crest of the Arch, called the Jessamine Dome, is located about 40 km north. The Cincinnati Arch trends southeast to another structural high called the Nashville Dome. Mississippi Valley-type deposits associated with the Cincinnati Arch include the central Kentucky fluorspar district and the zinc deposits in Smith County, Tennessee.

In Kentucky, the Borden Formation consists of, from the base upward, a sequence of shales, siltstones and silificied limestones which differ locally in proportion (Weir, 1970). In the Halls Gap area, it is conformably underlain by New Albany Shale of Late Devonian or Early Mississippian age, and overlain by the Salem Limestone of Middle Mississippian age. These units are quite evident in the roadcuts exposed on U.S. Highway 27 near the town of Halls Gap. Near the top of the hill the contact between the Halls

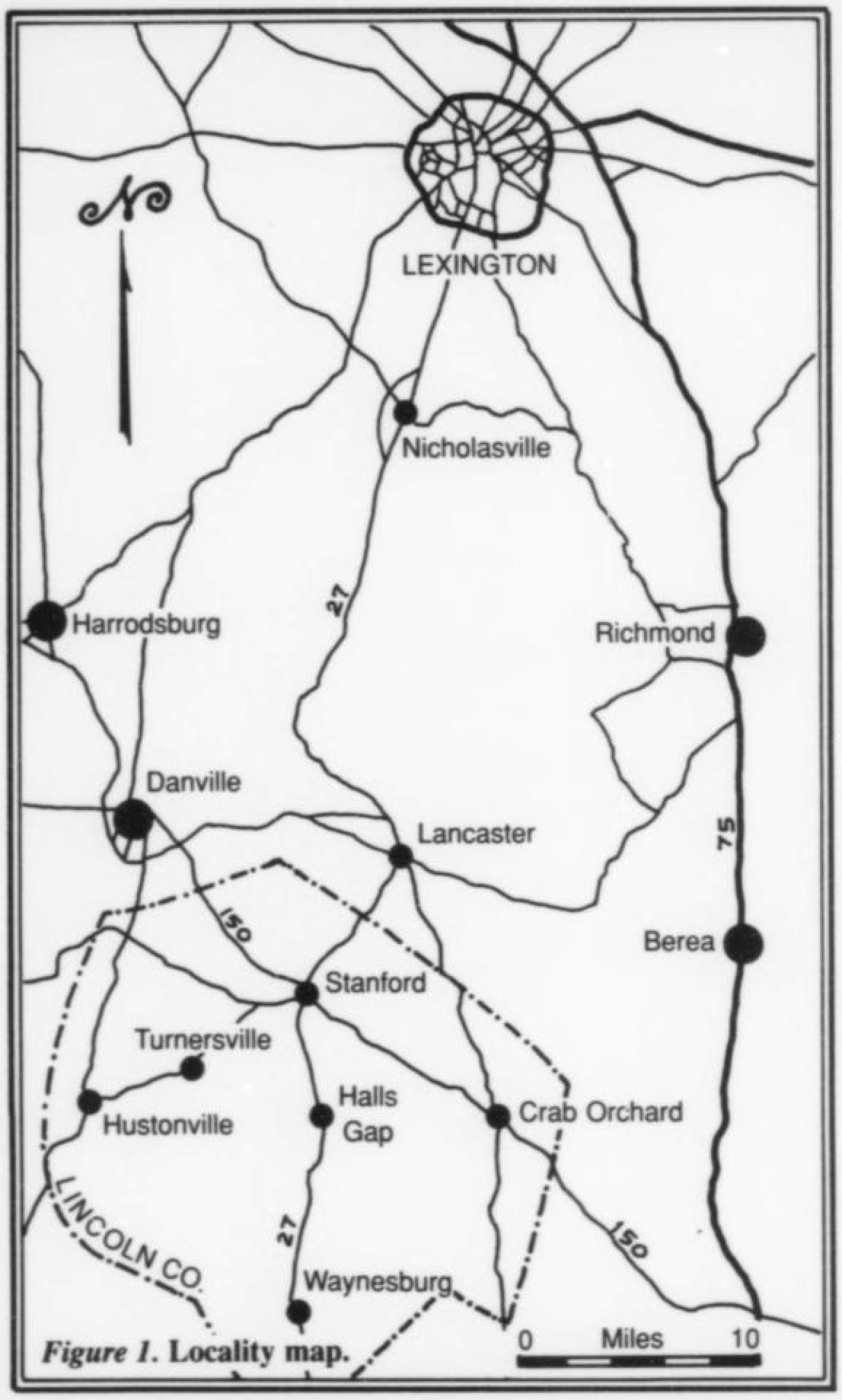

Figure 1. **Locality map.**

Gap and Muldraugh member is exposed. It is marked by a thin seam of dark green glauconitic shale (Weir, 1970) which is persistent throughout the Midwest. It was deposited contemporaneously over a vast area, extending from Ohio to Alabama and from Virginia to Kansas; it may record a period of extremely slow deposition caused by a sudden rise in sea level (Whitehead, 1976).

The overhanging ledge in the road cut represents the basal unit of the Muldraugh Member, whereas the face underneath, which has been driven back by years of collecting, represents the top-most units of the Halls Gap Member. Millerite-bearing geodes occur most abundantly in the 1.4-meter-thick unit, which is third below the contact. Rarely, millerite-bearing geodes are found in the overhang (Muldraugh); infrequently they are found in the first two units below the contact, and just slightly more frequently in the fourth and fifth units below the contact. There are two areas within the 1.4-meter unit (what is called the "millerite zone" throughout this article) that are unusually rich in geodes, including larger geodes up to 15 centimeters in diameter. One is located about 30 centimeters below the top of this unit, the other about 30 centimeters above the bottom.

Geodes are distributed throughout the strata. The density of distribution varies for each stratum, but within each unit is relatively uniform. Clustering of geodes has been observed, especially in the overlying Muldraugh member. Clustering may be lateral or vertical. Vertical clusters may resemble carrots or chimneys. Some geodes share common walls. Clusters of two to four geodes with shared walls are common, especially in the glauconitic layer. In larger geode clusters (i.e. four or more) the contents of one is a reliable guide to the mineralogy of an adjacent geode.

The millerite-bearing portion of the outcrop is characterized by alternating layers of siltstone of two lithologies: shaley and massive. The lowest exposed interval is a shaley siltstone containing very few geodes. Immediately above this is a massive siltstone ledge, which is probably dolomitic. The unit contains geodes, predominantly carbonate-filled (calcite, dolomite and ferroan dolomite or dolomite with oxidized pyrite). Much of this layer is covered with talus from collectors working the layers above.

Figure 2. **East side of the Halls Gap roadcut; removing geodes. Alan Goldstein photo.**

Figure 3. **West side of the Halls Gap roadcut. Bill McKenzie photo.**

The "millerite zone" is capped above and below by a shaley siltstone. The lower siltstone is rarely exposed. The eastern side of the roadcut is kept covered with debris from collectors working higher layers. The western side is heavily overgrown, but is relatively accessible during winter months.

The upper shaley siltstone is 25 to 30 cm thick and is very glauconitic. The rock shows extensive fossilized worm burrows filled with glauconite. The entire shaley siltstone horizon is a deep, bright green. Geodes collected from this layer are easily recognized by their distinctly green exterior.

Above the "millerite zone" is the massive ledge, almost 1.5 meters in thickness, which forms a precarious overhang where collectors have mined geodes. The geodes from this massive siltstone are frequently of large diameter, and there is an overall greater volume of geodes in this layer as compared to the "millerite zone." Solid quartz nodules and geodes to 15 cm in diameter are found in equal abundance. Marcasite nodules from 1 to 15 cm are especially common in this layer; reaction halos due to weathered

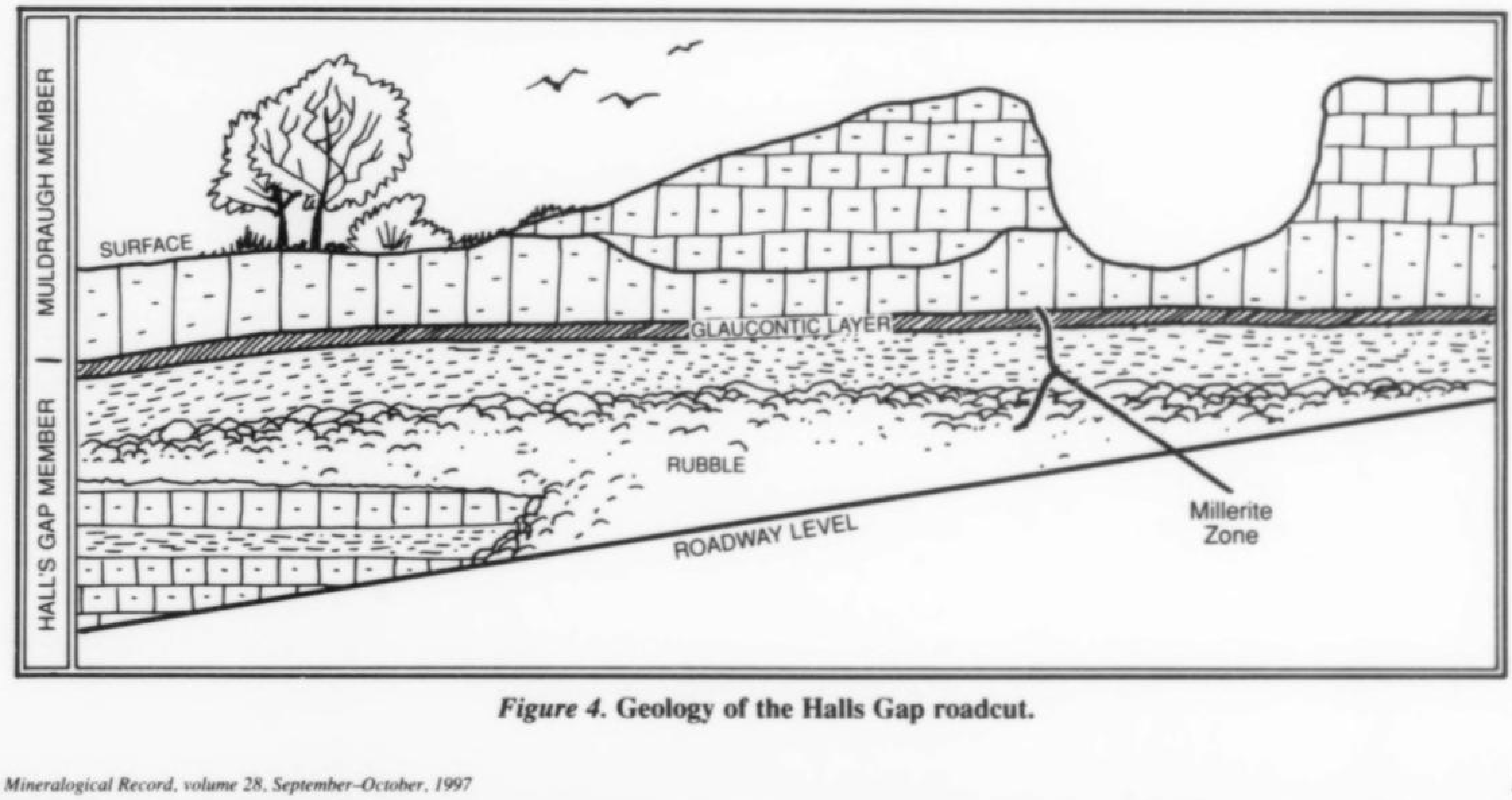

Figure 4. **Geology of the Halls Gap roadcut.**

marcasite form multicolored rings on the massive siltstone. (Such nodules are not found in the "millerite zone.")

Of the geodes found in this layer about a third contain quartz only. Another third are calcite-filled or contain calcite only. The remaining third contains sulfides (pyrite dominating) and may be partially or wholly filled with calcite. One geode in 50 may contain dolomite. Millerite is uncommon in this layer. Millerite epitaxially growing on chalcopyrite or (rarely) sphalerite is more common than as free-standing filaments. Sphalerite crystals to 1 cm occur with smaller pyrite and chalcopyrite crystals encrusting them. Pyrite cubes modified by the octahedron are predominant, though octahedral and pyritohedral forms may be found. Cubes elongated in one or two directions may also be found. Some of the pyrite is beautifully iridescent, much more so than in the "millerite zone." Among geodes in the Muldraugh and upper Halls Gap members, chalcedony is more abundant than drusy quartz (about 10 to 1).

The highest units in the sequence contain fewer geodes. The lithology of these layers consists of massive siltstones in horizontal layers, along with cut-and-fill channel deposits. They are largely inaccessible, and horizontal exposures are relatively small.

The concentration of sulfide-bearing geodes from this locality is similar to a low-grade Mississippi Valley-type deposit. By low-grade, we mean a similar mode of development but low in sulfide minerals. The usual minerals in Mississippi Valley-type deposits are galena, sphalerite, chalcopyrite and pyrite (all present here in varying amounts). Mississippi Valley-type deposits are not associated with igneous rocks, nor are the minerals thought to have been deposited with the enclosing rocks. Instead, this type of ore deposit is believed to originate by gradual leaching of metals from basinal sediments by hot brines moving upslope through the sediments. The original metal content may be very low—the lead for galena, the most important Mississippi Valley-type ore, is derived from trace amounts of lead in potassium feldspar! The metals are deposited where they encounter sulfide ions. In the case of geode minerals, the sulfide may be derived from the reduction of sulfate from precursor minerals such as gypsum and anhydrite (D. Coskren, personal communication, 1991). The full lateral extent of sulfide-bearing geodes on the Muldraugh escarpment is not known.

For comparison, another geode-bearing deposit located on a structural high is found on the Muldraugh Dome in Meade County, Kentucky (Goldstein, 1989, 1990). All sulfide minerals (primarily pyrite) have altered to an unknown, bladed mineral associated with powdered goethite. Curiously, fluorite crystals are found in the geodes on this structural feature, although they are almost unknown in other occurrences.

There are several geode-bearing outcrops farther down the road from the main Halls Gap exposures and lower in the stratigraphic section. However, only the millerite-bearing roadcut is dealt with here in detail. The next roadcut downhill is also in the Halls Gap member, and contains sulfides and abundant dolomite. The sulfides, which are not as spectacular as in the "millerite zone," consist primarily of pyrite and chalcopyrite. Some of the chalcopyrite has been altered to malachite.

Halls Gap is only one of many millerite geode occurrences across the Midwest. Other well-known localities include those near Keokuk, Iowa (perhaps the "old classic" locality); Hamilton, Illinois; Bedford, Indiana; and St. Louis, Missouri. Most of these millerite occurrences appear to have, in part, a stratigraphic control. The common thread that connects most of them is this: they are at or near the top of a thick pile of deltaic sediments, deposited in late Osagean (Middle Mississippian) time.

THE GEODES

The geodes at Halls Gap range from spherical to flattened and cylindrical in shape. Some geodes, especially in the Muldraugh Member, are associated with marcasite nodules. These geodes present storage problems, because the marcasite deteriorates. The chalcedony rind prevents the decomposing marcasite from attacking the geode's interior, but the acidic byproduct of the decomposition is deleterious to storage containers made of paper or cardboard.

Some geodes have a double wall. The outer wall may contain pyrite, frequently associated with red chalcedony. The gap between the two walls is seldom more than 3 mm. The interior of the inner geode is frequently solid quartz.

No systematic attempt has been made to plot the lateral distribution of minerals, however more millerite has apparently been found in geodes on the east side of the roadcut (as indicated by the heaviest collecting efforts). The western roadcut has not been as extensively collected; there is one relatively small "mined" area.

One of us (B.M.) has collected sufficiently to gain an understanding of some lateral mineralogical variation. Three occurrences are noteworthy. The north end of the eastern side of the roadcut has an odd form of calcite resembling blisters. The second area lies about 15 meters south, at the corner where collectors have removed the most rock. Here, large octahedral pyrite crystals are abundant. The northern 15 meters of the eastern roadcut has produced 75% of the jamborite. In the same area is a fairly persistent layer of large (to 5 cm) calcite rhombs and calcite fills with some millerite and other sulfides without calcite. This layer is in the lowest 25 cm above the lower shale unit. No other significant mineralogical differences have been noted within the outcrop.

The source of nickel in the local mineralogy is thought to be iron-nickel meteorites. Since meteoritic material continually "rains" down to earth as microscopic dust grains and as occasional meteorites, this source seems at least plausible. There are large cryptoexplosive structures in Shelby and Jessamine Counties, north of Halls Gap, 88 and 69 km respectively. The Middlesboro structure lies 125 km southeast, and the Serpent Mound structure in Adams County, Ohio, and several similar structures in Tennessee are located within a 160 km radius. Any or all of these probable meteorite impacts could have contributed quantities of nickel to the surrounding rock layers through groundwater over tens of millions of years.

D. Coskren (personal communication, 1991) proposes that the glauconite could be a reservoir for nickel. As an iron-magnesium sheet silicate, it could accommodate nickel in substitution for the iron and magnesium. It has been shown to act as a "scavenger" for heavy metals.

Carbonate minerals were deposited from meteoric water acting on limestone deposits. They are widespread in geodes throughout the region.

The origin of the geodes has been a subject of speculation for many years. One popular theory was developed by Chowns and Elkins (1974). Their studies indicate that geodes were preceded by anhydrite or gypsum nodules. The source was thought to be hypersaline water formed in an enclosed unreplenished basin. (Such an area is called a sabkha.) However, the nodular gypsum or anhydrite that preceded the geodes could not have formed in a restricted basin because the depositional characteristics of the rock that contains these geodes does not match the type found in a sabkha. Many geode-bearing rocks in the area (though not at Halls Gap) are richly fossiliferous. Hypersaline seas are not conducive to an abundance of life. The Borden delta, the depositional feature in which the Halls Gap geodes occur, has been studied by numerous geologists. None describe the formation as being a shallow, hypersaline basin.

Where, then, was the source of the anhydrite/gypsum? Dodd *et* *al.* (1987) review previous papers on the subject which were not seen—Maliva (1985, 1986) and Dodd *et al.* (1984). They theorize that the source of the anhydrite or gypsum was most likely the overlying St. Louis Limestone. That formation has been eroded away at Halls Gap. Throughout much of Kentucky and Indiana, the St. Louis Limestone has features characteristic of sabkha deposition. At localities in north-central Kentucky and south-central Indiana massive beds of gypsum with lesser amounts of anhydrite can be found at depth. The brines generated during the time of the deposition of the St. Louis Limestone are thought to have leached down from the overlying evaporites to form the nodules that would eventually become geodes. The brines would have been saturated with gypsum or anhydrite and would have had a high magnesium/sulfate ratio. This would lead to dolomitization (which has been observed in strata of comparable age). As dolomite is formed, calcium is released to combine with the sulfate to form gypsum or anhydrite. As sulfate ions are removed (combined with calcium), additional dolomitization would occur, which would continue the cycle.

At some point after the rock was formed, the anhydrite or gypsum was replaced by chalcedony on the outer edges, forming a geode shell. Further sulfate dissolution may have created a void in which addition mineral deposition could occur. It is possible that the brecciation observed in the inner layers of chalcedony, found in many Halls Gap geodes, was the result of the sulfate being removed, combined with lithostatic pressure compressing the geodes. Slumping and fracturing of the chalcedony, possibly from dissolution, occurred before additional minerals were deposited.

MINERALS

Anatase TiO_2

Anatase has been reported as red to butterscotch-yellow blades on sugary quartz (P. Smith, personal communication, 1991). It was identified by Dr. Harvey Belkin (U.S. Geological Survey) by electron microprobe analysis. Crystals are very tiny, requiring 30 to 60x magnification to be seen well. Anatase-bearing geodes appear to be restricted to the glauconitic layer at the contact of the Halls Gap and Muldraugh Members.

Calcite $CaCO_3$

Calcite is a common mineral which often completely fills the interior of geodes. Crystals form low-angle rhombohedra that range from less than 1 mm to greater than 5 cm across. The larger crystals show internal zoning due to inclusions of a dark mineral or carbonaceous substance. Crystals can be single or intergrown in flower bud-like forms. Calcite crystals are typically translucent white and do not fluoresce. Crystals have occasionally been found impaled on millerite. Overlapping relationships show that calcite is usually one of the last minerals to form. Sulfides, particularly chalcopyrite are found suspended inside calcite. Some calcite may have minute pyrite crystals sprinkled on the faces. The most attractive calcite is found contrasting sharply against bluish black chalcedony.

Calcite may be locally colored green by jamborite. It is unknown whether the color is a stain or a result of microscopic acicular crystals penetrating the calcite.

Rarely, calcite occurs as a crust of minute, intergrown, rhombic crystals. This crust may be observed directly on chalcedony and occasionally forms hemispherical bubbles. The fragile nature of this material may lead to its partial destruction when the geode is cracked open with a hammer. The finest examples of these calcite "blisters" occur on chalcedony with pyrite cubes sharply modified by the octahedron. Associated with this calcite is another kind that may have formed by dissolution. Although 10x is necessary to see it well, this bizarre calcite resembles colorless to white flos-ferri aragonite.

Geodes collected at Halls Gap that are completely calcite-filled may be carefully etched with weak hydrochloric acid, as sulfide minerals may then be exposed. In addition to "frozen" sulfides previously mentioned, sprays of millerite on chalcopyrite, individual millerite crystals, marcasite and pyrite may be found in otherwise bland-looking geodes. Microcrystals (single and intergrown) may be collected by the dozens in some of these geodes.

***Chalcocite** (?)* Cu_2S

Chalcocite was described from the Halls Gap area by Chromy (1972) as occurring in geodes. Chromy's report was not seen by the writers. However, one of us (B.M.) has a specimen which, based on visual identification, appears to contain chalcocite. This identification requires confirmation.

Chalcopyrite $CuFeS_2$

Chalcopyrite is an abundant sulfide mineral at Halls Gap, particularly in the "millerite zone." Crystals range from microscopic to 3 mm on edge. The habit is a simple disphenoid, although some crystals appear to be etched or to have unusual modifications. Some crystals form "flags on a pole," elongated in one direction and serrated along the edges. Intergrown chalcopyrite crystals are often found. Chalcopyrite is usually a brass-yellow color. Some of the most spectacular crystals show a range of iridescent colors, from red to magenta, green, blue and purple. Some are even a lustrous black.

The most curious chalcopyrite associations are with millerite. Chalcopyrite-millerite associations tend to be complex. Chalcopyrite probably formed in several episodes, at least one generation having formed after the millerite. Tiny crystals are found rarely in the midst of millerite strands or perched at the end of a single acicular crystal. Small disphenoids may be skewered by several millerite crystals. A 2-mm millerite crystal is known with more than a dozen very minute chalcopyrite crystals skewered across its length. Despite these rare examples, the bulk of the observed chalcopyrite appears to be among the earliest sulfides in the paragenetic sequence. Chalcopyrite may be coated by millerite, and some examples show a few millerite crystals which appear to protrude from the chalcopyrite. In other examples, millerite growth all but obscures the nucleating crystal. Some forms show a preferred orientation of millerite with respect to the chalcopyrite crystal faces. Ruez (1973) indicates that millerite occurs near the edges of chalcopyrite crystals. Polished sections showed substantial corrosion, probably prior to millerite deposition. Etched and corroded chalcopyrite crystals without millerite are common.

***Copiapite** (?)* $Fe^{2+}Fe^{3+}_4(SO_4)_6(OH)_2\cdot 20H_2O$

Copiapite is suspected as a decomposition product of pyrite and sphalerite (D. Coskren, personal communication), occurring as yellowish scales and crusts with these sulfides. A similar material associated with chalcopyrite could be copiapite or cuprocopiapite. Identification of these minerals requires confirmation.

Dolomite $CaMg(CO_3)_2$

Dolomite is less common than calcite at Halls Gap. Crystals occur in white to pink saddle-shaped aggregates. The interiors of geodes may be completely filled with pink dolomite. It formed late in the paragenetic sequence, though dolomite may be sprinkled with tiny pyrite cubes and may be stained orange or red by pyrite oxidation products. The best dolomite is found below the "millerite zone."

Galena PbS

Galena is very rare in the sulfide zone at Halls Gap, occurring

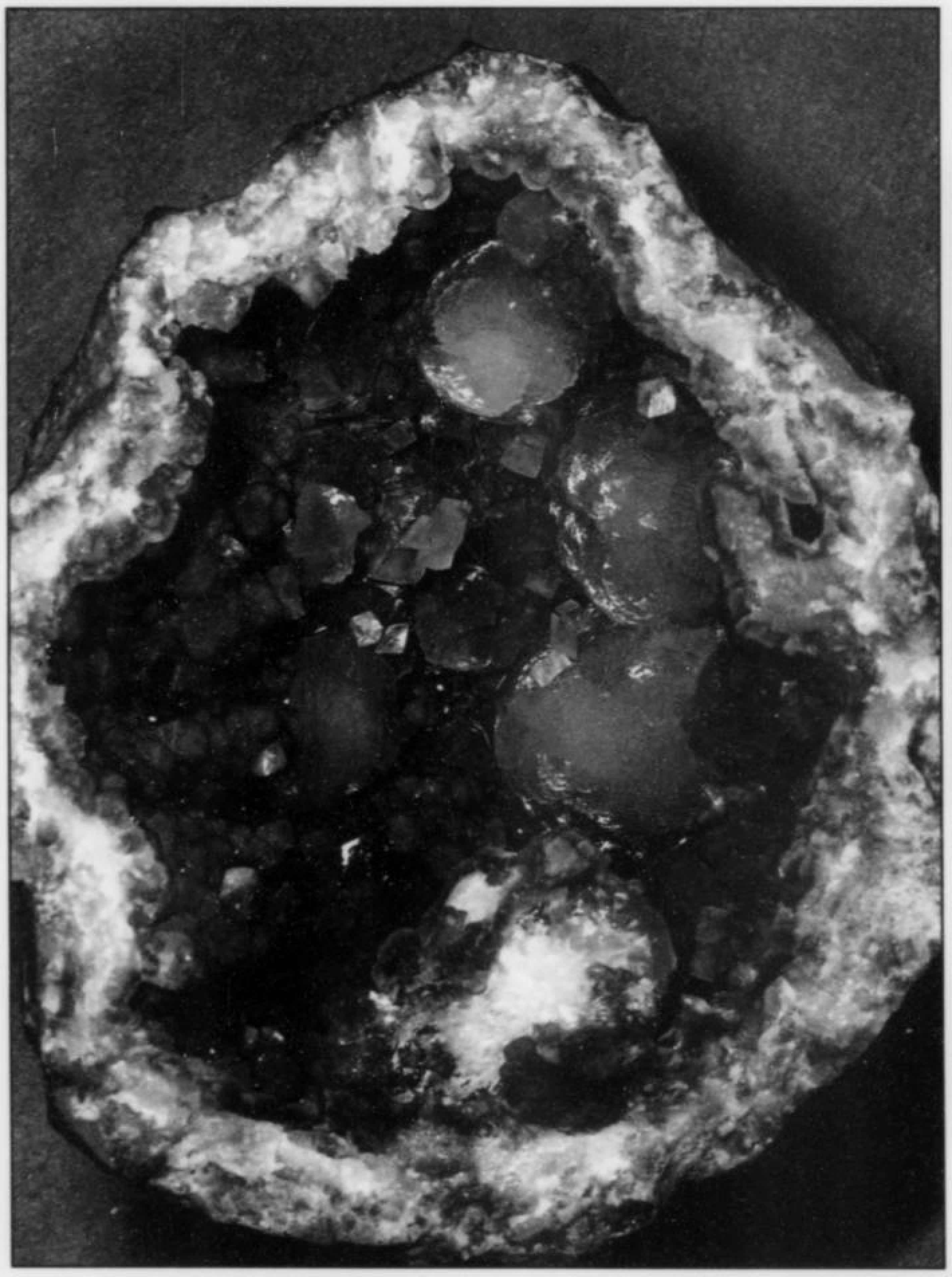

Figure 5. Geode, 5 cm, containing hemispherical aggregates of colorless calcite. Bill McKenzie collection; Chris Anderson photo.

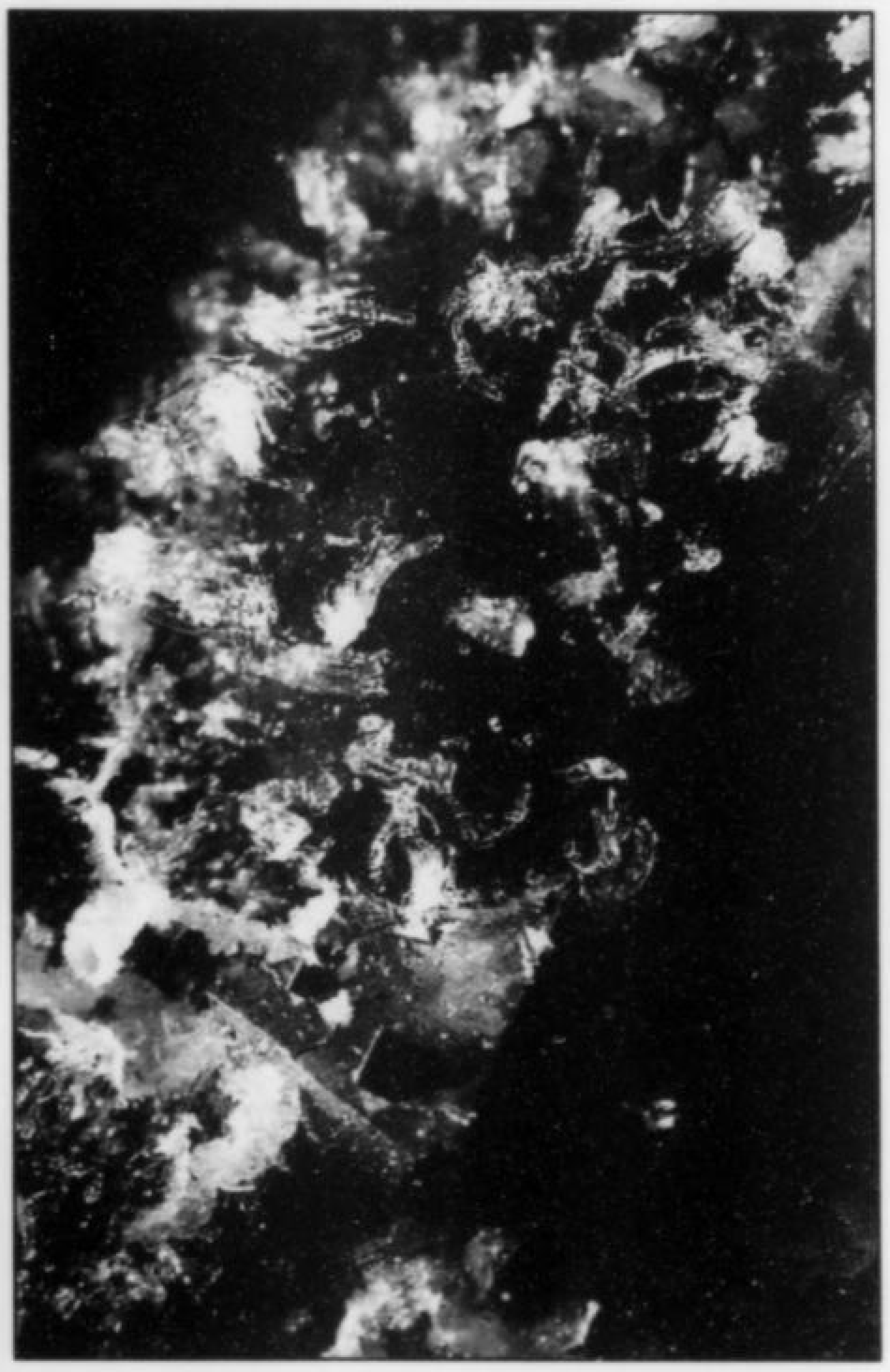

Figure 6. Flos ferri calcite or aragonite with 3 mm octahedral pyrite crystals and epitaxial cubes. Alan Goldstein collection; Chris Anderson photo.

Figure 7. Jamborite (?) after millerite lining a 4.5-cm geode cavity. Chris Anderson photo; Bill McKenzie collection.

Figure 8. Jamborite (?) after millerite lining a 2-cm geode cavity. Chris Anderson photo; Bill McKenzie collection.

Figure 9. Acicular millerite tuft, 1.5 cm, in a geode. Bill McKenzie collection; Chris Anderson photo.

Figure 10. Acicular millerite covering a 4-mm chalcopyrite crystal. Alan Goldstein collection; Chris Anderson photo.

Figure 11. Acicular millerite tuft, 3 cm, in a geode. Bill McKenzie collection; Chris Anderson photo.

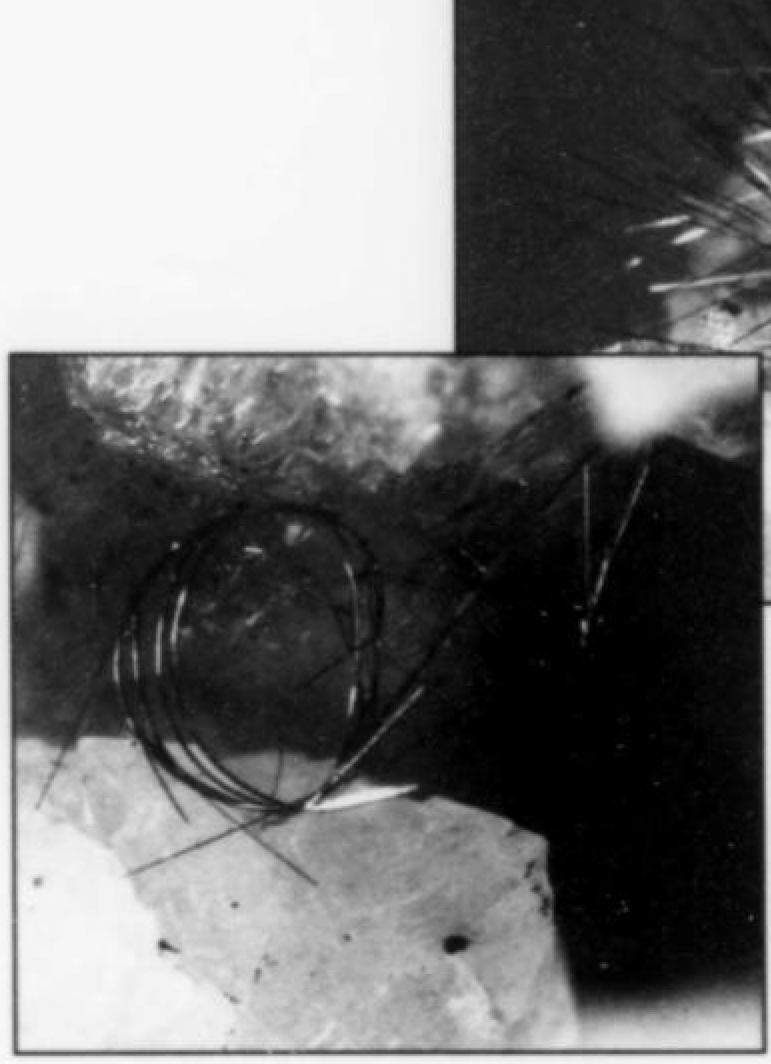

Figure 12. Millerite rings, 1 mm, in a geode. Alan Goldstein collection; Chris Anderson photo.

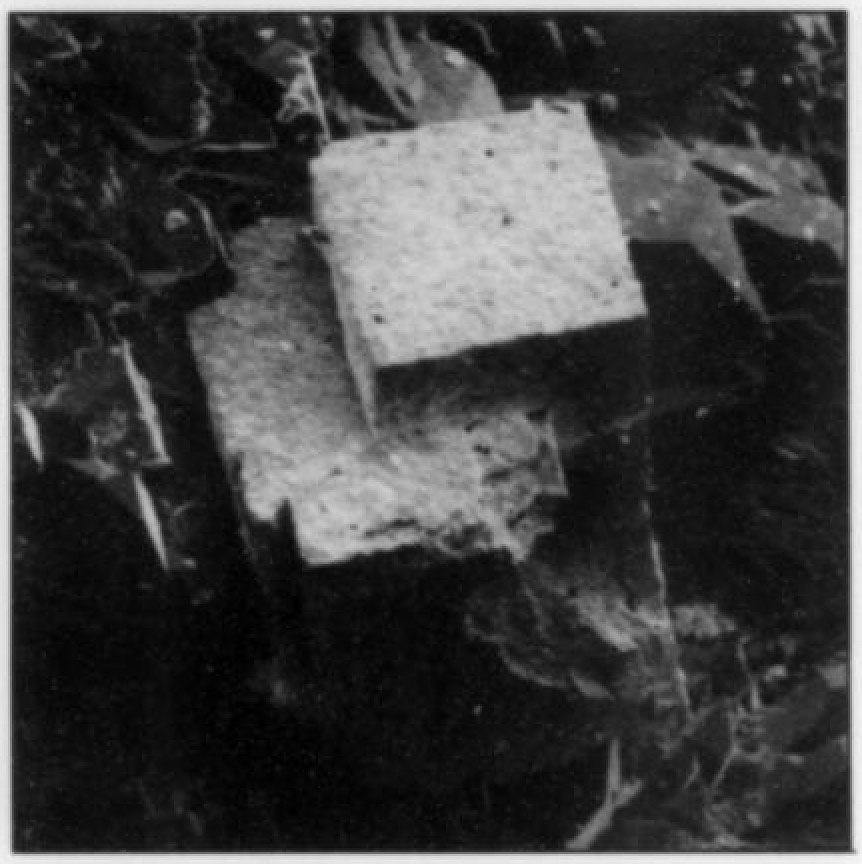

Figure 13. **Etched galena crystal, 0.4-mm on edge. Rudi Turner specimen and SEM.**

with less frequency than jamborite. Crystals are typically less than 1 mm across. The cubic form has been observed, though individual crystals may not be equi-dimensional on all axes. The metallic gray color may resemble silvery pyrite, but is usually distinctive. The texture of the crystals is most often granular, whereas pyrite is smooth. Of the half-dozen crystals observed, only one cube has lustrous faces. It is possible that the granular "galena" may be an alteration to anglesite ($PbSO_4$). Steve Garza (personal communication) indicates that a granular texture is common for anglesite after galena. Scanning electron microscopy has shown the granular texture to be from etched faces. The only clue as to its place in the paragenetic sequence is from a single cube found on a cube of pyrite. Cubic pyrite tends to be late in the sequence.

Glauconite $(K,Na)(Fe^{3+},Al,Mg)_2(Al,Si)_4O_{10}(OH)_2$

Glauconite occurs throughout the rock as inclusions in late-forming quartz. The contact between the Halls Gap Member and Muldraugh Formation contains an extremely rich glauconitic zone with layers and pods of bright pine-green silt and clay.

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

A single black lathe-like crystal of goethite (?) was observed in one geode, but was lost as it was detached. Its appearance resembled other goethite crystals found in geodes from other Kentucky localities. Goethite pseudomorphs after pyrite are common in the higher geode-bearing units. Goethite powder from decomposing pyrite is found sporadically in sulfide-bearing geodes.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum (visual identification only) occurs rarely at Halls Gap, resulting from the decomposition of sulfides. Crystals tend to be very crudely formed and would be more accurately called a crust. The mineral is usually associated with decomposing pyrite or chalcopyrite. One specimen has very crude, white or colorless 1-mm lathes suspended in a millerite cluster.

Halotrichite $Fe^{2+}Al_2(SO_4)_4 \cdot 22H_2O$

Halotrichite has been reported by D. Coskren (personal communication) as white, silky, fibrous crystals associated with millerite, pyrite and other sulfates.

***Jamborite** (?)* $(Ni^{2+},Ni^{3+},Fe)(OH_2)(OH,S,H_2O)$

Jamboritie (?), formerly known from Halls Gap as "honessite," is a rare alteration product of millerite; Morandi and Dalrio (1973) suggested the identification as jamborite but did not confirm it. An estimated one in 300 geodes in the "millerite zone" contains apple-green jamborite (?) pseudomorphs after millerite. There are gradations from greenish millerite with a metallic luster to a submetallic luster to the non-metallic luster that is characteristic for pure jamborite. It is not unusual for a single pseudomorph of jamborite (?) to have differing luster from one end to the other as the degree of alteration changes.

Jamborite (?) is also associated with corroded chalcopyrite crystals, forming the same "star burst" patterns observed with millerite.

SEM photos reveal jamborite (?) as ram's horns and needles similar to gypsum, but on a microscopic scale. One specimen consists of a crystal terminating in a tight curl. Like salt weathering in gypsum (which reduces limestone boulders to gravel) the expansion of jamborite (?) pushes and distorts the original millerite crystal shape.

Malachite $Cu_2CO_3(OH)_2$

Malachite has been reported as pseudomorphs after chalcopyrite disphenoids in the stratum beneath the "millerite zone."

Marcasite FeS_2

Marcasite is not very common at Halls Gap. Ruez (1973) analyzed a dark sulfide with worm-like shapes and determined it to be marcasite of probable colloidal origin. Specimens appear darker than polycrystalline pyrite. Marcasite also occurs as bundles of elongated blades of a brassy yellow color. This habit consists of masses of intergrown crystals from 5 to 30 mm across, which may completely fill the void. Ruez describes this type vaguely as a possible pyrite pseudomorph after marcasite. More study is needed.

Isolated doubly terminated blades less than 1 mm across are found with pyrite.

Marcasite nodules are abundant in several layers in the exposure. The largest nodules may be more than 10 cm in diameter.

***Melanterite** (?)* $Fe^{2+}SO_4 \cdot 7H_2O$

Melanterite is an alteration product of decomposing pyrite. Whitish fuzz, tentatively identified as melanterite, forming 1-mm ram's horns, has been observed.

Metavoltine $K_2Na_6Fe^{2+}Fe^{3+}_6(SO_4)_{12}O_2 \cdot 18H_2O$

Metavoltine occurs in 0.1-mm lemon-yellow flakey crystals associated with other sulfates including halotrichite, melanterite, roemerite and voltaite. A geode containing these minerals was obtained from a dealer by D. Coskrin.

Millerite NiS

Millerite is the mineral which has made Halls Gap famous among collectors. It is distributed widely across the Midwest and is found in vugs and geodes in several states. At no other geode locality does millerite occur in the quantity it does here. The millerite appears to be concentrated in a layer about 1 meter thick, and is especially abundant in the uppermost 15 cm of the so-called "millerite zone." About one in four geodes in this layer contains millerite.

The abundance of millerite crystals is highly variable. Some geodes contain a single filament. Other geodes may be packed so tightly with crystals that a tearing sound can be heard when separating the halves.

Millerite occurs as slender, hair-like, hexagonal crystals, highly elongated on the *c*-axis. The tenacity of millerite varies according to the length and diameter of the crystal. Short crystals are very brittle. Longer crystals are flexible to slightly elastic, depending on the diameter. Crystal diameters have not been measured, but there is a substantial range in thickness. Millerite crystals when uncoiled have lengths that may exceed the diameter of the geode.

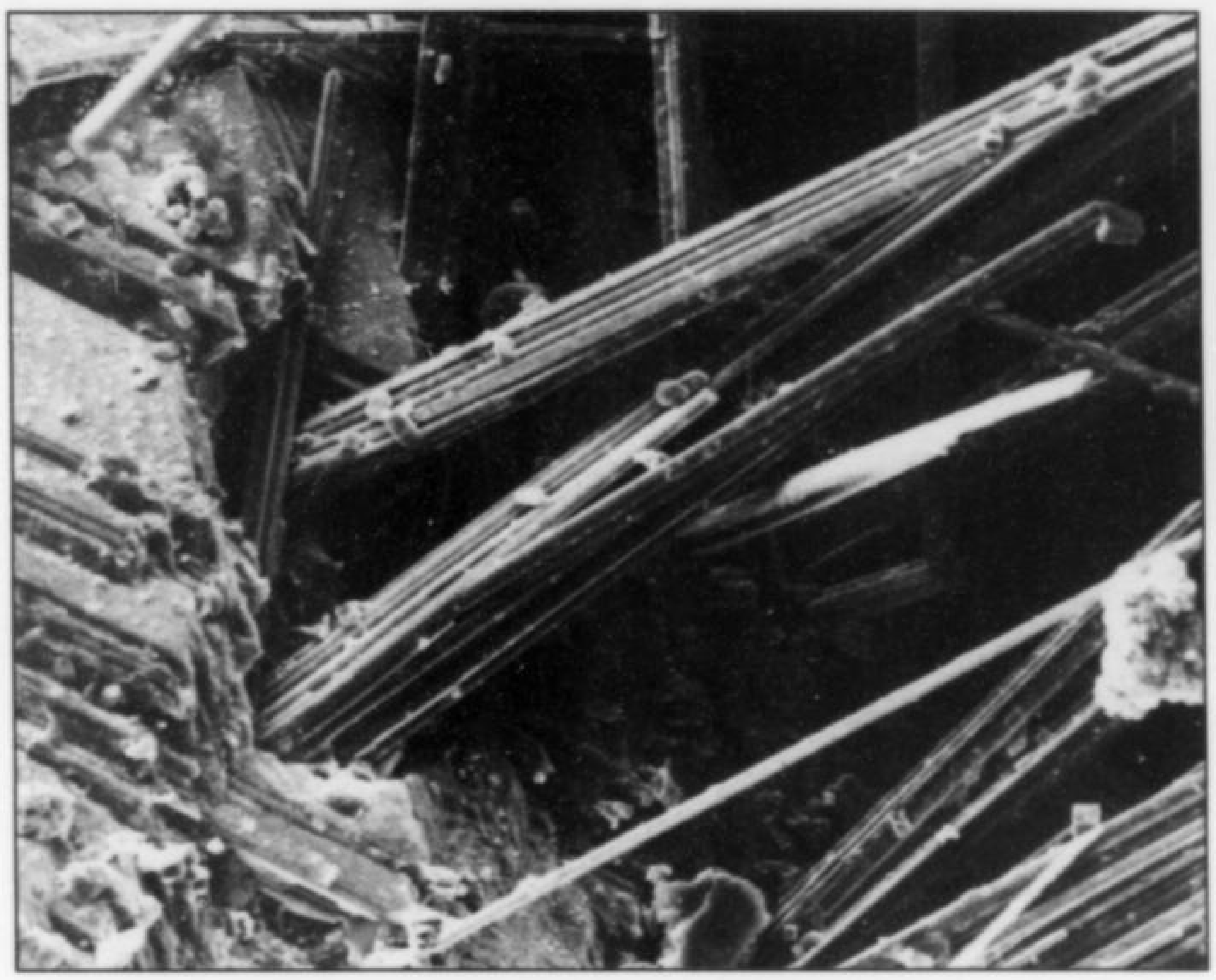

Figure 14. **Millerite needles to 0.03 mm across on chalcopyrite. Rudi Turner specimen and SEM.**

Figure 15. **Millerite needles, 0.01 to 0.03 mm across, altering to vermicular or ram's-horn jamborite (?). Rudi Turner specimen and SEM.**

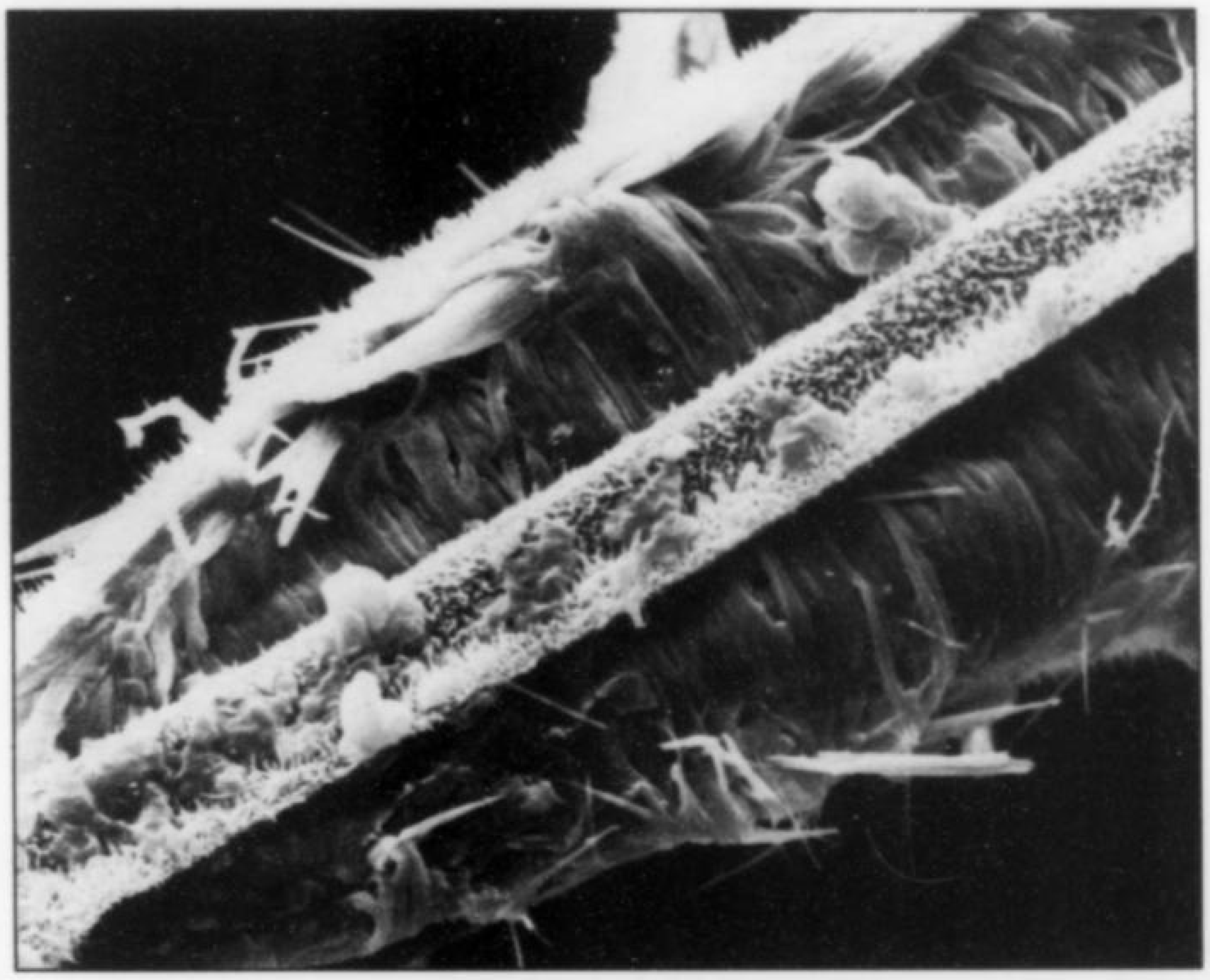

Figure 16. **Millerite crystal, 0.01 mm wide, altering to green jamborite (?). Rudi Turner specimen and SEM.**

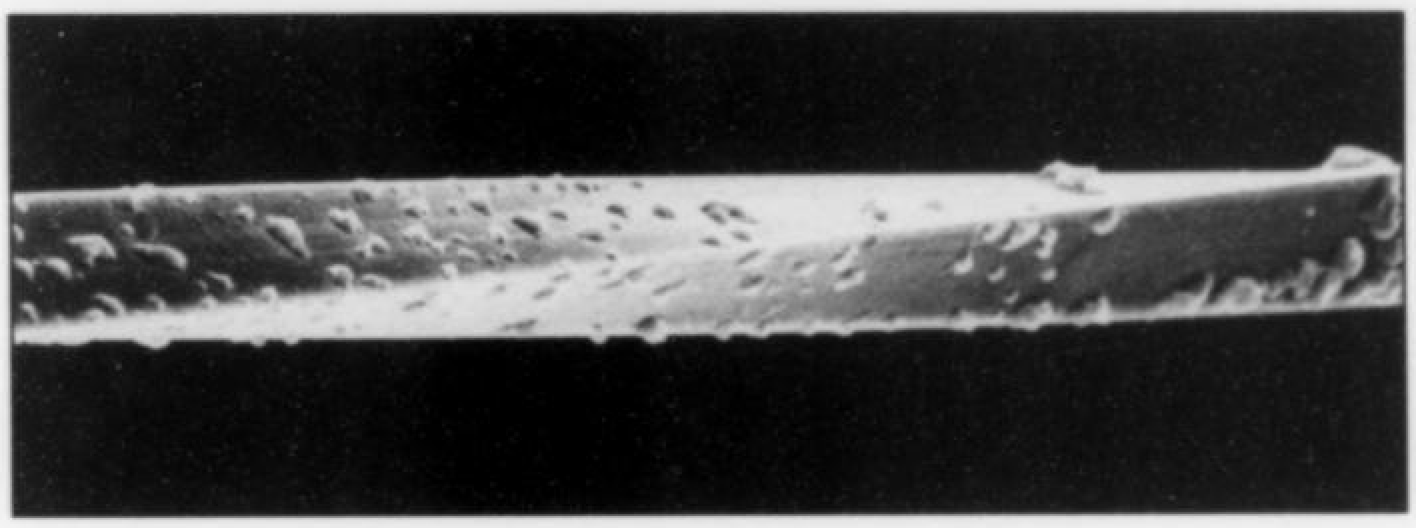

Figure 17. **Twisted millerite crystal, 0.01 mm wide. Rudi Turner specimen and SEM.**

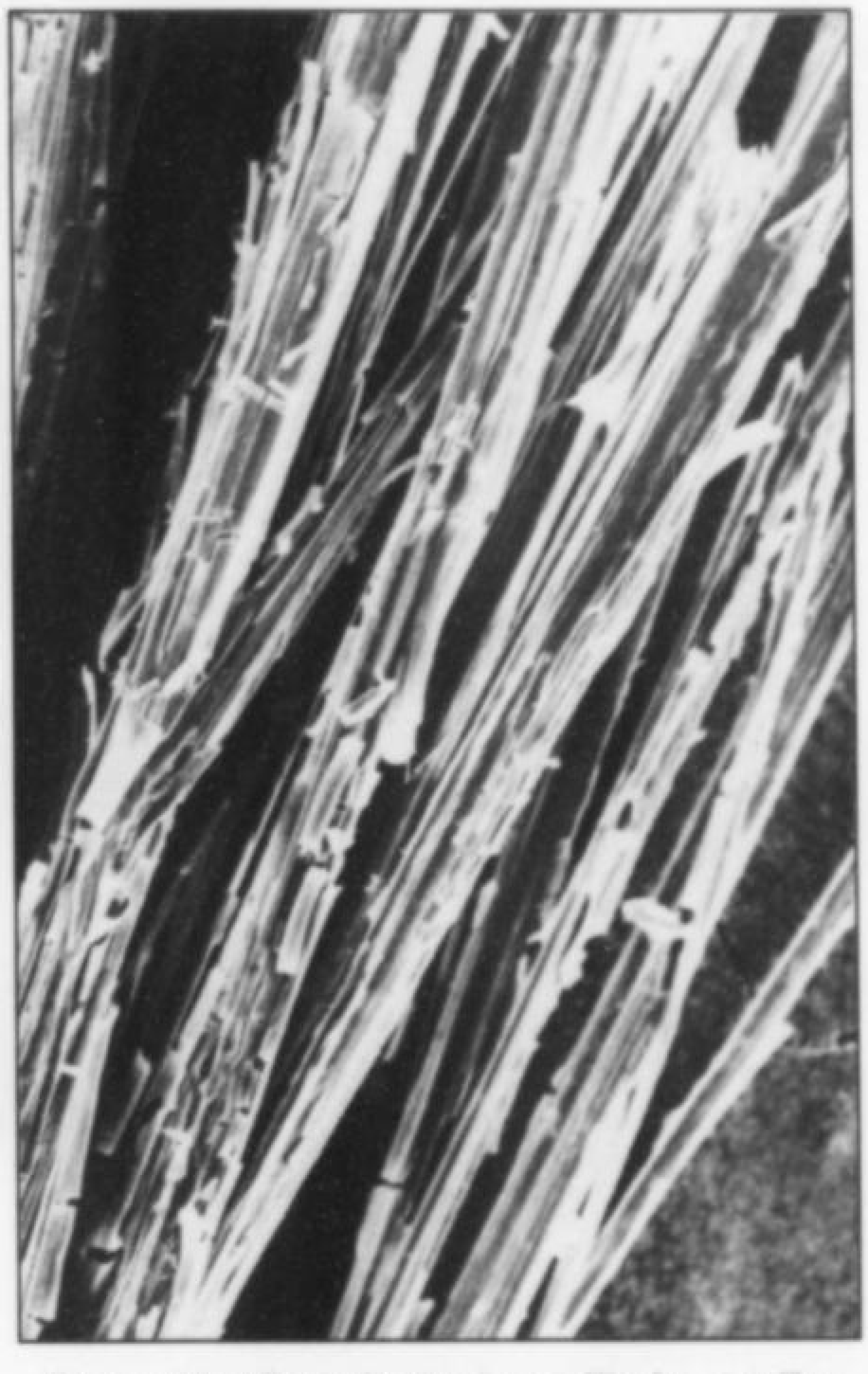

Figure 18. **"Rusty" altering millerite needles, 0.03 mm wide. Rudi Turner specimen and SEM.**

Figure 19. Pyrite ring, 5 mm, with acicular millerite in a geode. Bill McKenzie collection; Chris Anderson photo.

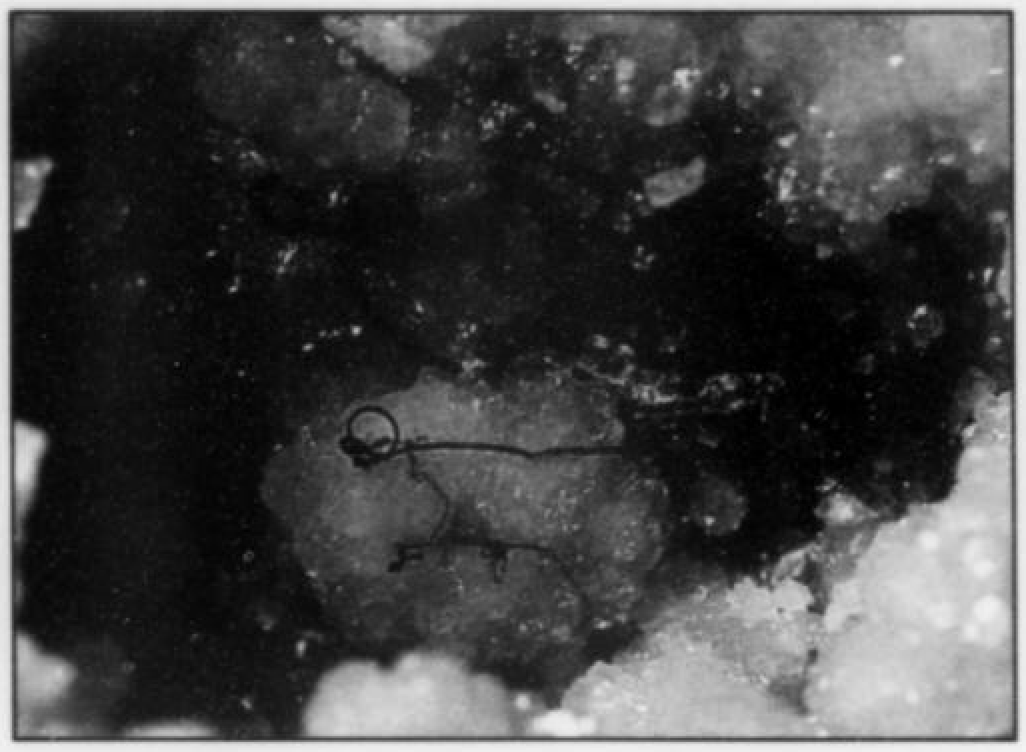

Figure 20. Ring and wire pyrite with yellow native sulfur in a 1-cm cavity. Bill McKenzie collection; Chris Anderson photo.

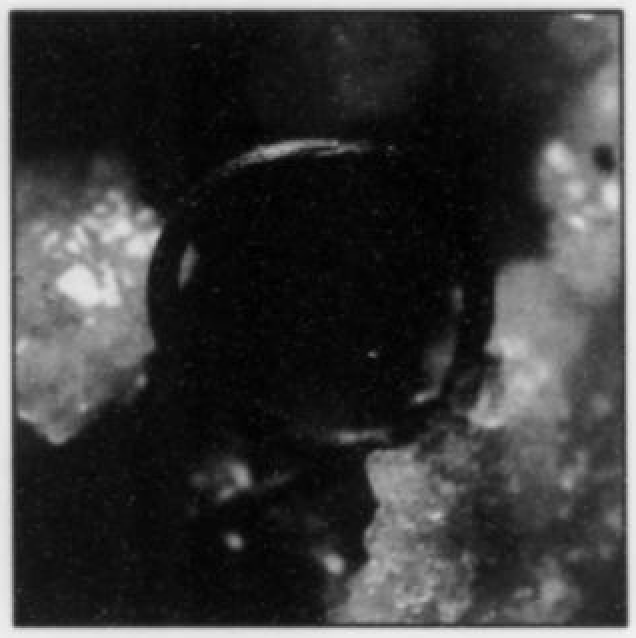

Figure 21. Pyrite ring, 2 mm, in geode. Bill McKenzie collection; Chris Anderson photo.

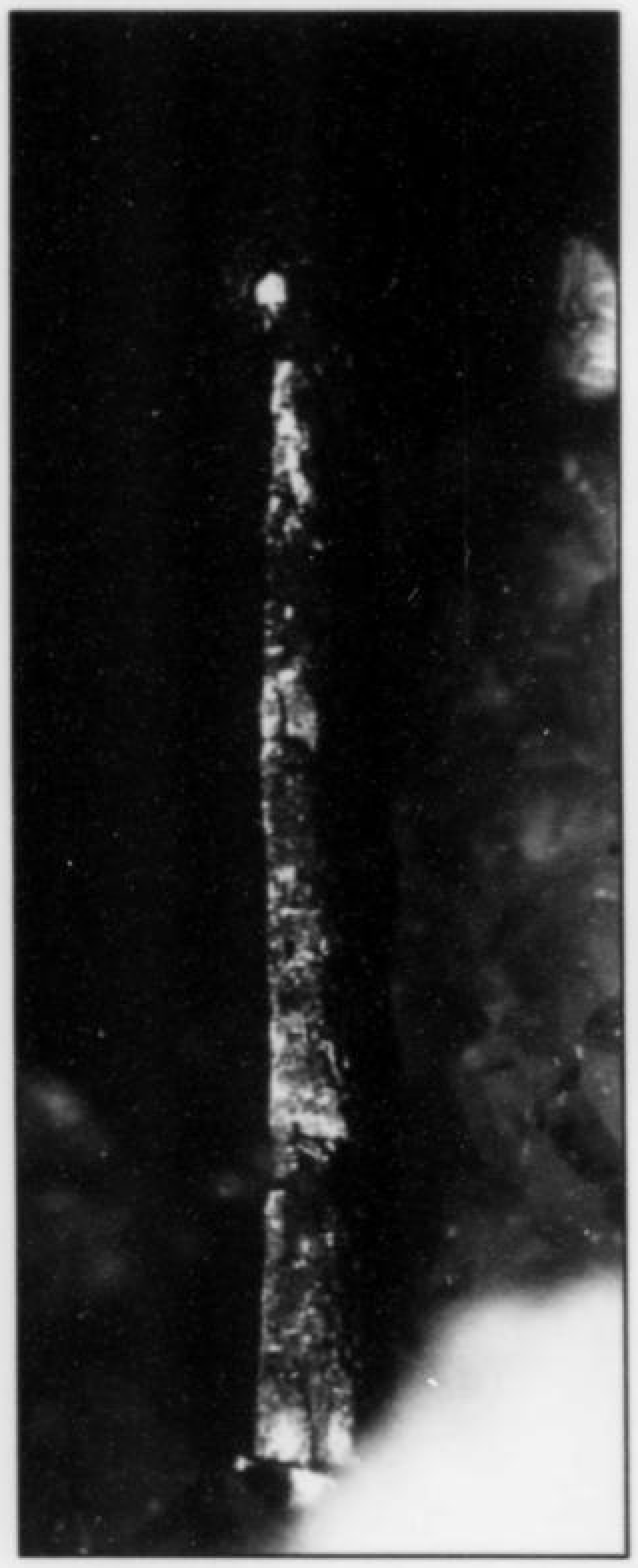

Figure 22. Pyrite scepter, 3 mm, in a geode. Alan Goldstein collection; Chris Anderson photo.

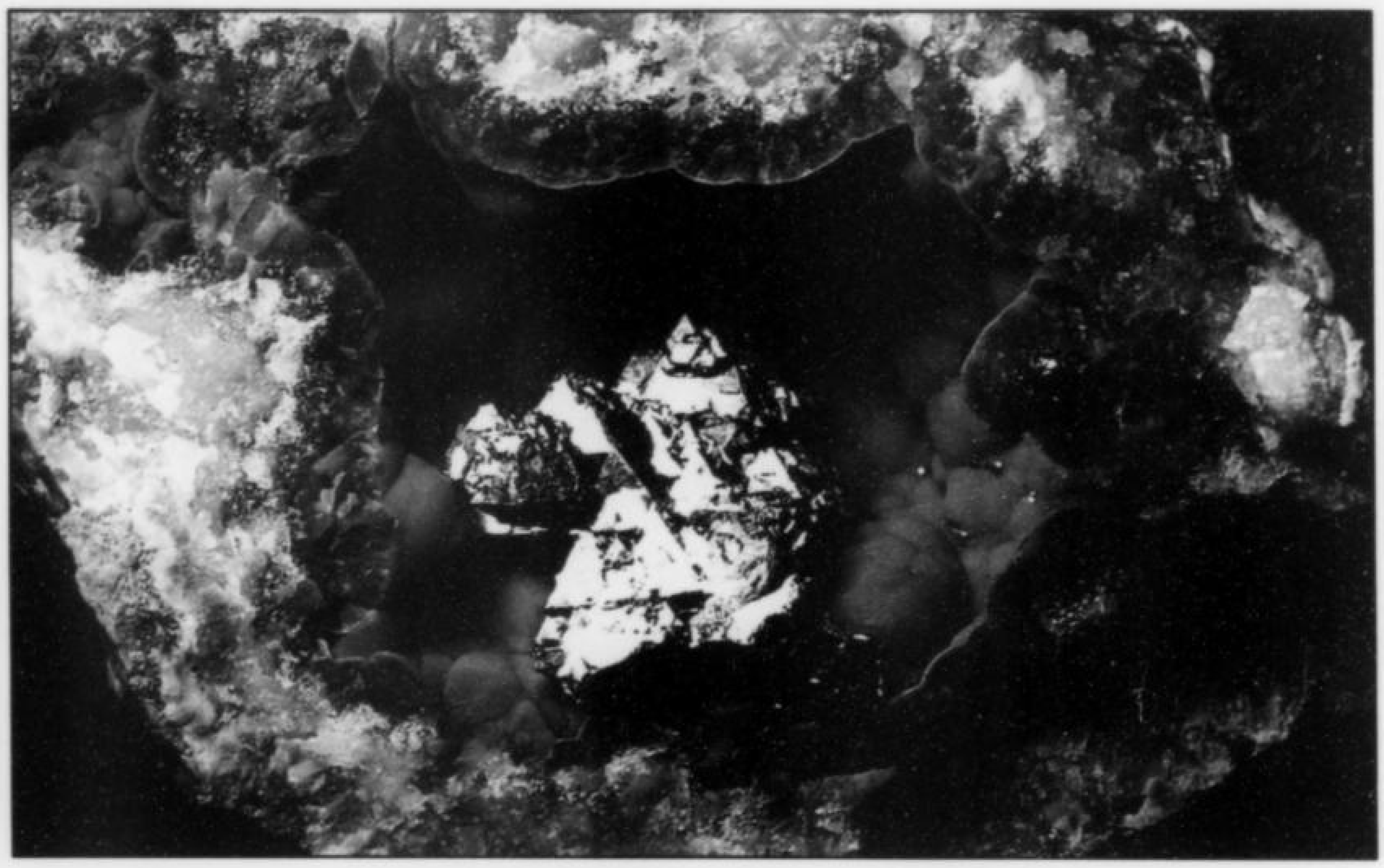

Figure 23. Octahedral pyrite crystal group, 1.5 cm, on blue chalcedony in a geode. Bill McKenzie collection; Chris Anderson photo.

Figure 24. Pyrite crystal cluster, 3 cm. Bill McKenzie collection; Chris Anderson photo.

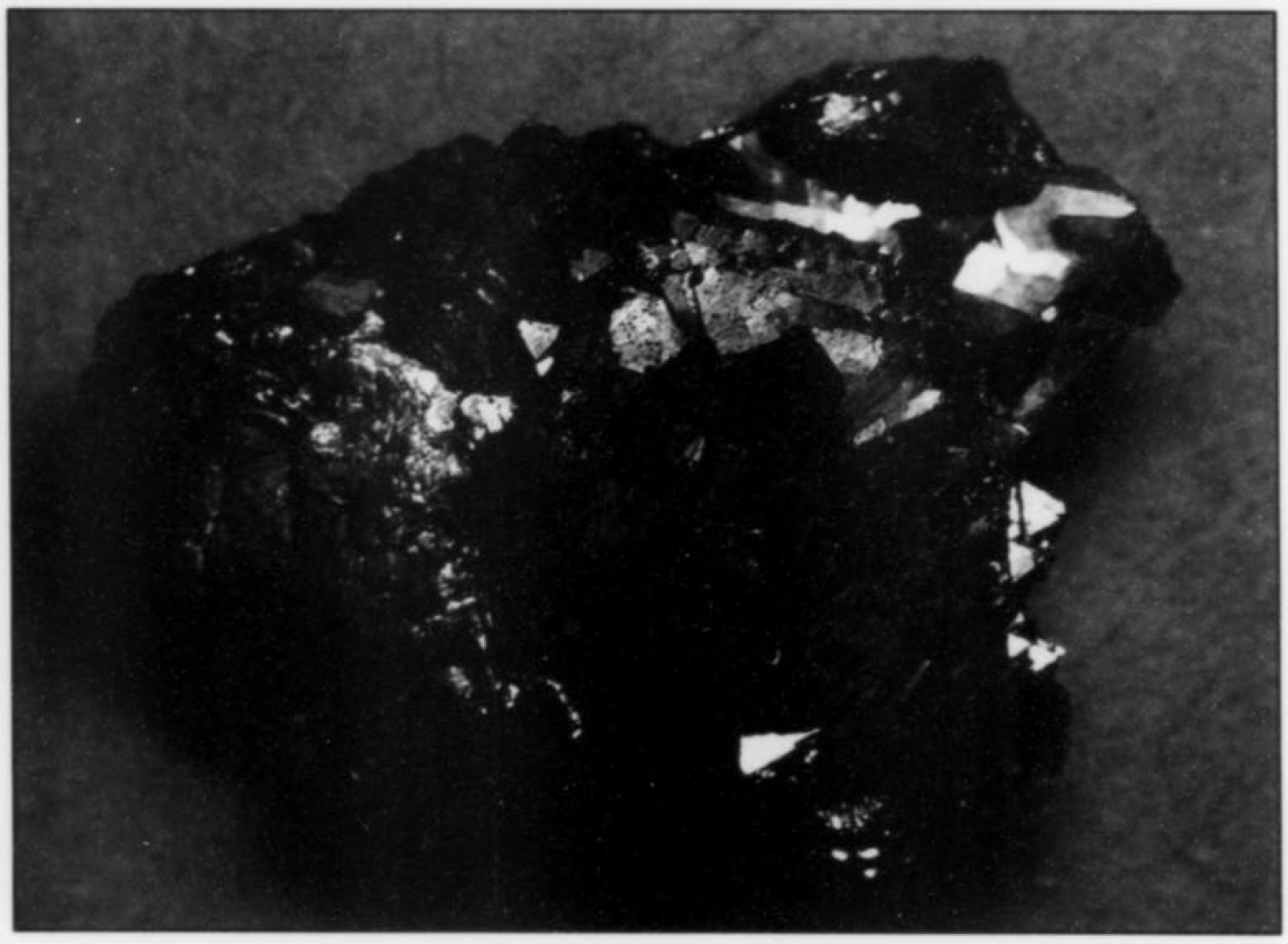

Figure 25. **"Elbow" pyrite, 2 mm, in a geode. Alan Goldstein collection; Chris Anderson photo.**

Figure 26. **Iridescent pyrite druse on chalcedony in a 7 cm geode cavity. Bill McKenzie collection; Chris Anderson photo.**

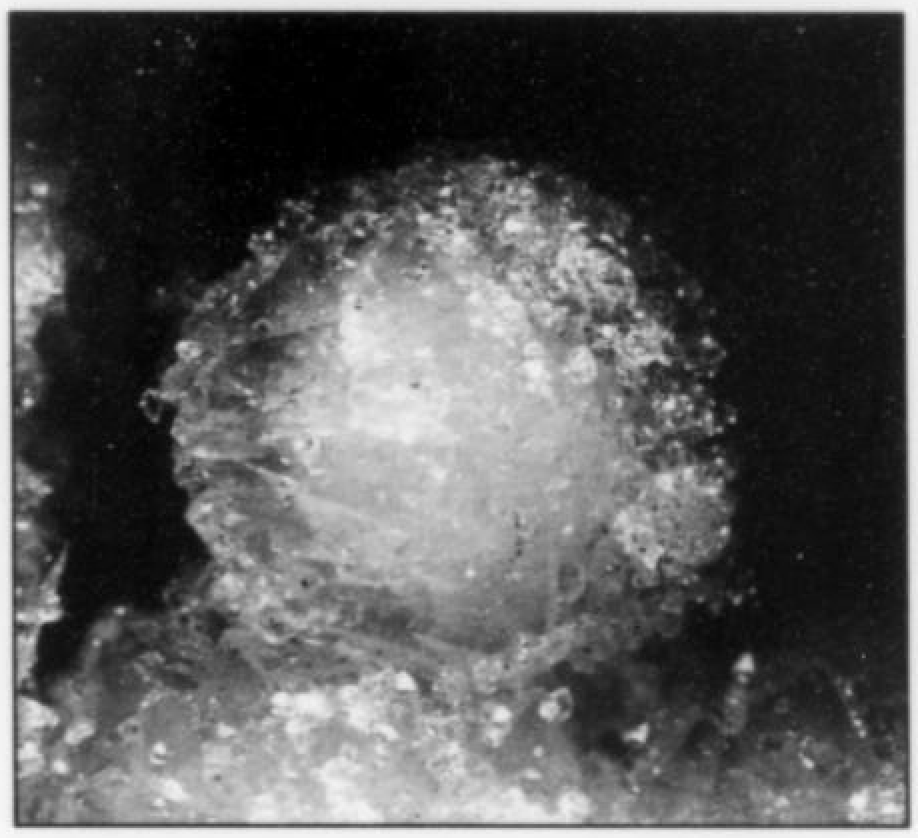

Figure 27. **Quartz spherule, 3 mm, showing a second generation of tiny quartz crystals. Alan Goldstein collection; Chris Anderson photo.**

Figure 28. **Black sphalerite with chalcopyrite and chalcedony, 1.5 cm. Bill McKenzie collection; Chris Anderson photo.**

Filamentary crystals may be twisted along the *c*-axis due to screw dislocations (W. A. Henderson, personal communication, 1992). These so-called "Eshelby" twists show variability in the degree of rotation. Some crystals are more tightly twisted than others. Smaller filaments may have several rotations per millimeter, whereas larger crystals may twist only once per millimeter. Some alternate irregularly. SEM photographs show a blade-like crystal and reveal striations parallel to the *c*-axis. Rings of millerite to 2 mm have also been found.

Paul Smith (personal communication, 1991) reports that a tiny white fuzz observed rarely coating millerite is actually microscopic millerite. One of us (A.G.) has observed a single millerite specimen exhibiting this same white material.

X-ray fluorescence analysis of various colors of millerite has revealed some interesting compositions (Ruez, 1973). Violet gray-coated millerite has higher than normal amounts of iron and cobalt. Greenish millerite (jamborite?) has unexpectedly high traces of platinum.

There are several unusual associations with millerite which are summarized here: apparent nucleation around chalcopyrite and sphalerite; impaled or suspended calcite, chalcopyrite, gypsum and pyrite; coatings of late-formed microscopic quartz; the alteration to a possible nickel sulfate; and violarite coatings.

Some millerite appears to be corroded or otherwise altered. The color varies from an orange rust (which may stain the interior of the geode) to a straw-yellow color. The luster of both types tend to be submetallic. Whether or not the end result of this alteration is another mineral species has not been determined. Bish and Livingstone (1981) describe from another locality a citrine-yellow encrusting film associated with chromite consisting of a mixture of reevesite, honessite and hydrohonessite. Whether a similar mixture is present at this locality is unknown. Further work on this yellowish millerite alteration is needed.

***Paratacamite** (?)* $Cu_2(OH)_3Cl$

Paratacamite has been reported as green botryoidal hemispheres on chalcopyrite (Medici, 1981; and D. Coskren, personal communication); confirmation of this identification is still pending.

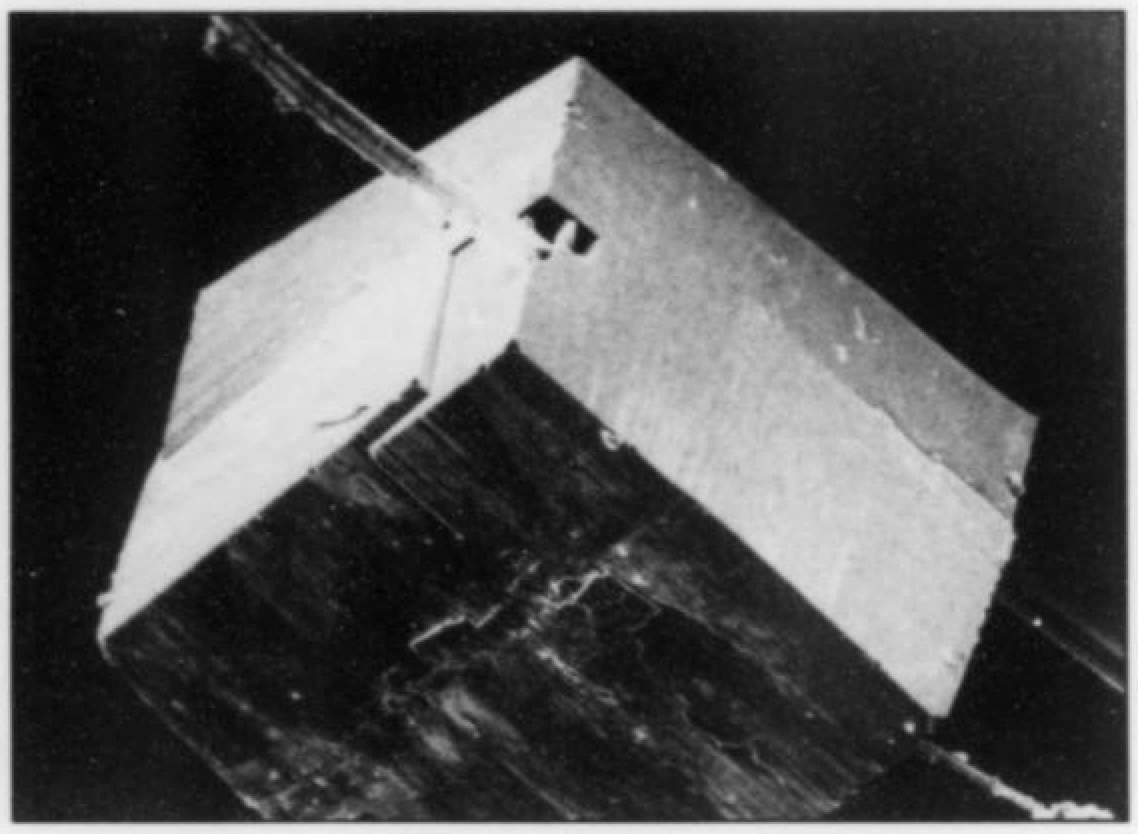

***Figure 29.* Millerite needles penetrating a pyrite crystal 0.3 mm on edge. Rudi Turner specimen and SEM.**

Pyrite FeS2

Pyrite is one of the most fascinating minerals at Halls Gap. Paragenetically it occurs in several generations, each with a different crystal habit. One type is the most unusual: the pyrite is polycrystalline and forms many odd shapes, including worm-like masses, loops, springs, coils and irregular shapes. Another type is a sceptered habit, which may be partially or completely coated with transparent crystals of quartz. Some ring-like shapes occur late in the paragenetic sequence, found on calcite and glauconite-bearing quartz. It is likely that polycrystalline pyrite formed intermittently throughout the mineralization process. Multiple polycrystalline pyrite habits may occur within the same geode.

Another early-generation pyrite habit is octahedral or cuboctahedral. It appears to be later than *most* polycrystalline pyrite, which it frequently overgrows. The octahedral forms may be quite complex, with successive parallel overgrowth. Crude octahedrons may form from stacks of smaller octahedral crystals. They can be smaller than 1 mm or larger 3 cm in diameter. Larger crystal faces may be slightly concave while others may show a pattern with triangular faces and holes. Perhaps the most intriguing are octahedral pyrite crystals with late-generation cubes in parallel overgrowth. A specimen was found with tabular pyrite capping the apex of an octahedron. One area in the "millerite zone" has a particularly high abundance of large octahedral pyrite.

Cuboctohedral pyrite is very abundant. It was deposited simultaneously with and somewhat later than the octahedral pyrite. The variation of the forms ranges from cubes with very minor octahedral faces to octahedrons with small cubic faces. Both octahedrons and cuboctahedrons may show etched, silky-lustered crystal faces. Cuboctahedral pyrite also occurs intergrown with sphalerite.

"Graphic pyrite" is another unusual habit at Halls Gap. The patterns may create a simple "L" or more complicated crystals with multiple 90° bends. There is no end to the variation that this odd crystal habit creates. In both size and thickness, significant variation occurs. Some crystals are filiform with multiple changes in the *x*, *y* and *z* directions. Others are thicker, with fewer kinks that are easier to see. Some writers (i.e. Berndt, 1969) liken this habit to structural steel used in tall buildings. This pyrite appears be related in time to cubic pyrite.

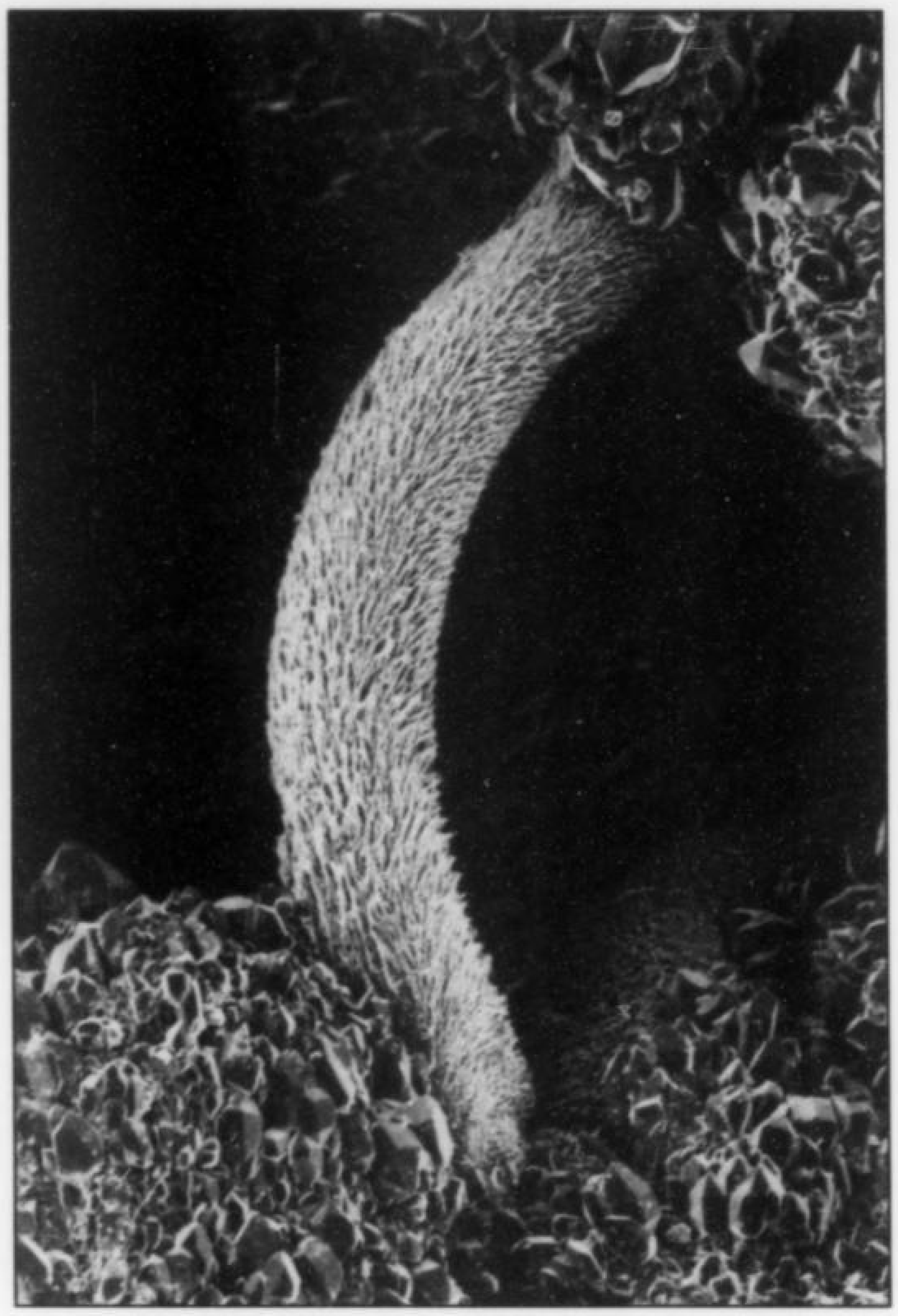

***Figure 30.* "Fuzzy" pyrite growth, 1 mm, on quartz. Rudi Turner specimen and SEM.**

Cubic pyrite is the latest generation, and the most common habit throughout the outcrop. The largest cubes are about 3 cm on edge and may be distorted (Medici, 1981). Most cubes are lustrous and brassy in color. Some have a silvery tinge or bright iridescent colors, blue being the most striking. One oddity that has been observed is etched cube faces with a "+" pattern or black dot at the center of each cube face.

Cubic or cuboctohedral pyrite may be found skewered by millerite; in such cases pyrite has nucleated on the side of a filamentary millerite crystal, and has grown equidimensionally while suspended on the millerite. Very rarely intergrown pyrite crystals will be found on a single millerite crystal. Usually only a single pyrite crystal will grow on a single millerite crystal. Even less common is a string of crystals. When pyrite grows on millerite, the cube will often be centered along the host's crystallographic axis. Pyrite attached to the wall of the geode may enclose a portion of adjacent millerite filaments. Millerite intersects at random angles to the pyrite's crystal faces. Berndt (1969) reports millerite nucleated around pyrite. All specimens analyzed by the writers show nucleation around chalcopyrite and less commonly sphalerite. Examination of hundreds of sulfide-bearing geodes indicates that most pyrite formed after the millerite.

Quartz SiO_2

Quartz is the most common mineral at Halls Gap. There are several generations of crystalline and cryptocrystalline quartz.

Chalcedony is the earliest material in a geode, occurring in a striking variety of colors including deep blue, pea-green and red-

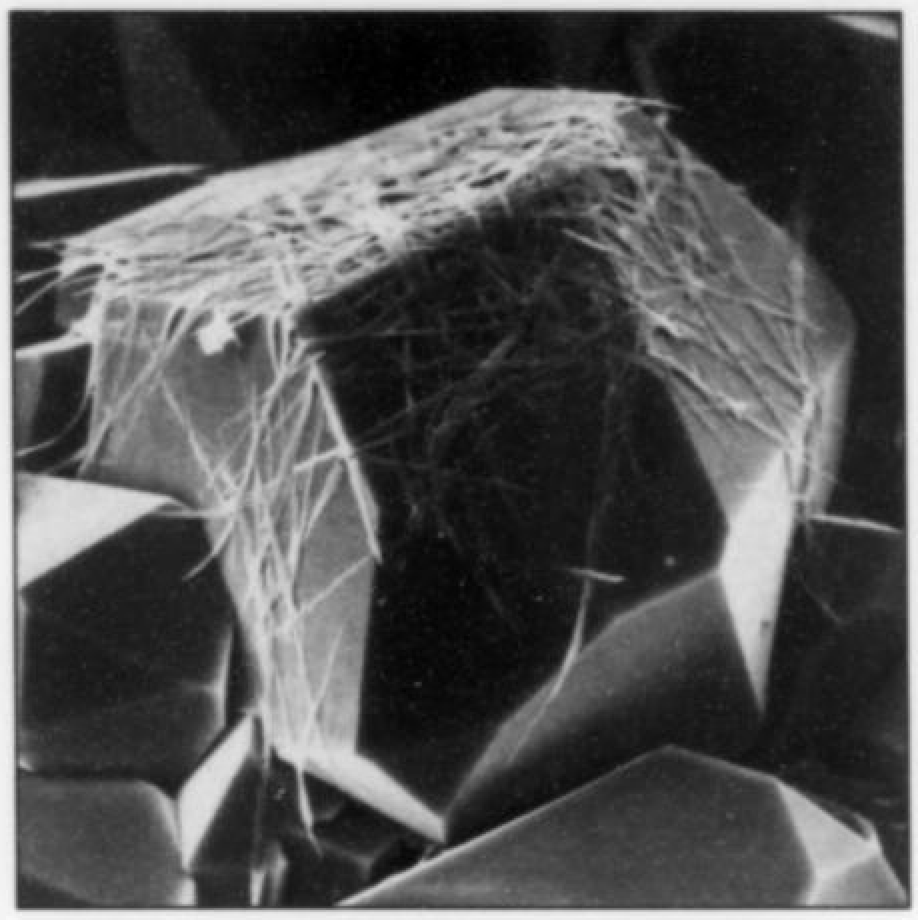

Figure 31. **Unknown #1 on quartz crystal, 0.1 mm. Rudi Turner specimen and SEM.**

orange. Multiple generations of chalcedony may consist of varying colors and show a thin agate-like banding in cross-section.

Chalcedony is followed paragenetically by crystalline quartz, which varies from drusy microcrystals to euhedral crystals exceeding 5 mm. Drusy quartz may be colorless to orange-red. Amethystine quartz occurs in singly and doubly terminated crystal prisms to 5 mm. Greenish late-forming drusy quartz contains glauconite inclusions.

Smoky quartz can be found in what almost appear to be bipyramidal crystals, mimicking the habit of beta (high temperature) quartz. Closer examination of some bipyramidal quartz reveals a minute *c*-pinacoid face. Colorless quartz may also be found.

A late generation consisting of microscopic euhedral quartz crystals is uncommon, but has been observed "dusting" larger quartz and other sulfides. A single specimen has been found by one of us (A.G.) that has the appearance of a quartz pseudomorph after millerite.

Quartz crystal scepters are found in many geodes. They are small, typically less than 1 cm in length. Some are stalactitic in appearance and can be straight or curved. Scepters tend to be white or colorless.

Roemerite $Fe^{2+}Fe_2^{3+}(SO_4)_2 \cdot 14H_2O$

Roemerite occurs in pale beige blocky crystals 0.25 mm across. It is associated with halotrichite, melanterite, metavoltine and voltaite (D. Koskren, pers. comm.).

Sphalerite ZnS

Sphalerite is relatively common, especially in the strata above the "millerite zone." The crystal habit is tetrahedral, usually in intergrown crystals which range from 1 to 10 mm in diameter; the larger crystals usually fill voids in the geode. Well-formed, isolated, 2 to 4 mm tetrahedra are rare. Millerite nucleated around sphalerite is very uncommon. Pyrite crystals are commonly intergrown with sphalerite crystals. Thin, tabular sphalerite occurs rarely, but usually breaks when the geode is opened.

Sulfur S

Sulfur occurs in microscopic crystals and grains as a result of decomposing sulfides. It is commonly associated with polycrystalline pyrite and marcasite and rarely with unknown mineral #1.

***Violarite** (?)* $FeNi_2S_4$

Violarite has been reported as a dark violet-blue coating on millerite (Medici, 1981). It may be present on one specimen seen by the writers, but this observation needs confirmation.

Voltaite $K_2Fe_5^{2+}Fe_4^{3+}(SO_4)_{12} \cdot 18H_2O$

Voltaite occurs as complex cuboctahedra and dodecahedra, dark oil-green to black-green in color and 0.25 mm across (D. Coskrin, personal communication). It is associated with pyrite, millerite and sulfates including roemerite.

Unknown #1

Unknown #1 is uncommon. It occurs as bright silvery mats or dustings on quartz and other sulfides. Under magnification it resembles wrinkled aluminum foil. This mineral often forms extremely unusual shapes, including loops, archs, blisters, fans and other complex forms. It seems to crystallize late in the paragenetic sequence because, other than microscopic sulfur grains, there are no later minerals. This mineral is typically deposited preferentially on one side of a geode. At first glance it resembles polycrystalline pyrite, but the silky texture is distinctive. SEM photos reveal elongated fiber-like crystals that may follow the contour of the substrate or matrix. Steve Garza examined several specimens and described its appearance as similar to lepidocrocite. Ruez (1973) calls it "marcasite."

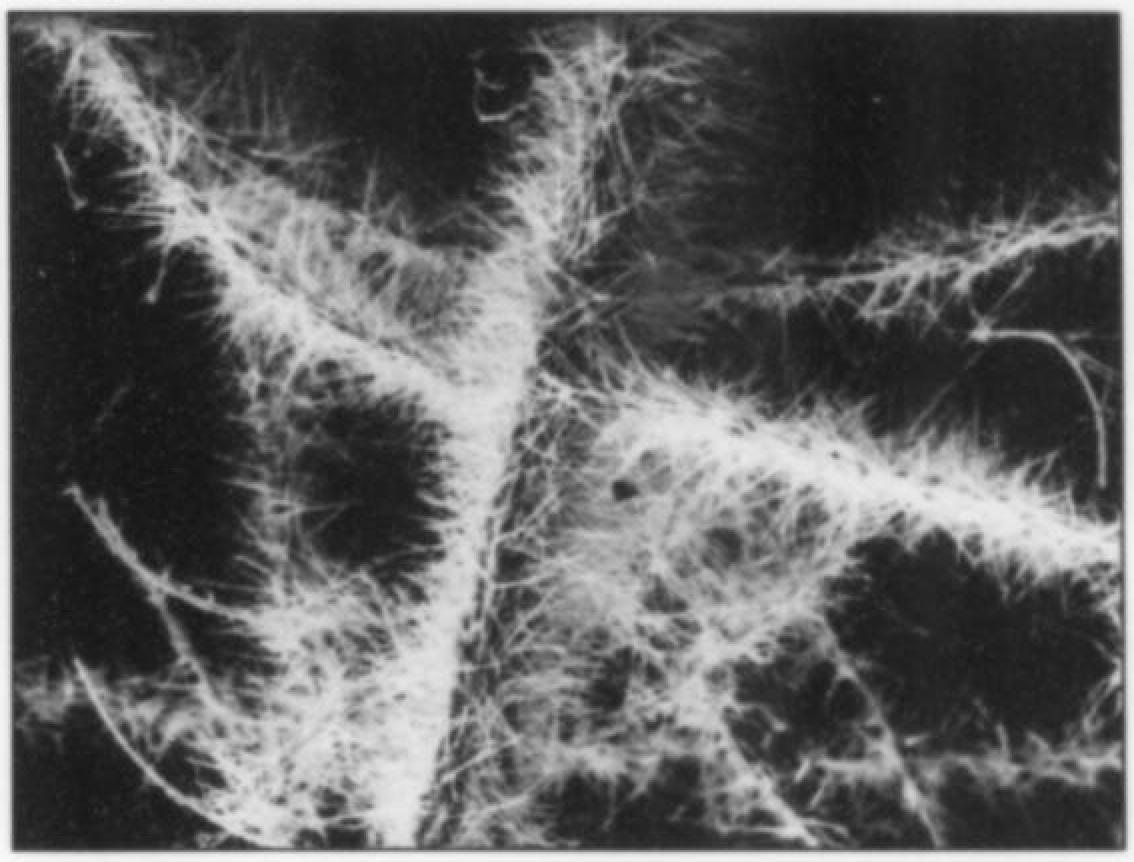

Figure 32. **Acicular blue-green Ni-sulfate unknown on 0.02-mm diameter millerite needles. Rudi Turner specimen and SEM.**

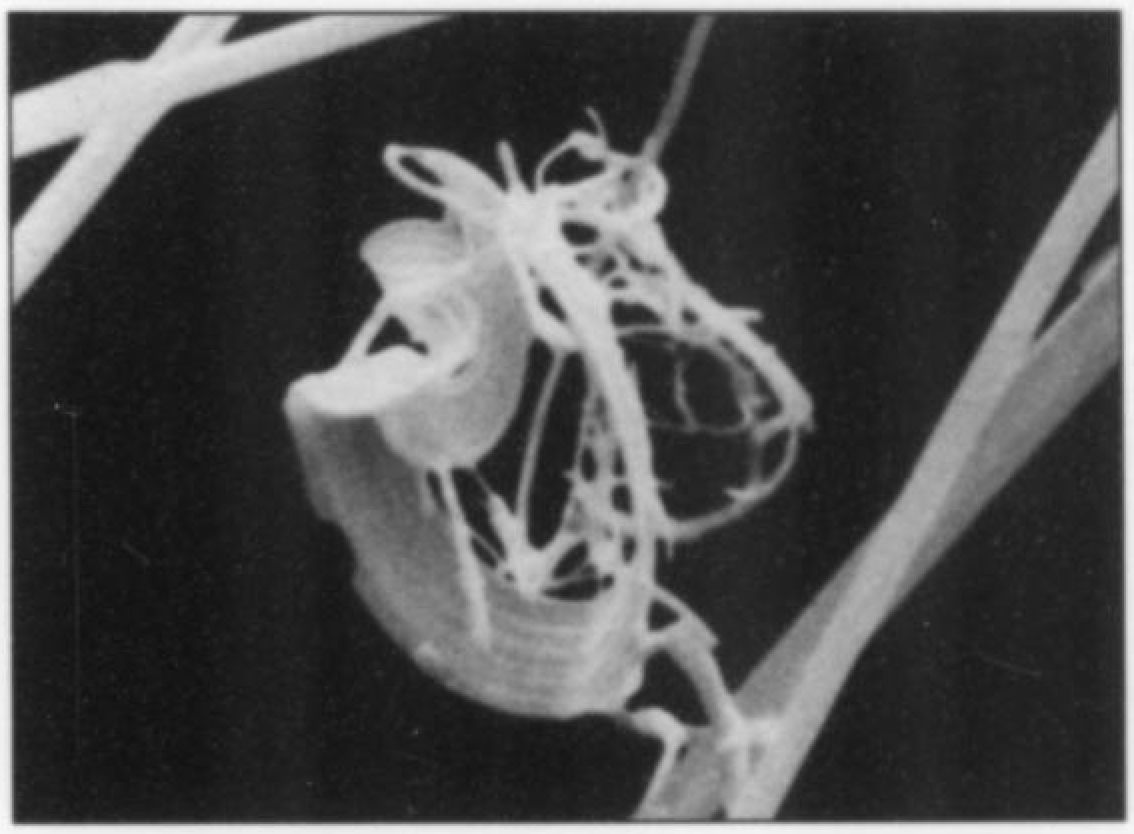

Figure 33. **Rings and curls, 0.004 mm across, of an unknown Ni-sulfate. Rudi Turner specimen and SEM.**

Unknown #2

Unknown #2 (nickel sulfate?) was discussed by Medici (1981), but there was insufficient material for a detailed analysis. This

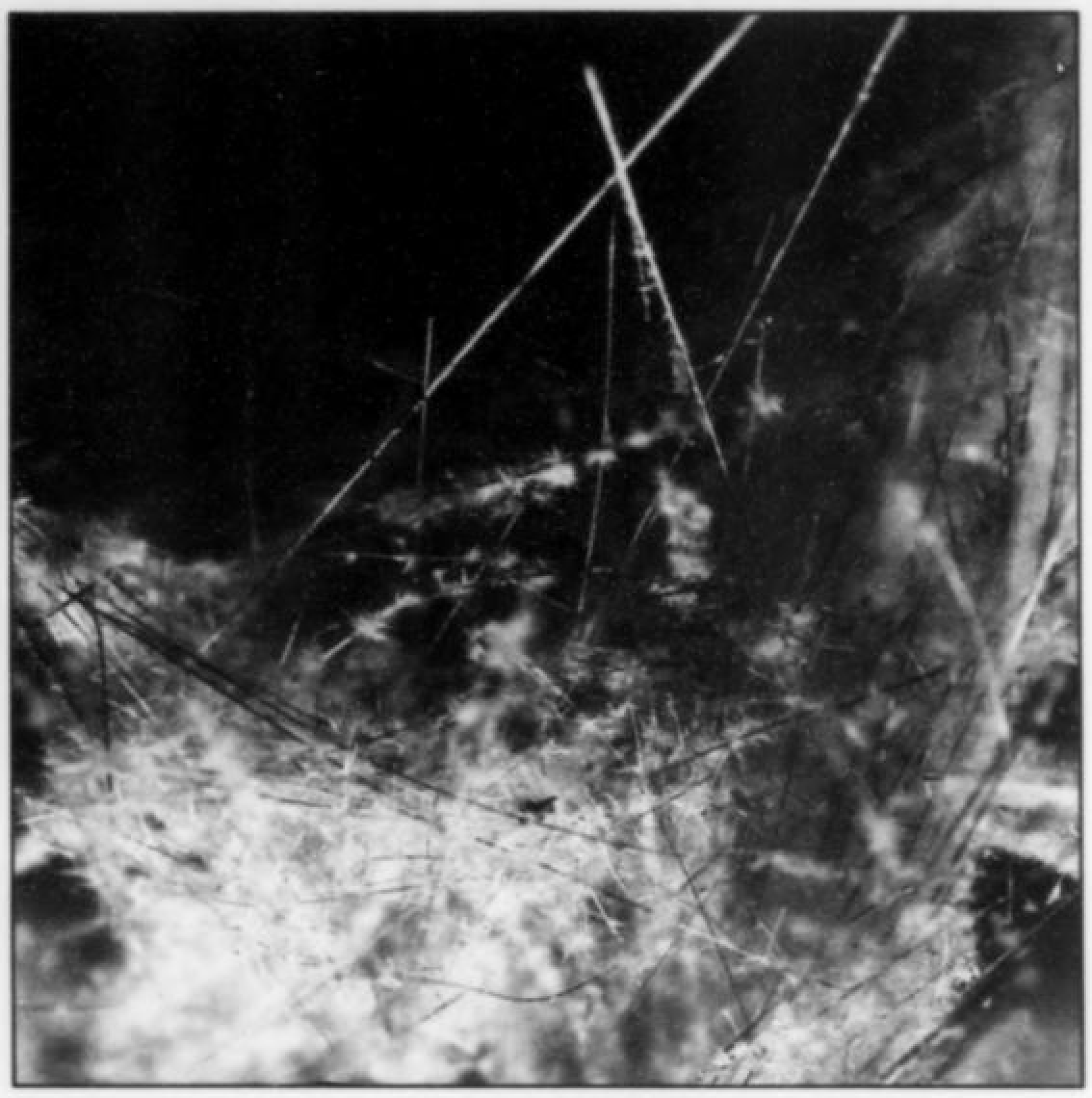

***Figure 34.* Unknown green nickel sulfate mineral with millerite, 1 cm across. Bill McKenzie collection; Chris Anderson photo.**

mineral occurs in greenish to blue-green tufts to 1 mm resembling "star-bursts" and as a "bottle brush" pattern on millerite or jamborite. It is usually sparse, but in at least one geode has been found in large quantities.

PARAGENESIS

In order to establish a paragenetic sequence, one of us (A.G.) examined under magnification hundreds of geodes from the "millerite zone" (collected by B.M.) to determine overlapping relationships. Specimens can be made available to mineralogists for further study.

Geodes are surrounded by a rind of chalcedony, which is first in the paragenetic sequence. The outside rind probably formed while anhydrite or gypsum was still in place. Chowns and Elkins (1974) found relict anhydrite in thin-section studies of geode rinds. Thin-rimmed gypsum geodes occur in Hardin and Meade County, Kentucky. Geodes over 15 cm in diameter may have chalcedony walls less than 2 mm thick.

Chalcedony deposition at Halls Gap produced multiple layers and colors. Late-forming chalcedony may show desiccation cracks up to 1 mm in width.

Geodes may be nested doubles, consisting of an exterior chalcedony rind separated by a narrow gap of drusy quartz and sulfides (chalcopyrite, pyrite and/or sphalerite), from an inner, very smooth, second chalcedony shell which is often quartz-filled.

Brecciation of chalcedony due to dissolution and slumping occurred before other minerals were deposited. Crystalline quartz follows chalcedony in most instances. Some early quartz may be followed by later chalcedony, visible in the cross-section of thick-walled geodes. Several episodes of crystalline quartz deposition have been observed. Some of the quartz druses are accompanied by a single large quartz crystal.

Polycrystalline pyrite follows and overlaps with early quartz in the paragenesis. However, it occurs intermittently throughout the paragenesis sequence, including after calcite. Most polycrystalline pyrite is firmly imbedded in early quartz. Smaller "wires" occur as inclusions in quartz.

Other sulfides including chalcopyrite, millerite, sphalerite, marcasite and, to a lesser extent, cuboctahedral pyrite occur at the end or slightly before the end of early quartz deposition. Additional study will be required to determined the precise paragenetic sequence of these sulfides. Each formed very close to the other in time, and in many cases are simultaneous.

Calcite, dolomite and sulfate alteration products of sulfides were late in the sequence. Cubic pyrite is consistently found late,

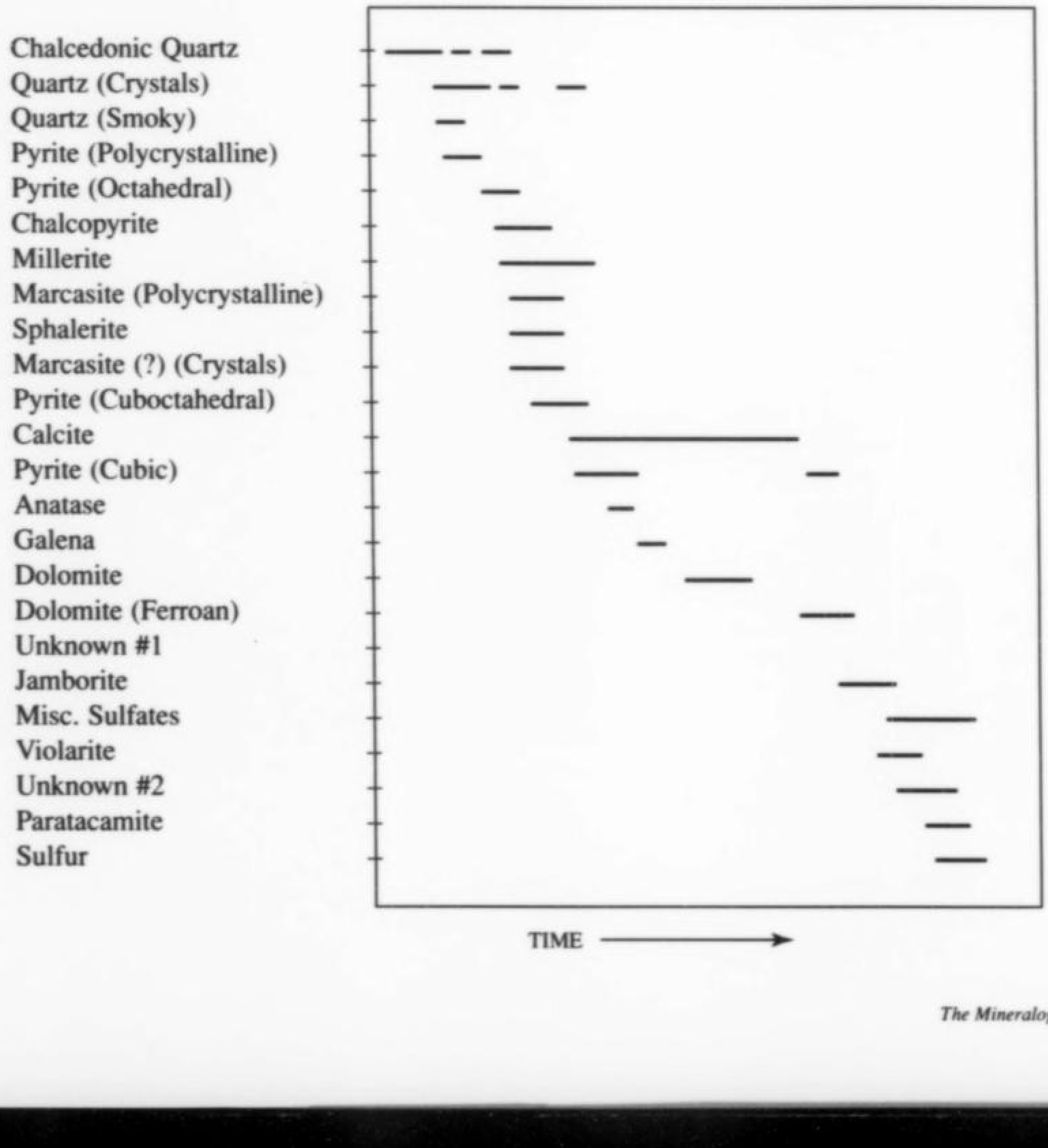

***Figure 35.* Paragenetic sequence of mineralization at Halls Gap.**

including less than 0.5-mm crystals on calcite and dolomite. Larger cubic pyrite preceded these carbonates, but followed other crystal habits of pyrite and other sulfides. Some chalcopyrite, millerite, and cuboctahedral pyrite occurs as "floaters" locked in calcite. The paragenetic relationship between the earliest calcite deposition and latest of the so-called "early" sulfides needs to be studied further. Galena occurs after cubic pyrite, the evidence provided by a single specimen.

The latest generation of quartz has a sugary appearance. It has been observed sprinkled over crystalline quartz and all sulfides, including millerite. Quartz with glauconite inclusions occurs late in the mineral depositional process.

Anatase is associated with microscopic euhedral quartz. It is probably late in the sequence, but its exact position has not been precisely determined.

COLLECTING

Collecting at Halls Gap has been complicated by the presence of a dangerous overhanging ledge which has been created by collectors working in the "millerite zone." We estimate that over 300 tons of rock have been removed by collectors in the eastern roadcut alone! Parts of the overhang are highly fractured. Collectors should avoid collecting beneath unstable overhangs.

The so-called "millerite zone," sandwiched between the overhang and the floor, is 1.4 meters thick. Usually, at the actual working face, about 1 meter of this is exposed. The majority is a dense, compact glauconitic siltstone with horizontal grain structure. In lateral extent, this face can have a good deal of unevenness, owing to the recent activity of collectors, especially those who may use power equipment. This creates localized protrusions that can be removed easier than where the face is laterally flat.

A promising-looking face is first selected using the criteria mentioned above. Additionally, cracks (horizontal or vertical) or localized spots of increased weathering (recognized by delamination of the rock) may be good places to begin. There are places that may be less comfortable to work. Much depends on the tools at hand. The eastern roadcut has been most productive for one of us (B.M.) over the years.

The order of the day when collecting at Halls Gap is to move rock. The number of geodes collected is more or less proportional to the volume of rock liberated from the face. Rock can be moved using chisels of 1.75 to 2.5 cm in width and a hand sledge. These are positioned pointing downward approximately 15 to 45 degrees from horizontal and driven with repeated heavy blows using a 3 to 8-pound hand-sledge. This splits sections of rock by a wedging action and normally removes 1 to 3 kg of rock. The rock can then be split further with chisels or a rock splitter. When a section of rock is removed and it has split along the plane of a geode, a portion or the whole may remain in the wall. It can be removed by carefully chiseling a groove in the wall, concentric with the geode, from 2.5 to 5 cm away. Next, the chisel is carefully worked around the groove, weakening the enclosing rock on all sides. The geode will then pop out, with or without matrix.

A much more productive technique requires drilling a series of horizontal holes with a hammer drill. The holes may be from 2 to 2.5 cm in diameter and 10 to 15 cm in depth. The holes should be drilled 15 to 20 cm apart, 3 to 4 at a time. Wedges and shims are then oriented in the holes to split the rock horizontally when hit sequentially with a sledge. This technique can remove some large blocks of rock which can be further broken to free any geodes. It is best to work one section of ledge at a time, moving from low to high.

The wall thickness of the geodes varies greatly. Much care should be taken in opening those geodes that are light in weight in relation to their volume. Most larger geodes have one or more seams surrounding them, reflecting fractures that have been recemented with quartz. These geodes can break quite erratically without sufficient care. If a geode is obviously hollow, it should be opened under the most controlled conditions possible.

Geodes opened at the outcrop, either accidentally or intentionally, should be immediately stored in egg cartons or other suitable protection. Many millerite tufts have been damaged or lost by a gust of wind from a passing truck.

When possible, the exterior of the geode should be cleaned prior to opening. This eliminates excessive loose debris which can become intermingled with acicular millerite or jamborite (?) crystals. Debris can be removed by upending the geode and gently tapping the bottom with a wooden peg. Dental picks can be used with a steady hand under a lens or microscope to remove stubborn debris. Badly dusted specimens can be dipped upright in distilled water. Soak for 30 seconds to 1 minute and then dry in an oven as described below. Jamborite (?) must not be allowed to get wet in any manner, as it will be destroyed.

Many geodes are totally calcite filled. These can be quite spectacular after the calcite has been removed with 3% to 5% HCl. After "etching," the geode should be neutralized in dilute ammonia, thoroughly rinsed in distilled water and heated to dryness in an oven at 200°F for 10 to 30 minutes, depending on the mass of the geode. It is surprising to what extent wet, matted millerite can "spring" back out to nearly its original aspect after drying in this way.

These geodes are best kept in a dust-free environment, such as tight mineral cabinets or display cases. In lieu of this, or when transporting them, they can be kept in hinged plastic boxes and secured with "mineral tack." They should never be packed with tissue or cotton, as the fibers will become hopelessly intertwined with millerite. Most of the minerals in the geodes are chemically stable over many years.

SUMMARY

The Halls Gap locality has produced millerite and its alteration products and unusual pyrite since its discovery. Continued collecting keeps the market well-stocked with specimens of millerite. Not everyone puts a lens to each Halls Gap geode; consequently, discoveries of additional alteration products and unusual pyrite habits are possible by anyone obtaining specimens. Much scientific work remains to be done. New studies employing microanalytical techniques are necessary because of the microscopic size of most minerals.

ACKNOWLEDGMENTS

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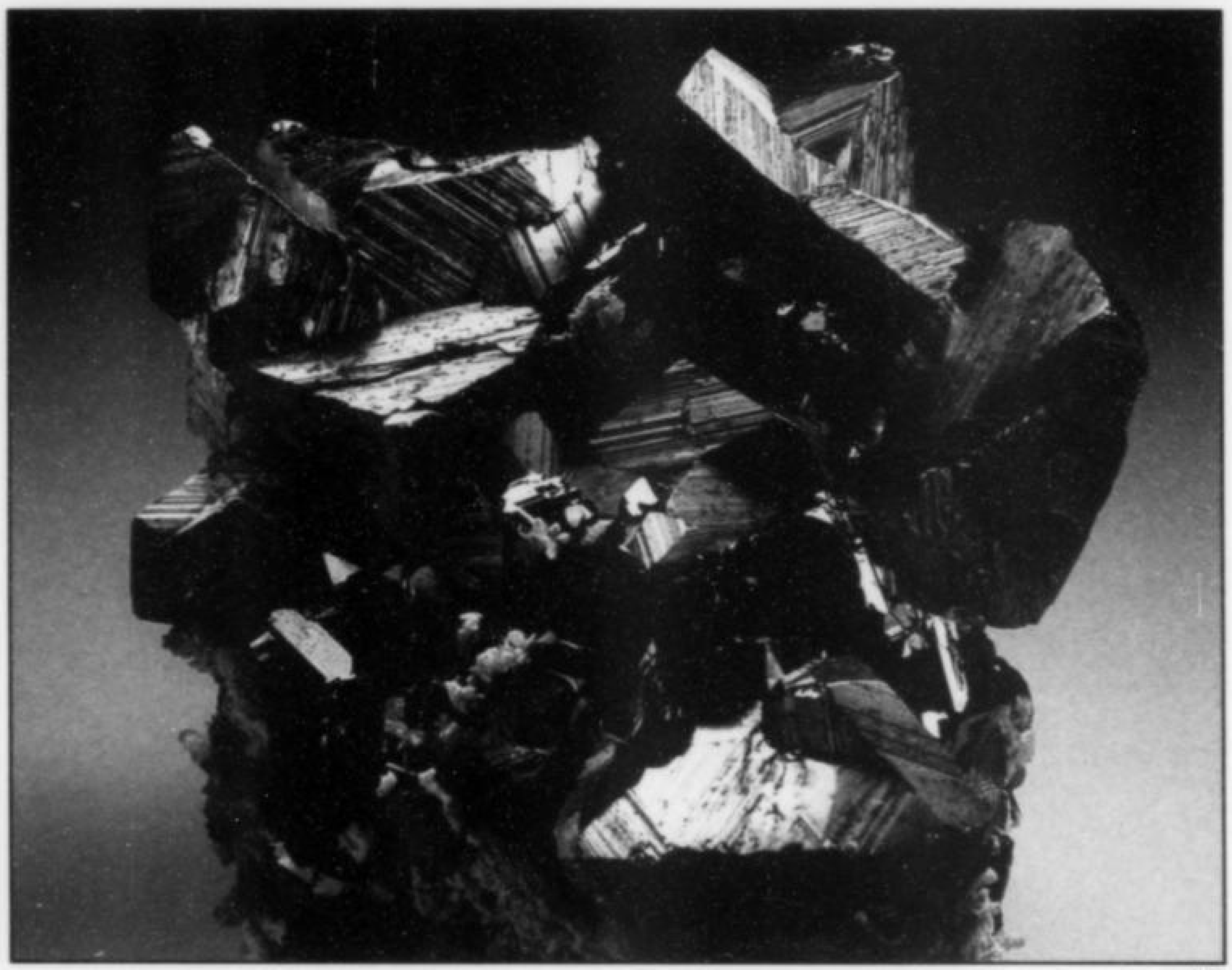

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SZENICSITE

A NEW COPPER MOLYBDATE FROM INCA DE ORO, ATACAMA, CHILE

Carl A. Francis, Lawrence C. Pitman,* and **David E. Lange**
Harvard Mineralogical Museum
24 Oxford Street
Cambridge, Massachusetts 02138

INTRODUCTION

In January 1993 Terry and Marissa Szenics of Santiago collected a beautiful green mineral, thought to be lindgrenite, at a small copper mine in northern Chile and through the Aurora Mineral Corporation submitted it to the Harvard Mineralogical Museum for identification. An X-ray diffraction pattern showed that the mineral is neither lindgrenite nor any other species in the Powder Diffraction File. Subsequent chemical study demonstrated it to be a copper molybdate new to science. The mineral was shown informally at the 1993 Tucson Gem and Mineral Show and the first notice of it, along with photographs, appeared three months later (Moore, 1993). However, the specimens were withheld from the market while a formal description was undertaken. The mineral and its name, which honors its finders, Terry Szenics (b. 1947) and Marissa Szenics (b. 1950), a husband and wife collecting team, were approved by the IMA Commission on New Minerals and Mineral Names. A suite of specimens documenting this find is preserved in the Harvard Mineralogical Museum under catalog numbers 133734–133773; szenicsite specimens 133734–133735 and 133738–133739 are the designated cotypes.

OCCURRENCE

Szenicsite was collected at the Jardinera No. 1 mine (69° 51.4′ W, 26° 4.44′ S), which exploits secondary copper ores. It is located in Chile's Atacama province 5 km east of Inca de Oro, which is 80 km north of Copiapo. To conceal the source, the specimens were originally mislabeled by Szenics as coming from Tierra Amarilla, a mining area 8 km southeast of Copiapo. Unfortunately our published abstract (Francis *et al.*, 1994) promulgated this disinformation and it was misquoted as "Tia Maria" by Moore (1993).

Szenicsite was discovered on an ore pile at the surface and was later found in place on the 60-meter level. The occurrence was only about 1 x 1 x 2 meters in extent and is now completely removed. Mining has progressed in 4 meter slices down to the 80 meter level but several visits over the past three years have failed to locate additional occurrences of szenicsite in the mine. The total quantity of szenicsite recovered is estimated to be on the order of 2 or 3 kilograms.

MORPHOLOGY

Szenicsite occurs primarily as bladed crystals in vugs but also fills fractures to about 5 mm in width. The {100} blades (habit 1) are elongated parallel to the *c*-axis and typically terminate with ragged edges. Crystals are typically about 1 cm in length, but may reach 1 x 3 cm in size. They may be intergrown in jackstraw fashion or in fans radiating like the pages of a partially opened book, often showing lustrous curved {010} cleavage faces. Terminated crystals are extremely rare. In addition to the most common habit, two specimens show crystals bladed parallel to the *b*-axis (habit 2), and three loose crystals consist of the dipyramid terminated by the brachypinacoid (habit 3).

PHYSICAL PROPERTIES

Szenicsite is transparent with an adamantine luster. Its color is dark green, reminiscent of the magnificent torbernites from Shinkolobwe, whereas its streak is malachite-green. Szenicsite does not fluoresce under shortwave or longwave ultraviolet radiation. Its Mohs hardness is $3\frac{1}{2}$ to 4. It is brittle with good cleavages on (100) and (010). The density measured using a Berman balance is 4.26(5) g/cm^3, which agrees well with the calculated values of 4.30 g/cm^3 (ideal composition), and 4.28 g/cm^3 based on the empirical formula and $Z = 4$.

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*Deceased, January 30, 1996

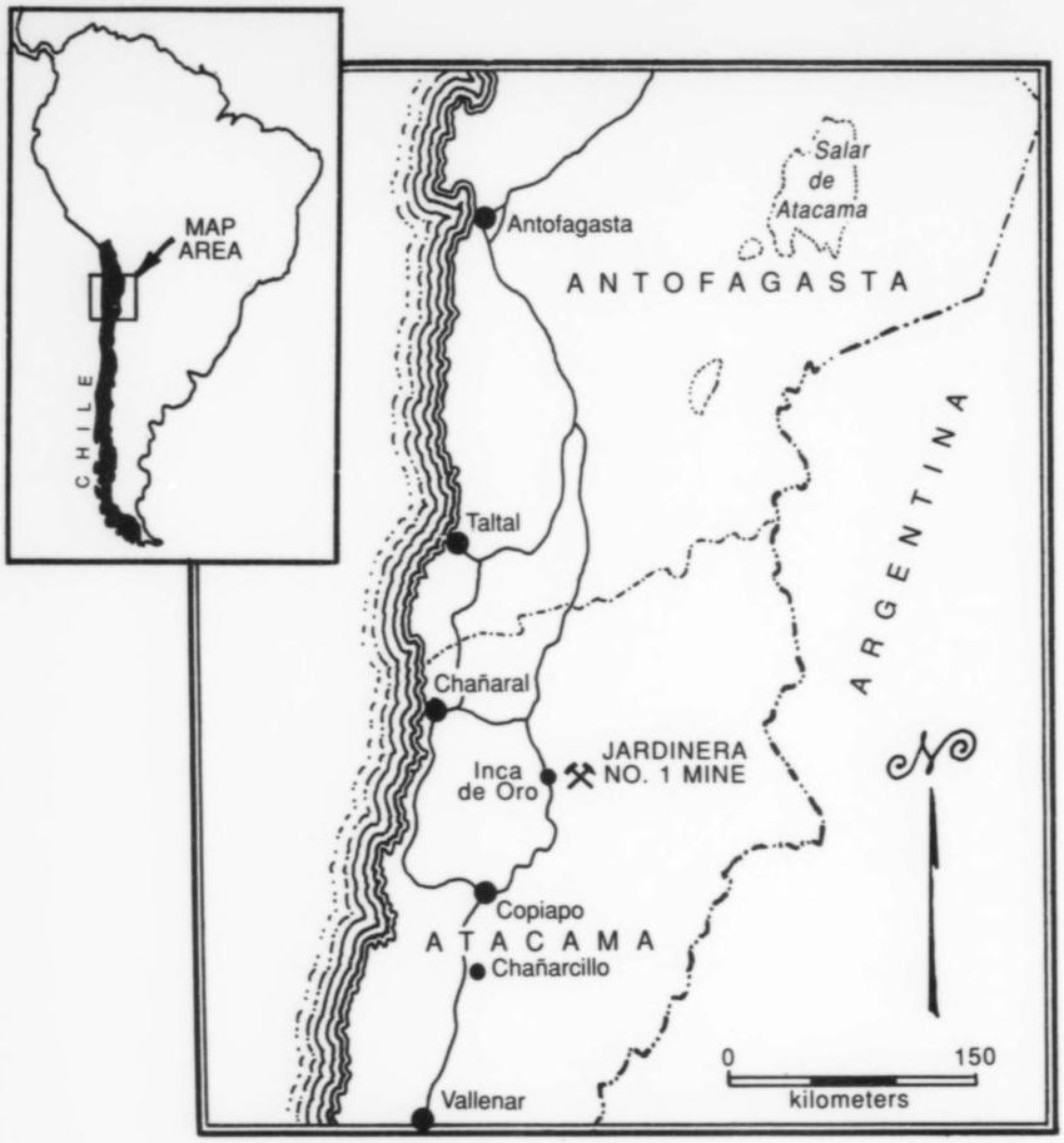

Figure 1. **Location map.**

Spindle-stage methods were used for the optical study. Szenicsite is biaxial positive with 2V = 74(3)° and the optical orientation is X = *b*, Y = *a*, and Z = *c*. The pleochroic scheme is X = yellow-green, Y and Z = green; dispersion is strong, with r > v. Its measured birefringence ($\gamma - \alpha = 0.017$) is low to moderate. The refractive indices are too high to measure with normal immersion fluids and our attempts using arsenic sulfide dissolved in methylene iodide were unsuccessful. The indices are probably greater than 1.8. The inadvisability of calculating optical data was pointed out in a review of this paper by J. A. Mandarino, and we advise readers to ignore the optical data presented earlier (Francis *et al.*, 1994), which were subsequently published in Mandarino (1997).

CHEMISTRY

Two chips of szenicsite were analyzed with a Cameca MBX electron microprobe using wavelength spectrometers. The average of 20 point analyses is reported in Table 1 along with details of the experimental conditions. A check for elements other than Cu, Mo, and O only showed a small amount of Al present. To be sure that this Al is not due to contamination introduced during polishing, the grain mount, which is free of other mineral species, was ground further using fresh SiC paper and polished on fresh diamond laps. In new analyses Al is still present in the same concentration. A grain mount of Jardinera No. 1 mine lindgrenite was made when the szenicsite samples were reground and its Al content is at the detection limit of 0.016 wt% Al_2O_3. We conclude that the small quantity of Al in szenicsite is re[illegible]. Water was determined by loss on ignition in air up to 800°C after drying the sample at 100°C. The

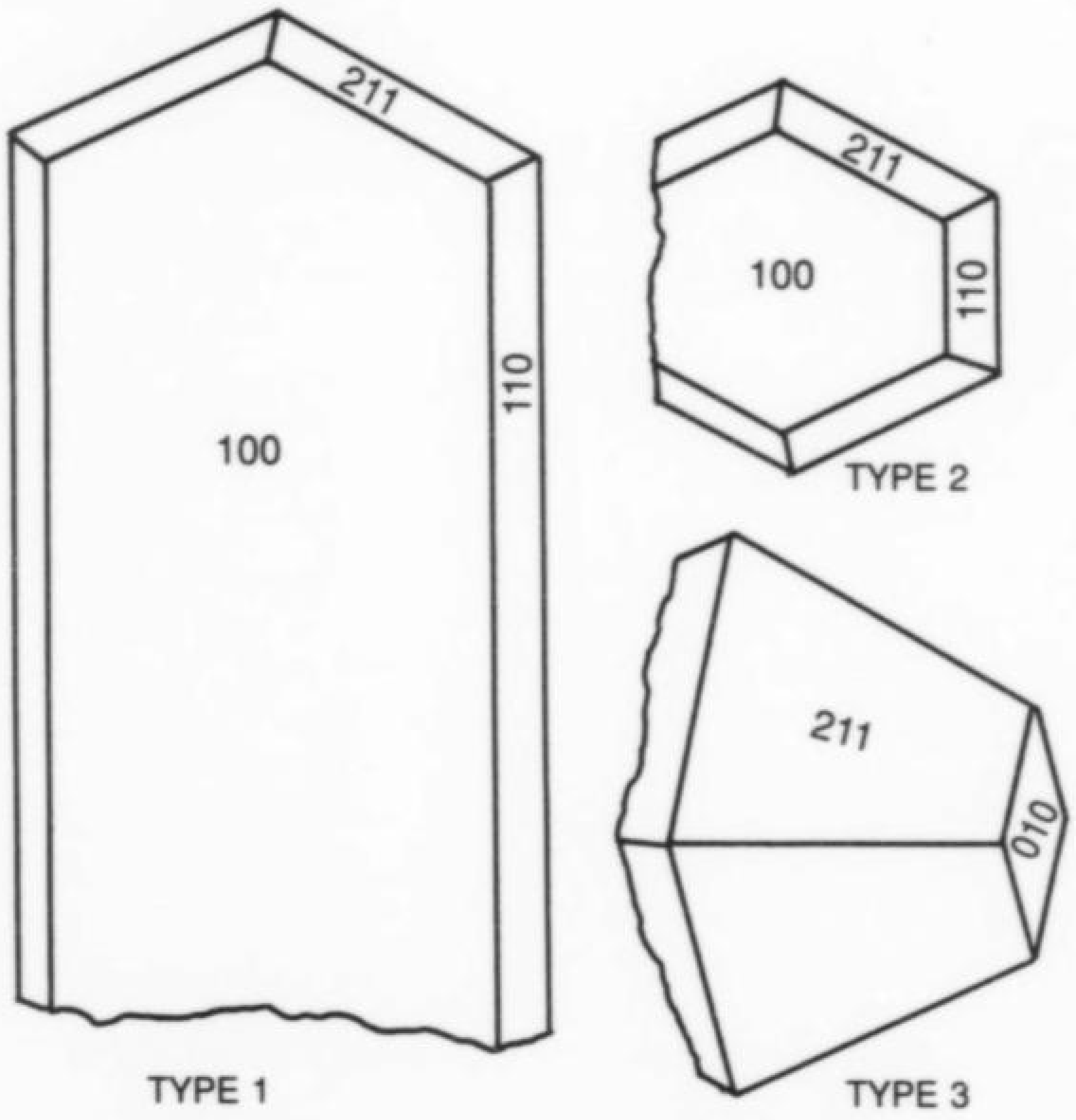

Figure 2. **Szenicsite crystal drawings (standard clinographic projections) illustrating the three known habits. Totally euhedral or doubly terminated crystals have yet to be found.**

oxygen content was also measured with the electron microprobe using $LiEuMo_2O_8$ as a standard. Calculating water from the measured oxygen content yields 8.91 wt.% H_2O versus 8.79 wt.% from the loss on ignition. On the basis of 8 oxygens the microprobe analysis gives a formula of $Cu_{2.97}Al_{0.01}(MoO_4)_{0.99}(OH)_{4.09}$ which is very close to $Cu_3MoO_4(OH)_4$. Chemical spot tests for Cu^{2+} and for Mo^{6+}, as described by Feigl and Anger (1972), confirmed the valences of the Cu and Mo in szenicsite.

Szenicsite joins ferrimolybdite, lindgrenite, powellite and wulfenite as a simple molybdate.

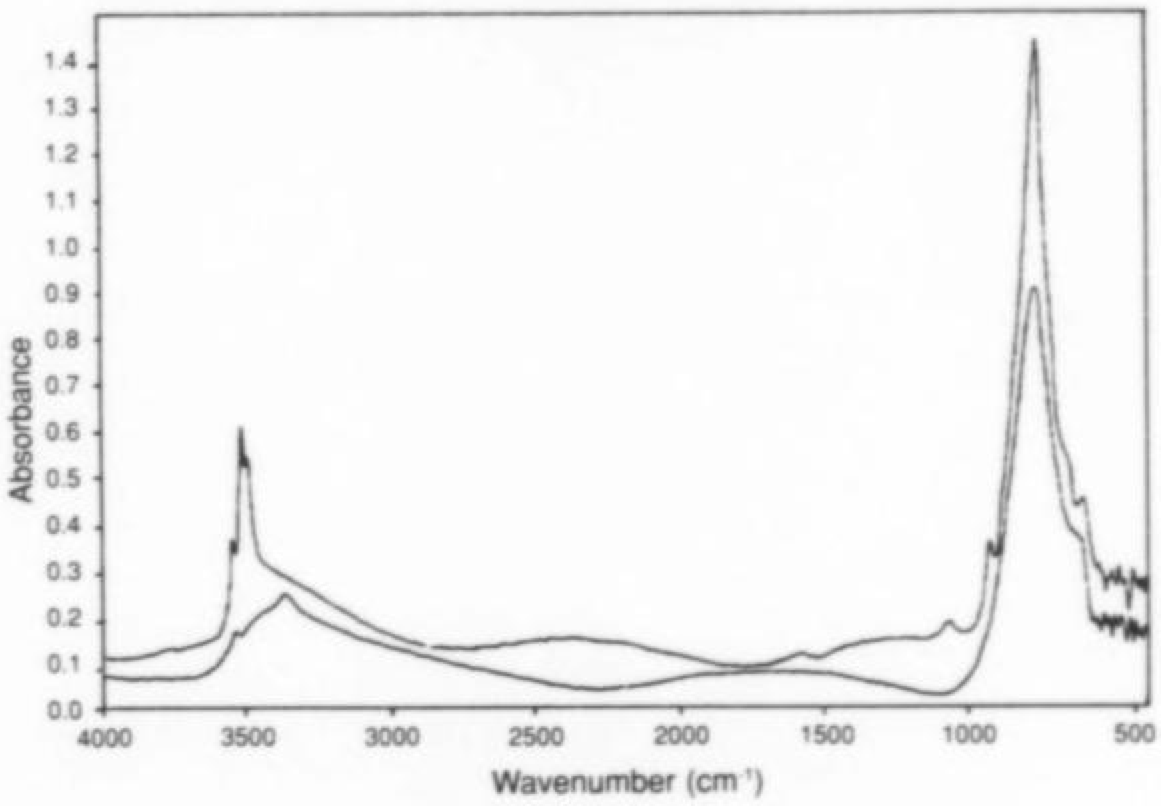

***Figure 3.* Infrared spectra of szenicsite (upper curve) and lingrenite (lower curve).**

SPECTROSCOPY

Infrared spectra of both szenicsite and type lindgrenite were recorded from single crystals mounted in a diamond cell on a Spectra Tech IR-Plan microscope attached to a Nicolet 510 FT-IR spectrometer by Eugene Farrell at the Harvard University Art Museums. The szenicsite pattern is more sharply resolved than the lindgrenite pattern. Absorption band positions are listed in Table 2. The very strong band in the 600–1000 cm⁻¹ region is due to the molybdate ion while the medium band near 3400 cm⁻¹ is due to hydroxyl. There is no evidence for molecular water in either mineral.

***Table 1.* Electron microprobe analysis of szenicsite.**

	Average	*Std. Dev.*	*Minimum*	*Maximum*	*Stoichiometric $Cu_3MoO_4(OH)_4$*
Al_2O_3	0.14	0.04	0.03	0.20	
CuO	56.26	0.25	55.88	56.69	57.01
MoO_3	34.00	0.50	33.00	34.72	34.38
H_2O	8.79				8.61
Total	99.19				100.00
Number of atoms on the basis of 8 Oxygens					
Al	0.01				0.00
Cu	2.97				3.00
Mo	0.99				1.00
H	4.09				4.00

Beam conditions: 15 KeV, 16 nanoamperes, 16 x 16 micrometer rastered beam. Ten analyses each on two chips. Sandia ZAF85 matrix correction progrram used. H_2O from loss on ignition. Microprobe gave 30.63% O which gives 8.91 % H_2O. Standards used: kyanite (Al), cuprite (Cu), $LiEuMo_2O_8$ (Mo, O). Other elements checked were below their detection limits: detection limit of 0.01 weight %: Cl; 0.06: F; 0.01 weight % oxide: Ca; 0.02 weight % oxide: Mg, Si, Ti, Cr, Mn, Zn, W; 0.03 weight % oxide: Fe, Co; 0.04: V, Ni; 0.09 weight % oxide: Pb.

***Table 2.* Infrared spectra of szenicsite and lindgrenite.**

Szenicsite		*Lindgrenite*	
Position	*Height*	*Position*	*Height*
3559	m	3526	m
3524	s	3420	m, shoulder
3505	s	3347	m
2409	w, broad	1633	w, broad
1089	w		
942	m	900	shoulder
795	vs	834	vs
690	shoulder	650	shoulder
625	m		

m medium, **s** strong, **vs** very strong, **w** weak

***Table 3.* X-ray powder diffraction data for szenicsite. (Recorded with CuKα radiation using a 114.6-mm diameter Debye-Scherrer camera.)**

I	$d_{meas.}$	$d_{calc.}$	*h*	*k*	*l*	*I*	$d_{meas.}$	$d_{calc.}$	*h*	*k*	*l*
w	6.270	6.263	0	2	0	m	2.125	2.125	4	0	0
s	5.471	5.460	0	1	1	vw	2.090	2.088	0	6	0
m	4.599	4.594	1	1	1	m	2.043	2.043	3	1	2
w	4.031	4.024	2	1	0	w	1.985	1.985	3	4	1
s	3.754	3.748	1	3	0	w	1.943	1.944	1	1	3
w	3.517	3.516	2	2	0	m	1.885	1.884	1	5	2
w	3.440	3.440	0	3	1	vw	1.856	1.855	3	3	2
w	3.121	3.131	0	4	0	vw	1.817	1.820	0	3	3
s	3.043	3.042	2	2	1	w	1.792	1.790	2	6	1
vw	2.981	2.978	2	3	0	w	1.758	1.758	4	4	0
m	2.759	2.763	3	1	0	w	1.742	1.740	4	0	2
w	2.641	2.645	1	4	1	w	1.719	1.720	0	6	2
vs	2.591	2.599	1	2	2	m	1.684	1.684	5	1	0
w	2.517	2.515	3	1	1	m	1.640	1.640	5	2	0
vw	2.470	2.469	2	0	2	w	1.594	1.594	2	6	2
m	2.415	2.422	2	1	2	m	1.566	1.566	4	5	1
m	2.357	2.358	1	3	2	s	1.519	1.517	0	0	4
w	2.295	2.297	2	2	2	vw	1.492	1.493	1	8	1
vw	2.235	2.234	1	5	1	w	1.472	1.473	5	1	2
m	2.180	2.179	0	4	2	w	1.453	1.452	1	2	4

CRYSTALLOGRAPHY

X-ray diffraction study by the precession method using MoKα radiation showed szenicsite to be orthorhombic, point group *mmm*, and space group P*nnm* or P*nn2*. The powder X-ray data reported in Table 3 were obtained using a 114.6-mm Debye-Scherrer camera with CuKα radiation. Refinement of all of the powder data using Burnham's program LCLSQ (version 8 adapted to run on personal computers) yielded a unit cell with $a = 8.499(3)$Å, $b = 12.526(5)$Å, $c = 6.067(2)$Å, and $V = 645.9(3)$Å³.

Eby and Hawthorne (1993) have published a structural classification of the copper oxysalts which is analogous to the familiar classification of the silicates. There is a systematic increase in the

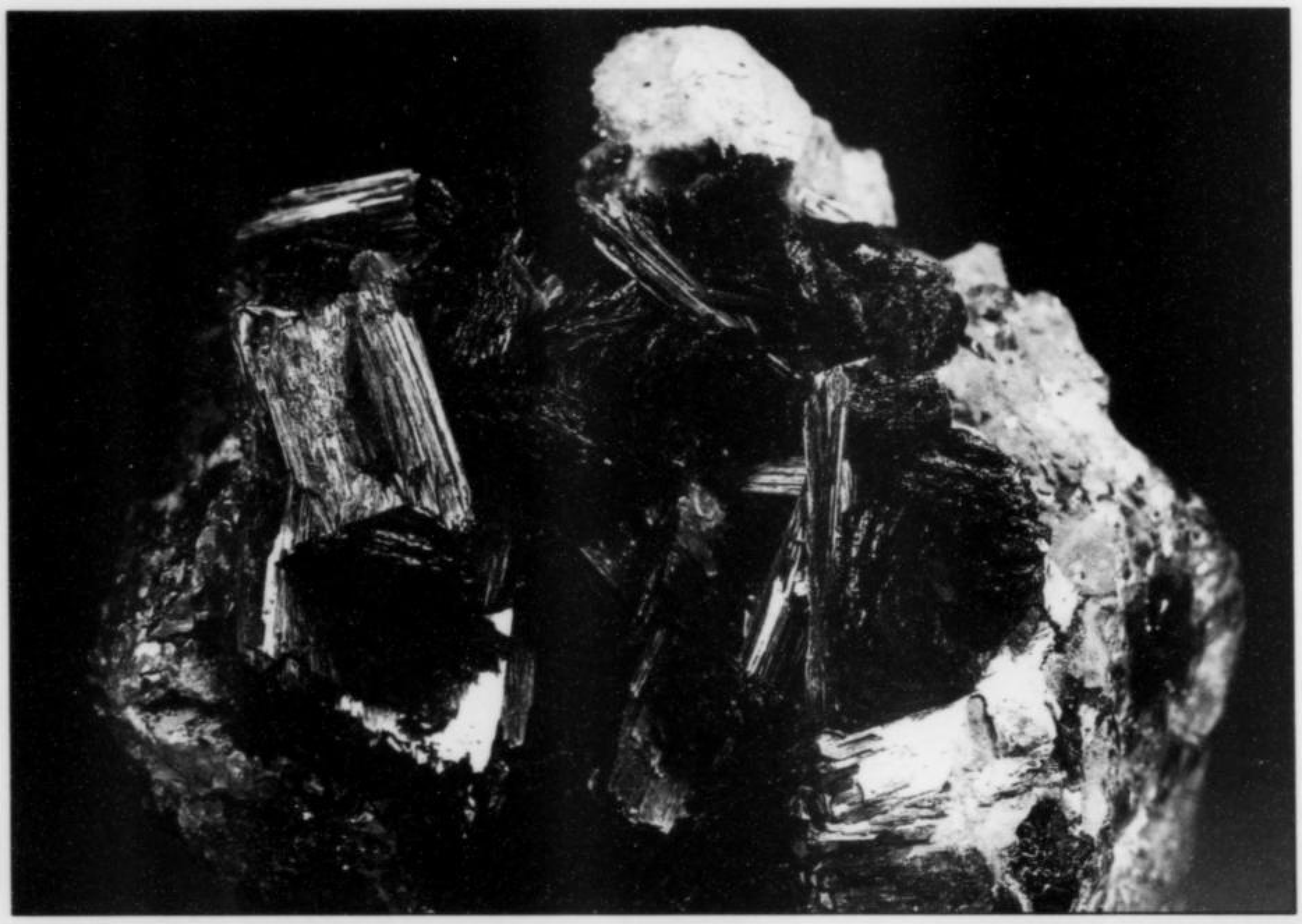

Figure 4. Szenicsite crystal cluster, 7.5 cm across, with yellow-green drusy powellite. Szenics specimen; Wendell Wilson photo.

Figure 5. Szenicsite sheaves to 2 cm on drusy yellow-green powellite. Szenics specimen; Wendell Wilson photo.

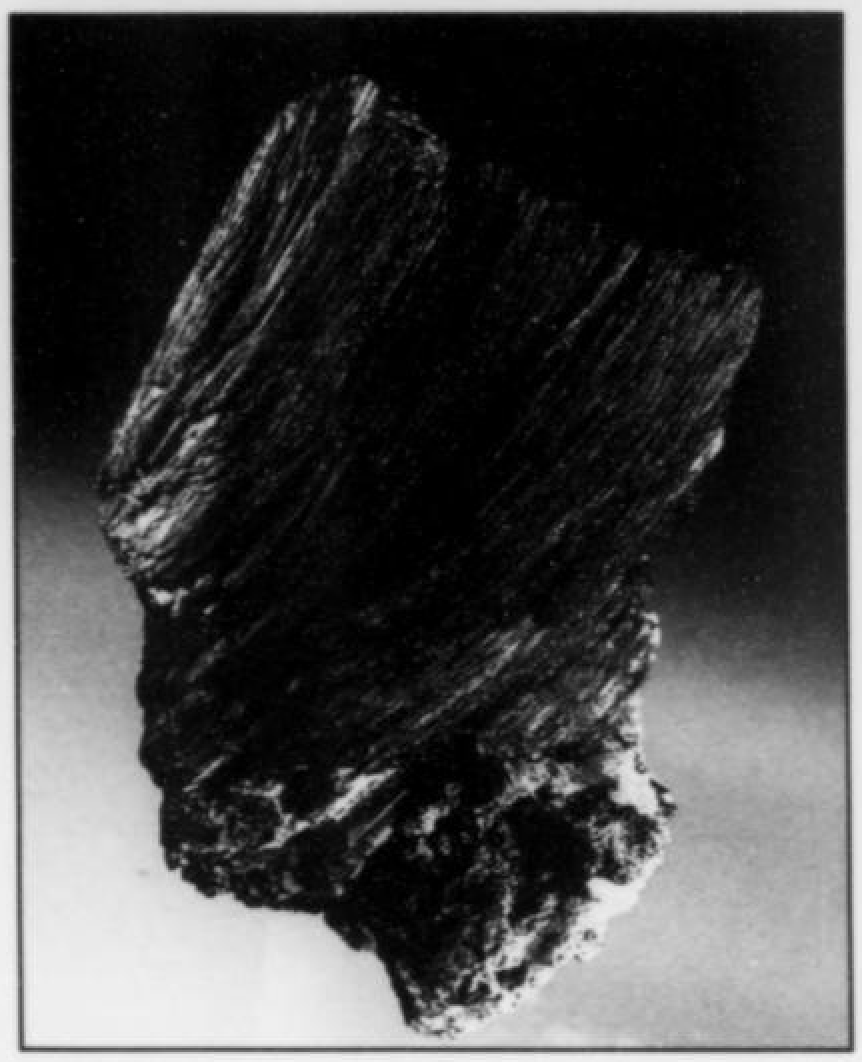

Figure 6. Twisted parallel growth of szenicsite, 4 cm. Szenics specimen; Wendell Wilson photo.

Figure 7. Tabular szenicsite crystals to 1 cm. Szenics specimen; Wendell Wilson photo.

Figure 8. **Powellite pseudomorphs after blocky molybdenite crystals with minor dark green szenicsite, 7 cm. Szenics specimen; Wendell Wilson photo.**

Figure 9. **Steeply dipyramidal crystals of pale yellow powellite to 4 mm. Szenics specimen; Wendell Wilson photo.**

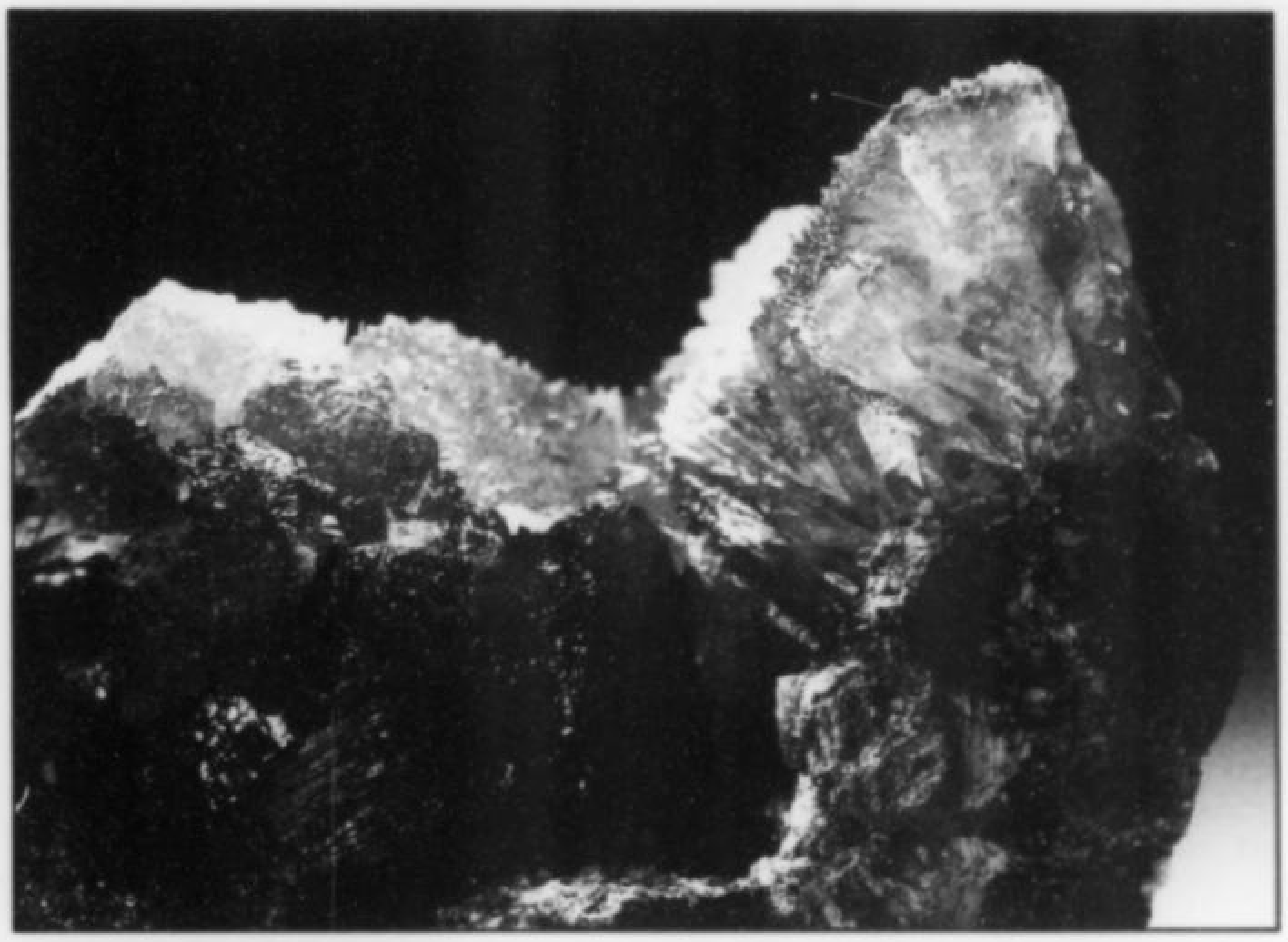

Figure 10. **Powellite in thick bundles terminated by drusy-like surfaces, with dark green szenicsite at the base; 2.5 cm across. Szenics specimen; Wendell Wilson photo.**

Figure 11. **Coarse druse of green powellite, 3 cm across. Szenics specimen; Wendell Wilson photo.**

average ratio of octahedral cations to tetrahedral cations as the degree of polymerization increases. Szenicsite has a ratio of 3:1, placing it among either the sheet structures or the framework structures. Its low birefringence implies that the bonding is fairly uniform in all directions and thus we predict that szenicsite has a framework structure. Significantly, lindgrenite with its lower Cu:Mo ratio of 3:2 is known to have a framework structure (Hawthorne & Eby, 1985).

PARAGENESIS

Szenicsite occurs as fracture fillings and as crystals in vugs closely associated with powellite. The granitic matrix has been hydrothermally altered. Feldspars have been completely converted to kaolinite, in some cases leaving quartz molds. Barite, brochantite, chalcocite, chalcopyrite, gold, hematite, lindgrenite and molybdenite-2H have also been identified in the specimen suite. All identifications except gold and quartz were verified by X-ray powder diffraction.

The primary ore assemblage is known from a single specimen which consists of a crystal of molybdenite embedded in a mass of chalcopyrite erroneously reported as bornite (Francis *et al.*, 1994). Chalcopyrite is veined and largely replaced by chalcocite which, in turn, is veined by an olive-brown, fine-grained material, and to a much lesser extent by veinlets of powellite and pulverulent red hematite. The olive-brown material is a mixture containing powellite. Small vugs contain dark dipyramidal millimeter-size crystals of powellite. Unlike the massive powellite veinlets, these crystals do not fluoresce.

Terry Szenics (personal communication, April 1996) asserts that the Jardinera No. 1 mine is very unusual among the mines in that area in having so much molybdenite present. The common *2H* polymorph of molybdenite occurs as isolated crystals to 2 cm in diameter and as masses of intergrown crystals. Hydrothermal breakdown of the molybdenite liberated molybdenum which oxidized in the solution forming the molybdate anion. According to Titley and Anthony (1961), the molybdate anion is stable in basic oxidizing solutions (Eh values > 0 and pH values > 6). Molybdate anions combined with calcium cations and precipitated as powellite. An influx of copper into the molybdate-bearing solution accounts for the green powellite and, more importantly, the subsequent precipitation of szenicsite. Lindgrenite occurs sparingly as seams in a white, altered rock in a zone beyond the szenicsite. Brochantite, the principal ore mineral, is a copper sulfate formed by oxidation of the copper sulfides. Brochantite and hematite form a colorful blue-green and dark red "spotted rock" which occasionally hosts szenicsite in cavities formerly occupied by molybdenite. The close association of powellite and szenicsite with molybdenite and its pseudomorphs suggests that molybdate ions are not very mobile in solution.

POWELLITE

The quality and variety of the powellite associated with szenicsite makes the Jardinera No. 1 mine a notable mineral locality regardless of the presence of copper molybdates! Worldwide, powellite typically occurs as inconspicuous pulverulent halos around molybdenite crystals, which are best observed under ultraviolet light. Crystals are known from several occurrences, including Houghton County, Michigan, and Tonopah, Nevada. The finest powellite crystals are from hydrothermal veins in the Deccan basalts at Nasik, India (Kothavala, 1982). In Chile, powellite crystals also occur sparingly at the nearby Tucumana mine, where Terry Szenics discovered them associated with chrysocolla and drusy quartz. In paragenetic order the three distinct types of powellite which occur at the Jardinera No. 1 mine are: pseudomorphs after molybdenite, massive vein-forming material and small, free-standing crystals in vugs.

***Table 4.* Electron microprobe analyses of powellite.**

Color	yellow	green	brown	pale green	dark green
CaO	27.84	27.85	28.35	27.69	28.23
MoO_3	70.38	70.30	70.11	69.81	69.87
CuO	0.08	0.02	0.08	0.09	0.30
Total	98.30	98.17	98.53	97.59	98.40
Number of atoms on the basis of 4 oxygens					
Ca	1.01	1.01	1.03	1.01	1.03
Mo	1.00	1.00	0.99	1.00	0.99
Cu	0.002	0.001	0.02	0.02	0.008

Beam conditions: 15 KeV, 21 nanoamperes, 16 x 16 micrometer rastered beam. Five analyses on each sample. Sandia ZAF85 matrix correction progrram used. Standards: wollastonite (Ca), $LiEuMo_2O_8$ (Mo) and cuprite (Cu). W and Fe were also analyzed for but were below their detection limits of 0.19 and 0.04 weight % oxide, respectively.

Although powellite is said to be found frequently as pseudomorphs after molybdenite (Palache *et al.*, 1954), a catalog of pseudomorphs in the American Museum of Natural History (Frondel, 1935) lists only a specimen from Clifton, Utah, and the only examples in the Harvard University collection are undistinguished examples from the Black Mountain district and the Benton Range in California. In contrast, the Jardinera No. 1 mine pseudomorphs clearly show the rosette form typical of the molybdenite crystal clusters. Numerous isolated and intergrown rosettes 1 to 2 cm in diameter popped free of the altered matrix. Matrix specimens are less common but careful inspection of the matrix of szenicsite specimens shows that powellite pseudomorphs are common. Szenicsite sometimes grows directly on the pseudomorphs.

Much of the powellite consists of gray-green porous masses containing flakes of fresh molybdenite. This material takes a good polish, and some was cut into spheres that fluoresce in shortwave ultraviolet radiation. A specimen measuring about 40 cm in diameter and estimated to weigh 70 kg, collected from the ore pile, yielded some of the finest specimens of szenicsite. It was unique because, in addition to the gray quartz and massive powellite matrix, vugs are lined with a distinctive reddish granular rind up to 2 cm thick which resembles a sandstone and may actually be a hematite-stained powellite sediment. This material is veined and overgrown by a centimeter-thick crust of green powellite reminiscent of the classic green smithsonite from Tsumeb. The few existing specimens are unique for powellite.

Crystals to 5 mm commonly form druses lining vugs in gray quartz and massive powellite. The crystals are steep dipyramids with lustrous, slightly convex faces. They may have multiple terminations giving them a splintery appearance. Tabular and blocky habits are very rare. Colors range from paragenetically early yellow-green to paragenetically late pale yellow. A few specimens of dark brown color were also noted. Anticipating that color would correlate with their minor element chemistry, five samples of differing color were analyzed (Table 4). Surprisingly, the crystals are essentially pure calcium molybdate, and appear not to be colored green by copper.

LINDGRENITE

Lindgrenite, $Cu_3(MoO_4)_2(OH)_2$, is well known at Chuquicamata, the type locality about 500 km north of Inca de Oro, so lindgrenite

Figure 12. **Terry and Marissa Szenics at the type locality.**

was a logical provisional identification when the szenicsite was first found; a comparison of their properties, however, shows them to be distinctly different. They are easily distinguished by color. Lindgrenite is yellow-green, szenicsite is a deep green like malachite. A small quantity of lindgrenite was found on a subsequent visit to the Jardinera mine. Most of the samples are yellow-green veinlets cutting a chalky white altered igneous rock. One or two small vugs contain euhedral crystals. The single instance of szenicsite and lindgrenite being found in the same specimen suggests that lindgrenite formed only at a distance from the molybdenite and powellite, where the molybdate ion was depleted relative to copper.

For analytical comparison a sample of type lindgrenite (Palache, 1935) from Chuquicamata (H#97527) was mounted and analyzed with the szenicsite. Lindgrenite from the Jardinera No. 1 mine was later mounted and analyzed by electron microprobe as well. The results are compared in Table 5. Jardinera lindgrenite is very pure. Silicon is present in quantities just above its detetion limits. The Chuquicamata sample contains small amounts of silicon, iron and lead. The average value of PbO is 0.46 weight % but individual analyses vary from 0.17 to 0.67 weight %. A second type of lindgrenite which is brighter in reflected light is present in the Chuquicamata sample. It occurs as a porous mass between blades of lindgrenite. Compositionally it has a lower lead content, is tungsten-rich and occurs in patches up to 1 micrometer in size. The tungsten-rich patches are too small to be resolved with the electron microprobe. Analyses show up to 22 weight % WO_3 with copper and molybdenum in nearly a 3 (Cu) to 2 (Mo, W) ratio. Thus these patches may be cuprotungstite intimately intergrown with lindgrenite, or they may be some undescribed intermediate copper molybdate-tungstate.

Table 5. **Electron microprobe analysis of lindgrenite.**

# of Analyses	*Jardinera 10*	*Chuquicamata 10 blades*	*Chuquicamata 3 porous*	*Chuquicamata Palache (1935)*	*Stoichiometric Cu_3Mo-$O_4(OH)_4$*
SiO_2	0.02	0.10	0.10		
FeO	<0.04	0.08	0.13		
CuO	43.65	43.01	42.69	42.8	43.82
MoO_3	53.36	52.88	53.50	53.7	52.87
PbO	<0.10	0.46	0.22		
H_2O	3.33	3.30	3.32	3.5	3.31
Total	100.36	99.82	99.95	100.0	100.00
Number of atoms on the basis of 99 oxygens excluding the H_2O					
Si	0.002	0.01	0.01		
Fe		0.01	0.01		
Cu	2.97	2.95	2.91	2.92	3.00
Mo	2.01	2.01	2.02	2.03	2.00
Pb		0.01	0.01		
H	4.98	4.98	4.96	4.95	5.00

Beam conditions: 15 KeV, 22 nanoamperes, 16 x 16 micrometer rastered beam. For Pb (L-alpha line): 25 KeV, 17 nanoamperes, 30 x 30 micrometer rastered beam. Sandia ZAF85 matrix correction progrram used. H_2O calculated from stoichiometry. Standards used: fayalite (Si, Fe), cuprite (Cu), $LiEuMo_2O_8$ (Mo), $PbTiO_3$ (Pb). Other elements checked were below their detection limits: detection limit of 0.01 weight %: Cl; 0.07: F; and 0.01: Ca; 0.02: Mg, Al, Ti, Cr, Zn, W; 0.03: Mn, Co; 0.04: V, Ni as weight % oxide.

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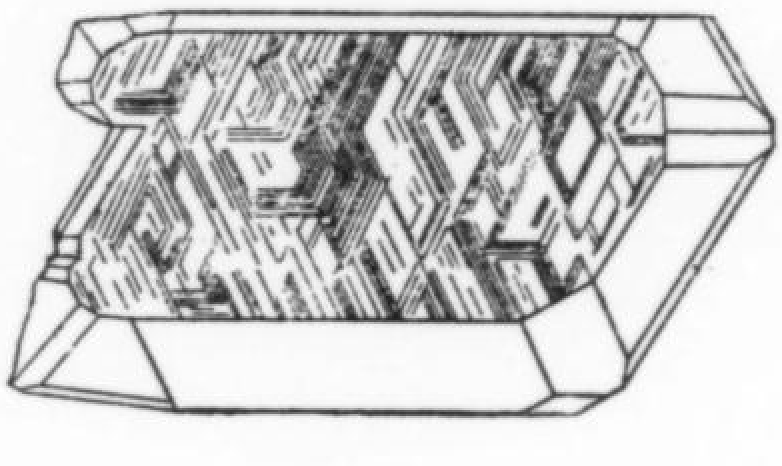

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1996 PROPOSALS

$Cu_5(Te^{6+}O_4)_2(As^{5+}O_4)_2\cdot 3H_2O$

Triclinic: P1 or $P\bar{1}$. a 8.984, b 10.079, c 8.975 Å, α 102.68°, β 92.45°, γ 70.45°. Emerald green; vitreous to adamantine; transparent to translucent. Biaxial, indices of refraction calculated from reflectance measurements are 1.71–1.73. 9.28 (70), 4.65 (70), 3.097 (100), 3.018 (60), 2.658 (50), 2.468 (50), 1.740 (50). IMA No. 96-001.

$[Ca_{0.75}(H_3O)_{0.25}](UO_2)_3(SeO_3)_2(OH)_{3.75}\cdot 2.5H_2O$

The calcium-dominant analog of guilleminite

Orthorhombic: Pmn2, or Pmnm. a 7.010, b 17.135, c 17.606 Å. Lemon-yellow; pearly; translucent. Biaxial (-), α 1.1.54 calc., β 1.73, γ 1.75, 2V(meas.) 33°. 8.79 (80), 8.56 (40), 3.51 (100), 3.24 (40), 3.093 (50), 3.032 (100), 1.924 (40). IMA No. 96-002.

$(Fe^{3+},Te^{6+},Ti^{4+},Mg^{2+})Te^{4+}_3O_8$

The Fe^{3+}-dominant analog of winstanleyite

Cubic: Ia3. a 11.011 Å. Orange; adamantine; translucent. Isotropic, n(calc) = 2.17. 4.486 (29), 3.175 (100), 2.943 (23), 2.749 (37), 2.592 (22), 1.944 (44), 1.658 (45). IMA No. 96-003.

$Al_2(OH)_5Cl\cdot 2H_2O$

Cubic: Im3m. a 19.878 Å. Yellow-orange to yellow-brown; vitreous; transparent. Isotropic, n 1.53–1.55. 8.11 (70), 7.03 (50), 4.47 (60), 3.23 (70), 2.706 (100), 2.446 (80), 1.957 (70). IMA No. 96-004.

$Mg_2(CO_3)Cl(OH)\cdot 3H_2O$

Hexagonal (trigonal): R3c or $R\bar{3}c$. a 23.163, c 7.221 Å. White; lustre and diaphaneity unknown. Uniaxial, ω 1.510, ε 1.510. 11.66 (100), 3.396 (17), 3.356 (17), 3.264 (21), 3.218 (21), 3.000 (41), 2.657 (22). IMA No. 96-005.

$NaZn_4(SO_4)(OH)_6Cl\cdot 6H_2O$

Hexagonal (trigonal): $P\bar{3}$. a 8.359, c 13.059 Å. Colorless to white; pearly; translucent. Uniaxial (-), ω 1.5607, ε 1.5382. 14.244 (100), 6.501 (23), 4.339 (15), 3.258 (14), 2.967 (10). IMA No. 96-006.

$(K,Na)_5Fe^{3+}_7[Si_{20}O_{50}(OH)_6]\cdot 12H_2O$

Triclinic: $P\bar{1}$. a 14.86, b 20.54, c 5.29 Å, α 95.6°, β 92.3°, γ 94.4°. Pink-brownish; silky to earthy; translucent. Biaxial (+), α 1.523, β 1.525, γ 1.550, 2V(meas.) 30°, 2V(calc.) 32°. 12.36 (100), 11.60 (40), 10.21 (14), 3.411 (37), 3.281 (15), 2.896 (12). IMA No. 96-007.

$(Fe,Mg,Al)_2(Na,\square)[Be_3Si_6O_{18}]\cdot H_2O$

The Fe^{3+}-dominant analog of beryl

Hexagonal: P6/mcc. a 9.387, c 9.202 Å. Light-blue; vitreous; transparent. Uniaxial (-), ω 1.625, ε 1.619. 8.12 (S), 4.00 (M), 3.278 (VS), 2.903 (S), 2.553 (MW), 1.752 (MW). IMA No. 96-008.

$Ca_3[B_5O_6(OH)_7]Cl_2\cdot 8H_2O$

Monoclinic: Pn. a 17.42, b 8.077, c 17.33 Å, β 121.48°. Colorless to white; vitreous; transparent to translucent. Biaxial (-), α 1.506, β 1.527, γ 1.532, 2V(meas.) 56°, 2V(calc.) 51°. 8.10 (10), 4.04 (4), 3.56 (2), 2.834 (2), 2.535 (2), 2.276 (2). IMA No. 96-009.

$(Fe^{3+},Ti)_4Ti_3AsO_{13}(OH)$

The Fe^{3+}-dominant analog of tomichite

Monoclinic: A2/m. a 7.184, b 14.289, c 5.006 Å, β 105.17°. Black; metallic; opaque. In reflected light: greyish-white, no bireflectance, nonpleochroic. R_1 & R_2: (20.1, 20.8%) 460nm, (18.7, 19.3%) 540nm, (18.2, 18.9%) 580nm, (17.5, 18.1%) 660nm. 3.117 (30), 2.846 (80), 2.681 (100), 2.029 (30), 1.5825 (50). IMA No. 96-010.

$Ca(H_2O)_3(C_2O_4)$ or $CaC_2O_4\cdot 3H_2O$

Triclinic: $P\bar{1}$. a 6.097, b 7.145, c 8.434 Å, α 76.54°, β 70.30°, γ 70.75°. Colorless; vitreous; transparent. Biaxial (-), α′ 1.483, β 1.516(calc.), γ′ 1.533, 2V(meas.) 70°, 2V(calc.) 70°. 7.92 (M), 5.52 (VS), 5.26 (M), 4.99 (M), 3.642 (M), 2.834 (S), 2.758 (M), 2.732 (M). IMA No. 96-012.

$Fe^{2+}(UO_2)_2(SO_4)_2\ (OH)_2\cdot 3H_2O$

Orthorhombic: Pnnm or Pnn2. a 15.908, b 16.274, c 6.903 Å. Pale yellow to white; vitreous; transparent. Biaxial (-), α 1.470, β 1.492, γ 1.504(calc.), 2V(meas.) 73°. 7.95 (81), 5.91 (100), 3.941 (71), 3.451 (67), 3.166 (50), 2.894 (41), 2.596 (70). IMA No. 96-013.

$Pb_{14}Sb_{30}S_{54}O_5$

Monoclinic: C2/m. a 52.00, b 8.148, c 24.311 Å, β 104.09°. Bluish-black; metallic; opaque. In reflected light: black with blue-red reflections, low anisotropism, low bireflectance, nonpleochroic. R_1 & R_2: (40.03, 42.90%) 470nm, (36.46, 40.92%) 546nm, (35.65, 40.25%) 589nm, (32.40, 36.00%) 650nm. 4.04 (m), 3.47 (s), 3.44 (m), 3.04 (m), 2.96 (s), 2.296 (m). IMA No. 96-014.

$Cu_5O_2(SeO_3)_2Cl_2$

Monoclinic: $P2_1/c$. a 6.045, b 13.778, c 5.579 Å, β 95.76°. Chestnut to dark brown; very strong vitreous to adamantine; translucent. Biaxial (-), α 2.06, β 2.11, γ 2.15, 2V(meas.) large, 2V(calc.) 82°. 6.88 (68), 5.511 (50), 2.990 (100), 2.963 (94), 2.566 (67), 2.296 (95). IMA No. 96-015.

$Cu_3(AsO_4)(OH)_3$

A triclinic polymorph of clinoclase

Triclinic: P1. a 5.445, b 5.873, c 5.104 Å, α 114.95°, β 93.05°, γ 91.92°. Green-blue; vitreous; transparent. Biaxial (-), α 1.760, β 1.80, γ 1.83, 2V(meas.) 77°, 2V(calc.) 80°. 4.613 (100), 4.580 (50), 3.390 (60), 2.713 (40), 2.543 (40), 2.445 (30). IMA No. 96-017.

$NaCa_3(CO_3)_2F_3\cdot H_2O$

Hexagonal (trigonal): $P3_2$ a 6.718, c 15.050 Å. Colorless to white; vitreous; transparent to translucent. Uniaxial (+), ω 1.538, ε 1.563. 5.809 (30), 5.010 (30), 3.358 (30), 2.791 (50), 2.508 (40), 2.010 (100), 1.939 (40). IMA No. 96-019.

$Pb_{12}O_6Mn(Mn,Mg)_4(Mg,Mn)_2(SO_4)$ $(CO_3)\ {}_4Cl_4(OH)_{12}$

Tetragonal: $P4_2/nnm$. a 12.627, c 12.595 Å. Apple green to emerald green; vitreous to adamantine; transparent. Anomalously biaxial (+), α, β, and γ > 1.92. 8.95 (20), 7.30 (20), 3.99 (30), 2.975 (100), 2.752 (30), 2.473 (20), 1.716 (20). IMA No. 96-020.

$(Ca,R)_5(PO_4)_3F \quad R = Sr, Na, REE$

A polymorph of fluorapatite

Hexagonal: $P6_3$ a 9.485, c 7.000 Å. Pale yellow; vitreous; transparent. Uniaxial (-), ω 1.649, ε 1.637. 3.498 (45), 3.104 (22), 2.838 (100), 2.814 (48), 2.740 (53), 1.963 (21), 1.865 (31). IMA No. 96-022.

$(Na,RE)_{15}(Ca,RE)_6Mn_3Zr_3NbSi_{25}O_{76}F_2$

A manganese- and fluorine-rich member of the eudialyte group

Hexagonal (trigonal): R3m. a 14.1686, c 30.0847 Å. Yellow-brown; vitreous; transparent. Uniaxial (-), ω 1.628, ε 1.623. 11.362 (43), 7.084 (41), 5.681 (30), 4.296 (34), 3.382 (37), 2.962 (91), 2.840 (100). IMA No. 96-023.

$ScPO_4$

The scandium-dominant analog of xenotime-(Y)

Tetragonal: $I4_1/amd$. a 6.589, c 5.806 Å. Pale-pink; vitreous; transparent. Uniaxial (+), ω 1.790, ε 1.86. 3.293 (100), 2.464 (8), 2.178 (4), 2.055 (4), 1.693 (6), 1.647 (6). IMA No. 96-024.

$Na_3Ca_4Al_{11}Si_{85}O_{192}\cdot 60H_2O$

A member of the zeolite group

Orthorhombic: Pnma. a 20.223, b 20.052, c 13.491 Å. Colorless to milky-white; silky to vitreous; opaque to transparent. Biaxial (-), α 1.485, β 1.487, γ 1.488, 2V(calc.) 70°. 11.20 (84), 9.98 (35), 3.85 (100), 3.75 (98), 3.67 (27), 3.00 (32). IMA No. 96-025.

$\gamma\text{-}Hg_3S_2Cl_2$

An orthorhombic polymorph of corderoite

Orthorhombic: Ammm, A222 or A2mm (Am2m, Amm2). a 9.332, b 16.82, c 9.108 Å. Canary yellow; glassy; transparent. Biaxial (+), mean index of refraction 2.25, 2V(meas.) > 70°. In reflected light: white, anisotropism and bireflectance not observed, R(est.) ≈ 15%. 3.65 (90), 3.11 (51), 2.83 (36), 2.60 (49), 2.58 (100), 2.33 (41), 2.11 (31). IMA No. 96-026.

$NaCu_5O_2(SeO_3)_2Cl_3$

Orthorhombic: Pbnm. a 10.482, b 17.732, c 6.432 Å. Emerald-green; vitreous; transparent. Biaxial (-), α 1.845, β 1.968, γ 1.975, 2V(meas.) 20°, 2V(calc.) 31°. 9.01 (10), 8.84 (60), 5.24 (100), 3.251 (40), 2.955 (27), 2.626 (25), 2.513 (12). IMA No. 96-027.

$NaFe_4^{2+}(PO_4)_3$

Hexagonal (trigonal): $R\bar{3}$. a 14.97, c 41.66 Å. Very pale amber; waxy; transparent. Uniaxial (+), ω 1.72, ε 1.75. 4.13 (80), 3.47 (50), 3.21 (50), 3.01 (90), 2.93 (50), 2.85 (50), 2.71 (100), 2.57 (50). IMA No. 96-028.

$Al_{16}B_6Si_2O_{37}$

Monoclinic: C2/m, Cm or C2. a 14.767, b 5.574, c 15.079 Å, β 91.959°. White; vitreous; transparent. Biaxial (+), α 1.629, β 1.640, γ 1.654, 2V(meas.) 82°, 2V(calc.) 84°. 5.41 (70), 5.19 (100), 4.95 (60), 4.31 (70), 3.378 (60), 2.162 (40). IMA No. 96-029.

$(Rh,Pd)_2As$

Orthorhombic: Pnma or $Pn2_1a$. a 5.866, b 3.893, c 7.302 Å. Color not observed, metallic, opaque. In reflected light: brownish with a pale green tinge, anisotropism moderate-distinct from dark brown to pale greyish green, bireflectance weak, pleochroism brownish to greenish. R_{min} & R_{max}: (45.5, 46.3%) 470nm, (47.6, 48.4%) 546nm, (48.2, 49.5%) 589nm, (49.8, 51.2%) 650nm. 2.426 (7), 2.348 (4), 2.237 (10), 2.067 (8), 1.935 (6), 1.860 (5). IMA No. 96-030.

$NaY(CO_3)F_2$

Orthorhombic: Pmcn. a 6.964, b 9.173, c 6.302 Å. Colorless to pale yellow; vitreous; transparent and translucent. Biaxial (-), α 1.457, β 1.543, γ 1.622, 2V(meas.) 82°, 2V(calc.) 83°. 5.19 (90), 3.477 (100), 2.800 (50), 2.087 (50), 2.057 (50), 1.966 (50), 1.849 (50), 1.763 (50). IMA No. 96-032.

$Na_3Ce_2(CO_3)_4F$

Hexagonal: $P6_3/mmc$. a 5.068, c 22.87 Å. Colorless to slightly beige; vitreous to somewhat pearly; transparent to translucent. Uniaxial (-), ω 1.728, ε 1.542. 4.31 (100), 3.169 (70), 2.877 (60), 2.534 (70), 2.192 (90B), 1.978 (70). IMA No. 96-033.

$Mg_7(PO_4)_2(OH)_8$

The magnesium- and phosphate-dominant analogue of allactite

Monoclinic: $P2_1/n$. a 5.250, b 11.647, c 9.655 Å, β 95.93°. Colorless; pearly; transparent. Biaxial (-), α 1.5945, β 1.6069, γ 1.6088, 2V(meas.) 46°, 2V(calc.) 43°. 4.436 (75b), 3.521 (80), 3.145 (70), 3.087 (70), 2.905 (100), 2.794 (75), 2.199 (80). IMA No. 96-034.

$PbCuFe^{3+}(PO_4)_2(OH,H_2O)_2$

The phosphate-dominant analog of gartrellite

Triclinic: P1 or $P\bar{1}$. a 5.320, b 5.528, c 7.434 Å, α 67.61°, β 69.68°, γ 70.65°. Green; vitreous to adamantine; transparent to translucent. Biaxial (+), α 1.90, β 1.93 (calc.), γ 2.00, 2V(meas.) 70°. 4.720 (67), 4.502 (61), 4.360 (100), 3.250 (70), 3.138 (57), 2.885 (89), 2.868 (69). IMA No. 96-035.

$Th(Ca,Na)_2(K_{1-x}\square_x)Si_8O_{20}\cdot nH_2O$

The calcium-dominant analog of steacyite

Tetragonal: P4/mcc. a 7.592, b 7.592, c 14.824 Å. Apple-green to dark-green and brown; vitreous; transparent. Uniaxial (-), ω 1.611, ε 1.606. 5.36 (40), 5.31 (70), 3.40 (100), 3.33 (65), 2.654 (59), 2.231 (50). IMA No. 96-036.

$(Ba,Ca,K,Na)_x[(V,Al)_2P(O,OH)_8]\cdot 6H_2O$

Cubic: $I\bar{4}3m$. a 15.470 Å. Pale greenish blue; vitreous; transparent. Isotropic, n 1.566. 10.8 (29), 7.73 (34), 3.164 (100), 2.827 (28), 2.738 (29), 2.582 (37), 2.445 (36). IMA No. 96-037.

$[Cu_{1-x}Al_x(OH)_2][(SO_4)_{x/2}(H_2O)_n]$

$0 < x < 0.67$ and $n > 3x/2$

The copper-dominant analog of carrboydite and glaucocerinite

Hexagonal (trigonal): $R\bar{3}m$. a 3.070, c 31.9 Å. Blue to pale blue; vitreous; translucent. Uniaxial (+), n_{min} 1.549, n_{max} 1.565. 10.5 (100), 5.26 (17), 3.50 (6), 2.60 (5), 2.46 (2), 2.23 (2), 1.524 (5b). IMA No. 96-038.

$(Cr,Fe)_{23}C_6$

The chromium-dominant analog of haxonite

Cubic: $Fm3m$. a 10.65 Å. Iron-grey; metallic; opaque. In reflected light: white. R: (46.5%) 470nm, (43.7%) 546nm, (43.2%) 589nm, (44.4%) 660nm. 2.38 (3), 2.17 (5), 2.05 (10). IMA No. 96-039.

$Ca_2(Zr,Ti)_5(Sb^{5+},Mn^{3+})_2O_{16}$

The antimony-dominant analog of calzirtite

Tetragonal: $I4_1/acd$. a 15.199, c 10.181 Å. Bright red; adamantine; translucent. Uniaxial (+), ω 2.12, ε 2.16. 3.45 (40), 2.92 (100), 2.539 (60), 1.794 (90), 1.535 (80), 1.0353 (40). IMA No. 96-040.

$KLi_3Ti_2Si_{12}O_{30}$

The titanium-dominant analog of brannockite

Hexagonal: $P6/mcc$. a 9.903, c 14.276 Å. White; vitreous; transparent. Uniaxial (-), ω 1.635, ε 1.630. 7.15 (40), 4.29 (50), 4.07 (85), 3.57 (80), 3.16 (100), 2.895 (95), 2.742 (30). IMA No. 96-041.

$Pb_3Sb^{5+}(SO_4)(AsO_4)(OH)_6\cdot 3H_2O$

The antimony-dominant analog of fleischerite (with AsO_4 replacing one SO_4)

Hexagonal: $P6_322$. a 8.939, c 11.102 Å. Colorless; adamantine; transparent. Uniaxial (+), ω 1.760, ε 1.801. 6.35 (44), 3.655 (100), 3.481 (80), 3.175 (31), 2.675 (62), 2.235 (35). IMA No. 96-043.

$Ag_2Pd_3Se_4$

Monoclinic: $P2_1/m$ or $P2_1$ a 6.350, b 10.387, c 5.683 Å, β 114.90°. Color unknown, only visible in polished section; metallic; opaque. In reflected light: buff to slightly grey-green buff; moderate anisotropism, rotation tints rose-brown, grey-green, pale bluish grey and dark steel-blue; bireflectance weak (air), moderate (oil); very weak pleochroism. R_1, R_2; ${}^{im}R_1$, ${}^{im}R_2$: (39.7, 47.2; 26.2, 34.4%) 470nm, (43.1, 48.8; 29.3, 35.15%) 546nm, (44.3, 49.4; 30.4, 35.5%) 589nm, (44.4, 49.2; 31.0, 35.6%) 650nm. 2.868 (50b), 2.742 (100), 2.688 (80), 2.367 (50), 1.956 (100), 1.829 (30). IMA No. 96-044.

$Pb_{7.5}B_{0.5}(OH)_{3.5}O_{4.5}Cl_4$ or $Pb_8O_4(OH)_4Cl_4$

Monoclinic: $C2/c$. a 5.673, b 5.580, c 13.152 Å, β 90.47°. Pale yellow to reddish orange; vitreous, resinous; translucent. In reflected light: grey; internal reflections ubiquitous, amber to light yellow; anisotropism masked (if present) by the internal reflections; bireflectance weak, nonpleochroic. R_1, R_2; ${}^{im}R_1$, ${}^{im}R_2$: (15.2, 16.3; 4.07, 4.67%) 470nm, (14.2, 15.3; 3.59, 4.17%) 546nm, (13.9, 15.0; 3.44, 4.02%) 589nm, (13.7, 14.7; 3.37, 3.91%) 650nm. 6.581 (37), 3.785 (48), 3.267 (35), 2.930 (100), 2.825 (43), 2.780 (36), 2.182 (37), 1.980 (33). IMA No. 96-045.

$(Fe,Cu)(Rh,Ir,Pt)_2S_4$

The iron-dominant analog of cuprorhodsite

Cubic: $Fd3m$. a 9.89 Å. Black; metallic; opaque. In reflected light: white, isotropic. R: (41.4%) 470nm, (41.8%) 546nm, (41.8%) 589nm, (41.7%) 650nm. 5.72 (7), 2.99 (10), 2.471 (8), 1.903 (7), 1.750 (9), 1.674 (3), 1.009 (3). IMA No. 96-047.

$Cu_9O_2(SeO_3)_4Cl_6$

Monoclinic: $I2$. a 14.110, b 6.27, c 12.997 Å, β = 113.0°. Tobacco-green; strong vitreous; transparent. Biaxial (-), α 1.87, β 1.92, γ 1.94, 2V(meas.) 66°, 2V(calc.) 63°. 11.29 (63), 5.56 (83), 3.450 (100), 3.239 (39), 2.714 (33), 2.486 (61). IMA No. 96-048.

$CaMgNa_6(IO_3)_6[(Cr_{0.84}S_{0.16})O_4]_2\cdot 12H_2O$

Monoclinic: $C2/c$. a 23.645, b 10.918, c 15.768 Å, β 114.42°. Pale yellow to bright lemon yellow; vitreous; transparent to translucent. Biaxial (+), α 1.647, β 1.674, γ 1.704, 2V(calc.) 88°. 10.69 (100), 6.36 (50), 5.65 (50), 3.590 (70), 3.121 (80), 3.051 (80). IMA No. 96-049.

Cu_2CdGeS_4

The cadmium-dominant analog of briartite

Tetragonal: $I\bar{4}2m$. a 5.45, c 10.6 Å. Color unknown, only visible in polished section; metallic; opaque. In reflected light: grey with pale violet tint, very weak anisotropism, very weak bireflectance and very weak pleochroism. R and ${}^{im}R$: (24.42, 10.79%) 460nm, (23.29, 9.85%) 540nm, (23.04, 9.59%) 580nm, (23.46, 9.91%) 660nm. 3.10 (100), 2.79 (10), 1.92 (80), 1.89 (70), 1.64 (60), 1.60 (20). IMA No. 96-050.

$Ca_2B_2O_5\cdot H_2O$

A polymorph of sibirskite

Monoclinic: $P2_1/m$. a 6.722, b 5.437, c 3.555 Å, β 93.00°. White; weak pearly; translucent. Biaxial (+), α 1.556, β 1.593, γ 1.663, 2V(calc.) 75°. 6.73 (70), 3.354 (30), 2.975 (60), 2.855 (20), 2.237 (100), 1.776 (20). IMA No. 96-051.

Cu_2HgSnS_4

The mercury-dominant analog of černýite and stannite

Tetragonal: $I\bar{4}$. a 5.555, c 10.911 Å. Dark grey; metallic; opaque. In reflected light: greenish-grey to light grey with greenish-brownish tint, moderate anisotropism with faded color effects from violet-blue to dark-greenish blue, insignificant bireflectance, weakly pleochroic from yellowish-olive-green to brownish-olive. R_{max}: (26.0%) 470nm, (26.3%) 546nm, (25.6%) 589nm, (24.8%) 650nm. 3.17 (10), 1.958 (2.5), 1.941 (8), 1.671 (4), 1.646 (3.5), 1.264 (2.5). IMA No. 96-052.

$Ca_4Al_2(OH)_{12}(SO_4)\cdot 6H_2O$

The sulfate-dominant rhombohedral analog of hydrocalumite

Hexagonal (trigonal): $R\bar{3}$ or $R3$. a 5.76, c 53.66 Å. White; vitreous; transparent. Uniaxial (-), ω 1.504, ε 1.485. 8.972 (100), 4.476 (70), 2.362 (40), 2.190 (40), 2.071 (35). IMA No. 96-053.

$Ba[Fe^{2+}_6Ti_5Mg]O_{19}$

The Fe^{2+}-dominant analog of hawthorneite

Hexagonal: $P6_3/mmc$. a 5.926, c 23.32 Å. Color unknown, only visible in polished section; metallic; opaque. In reflected light: light grey; very weak anisotropism, nearly isotropic; bireflectance very weak, but measurable; non-pleochroic. R_E, R_O; ${}^{im}R_E$, ${}^{im}R_O$, R_{min}: (16.9, 17.3; 5.13, 5.37%) 470nm, (16.35, 16.8; 4.90, 5.19%) 546nm, (16.3, 16.9; 4.92, 5.29%) 589nm, (16.4, 17.1; 5.00, 5.42%) 650nm. 2.963 (44), 2.795 (90), 2.641 (100), 2.437 (46), 1.676 (37), 1.634 (47), 1.481 (47). IMA No. 96-054.

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

The cerium-dominant analog of 96-057, but structurally different

Monoclinic: $C2/c$. a 8.718, b 18.313, c 13.128 Å, β 93.90°. Very pale pink (incandescent light) and very pale blue (fluorescent light); vitreous; transparent. Biaxial (+), α 1.455, β 1.485, γ 1.528, 2V(meas.) 85°, 2V(calc.) 82°. 7.9 (100), 5.36 (50), 5.01 (40), 3.93 (70), 3.74 (20), 3.29 (20), 3.07 (20). IMA No. 96-055.

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

Triclinic: $P\bar{1}$. a 6.007, b 8.368, c 9.189 Å, α 99.90°, β 105.55°, γ 107.71°. Pale pink (incandescent light), pale blue (fluorescent light), some cream-colored; vitreous; transparent. Biaxial (-), α 1.544, β 1.578, γ 1.602, 2V(meas.) 65°, 2V(calc.) 78°. 8.52 (70), 6.72 (60), 5.48 (100), 4.26 (50), 3.84 (60), 3.35 (40), 2.744 (40). IMA No. 96-056.

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

The yttrium-dominant analog of 96-055, but structurally different

Monoclinic: $P2/n$. a 10.289, b 19.234, c 11.015 Å, β 108.50°. Colorless; vitreous; transparent. Biaxial (+), α 1.48, β 1.49, γ 1.55, 2V(meas.) 7°, 2V(calc.) 46°. 9.3 (100), 6.28 (90), 5.20 (40), 4.89 (60), 4.63 (30), 4.09 (50), 3.700 (30). IMA No. 96-057.

$(Rb,K)AlSi_3O_8$

The rubidium-dominant analog of microcline

Triclinic: $P\bar{1}$. a 8.81, b 13.01, c 7.18 Å, α 90.3°, β 115.7°, γ 88.2°. Colorless; vitreous; transparent. Biaxial, indices of refraction slightly higher than host microcline. 5.82, 5.77, 4.62, 3.88, 3.61, 3.60, 3.59, 2.94, 2.65, 2.63, 2.61, 2.56 (electron diffraction, no intensities). IMA No. 96-058.

$Fe^{3+}Mo_2O_6(OH)_3\cdot H_2O$

Triclinic: $P\bar{1}$. a 5.878, b 7.536, c 9.436 Å, α 71.66°, β 83.43°, γ 72.85°. Green with a yellowish tinge; vitreous to earthy; transparent to opaque. Biaxial (-), α 1.91, β 2.03, γ 2.11, 2V(meas.) ~ 90°, 2V(calc.) 74°. 5.620 (70), 4.711 (50), 4.095 (70), 3.319 (100), 3.232 (90), 2.614 (50), 1.956 (50). IMA No. 96-059.

$CaMgSc(PO_4)_2(OH) \cdot 4H_2O$
The scandium-dominant analog of overite and segelerite

Orthorhombic: Pbca. a 15.03, b 18.95, c 7.59 Å. Colorless, light yellow to yellowish brown; vitreous; transparent. Biaxial (-), α 1.574, β 1.579, γ 1.582, 2V(meas.) ~ 50°, 2V(calc.) 75°. 9.49 (100), 4.75 (17), 3.440 (31), 2.942 (27), 2.912 (44), 2.890 (35), 2.018 (15). IMA No. 96-060.

$(Ti,Cr,Fe)[O_{2-x}(OH)_x]$

Monoclinic: $P2_1/c$. a 7.688, b 4.5495, c 20.147 Å, β 92.27°. Black; metallic; translucent to opaque. Biaxial, mean n 2.47 (calc.). In reflected light: grey, with R lower than that of rutile, crichtonite, and srilankite and higher than that of pyrope. 3.766 (66), 2.835 (100), 2.660 (73), 1.6842 (94), 1.6760 (73), 1.6574 (71). IMA No. 96-062.

$Na_4Zr_2Si_{10}O_{26} \cdot 9H_2O$
The sodium-dominant analog of lemoynite with additional H_2O

Monoclinic: C2/m. a 10.5150, b 16.2534, c 9.1029 Å, β 105.46°. Colorless to white; vitreous; transparent to translucent. Biaxial (-), α 1.533, β 1.559, γ 1.567, 2V(meas.) 63°, 2V(calc.) 57°. 8.832 (30), 8.135 (100), 5.975 (40), 3.974 (35), 3.693 (30), 3.564 (40), 3.490 (35), 2.804 (30). IMA No. 96-063.

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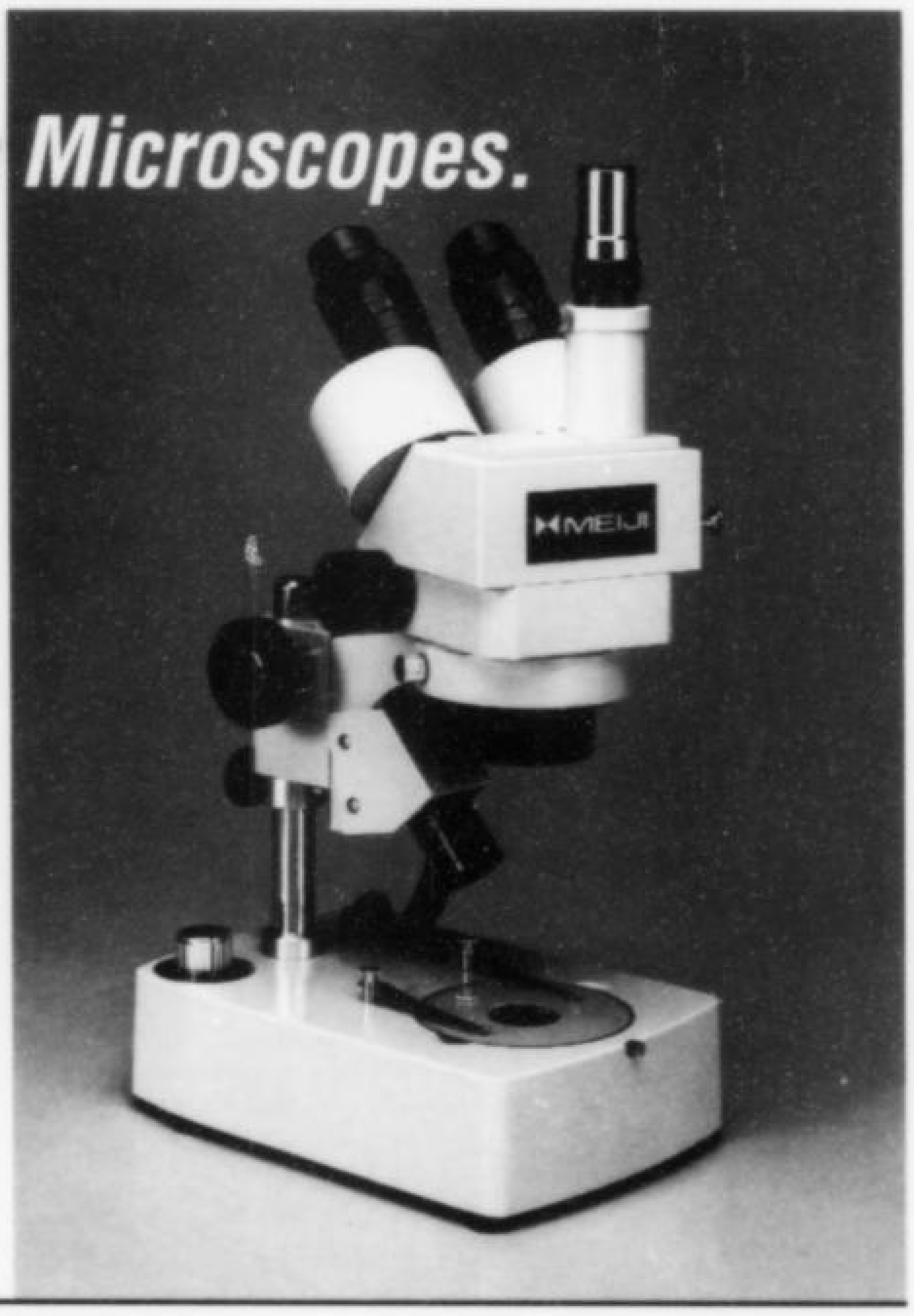

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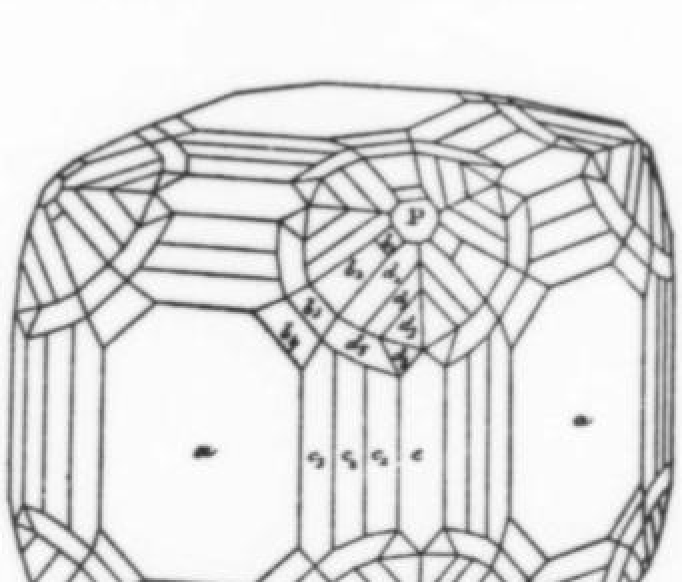

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Christelite — Triclinic

$Zn_3Cu_2(SO_4)_2(OH)_6 \cdot 4H_2O$

Locality: The San Francisco mine, Sierra Gorda, northeast of Antofagasta, in the 2nd region of northern Chile.

Occurrence: Presumably in a secondary assemblage. Associated minerals are: zincian paratacamite, anglesite, hemimorphite, quartz, and two other new minerals.

General appearance: Thin, bladed crystals (up to 13 x 4 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* greenish blue. *Streak:* bright greenish blue. *Luminescence:* non-fluorescent. *Hardness:* not given. *Tenacity:* not given. *Cleavage:* {001} perfect. *Fracture:* not given. *Density:* 3.14 g/cm³ (meas.), 2.98 g/cm³ (calc.) (see comments). ***Crystallography:*** Triclinic, $P\bar{1}$, a 5.415, b 6.338, c 10.475 Å, α 94.38°, β 90.08°, γ 90.24°, V 358.45 Å³, Z 1, a:b:c = 0.8544:1:1.6527. Morphology: forms, only {001} was observed. Twinning: none observed. ***X-ray powder diffraction data:*** 10.459 (82), 5.240 (7), 5.230 (100), 3.486 (54), 3.157 (8), 2.728 (8), 2.493 (10), 2.355 (10). ***Optical data:*** Biaxial (-), α 1.5977, β 1.6259, γ 1.6354, 2V(meas.) 59.4°, 2V(calc.) 58°; dispersion not given; pleochroism X = pale blue, Y and Z = blue; orientation not given. ***Chemical analytical data:*** Means of three sets of electron microprobe data: CuO 18.62, ZnO 36.25, SO_3 23.53, H_2O 23.05, Total 101.45 wt.%. Empirical formula: $Cu_{1.48}Zn_{2.82}(SO_4)_{1.86}(OH)_{4.88} \cdot 5.66H_2O$ (see comments). ***Relationship to other species:*** It is chemically similar to ktenasite.

Name: For Mrs. Christel Gebhard-Giesen (1950–) who discovered the mineral. ***Comments:*** IMA No. 95-030. The calculated density given by the authors is 3.14 g/cm³ based on the ideal composition. They also give an empirical formula based on 2 SO_4 groups; their subscripts are quite different from those given here.

SCHLÜTER, J., KLASKA, K.-H., ADIWIDJAJA, A., and GEBHARD, G. (1996) Christelite, $Zn_3Cu_2(SO_4)_2(OH)_6 \cdot 4H_2O$, a new mineral from the San Francisco Mine, Antofagasta, Chile. *Neues Jahrbuch für Mineralogie, Monatshefte* **1996**, 188–192.

Deloneite-(Ce) — Hexagonal (trigonal)

$NaCa_2SrCe(PO_4)_3F$

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

Occurrence: Associated minerals are: belovite-(Ce), a strontium-rare-earth apatite-like mineral, natrolite, pectolite, alkali amphibole, lomonosovite, labuntsovite, and sphalerite.

General appearance: Small grains (0.05 to 0.5 mm; rarely up to 1.5 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* bright yellow. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 5. *Tenacity:* brittle. *Cleavage:* {100} and {001} "uneven." *Fracture:* step-like. *Density:* 3.92 g/cm³ (meas.), 3.95 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), P3, a 9.51, c 7.01 Å, V 549.0 Å³, Z 2, c:a = 0.7371. Morphology: forms, {100} and {001}, but $\{00\bar{1}\}$ must be present also. Twinning: none observed. ***X-ray powder diffraction data:*** 3.51 (30), 3.12 (40), 2.84 (100B), 2.753 (40), 1.967 (30), 1.870 (30). ***Optical data:*** Uniaxial (-), ω 1.682, ε 1.660, nonpleochroic. ***Chemical analytical data:*** Means of five sets of electron microprobe data: Na_2O 4.45, K_2O 0.07, CaO 14.77, SrO 18.19, BaO 0.10, La_2O_3 8.12, Ce_2O_3 13.15, Pr_2O_3 1.13, Nd_2O_3 3.81, Sm_2O_3 0.34, Y_2O_3 0.02, SiO_2 0.74, P_2O_5 30.71, ThO_2 0.02, H_2O 0.38, F 2.03, sum 98.03, less O = F 0.85, Total 97.18 wt.%. Empirical formula: $(Na_{0.96}K_{0.01})_{\Sigma 0.97}Ca_{1.77}Sr_{1.18}(Ce_{0.54}La_{0.33}Nd_{0.15}Pr_{0.05}Sm_{0.01})_{\Sigma 1.08}(P_{2.91}Si_{0.08})_{\Sigma 2.99}O_{12.00}[F_{0.72}(OH)_{0.28}]_{\Sigma 1.00}$. ***Relationship to other species:*** Chemically, the calcium-dominant analogue of belovite-(Ce), but with a different space group.

Name: For B. N. Delone (Delaunay) (1890–1980), Russian mathematical crystallographer. ***Comments:*** IMA No. 95-036.

KHOMYAKOV, A. P., LISITSIN, D. V., KULIKOVA, I. M., and RASTSVETAEVA, R. K. (1996) Deloneite-(Ce) $NaCa_2SrCe(PO_4)_3F$—a new mineral with a belovite-like structure. *Zapiski Vserossuskogo mineralogicheskogo obshchestva* **125(5)**, 83–94.

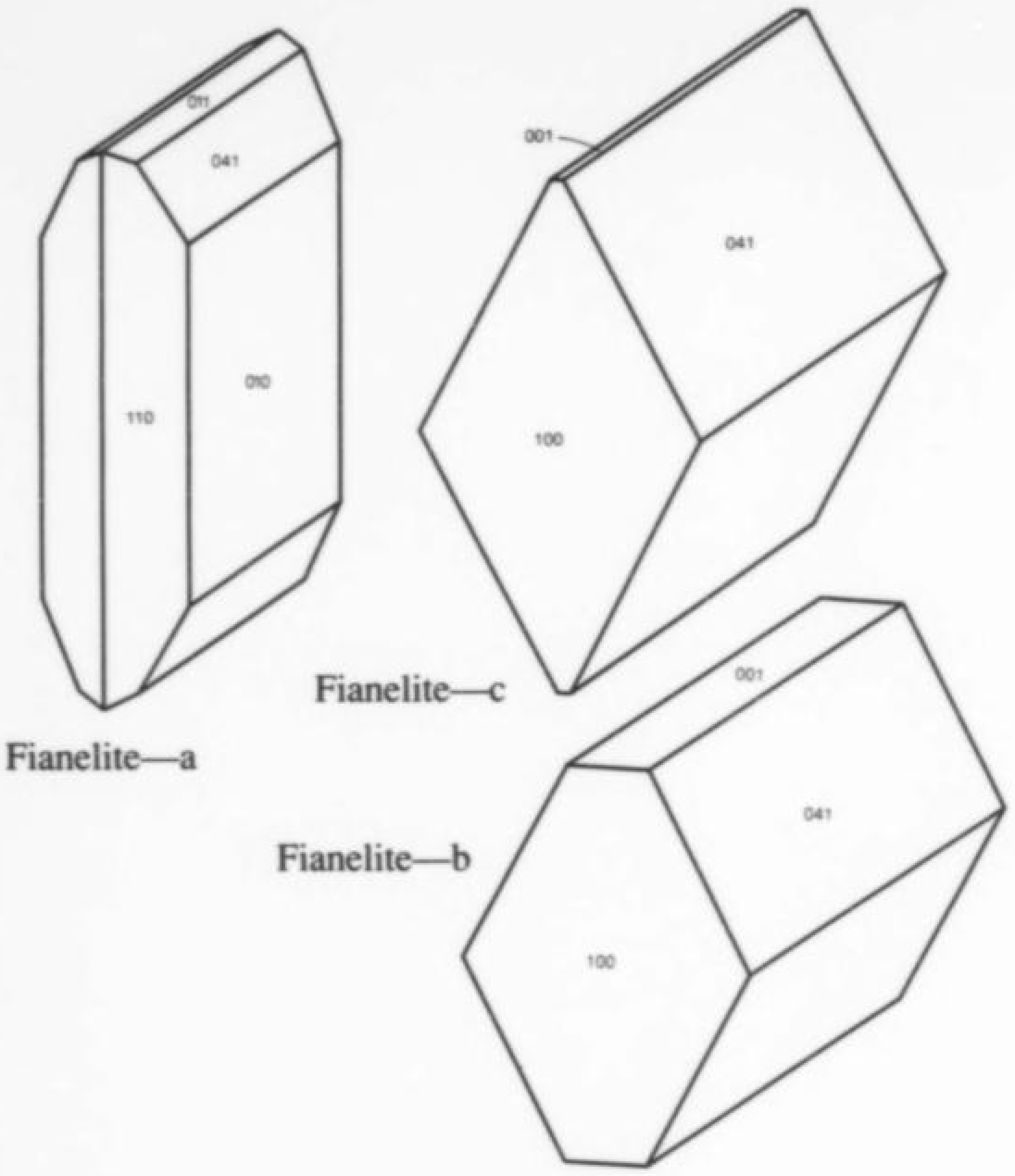
RASTSVETAEVA, R. K. and KHOMYAKOV, A. P. (1996) Crystal structure of deloneite-(Ce), the highly ordered Ca analog of belovite. *Doklady Akademia Nauk* **349(3)**, 354–357.

Fianelite — Monoclinic

$Mn_2^{2+}V^{5+}(V^{5+},As^{5+})O_7 \cdot 2H_2O$

Locality: The Fianel mine, Val Ferrera, Canton Graubünden, Switzerland.

Occurrence: In iron and manganese ores. Associated minerals are: quartz, aegirine, and "limonite."



Fianelite—a

Fianelite—c

Fianelite—b

General appearance: Polycrystalline crusts (less than 100 µm thick and up to 2.5 mm in diameter). Also, rare single crystals (up to 0.2 mm).

Physical, chemical and crystallographic properties: *Luster:* given as vitreous, but the indices of refraction indicate it should be adamantine. *Diaphaneity:* transparent. *Color:* orange-red. *Streak:* orange. *Luminescence:* non-fluorescent. *Hardness:* VHN_{15} 86.5 kg/mm^2, Mohs ~ 3. *Tenacity:* brittle. *Cleavage:* good parallel to {001} (?) and {100} (?). *Fracture:* not observed. *Density:* 3.21 g/cm^3 (meas.), 3.22 g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1/n$, a 7.809, b 14.554, c 6.705 Å, β 93.27°, V 760.8 Å^3, Z 4, a:b:c = 0.5366:1:0.4607. Morphology: forms, {100}, {010}, {001}, {011}, {041}. Twinning: none observed. ***X-ray powder diffraction data:*** 5.32 (80), 3.436 (50), 3.039 (100), 2.721 (60), 2.573 (50), 2.444 (50), 1.593 (60). ***Optical data:*** Biaxial (sign unknown), n_{yellow} 1.82, n_{red} 1.82, 2V(meas.) small; dispersion could not be determined; strong pleochroism on (010) yellow to red; $n_{yellow} \wedge a = 16°$ (in obtuse angle β), $n_{red} \wedge c = 13°$ (in acute angle β). The optic axes may lie in a plane at 90° to the b-axis (Brugger, personal communication). If this is so, the rest of the orientation is Y = b. ***Chemical analytical data:*** Means of eight sets of electron microprobe data: MnO 37.49, SiO_2 0.12, V_2O_5 38.23, As_2O_5 13.57, H_2O (9.64), Total 99.05 wt.%. H_2O calculated from the crystal structure to give $2H_2O$. Empirical formula: $Mn_{1.97}V^{5+}_{1.00}(V^{5+}_{0.57}As^{5+}_{0.44})_{\Sigma 1.01}O_{7.00}\cdot 2.00H_2O$. ***Relationship to other species:*** None apparent.

Name: For the locality. ***Comments:*** IMA No. 95-016. The two smaller drawings (b and c) represent very tiny crystals found on the (010) face of the larger crystal (a). In the optical data, the expressions n_{yellow} and n_{red} are for indices of refraction referred to the vibration directions which appear yellow and red, respectively (Brugger, personal communication).

BRUGGER, J. and BERLEPSCH, P. (1996) Description and crystal structure of fianelite, $Mn_2V(V,As)O_7\cdot 2H_2O$, a new mineral from Fianel, Val Ferrera, Graubünden, Switzerland. *American Mineralogist* **81**, 1270–1276.

Frankamenite Triclinic

$K_3Na_3Ca_5(Si_{12}O_{30})[F,(OH)]_4\cdot H_2O$

Locality: Near the Murunsky alkaline massif on the watershed of the Charo and Tokko rivers, Yakutia, Russia.

Occurrence: In charoitic rocks. Associated minerals are: charoite, orthoclase, aegirine, and tinaksite.

General appearance: Bladed crystals typically 1 cm long (rarely up to 15 cm long).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* translucent. *Color:* lilac-grey, blue-grey, greenish. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* 5 to 6. *Tenacity:* brittle. *Cleavage:* {010} and {100} perfect. *Fracture:* step-like. *Density:* 2.68 g/cm^3 (meas.), 2.68 g/cm^3 (calc.). ***Crystallography:*** Triclinic, P1, a 10.094, b 12.691, c 7.240 Å, α 90.00°, β 111.02°, γ 110.20°, V 804.5 Å^3, Z 1, a:b:c = 0.7954:1:0.5705. Morphology: forms, {100}, {010}, {110}. Twinning: microtwinning on (010). ***X-ray powder diffraction data:*** 5.88 (37), 4.70 (54), 4.21 (40), 3.01 (25), 2.915 (100), 2.354 (30), 2.307 (21). ***Optical data:*** Biaxial (-), α 1.536, β 1.539, γ 1.542, 2V(meas.) 70°, 2V(calc.) 90°; dispersion r < v, weak; nonpleochroic; X ∧ a = 33°, Y ≈ c, Z ≈ b. ***Chemical analytical data:*** Means of twelve sets of electron microprobe data: Na_2O 6.93, K_2O 10.53, MgO 0.07, CaO 21.62, MnO 0.38, FeO 0.13, SrO 0.23, SiO_2 55.06, H_2O 2.00, F 4.10, sum 101.05, less O = F 1.73, Total 99.32 wt.%. Empirical formula: $K_{2.93}Na_{2.93}(Ca_{5.05}Mn_{0.07}Sr_{0.03}Fe_{0.02}Mg_{0.02})_{\Sigma 5.19}(Si_{12.00}O_{30.00})F_{2.83}(OH)_{1.41}\cdot 0.75H_2O$. ***Relationship to other species:*** A fluorine-dominant, triclinic polymorph of canasite.

Name: For Prof. V. A. Frank-Kamenetsky (1915–1994), noted crystallographer of St. Petersburg University. ***Comments:*** IMA No. 94-050. In spite of a statement in the authors' abstract of the first paper cited below ("All the necessary data on physical properties and crystallochemical composition of frankamenite are presented in this paper."), many of the data are not given, but were given in the earlier (1992) paper which did not give the mineral name.

NIKISHOVA, L. V., LAZEBNIK, K. A., ROZHDESTVENSKAYA, I. V., EMELYANOVA, N. N., and LAZEBNIK, Yu. D. (1996) Frankamenite $K_3Na_3Ca_5(Si_{12}O_{30})F_3(OH)\cdot H_2O$—a new mineral, triclinic variety of canasite from charoitites. *Zapiski Vserossuskogo mineralogicheskogo obshchestva* **125(2)**, 106–108. NIKISHOVA, L. V., LAZEBNIK, K. A., ROZHDESTVENSKAYA, I. V., EMELYANOVA, N. N., and LAZEBNIK, Yu. D. (1992) Triclinic canasite from charoitites of Yakutia. *Mineralogicheskii Zhournal* **14(1)**, 71–77. ROZHDESTVENSKAYA, I. V., NIKISHOVA, L. V., and LAZEBNIK, K. A. (1996) The crystal structure of frankamenite. *Mineralogical Magazine* **60**, 897–905.

Gallobeudantite Hexagonal (trigonal)

$PbGa_3[(AsO_4),(SO_4)]_2(OH)_6$

Locality: Tsumeb, Namibia.

Occurrence: A secondary mineral. Associated minerals are: renierite, a germanite-like mineral, antimony-free gallian tennantite, chalcocite, hematite, goethite, stolzite, mercurian silver, and otjisumeite.

General appearance: Sparsely disseminated rhombohedra (up to 200 µm; most are less than 100 µm).

Physical, chemical and crystallographic properties: *Luster:* given as vitreous, but the indices of refraction indicate adamantine. *Diaphaneity:* transparent. *Color:* pale yellow to slightly greenish to cream-colored. *Streak:* white to pale yellow. *Luminescence:* non-fluorescent. *Hardness:* 4. *Tenacity:* brittle. *Cleavage:* {001} may be present. *Fracture:* even to conchoidal. *Density:* could not be determined, 4.58 g/cm^3 (calc.) (see comments). ***Crystallography:*** Hexagonal (trigonal), R3m, a 7.225, c 17.03 Å, V 770 Å^3, Z 3, c:a = 2.3571. Morphology: forms, an unidentified pseudo-cubic rhombohedron, probably {101}, and, on some crystals, {001} (see comments). Twinning: none observed. ***X-ray powder diffraction data:*** 5.85 (90), 3.59 (40), 3.038 (100), 2.851 (30), 2.513 (30), 2.271 (40), 1.948 (30), 1.797 (30). ***Optical data:*** Uniaxial (-), ω 1.763, ε 1.750, nonpleochroic. ***Chemical analytical data:*** Several sets of electron microprobe data are given. The data for the material used for the crystal structure analysis are: ZnO 2.0, PbO 32.2, Al_2O_3 8.1, Fe_2O_3 3.7, Ga_2O_3 20.0, P_2O_5 0.5, As_2O_5 16.6, SO_3 10.7, H_2O 7.8, Total 101.6 wt.%. Empirical formula: $Pb_{1.01}(Ga_{1.49}Al_{1.11}Fe^{3+}_{0.32}Zn_{0.17})_{\Sigma 3.09}[(AsO_4)_{1.01}(SO_4)_{0.93}(PO_4)_{0.05}]_{\Sigma 1.99}(OH)_{6.03}$. ***Relationship to other species:*** The gallium-dominant analogue of beudantite.

Name: For the relationship to beudantite. ***Comments:*** IMA No. 94-021. The calculated density for the ideal formula with AsO_4:SO_4 = 1:1 is given as 4.87 g/cm^3; in the paper's abstract, the calculated density is given as 4.61 g/cm^3. Lambohedra are not permitted in this crystal class.

JAMBOR, J. L., OWENS, D. R., GRICE, J. D., and FEINGLOS, M. N. (1996) Gallobeudantite, $PbGa_3[(AsO_4),(SO_4)]_2(OH)_6$, a new mineral species from Tsumeb, Namibia, and associated new gallium analogues of the alunite-jarosite family. *Canadian Mineralogist* **34**, 1305–1315.

Kukharenkoite-(Ce)

Monoclinic

$Ba_2Ce(CO_3)_3F$

Locality: From the following four localities: (KH) Khibina alkaline massif, Kola peninsula, Russia; (V) Vuorijärvi alkaline massif, Kola peninsula, Russia; (MSH) Mont Saint-Hilaire alkaline complex, Rouville County, Quebéc, Canada; (SA) Saint-Amable alkaline sill, near Varennes, Verchères County, Quebéc, Canada.

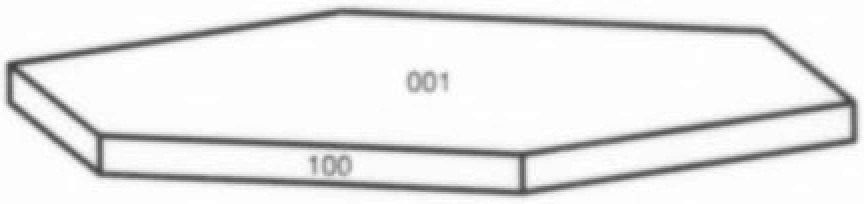
Occurrence: Associated minerals are: (KH) synchysite-(Ce), ewaldite, cordylite-(Ce), mckelveyite-(Y), orthoclase, barite, pyrite, sphalerite, galena, fluorite, zircon, burbankite, natrolite, belovite, nenadkevichite, ancylite-(Ce), and calcite; (V) vaterite, alstonite, ancylite-(Ce), cordylite-(Ce), mckelveyite-(Y), fluorapatite, and barite; (MSH) calcite, siderite, cordylite-(Ce), albite, quartz, pyrrhotite, pyrite, and rutile; (SA) microcline, natrolite, eudialyte, mangan-neptunite, aegirine, mosandrite, pyrite, zakharovite, yofortierite, låvenite, astrophyllite, and calcite.

General appearance: Small (0.01 to 1 mm) prismatic crystals often in dendritic, stellate, or irregular intergrowths (up to 3 mm across) (KH, V, and MSH); rarely as platy crystals (0.1 to 2 mm) or anhedral grains (0.05 to 0.2 mm) (KH); tapering, bladed crystals (0.3 to 1 mm long) forming reticulated aggregates (up to 3 mm across) or as fibrous aggregates of fine needles (SA).

Physical, chemical and crystallographic properties: *Luster:* vitreous to greasy, also earthy. *Diaphaneity:* transparent to translucent, also opaque. *Color:* yellow, reddish-brown (KH and V); colorless, very pale white, silvery grey, pinkish grey (MSH and SA). *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* about 4½. *Tenacity:* brittle. *Cleavage:* none observed. *Fracture:* uneven. *Density:* 4.7 (KH) g/cm^3 (meas.), 4.61 (KH) and 4.68 (MSH) g/cm^3 (calc.). ***Crystallography:*** Monoclinic, $P2_1/m$; (KH) a 13.396, b 5.067, c 6.701 Å, β 106.58°, V 435.8 Å^3, Z 2, a:b:c = 2.6438:1:1.3225; (MSH) a 13.418, b 5.077, c 6.714 Å, β 106.56°, V 438.3 Å^3, Z 2, a:b:c = 2.6429:1:1.3224. Morphology: no forms observed. Twinning: none observed. ***X-ray powder diffraction data:*** (MSH) 4.015 (100), 3.273 (100), 2.539 (20), 2.143 (40), 2.007 (50), 1.637 (30), 1.376 (20). ***Optical data:*** KH and (MSH) Biaxial (-), α 1.584 (1.594), β 1.724 (1.710), γ 1.728 (1.715), 2V(meas.) 16° (16°), 2V(calc.) 18° (22°); dispersion r > v, moderate; pleochroism not mentioned; Y = b, Z ∧ c = 26.5° (in obtuse angle β). ***Chemical analytical data:*** Analyses were carried out on four samples from KH, one from MSH and one from SA. Means of twelve sets of electron microprobe data for one KH sample: Na_2O n.d., CaO 0.39, FeO n.d., SrO 1.55, BaO 47.39, La_2O_3 6.61, Ce_2O_3 15.30, Pr_2O_3 1.19, Nd_2O_3 4.26, Sm_2O_3 n.d., Gd_2O_3 n.d., Y_2O_3 0.15, ThO_2 n.d., CO_2 21.95, F 3.18, sum 101.97, less O = F 1.34, Total 100.63 wt.%. Note: "n.d." means not detected. Empirical formula: $(Ba_{1.86}Sr_{0.09}Ca_{0.04})_{\Sigma 1.99}(Ce_{0.56}La_{0.24}Nd_{0.15}Pr_{0.04}Y_{0.01})_{\Sigma 1.00}(CO_3)_{3.00}F_{1.01}$. One set of data for MSH: Na_2O 0.14, CaO 0.38, FeO 0.10, SrO 2.29, BaO 47.63, La_2O_3 5.77, Ce_2O_3 9.91, Pr_2O_3 n.d., Nd_2O_3 1.31, Sm_2O_3 n.d., Gd_2O_3 0.20, Y_2O_3 n.d., ThO_2 7.61, CO_2 20.72, F 3.31, sum 99.37, less O = F 1.39, Total 97.98 wt.%. Empirical formula: $(Ba_{1.96}Sr_{0.14})_{\Sigma 2.12}(Ce_{0.38}La_{0.22}Th_{0.18}Nd_{0.05}Ca_{0.04}Na_{0.03}Fe_{0.01}Gd_{0.01})_{\Sigma 0.92}(CO_3)_{2.97}F_{1.10}$. ***Relationship to other species:*** The natural equivalent of synthetic $Ba_2Ce(CO_3)_3F$.

Name: For Prof. Alexander A. Kukharenko (1914–1993), Department of Mineralogy, St. Petersburg University, St. Petersburg, Russia. ***Comments:*** IMA No. 95-040.

ZAITSEV, A. N., YAKOVENCHUK, V. N., CHAO, G. Y., GAULT, R. A., SUBBOTIN, V. V., PAKHOMOVSKY, Ya. A., and BOGDANOVA, A. N. (1996) Kukharenkoite-(Ce), $Ba_2Ce(CO_3)_3F$, a new mineral from Kola peninsula, Russia, and Québec, Canada. *European Journal of Mineralogy* **8**, 1327–1336.



Nežilovite

Nežilovite

Hexagonal

$PbZn_2(Mn^{4+},Ti^{4+})_2Fe^{3+}_8O_{19}$

Locality: Nežilovo, Republic of Macedonia.

Occurrence: In pink dolomitic marble from a Precambrian metamorphic complex of gneisses, schists, and marbles. Associated minerals are: "plagioclase," "chlorite," phlogopite, cymrite, talc, piemontite, barite, hedyphane, braunite, gahnite, franklinite, and hematite.

General appearance: Thin tabular crystals (0.2 to 1 mm).

Physical, chemical and crystallographic properties: *Luster:* metallic. *Diaphaneity:* opaque. *Color:* black. *Streak:* dark brown or nearly black. *Hardness:* VHN_{25} 735 kg/mm^2. *Tenacity:* brittle. *Cleavage:* {001} perfect. *Fracture:* conchoidal. *Density:* could not be determined, 5.69 g/cm^3 (calc.). *Other:* magnetic. ***Crystallography:*** Hexagonal, $P6_3/mmc$, a 5.854, c 22.882 Å, V 679.1 Å^3, Z 2, c:a = 3.9088. Morphology: forms, {001}, {100}. Twinning: none observed. ***X-ray powder diffraction data:*** 11.39 (45), 3.811 (100), 2.925 (20), 2.858 (75), 2.745 (50), 2.605 (40), 2.407 (25), 1.6361 (30). ***Optical data:*** In reflected light: anisotropic, bireflectant, nonpleochroic. Reflectance from an isotropic {001} plate, R_O, $^{im}R_O$: (23.8, 10.0%) 470nm, (22.4, 8.8%) 546nm, (21.7, 8.3%) 589nm, (20.7, 7.7%) 650nm.

Chemical analytical data: MgO 0.08, CaO 0.03, ZnO 13.23, PbO 19.01, Al_2O_3 4.52, Mn_2O_3 7.13, Fe_2O_3 41.96, MnO_2 11.01, TiO_2 2.84, Sb_2O_5 0.25, Total 100.06 wt.%. Empirical formula: $(Pb_{0.99}Ca_{0.01})_{\Sigma 1.00}(Zn_{1.89}Fe^{3+}_{1.11})_{\Sigma 3.00}(Fe^{3+}_{5.00}Mn^{3+}_{1.05}Mn^{4+}_{1.47}Al_{1.03}Ti_{0.41}Mg_{0.02}Sb^{5+}_{0.02})_{\Sigma 9.00}O_{19.00}$. ***Relationship to other species:*** A member of the magnetoplumbite group, specifically the lead- and zinc-dominant member.

Name: For the locality. ***Comments:*** IMA No. 94-020. The crystal drawing for this abstract was produced from the data given in the paper.

BERMANEC, V., HOLTSTAM, D., STURMAN, D., CRIDDLE, A. J., BACK, M. E., and ŠĆAVNIČAR, S. (1996) Nežilovite, a new member of the magnetoplumbite group, and the crystal chemistry of magnetoplumbite and hibonite. *Canadian Mineralogist* **34**, 1287–1297.

Odintsovite

Orthorhombic

$K_2Na_4Ca_3Ti_2Be_4Si_{12}O_{38}$

Locality: Murunsky alkaline massif (220 km south of the city of Olekminsk), Aldan shield, Russia.

Occurrence: In a vein in alkaline syenite pegmatite and in kalsilite syenite. Associated minerals are: aegirine, potassium feldspar, titanite, barytolamprophyllite, strontianite, wadeite, galena and an unidentified mineral.

General appearance: Equant grains (0.5–1.0 mm).

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless to light pink to pink with a brownish hue. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 5 to 5½. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* uneven. *Density:* 2.94 to 2.98 g/cm³ (meas.), 2.91 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, Fddd, a 14.243, b 13.045, c 33.484 Å, V 6221 Å³, Z 8, a:b:c = 1.0918:1:2.5668 (see comments). Morphology: no forms observed. Twinning: none observed. ***X-ray powder diffraction data:*** 9.23 (9), 4.15 (10), 3.30 (10), 3.16 (10), 2.53 (10), 2.42 (10), 1.582 (9). ***Optical data:*** Biaxial (+), α 1.630, β 1.644 (calc.), γ 1.675, 2V(meas.) 70°; pleochroism X = colorless, Y = pink, Z = pink; orientation, X = a, Y = b, Z = c. ***Chemical analytical data:*** Means of ten sets of electron microprobe data (BeO by atomic absorption spectroscopy and Li_2O by spectroscopy): Na_2O 8.57, K_2O 6.86, Li_2O 0.05, BeO 6.75, CaO 11.51, MnO 0.05, FeO 0.42, SrO 1.21, Al_2O_3 0.11, SiO_2 52.56, TiO_2 11.42, Total 99.51 wt.%. Empirical formula: $K_{2.02}(Na_{3.83}Li_{0.05})_{\Sigma 3.88}(Ca_{2.84}Sr_{0.16}Fe_{0.08}Mn_{0.01})_{\Sigma 3.09}Ti_{1.98}Be_{3.74}(Si_{12.11}Al_{0.03})_{\Sigma 12.14}O_{38.00}$. ***Relationship to other species:*** None apparent.

Name: For Prof. M. M. Odintsova (1911–1979), a founder of the Institute of the Earth's Crust, Irkutsk. ***Comments:*** IMA No. 94-052. Much of the data given in this abstract were taken from the original IMA proposal. The cell parameters given here are from the paper by Rastsvetaeva, Evsyunin, and Kashaev (1995); the paper by Konev, Vorobjev, Saposhnikov, Piskunov, and Ushchapovskaya (1995) gives a 12.778, 14.343, c 33.69 Å, V 6174 Å³.

KONEV, A. A., VOROBJEV, E. I., SAPOSHNIKOV, A. N., PISKUNOV, L. R., and USHCHAPOVSKAYA, Z. F. (1995) Odintsovite—$K_2Na_4Ca_3Ti_2Be_4Si_{12}O_{38}$—a new mineral from the Murunsky massif. *Zapiski Vserossuskogo mineralogicheskogo obshchestva* **124(5)**, 92–96. RASTSVETAEVA, R. K., EVSYUNIN, V. G., and KASHAEV, A. A. (1995) Crystal structure of a new natural K, Na, Ca-titanoberyllosilicate. *Crystallography Reports* **40**, 228–232.

Piretite

Orthorhombic

$Ca(UO_2)_3(SeO_3)_2(OH)_4\cdot 4H_2O$

Locality: Shinkolobwe uranium deposit, Shaba, Zaïre.

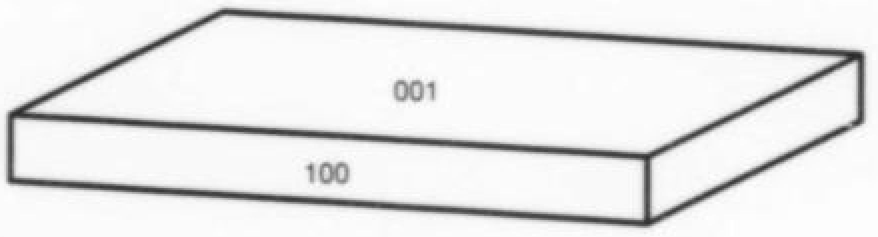
Occurrence: In the alteration zone. Associated minerals are: uraninite and a masuyite-like mineral.

General appearance: Elongate tablets with irregular outlines (2 to 3 mm long and 1 mm wide); also acicular prisms (up to 5 mm long).

Physical, chemical and crystallographic properties: *Luster:* pearly. *Diaphaneity:* transparent to translucent. *Color:* lemon yellow. *Streak:* pale yellow. *Luminescence:* non-fluorescent. *Hardness:* 2½. *Tenacity:* weak. *Cleavage:* {001} good. *Fracture:* uneven. *Density:* 4.00 g/cm³ (meas.), 4.01 g/cm³ (calc.). ***Crystallography:*** Orthorhombic, $Pmn2_1$ or Pmnm, a 7.010, b 17.135, c 17.606 Å, V 2114.8 Å³, Z 4, a:b:c = 0.4091:1:1.0275. Morphology: forms, {100}, {010}, {001}. Twinning: none observed. ***X-ray powder diffraction data:*** 8.79 (80), 8.56 (40), 3.51 (100), 3.24 (40), 3.093 (50), 3.032 (100), 1.924 (40). ***Optical data:*** Biaxial (-), α 1.54 (calc.), β 1.73, γ 1.75, 2V(meas.) 33°; dispersion r > v, weak; nonpleochroic; orientation, X = c, Y = a, Z = b. ***Chemical analytical data:*** Means of fifteen sets of electron microprobe data: CaO 3.57, UO_3 72.00, SeO_2 19.29, H_2O 8.00, Total 102.86 wt.%. Empirical formula: $Ca_{0.79}(UO_2)_{3.13}(SeO_3)_{2.16}[(OH)_{3.52}O_{0.25})_{\Sigma 3.77}\cdot 3.76H_2O$. ***Relationship to other species:*** None apparent.

Name: For Dr. Paul Piret (1932–), Professor of Crystallography, University of Louvain-la-Neuve, Belgium. ***Comments:*** IMA No. 96-002.

VOCHTEN, R., BLATON, N., PEETERS, O., and DELIENS, M. (1996) Piretite, $Ca(UO_2)_3(SeO_3)_2(OH)_4\cdot 4H_2O$, a new calcium uranyl selenite from Shinkolobwe, Shaba, Zaire. *Canadian Mineralogist* **34**, 1317–1322.



Vlodavetsite

Vlodavetsite

Tetragonal

$AlCa_2(SO_4)_2F_2Cl\cdot 4H_2O$

Locality: The Tolbachik Main Fracture eruption (Cone II of the Northern fissure), Kamchatka, Russia.

Occurrence: A product of fumarolic exhalations at temperatures below 100°C. Associated minerals are: spinel, gypsum, sellaite, hydrophilite, bischofite, chlorides, and altered volcaniclastics.

General appearance: Fine-grained material, but flakes, tablets, and plates (up to 0.3 mm) occur rarely.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless. *Streak:* white. *Luminescence:* non-fluorescent. *Hardness:* could not be determined. *Tenacity:* brittle. *Cleavage:* {100} perfect. *Fracture:* not observed. *Density:* could not be determined, 2.35 g/cm³ (calc.). ***Crystallography:*** Tetragonal, I4/m, a 6.856, c 13.325 Å, V 626.2 Å³, Z 2, c:a = 1.9436. Morphology: forms, {001}, {100}. Twinning: none observed. ***X-ray powder diffraction data:*** 6.67 (60), 3.922 (50), 3.729 (40), 3.431 (100), 3.335 (80), 3.052 (40), 2.483 (40). ***Optical data:*** Uniaxial (+), ω 1.509, ε 1.526, nonpleochroic. ***Chemical analytical data:*** Means of eleven sets of electron microprobe data: CaO 25.11, Al_2O_3 12.37, SO_3

35.97, H_2O 16.10, F 8.10, Cl 6.08, sum 103.73, less O = F + Cl 4.78, Total 98.95 wt.%. H_2O by stoichiometry, F and Cl by wet chemistry. Empirical formula: $Ca_{2.00}Al_{1.09}(SO_4)_{2.01}F_{1.91}Cl_{0.77}O_{0.28}\cdot 4.00H_2O$. ***Relationship to other species:*** None apparent.

Name: For V. I. Vlodavets (1893–1993), Russian volcanologist. ***Comments:*** IMA No. 93-023. The drawing for this abstract was produced from the data given in the first and third papers.

VERGASOVA, L. P., FILATOV, S. K., STAROVA, G. L., MATUSEVICH, G. L., and FILOSOVA, T. M. (1995) Vlodavetsite $AlCa_2(SO_4)_2F_2Cl\cdot 4H_2O$—a new mineral from volcanic exhalations. *Doklady Akademia Nauk* **343(3)**, 358–360. STAROVA, G. L., FILATOV, S. K., MATUSEVICH, G. L., and FUNDAMENSKY, V. S. (1995) The crystal structure of vlodavetsite, $AlCa_2(SO_4)_2F_2Cl\cdot 4H_2O$. *Mineralogical Magazine* **59**, 159–162. VERGASOVA, L. P., STAROVA, G. L., FILATOV, S. K., FILOSOFOVA, T. M., MATUSEVICH, G. L., and DUNIN-BARKOVSKAYA, V. V. (1996) Mineralogy and crystal chemistry of vlodavetsite $AlCa_2(SO_4)_2F_2Cl\cdot 4H_2O$, a new fumarolic mineral. *Volcanology and Seismology* **17**, 649–660.

Zajacite-(Ce) Hexagonal (trigonal)

$Na(REE_xCa_{1-x})(REE_yCa_{1-y})F_6$ where $x \neq y$

Locality: The Strange Lake rare-earth-element deposit, about 250 km northeast of Schefferville, Québec, on the Québec-Labrador border, Canada.

Occurrence: In a Precambrian peralkaline granitic complex. Associated minerals are: quartz, perthite, arfvedsonite, vlasovite, narsarsukite, willemite, bastnäsite-(Ce), and fluorite.

General appearance: Xenomorphic grains 1.5 to 2 mm across.

Physical, chemical and crystallographic properties: *Luster:* vitreous. *Diaphaneity:* transparent. *Color:* colorless to pale pink, increasing replacement by bastnäsite-(Ce) changes the color to pink and more orange. *Streak:* white. *Luminescence:* nonfluorescent. *Hardness:* 3½. *Tenacity:* brittle. *Cleavage:* none. *Fracture:* conchoidal. *Density:* 4.44 g/cm³ (meas.), 4.55 g/cm³ (calc.). ***Crystallography:*** Hexagonal (trigonal), $P\bar{3}$, a 6.099, c 11.064 Å, V 356.4 Å³, Z 3, c:a = 1.8141. Morphology: no forms were observed. Twinning: none observed. ***X-ray powder diffraction data:*** 5.29 (70), 3.036 (100), 2.146 (70), 1.757 (80), 1.152 (40), 0.9189 (40). ***Optical data:*** Uniaxial (+), ω 1.483, ε 1.503, nonpleochroic. ***Chemical analytical data:*** Means of eight sets of electron microprobe data: Na 6.4, Ca 11.5, Y 2.2, La 11.3, Ce 22.0, Nd 8.0, Sm 1.1, Gd 2.9, Dy 0.4, F 35.4, Total 101.2 wt.%. Empirical formula: $Na_{0.90}[(Ce_{0.51}La_{0.26}Nd_{0.18}Y_{0.08}Gd_{0.06}Sm_{0.02}Dy_{0.01})_{\Sigma 1.12}Ca_{0.92}]_{\Sigma 2.04}F_{6.00}$. The crystal structure analysis indicates that the rare-earth-elements and calcium preferentially occupy different sites, so the formula is given as $Na(REE_xCa_{1-x})(REE_yCa_{1-y})F_6$, where $x \neq y$. ***Relationship to other species:*** None apparent.

Name: For Dr. Ihor Stephan Zajac (1935–), the geologist who led the exploration group that discovered the Strange Lake deposit and who first recognized the mineral. ***Comments:*** IMA No. 93-038. The results of the crystal structure analysis will be published later.

JAMBOR, J. L., ROBERTS, A. C., OWENS, D. R., and GRICE, J. D. (1996) Zajacite-(Ce), a new rare-earth fluoride from the Strange Lake deposit, Québec-Labrador. *Canadian Mineralogist* **34**, 1299–1304.

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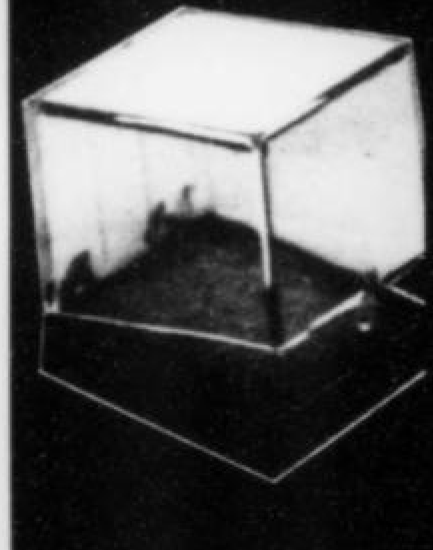

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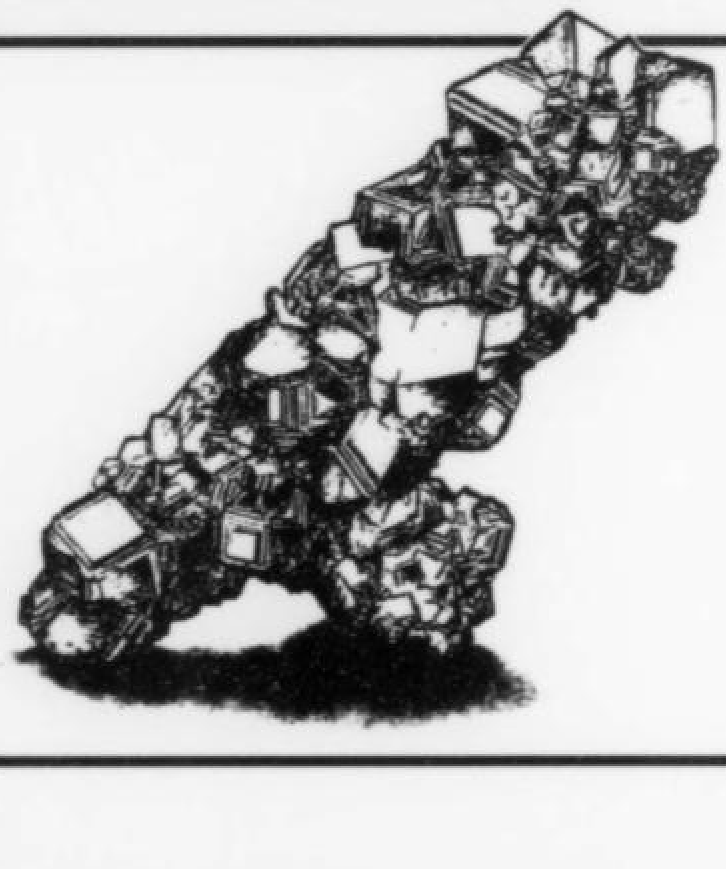

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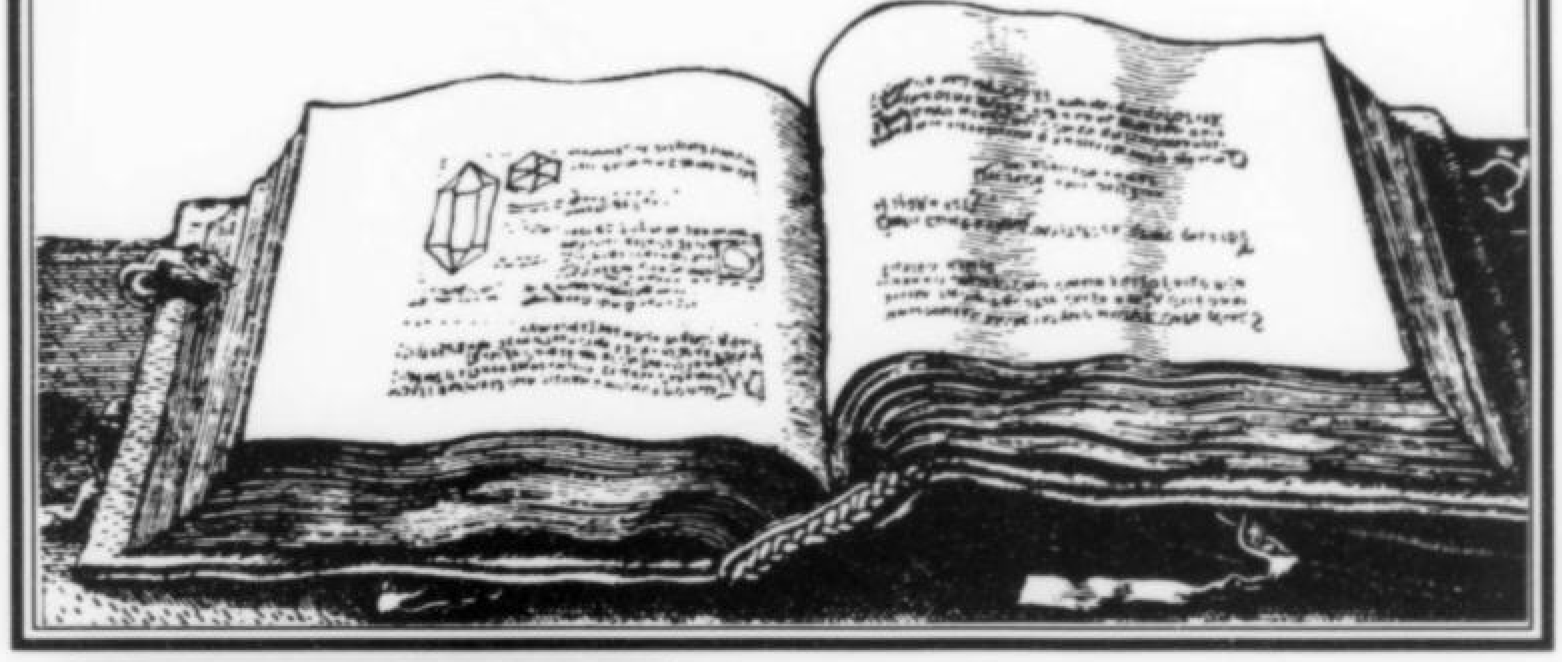
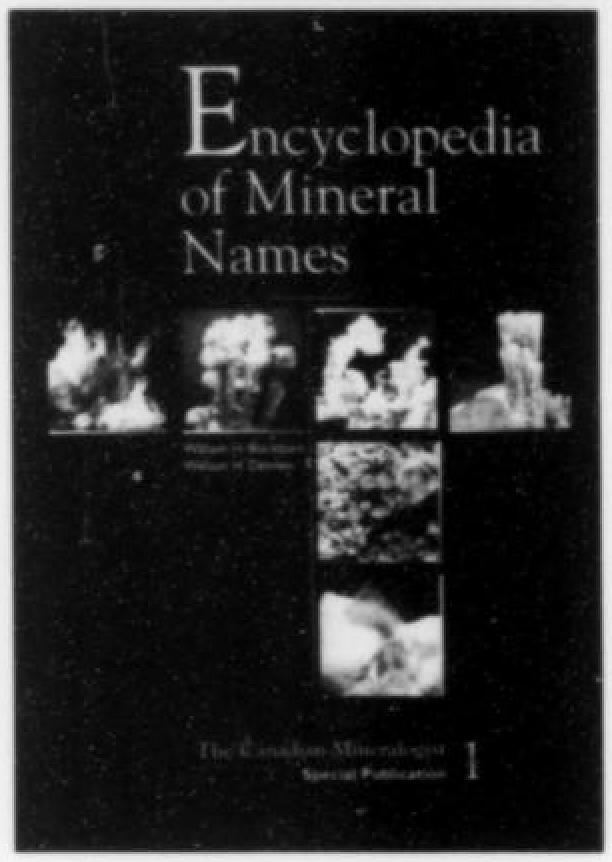
Book Reviews





Encyclopedia of Mineral Names

by William H. Blackburn and William H. Dennen, with illustrations by Peter Russell. Published (1997) by the Mineralogical Association of Canada, P.O. Box 78087, Meriline Postal Outlet, 1460 Merivale Road, Ottawa, Ontario, Canada K2E 1B1; hardcover, 8.25 x 11.63 inches, 360 pages, priced at $40 CDN in Canada and $40 US in the U.S. and elsewhere, postpaid.

This book is Number 1 in the Special Publication series of *The Canadian Mineralogist*. Written by two well known mineralogists, and illustrated by a long-established geological and petrological draftsman, it brings a new and welcome look to the field of mineralogy.

Interest in the "human" side of mineralogy is not new; confirmation of this is near at hand in the series of mineral-related biographies published by Dr. R. I. Gait in *Rocks & Minerals*. Or, check the popularity of *Matrix*, the magazine of the history of minerals published by Jay Lininger, or look at the references to history and biography in the cumulative index to the *Mineralogical Record* itself. The naming of minerals has a strong "human" subjective component. Mineral names are memorable, colorful, and often very informative—if only we knew the stories behind them. This book tells the stories, or at least the *ends* of the stories. The interested reader may well wish to track backwards from there on his own.

Strangely, perhaps, for a book dealing with minerals, this text begins with a history of the development of European languages. It traces an evolutionary tree from Indo-European beginnings before 2,000 years BC to modern English beginning around 1350 AD, then gives a short table of examples. Here, for instance, we learn that the Indo-European root *lep-i* (to peel) led to the Greek *lepis* (a scale), thence to *lepidolite* as a mineral (or *leprosy* as a disease!).

From language derivations, the text leads to what one might term the theory of the naming of minerals. It may surprise some readers to learn that there were attempts in times past to apply the Linnaean taxonomic classification method to minerals. In one such scheme, cubic pyrite formed the genus *Pyricubia*, with striated cubic pyrite *Pyricubium maximum foliaceum*, and unstriated cubic pyrite *Pyricubium solidum minus* as separate species.

Fortunately, since 1970, guidelines for the establishment of new mineral names have been laid down by the Commission on New Minerals and Mineral Names (CNMMN) of the International Mineralogical Association. The book states the guidelines clearly, and outlines the philosophy of the authors on how they chose to follow those guidelines. They have included almost exclusively the names accepted by the CNMMN, given in bold face type. Names commonly used but not necessarily accepted by the CNMMN are in plain type. Accompanying each name is the chemical formula of the mineral, its crystal system, its space group, and (where appropriate) its relationship, structural or chemical, to other minerals. Those, in turn, are followed by the etymology of the name. If the mineral was named for a person, a brief biography is included. Finally, the entry is closed by references to the original work, or to relevant papers published later. For the most part, chemical formulae correspond to Fleischer and Mandarino (1995), although there are minor exceptions.

At 360 pages, this is far from a trivial book. It is clearly a substantial work, involving research and scholarship of a high order, as might be expected when one reflects that there are now some 3,800(+) described minerals. The book is a full compilation of known minerals to the end of 1996, and includes the new IMA recommendations on the nomenclature of the amphiboles published in February 1997 in *The Canadian Mineralogist*. That makes it the most up-to-date reference work available today. [An update to the *Glossary of Mineral Species 1995* on the revisions in amphibole nomenclature will appear in the next issue of the *Mineralogical Record*. Ed.] Furthermore, the names reflect a new emphasis in the IMA on diacritical marks, including accents on names deriving from French or other languages (*vide* sérandite and horváthite, from French and Hungarian respectively). In general also, the umlaut "ö" is preferred to the "oe" form seen frequently in some references (although the Germans themselves often say that they don't care how it's spelled as long as it's pronounced properly).

It would be hard to judge the overall accuracy of the contents without repeating the research involved. As far as the formulae, crystal systems and space groups are concerned, we should note the authors' personal reputations in mineralogy, their preference for Fleischer and Mandarino (1995), that the book is edited by Dr. Robert Martin (editor of *The Canadian Mineralogist* and professor at McGill University in Montreal), and that it bears the *imprimatur* of Dr. Ernest H. Nickel in an appreciative preface.

In terms of the etymology of the names, there is more room for caution, for many are somewhat dimmed by the passage of time, while others are open to simple transcription or interpretive errors, particularly where foreign languages are involved. This is not to suggest that such errors exist—simply to note the difficulty of the research involved. In fact, I noted only three errors—one in the entry for willhendersonite, and two in the entry for voggite. In the entry for willhendersonite, Dr. Henderson is referred to as a physician; in fact, he has a Ph.D. in chemistry. The voggite entry states that it was named after "Albert Vogg, an amateur mineralogist of the Montreal area," but voggite was named for *Adolf* Vogg (1931–1995) of Arnprior, Ontario. The Montreal area is where the type locality is located; Montreal and Arnprior are 200 km apart—and in different provinces. But I'm nit-picking, probably because those are the only errors I saw. In general the etymology appears sound.

In layout, the book is a non-standard size for North America, having pages 21 x 29.7 cm, or 8.25 x 11.63 inches (presumably A4 size before trimming). This size gives ample area for text to be set up in well-spaced, highly readable fashion. Entries are laid out alphabetically, with each new letter "chapter" headed by a superb black and white drawing of a mineral specimen done by Peter Russell, retired (but still part-time) Curator of the Earth Sciences Museum at the University of Waterloo, Ontario. The only quibble I have about the layout of the entries is an apparent inconsistency in the placing of information pertaining to minerals having suffix modifications of the same name. For example, pumpellyite-(Fe^{3+}) and pumpellyite-(Fe^{2+}) are followed by pumpellyite-(Mg) and pumpellyite-(Mn), but the etymology of the name pumpellyite is not given until the pumpellyite-(Mg) entry (presumably because that was the original description). For monazite-(Ce), monazite-(La) and monazite-(Nd) the derivation of the name is given with the first entry, while for lanthanite-(Ce), lanthanite-(La) and lanthanite-(Nd) the derivation is with the second. One cannot argue with the logic involved, which is why the inconsistency is only apparent, not real, but I must admit a sneaking preference for having the etymology of the name uniformly with the first entry. It would merely provide a neater appearance to the whole.

The alphabetized entries are followed by two appendices. Appendix A lists the etymology of the chemical elements, and Appendix B the abbreviations of journal references.

Yearly updates will be published in *The Canadian Mineralogist*.

In sum, this is a book that should be on the shelf of any serious collector. It is easy to follow, well researched, up-to-date, and authoritative. Besides, how many others will tell you that stenhuggarite was named for Brian Mason?

Quintin Wight

What's New

in Minerals

Bilbao and Barcelona Shows 1996

by **Miguel Calvo**

The two largest mineral shows in Spain, at Bilbao and Barcelona, are generally scheduled around Europe's biggest mineral *bourse*, the Munich Show, so as not to conflict. Last year the Bilbao Show was held two weeks before Munich, and the Barcelona Show one week after. All of the most important Spanish dealers and many local part-time dealers attended each show.

A highlight of both shows was the **pyromorphite** from the Resuperferolitica mine at Santa Eufemia, Cordoba Province, Spain. The old workings in this area, some of which date back to Roman times, have occasionally yielded pyromorphite specimens. Juan Peña, a mineral collector and dealer from Sevilla, discovered a zone there in 1955 which proved to be heavily mineralized with pyromorphite. He and his collecting partners, José Manuel Ceruelo and Luis Miguel Fernandez (both from Zaragoza), recovered more than 1,000 specimens ranging from thumbnail to large cabinet size. The brownish green to pale green pyromorphite crystals, up to 1 cm in size, completely cover pieces of matrix and, in some cases, occur as unattached "floater" specimens. Some crystals are actually cavernous parallel-aggregate crystals (like the vanadinite from the North Geronimo mine in Arizona). Although the color is less attractive than the rich, bright green pyromorphite from the Horcajo and San Andres mines, the thick coverage, large crystal size and reasonable prices make them interesting to the collector.

A second major highlight of the shows was the discovery of **anatase** from a roadcut near an old tin mine at Penouta, Viana do Bollo, in Orense Province. The red crystals are usually small (under 4 mm), but are generously sprinkled on quartz crystals to 5 cm, and sometimes on plates and clusters of quartz crystals. Specimens from thumbnail size to 30 cm have been recovered, the largest bearing literally hundreds of anatase crystals. The main source for these specimens is José Fernández of Villamartin de Valdeorras, in Orense Province, who discovered the roadcut occurrence. Jordi Fabri of Barcelona and José Vicente Casado of León, among others, also had specimens at the shows.

Another interesting find in the booth of José Vicente Casado was the specimens of **talc** pseudomorphs after dolomite crystals from the Respina mines, Puebla de Lillo, in León Province. José had about 40 specimens, with large, pseudomorphic crystals up to 7 cm on an edge (!), and very perfectly formed. Most even retain the surface growth features of the parent dolomite crystals.

The La Unión area (which includes the large town of La Unión as well as other small villages such as Portman, Gorguel and Llano de Beal) has been a prolific producer of specimens in recent times, due to the work of many local collectors and part-time dealers. In 1996 a large pocket of **barite** was discovered in the Marisol mine, La Unión-Cartagena area, by Juan Antonio Robles of La Unión. The pocket was named "The Submarine" because of its overall shape and the small entrance hole in the 50-square-meter ceiling. The ceiling and the walls were completely covered by bluish white barite (deepening to pale blue on exposure to sunlight) in crystals to 5 cm. I can testify that the pocket size has not been exaggerated, because I visited the site myself as specimens were being removed.

Gypsum crystals in acicular tufts (as reported in this column in the May–June 1994 issue), purportedly from "an old mine near Gorguel," have flooded the Spanish mineral market, from the biggest shows down to small shows and Sunday street markets. Specimens now sell for just a small fraction of what they did initially. The correct locality is actually Portman, probably the old San Timoteo mine; however, there is such an abundance of abandoned, inter-connected workings in the area that determination of the exact mine and name is difficult. It may instead be the Humboldt mine. In any case, the acicular gypsum crystals cover hundreds of square meters in the old stopes and cavities, with easily tens of thousands of fine specimens still recoverable. This is in spite of someone's attempt to limit the supply by destroying much of the *in situ* crystal growth, presumably after having collected their own stock of specimens.

Gypsum has also been found in the La Union area, in large, perfect, pencil-size, water-clear crystals scattered on matrix, and in smaller acicular crystals associated with iron oxides. The entrance to the old workings is through the Balsa mine, but the specimens are actually being found in the Depositaria mine. The transition from one mine to the other is well-marked underground by a wall and door in the stope. Unfortunately the supply of these specimens is limited.

Also from the La Unión-Cartagena area are the **cerussite** pseudomorphs after anglesite first found in 1955 by José Javier Saura in the San Valentín mine. The pseudomorphs, up to 2 cm each, are on an iridescent goethite matrix, and most are covered by a thin film of this material; they are nevertheless quite attractive and uncommon. Several dealers had specimens at the shows.

Juan Peña had some fine **amethyst** specimens from the Suerte Inesperada mine. The smaller crystals (around 4 x 7 cm) are doubly terminated, usually in parallel pairs with a sharply defined mutual border and showing purple color only in the transparent tips; the central prism zones are milky white. The largest crystals, up to 7 cm *wide*, are only singly terminated but exhibit the same color zoning. These are certainly the finest specimens of amethyst found in Spain in many years.

Juan Peña also had a number of other interesting Spanish minerals, including tabular orange **barite** crystals from Lucairena de las Torres in Almería Province, and "hessonite" **grossular** from Cartama in Malaga Province. The grossular is found as gemmy orange, individual crystals to 5 mm with feldspar and tourmaline crystals. It is being mined by Manuel Moreno, who made the initial discovery.

Among the most popular minerals from Spain are the beautiful and lustrous **Pyrite** crystals in matrix from the Victoria mines at

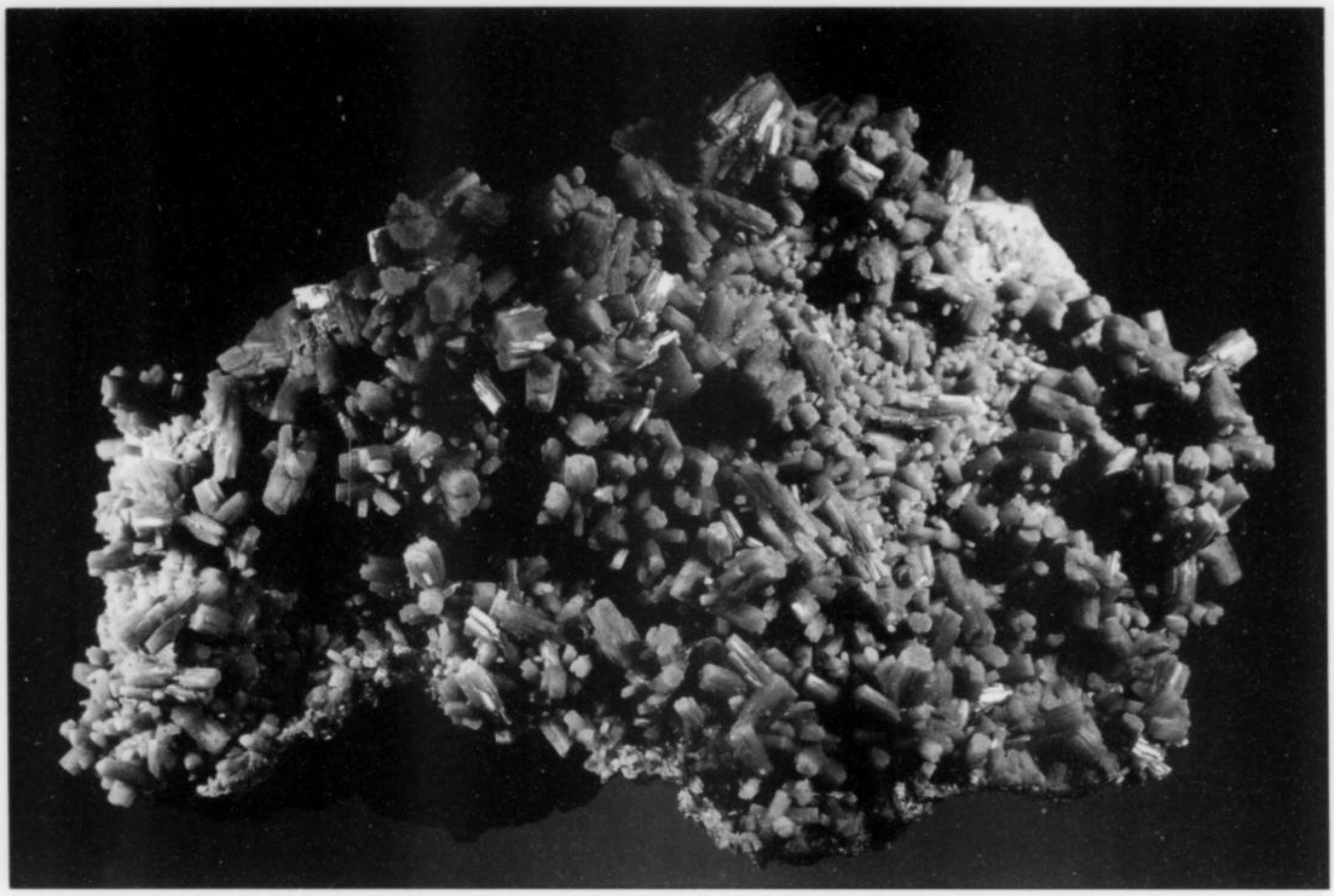


Figure 1. **Pyromorphite crystal group, 15 cm, from the Resuperferolitica claim, Santa Eufemia, Cordoba, Spain. Juan Peña specimen; J. M. Sanchis photo.**

Navajún, La Rioja Province. The mining company's booth at the Barcelona Show contained an abundance of fine specimens, all recently mined. In addition, pyrite from other nearby occurrences has also been appearing. All of the pyrite prospects and mines near Ambasaguas in La Rioja Province (see the article in vol. 20, no. 6) are now under claim by Manuel Urruchi of Ambasaguas. The deposits are being worked with machinery, and a great many specimens are being recovered which are superior in size and quality to anything found before. Not just cubes, but also complex crystals consisting of a dodecahedron-octahedron-diploid combination up to 6 cm across, and also some "iron cross" twins to 1 cm, have been collected.

It is surprising that a twin such as the **pyrite** "iron cross," described in nearly all mineral books including the most elementary, should be so difficult to find in collector-quality specimens. During the last year, however, another Spanish source for these twins has appeared: an unnamed quarry near Arrigorriaga in Vizcaya Province. At the last Bilbao Show, J. L. Forcada of that town, had about 40 "iron-cross" pyrite twins in calcite matrix. The crystal size is rather small, generally under 1 cm, but the luster is bright.

As usual at the Barcelona Show, Joan Viñals of Barcelona had an assortment of new rarities from Spain. This year his stock included remarkable acicular **warwickite** microcrystals from the La Cella mine near Jumilla, Murcia Province; microcrystals of **montgomeryite** and **alumohydrocalcite** from Montcada in Barcelona Province, **melilite** and **nepheline** from a basalt quarry near Ciudad Real, and microcrystals of **synchysite-(Ce)** from the Valle de Arán in Lérida Province.

Outside of Spanish minerals the most eye-catching specimens at the shows were the **fluorites** from the Xianghualin mine in Hunan, China. Luis Miguel Fernandez of Zaragoza and Enrique Kucera of Barcelona had many specimens of pale green, lustrous cubes to 7 cm, lacking any matrix or associated species. **Stibnite** crystals from the Linshu mine, also in China, were also available at their booths. Luis Miguel had many fine specimens of **sphalerite** from the Cumberland mine at Carthage, Tennessee, and some large (to 10 cm) **rutile** crystals from the old classic locality at Graves Mountain, Georgia. Jordi Fabre had a good selection of minerals from Panasqueira, including a 15-cm **siderite** crystal, and a 30-cm quartz crystal on muscovite matrix.

That's all for now. The 1997 shows are coming up soon; if you are in Europe at the time, be sure to see them if you can.

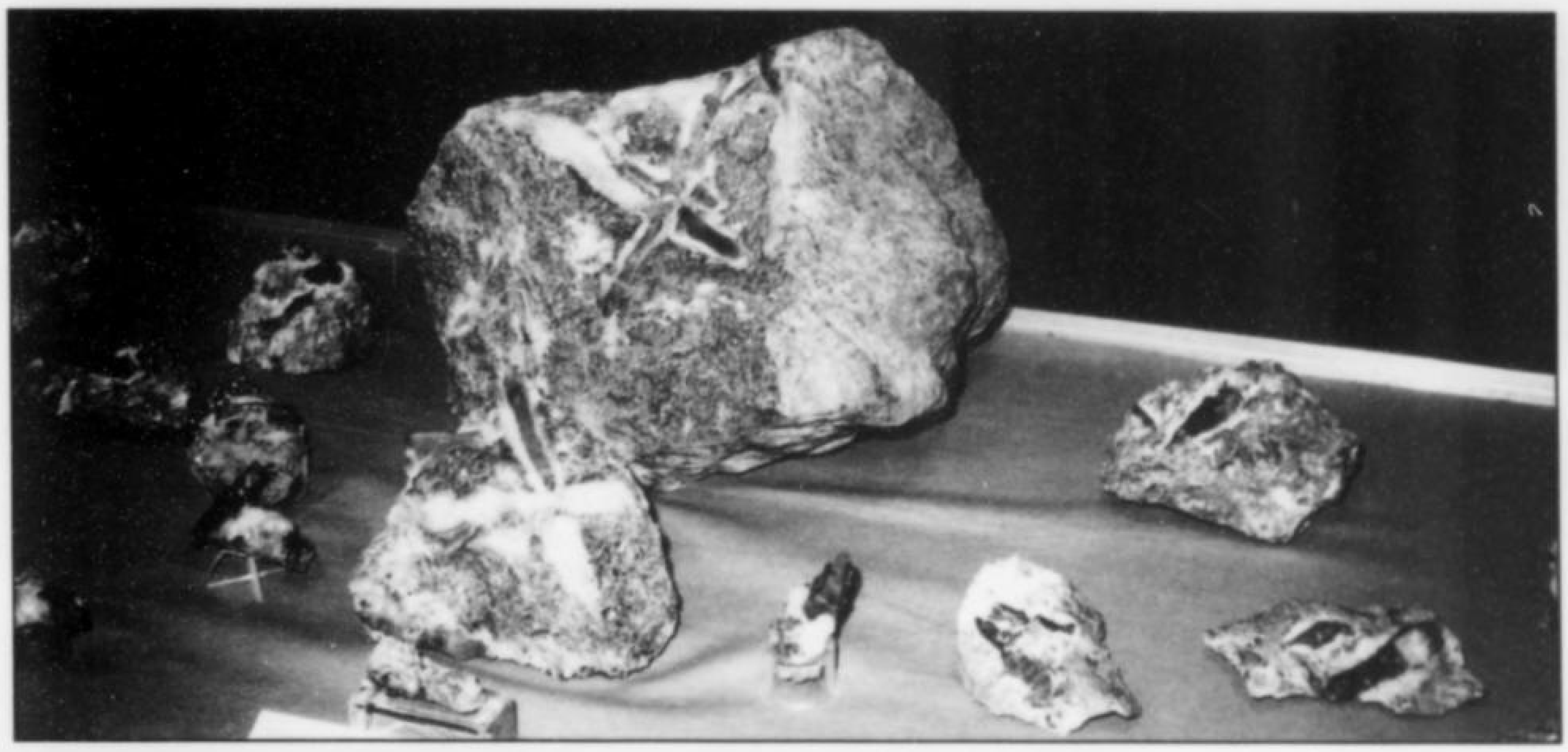
New York Show 1997

by **Joe Polityka**

[March 1–2] E-mail: artinite@aol.com

In comparison to the winter of 1996, this New York City winter (1997) was balmy. Most of the time it felt as if I was down in Dixie, so I spent most of my lunch hours in January and February walking around my Manhattan work-neighborhood. Although I did not suffer from "cabin fever" this winter, I did experience some mineral anxiety as I took my daily strolls. Several large buildings are being constructed on 14th Street which require excavations down to bedrock. What was I looking for? Pegmatite veins, of course, and any other signs of mineralization. Did I find anything? No, just a lot of black Manhattan Schist and not a quartz vein in sight.

As a trained economist and marketing specialist, I look at the "acquisition cost" of my mineral specimens. In other words, I factor my expenses (travel, lodging, food, etc.) into what I pay for minerals. This gives me the true cost of my purchases. For example, if I spent $900 on travel per year I would have about $100 to spend on minerals. This unfavorable ratio would lead to a lot of



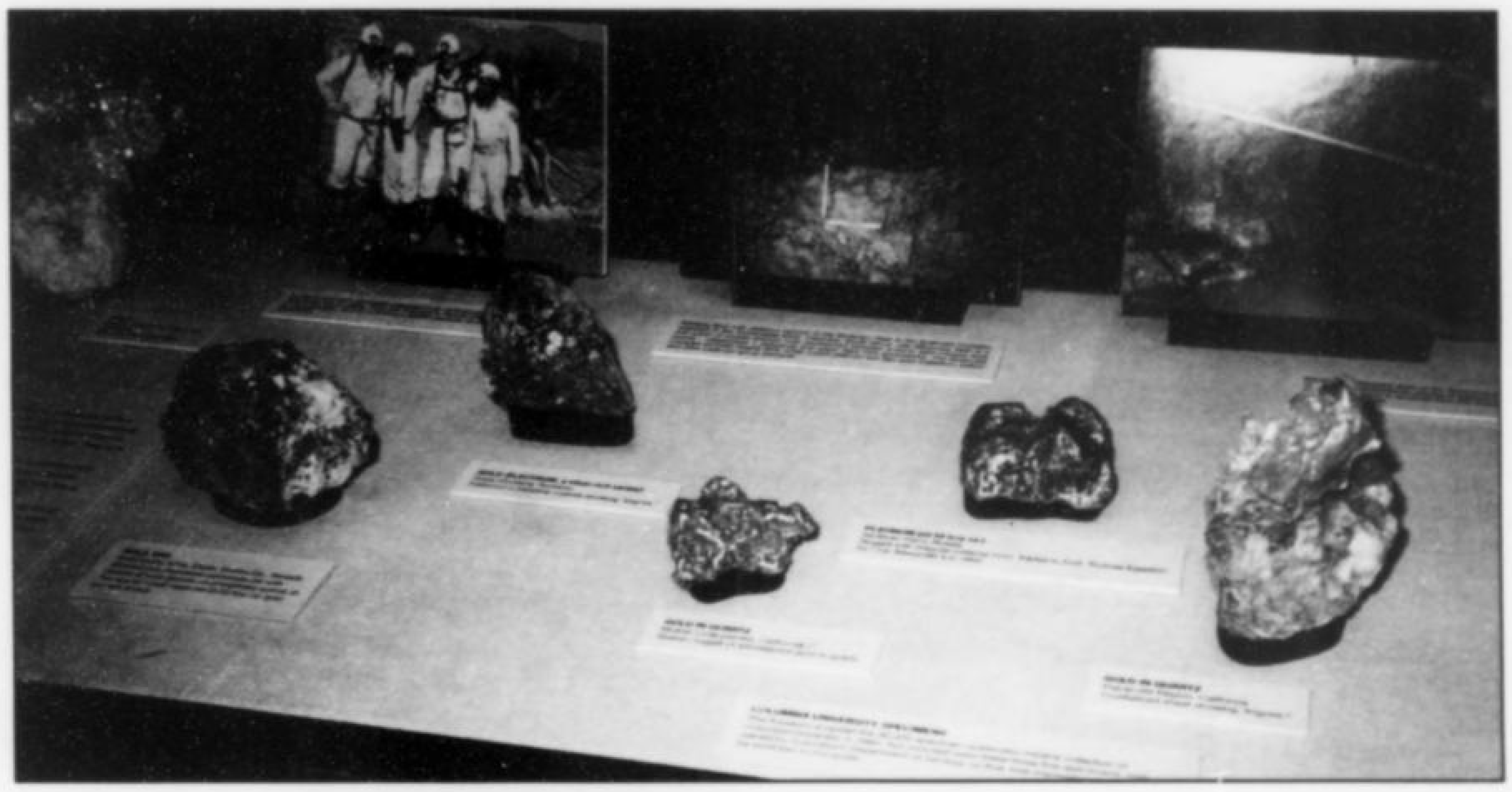


Figure 2. (above) **Steve Kuitem's display of Limecrest, New Jersey, corundum crystals in matrix. Joe Polityka photo.**

Figure 3. (left) **Gold and platinum specimens from the Columbia University Collection, displayed by the American Museum of Natural History. Joe Polityka photo.**

Figure 4. (below) **Robert Hauck's display of silver from Cobalt, Ontario. Joe Polityka photo.**

anxiety and expensive calcite miniatures; therefore, I always make it a point to visit the American Museum of Natural History in February to help me overcome the winter doldrums.

This year, in the special exhibits case, the museum featured **gold** and **platinum** specimens from the collection of Columbia University. Many specimens are fist-size or larger, from various U.S. and foreign locations.

The following weekend I attended the New York mineral show co-sponsored by The New York Mineralogical Club (founded 1886) and Excalibur Mineral Company. The show was held at the Holiday Inn on 57th Street in Manhattan, within walking distance of the American Museum, Carnegie Hall, the Hard Rock Cafe and restaurants offering food from almost every known world culture.

The night before the show opened, construction forced everyone out of the main ballroom and into two separate levels of the hotel. The show committee did an outstanding job and had the dealers ready for business at the scheduled hour. Moving around the narrow walkways was difficult, especially as the "shopping bag" crowd arrived; however, I ride the New York subway and was not bothered by the cramped quarters.

Detrin Minerals had a large selection of **fluorite** in all size ranges, from Xiang Hualin, Hunan Province, China. Most specimens are undamaged and of a sea-green color. Some specimens have white tabular **calcite** crystals perched attractively on the fluorite. Also available was the usual suite of minerals from Dal'negorsk, Russia. *Willis Earth Treasures* had two 10 by 10-cm plates of sea-green **prehnite** from Paterson, New Jersey, on which are perched acicular **natrolite** sprays to 4 cm. They also had some excellent **esperite** from Franklin, New Jersey, which had a bright lemon-yellow fluorescence in interesting contrasts and patterns. In total, 19 dealers offered a wide inventory of meteorites, fossils, minerals and jewelry. The exhibits were excellent, especially the case of New York area minerals from the New York Mineralogical Club's collection. George Feist's display of museum-size, and quality, quartz specimens was a real eye-catcher!

The lectures were excellent and featured Larry Conklin ("George Kunz, a Life of Minerals"), Will Heierman ("Gold!—The Collector's Choice"), and Karen Rice ("The Ruby Mines of Azad Kashmir"). Larry, of course, needs no introduction; Will and Karen are experts in their field and are actively involved in gold mining and gem mining respectively.

In the Club's 110 years of existence, club members have included such luminaries as Marie Sklodowska-Curie, Edward S. Dana, Clifford Frondel, Victor Goldschmidt, Charles Palache, Frederick Pough, John Sinkankas and others. Thirty-plus members have had minerals named in their honor.

If you plan to visit New York City next March, I suggest you pay this show a visit and round out your day by visiting the American Museum of Natural History and one of the city's many ethnic restaurants.

Delaware Show 1997

by **Joe Polityka**

[March 8–9]

The following week, I was rollin' down Interstate 95 to the 34th Annual show of the Delaware Mineralogical Society in Claymont, Delaware. In contrast to March 1996, this trip was uneventful and, honestly, did not include any praying for forgiveness or promising to the Heavens that I would be a better person should I survive the trip. In fact, this year my snow shovels were hardly used and my 50-pound bag of calcium chloride was hardly touched.

The theme was "Copper Minerals"; as a result, a lot of green and blue was seen in the exhibit cases. The University of Delaware set up a case and there were also displays of lapidary, fossils and field collected specimens. Yale University's case of rare pseudomorphs was outstanding.

M. Phantom Minerals (Columbus, Ohio) had the widest variety of minerals at the show. Neal and Chris Pfaff had about 20 specimens, in miniature and thumbnail size, of **calcite** crystals surrounded by halos of drusy black **ilvaite** from Dal'negorsk, Russia. The miniature-size specimens have water-clear calcite crystals to 3 cm which are sitting on the drusy ilvaite matrix. Needless to say, the contrast is striking. They also had several exceptional specimens of **fluorite** with **calcite** from Xiang Hualin, Hunan Province, China. The specimens are undamaged and aesthetic, a rare combination for this location. They also had about six cabinet-sized specimens of **celestine**, with pale blue crystals to 2 cm, from the Meckley quarry, Mandata, Pennsylvania. These specimens are from the recent find (1996) and are the best ever found at the quarry. Needless to say, all specimens were sold right after the show opened on Saturday.

Other dealers selling a wide range of quality minerals included *The Rocksmiths*, *Broken Back Minerals*, and *Octahedron*.

New Jersey Shows 1997

by **Joe Polityka**

[March 15–16]
[April 26–27]

The following weekend I was headed in the opposite direction on Interstate 95 toward the Clifton, New Jersey, show. My commuter bus takes me on part of this route everyday, therefore, I made this trip in a hypnotic state. Even the Manhattan skyline gets boring after a while!

About 20 dealers were set up at the show, with the majority selling minerals, a nice change from the usual mineral-to-jewelry ratio. Ted Johnson of *Yankee Minerals* had some interesting specimens of **byssolite** on white **pericline** from Val d'Ala, Piemonte, Italy. The specimens are in cabinet sizes and very attractive. The 1-cm hairs sit vertically on the pericline matrix.

John Betts (New York, New York) had **almandine** garnet from Green's Farm, Roxbury, Connecticut. The specimens are in small to large cabinet sizes and have 1 to 2-cm crystals sitting on pale colored schist matrix. Speaking of garnets, *Carter Rich* had a large selection (from many locations) of specimens from the late Ned Blanford's collection. Ned lived in Mclean, Virginia, and went under the business name of *Orbit Minerals*. I picked up a small cabinet specimen of **andradite** in matrix from Cornwall, Lebanon County, Pennsylvania.

Lambert's Minerals (152 Colleen Drive, Ancaster, Ontario, Canada) had about 50 specimens, in all sizes, of **grossular** from the Jeffrey mine, Asbestos, Quebec. The crystals reach 1 cm and are quite gemmy, with a pale honey color.

The 25th annual New Jersey Earth Science Association show was held at the Westfield Armory in (you guessed it) Westfield, New Jersey. I set up an exhibit this year, so I was able to preview the show on Friday evening. Last year I was overcome by the sight of the large open drill hall; this year I was overcome by shades of red, green, brown, yellow and blue. Minerals? No, I am talking about the pre-show banquet set up by Irwin and Lorraine Hammer and their helpers. What a sight to behold! Lots of local ethnic treats and great desserts: exactly what I needed to get me through two and a half days of mineral viewing, so I thought.

My Friday evening ended on a sour note with humorous overtones! My alternator failed on my drive home, so my daughter Renee and I spent three hours waiting for a tow truck to take us back to Staten Island. For you thrill-seekers out there I suggest you take a ride in a tow truck at 3 a.m. with a driver who is about to fall asleep at the wheel; a driver who runs every red light while doing

60 miles per hour while telling your 12-year-old daughter about the crashes he has been in. Needless to say "we" were wide awake when we got home! On the humorous side, while unpacking purchases I made at the show, I discovered that I had mistakenly picked up *Hawthorneden*'s brown paper "garbage bag" instead of my similar bag of specimens. Imagine my surprise when I discovered banana peels and an over-ripe pear, instead of minerals. Luckily, Wendy Melanson discovered my mistake when she was about to dispose of some garbage.

Speaking of *Hawthorneden*, Frank and Wendy had good **fluorite** from Weardale, Durham, England. I purchased a cabinet specimen of green crystals from Heights Pasture, Westgate County, Durham, and a group of large purple crystal from the Black Dene mine, Ireshopeburn, also from Weardale. They also had a football-size **aegerine on feldspar** specimen with undamaged aegerine crystals to 10 cm sitting on feldspar matrix. At the base of the matrix are two 10-cm **smoky quartz** crystals. This sweetheart specimen is from Mt. Malosa, Zomba District, Malawi, and is truly of "museum-quality."

Quartz crystals with **pyrite** inclusions from Diamantina, Minas Gerais, Brazil, were being offered by *Hawthorneden* and *Wright's Rock Shop*. The quartz crystals reach about 5 cm and have inclusions of pyrite crystals that reached about 5 mm.

Dave Bunk had some **beryl** and associated pegmatite species from Pakistan. These are all Dave has left after a very successful Tucson show. Dave also had a singular **silver** specimen from Kongsberg, Norway, that has a 6-cm mass of wires perched on matrix.

Parker Minerals (Columbia, Maryland) had recently purchased an antique collection of New Jersey minerals. There were many specimens from closed locations including native copper from the Edison mine, Edison, New Jersey. If mineral history is in your blood, I suggest you give Fred Parker a call.

Mountain Minerals and *Graeber & Himes* had their usual selection of gem crystals. Most prominent was the already famous **zoisite** (tanzanite) from Tanzania. Mountain Minerals had the best crystal, a transparent blue crystal almost 3 cm long.

Hewin's Mineral (P.O. Box 93, Charley, MA 02712) was selling an antique collection of **fluorite** from many classic locations. I purchased a cabinet specimen of fluorite from Val Sugano, Trentino, Italy.

In total, 37 mineral, jewelry and gem dealers were present. As is always the case at this show, there were thousands of one-of-a-kind pieces from countless locations. You will have to come to next year's show to see for yourself.

Fifty-four exhibits were set up which covered the entire mineral spectrum, fluorescence included. Unfortunately, no major museums exhibited this year, however, what was on display was outstanding. Robert Hauck's case of Cobalt, Ontario, **silver** was an eye-grabber. The huge polished boulders reflected so much light that I had to view the display from the side. Brother Dick Hauck displayed the famous Paterson, New Jersey, **silver** with more than enough documentation to prove its pedigree. Steve Kuitem's case of Limecrest, New Jersey, **blue corundum** proves that the East Coast is still full of surprises. "X" marked the location of this display.

The show theme for 1998 will be fluorescence. This theme should make it easy to find the show after dark should you decide to attend. I will see you in 1998!

Paris Show 1997

by **Pierre-Nicolas Schwab**

[March 15–16] E-mail: Pnschwab@universinet.com

Two mineral shows are held in Paris annually, and are run by the same man: Roger Pelloux from Garges-les-Gonnesses. Since moving to Orleans in September, about 120 km south of Paris, I've visited both the Aquaboulevard show (previously known as the "PLM" held at the Pullman-Saint-Jacques hotel) which is now held in a sports center, and the Hilton show, held at the Hilton hotel near the Eiffel Tower. The Aquaboulevard show was held in late November, while the Hilton show is held in March. The Aquaboulevard show was rather disappointing, with few new items or high-quality specimens. As a consequence, the following report covers only the Hilton show.

The first booth I visited at the Hilton was French dealer *Frédéric Escaut* (11 place du Commerce, 75015 Paris, France). Frédéric is a long-time specialist in Chinese minerals, so, not surprisingly, he was the only one to offer valuable Chinese specimens at the show. First, he had some interesting **sphalerite** labeled "Shuikoushan, Hunan." These consist of gemmy crystals up to 2 cm on an edge, on calcite. Although rather small, these specimens are especially attractive because of the contrast with matrix. Frédéric told me that huge crystals to 15 cm have also been found, but he has not yet been able to obtain any of them.

A new item—at least for me—was the **vesuvianite** from Anhui, Hebei province, China. The crystals are up to 14.5 cm in size. They are always off matrix and are sometimes associated with garnets.

Finally, I was very impressed by some **cassiterite** from Xu Bao Diang, Piugwu, Sichuan. Chinese cassiterites have become instant classics in recent years, and several localities are already known, the latest being Xianghuapu, Hunan, reported by Jeff Scovil in the *Mineralogical Record* (vol. 27, no. 6). But Frédéric's specimens are very different from the material that first came out on the market. Indeed, these cassiterites are twinned and associated with 1.2-cm *goshenite* (colorless **beryl** crystals), making spectacular pieces. According to Frédéric, only about 2–3% of the cassiterite specimens recovered from the mine are associated with goschenite.

Since they became popular in the 1970's, Indian zeolites and their associated specimens have become classics, and are still popular with collectors worldwide. Their origin is the vast Deccan Plateau, the expanse of which helps explain why so many specimens are available. While truly new finds of these minerals are pretty rare, I noticed two novelties at the Hilton:

Patrick Allier (33 allée des Tilleuls, 38130 Echirolles, France) could easily be regarded as the French specialist for Indian minerals. For those interested in strange specimens, he had the ticket: a dozen specimens of the rare monoclinic zeolite **goosecreekite**, recently mined in Nasik. Actually it is not very impressive visually, but it is seldom seen at shows. The specimens consist of radiating masses of lustrous creamy white crystals, up to 2 cm in length, perched on quartz and very reasonably priced around $50. **Heulandite**, also monoclinic, was first described from specimens discovered in Faero Islands. Since then, the Jalgaon quarries have become the standard for the species. Several habits and colors are known, including lustrous white crystals and chlorite-included green ones, for example. Patrick had a batch of very appealing new heulandite samples. They are fan-shaped and deep orange to almost red in color. The best piece is a large cabinet specimen with numerous flawless crystals up to 4 cm, priced at about $2,000. Not bad for a world-class specimen.

Last but not least in the "Asian novelties" section is the ruby **corundum** from Luc-Yen, Vietnam, that *Patrick de Koenigswarter* (en Bérou, 31540 Saint-Julia-de-Gras-Capou, France) was offering for sale. The crystals are up to 5 cm, on calcite matrix, and are of a beautiful raspberry-red color. These specimens were discovered at the end of 1996 and brought to France just before the Hilton show. The best piece, priced at $1,500, is a cabinet-size specimen that displays an exquisite flawless crystal. The Luc-Yen mine, located near the Laos-China border, has been known for several

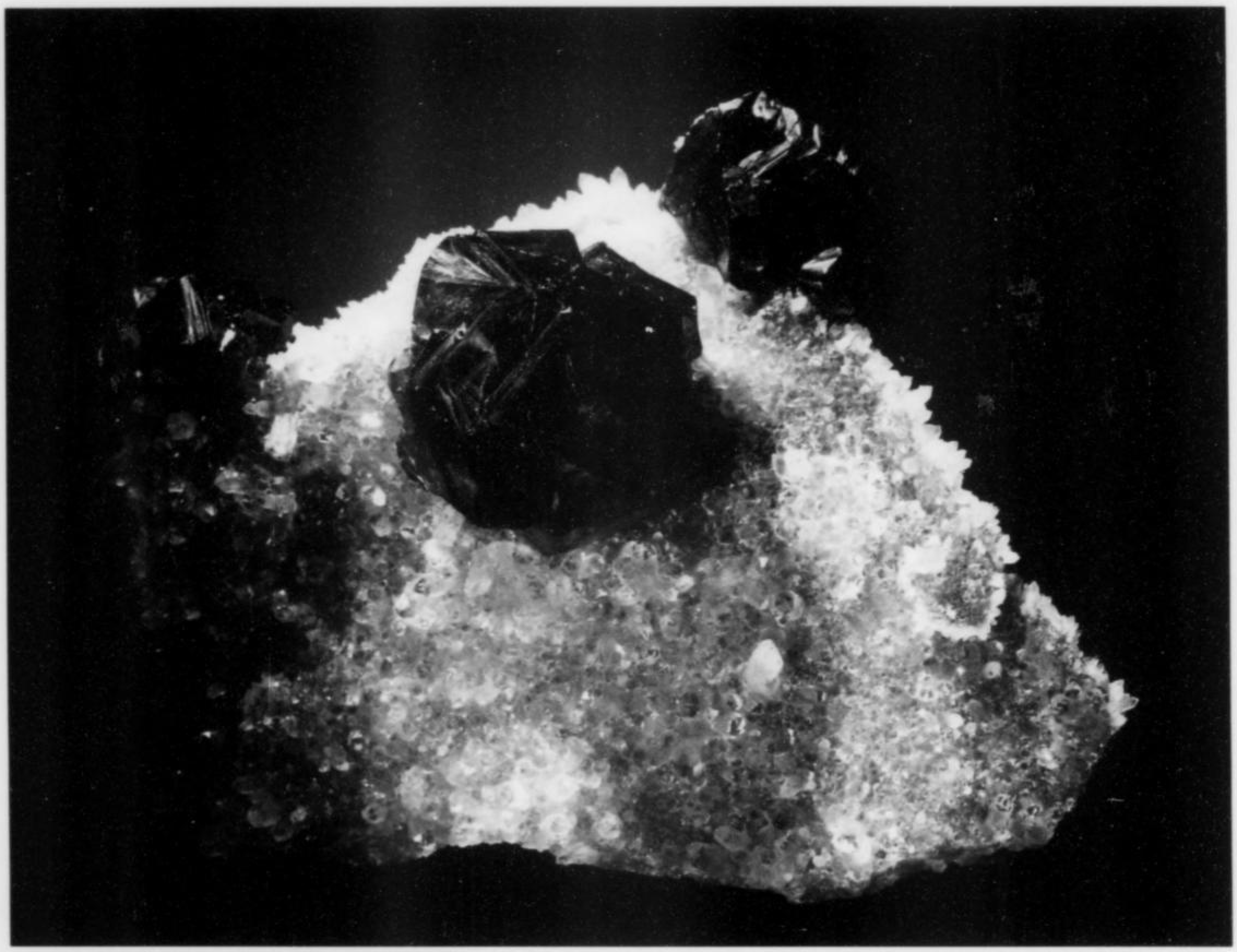


Figure 5. Sphalerite crystals on matrix, 6.2 cm, from Shuikoushan, Hunan, China. Roberts Minerals specimen; Jeff Scovil photo.

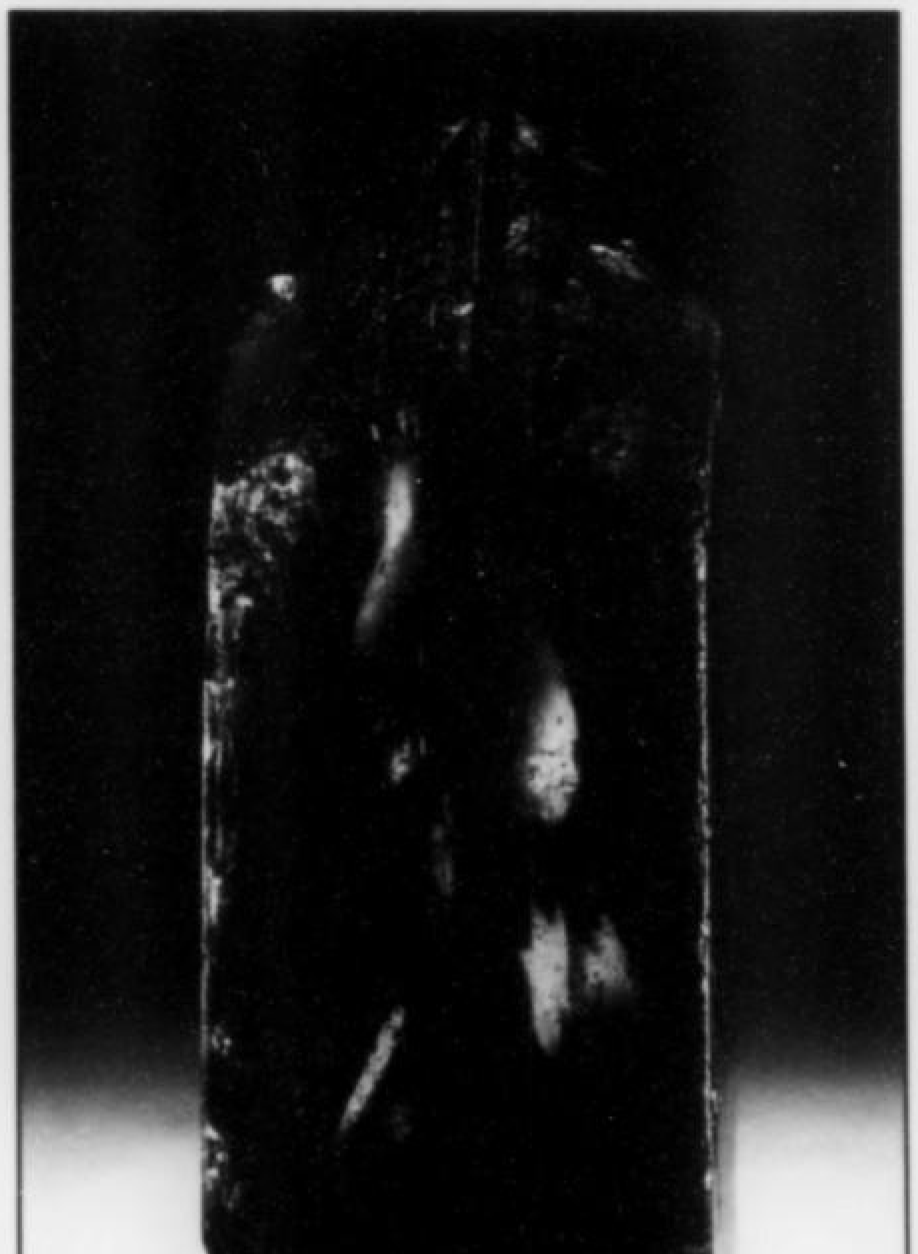
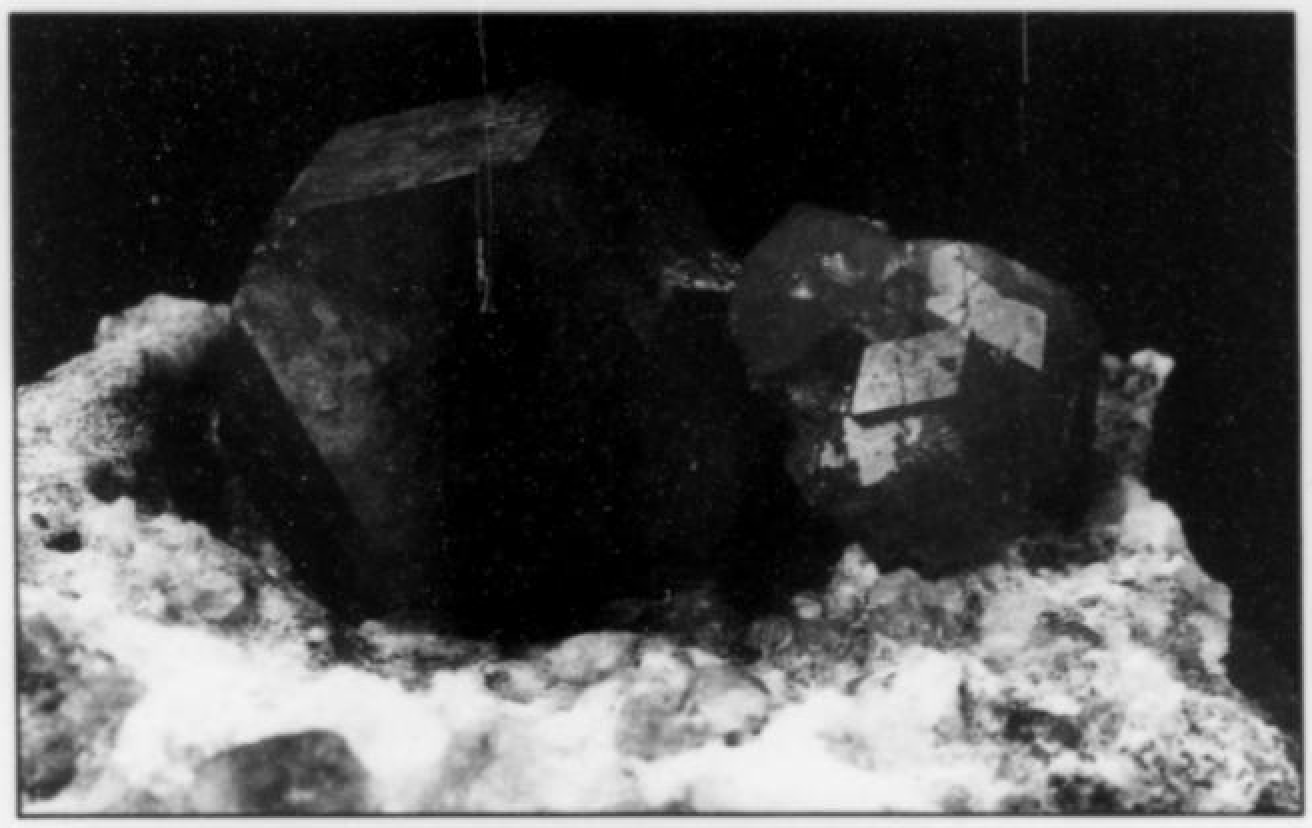


Figure 6. Diopside crystal, 4 cm, from southern Madagascar. Denis Gravier specimen; L. D. Bayle photo.

Figure 7. Ruby corundum crystals in matrix, 5 cm, from Luc-Yen, Vietnam. Patrick de Koenigswater specimen; L. D. Bayle photo.



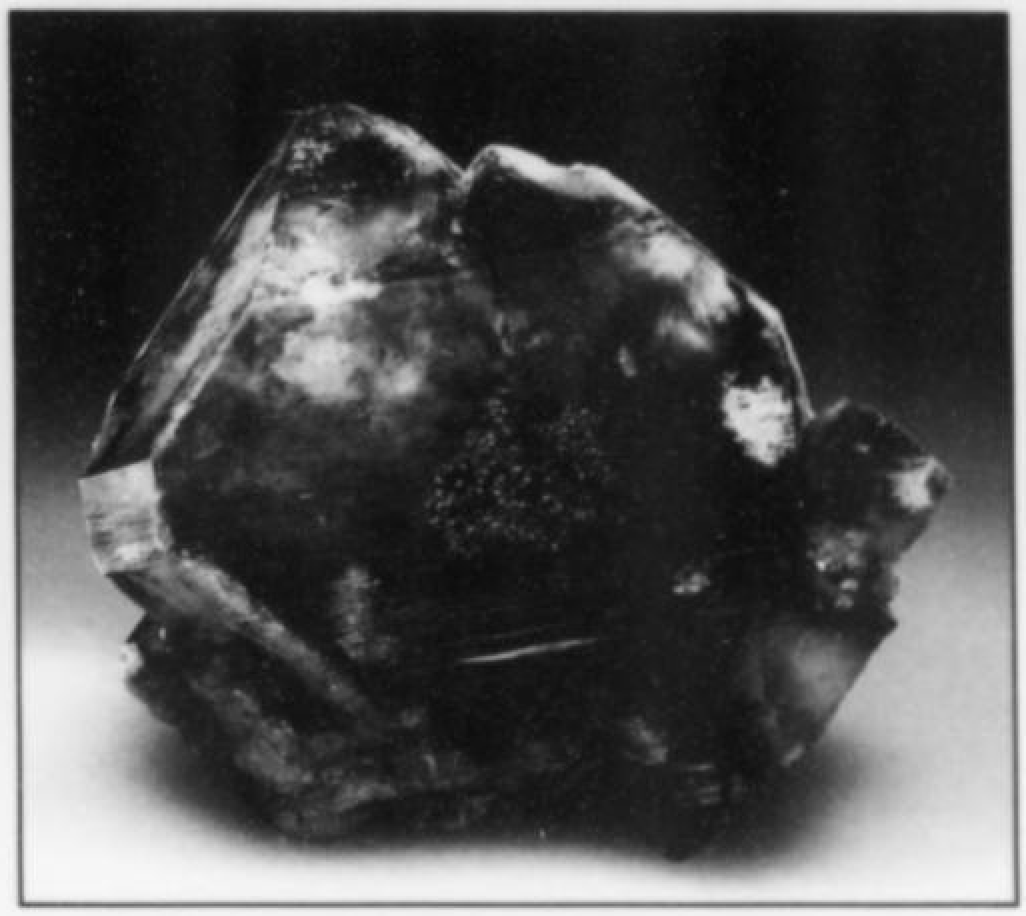


Figure 9. Amethystine and smoky quartz, 12.7 cm, from the Phyllis Ann claim, Lake George, Colorado. "Crystal Group" specimen; Jeff Scovil photo.

Figure 8. (above) Grossular crystal group, 2.8 cm, from Sierra de las Cruces, Coahuila, Mexico. Blue Sky Mining specimen; Jeff Scovil photo.

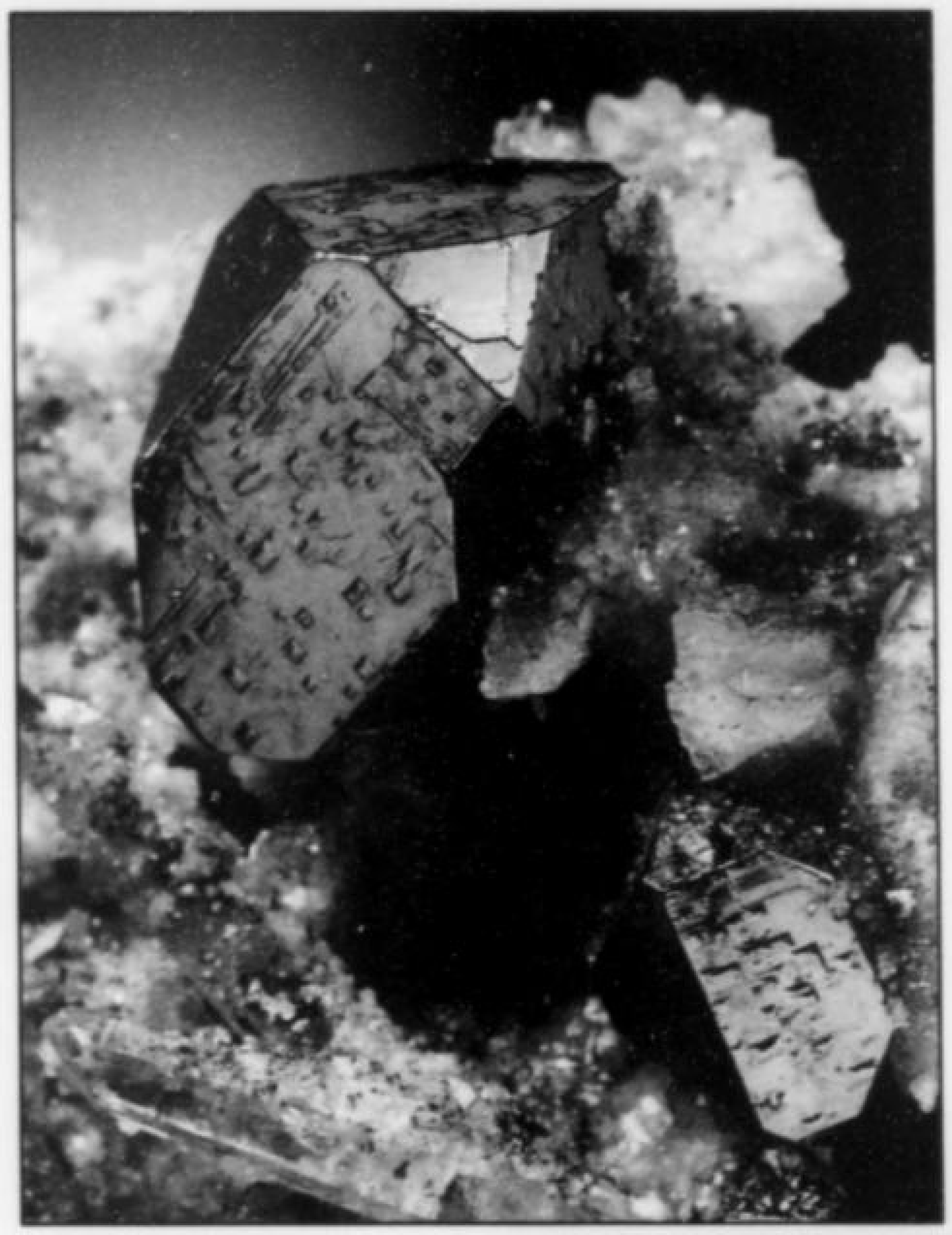


Figure 10. (above) Carrollite crystals to 1 cm from the Kamoto Fond mine, Katanga, Zaire. Graeber Minerals specimen; Jeff Scovil photo.

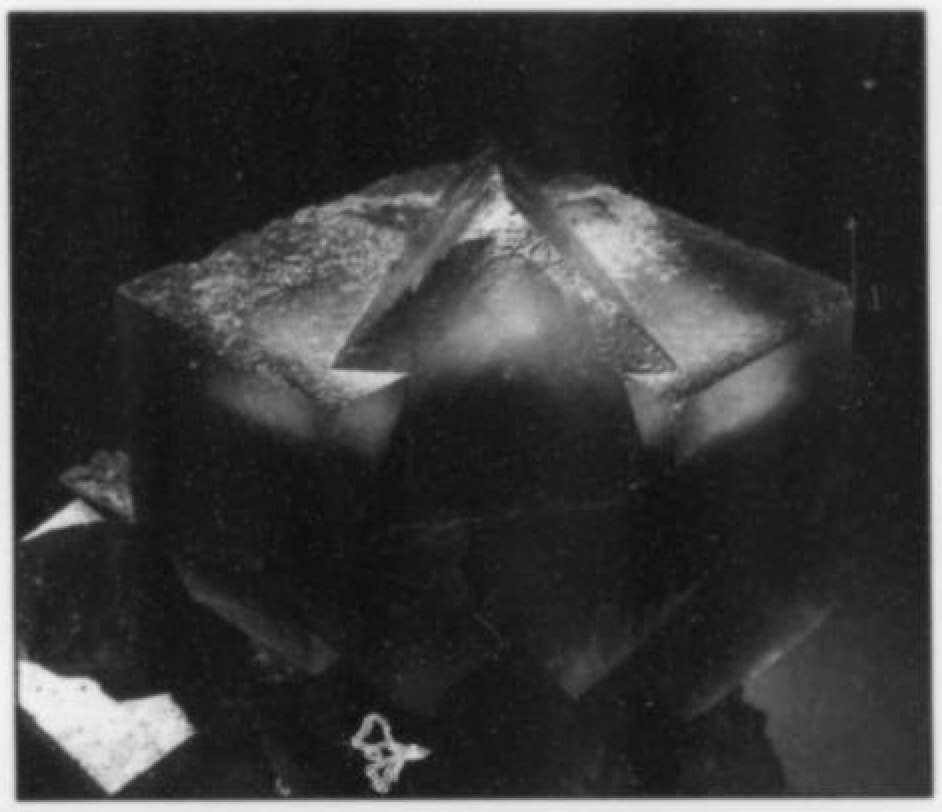


Figure 11. (right) Fluorite twin, 5.5 cm, from the Phyllis Ann claim, Lake George, Colorado. "Crystal Group" specimen; Jeff Scovil photo.

Figure 12. (right) Cassiterite with microcline, 9.2 cm, from the Bennett mine, Buckfield, Maine. Mt. Mann Minerals; Jeff Scovil photo.

years for ruby specimens that contend for the best-of-species title. They rival the specimens from Mogok, Burma.

Denis Gravier of *Le Mineral Brut* (Hauterive, 01644 Saint-Sens-le-Vieux, France) had a perfect, single, gemmy **diopside** crystal for sale. The crystal measures 1.2 x 1.5 x 4.0 cm; it was discovered in January in southern Madagascar, in a metamorphosed limestone deposit.

The only new item produced from Europe was **barite** from the Barega mine, Carbonia, Italy, displayed in the booth of *Angelo Corona* (Sandstrasse 87, 4130 Moers 1, Germany). The crystals are tabular, reach 4.5 cm on an edge, and are similar in color (bright yellow) to specimens from the French locality of Châtel-Guyon.

Reading this report you've probably noted that most new finds were carried by dealers specialized in one country (Frédéric Escaut in China, Patrick Allier in India, Denis Gravier in Madagascar). With many dealers focusing on a single area of the world, it makes me wonder how this benefits the mineral community. On the one hand, specialization gives dealers extensive knowledge of a particular country, as well as close contact with local representatives of the mineralogical scene. Thus, they're always aware of new discoveries, and are the most likely to offer them on the market. But, on the other hand, there exists a danger that the more specialized the dealers become, the more narrow minded they might become. The mineralogical market reflects what is fashionable. My observation is that dealers don't (or perhaps can't afford to) pay attention to countries that aren't actively producing exotic, highly salable minerals. The dealer playground was Africa in the 1970's, and Russia in the 1990's, with China now probably emerging as the most promising area for the 21st century. But the fact remains (and I'm especially familiar with this as I attend mostly European shows) that European novelties are becoming rarer and rarer, and are seldom offered or exhibited at mineral shows.

With this assessment, I'll stop my complaining here. My next report will be about the Chamonix *bourse*, held in August. Chamonix is a temple of *alpine minerals*, which just so happens to be the theme of the Tucson Gem & Mineral Show in 1998.

Rochester Symposium 1997

by **Jeffrey A. Scovil**

[April 11–13]

Spring has been a long time coming to much of the country, but in spite of the cold and rain, the mineral shows of spring have produced their usual crop of attractive specimens. The venerable Rochester Mineralogical Symposium was a delight to attend as usual. Held the second weekend in April, it is the first mineral event I attend after the hustle and bustle of Tucson.

Frank and Wendy Melanson of *Hawthorneden* usually have some goodies to show me, and I was not disappointed. It seems that some wily collectors have gotten back into the classic **anatase** locality of Hardangervidda, Norway. They were rewarded for their efforts with some of the largest anatase the site has produced. The anatase crystals are not on quartz as in the previous find, but are mostly loose singles, occasionally with a little bit of albite matrix. Crystals I saw reached lengths of nearly 2 cm. The dipyramidal crystals are nearly all truncated by the pinacoid, whereas most older specimens seldom show that modification developed to any degree. The source of the new crystals is being called the Valdres Vein, which was worked during the summer of 1996.

Miners have also been busy recently at Cavnic, Romania, producing beautiful **barite** in shades of blue and yellow. Frank's barites are yellow, in plates up to 40 cm across (15 cm being the average). Cavnic has also been producing some very attractive **chalcopyrite** crystals to 2.5 cm perched on druses of prismatic quartz plates to 15 cm across.

Jeff and Val Collins of *Mohawk Enterprises* (1334 Old Trail Road, Johnstown, NY 12095; 518-762-1338) have been collecting at the well-known Walworth, New York, locality. The precise locality name is the Dolomite Products Quarry, known for its superb, glassy clear, colorless to pale blue **fluorite** cubes. Like many of the dolostone quarries in that region of New York, fine **sphalerite** crystals are also found, along with dolomite and calcite crystals. I was surprised to also see water-clear **gypsum** crystals reminiscent of those from Naica, Mexico, up to 8 cm in length. Besides selling the sphalerite, Jeff and Val had a display in the exhibits room completely filled with fine specimens from this quarry. The sphalerite is a deep, gemmy orange-red, some with unidentified black inclusions, and are up to 4 cm long. Val also told me that **galena** crystals to 4 cm have been found, but most are about 1 cm. The material was collected mostly during 1995 and 1996.

The Bennett mine in Buckfield, Maine, continues to produce interesting things, including a 4.7-cm-wide **cassiterite** on **microcline**. Jim Mann of Mt. Mann always brings samples from this mine to the Symposium. He also had a plate of microcline 12 cm across with gemmy albites over 4 cm across on it.

There were many fine specimens on the dealers shelves and in the display cases, but I did not really see much else that was new at Rochester.

Spring Denver Show 1997

by **Jeffrey A. Scovil**

[April 25–27]

Nature abhors a vacuum, and so late April found me heading north to Denver on a weekend when I would otherwise be relaxing or trying to work on my house. This was the second year of the new "Spring Time in the Rockies" show at the Holiday Inn North. I usually head in that direction a little later in the spring, but the show's organizers, Regina Modreski and Karen Wenrich, convinced me that earlier is better. As I battled a snow storm coming up Route 25 the day before the show started I was wondering about the folly of it all. I managed to arrive unscathed and the weather cleared up.

John Seibel and his son are very able field collectors and have been very busy at an old locality in the Nelson Range, Saline Valley, Inyo County, California. The site has been known for producing large, single **epidote** crystals to 25 cm in size back in 1982. The Seibels recently collected a series of pockets producing druses of small green crystals to 1 cm coating quartz crystals. Most of the pockets are collapsed and filled with calcite which must be etched off.

John has also been collecting in the Thomas Range, Utah, and had some large **bixbyite** crystals (to 1 cm) on matrix with a drusy coating of purple **fluorite**. These were collected in early April of 1997. From a little further afield, John had some very interesting pale blue **hemimorphite** in druses of equant crystals from the M'Fuati mine, Mindouli District, Congo. Only a few were found in October of 1996, the largest of which is 15 cm across. From the same locality he had old-style wulfenite crystals to over 1 cm coated with drusy quartz.

Dan Belsher of *Blue Sky Minerals* has been busy in Mexico as usual and showed me some interesting specimens. The by now well-known locality of Sierra de las Cruces, Coahuilla, continues to produce beautiful **grossular** garnets. Their color somehow keeps improving, becoming more and more red. From the San Antonio mine, San Antonio, Chihuahua, were brownish, stalactitic to botryoidal **smithsonite** specimens. And the famous San Carlos mine, Manuel Benavides, Chihuahua, has produced some nice orange **wulfenite**. The crystals are not much larger than 1 cm, but are sharp and gemmy and have a nice bright color.

The award for the most interesting locality name goes to *Bill Hawes Minerals and Fossils* for the Brass Balls Claim, Eagle County, Colorado. Bill tells me that the claim has been known for some time and produces attractive brassy-colored concretions in shale. The concretions are made of **pyrite** crystals to 1 cm, in spherical masses as large as 18 cm. All seem to have as a nucleus either a fossil or a fossil worm hole. Pyritized cephalopods, gastropods and ammonites have been found in the cretaceous Pierre Shale of the site.

In the room of *Mineral Search* I found some highly lustrous, modified **perovskite** crystals to 1 cm on black **andradite** ("melanite") garnet from a new locality in San Benito County. The new site is within a couple of miles of the old Perovskite Knob that produces rough cubes. The new material was collected just a month before.

The Crystal Group, a combination of *Fisher's Minerals* (511 Foothills Road, Colorado Springs, CO 80906) and *Doug Collyer*, have been working the Phyllis Ann Claim, Lake George, Colorado, for about two years. The miarolitic granite has produced some fine **smoky quartz** as expected, some very sharp **hematite** (pseudos?), and some of the best Colorado pegmatite **fluorite** I have seen. The crystals are deep purple octahedra with minor cube modifications. At another spot on the claim **amethyst** was found, and more fluorite, but of a pale purple color, and every one a penetration-twinned cube!

Cincinnati Show 1997

by **Jeffrey A. Scovil**

May 3 and 4 found me at the Cincinnati Show, where I saw a stunning, self-collected **cerussite twin** from the Blanchard mine, Bingham, New Mexico. The 14-cm crystal, collected by David Pachan, had aficionados of New Mexico minerals drooling.

The *Rocksmiths* had a batch of newly mined **pyromorphites** from the Pchelojad mine, Kardzah, Bulgaria. The brown, well-formed crystals to 1 cm are aesthetically sprinkled over a drusy white quartz matrix. I was told that the material had just been received a week before the show. Once again, it was a great show with fine minerals and dealers, but not a lot that was truly new.

Costa Mesa Show 1997

by **Jeffrey A. Scovil**

[May 16–17]

My last stop on the spring show tour was the *West Coast Gem & Mineral Show* (otherwise known as Costa Mesa). It was a welcome change from the steadily growing heat of my home town of Phoenix.

In the Ballroom I found *Haystack Minerals* and their offering of **anatase** from Lavrinha, Minas Gerais, Brazil. The material is not new, but this was a recently acquired lot collected in the 1960's by Ed Swoboda. The dark brown dipyramids to 1 cm are sprinkled on quartz that contains inclusions of some finely divided brown material.

Several people said that I should see the new **brazilianite** in Luis Menezes' room. They are from a new locale—São Geraldo do Baixio, Minas Gerais, Brazil. The crystals, up to 8 cm long, are similar to specimens from the well-known Corrego Frio locality. Most crystals are loose with minor etched **perthite** and small, milky **quartz** crystals. Luis said that the material was collected in January of 1997.

Luis also had some very nice **stokesite** from the Corrego do Urucum mine, Galiléia, Minas Gerais, Brazil. The specimens are tan spheres to 3 cm, in singles and clusters. The material was recovered by reworking the dumps.

Probably the most exciting item at the show was the superb **carrollite** that Gilbert Gauthier was selling. Again, the material is not new—having been collected about seven years ago and bought recently from the collector, a Belgian mining engineer. The locality is the Kamoto-Fond mine, Katanga, Zaire; the crystals are highly lustrous cubes with minor octahedral modifications. Both loose and matrix specimens were available with crystals up to 1.5 cm.

There was one Bolivian dealer in the breezeway outside the Ballroom selling some very nice **vivianite** from Huanuni, Bolivia. Unfortunately I did not catch his name because he had left by the time I went to see him on Sunday. The new specimens are made up of long (to 5 cm or more) crystals, radiating out from the sulfide matrix. The specimens are quite delicate, so it was no surprise that most are single crystals.

That about wraps up the spring season for me. By the time you read this, I will have racked up a few thousand more miles on the truck and some more frequent-flier miles. See you at the next show.

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Letters

QUARTZ

I have just been reading with great interest the latest issue of the *Mineralogical Record* which, as always, is excellent. Due to the fact that I am now disabled and forced to use a wheelchair, I find it very difficult to attend mineral shows or talks. Your excellent magazine proves on many occasions to be the highlight of the year for me and is a lifeline for my particular passion. I sincerely hope that it will long continue to provide me with the stimulus I now increasingly need. Please continue to keep up the good work.

On browsing through the May-June issue I notice a drawing of what appears to me to be a quartz specimen (p. 194, bottom box, top right illustration in the article on J. G. Lenz) shaped similar to the examples illustrated from Tirniauz (p. 206). Has anyone else noticed the similarity?

Barry Taylor
Birmingham, England

You're right—now that you mention it, it does. One would have to examine the original specimen to be sure, of course. I wonder if it still exists? Ed.

EDWIN MARSHALL FOX

During the course of my research into the history of the Snelston copper mine in Derbyshire, England, it became apparent that an American, Edwin Marshall Fox, invested in and ran the mine for a short period at the beginning of this century before dying in the early 1920's. He is reported to have had property, "a mansion," on Long Island, New York, as well as houses in London, England and Shoreham, a seaside resort in Sussex, England. He was, it seemed, a wealthy man and had coal mining and steel interests in the United Kingdom but did unfortunately lose a great deal of money in some of his ventures here.

When Fox died the Snelston copper mine was in financial difficulties and his family, two sons in the USA, quite sensibly declined to become involved. Soon afterward the mine closed, and has been flooded and inaccessible ever since.

The history of the mine, as far as I know it, has recently been published in the UK journal *Mining History*, and the mineralogy will soon be published in the *Journal of the Russell Society*. The story of the Snelston copper mine is, however, still incompletely researched and I would very much like to learn more about Edwin Marshall Fox. Apart from his obvious profit motive, I am interested to learn about his reasons for spending so much time in England and becoming so involved in British industry when the opportunities in North America must have been plenty. Was he perhaps one of your family and would you be prepared to share a few gems of knowledge about him for later publication? I would like to hear from you.

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REPARTITIONING SOUTH AFRICA

Relative to my article on the Kruisrivier cobalt mine (vol. 27, no. 6), it should be noted that, since the article was submitted for publication, the four provinces of South Africa have been redivided into 11 new provinces. The implications are horrendous for specimen labeling and locality databases. The former Transvaal Province has been split up into four new provinces, the Kruisrivier mine now being located in ***Mpumulanga*** Province.

Graham Reeks
Roodepoort, South Africa

MINERAL FAKES

Among the mineral fakes making the rounds these days are the so-called malachite pseudomorphs after calcite after glauberite from Camp Verde, Arizona. Yes, a pseudomorph of a pseudomorph. Tens of thousands of calcite-after-glauberite pseudomorphs (all white) have been collected at the locality for many decades, and have always been abundant, inexpensive and commonplace. Suddenly green ones have started showing up on dealers' tables. The story put forth was that a copper prospect adjacent to the Camp Verde salt mine was contributing copper in solution, by groundwater or tailings pond overflow, into the Camp Verde deposit resulting in malachite pseudomorphs. It is, however, a bogus story. As any experienced Arizona field collector knows, there is no copper prospect at Camp Verde. David Shannon, a well-respected Arizona mineral dealer, thinks he has figured out the method being used to create the fakes: soak the calcite-after-glauberite pseudomorphs in a concentrated basic solution of copper sulfate for a few days and, *voilà*, malachite pseudomorphs!

Some interesting specimens of native gold have also been on the market lately. I first saw a lot of six matrix specimens, each bearing a single isolated cube of gold to about 4 mm. Inspection under magnification revealed that some of the cubes are a bit squashed or deformed at the corners in contact with the cavity walls, suggesting that they had been forcibly pressed into place in the matrix. The crystals have striations on each cube face running perpendicular to striations on each adjacent face, exactly as seen on pyrite crystals but which, for crystallographic reasons, cannot form on gold crystals. One was priced at $1400. The only way such a crystal could be natural is if it were a gold pseudomorph after pyrite. Is such a thing possible?

Patrick E. Haynes
Cortez, CO

I have studied these gold crystals under magnification and concluded that they are too small and perfect to be man-made replicas or cast fakes. Yes, gold replacing pyrite is certainly possible, and I have heard that such pseudomorphs are quite common at a particular Russian gold mine, although only as loose singles. How the crystals came to be in the matrix specimens is still debatable, but the deformed corners are suspicious. Ed.

NEW MINERALS BOOK

I got my *New Minerals, 1990–1994* in the mail yesterday and I like the format and having all the information on new minerals in one publication. The crystal diagrams are a must for us micromineral collectors. It will have a prominent place on my reference shelf next to the *Glossary of Mineral Species, 1995*. I sure hope it flies so you can do more of them.

Since the *Mineralogical Record* is often a good bridge between professional mineralogists and collectors, I would suggest one other category to be included for each mineral: the name of the discoverer. Often the discovery is instigated by a dedicated, knowledgeable collector who does not get the mineral named after him and who receives little or no recognition for bringing the information to a professional mineralogist and sharing his specimens. In this volume I note the absence, for example, of the name of Gene Bearss, who discovered and recognized as something noteworthy both kosnarite and mccrillisite at Mount Mica, and who generously shared the limited specimens he found. I am sure there are other similar incidents. True, the original articles give him credit, but Gene is just one of those many collectors who help make the hobby very special and who should receive all the recognition they deserve. Knowing the name of the discoverer would also be useful to people interested in obtaining specimens.

Arthur Smith
Houston, TX

ALLANITE-(La) and VANADINITE

I just wanted to let you know that the allanite-(La) specimen pictured on p. 210, vol. 28, no. 3 of the *Mineralogical Record* is in the collection of Steve Shailer, not Steve Smale. For a serious collector like myself, having one's specimen pictured in the *Mineralogical Record* is the highest honor. Sort of like playing baseball and being in the World Series.

On a different note, here is something you might find interesting. In the Otavi Mountain Land article (vol. 28, no. 2), the author states that the Transvaal Museum, Pretoria, has a vanadinite specimen with crystals up to 12 cm, making it the largest vanadinite known. I have a former Roebling specimen, no. R-6662 of vanadinite from the Abenab mine, Grootfontein, Namibia. It is a solid mass of crystals, coated with descloizite, measuring 22 x 13 cm. It weighs 27 lbs. One crystal has a length of 14 cm, quite possibly making this the longest vanadinite crystal known. The specimen itself is not all that aesthetic, but mineralogically speaking, it is pretty amazing.

In closing, I would also like to say that in the past 20 years, the *Mineralogical Record* has provided me with a wealth of information, and it is truly appreciated. I wish it many more years of continued success. Thank you.

Steve Shailer
Long Beach, CA

BERG AUKAS WILLEMITE

Bruce Cairncross's article, "The Otavi Mountain Land Cu-Pb-Zn-V Deposits, Namibia" (vol. 28, no. 2, p. 109–130, 157) is a welcome addition to the *Mineralogical Record*'s continuing series on famous localities. We wish, however, to clarify two points concerning willemite from Berg Aukas: its abundance there versus at other localities, and its purported lack of fluorescence.

On p. 119 of this article is a statement that 40% of the total zinc produced from the Berg Aukas mine is reputed to have come from willemite, and that this has led to "suggestions that Berg Aukas has the world's largest accumulation of willemite." Similar statements appear on pages 109 and 113. This may be true for willemite formed by direct alteration of sphalerite, which is the common mode of occurrence of willemite worldwide. However, there were far greater amounts of willemite in the Franklin and Sterling Hill Zn-Mn-Fe deposits of Sussex County, New Jersey. There willemite was a primary ore mineral, the second most important after franklinite, in two large, closely related orebodies which together produced 33,000,000 tons of ore with an average grade of over 19% Zn.

Published data from the 1950's indicate that the Franklin deposit produced about 5,060,000 short tons of willemite, and the nearby Sterling Hill deposit about 1,760,000 short tons, or 6,820,000 short tons of willemite altogether. Calculating from Cairncross's figures (willemite supplying 40% of the Zn in a deposit which contained 3,250,000 metric tons of ore, averaging 16.89% zinc), we estimate the amount of Berg Aukas willemite at about 360,000 short tons, or roughly one-nineteenth the amount of willemite recovered from Franklin and Sterling Hill.

We wish also to comment on the statement (p. 118) that Berg Aukas willemite, "unlike willemite from other world localities, does not fluoresce in ultraviolet light." This runs counter to our experience. Of four Berg Aukas willemite specimens in our possession, all show obvious fluorescence under shortwave ultraviolet light in a range of hues from pale bluish white through white to pale yellow and yellow-orange. The fluorescence is of moderate intensity and is followed by a persistent phosphorescence remaining visible for 10 minutes or more. The response to longwave ultraviolet light is less pronounced, but the fluorescence and phosphorescence are unambiguous. The fluorescence of Berg Aukas willemite was previously noted by Robbins in his 1995 book (*Fluorescence: Gems and Minerals Under Ultraviolet Light*), where on p. 116 appears the following statement: "Berg Aukas, in Namibia, has produced willemite specimens consisting of dense masses of colorless acicular crystals to 1 cm in length that fluoresce yellowish white under shortwave ultraviolet. In some specimens, a weak orange fluorescence under longwave ultraviolet is evident." Similar fluorescence is common to secondary willemite from dozens of other localities worldwide.

Earl Verbeek
Tonopah, NV

Richard Bostwick
New York, NY

Author's Response

I would like to thank Earl Verbeek and Richard Bostwick for their positive criticism regarding the fluorescence of willemite and the size of the willemite deposit at Berg Aukas.

After reading the literature documenting the non-fluorescence of willemite (Spencer, 1927; Verwoerd, 1957), I tested my own specimens (about a dozen) under longwave and shortwave ultraviolet light and none showed any reaction whatsoever. I subsequently asked two other Johannesburg collectors to do the same with their Berg Aukas specimens and they reported that they too had no success with fluorescence. In hindsight, it was wrong of me to insert a "blanket" statement regarding the non-fluorescence of the willemite, but based on the literature and our own tests the statement appeared to be valid.

I did not personally calculate ore reserves for the deposits but was quoting from what I presumed to be reliable sources (again in hindsight, obviously not so). The statements were made by Verwoerd (1957), Misiewicz (1988) and Chadwick (1993), all of whom had been geologists working on the mine. I was well aware of the New Jersey deposits and should have checked the tonnage figures from the Franklin and Sterling Hill mines.

(References are those appearing in my Otavi Mountain Land article.)

Bruce Cairncross
Johannesburg, South Africa

HISTORY of THUMBNAILS

Regarding your request for information about the history of thumbnail-size mineral specimens (vol. 27, no. 3, p. 162): I was the assistant curator of minerals for a few years under the late Arthur L. Flagg when the Arizona Mineral Museum was located on the Fairgrounds in Phoenix. I kept the Museum open for a few hours on weekends during the time I attended Arizona State College (as A.S.U. was then known). Dating back even earlier, I have considerable correspondence from Mr. Flagg from when I was in grade school. This was during the early 1940's to mid-1950's, when I was quite active in the local club. From my earliest recollection, the term "thumbnail" was in common use as a category for competition at shows and as a collecting specialty in the Mineralogical Society of Arizona. There were established rules for mounting and displaying, and a number of people had very fine collections.

George E. Lammer
Winnipeg, Manitoba

In the 1940's, 1 x 1 specimens were referred to as STUDENT SPECIMENS, to be used by mineralogy students to study and practice identification methods on, such as: blow-pipe analysis, petrographic and optical work under the petrographic scope, and/or as unknown specimens to identify for course credit. They were sold by Scott J. Williams, *Burminco* (George Burham) and *Wards*, usually in groups of 10 for a dollar, but sometimes they would sell them alone. Rare ones could go for as much as a dollar each.

I purchased and traded for student specimens, with the above dealers, and many adult collectors would give me their trims off their bigger specimens in the late 1940's, which I used to build my Dana collection, when I was a junior in the Central Iowa Mineral Society. I kept them in an antique spool cabinet which I purchased for $12.00. I remember that the western dealers had more of them. As for eastern minerals, I traded with another young collector from Danbury, Connecticut, named Januzzi, whom I got to meet when on vacation with my parents.

The spool cabinet Dana collection was entered in the 3rd annual AFMS Convention, Milwaukee, Wisconsin, on June 28–30, 1950, winning Best in Juniors (under 21). The AFMS had no size limits on specimens or number of specimens in the competition in those days. The display was very popular, and being the only one, it was unique. However, my traveling patron, H. R. Straight, won Best in Seniors with four large showcases of museum-sized specimens, which filled the back of his new '49 Ford Station Wagon on the way to the show. Later on, Mr. Funk (seed corn) from Illinois, and others built similar collections for a while, but these were very expensive and took up too much room in competition.

Leo Langland
Phoenix, AZ

ERRATA

In the article on hyalophane from Zagradski Potok (vol. 27, no. 5), the map shown in Figure 1 was supplied by the editor, based on a very recent map in *Time* magazine. It is not necessarily incorrect; the author only wishes to specify that he did not supply it, and does not personally underwrite the partitioning or the "Serb Republic."

In the same article, the reference to the caption to Figure 30 cites Figure "16," which should have been Figure "29." Figures 33 and 34 were inadvertently "flopped" (mirror image), which is of importance in Figure 34 because it appears to be an LL′-Dauphine twin instead of the RR′-Dauphine twin as correctly stated in the caption.

Mirjan Žorž
Grosuplje, Slovenia

Regarding the "Microminerals" column on Vesuvius in vol. 27, no. 6, there may be some confusion regarding "Monte Somma" vs. "Vesuvius." Corrections from the author, Bill Henderson, which were delayed in the post until we had gone to press, specify that the volcanoes are not exactly "one inside the other" but rather "one on the flank of the other." The Italian collectors distinguish clearly between the two as separate localities; the specimens shown in Figures 3, 4, 7, 10, 11, 17 and 18 are from Monte Somma whereas those in Figures 5, 6, 8, 9, 12, 13, 14 and 15 are from Mount Vesuvius.

Ed.

BARLOW BOOK

Through a regrettable and disturbing oversight I neglected to mention in the "Acknowledgments" in my book (*The F. John Barlow Mineral Collection*, reviewed in vol. 28, no. 2, p. 147) the invaluable help given to me by the editor of the *Mineralogical Record*, Wendell Wilson. His initial offer years ago to publish a biography and article on my collection in the *Mineralogical Record* lit a fire. When the estimate of length grew from 40 pages to 100 pages he offered to publish it as a supplement. His help in selecting authors for the various chapters brought me into contact with some wonderful writers I had never met, and reminded me of competent people I already knew.

With Wendell's continued encouragement the projected length grew to 150 pages, at which point it was beyond the scope of the *Mineralogical Record*, so he urged me to publish it myself. He never failed to push for quality, and to offer guidance when I needed it. When I was uncertain of how many silver specimens to include, for example, he urged me to not worry about numbers. "It's your collection," he said, "and people want to see what *you* like. If that means picturing 30 native silvers, be true to yourself and do it." That was good advice.

From then on, as the book continued to grow, I consulted with him frequently on the many problems that face a publisher (especially a first-time publisher as I was) and how to surmount them. He was always free with his advice, help and encouragement even though there was no profit in it for the *Mineralogical Record* anymore. Without him, I am not sure the book would have ever been completed.

I just thought the world should know this background. Thanks a million, Wendell!

F. John Barlow
Appleton, WI

ROMERO AWARD

Tom Moore has done a wonderful job of reporting "What's new in minerals" in the *Mineralogical Record*, however I must correct a statement made in the May–June issue, p. 216: Tom gave the Friends of Mineralogy credit for presenting the Miguel Romero Award, and while I wish that were true, it was actually the Tucson Gem & Mineral Society who presented the award.

Beau Gordon, President
Friends of Mineralogy

The Friends of Mineralogy

Who We Are:

Vol 1, No 1, Mineralogical Record, Spring 1970
The *Friends of Mineralogy* was founded in Tucson, Arizona, on February 13, 1970. Its objectives are 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.

Co-Sponsor, with the Tucson Gem & Mineral Society and the Mineralogical Society of America, of the Annual Tucson Mineralogical Symposia.

* * *

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- All submitted photos become the property of *FM*. Copyright will be retained by photographer, but *FM* will have royalty-free use.
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Pacific Northwest Chapter: 1997 Mineralogical Symposium: for information contact Wes Gannaway, 1604 Brookwood Dr., Ferndale, WA 98248

Pennsylvania Chapter: Mineralogical Symposium and field trip, West Chester University, PA: Oct. 24–26, 1997. Information contact: Roland Bounds, 215 Stamford Dr., Newark, DE 19711

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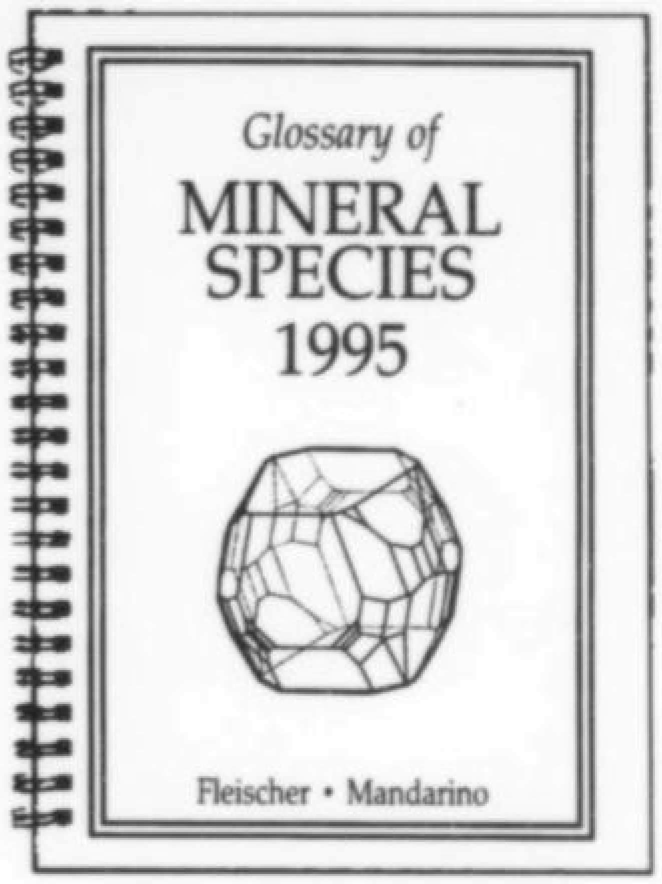

THE FIRST LIST OF ADDITIONS AND CORRECTIONS TO THE GLOSSARY OF MINERAL SPECIES (1995)

Michael Fleischer and **Joseph A. Mandarino**

Since the preparation of the Seventh Edition of the *Glossary of Mineral Species 1995*, descriptions of 115 new minerals have been published and new data have appeared for many minerals. This list covers the period from August 31, 1994 to May 31, 1997. The page numbers listed are those of the Seventh edition. All new entries are given in bold face, signifying that they have been approved by the Commission on New Minerals and Mineral Names of the International Mineralogical Association.

Two new sets of references have been added to the entries for species whose descriptions have been published after 1989. *New Minerals 1990–1994* by Mandarino (1997) is given for species whose abstracts appear there. Abstracts of new species published after 1994 have been published by Mandarino in the *Mineralogical Record* and these abstracts are given as references.

We are deeply indebted to many persons for helpful data and suggestions, and especially to Dr. J. H. Bernard, Prague, Czech Republic; Dr. U. Kolitsch, Stuttgart, Germany; Mr. R. Bideaux, Tucson, Arizona; Dr. J. L. Jambor, Tsawwassen, British Columbia; Mr. A. C. Roberts, Ottawa, Ontario; Mr. M. E. Back, Toronto, Ontario; Prof. G. Ferraris, Torino, Italy; and Mr. J. Ferraiolo, Bowie, Maryland.

In the table "**The Elements and Their Abbreviations**" on the page after the **Introduction**, change Termium to Terbium

Add to the list of abbreviations:

N. Jb. Min. Mh.	*Neues Jahrbuch für Mineralogie Monatshefte*
Acta Cryst.	*Acta Crystallographica*
New Mins. (1997)	*New Minerals 1990–1994*

Page

1 To follow **Abelsonite**:
☐ **Abenakiite-(Ce)**, $Na_{26}(Ce,REE)_6(SiO_3)_6(PO_4)_6$-$(CO_3)_6(S^{4+}O_2)O$, trig., pale brown, *New Mins.* (1997)
1 **Abswurmbachite**: change the formula to $Cu^{2+}Mn^{3+}_6SiO_{12}$; replace the references with *New Mins.* (1997)
3 **Akaganeite**: change the name to **Akaganéite**
3 **Akhtenskite**: change **Akhtenskite** (epsilon-MnO_2) to **Akhtenskite**, epsilon-MnO_2,
3 To follow **Alamosite**:
☐ **Alarsite**, $AlAsO_4$, trig., *New Mins.* (1997)
4 **Allargentum**: change the formula from Ag_{1-x},Sb_x to Ag_{1-x},Sb_x

(continued on p. 428)

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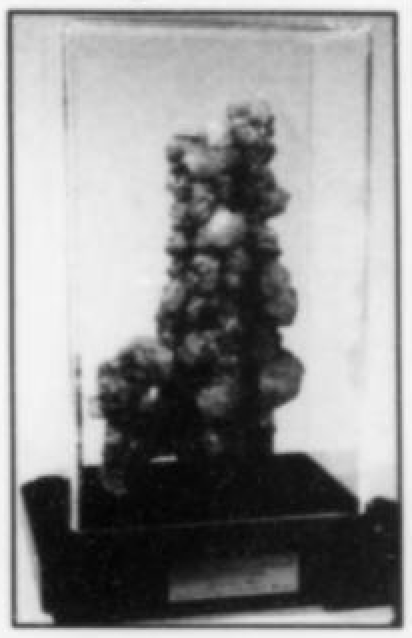

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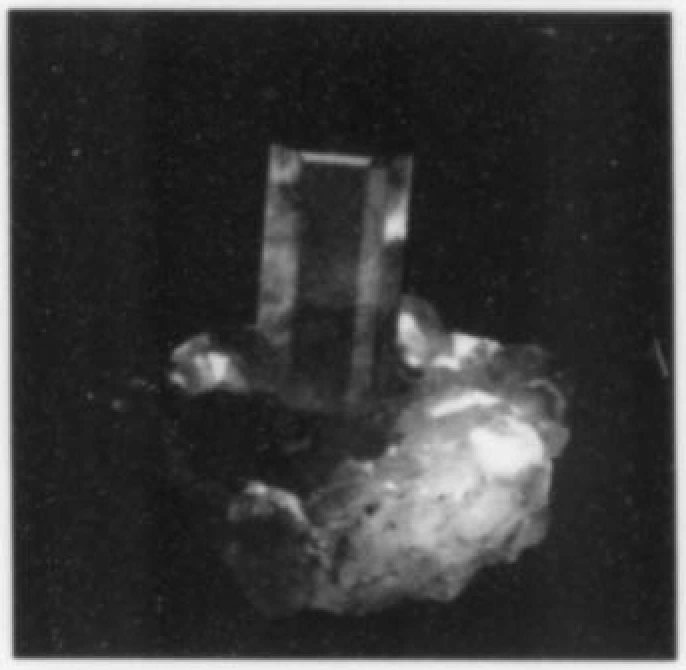

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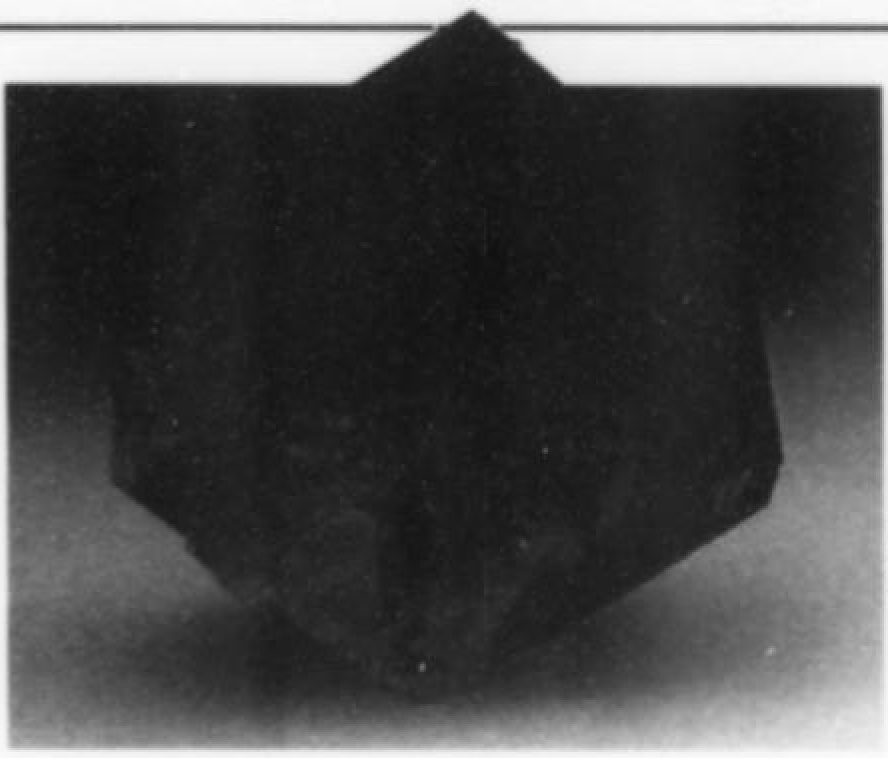

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4 **Alluaivite**: change the reference to *New Mins.* (1997)

5 To follow **Althupite**:

☐ **Altisite**, $Na_3K_6Ti_2Al_2Si_8O_{26}Cl_3$, mon., *New Mins.* (1997)

5 To follow **Alumohydrocalcite**:

☐ **Alumoklyuchevskite**, $K_3Cu_3AlO_2(SO_4)_4$, mon., dark green, *Mineral. Rec.* **27**, 116 (1996)

6 **Aminoffite**: change the formula to $Ca_3Be_2Si_3O_{10}(OH)_2$

7 To follow Andrewsite:

☐ **Androsite-(La)**, $(Mn,Ca)(La,Ce,Ca,Nd)Al\text{-}Mn^{3+}Mn^{2+}(SiO_4)(Si_2O_7)O(OH)$, mon., brown-red, *Epidote* group, **81**, 735–742 (1996)

8 **Antimonselite**: change the reference to *New Mins.* (1997)

10 **Aristarainite**: change the formula to $Na_2MgB_{12}O_{20}\cdot 10H_2O$

10 Arizonite: replace the entry with: Arizonite = a mixt., **80**, 1077 (1995)

11 **Arrojadite**: after **Dickinsonite** add compare **Sigismundite**

11 **Arsenocrandallite**: delete blue to bluish-green

11 **Arsenogorceixite**: change the reference to *New Mins.* (1997)

12 To follow **Artinite**:

☐ **Artroeite**, $PbAlF_3(OH)_2$, tric., *Mineral. Rec.* **27**, 116 (1996)

12 **Arupite**: add the reference *New Mins.* (1997)

13 **Ashburtonite**: change the reference to *New Mins.* (1997)

13 **Astrocyanite-(Ce)**: change the references to *New Mins.* (1997)

13 **Atelestite**: replace entry with the following:

☐ **Atelestite**, $Bi_2O(OH)(AsO_4)$, mon., yellow, compare **Smrkovecite**

14 **Aurichalcite**: change orth. to mon.; add **80**, 1076 (1995)

15 To follow **Babingtonite**:

☐ **Babkinite**, $Pb_2Bi_2(S,Se)_3$, trig., silver-grey, *Mineral. Rec.* **28**, 219 (1997)

15 To follow **Bakerite**:

☐ **Baksanite**, $Bi_6(Te_2S_3)$, trig., steel-grey

16 **Baratovite**: delete comma before O_{36} in formula; i.e., $KCa_7(Ti,Zr)_2Li_3Si_{12}O_{36}F_2$

16 **Barberiite**: change the reference to *New Mins.* (1997)

16 **Bariomicrolite**: delete (Rijkeboerite); change the formula to: $Ba_2(Ta,Nb)_2(O,OH)_7$

17 **Barstowite**: change the reference to *New Mins.* (1997)

18 **Baumhauerite-*2a***: change the reference to *New Mins.* (1997)

18 **Bearthite**: change the reference to *New Mins.* (1997)

18 To follow **Beaverite**:

☐ **Bechererite**, $(Zn,Cu)_6Zn_2(OH)_{13}[(S,Si)(O,OH)_4]_2$, trig., light green, *Mineral. Rec.* **27**, 393 (1996)

19 **Belendorffite**: change the reference to *New Mins.* (1997)

19 **Belkovite**: change the reference to *New Mins.* (1997)

19 **Bellbergite**: change the reference to *New Mins.* (1997)

19 **Belovite**: change the name to **Belovite-(Ce)**, the formula to $Sr_3Na(Ce,La)(PO_4)_3(F,OH)$, and the crystal system to trig.

19 To follow **Belovite-(Ce)**:

☐ **Belovite-(La)**, $Sr_3Na(La,Ce)(PO_4)_3(F,OH)$, trig., bright yellow to greenish yellow, *Mineral. Rec.* **28**, 219–220 (1997)

19 To follow **Bementite**:

☐ **Benauite**, $HSrFe_3^{3+}(PO_4)_2(OH)_6$, trig., yellow to brown, *Crandallite* group, *Mineral. Rec.* **28**, 141 (1997)

20 **Bergslagite**: change the page number in second reference from 901 to 951

20 **Bernalite**: change the references to *New Mins.* (1997)

20 **Bernardite**: change the formula to $Tl(As,Sb)_5S_8$

20 **Berthierine**: add the following polytypes are known **-1*M*** and **-1*H***

22 **Biotite**: change everything after the formula to: mon. and tric., forms a series with **Phlogopite**, *Mica* group, the following polytypes are known: **-1*M***, **-2*M***, **-5M_1**, and **-6*A***

22 **Bismutocolumbite**: change the reference to *New Mins.* (1997)

23 **Blakeite**: remove the ☐ and make the name non-BOLD type

24 **Boggildite**: change the name to **Bøggildite**

24 **Boggsite**: change the reference to *New Mins.* (1997)

24 **Bolivarite**: remove ☐ and make name non-BOLD, add may = Evansite

25 **Borcarite**: change tric. to mon.; add *Min. Mag.* **59**, 297–304 (1995)

25 **Borishanskiite**: change the formula to $Pd_{1+x}(As,Pb)_2$

25 **Borodaevite**: change the reference to *New Mins.* (1997)

25 **Boromuscovite**: change the reference to *New Mins.* (1997)

25 **Bottinoite**: change the reference to *New Mins.* (1997)

27 **Brianyoungite**: change the reference to *New Mins.* (1997)

27 **Briartite**: change the formula to $Cu_2(Zn,Fe)GeS_4$; add **80**, 849 (1995)

27 **Britholite-(Ce)**: after hex., add compare **Britholite-(Y)** and **Fluorbritholite-(Ce)**

27 **Britholite-(Y)**: after hex., add compare **Britholite-(Ce)** and **Fluorbritholite-(Ce)**

27 To follow **Britholite-(Y)**:

☐ **Brizziite**, $NaSb^{5+}O_3$, trig., light pink to yellow, *New Mins.* (1997)

27 Bröggerite: replace the entry with: Bröggerite = thorian **Uraninite**, $(U,Th)O_2$

27 **Brokenhillite**: remove ☐ and make name non-BOLD

28 **Buckhornite**: change the references to *New Mins.* (1997)

29 **Burbankite**: after hex. change "compare **Khanneshite** and **Remondite-(Ce)**" to "compare **Calcioburbankite**, **Khanneshite**, **Petersenite-(Ce)** and **Remondite-(Ce)**"

29 **Burpalite**: change the reference to *New Mins.* (1997)

29 **Bystrite**: change the reference to *New Mins.* (1997)

30 **Calcio-ancylite-(Nd)**: change the reference to *New Mins.* (1997)

30 To follow **Calcio-ancylite-(Nd)**:

☐ **Calcioaravaipaite**, $PbCa_2Al(F,OH)_9$, mon., compare **Aravaipaite**, *Mineral. Rec.* **27**, 293–300 (1996), *Mineral. Rec.* **28**, 220 (1997)

30 **Calciobetafite**: change the formula to $Ca_2(Ti,Nb)_2(O,OH)_7$

30 To follow **Calciobetafite**:

☐ **Calcioburbankite**, $Na_3(Ca,REE,Sr)_3(CO_3)_5$, hex., deep orange also silky white to light pink, compare **Burbankite**, **Khanneshite**, **Petersenite-(Ce)** and **Remondite-(Ce)**, *Mineral. Rec.* **27**, 301 (1996)

31 **Calciohilairite**: after **Hilairite** add **Pyatenkoite-(Y)**, and **Sazykinaite-(Y)**

32 **Camerolaite**: change the reference to *New Mins.* (1997)

32 **Cancrisilite**: change the reference to *New Mins.* (1997)

32 **Cannizzarite**: change the entry to:

☐ **Cannizzarite**, $Pb_{46}Bi_{54}S_{127}$, mon., *Acta Cryst.* **B35**, 133–136 (1979)

32 **Cannonite**: change the references to *New Mins.* (1997)

32 **Capgaronnite**: change the reference to *New Mins.* (1997)

33 **Carbonate-cyanotrichite**: in the formula, change the 2 after Al to a subscript and the superscript $^{2+}$ after Cu; i.e., $Cu_4^{2+}Al_2(CO_3,SO_4)(OH)_{12}\cdot 2H_2O$

33 **Carlosturanite**: add $\cdot H_2O$ to end of formula; i.e., $(Mg,Fe^{2+},Ti)_{21}(Si,Al)_{12}O_{28}(OH)_{34}\cdot H_2O$

33 To follow **Carlosturanite**:

☐ **Carlosruizite**, $K_6(Na,K)_4Na_6Mg_{10}(Se^{6+}O_4)_{12}(IO_3)_{12}\cdot 12H_2O$, trig., cols. to pale yellow, forms a series with **Fuenzalidaite**, *New Mins.* (1997)

34 **Caysichite-(Y)**: change the formula to $Y_4(Ca,REE)(OH)(H_2O)_5(Si_8O_{20})(CO_3)_6\cdot 2H_2O$

35 **Cerite-(Ce)**: in the formula, change Cd to Ce

37 **Chalcomenite**: change **Clinoehaleomenite** to **Clinochalcomenite**

37 **Chalcophyllite**: at the end of formula, change $\cdot 3H_2O$ to $\cdot 33H_2O$

38 To follow **Chenevixite**:

☐ **Chengdeite**, Ir_3Fe, cub., steel black, compare **Isoferroplatinum**, *Mineral. Rec.* **27**, 202 (1996)

38 **Cheralite**: change the entry to:

Cheralite-(Ce), $(Ce,Ca,Th)(P,Si)O_4$, mon., *Monazite* group, **38**, 734 (1953), **39**, 403 (1954), *N. Jb. Min. Mh.* **1995**, 344–350

38 **Cheremnykhite**: change the reference to *New Mins.* (1997)

39 **Chevkinite**: change the name to **Chevkinite-(Ce)** and change the formula to $(Ce,La,Ca,Na,Th)_4(Fe^{2+},Mg)_2(Ti,Fe^{3+})_3Si_4O_{22}$

39 **Chladniite**: change the reference to *New Mins.* (1997)

40 **Choloalite**: change the formula to $Cu^{2+}Pb(Te^{4+}O_3)_2$; add **80**, 634 (1995)

40 To follow **Chondrodite**:

☐ **Christelite**, $Zn_3Cu_2(SO_4)_2(OH)_6\cdot 4H_2O$, tric., greenish blue, compare **Ktenasite**, *N. Jb. Min. Mh.* **1996**, 188–192

40 To follow **Chromatite**:

☐ **Chrombismite**, $Bi_{16}CrO_{27}$, tet., orange to yellowish brown, *Can. Min.* **35**, 35–38 (1997)

41 **Cianciulliite**: change the reference to *New Mins.* (1997)

41 **Claringbullite**: change the formula to $Cu_4^{2+}(OH)_7Cl$; add *Can. Min.* **33**, 633–639 (1995)

41 To follow Cleavelandite:

☐ **Clerite**, $MnSb_2S_4$, orth., black, compare **Berthierite**, *Mineral. Rec.* **28**, 220 (1997)

42 To follow Cliftonite:

☐ **Clinoatacamite**, $Cu_2^{2+}(OH)_3Cl$, mon., green to dark greenish black, polymorph. with **Atacamite**, **Paratacamite**, and **Botallackite**, *Mineral. Rec.* **27**, 463 (1996)

43 **Clinomimetite**: change the reference to *New Mins.* (1997)

43 **Clinotobermorite**: change the reference to *New Mins.* (1997); after **Tobermorite** add compare **Plombierite**

45 **Coombsite**: change the reference to *New Mins.* (1997)

45 **Coquandite**: change the reference to *New Mins.* (1997)

46 **Cornubite**: after green, add dimorph. with **Cornwallite**

46 **Cornwallite**: delete $\cdot H_2O$ from the formula; after dark green, add dimorph. with **Cornubite**

46 **Corvusite**: after (1994) add **80**, 407 (1995)

46 To follow **Crandallite**:

☐ **Crawfordite**, $Na_3Sr(PO_4)(CO_3)$, mon., compare **Bradleyite**, **Bonshtedtite**, and **Sidorenkite**, *New Mins.* (1997)

46 To follow **Creedite**:

☐ **Crerarite**, $(Pt,Pb)Bi_3(S,Se)_{4-x}$ $x \sim 0.7$, cub., *New Mins.* (1997)

47 **Cualstibite**: change the subscript after Al to a subscript 3; i.e., $Cu_6^{2+}Al_3Sb_3^{5+}O_{18}\cdot 16H_2O$

48 **Cuprobismutite**: change the subscript after Bi to a subscript 12; i.e., $Cu_{10}Bi_{12}S_{23}$

48 **Cupropavonite**: after **Mummeite** add **Makovickyite**

48 **Cuprorivaite**: after azure-blue add compare **Gillespite**, **Effenbergerite**, and **Wesselsite**

49 **Cyanophyllite**: change the formula to: $Cu_5^{2+}Al_2(Sb^{5+}O_4)_3(OH)_7\cdot 9H_2O$

50 **Damaraite**: change the references to *New Mins.* (1997)

51 **Deanesmithite**: change the reference to *New Mins.* (1997)

51 To follow **Dellaite**:

☐ **Deloneite-(Ce)**, $NaCa_2SrCe(PO_4)_3F$, trig., bright yellow, compare **Belovite-(Ce)**

52 **Deloryite**: change the reference to *New Mins.* (1997)

53 **Dickinsonite**: after **Arrojadite** add compare **Sigismundite**

53 **Dissakisite-(Ce)**: change the reference to *New Mins.* (1997)

54 **Djerfisherite**: after **Thalfenisite** add **Owensite**

54 **Dmisteinbergite**: add the reference *New Mins.* (1997)

54 **Dorallcharite**: change the reference to *New Mins.* (1997)

55 To follow **Doyleite**:

☐ **Dozyite**, $(Mg_7Al_2)(Si_4Al_2)O_{15}(OH)_{12}$, mon., a regular 1:1 interstratification of serpentine and chlorite, *Mineral. Rec.* **27**, 301–302 (1996)

55 **Durangite**: after **Maxwellite** add and with **Tilasite**

55 To follow **Duranusite**:

☐ **Dusmatovite**, $K(K,Na,\square)(Mn^{2+},Y,Zr)_2(Zn,Li)_3Si_{12}O_{30}$, hex., blue to brown, *Osumilite* group, *Mineral. Rec.* **28**, 220–221 (1997)

56 To follow **Dzhalindite**:

☐ **Dzharkenite**, $FeSe_2$, cub., black, polymorph. with **Ferroselite**, *Pyrite* group, *Mineral. Rec.* **27**, 116–117 (1996)

57 **Edenharterite**: change the references to *New Mins.* (1997)

57 **Edgarbaileyite**: change the references to *New Mins.* (1997)

57 **Edoylerite**: change the reference to *New Mins.* (1997)

57 To follow **Edoylerite**:

☐ **Effenbergerite**, $BaCuSi_4O_{10}$, tet., blue, compare **Wesselsite**, **Cuprorivaite**, and **Gillespite**, *New Mins.* (1997)

57 **Efremovite**: change the 2 after Mg to a subscript 2; i.e., $(NH_4)_2Mg_2(SO_4)_3$

60 **Ernienickelite**: change the reference to *New Mins.* (1997)

60 **Erniggliite**: change hex. to trig. and change the reference to *New Mins.* (1997)

60 To follow **Ernstite**:

☐ **Ershovite**, $Na_4K_3(Fe^{2+},Mn^{2+},Ti)_2Si_8O_{20}(OH)_4\cdot 4H_2O$, tric., olive green, *New Mins.* (1997)

61 **Eugenite**: add **80**, 845–846 (1995)

61 **Evansite**: remove ☐ and make name non-BOLD

62 **Fangite**: change the reference to *New Mins.* (1997)

64 **Fernandinite**: after (1994) add **80**, 407 (1995)

64 **Ferrihydrite**: after (1990) add **79**, 767 (1994)

64 **Ferrilotharmeyerite**: change the reference to *New Mins.* (1997)

65 **Ferrisurite**: change the reference to *New Mins.* (1997)

65 **Ferritungstite**: change the entry to:

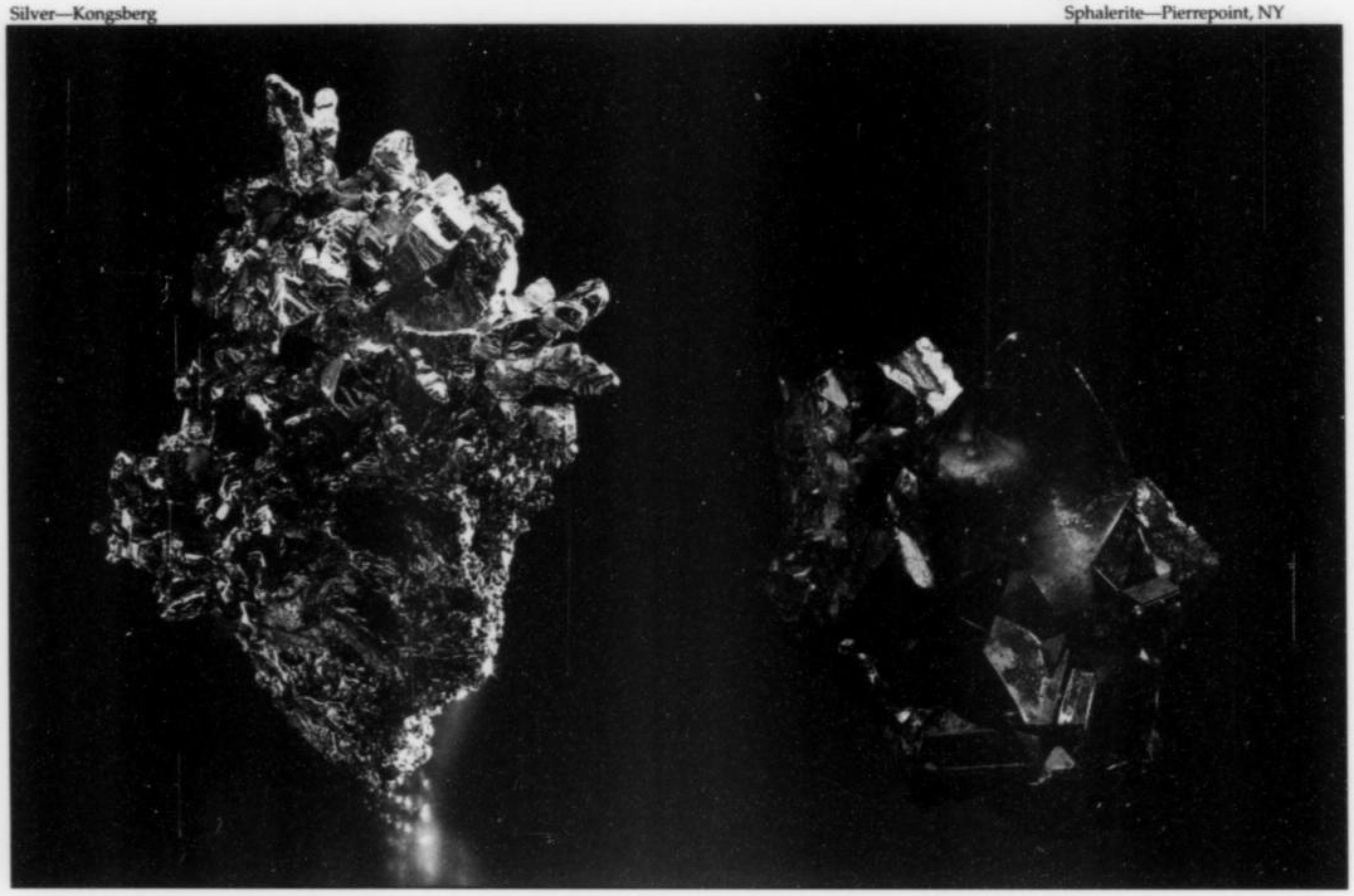
☐ **Ferritungstite**, $(W^{6+},Fe_2^{3+})(O,OH)_6\cdot pH_2O$ p up to 1.75, cub., yellow, related to the *Pyrochlore* group, **42**, 83–90 (1957), *Mineral. Rec.* **12**, 82–85 (1981), **80**, 849 (1995)

68 **Ferrowodginite**: change the references to *New Mins.* (1997)

68 To follow **Fervanite**:

☐ **Fetiasite**, $(Fe^{2+},Fe^{3+},Ti^{4+})_3O_2As_2^{3+}O_5$, mon., brown to black, *New Mins.* (1997)

(continued on p. 432)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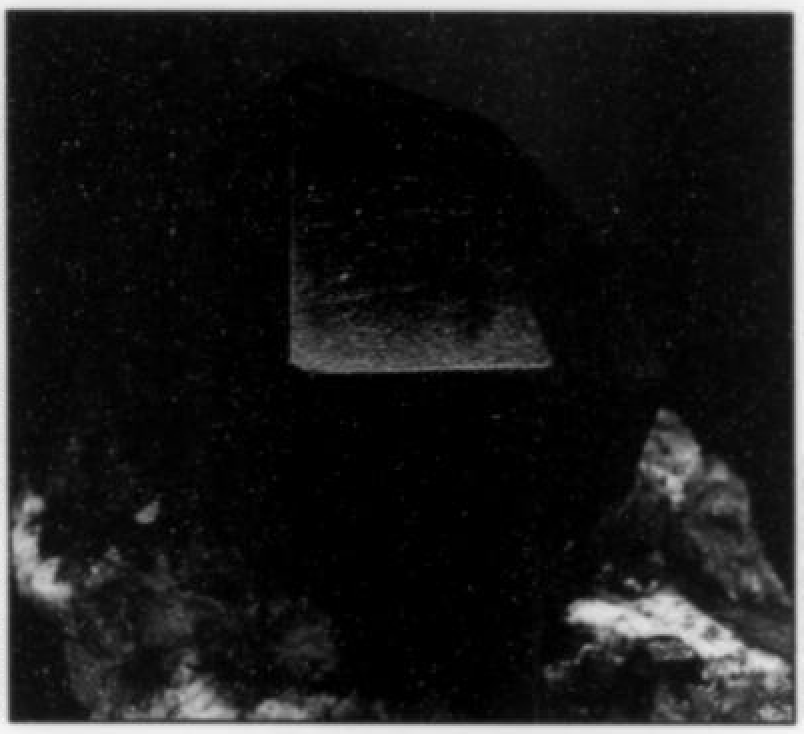

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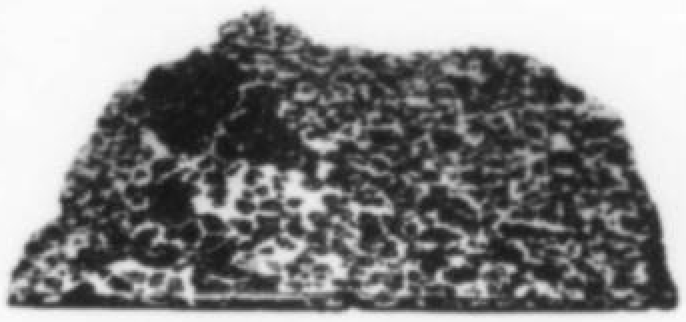

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68 To follow **Fetiasite**:
☐ **Fettelite**, $Ag_{24}HgAs_5S_{20}$, trig., dark violet to scarlet, *Mineral. Rec*. **28**, 141 (1997)

68 To follow **Fettelite**:
☐ **Fianelite**, $Mn_2^{2+}V^{5+}(V^{5+},As^{5+})O_7 \cdot 2H_2O$, mon., orange-red, **81**, 1270–1276 (1996)

68 **Fiedlerite**: in the formula, add F after Cl, i.e., $Pb_3Cl_4F(OH) \cdot H_2O$; change **Fiedlerite-2*M*** to **Fiedlerite-2M_1**; after (1994) add **79**, 1014 (1994)

69 To follow **Fluorapophyllite**:
☐ **Fluorbritholite-(Ce)**, $(Ce,La,Na)_5(Si,P)_3O_{12}F$, hex., pale yellow, tan, reddish brown, compare **Britholite-(Ce)**, related to the *Apatite* group, *New Mins*. (1997)

69 To follow **Fluorbritholite-(Ce)**:
☐ **Fluor-cannilloite**, $CaCa_2(Mg_4Al)(Si_5Al_3)O_{22}F_2$, mon., grey-green, *Amphibole group*, *Mineral. Rec*. **28**, 142 (1997)

69 To follow **Fluorellestadite**:
☐ **Fluor-ferro-leakeite**, $NaNa_2(Fe_2^{2+}Fe_2^{3+}Li)Si_8O_{22}F_2$, mon., bluish-black to black, *Amphibole* group, *Mineral. Rec*. **27**, 393–394 (1996)

70 **Fluorrichterite**: change the formula to $(Na,K)(Ca,Na)_2(Mg,Fe)_5Si_8O_{22}(F,OH)_2$ and add the reference *New Mins*. (1997)

70 **Foitite**: change the reference to *New Mins*. (1997)

70 **Fontanite**: change the references to *New Mins*. (1997)

70 **Francisite**: change the reference to *New Mins*. (1997)

71 To follow **Franconite**:
☐ **Frankamenite**, $K_3Na_3Ca_5(Si_{12}O_{30})[F,(OH)]_4 \cdot H_2O$, tric., lilac-grey, blue- grey, greenish, polymorph. with **Canasite** but with F > OH

71 To follow **Frankdicksonite**:
☐ **Frankhawthorneite**, $Cu_2Te^{6+}O_4(OH)_2$, mon., medium leaf green, *Mineral. Rec*. **27**, 117 (1996)

71 **Franklinphilite**: change the references to *New Mins*. (1997)

71 **Fredrikssonite**: in the formula, change (BO_5) to (BO_3)

72 To follow Fuchsite:
☐ **Fuenzalidaite**, $K_6(Na,K)_4Na_6Mg_{10}(SO_4)_{12}(IO_3)_{12} \cdot 12H_2O$, trig., cols. to pale yellow, forms a series with **Carlosruizite**, *New Mins*. (1997)

73 **Gainesite**: change the formula to $NaNa(Be,Li)$-$(Zr,Zn)_2(PO_4)_4 \cdot 1\text{–}2H_2O$; add compare **Mccrillisite** and **Selwynite**, **80**, 1074 (1995)

74 To follow **Gallite**:
☐ **Gallobeudantite**, $PbGa_3[(AsO_4),(SO_4)]_2(OH)_6$, trig., pale yellow to greenish to cream, *Beudantite group*, *Can. Min*. **34**, 1305–1315 (1996)

74 To follow **Ganophyllite**:
☐ **Gaotaiite**, Ir_3Te_8, cub., steel black, *Mineral. Rec*. **27**, 117 (1996)

74 **Gatehousite:** change the name to **Gatehouseite** and change the reference to *New Mins*. (1997)

74 To follow **Gaudefroyite**:
☐ **Gaultite**, $Na_4Zn_2Si_7O_{18} \cdot 5H_2O$, orth., cols. to pale mauve, related to the *Zeolite* group, *New Mins*. (1997)

75 **Geminite**: change the formula to $Cu^{2+}(As^{5+}O_3OH)(H_2O)$; change the reference to *New Mins*. (1997)

75 **Georgeite**: change the formula to $Cu_5^{2+}(CO_3)_3(OH)_4 \cdot 6H_2O$

76 **Germanocolusite**: change the reference to *New Mins*. (1997)

76 **Gillespite**: after red add compare **Cuprorivaite, Effenbergerite**, and **Wesselsite**

76 **Gillulyite**: change the reference to *New Mins*. (1997)

77 **Girvasite**: change the reference to *New Mins*. (1997)

79 To follow **Goslarite**:
☐ **Gottardiite**, $Na_3Mg_3Ca_5Al_{19}Si_{117}O_{272} \cdot 93H_2O$, orth., *Zeolite* group, *Mineral. Rec*. **28**, 142 (1997)

80 **Gravegliaite**: change the references to *New Mins*. (1997)

80 **Grossite**: change the reference to *New Mins*. (1997)

81 **Guarinoite**: change the reference to *New Mins*. (1997)

82 **Guilleminite**: change the formula to: $Ba(UO_2)_3(SeO_3)_2O_2(H_2O)_3$; add *Can. Min*. **33**, 1103–1109 (1995)

82 **Gyrolite**: after **Orlymanite**, add and **Tungusite**

83 **Hakite**: delete Ag from formula; i.e., $(Cu,Hg)_{12}Sb_4(Se,S)_{13}$

83 To follow **Hammarite**:
☐ **Hanawaltite**, $Hg_6^{1+}Hg^{2+}[Cl,(OH)]_2O_3$, orth., black to very dark brown-black, *Mineral. Rec*. **27**, 463–464 (1996)

84 **Haradaite**: change the formula to $Sr_2V_2^{4+}O_2(Si_4O_{12})$, add *N. Jb. Min. Mh*. **1995**, 281–288; also change *Suzukiite* to **Suzukiite**

84 **Harrisonite**: change the reference to *New Mins*. (1997)

85 **Haynesite**: change the reference to *New Mins*. (1997)

87 **Hennomartinite**: after **Lawsonite**, add and **Noélbensonite;** change the references to *New Mins*. (1997)

88 **Hibbingite**: change the reference to *New Mins*. (1997)

88 **Hilairite**: after **Calciohilairite** add **Pyatenkoite-(Y)**, and **Sazykinaite-(Y)**

89 **Høgtuvaite**: change the reference to *New Mins*. (1997)

90 **Huangite**: change the reference to *New Mins*. (1997)

91 **Hunchunite**: change the reference to *New Mins*. (1997)

93 **Hydroxycancrinite**: change the reference to *New Mins*. (1997)

94 To follow Hypersthene:
☐ **Hyttsjöite**, $Pb_{18}Ba_2Ca_5Mn_2^{2+}Fe_2^{3+}Si_{30}O_{90}Cl \cdot 6H_2O$, trig., *Mineral. Rec*. **28**, 221 (1997)

96 To follow **Insizwaite**:
☐ **Intersilite**, $Na_6Mn^{2+}Ti[Si_{10}O_{24}(OH)](OH)_3 \cdot 4H_2O$, mon., yellow to pink, *Mineral. Rec*. **28**, 221 (1997)

97 **Iowaite**: after (1994) add **79**, 1014 (1994)

98 **Isokite**: change the formula to $CaMg(PO_4)F$

98 **Isomertieite**: change the formula to $Pd_{11}Sb_2As_2$

99 To precede **Jacobsite**:
☐ **Jáchymovite**, $(UO_2)_8(SO_4)(OH)_{14} \cdot 13H_2O$, mon., yellow, compare **Uranopilite** and **Meta-uranopilite**, *Mineral. Rec*. **28**, 142–143 (1997)

99 **Jahnsite-(CaMnFe)**: change the formula to $CaMn^{2+}Fe_2^{2+}Fe_2^{3+}(PO_4)_4(OH)_2 \cdot 8H_2O$

99 **Jahnsite-(CaMnMg)**: change the formula to $CaMn^{2+}(Mg,Fe^{2+})_2Fe_2^{3+}(PO_4)_4(OH)_2 \cdot 8H_2O$

99 **Jahnsite-(CaMnMn)**: change the reference to *New Mins*. (1997)

99 To follow **Janhaugite**:
☐ **Jankovićite**, $Tl_5Sb_9(As,Sb)_4S_{22}$, tric., black, *Mineral. Rec*. **27**, 302 (1996)

99 **Jarlite**: change the formula to $Na_2(Sr,Na,\square)_{14}(Mg,\square)_2$-$Al_{12}F_{64}(OH,H_2O)_4$ and add *Can. Min*. **21**, 553–560 (1983)

100 To follow **Jennite**:
☐ **Jensenite**, $Cu_3^{2+}Te^{6+}O_6 \cdot 2H_2O$, mon., emerald green, *Mineral. Rec*. **27**, 464 (1996)

100 To follow **Jensenite**:
☐ **Jentschite**, $TlPbAs_2SbS_6$, mon., black to dark red, compare **Edenharterite**

100 **Jianshuiite**: change the reference to *New Mins*. (1997)

101 **Joesmithite**: change the last reference to **73**, 843–844 (1988)

101 **Johninnesite**: change the formula to $Na_2Mn_9^{2+}(Mg,Mn^{2+})_7(OH)_8(AsO_4)_2(Si_6O_{17})_2$; after (1988), add **79**, 991–995 (1994)

102 **Jolliffeite**: change the reference to *New Mins.* (1997)

102 To follow **Jordisite**:
☐ **Jørgensenite**, $Na_2(Sr,Ba)_{14}Na_2Al_{12}F_{64}(OH,F)_4$, mon., compare **Jarlite**, *Can. Min.* **35**, 175–179 (1997)

102 To follow **Jouravskite**:
☐ **Juabite**, $Fe^{2+}Cu_{10}(Te^{4+}O_3)_4(As^{5+}O_4)_4(OH)_2\cdot 4H_2O$, tric., emerald-green to lighter green, *Min. Mag.* **61**, 139–144 (1997)

103 **Kalipyrochlore**: change the formula to $(K,Sr)_{2-x}Nb_2O_6(O,OH)\cdot nH_2O$ and after (1994) add **80**, 407 (1995)

104 **Kamphaugite-(Y)**: change the reference to *New Mins.* (1997)

104 **Kanemite**: change the formula to $NaSi_2O_5\cdot 3H_2O$

105 **Karasugite**: change the reference to *New Mins.* (1997)

105 **Kawazulite**: change the formula to $Bi_2(Te,Se,S)_3$

107 **Keyite**: change the formula to $Cu_3^{2+}(Zn,Cu^{2+})_4Cd_2(AsO_4)_6(H_2O)_2$; after 1977 add *Can. Min.* **34**, 623–630 (1996)

107 **Keystoneite**: change the formula to $Mg_{0.50}[Ni^{2+}Fe^{3+}(TeO_3)_3]\cdot 4.5H_2O$; add *Eur. J. Min.*, **7**, 509–523 (1995)

107 **Khanneshite**: after hex. change "compare **Burbankite** and **Remondite-(Ce)**" to "compare **Burbankite**, **Calcioburbankite**, **Petersenite-(Ce)** and **Remondite-(Ce)**"

107 **Kharaelakhite**: change subscript 4 to subscript 9, i.e. $(Pt,Cu,Pb,Fe,Ni)_9S_8$

107 **Khristovite-(Ce)**: after *Epidote* group add *New Mins.* (1997)

107 **Kieftite**: change the reference to *New Mins.* (1997)

108 **Kinichilite**: change the formula to $Mg_{0.5}[Mn^{2+}Fe^{3+}(TeO_3)_3]\cdot 4.5H_2O$, add *Eur. J. Min.*, **7**, 509–523 (1995)

108 To follow **Kinoshitalite**:
☐ **Kintoreite**, $PbFe_3^{3+}(PO_4)_2(OH,H_2O)_6$, trig., cream to yellowish green and brownish yellow, *Alunite* group, compare **Segnitite**, *Mineral. Rec.* **27**, 302–303 (1996)

109 Kleberite: replace the entry with: Kleberite = hydroxylian **Pseudorutile**, **80**, 1077 (1995)

110 **Komkovite**: change the references to *New Mins.* (1997)

110 To follow **Konyaite**:
☐ **Koragoite**, $(Mn^{2+},Fe^{2+})_3(Nb,Mn^{2+})_2(Nb,Ta)_3W_2O_{20}$, mon.

110 **Kornite**: change the reference to *New Mins.* (1997)

111 **Kosnarite**: change the reference to *New Mins.* (1997)

111 **Kovdorskite**: change the formula to $Mg_5(PO_4)_2(CO_3)(OH)_2\cdot 4.5H_2O$

111 To follow **Kraisslite**:
☐ **Krasnovite**, $Ba(Al,Mg)(PO_4,CO_3)(OH)_2\cdot H_2O$, orth., pale blue, *Mineral. Rec.* **28**, 221–222 (1997)

112 **Kröhnkite**: make **(Kroehnkite)** not-BOLD: (Kroehnkite)

112 To follow **Ktenasite**:
☐ **Kukharenkoite-(Ce)**, $Ba_2Ce(CO_3)_3F$, mon., *Eur. J. Min.* **8**, 1327–1336 (1996)

112 **Kukisvumite**: add the reference *New Mins.* (1997)

112 **Kuksite**: add the reference *New Mins.* (1997)

113 To follow **Kurumsakite**:
☐ **Kusachiite**, $CuBi_2O_4$, tet., black, *Mineral. Rec.* **27**, 303 (1996)

113 **Kutnohorite**: the word **with** before **Ankerite** should not be BOLD

113 **Kuznetsovite**: after (1981) add **80**, 188 (1995)

114 **Labuntsovite**: add subscript 7 after (O,OH), i.e. $(K,Ba,Na)(Ti,Nb)(Si,Al)_2(O,OH)_7\cdot H_2O$

115 **Lannonite**: change the formula to $HCa_4Mg_2Al_4(SO_4)_8F_9\cdot 32H_2O$

116 **Lautenthalite**: add superscript 2+ to Cu_4, i.e. $PbCu_4^{2+}(OH)_6(SO_4)_2\cdot 3H_2O$ and change the reference to *New Mins.* (1997)

116 **Lavendulan**: after **Sampleite** add and **Zdenekite**

116 **Lawsonite**: after **Partheite** add compare **Hennomartinite** and **Noélbensonite**

117 **Leakeite**: in the formula, change Fe_2^{2+} to Fe_2^{3+} and change the reference to *New Mins.* (1997)

117 To follow **Leightonite**:
☐ **Leisingite**, $Cu(Mg,Cu,Fe,Zn)_2Te^{6+}O_6\cdot 6H_2O$, trig., yellow to orange-yellow, *Mineral. Rec.* **28**, 222 (1997)

117 To follow **Lemoynite**:
☐ **Lenaite**, $AgFeS_2$, tet., related to the *Chalcopyrite* group, *Mineral. Rec.* **27**, 464 (1996)

117 **Leningradite**: add the reference *New Mins.* (1997)

118 Leucoxene: replace the entry with: Leucoxene = a mixt., **80**, 1077 (1995)

118 **Levyclaudite** change the spelling to **Lévyclaudite** and change the reference to *New Mins.* (1997)

118 **Libethenite**: change orth. to mon.; add *Can. Min.* **33**, 885–888 (1995)

119 **Liebauite**: change the references to *New Mins.* (1997)

119 **Lindqvistite**: change the formula to $Pb_2(Mn^{2+},Mg)Fe_{16}^{3+}O_{27}$ and change the reference to *New Mins.* (1997)

119 **Lintisite**: change the reference to *New Mins.* (1997)

120 **Lishizhenite**: add the reference *New Mins.* (1997)

120 **Lithiomarsturite**: change the reference to *New Mins.* (1997)

120 **Lithiowodginite**: change the reference to *New Mins.* (1997)

122 **Luberoite**: change the reference to *New Mins.* (1997)

122 **Ludlockite**: change the formula to $Pb^{2+}Fe_4^{3+}As_{10}^{3+}O_{22}$; add *Can. Min.* **34**, 79–89 (1996)

122 **Lunijianlaite**: add the reference *New Mins.* (1997)

123 **Lusungite**: delete box, name should not be BOLD; change the entry to:
Lusungite = **Goyazite**, *Min. Mag.* **59**, 143–148 (1995), **80**, 1077 (1995)

124 **Mackinawite**: after (1994) add **80**, 188 (1995)

124 **Macquartite**: change the formula to $Pb_7^{2+}Cu_2^{2+}(CrO_4)_4(SiO_4)_2(OH)_2$; after (1981) add **80**, 408 (1995)

125 To follow **Magnesiocopiapite**:
☐ **Magnesiocoulsonite**, MgV_2O_4, cub., black, compare **Coulsonite**, *Spinel* group, *Mineral. Rec.* **27**, 303 (1996)

125 To follow **Magnesiocummingtonite**:
☐ **Magnesiodumortierite**, $(Mg,Ti,\square)(Al,Mg)_2Al_4Si_3O_{18-y}(OH)_yB$, $y = 2–3$, orth., pink to red, compare **Dumortierite**, *Mineral. Rec.* **27**, 303 (1996)

127 **Mahlmoodite**: change the reference to *New Mins.* (1997)

127 To follow **Mahlmoodite**:
☐ **Mahnertite**, $(Na,Ca)Cu_3^{2+}(AsO_4)_2Cl\cdot 5H_2O$, tet., blue to emerald green

127 To follow **Mäkinenite**:
☐ **Makovickyite**, $Ag_{1.5}Bi_{5.5}S_9$, mon., compare **Mummeite**, **Pavonite**, and **Cupropavonite**, *New Mins.* (1997)

128 **Manaksite**: change the reference to *New Mins.* (1997)

128 **Manandonite**: change (1988) at end to (1989)

129 **Mangangordonite**: add the reference *New Mins.* (1997)

129 **Manganosegelerite**: change the reference to *New Mins.* (1997)

129 **Manganotychite**: add the reference *New Mins.* (1997)

131 Maskelynite: **Plagioclase** should not be BOLD

132 **Maxwellite**: add isostructural with **Titanite**, **Malayaite**, and **Vanadomalayaite**; change the reference to *New Mins.* (1997) and add *N. Jb. Min. Mh.* **1995**, 97–104

132 **Mayenite**: change the A in the formula to Al, i.e. $Ca_{12}Al_{14}O_{33}$

132 To follow **Mayenite**:
☐ **Mayingite**, IrBiTe, cub., steel black, *Mineral. Rec.* **27**, 117–118 (1996)

132 To follow **Mcallisterite**:
☐ **Mcalpineite**, $Cu^{2+}_3Te^{6+}O_6\cdot H_2O$, cub., emerald green, *New Mins.* (1997)

132 To follow **Mcconnellite**:
☐ **Mccrillisite**, $NaCs(Be,Li)Zr_2(PO_4)_4\cdot 1\text{–}2H_2O$, tet., compare **Gainesite** and **Selwynite**, *New Mins.* (1997)

132 **Mcgillite**: change "mon., ps. trig." to trig.

133 To follow **Medaite**:
☐ **Medenbachite**, $Bi_2Fe^{3+}(Cu,Fe^{2+})(O,OH)_2(OH)_2(AsO_4)_2$, tric., yellow to brown-yellow, *Mineral. Rec.* **27**, 464–465 (1996)

133 **Megacyclite**: add the reference *New Mins.* (1997)

134 To follow **Mercury**:
☐ **Mereiterite**, $K_2Fe^{2+}(SO_4)_2\cdot 4H_2O$, mon., pale yellow, compare **Leonite**, *Mineral. Rec.* **27**, 304 (1996)

136 **Metamunirite**: change the reference to *New Mins.* (1997)

137 To follow **Metazeunerite**:
☐ **Meurigite**, $KFe^{3+}_7(PO_4)_5(OH)_7\cdot 8H_2O$, mon., yellowish brown, *Mineral. Rec.* **28**, 143 (1997)

138 To follow **Miharaite**:
☐ **Mikasaite**, $Fe^{3+}_2(SO_4)_3$, trig., white to light brown, compare **Millosevichite**, *New Mins.* (1997)

138 **Mineevite-(Y)**: change the reference to *New Mins.* (1997)

138 **Minehillite**: after **Truscottite** add **Tungusite**

141 **Montesommaite**: change the reference to *New Mins.* (1997)

142 To follow Morganite:
☐ **Morimotoite**, $Ca_3TiFe^{2+}Si_3O_{12}$, cub., black, *Garnet* group, *Mineral. Rec.* **27**, 304 (1996)

142 **Moschelite**: change the formula to $Hg^{1+}_2I_2$

143 **Mozartite**: change the reference to *New Mins.* (1997)

143 **Mrazekite**: change the name to **Mrázekite**; change the reference to *New Mins.* (1997)

143 **Mummeite**: change the reference to *New Mins.* (1997); after **Cupropavonite** add and **Makovickyite**

143 **Murataite**: change the formula to $(Y,Na)_6(Zn,Fe^{3+})_5Ti_{12}O_{29}(O,F)_{10}F_4$ and add the reference *Can. Min.* **33**, 1223–1229 (1995)

145 To follow **Nadorite**:
☐ **Nafertisite**, $Na_3(Fe^{2+},Fe^{3+})_6(Ti_2Si_{12}O_{34})(O,OH)_7\cdot 2H_2O$, mon., light green, *Mineral. Rec.* **28**, 143 (1997)

145 **Nagyagite**: delete (?); after **Buckhornite** add **80**, 188 (1995)

145 **Nalipoite**: change the references to *New Mins.* (1997)

145 **Namansilite**: change the reference to *New Mins.* (1997)

146 **Namibite**: change the formula to $Cu^{2+}(BiO)_2V^{5+}O_4OH$; add **80**, 1076–1077 (1995)

146 **Namuwite**: change the crystal system to trig.

147 **Natronambulite**: change the last reference to **72**, 224 (1987)

147 **Natrotantite**: change the entry to:
☐ **Natrotantite**, $Na_2Ta_4O_{11}$, trig., *Bull. Min.* **108**, 541–549 (1985)

147 To follow **Natrotantite**:
☐ **Natroxalate**, $Na_2C_2O_4$, mon., pink or greenish yellow, *Mineral. Rec.* **28**, 222 (1997)

147 To follow **Navajoite**:
☐ **Nchwaningite**, $Mn^{2+}_2SiO_3(OH)_2\cdot H_2O$, orth., light brown, structurally related to the *Pyroxene* group, *Mineral. Rec.* **27**, 203–204 (1996)

148 To follow **Neyite**:
☐ **Nežilovite**, $PbZn_2(Mn^{4+},Ti^{4+})_2Fe^{3+}_8O_{19}$, hex., black, *Magnetoplumbite* group, *Can. Min.* **34**, 1287–1297 (1996)

149 **Nickeline**: **(Niccolite)** should not be BOLD, i.e. (Niccolite)

149 **Nickenichite**: change the reference to *New Mins.* (1997)

149 To follow **Nickenichite**:
☐ **Nierite**, Si_3N_4, trig., *Mineral. Rec.* **27**, 118–119 (1996)

150 To follow **Nobleite**:
☐ **Noélbensonite**, $BaMn^{3+}_2(Si_2O_7)(OH)_2\cdot H_2O$, orth., dark brown, compare **Lawsonite** and **Hennomartinite**, *Mineral. Rec.* **27**, 465 (1996)

151 **Nordite-(Ce)**: add reference **51**, 152 (1966)

153 To follow **Odinite**:
☐ **Odintsovite**, $K_2Na_4Ca_3Ti_2Be_4Si_{12}O_{38}$, orth., cols. to pink

153 **Okanoganite-(Y)**: after trig add compare **Vicanite-(Ce)**

153 **Oldhamite**: change the formula to (Ca,Mg,Fe,Mn)S; add *Min. Mag.* **37**, 144–145 (1969)

153 **Olekminskite**: change the reference to *New Mins.* (1997)

154 Oligoclase: **Plagioclase** should not be BOLD

154 **Olivenite**: change orth. to mon.; add *Can. Min.* **33**, 885–888 (1995)

154 *Olivine*: should not be in italics

154 To follow Olivine:
☐ **Olkhonskite**, $(Cr^{3+},V^{3+})_2Ti_3O_9$, mon., black, compare **Schreyerite**, *New Mins.* (1997)

154 **Olympite**: change the formula to $LiNa_5(PO_4)_2$; after (1981) add **80**, 408 (1995)

155 **Orlymanite**: change the reference to *New Mins.* (1997)

155 **Orschallite**: change the reference to *New Mins.* (1997)

156 To follow **Orthoserpierite**:
☐ **Orthowalpurgite**, $(UO_2)Bi_4O_4(AsO_4)_2\cdot 2H_2O$, orth., pale yellow, dimorph. with **Walpurgite**, *Mineral. Rec.* **27**, 465 (1996)

156 To follow **Otwayite**:
☐ **Oulankaite**, $(Pd,Pt)_5(Cu,Fe)_4SnTe_2S_2$, tet., *Mineral. Rec.* **27**, 465–466 (1996)

156 To follow **Overite**:
☐ **Owensite**, $(Ba,Pb)_6(Cu,Fe,Ni)_{25}S_{27}$, cub., compare **Djerfisherite** and **Thalfenisite**, *Mineral. Rec.* **27**, 119 (1996)

157 **Padmaite**: change the reference to *New Mins.* (1997)

157 **Pahasapaite**: in the references, delete 1495

158 **Parachrysotile**: change the formula to $Mg_3Si_2O_5(OH)_4$

158 **Parafransoletite**: change the reference to *New Mins.* (1997)

159 **Parakhinite**: change the formula to $Cu^{2+}_3PbTe^{6+}O_6(OH)_2$; change hex. to trig.; add **80**, 1077 (1995)

159 **Paranatisite**: change the reference to *New Mins.* (1997)

159 **Paranite-(Y)**: change the name to **Paraniite-(Y)**; change the reference to *New Mins.* (1997)

160 **Parisite-(Ce)**: change the last statement to: the following polytypes are known: **-3*R***, **-4*H***, **-6*R***, **-8*H***, **-10*H***, **-16*H***, **-42*R***, **-48*R***

161 **Parkinsonite**: change the reference to *New Mins.* (1997)

161 **Pavonite**: after **Cupropavonite** add and **Makovickyite**

162 To follow Pennine:
☐ **Penobsquisite**, $Ca_2Fe^{2+}[B_9O_{13}(OH)_6]Cl\cdot 4H_2O$, mon., pale yellow, *Mineral. Rec.* **28**, 143–144 (1997)

163 **Peprossiite-(Ce)**: change the references to *New Mins.* (1997)

163 **Perraultite**: change the reference to *New Mins.* (1997)

163 **Perroudite**: change the formula to $Hg_{5-x}Ag_{4+x}S_{5-x}(Cl,I,Br)_{4+x}$

164 To follow **Petedunnite**:
☐ **Peterbaylissite**, $Hg^{1+}_3(CO_3)(OH)\cdot 2H_2O$, orth., black to very dark red-brown, *Mineral. Rec.* **27**, 119 (1996)

164 **Petersenite-(Ce)**: after mon. add compare **Burbankite**, **Calcioburbankite**, **Khanneshite** and **Remondite-(Ce)**; change the reference to *New Mins.* (1997)

164 **Petitjeanite**: change the formula to $Bi^{3+}_3(PO_4)_2O(OH)$; change the reference to *New Mins.* (1997)

165 **Phosinaite**: change the name to **Phosinaite-(Ce)**; change the formula to $Na_{13}Ca_2Ce[Si_4O_{12}](PO_4)_4$; add *Can. Min.* **34**, 107–114 (1996)

166 To follow **Pinchite**:
☐ **Pingguite**, $Bi^{3+}_6Te^{4+}_2O_{13}$, orth., yellowish-green, *New Mins.* (1997)

166 To follow **Pintadoite**:
☐ **Piretite**, $Ca(UO_2)_3(SeO_3)_2(OH)_4\cdot 4H_2O$, orth., lemon yellow, *Can. Min.* **34**, 1317–1322 (1996)

166 **Pitiglianoite**: change the reference to *New Mins.* (1997)

167 **Plombierite**: add compare **Tobermorite** and **Clinotobermorite**

168 **Plumboferrite**: change the entry to:
☐ **Plumboferrite**, $Pb_2(Mn^{2+},Mg)_{0.33}Fe^{3+}_{10.67}O_{18.33}$, hex., black, **80**, 1065–1072 (1995)

168 **Poitevinite**: change the entry to:
☐ **Poitevinite**, $(Cu^{2+},Fe^{2+},Zn)SO_4\cdot H_2O$, tric., salmon-colored, **50**, 263 (1965), *Can. Min.* **32**, 873–884 (1994)

168 **Poldervaartite**: in the formula, change (Si_3OH) to (SiO_3OH); change the reference to *New Mins.* (1997)

169 **Polyphite**: change the reference to *New Mins.* (1997)

169 **Potassium-fluor-richterite**: change the reference to *New Mins.* (1997)

170 **Povondraite**: change the reference to *New Mins.* (1997)

170 **Pringleite**: change the reference to *New Mins.* (1997)

171 Pseudorutile: replace the entry with:
☐ **Pseudorutile**, $Fe^{3+}_2Ti_3O_9$, hex., black, brown, red, and grey, *Min. Mag.* **58**, 597–600 (1994), **80**, 1077 (1995)

172 To follow **p-Veatchite**:
☐ **Pyatenkoite-(Y)**, $Na_5(Y,Dy,Gd)TiSi_6O_{18}\cdot 6H_2O$, trig., compare **Sazykinaite-(Y)**, **Hilairite** and **Calciohilairite**, *Mineral. Rec.* **28**, 222–223 (1997)

174 **Qilianshanite**: change the reference to *New Mins.* (1997)

174 **Quadridavyne**: change the reference to *New Mins.* (1997)

174 **Quadruphite**: change the reference to *New Mins.* (1997)

175 **Rabejacite**: change the reference to *New Mins.* (1997)

175 **Radtkeite**: change the reference to *New Mins.* (1997)

176 **Rankinite**: change the formula to $Ca_3Si_2O_7$

176 **Ravatite**: change the reference to *New Mins.* (1997)

176 To follow **Redledgeite**:
☐ **Reederite-(Y)**, $Na_{15}Y_2(CO_3)_9(SO_3F)Cl$, hex., yellow to orange-brown, *Mineral. Rec.* **27**, 304–305 (1996)

177 **Remondite-(Ce)**: after red-orange, change "compare **Burbankite**, **Khanneshite**: to "compare **Burbankite**, **Calcioburbankite**, **Khanneshite** and **Petersenite-(Ce)**"

177 **Reppiaite**: change the references to *New Mins.* (1997)

177 **Reyerite**: after **Truscottite**, add and **Tungusite**,

177 Rezbanyite: change the entry to: Rezbanyite, a mixt., **77**, 1308–1309 (1992), **80**, 409 (1995)

178 **Rhomboclase**: change the entry to:
☐ **Rhomboclase**, $(H_5O_2)^{1+}Fe^{3+}(SO_4)_2\cdot 2H_2O$, orth., **80**, 408 (1995)

178 **Rhönite**: change the formula to: $Ca_2(Mg,Fe^{2+},Fe^{3+},Ti)_6(Si,Al)_6O_{20}$; add the reference *Eur. J. Min.* **2**, 203–218 (1990)

179 To follow **Rilandite**:
☐ **Rimkorolgite**, $Mg_5Ba(PO_4)_4\cdot 8H_2O$, orth., ps. hex., yellow-brown to light pink, *Mineral. Rec.* **27**, 305 (1996)

179 **Robertsite**: change the formula to $Ca_6Mn^{3+}_9(PO_4)_9O_6(H_2O)_6\cdot 3H_2O$ and add the reference *Min. Mag.* **52**, 505–508 (1988)

180 **Roggianite**: change the fourth reference to *N. Jb. Min. Mh.* **1991**, 307–314

180 **Romanechite**: change the formula to $(Ba,H_2O)_2(Mn^{4+},Mn^{3+})_5O_{10}$

180 **Rorisite**: change the reference to *New Mins.* (1997)

181 **Rosenbergite**: change the reference to *New Mins.* (1997)

181 **Roshchinite**: add the reference *New Mins.* (1997)

181 To follow **Roshchinite**:
☐ **Rosiaite**, $PbSb^{5+}_2O_6$, trig., cols. to pale yellow, *Mineral. Rec.* **28**, 144 (1997)

182 **Rouvilleite**: change the references to *New Mins.* (1997)

182 **Ruitenbergite**: change the reference to *New Mins.* (1997)

184 **Sabatierite**: change the formula to Cu_6TlSe_4

184 To follow **Sabatierite**:
☐ **Sabelliite**, $(Cu,Zn)_2Zn[(As,Sb)O_4](OH)_3$, trig., emerald-green, *Mineral. Rec.* **27**, 305 (1996)

184 **Sakhaite**: change the formula to $Ca_{12}Mg_4(BO_3)_7(CO_3)_4Cl(OH)_2\cdot H_2O$

185 **Saliotite**: add the reference *New Mins.* (1997)

185 **Samarskite**: change the name to **Samarskite-(Y)**, delete the last reference and change the formula to $(Y,Ce,U,Fe^{3+})_3(Nb,Ta,Ti)_5O_{16}$

185 **Samfowlerite**: change the reference to *New Mins.* (1997)

185 **Sampleite**: after **Lavendulan** add **Zdenekite**

186 **Sapphirine**: combine the hyphen at the end of the first line with **4*M***

186 **Sasaite**: change the formula to $(Al,Fe^{3+})_6[(PO_4),(SO_4)]_5(OH)_3\cdot 35\text{–}36H_2O$ and add the reference *Can. Min.* **21**, 497 (1983)

187 To follow **Sazhinite-(Ce)**:
☐ **Sazykinaite-(Y)**, $Na_5YZrSi_6O_{18}\cdot 6H_2O$, trig., light green to yellow, compare **Hilairite**, **Calciohilairite**, and **Pyatenkoite-(Y)**, *New Mins.* (1997)

188 **Schmiederite**: change the year in the last reference from (1987) to (1988)

188 **Schoepite**: change the formula to $[(UO_2)_8O_2(OH)_{12}](H_2O)_{12}$; after (1960) add *Can. Min.* **34**, 1071–1088 (1996)

189 **Schreyerite**: after **Kyzylkumite** add compare **Olkhonskite**

189 To follow Schwatzite:
☐ **Schwertmannite**, $Fe^{3+}_{16}O_{16}(OH)_{12}(SO_4)_2$, tet., brownish yellow, probably related to **Akaganéite** and **Hollandite**, *New Mins.* (1997)

190 **Seelite**: change the formula to $Mg(UO_2)_2(AsO_3)_{1.4}(AsO_4)_{0.6}\cdot 7H_2O$; change the reference to *New Mins.* (1997)

190 **Segnitite**: change the reference to *New Mins.* (1997)

191 To follow **Sellaite**:
☐ **Selwynite**, $NaK(Be,Al)Zr_2(PO_4)_4\cdot 2H_2O$, tet., deep purplish blue, compare **Gainesite** and **Mccrillisite**, *Mineral. Rec.* **27**, 120 (1996)

192 To follow **Shandite**:
☐ **Shannonite**, Pb_2OCO_3, orth., *Mineral. Rec.* **27**, 305–306 (1996)

192 To follow **Shcherbinaite**:
☐ **Sheldrickite**, $NaCa_3(CO_3)_2F_3 \cdot H_2O$, trig., *Can. Min.* **35**, 181–187 (1997)

192 **Shigaite**: change the formula to $[AlMn^{2+}_2(OH)_6]_3(SO_4)_2$-$Na(H_2O)_6\{H_2O\}_6$; add *Can. Min.* **34**, 91–97 (1996)

192 To follow **Shigaite**:
☐ **Shkatulkalite**, $Na_{10}Mn^{2+}Ti_3Nb_3(Si_2O_7)_6(OH)_2F \cdot 12H_2O$, mon., *Mineral. Rec.* **28**, 223 (1997)

192 **Shomiokite-(Y)**: change the reference to *New Mins.* (1997)

192 To follow **Shortite**:
☐ **Shuangfengite**, $IrTe_2$, trig., black, *New Mins.* (1997)

193 To follow **Sieleckiite**:
☐ **Sigismundite**, $(Ba,K,Pb)Na_3(Ca,Sr)(Fe^{2+},Mg,Mn)_{14}Al$-$(OH)_2(PO_4)_{12}$, mon., compare **Arrojadite** and **Dickinsonite**, *Mineral. Rec.* **28**, 223 (1997)

193 **Silinaite**: change the references to *New Mins.* (1997)

193 **Silver**: the hyphen should not be on a separate line from the rest of the polytype suffix ***-2H***

194 **Sitinakite**: change the reference to *New Mins.* (1997)

194 **Sklodowskite**: change the formula to $(H_3O)_2Mg(UO_2)_2(SiO_4)_2 \cdot 4H_2O$

195 To follow **Smolianinovite**:
☐ **Smrkovecite**, $Bi_2O(OH)(PO_4)$, mon., white to yellow, compare **Atelestite**, *Mineral. Rec.* **28**, 144–145 (1997)

195 **Smythite**: after (1994) add **80**, 188 (1995)

197 **Sorensenite**: change the name to **Sørensenite**

197 To follow **Spessartine**:
☐ **Sphaerobismoite**, Bi_2O_3, tet., green, yellowish, grey, dimorph with **Bismite**, *Mineral. Rec.* **28**, 223–224 (1997)

198 **Squawcreekite**: change the formula to $(Fe^{3+},Sb^{5+},Sn^{2+})O_2$; change **Tripuhyite** to **Cassiterite** and change the reference to *New Mins.* (1997)

198 **Stalderite**: change the formula to $TlCu(Zn,Fe,Hg)_2As_2S_6$ and change the reference to *Mineral. Rec.* **27**, 466 (1996)

198 Staringite: after (1994) add **80**, 188 (1995)

200 **Stibiocolusite**: change the reference to *New Mins.* (1997)

201 **Straczekite**: change the formula to $(Ca,K,Ba)_2(V^{5+},V^{4+})_8O_{20} \cdot 3H_2O$

201 To follow Straetlingite:
☐ **Strakhovite**, $NaBa_3(Mn^{2+},Mn^{3+})_4Si_6O_{19}(OH)_3$, orth., greenish black, *New Mins.* (1997)

201 **Stranskiite**: change the formula to $Zn_2Cu^{2+}(AsO_4)_2$

202 Strontiohilgardite: change **Tyretskite-1Tc** to **Tyretskite-1*A***

202 **Strontiopiemontite**: change the references to *New Mins.* (1997)

202 **Strontiowhitlockite**: change the references to *New Mins.* (1997)

202 To follow **Struvite**:
☐ **Studenitsite**, $NaCa_2[B_9O_{14}(OH)_4] \cdot 2H_2O$, mon., cols. to light yellow, *Mineral. Rec.* **27**, 466 (1996)

203 **Sulphotsumoite**: change the formula to Bi_3Te_2S

204 **Sussexite**: change "orth. or mon., ps. orth." to "mon."

204 **Swaknoite**: change the reference to *New Mins.* (1997)

205 **Synchysite-(Ce)**: change orth. to mon.; add **80**, 1077 (1995)

205 **Szenicsite**: change the reference to *New Mins.* (1997)

205 **Szymanskiite**: change the name to **Szymańskiite**, change the references to *New Mins.* (1997)

206 To follow **Takanelite**:
☐ **Takedaite**, $Ca_3B_2O_6$, trig., *Mineral. Rec.* **27**, 306 (1996)

207 **Tangeite**: after (1994) add **80**, 185–186 (1995)

209 **Tetrarooseveltite**: change the reference to *New Mins.* (1997)

210 **Thalenite**: change the formula to $Y_3Si_3O_{10}(OH)$ and remove the question mark after the formula

210 **Thalfenisite**: after **Djerfisherite** add **Owensite**

210 **Thaumasite**: after hex., add *Ettringite* group

210 **Theresmagnanite**: change the reference to *New Mins.* (1997)

211 **Tiettaite**: change the reference to *New Mins.* (1997)

211 **Tilasite**: after **Maxwellite** add and with **Durangite**

212 **Titanite**: after **Malayaite** add and **Vanadomalayaite**

212 **Titanowodginite**: change the references to *New Mins.* (1997)

213 **Tobermorite**: after **Clinotobermorite** add compare **Plombierite**

213 **Tooeleite**: change the reference to *New Mins.* (1997)

214 **Tounkite**; change the reference to *New Mins.* (1997)

214 **Toyohaite**: change the reference to *New Mins.* (1997)

214 **Trembathite**: change the reference to *New Mins.* (1997)

215 **Trimounsite-(Y)**: change the references to *New Mins.* (1997)

216 **Tsaregorodtsevite**: add the reference *New Mins.* (1997)

216 **Tschernichite**: change the formula to: $(Ca,Na)(Si_6Al_2)$-$O_{16} \cdot 4$–$8H_2O$ and change the reference to *New Mins.* (1997)

216 **Tsnigriite**: change the reference to *New Mins.* (1997)

217 **Tuliokite**: change the formula to $BaNa_6Th(CO_3)_6 \cdot 6H_2O$ and change the references to *New Mins.* (1997)

217 To follow **Tungstenite**:
☐ **Tungstibite**, $Sb_2O_3 \cdot WO_3$, orth., green, *Mineral. Rec.* **27**, 394 (1996)

217 **Tungusite**: replace the entry with the following:
☐ **Tungusite**, $Ca_{14}(OH)_8(Si_8O_{20})_3Fe^{2+}_9(OH)_{14}$, tric., green, structurally related to **Gyrolite** and **Reyerite**, **52**, 927–928 (1967), *Min. Mag.* **59**, 535–543 (1995)

217 **Tuperssuatsiaite**: change the formula to $NaFe^{3+}_3Si_8O_{20}(OH)_2 \cdot 4H_2O$

218 **Tuzlaite**: change the reference to *New Mins.* (1997)

218 **Tvedalite**: change the reference to *New Mins.* (1997)

219 To follow **Umohoite**:
☐ **Ungarettiite**, $NaNa_2(Mn^{2+}_2Mn^{3+}_3)Si_8O_{22}O_2$, mon., red, *Amphibole* group, *Mineral. Rec.* **27**, 394 (1996)

220 **Uranopolycrase**: change the reference to *New Mins.* (1997)

221 **Uranotungstite**: change the first part of the formula from (Ba,Pb,Fe^{2+}) to (Fe^{2+},Ba,Pb)

222 To follow **Vanadinite**:
☐ **Vanadomalayaite**, $CaVOSiO_4$, mon., deep red, compare **Malayaite** and **Titanite**, *New Mins.* (1997)

222 To follow **Vanuranylite**:
☐ **Varennesite**, $Na_8Mn^{2+}_2Si_{10}O_{25}(OH,Cl)_2 \cdot 12H_2O$, orth., pale brownish yellow to orange, *Mineral. Rec.* **27**, 306 (1996)

222 Varlamoffite: add the following: may be a valid species with formula $Sn_2Fe^{3+}O_5(OH)$, **80**, 850 (1995)

223 **Vasilite**: change the reference to *New Mins.* (1997)

224 To follow **Veszelyite**:
☐ **Viaeneite**, $(Fe,Pb)_4S_8O$, mon., yellow, *Mineral. Rec.* **28**, 224 (1997)

224 To follow **Viaeneite**:
☐ **Vicanite-(Ce)**, $(Ca,Ce,La,Th)_{15}As^{5+}(As^{3+}_{0.5}Na_{0.5})Fe^{3+}Si_6B_4O_{40}F_7$, trig., yellowish green, compare **Okanoganite-(Y)**, *Mineral. Rec.* **27**, 394 (1996)

225 **Vistepite**: after mon. add orange-yellow, change the reference to *New Mins.* (1997)

225 To follow **Vlasovite**:
☐ **Vlodavetsite**, $AlCa_2(SO_4)_2F_2Cl\cdot 4H_2O$, tet., *Min. Mag.* **59**, 159–162 (1995)

225 **Vochtenite**: change the second Fe^{2+} to Fe^{3+}, i.e., $(Fe^{2+},Mg)Fe^{3+}[(UO_2)(PO_4)]_4(OH)\cdot 12–13H_2O$

225 **Voggite**: change the reference to *New Mins.* (1997)

225 Volfsonite: change the year in the reference from (1985) to (1988)

226 **Vonbezingite**: change the reference to *New Mins.* (1997)

226 **Vyalsovite**: change the reference to *New Mins.* (1997)

227 **Wadeite**: change the formula to $K_2ZrSi_3O_9$; after (1940) add *Min. Mag.* **30**, 585 (1955)

227 **Walthierite**: change the reference to *New Mins.* (1997)

228 **Warwickite**: change the formula to $Mg(Ti,Fe^{3+},Al)(BO_3)O$; after orth. add compare **Yuanfuliite**

228 **Watanabeite**: change the reference to *New Mins.* (1997)

228 **Wattersite**: change the reference to *New Mins.* (1997)

228 **Wawayandaite**: change the reference to *New Mins.* (1997)

229 **Weinebeneite**: change the references to *New Mins.* (1997)

229 **Werdingite**: change the references to *New Mins.* (1997)

229 **Wermlandite**: after (1984) add **80**, 408 (1995)

229 To follow Wernerite:
☐ **Wesselsite**, $SrCu^{2+}Si_4O_{10}$, tet., blue, compare **Gillespite**, **Cuprorivaite**, and **Effenbergerite**, *Mineral. Rec.* **28**, 145 (1997)

230 **Wherryite**: after (1994) add **80**, 408 (1995)

230 **Whitlockite**: change the formula to:
$Ca_9(Mg,Fe^{2+})(PO_4)_6(PO_3OH)$

230 **Wickenburgite**: change hex. to trig.; add **80**, 850 (1995)

230 **Widgiemoolthalite**: change the reference to *New Mins.* (1997)

231 **Wilkinsonite**: change the reference to *New Mins.* (1997)

232 **Wolframite**: delete box and make name non-BOLD

232 To follow **Wülfingite**:
☐ **Wupatkiite**, $(Co,Mg,Ni)Al_2(SO_4)_4\cdot 22H_2O$, mon., rose, *Halotrichite* group, *Mineral. Rec.* **27**, 394–395 (1996)

232 To follow **Wyartite**:
☐ **Wycheproofite**, $NaAlZr(PO_4)_2(OH)_2\cdot H_2O$, tric., pale pinkish orange to pale brownish orange, *New Mins.* (1997)

232 **Wyllieite**: change **Quingheiite** to **Qingheiite**

233 **Xingzhongite**: change the formula to $(Pb,Cu,Fe)(Ir,Pt,Rh)_2S_4$

234 **Yagiite**; change the page numbers in the reference to 14–18

234 **Yanomamite**: change the reference to *New Mins.* (1997)

234 **Yingjiangite**: change the reference to *New Mins.* (1997)

235 To follow **Yttrotungstite-(Y)**:
☐ **Yuanfuliite**, $(Mg,Fe^{2+})(Fe^{3+},Al,Mg,Ti,Fe^{2+})(BO_3)O$, orth., compare **Warwickite**, *New Mins.* (1997)

235 To follow **Yuanfuliite**:
☐ **Yuanjiangite**, AuSn, hex., silver white, compare **Nickeline**, *New Mins.* (1997)

236 To follow **Zairite**:
☐ **Zajacite**, $Na(REE_xCa_{1-x})(REE_yCa_{1-y})F_6$ where $x \neq y$, trig., cols. to pale pink, *Can. Min.* **34**, 1299–1304 (1996)

236 **Zanazziite**: change the reference to *New Mins.* (1997)

236 To follow **Zavaritskite**:
☐ **Zdenekite**, $NaPbCu_5(AsO_4)_4Cl\cdot 5H_2O$, tet., turquoise blue, compare **Lavendulan** and **Sampleite**, *Mineral. Rec.* **27**, 395 (1996)

236 **Zemannite**: change the formula to $Mg_{0.5}[Zn^{2+}Fe^{3+}(TeO_3)_3]\cdot 4.5H_2O$, add *Eur. J. Min.*, **7**, 509–523 (1995)

236 **Zenzenite** change the name to **Zenzénite** and change the references to *New Mins.* (1997)

238 **Zippeite**: change the entry to:
☐ **Zippeite**, $K(UO_2)_2(SO_4)(OH)_3\cdot H_2O$, mon., yellow, *Can. Min.* **14**, 429–436 (1976), *Can. Min.* **33**, 1091–1101 (1995)

238 **Zirconolite**: replace the entry with:
☐ **Zirconolite**, $CaZrTi_2O_7$, orth., mon., trig. and metamict, polytypes ***-3O***, ***-3T***, ***-2M***, black to brown, compare **Polymignite**, **68**, 262–276 (1983)

238 Zirconolite: delete entire entry

238 **Zirkelite**: replace the entry with:
☐ **Zirkelite**, $(Ca,Th,Ce)Zr(Ti,Nb)_2O_7$, trig., dimorph. with **Calciobetafite**, related to the *Pyrochlore* group, compare **Polymignite**, **68**, 262–276 (1983)

238 To follow **Zirsinalite**:
☐ **Zlatogorite**, $CuNiSb_2$, hex., silver white, *Mineral. Rec.* **27**, 395 (1996)

238 **Znucalite**: change the reference to *New Mins.* (1997)

MINERAL GROUPS

240 *Alunite Group*
Add: **Kintoreite**, $PbFe^{3+}_3(PO_4)_2(OH,H_2O)_6$

243 *Amphibole Group*
Add: **Fluor-cannilloite**, $CaCa_2(Mg_4Al)(Si_5Al_3)O_{22}F_2$
Add: **Fluor-ferro-leakeite**, $NaNa_2(Fe^{2+}_2Fe^{3+}_2Li)Si_8O_{22}F_2$
Add: **Ungarettiite**, $NaNa_2(Mn^{2+}_2Mn^{3+}_3)Si_8O_{22}O_2$

243 *Apatite Group*
Change the species names in the last three lines to **BOLD**: **Britholite-(Ce)**, **Britholite-(Y)**, **Fluorbritholite-(Ce)**, **Chlorellestadite**, **Fluorellestadite**, **Hydroxylellestadite**, and **Mattheddleite** are silicates that are isostructural with members of the Apatite group; so is the sulfate **Cesanite**.

245 *Barite Group*
In the second line, insert a comma after Cr^{6+}

245 *Beudantite Group*
In the second line, insert Ga after Fe^{3+}
In the third line, insert a comma after As^{5+}
Add: **Gallobeudantite**, $PbGa_3[(AsO_4),(SO_4)]_2(OH)_6$

246 *Brackebushite Group*
After the last line add **Fornacite** and **Vauquelinite** are structurally related to the members of this group.

247 *Chalcopyrite Group*
After the last line add **Lenaite** is a related mineral.

248 *Chlorite Group*
Change the species name in the last line to **BOLD**: Compare **Franklinfurnaceite**.

249 *Crandallite Group*
Add: **Benauite**, $HSrFe^{3+}_3(PO_4)_2(OH)_6$

250 *Descloizite Group*
In the second line, insert a comma after As^{5+}

250 *Dolomite Group*
In the second line, insert commas after Mg and Mn^{2+}
Change the species names in the last line to **BOLD**: Isostructural with the borates **Nordenskiöldine** and **Tusionite**.

251 *Epidote Group*
Add: **Androsite-(La)**, $(Mn,Ca)(La,Ce,Ca,Nd)Al$-$Mn^{3+}Mn^{2+}(SiO_4)(Si_2O_7)O(OH)$

253 *Gadolinite Group*
Change the species names in the last two lines to **BOLD**: The phosphates **Drugmanite**, **Herderite**, and **Hydroxylherderite** and the arsenate **Bergslagite** are structurally related to the silicates of this group.

253 *Garnet Group*
Add: **Morimotoite**, $Ca_3TiFe^{2+}Si_3O_{12}$
Change the species names in the last three lines to **BOLD**: The tellurate **Yafsoanite**, the arsenates **Berzeliite** and **Manganberzeliite**, the vanadate **Palenzonaite**, and the halide **Cryolithionite** are isostructural with the minerals of the Garnet group. **Henritermierite** is a related mineral.

253 *Halotrichite Group*
Add: **Wupatkiite**, $(Co,Mg,Ni)Al_2(SO_4)_4 \cdot 22H_2O$

255 *Hydrotalcite Group*
Change the species names in the last two lines to **BOLD**: **Meixnerite** and the sulfates **Honessite** and **Wermlandite** are structurally related to the minerals of this group.

256 *Kieserite Group*
Delete the entry for **Poitevinite**.

257 *Ludwigite Group*
Change the species names in the last line to **BOLD**: Compare **Hulsite**, **Orthopinakiolite**, **Pinakiolite**, **Takeuchiite**.

258 *Magnetoplumbite Group*
In the second line, insert a comma after Mn^{3+}
Add: **Nežilovite**, $PbZn_2(Mn^{4+},Ti^{4+})_2Fe^{3+}_8O_{19}$

259 *Melilite Group*
Change the species names in the last two lines to **BOLD**: **Jeffreyite**, **Leucophanite**, and **Meliphanite** are silicates structurally related to the minerals of this group.

260 *Mica Group*
Change **two** of the species names in the last line to **BOLD**: **Norrishite** is an oxymica. Compare Brammallite, Illite, **Rectorite**.

261 *Monazite Group*
Change the line for **Cheralite** to: **Cheralite-(Ce)**, $(Ce,Ca,Th)(P,Si)O_4$

262 *Osumilite Group*
In the first three lines dealing with the formula, add the following elements: in "B" add Y; in "C" add Zn
Add: **Dusmatovite**, $K(K,Na,\square)(Mn^{2+},Y,Zr)_2(Zn,Li)_3Si_{12}O_{30}$

263 *Plumbogummite Group*
Change Crandalite group to **Crandallite Group**

265 *Pyrochlore Group*
Change the formula of **Calciobetafite** to $Ca_2(Ti,Nb)_2(O,OH)_7$
Change the last four lines to: **Ferritungstite** (cub.), **Jixianite** (cub.) and **Zirkelite** (mon.) are structurally related oxides; **Ralstonite** is an isostructural halide. The nomenclature of the group, with recommendations by the I.M.A. Commission on New Minerals and Mineral Names are given in **62**, 403–410 (1977). (Note that the spelling of the first "Mineral" in the fourth line has been changed to "Minerals" and that species names are given in **BOLD**.)

266 *Pyroxene Group*
Add the following as a last line: **Nchwaningite** is structurally related.

266 *Rosasite Group*
Change the species name in the last line to **BOLD**: **Pokrovskite** is a related mineral.

267 *Rutile Group*
Change the formula of **Squawcreekite** to $(Fe^{3+},Sb^{5+},Sn^{2+})O_2$
Change the species name in the last line to **BOLD**: **Sellaite**, MgF_2, is structurally related to the Rutile group.

268 *Smectite Group*
Change one of the species names in the last line to **BOLD;** delete **Yakhontovite** from the same line: Compare Brammallite, Illite, **Rectorite**.

269 *Spinel Group*
Add: **Magnesiocoulsonite**, MgV_2O_4
Change the species name in the last line to **BOLD**: **Ringwoodite** is an isostructural silicate. Compare the sulfides of the Linnaeite group.

269 *Stannite Group*
Change the species names in the last line to **BOLD**: **Kesterite** and **Ferrokesterite** are structurally related minerals.

270 *Stibiconite Group*
Change the species name in the last line to **BOLD**: **Jixianite** is a structurally related lead tungsten oxide.

270 *Tetrahedrite Group*
In the formula for **Hakite**, delete Ag.

272 *Vivianite Group*
Change the species names in the last two lines to **BOLD**: **Bobierrite** and **Manganese-hörnesite** are related minerals, with b-axes twice those of minerals of this group.

273 *Zeolite Group*
Add: **Gottardiite** $Na_3Mg_3Ca_5Al_{19}Si_{117}O_{272} \cdot 93H_2O$
Tschernichite: change the formula to: $(Ca,Na)(Si_6Al_2)O_{16} \cdot 4\text{–}8H_2O$
Replace last line with: **Partheite**, **Roggianite** and **Gaultite** are related minerals.

Note added in proof:

Shortly after these *Additions and Corrections to the Glossary of Mineral Species 1995* were submitted for publication, the report of the Amphibole Subcommittee of the Commission on New Minerals and Mineral Names of the International Mineralogical Association appeared in several mineralogical journals. This report establishes a new classification scheme for the amphibole group of minerals. This will require major revisions of the entries for individual amphibole species and for the Amphibole Group section in the *Glossary of Mineral Species 1995*. These will be presented in a special article in a forthcoming issue of the *Mineralogical Record*.

Corrections to *New Minerals 1990–1994*

Page 6	Antimonselite: The ideal formula at the top of the page should be changed from Sb_2S_3 to Sb_2Se_3
Page 75	Gravegliaite: Add A. Palenzona to the list of authors in the reference
Page 158	Reppiaite: Add A. Palenzona to the list of authors in the reference
Page 180	Szenicsite: Change the optical data to: Biaxial (+), indices of refraction probably greater than 1.8, 2V(meas.) 74°; dispersion r > v, strong; pleochroism, X yellow-green, Y and Z green; orientation, X = b, Y = a, Z = c. Also change the crystal forms to {100}, {110}, {211}, and {010}

Corrections to abstracts published in the *Mineralogical Record:*
Vol. 27, March–April 1996:
Page 116 Crerarite: Change the mean diameter of the grains from 12 mm to 12 µm
Page 119 Owensite: Change the dimensions of the grains from 6 x 12 µm up to a maximum of 43 x 110 mm to 6 x 12 µm up to a maximum of 43 x 110 µm

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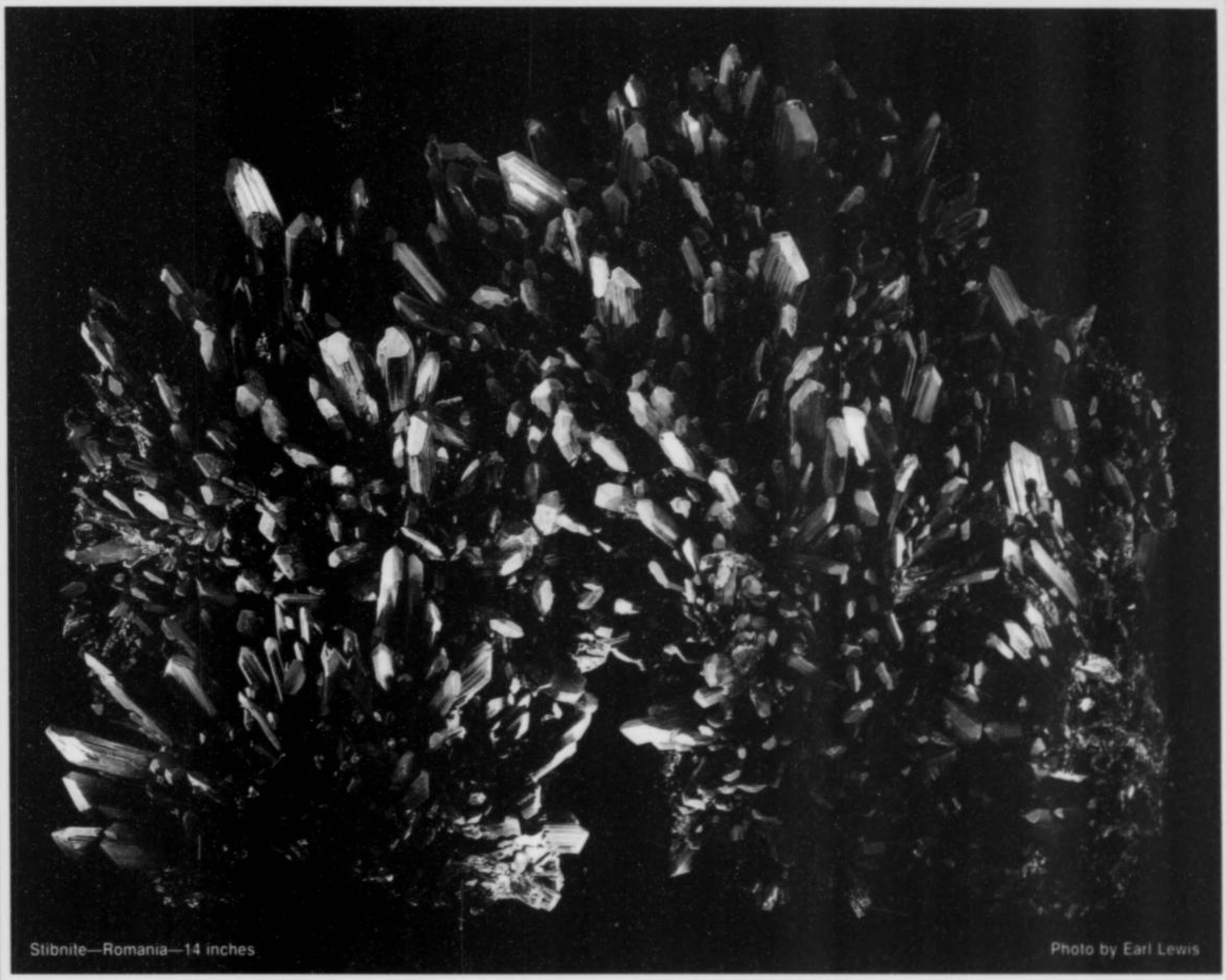

Stibnite—Romania—14 inches

Photo by Earl Lewis

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