the Mineralogical Record

Volume Twenty-five, Number Three
May–June 1994
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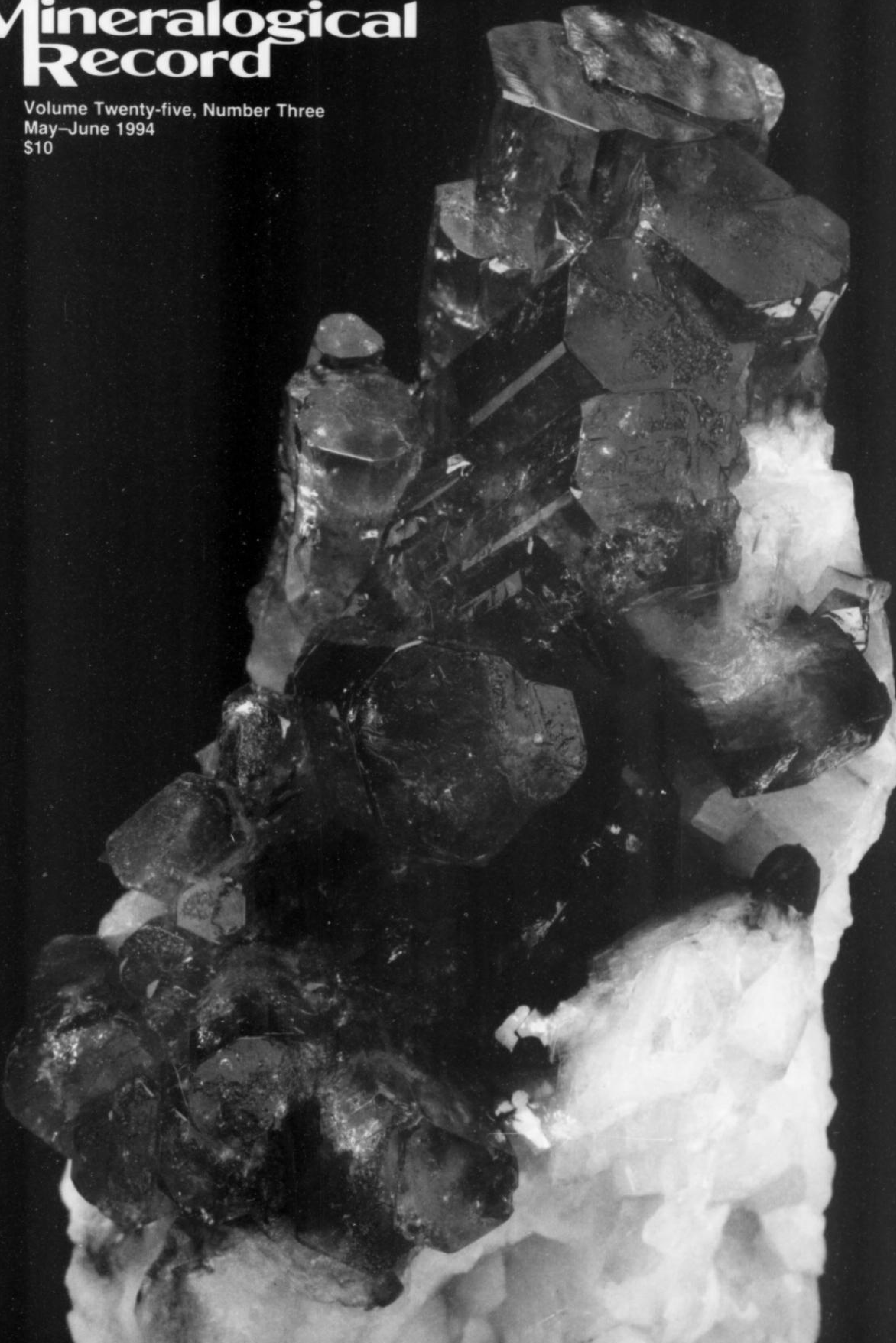

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Printed in the U.S.A.

The Mineralogical Record (ISSN 0026-4628) is a bi-monthly publication of the Mineralogical Record, Inc., a non-profit organization. Special second-class postage (USPS 887-700) paid at Tucson, Arizona, and additional mailing offices. POSTMASTER: Send address changes to: The Mineralogical Record, 7413 N. Mowry Place, Tucson, AZ 85741

*Continued on p. 239

the Mineralogical Record ®

May–June 1994
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Articles

Columns

COVER: BERYL, a spectacular, 9-cm fan-shaped group of crystals on white calcite matrix from the Coscuez mine, Muzo, Colombia. This mine is located 12 km north, on the other side of the mountain, from the famous Muzo mine (see the article on the Colombian emerald districts in vol. 1, no. 4, p. 146). The specimen shown was found about two years ago. It may be the finest surviving cluster of Colombian emerald crystals. The piece was sold at the 1994 Tucson Show by Bryan Lees of *Collector's Edge.* Photo by Jeffrey A. Scovil.

notes from the EDITOR

NECESSARY WORDS

Mineralogy is, in large part, a descriptive science, especially as far as amateur mineralogists and collectors are concerned. Consequently, people who have occasion to describe the appearance or nature of minerals to each other require a battery of adjectives designed for that purpose. Being able to call up just the right descriptive term for a particular habit or feature lends elegance, accuracy and an admirable conciseness to one's speech and writing. Having a good vocabulary of such terms is the mark of experience and knowledge which sets the mineral person above the layman and which helps one mineral person to recognize others through their casual conversation. It is, put simply, one mark of competence that demonstrates some effort has been expended in learning about a chosen field of endeavor.

Besides which, it's just fun to have these arcane terms at one's command. In fact, one can actually "collect" them by making a mental or written note when a particularly nifty word is encountered. Some of them are satisfyingly long and technical-sounding, which only adds to their charm. Of course, the user of such words is open to the charge of *sesquipedality* ("using long words"). But who cares? (Incidentally, one of the unique things about the word *sesquipedalian* is that you can't use it without automatically *being* sesquipedalian!)

Georgius Agricola (1494–1555), widely considered to be the Father of the Geological Sciences, was the first to introduce the serious description of the external characteristics of minerals (*De natura fossilium*, 1546). He introduced such terms as *capillary* (hair-like), *lenticular* (lens-like), and *stellate* (star-like), among many others. Later early mineralogists such as Conrad Gesner, Christoph Hausen, Wallerius, Hebenstreit, Linnaeus and Valmont de Bomare added others to the ever-growing list, including: *tessellated* (like a mosaic of small squares), *diaphanous* (semi-transparent), *pellucid* (transparent), *pulverulent* (dusty), and *reniform* (kidney-shaped).

The adjectival vocabulary of mineralogy was ultimately refined and brought to a high state by the illustrious Werner, who in 1774 published a pivotal work, *On the External Characters of Minerals*. Here he set out a comprehensive system for describing and classifying minerals on the basis of their appearance, verifying or introducing in the process a vast number of useful terms. These included such euphonious examples as: *dentiform* (tooth-like), *reticulated* (superposed parallel sets), *arbustiform* (cauliflower-like), *acuminated* (with beveled edges), and *scopiform* (fibers radiating in one or two directions from a common point, like a bow tie).

Since then, even more terms have been discovered in obscure literature or coined for special purposes. Many have a flavor all their own. Some of my own favorites include *lixivious* (tasting like alkali), *squamose* (scaly), *auricular* (ear-like), *axifrangible* (tending to cleave or fracture along the axes), *flabelliform* (fan-like), and *vermicular* (worm-like).

In some ways, fighting for the preservation and perpetuation of these terms is a losing battle. "Tooth-like" is more generally understandable than *dentiform*, despite its lesser linguistic elegance. But, in this editor's opinion, eloquence is worth standing up for, even if it means we all have to check our dictionaries a bit more often.

I'm sure readers have their own favorite mineralogical adjectives. Drop me a letter listing some of them and I'll share them with readers in a future column. Until then, may your minerals remain *coruscant* (sparkling).

MORE BARRIERS TO COLLECTING

In what will amount to another setback for field collectors, the federal Bureau of Mines in Lakewood, Colorado, is developing techniques for sealing abandoned mines. The procedure involves suspending a form down inside the shaft, and then pumping in lightweight foam concrete to build an initial seal. Steel I-beams and reinforcing bars coated to prevent corrosion are then laid in, and standard concrete is poured over them to complete the cap. Once the concrete has set, the cap can be paved over with topsoil and native plants to complete the reclamation of the site. This process will not only make the mine extremely difficult or impossible to enter, it will make it impossible to *find*.

According to a study published in 1993 by the Mineral Policy Center, there are approximately 558,000 abandoned mines in the United States. Since 1977 an average of ten people per year have been killed in abandoned mines, most of them non-collectors and non-scientists. Children, skiers, hunters, hikers, and four-wheelers are at the most risk, little though it is.

At $33,000 per plug, it seems unlikely that the U.S. government would ever authorize the $18 billion necessary to seal *all* of the abandoned mines in the country, in order merely to save ten lives per year. (This is the same government that *subsidizes* tobacco growing, at an incalculable cost in human life and suffering.) But local and state authorities could begin capping on a small scale in critical areas if the collector community does not make itself heard (see Bill Smith's editorial in vol. 23, no. 5, p. 374). Capping coal mines is fine; they have little scientific value. But metal mines constitute a valuable eyehole into the earth which can be used by collectors and geologists as long as the workings remain stable. There is no telling what future discoveries may be lost by capping such mines, not to mention the potential for renewed mining someday if access is not blocked.

Especially in the Western states, many mines that have been long abandoned have yet to be properly explored and examined by mineralogists, collectors and historians. The cap being developed by the Bureau of Mines is expected to last 100 years. (After which, what? It spontaneously caves in? There would seem to be a safety risk there that is deferred to the future.) I guess we will have to regard capped mines as time-capsules for our great-great grandchildren. That is, assuming anyone still remembers how to field collect by that time.

CALL FOR PAPERS
16th FM-TGMS-MSA MINERALOGICAL SYMPOSIUM

The 16th Mineralogical Symposium sponsored jointly by the Friends of Mineralogy, the Tucson Gem and Mineral Society, and the Mineralogical Society of America will be held in conjunction with the 41st Tucson Gem and Mineral Show, Saturday February 11, 1995. The topic of the symposium will be **topaz**—the theme mineral for the show. Papers on descriptive mineralogy, paragenesis, classic and new localities, etc. are invited. An audience of knowledgeable amateurs as well as professional mineralogists and geologists is expected.

If you wish to present a paper, please write or call (**immediately**) Mr. Beau Gordon, Symposium Chairman (P.O. Box 6214, Rome, GA 30162; Tel: 706-291-4618), with your topic, a few sentences describing the paper, and your address and phone number. Presentations will be 15 or 20 minutes in length followed by a period for questions. Upon acceptance of topics all authors will be required to submit a 200-300 word abstract by September 1, 1994 (**firm date**). Those abstracts will be published in the January-February issue of the *Mineralogical Record* (subject to the approval of the editor), which will be available for sale at the 41st Tucson Gem and Mineral Show.

Mineralogical Record BACK ISSUES!

v.1/#1 Early Amer. collectors, Mirabilite (Chile), Mult. Japan-law Qtz. twins, Lunar minerals (*facsimile:* **$10**)	**v.1/#2** Moctezuma mine (Mexico), Cleaning Minerals, Lake Baikal (Russia), Tilasite (Bisbee), Minas Gerais *Original* **$30** (*facsimile:* **$10**)	**v.1/#3** Rutile (CT), Eakerite, Cenosite (Switz.), Mineral Rings, Cornetite (AZ), Basaluminite (*facsimile:* **$10**)	**v.1/#4** Colombia Emeralds, Natrolite (Oreg.), Benstonite (Ill.), Långban (Sweden) *Original* **$30** (*facsimile:* **$10**)	**v.2/#1** Delafossite (Wyo.), Ancylite (Pa.), Stevensite, Lancasterite (Pa.), Monte Redondo (Portugal) (*facsimile:* **$10**)
v.2/#2 Chessy (France), Blue Quartz, Panasqueira (Portugal), X-ray crystallography (pt. I) (*facsimile:* **$10**)	**v21/#3** Rhodochrosite (West U.S.), Chalcoalumite (Bisbee), Ytterby (Swed.), X-ray crystallography (pt. II) (*facsimile:* **$10**)	**v.2/#4** California: New Minerals, Churchite, Florencite-(Nd), Antarcticite; X-ray crystallography (pt. III) (*facsimile:* **$10**)	**v.2/#5** Gold Hill (UT), Rose Quartz, Grandview mine (AZ), Crandallite (VA), Early American Mineral Specimens (*facsimile:* **$10**)	**v.2/#6** Apache mine (AZ), Opal structure, Mont St-Hilaire (Que.), Museum Record, Spec. Holders (*facsimile:* **$10**)

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The Jaguaraçu Pegmatite

Minas Gerais, Brazil

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The Jaguaraçu pegmatite, discovered during World War II, has produced what are arguably the world's finest crystals of milarite. Excellent albite, euxenite, monazite and zircon crystals have been found there as well. In 1986 the deposit became the type locality for a new yttrium silicate, minasgeraisite.

LOCATION

The Jaguaraçu pegmatite is situated in the Piracicaba river valley (a tributary of the Rio Doce) near the small town of Jaguaraçu (or Jaguaruçu), south-southwest of Governador Valadares and east-northeast of Belo Horizonte, in the state of Minas Gerais, Brazil. The precise location is near the José Miranda farm about 500 meters southeast of the town and adjacent to a soccer field (coordinates x = 736.4, y = 7825.5 on the Coronel Fabriciano map, IBGE, 1/100,000 SE-23-Z-D-V, published in 1980), in the old Municipio de Timoteo (now the Municipio de Jaguaraçu).

Access is via the 310-km tarred highway BR-381 which joins Governador Valadares and Belo Horizonte. At a point 180 km from Belo Horizonte there is a junction with another tarred road leading 6.5 km to Jaguaraçu. On the other side of town a good dirt road proceeds for 600 meters from the entrance to the farm to the mine dumps.

The surrounding area is covered with high grass and occasional patches of forest on an undulating terrain with inselbergs. It constitutes a part of the Lower Precambrian granite-gneiss basement complex.

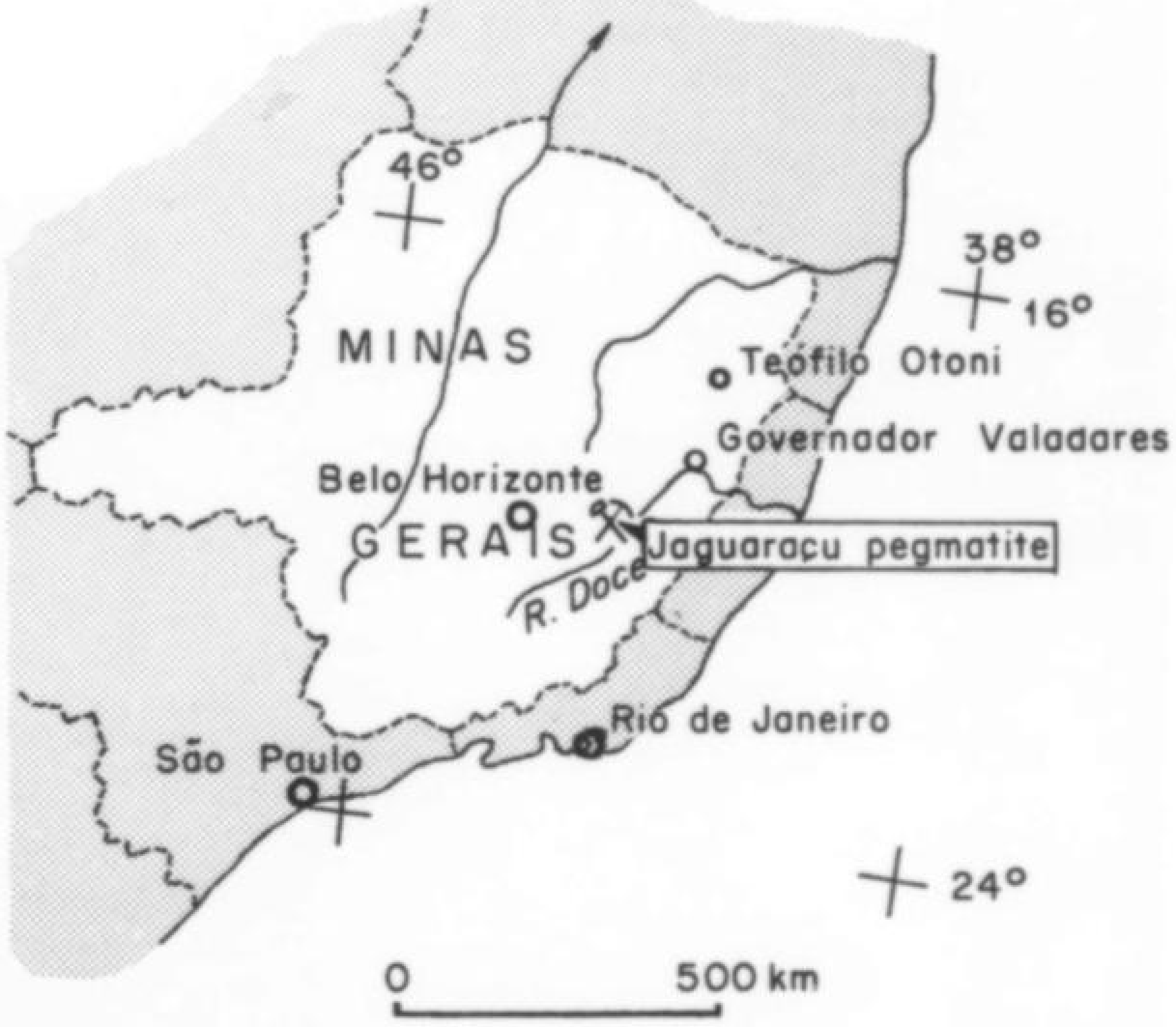

Figure 1. **Location map.**

HISTORY

The pegmatite deposit known today as Jaguaraçu was first located during the second World War, and was originally called the Carneirinho mine. It operated sporadically for about 25 years, producing industrial beryl and mica. During this period, excellent crystal specimens of

euxenite, monazite and zircon were recovered through the efforts of mineral dealers operating out of Governador Vadadares.

After a period of dormancy the mine was reopened in 1980 by José Pinto. He worked a long adit in search of mineral specimens, primarily tourmalinated quartz crystals and "cleavelandite" albite groups. By early 1981 superb crystals of milarite had also been found (first reported by Wilson, 1981), along with an unknown lilac-colored mineral that five years later would be described as the new species minasgeraisite.

In July of 1981 the adit became flooded and the workings were partially buried by mud slides. Since that time the property has stood abandoned, although part of the dumps have been removed as gravel paving for nearby roads.

Figure 2. **Entrance of the 460-meter adit in September of 1981. The milarite zone is located in the left side of the level where a small stope has caved. Cassedanne photo.**

The deposit has also sometimes been known as the José Miranda mine (after the nearby farm) and the Zé Pinto or José Pinto mine (after the 1980 operator).

WORKINGS

The mine workings are located in a west-northwest-trending lenticular granite pegmatite which is over 100 meters in length and dips

Figure 3. **A large tourmalinated quartz crystal on the dumps, 1981. Cassedanne photo.**

Figure 4. **Cassiterite/tapiolite (formerly "staringite") crystal group, 9 cm. Cassedanne specimen and photo.**

Figure 5. (right) **Superb yellow-green milarite crystals to 2.5 cm. Carlos Barbosa specimens.**

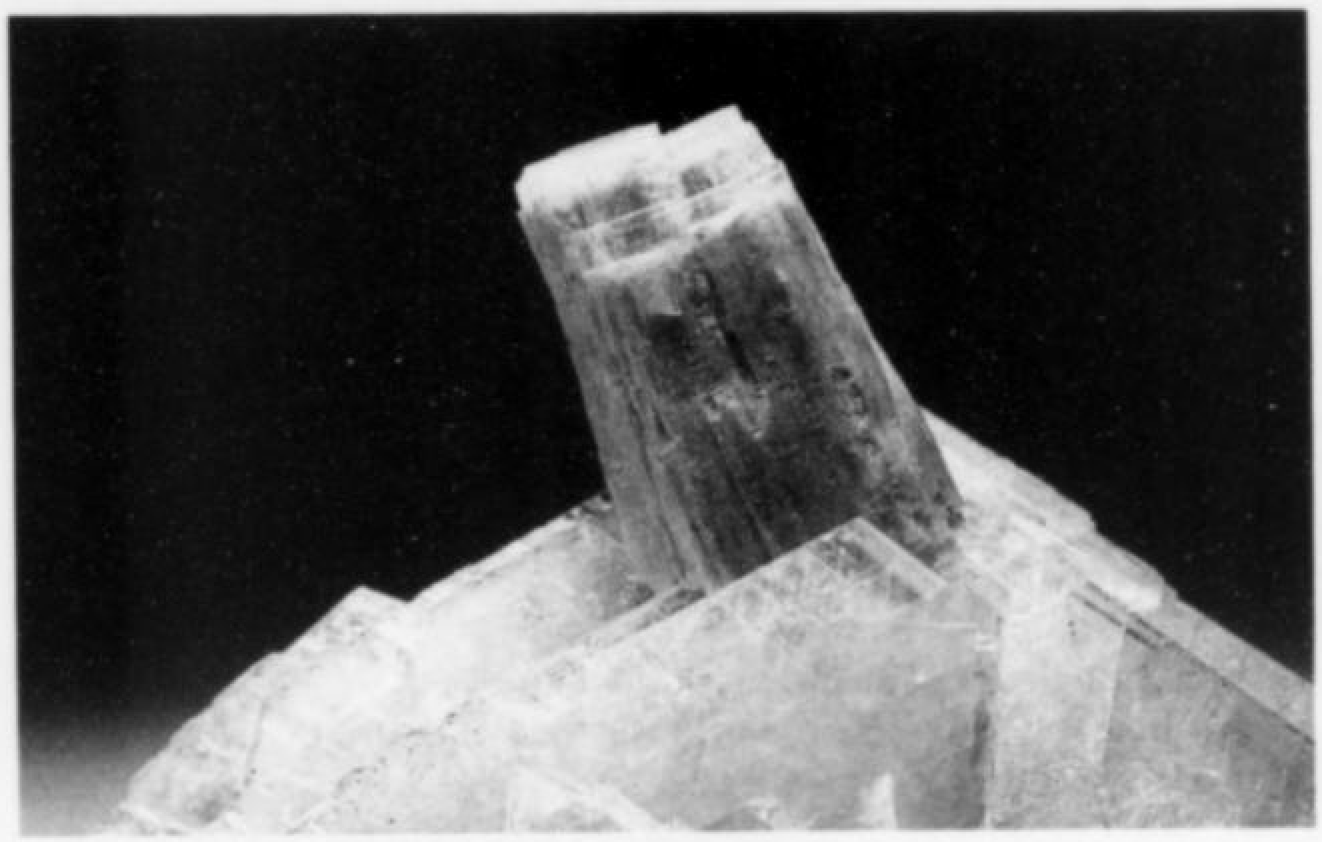

Figure 6. **Tan-colored milarite crystal, 2.9 cm, on albite. R. V. Gaines specimen.**

Figure 7. **Flattened monazite-(Ce) crystal, 12 cm. Cassedanne specimen and photo.**

Figure 8. **Euxenite crystal group, 6 cm. Cassedanne specimen and photo.**

Figure 9. **Zircon crystal group, 10 cm. Cassedanne specimen and photo.**

vertically or at a high angle toward the south-southwest. The width of the pegmatite lens varies from 5 meters at the west end to about 20 meters in the eastern portion. The lens crops out on a steep hillside, pinching out to less than a meter on the uppermost margin.

An open pit with a gently sloping floor reaches approximately 450 meters elevation at its lowest point. The western margin of the pit is caved along the strike of the pegmatite. The pit widens out to the south, where a pegmatite septum is visible.

At the eastern margin of the pit, at the base of a hill, an adit slopes gently downward from about 460 meters elevation and follows the pegmatite. It once extended for more than 70 meters, with irregular stopes on both sides, but is now caved. Two smaller, subparallel adits (also caved) were driven from the west-southwest margin of the pit, and a third was driven perpendicular to these at about 480 meters elevation.

THE PEGMATITE

The pegmatite ranges from mineralogically homogeneous in the west to more complex and fractionated in the east. Pink potassium feldspar, gray to milky quartz, biotite, hematite, magnetite and secondary iron oxides characterize the western portion. The pegmatite gradually becomes richer in giant crystals of rose-colored microcline, green microcline (commonly surrounded by an albite rim) and quartz crystals toward the east. The eastern end of the body is well zoned, with a quartz core between two wide, irregular bands containing irregularly scattered albite replacement bodies rich in pale blue "cleavelandite" albite crystals, pale gray-green muscovite and the rarer accessory minerals. A replacement zone in which an Alpine cleft-type environment developed (Stalder *et al.*, 1973) has yielded specimens of adularia, albite, hematite rosettes, muscovite, quartz and milarite. Thinner, fine-grained granitic bands occupy the zone adjacent to the wall rock. A fault (trending N30°E, dipping 70°SE) intersects the vuggy zone, along with other parallel fissures, and acts as a drain for surface waters.

MINERALS

Albite $NaAlSi_3O_8$

Albite, always of the platy "cleavelandite" habit, occurs as irregular masses with silky cleavage, as diminutive (micromount-worthy) crystals showing multiple growth steps lining cavities in small hydrothermalized bodies, as large milky blades in dark quartz, and as thick layers of crystals lining cavities in the replacement bodies. Individual crystals in the latter case reach more than 8 cm in length, are randomly oriented, commonly translucent, and a pale sky-blue color.

Almandine-Spessartine $(Fe,Mn)_3^{2+}Al_2(SiO_4)_3$

A few rounded, weathered crystals of almandine-spessartine garnet, reddish brown in color and reaching up to 1 cm, occur in the zone near the wall rocks.

Anatase TiO_2

Numerous round, ocherous patches of powdery, pale yellow, pisolitic anatase are commonly found embedded in the surface of late-stage gray quartz and adularia crystals.

Beryl $Be_3Al_2Si_6O_{18}$

Anhedral industrial-grade beryl crystals occur embedded in quartz and feldspar. Small "eyes" in the beryl crystals turn blue when heated.

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

Biotite occurs as small flakes altering to fine-grained vermiculite, and as large blades or books several tens of centimeters across and several centimeters thick. These large blades contain alternating bands of powdery red hematite with rarer pink to white feldspar and quartz intercalations. In some cases a thin felted layer of minute tourmaline crystals coats the biotite crystals. This peculiar habit of biotite is common in beryl-bearing pegmatites throughout Minas Gerais (Cassedanne and Alves, 1992).

Cassiterite SnO_2

Cassiterite is rather rare at Jaguaraçu, as small, anhedral, brownish scattered crystals. Material formerly known as "staringite" (discredited in 1992 by Groat *et al.* as a submicroscopic mixture of cassiterite and tapiolite) occurs as apparently well-formed crystals, randomly or preferentially oriented, in groups to 10 cm across. These specimens, powdered by a thin pale-yellow coating, were collected before 1965.

Cerussite $PbCO_3$

Nodules of a cerussite/pyromorphite mixture up to several centimeters across represent the alteration of a pre-existing lead mineral (Foord *et al.*, 1986). Similar nodules are fairly common in neighboring pegmatites (Cassedanne and Baptista, 1984; Cassedanne *et al.*, in press).

Chernovite-(Y) $YAsO_4$

Very rare, millimeter-size crystals of brown chernovite-(Y) have been found near the base of some quartz crystals. Semi-quantitative X-ray fluorescence analysis indicates trace quantities of Mn, U, Hf and Zn.

Churchite-(Y) $YPO_4{\cdot}2H_2O$

Churchite-(Y) has been identified as a thin, powdery, greenish yellow to yellowish orange coating on some crystals of ferrocolumbite.

Elbaite and **Schorl** $Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$ and $NaFe_3^{2+}Al_6(BO_3)_3Si_6O_{18}(OH)_4$

In addition to the tourmalinated quartz, fine-grained acicular tourmaline (parallel and randomly oriented) occurs in biotite, muscovite and magnetite. Schorl crystals, in some cases fibrous, are uncommon, as are small irregular masses of sky-blue elbaite (Foord *et al.*, 1986). Fine-grained tourmaline lenses associated with bronze-colored biotite and argillized feldspar are visible near the wall rock contacts.

Euxenite-(Y) $(Y,Ca,Ce,U,Th)(Nb,Ta,Ti)_2O_6$

Euxenite-(Y) was once rather common at Jaguaraçu, as fine fan-shaped groups of tabular crystals up to 1 kg in weight, all recovered before 1965. Weathered, irregular, metamict nodules and rounded, elongated crystals of red-brown color and glassy to waxy luster were found on the dumps shortly after the mine ceased operating in 1981. Thin, pale yellow needles to 1 cm were also found embedded in uraninite cubes scattered sporadically in the magnetite masses. Semi-quantitative X-ray fluorescence analysis indicates trace quantities of Fe, Mn, Ce, La, Nd, Pr, Sr, Pb, As, Zn and Sm.

Ferrocolumbite $Fe^{2+}Nb_2O_6$

Irregular masses of ferrocolumbite ($d_{meas.}$ = 5.92 g/cm^3), generally anhedral but showing occasional crystal faces, have been found up to 1.5 kg in weight. The ferrocolumbite (which is weakly radioactive) occurs in feldspar, locally showing simultaneous growth in relation to platy albite. In some cases it also carries a coating of churchite-(Y). Semi-quantitative X-ray fluorescence analysis indicates trace quantities of Zr, Y, U, Pb, Ti and Yb.

Fluorapatite $Ca_5(PO_4)_3F$

Fluorapatite occurs in two habits: (1) as anhedral, greenish gray crystals scattered in feldspar and quartz, and (2) as milky needles and sprays to several millimeters included in translucent quartz crystals.

Fluorite CaF_2

Anhedral, purplish blue fluorite has occasionally been found on the dumps. A very small production for industrial use is reported prior to 1980.

Hematite Fe_2O_3

Hematite generally occurs as large, gray, subhedral, metallic masses to 15 cm across. These show abundant growth figures on the crystal faces, and a prominent cleavage; a thin film of leucoxene invades some of the cleavage planes. Black tourmaline needles and grains of feldspar occur scattered throughout the crystals. An exsolution texture is visible on cleaved faces, with lamellae oriented at 60° to each other. Small cavities in hematite masses sometimes contain small, free-growing plates of a translucent blood-red color which make fine micromounts. A late-stage growth of hematite as sprays, tufts and fine-grained powdery aggregates coats many specimens, especially adularia. Where thoroughly weathered the hematite has altered to blood-red, clay-like rounded masses.

Ilmenite $Fe^{2+}TiO_3$

Rare anhedral crystals of ilmenite to a few millimeters in size have been found as inclusions in feldspar.

Kaolinite $Al_2Si_2O_5(OH)_4$

Kaolinite and other clays (such as nontronite and montmorillonite) produced as weathering products are not abundant at Jaguaraçu. Nontronite is produced by the weathering of tourmaline, and pink soapy montmorillonite by the weathering of spodumene (as at the Cruziero mine; Cassedanne and Sauer, 1980).

Lepidolite $K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$

Small flakes and fine-grained masses of lepidolite are found mainly in the eastern portion of the pegmatite.

Magnetite $Fe^{2+}Fe^{3+}_2O_4$

Magnetite is abundant at Jaguaraçu, as pure material and as crystals in various stages of alteration to hematite ("martite"). Some martite nodules reach 25 cm across. Octahedral crystals to 10 cm have been collected, showing lightly rounded edges and prominent growth figures on the crystal faces. Bladed or tabular crystals and groups to several centimeters are also known. Cleavage (the planes coated by ochreous oxides, leucoxene, sericite or clay) becomes more prominent with increasing alteration to hematite.

Magnetite commonly exhibits an exsolution texture comprised of intergrown magnetite, hematite, rutile and (rarely) translucent brown euxenite with a yellowish alteration surface. Polished sections of these crystals will delight any ore mineralogist.

Manganese Oxides

Secondary manganese oxides, dull or lustrous, occur as thin, mammillary crusts and small stalactites coating other minerals in vugs. The precise species present have not been determined.

Microcline $KAlSi_3O_8$

Microcline, as the green variety "amazonite," is locally abundant at Jaguaraçu, some subhedral crystals reaching more than a meter in length and surrounded by quartz. It is always of a medium green color with pronounced cleavages. Amazonite crystals are commonly surrounded by nodules and sprays of "cleavelandite" albite and thin "adularia" orthoclase coatings and cleavage-plane replacement zones. Large blocks of pink microcline displaying an aesthetic granitic texture are suitable as carving material.

Milarite $KCa_2Be_2AlSi_{12}O_{30}\cdot H_2O$

The Jaguaraçu pegmatite is the first and only occurrence of milarite in Brazil. And, although very limited in number, the best specimens probably qualify as the finest known examples of the species.

The best milarite specimens were collected in the northern margin of the quarry, inside the entrance to the main adit, on the left side, in vugs in an albitic zone several meters in length. Up to that time milarite at Jaguaraçu had always been found associated with concentrations of biotite altering to vermiculite, and amid crystal crusts of albite (with or without muscovite and tourmalinated quartz).

The largest milarite crystals are up to 3 cm in length and 1.2 cm across. They are generally tan in color, but a few very attractive examples are yellow-green, especially among the smaller crystals. The crystals are typically "floaters" (unattached to any matrix), as singles and parallel groups, although a few perched on white albite are also known. The habit is simple: smooth to striated hexagonal prisms with basal pinacoids. Crystals are translucent to transparent, brittle, with a vitreous glint and irregular fracture. Commonly the uppermost part of a crystal is paler in color than the rest. Microscopic crystals of muscovite, feldspar and quartz form a powdery dusting on the crystals.

The density of Jaguaraçu milarite, measured using heavy liquids, is 2.46 ± 0.02 g/cm^3. Indices of refraction (in Na light) are: $\alpha = 1.548$, $\beta = 1.551 \pm 0.001$. The X-ray diffraction pattern is a close match with the JCPDS standard. Jaguaraçu milarite shows enrichment in Y and rare-earth elements in the outermost zones, in networks of fracture fillings, and in replacement veinlets of a (Y,REE)-rich, Al-poor phase in the primary (Y,REE)-poor crystal interiors and pinacoidal cap zones. Idealized formulae for the compositions therefore range from $KCa_2(Be_2Al)Si_{12}O_{30}$ to the more enriched $K(Ca,Y,REE)_2\text{-}Be_3Si_{12}O_{30}$. A complete analysis of the structural relations is given by Hawthorne *et al.* (1991).

Minasgeraisite-(Y) $CaY_2Be_2Si_2O_{10}$

Minasgeraisite is found as a rare late-stage accessory mineral occurring in small druses associated with milarite, muscovite, quartz, albite and other species. It forms single and multiple rosettes from 0.2 to 1 mm across, covering surfaces on matrix several centimeters across. It was among the last minerals to form; only crystals of quartz have been seen completely enclosing it.

Individual rosettes of minasgeraisite are concentrically zoned, pale purple in the center to medium purple on the rim. The mineral has a sheaf-like habit composed of individual crystals less than 5 mm across. Under the polarizing microscope a pronounced mosaic texture is evident. Minasgeraisite is non-magnetic, non-fluorescent (under longwave and shortwave ultraviolet light), has a faint purple streak and an earthy to subvitreous luster. The Mohs hardness is estimated at 6 to 7, and $d_{meas.}$ exceeds 4.25 g/cm^3. The mineral is insoluble, and gelatinizes in hot sulfuric or hydrochloric acids. It shows an excellent cleavage {001}. Optically it is biaxial (Foord *et al.*, 1986).

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

Monazite-(Ce) was found during the early years of the mine's operation as fine, large, elongated to blocky crystals (commonly singles) up to 20 cm in length. Today only very small crystals scattered in feldspar can be found on the dumps. Semi-quantitative X-ray fluorescence analysis indicates trace amounts of Pr, As, Fe, Gd, Mn, Pb, Sm, U and Y.

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

Muscovite occurs at Jaguaraçu as gray to greenish gray pseudohexagonal crystals to a few centimeters across, and as large gray-brown to ruby-red plates having a mosaic texture. The muscovite which serves as matrix for most of the minasgeraisite is a yellowish bronze-colored variety enriched in iron and lithium.

A small quantity of industrial-grade muscovite is recorded as having been produced in the early years of mining.

Orthoclase $KAlSi_3O_8$

Orthoclase is abundant at Jaguaraçu as small salmon-pink to flesh-colored elongated or saddle-shaped crystals of "adularia" up to several millimeters in size. It also occurs as sheet-like to irregular and cavernous overgrowths on green microcline, hematite, hydrothermalized albite, dark quartz and schorl. Locally it is found sprinkled with delicate hematite rosettes, small, transparent, doubly terminated quartz crystals, pale green flakes of chlorite or white, late-stage albite crystals. Adularia is common on the dumps as microcrystals suitable for micromounting.

Table 1. **Minerals identified from the Jaguaraçu pegmatite, Minas Gerais, Brazil.**

Sulfides	
Pyrite	FeS_2
Fluorides	
Fluorite	CaF_2
Oxides	
Anatase	TiO_2
Cassiterite	SnO_2
Euxenite-(Y)	$(Y,Ca,Ce,U,Th)(Nb,Ta,Ti)_2O_6$
Ferrocolumbite	$Fe^{2+}Nb_2O_6$
Ferrotapiolite	$(FeMn)^{2+}(Ta,Nb)_2O_6$
"Gummite"	misc. U oxides
Hematite	Fe_2O_3
Ilmenite	$Fe^{2+}TiO_2$
Magnetite	$Fe^{2+}Fe_2^{3+}O_4$
"Wad"	misc. Mn oxides
Uraninite	UO_2
Carbonates	
Cerussite	$PbCO_3$
Silicates	
Almandine-Spessartine	$(Fe,Mn)_3^{2+}Al_2(SiO_4)_3$
Beryl	$Be_3Al_2Si_6O_{18}$
Clays	
Kaolinite	$Al_2Si_2O_5(OH)_4$
Montmorillonite	$(Na,Ca)_{0.3}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$
Nontronite	$Na_{0.3}Fe_2^{3+}(Si,Al)_4O_{10}(OH)_2 \cdot nH_2O$
Feldspars	
Albite	$NaAlSi_3O_8$
Microcline	$KAlSi_3O_8$
Orthoclase	$KAlSi_3O_8$
Micas	
Biotite	$K(Mg,Fe^{2+})_3(Al,Fe^{3+})Si_3O_{10}(OH,F)_2$
Lepidolite	$K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$
Muscovite	$KAl_2(Si_3Al)O_{10}(OH,F)_2$
Milarite	$KCa_2Be_2AlSi_{12}O_{30} \cdot H_2O$
Minasgeraisite-(Y)	$CaY_2Be_2Si_2O_{10}$
Quartz	SiO_2
Spodumene	$LiAlSi_2O_6$
Tourmalines	
Elbaite	$Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$
Schorl	$NaFe_3^{2+}Al_6(BO_3)_3Si_6O_{18}(OH)_4$
Zircon	$ZrSiO_4$
Phosphates, Arsenates	
Chernovite-(Y)	$YAsO_4$
Churchite-(Y)	$YPO_4 \cdot 2H_2O$
Fluorapatite	$Ca_5(PO_4)_3F$
Monazite-(Ce)	$(Ce,La,Nd,Th)PO_4$
Pyromorphite	$Pb_5(PO_4)_3Cl$

Pyrite FeS_2

Pyrite is encountered only rarely at Jaguaraçu, and always as microcrystals.

Quartz SiO_2

As in most pegmatites, quartz is very abundant at Jaguaraçu. It is commonly tourmalinated, which renders the crystals dark greenish gray to nearly black, with abrupt color variations across individual crystals. Other inclusions responsible for coloration in quartz are black iron oxide blebs, hematite discs, brown to golden yellow mica, rutile needles, clays, etc. Single crystals of quartz, often flattened parallel to a prism face and doubly terminated, reach more than a meter in length. Groups of elongated, subparallel or randomly oriented crystals of large size are common as well. Small, late-stage, milky to translucent crystals line interstices between large quartz crystals and partially coat feldspar crystals. Microcrystalline mica, albite plates, anatase, hematite, adularia and quartz form powdery coatings on larger crystals.

Spodumene $LiAlSi_2O_6$

Lath-like crystals of spodumene more than a meter long once existed in the eastern portion of the pegmatite body, but have been completely altered to clays.

Uraninite UO_2

Cubic uraninite crystals to a millimeter or so in size occur scattered through feldspar, euxenite and magnetite. Some have weathered to a pale yellowish, non-fluorescent mixture of secondary minerals ("gummite").

Zircon $ZrSiO_4$

In the early years of mining at Jaguaraçu, zircon was collected in well-formed fan-shaped groups, coralloid aggregates and sub-parallel groups reaching more than 15 cm in length. Small, wine-red, translucent to opaque crystals have been found in the feldspars, and acicular crystals penetrate iron oxides and biotite crystals. The largest zircon needles have a waxy brown core and beige-colored exterior. Semi-quantitative X-ray fluorescence analysis indicates trace amounts of Y, Mn, Hf, U, Bi, Pb and Zn.

ACKNOWLEDGMENTS

We are indebted to Dr. A. Baptista of the IEN, Rio de Janeiro, who kindly performed the X-ray fluorescence analyses.

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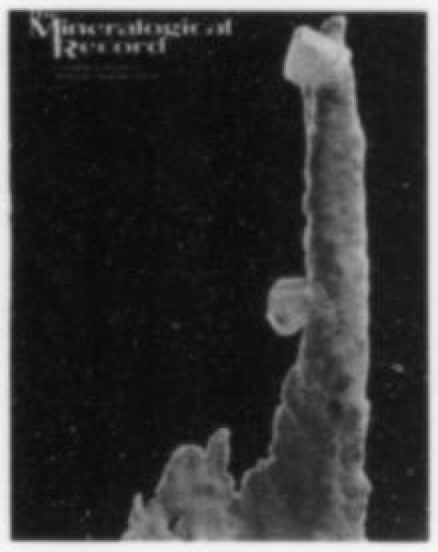

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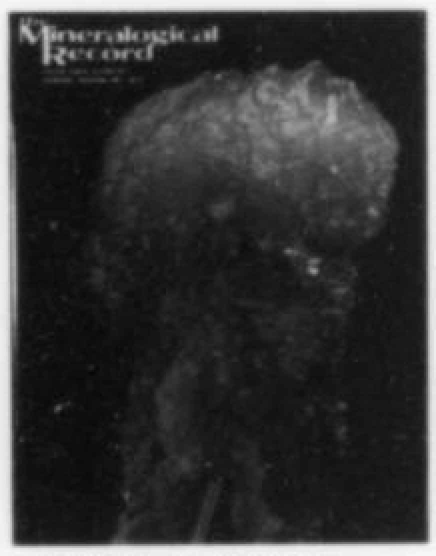

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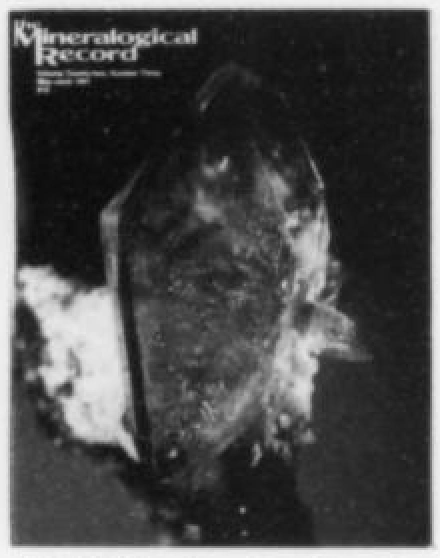

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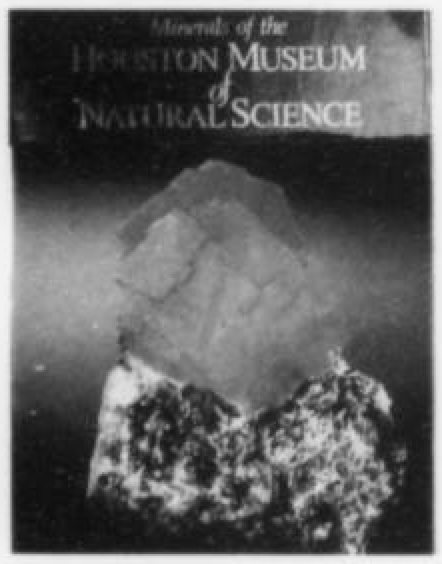

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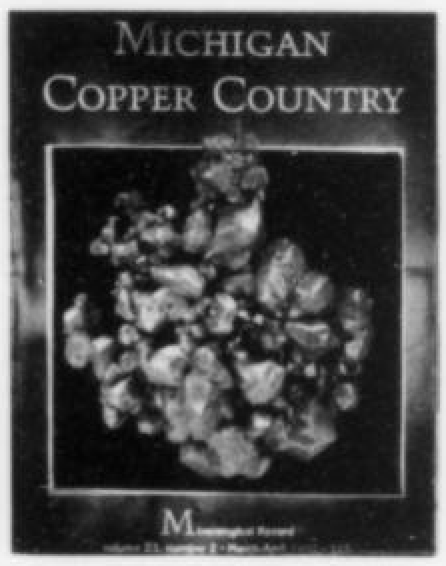

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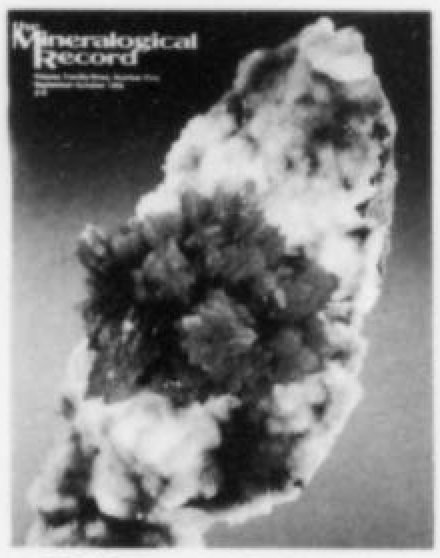

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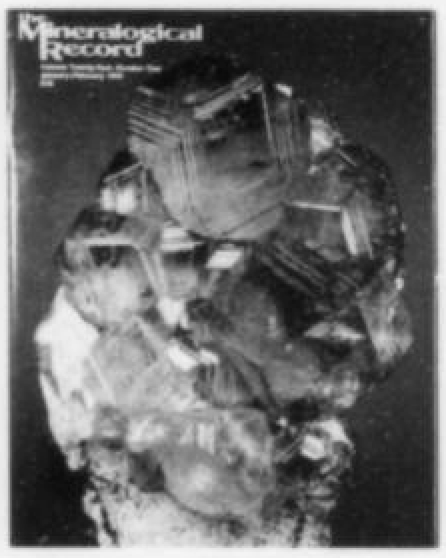

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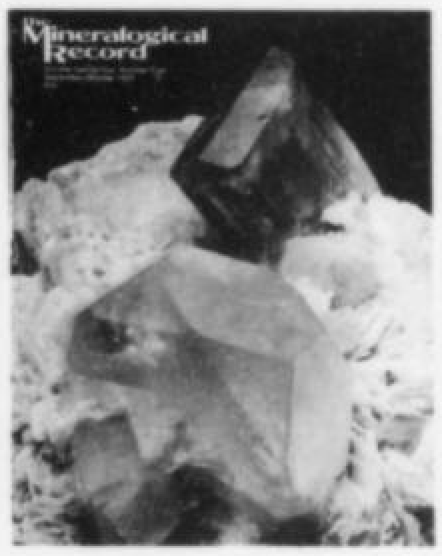

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Mineralogy of the Bennett Pegmatite Oxford County, Maine

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The Bennett pegmatite, discovered around the turn of the century, has produced attractive specimens of tourmaline, fluorapatite and beryl. Its most famous specimen, a giant morganite crystal nicknamed "the Rose of Maine," was found in 1989 but was broken up for gem rough. The quarry is open to collectors for a fee.

INTRODUCTION

The Bennett quarry is one of several complex, rare-element granitic pegmatites located in the well-known pegmatite region of western Maine, which covers an area of approximately 22,000 square kilometers. These pegmatites contain high concentrations of Be, Nb, Ta, Li and B, and many have produced fine collectible mineral specimens as well as gem-quality tourmaline and beryl. Classic localities such as Mt. Mica, Newry and Mt. Apatite are well-known for their pink and green elbaite and purple apatite. Feldspar and mica, along with minor amounts of beryl and pollucite, also have been extracted commercially from some pegmatites.

The Bennett quarry was originally mined for feldspar, but also has produced its share of specimen-grade and gem-quality tourmaline and beryl. Aquamarine, morganite and multi-colored elbaite have been found in a number of pockets along with lepidolite, blue fluorapatite and giant quartz crystals. Other less common minerals such as lithiophilite, spodumene, cassiterite, columbite-tantalite and hydroxylherderite have also been found in the pegmatite. The quarry is currently owned by Bennett Brothers Farms, Inc. and is leased to Ronald E. Holden, Jr.; it is open to collectors for a nominal fee.

HISTORY

Loren Merrill, one of the early pioneers of Maine pegmatite mining, began exploration of the Melzer Buck farm in West Buckfield as early as 1890. Merrill suspected that the mineralization observed on the Buck farm was a continuation of the mineralization at the nearby Mt. Mica mine (Blanche Bennett, unpublished memoirs, 1959). Merrill secured the mineral rights to the property and in 1917 began prospecting on a small scale, eventually discovering a large deposit of fine quality feldspar and quartz crystals. Paul Bennett began mining for feldspar in 1920 and, aided by Merrill and Dick Nevel, mined on a nearly continuous basis from 1920 to 1923. Mining proceeded on two levels: an upper terrace was cut into the hill for roughly 30 meters, where it had a depth of 11 meters, and a second cut lowered the floor of the quarry to about 15 meters. In 1924, Merrill and Nevel opened a large, east-west trending pocket approximately 1.8 to 2.1 meters wide, 0.5 to 1.5 meters deep and 9 meters in length. Large milky quartz crystals weighing up to 300 kg were found, along with what was considered to be some of the best smoky-citrine quartz known from Maine. Several tons of pink montmorillonite were also found in the pocket (Perham, 1987).

From 1923 to 1926, the Maine Feldspar Company of Auburn mined the pegmatite for feldspar. It was during this period that Landes (1925) provided the first detailed description of the minerals found in the Bennett quarry. In 1926, Harold C. Perham of West Paris obtained the lease and operated the mine until 1931. During the Perham operation, the farther end of the large pocket discovered by Merrill and Nevel was explored, revealing numerous milky and smoky quartz crystals, many of which are coated with small straw-colored hydroxyl-herderite crystals. Further excavation of a connecting chamber at the far end of the pocket revealed abundant dark green tourmaline crystals varying from 3 mm to 1.3 cm in diameter and from 5 to 10 cm long. A third pocket, discovered approximately halfway into the quarry and adjacent to the north wall, contained fine specimens of lepidolite and clusters of hydroxyl-herderite (Perham, 1987).

In 1931, the Whitehall Feldspar Company of Keene, New Hampshire, obtained the lease to the Bennett quarry and mined feldspar until 1933. Mining activities thereafter remained idle until 1944, when the United Feldspar and Minerals Company of West Paris leased the property and enlarged the pit to a depth of 22 meters. During the summer of 1942, the deposit was mapped by L. R. Page and J. B. Hanley, and again in 1945 by D. M. Larrabee and K. S. Adams (Cameron *et al.*, 1954). From 1945 to 1962, the quarry remained inactive. During the summer of 1962, Frank Perham mined the adjacent Orchard pit for blue and green beryl crystals. A few years later, a 30-meter hole was drilled in a small prospect pit about 70 meters north of the entrance to the Bennett quarry. The core consisted of about 7.5 meters of relatively fine-grained pegmatite underlain by 23 meters of gneiss with only two small pegmatite stringers about 15 and 21 meters below the surface (Barton and Goldsmith, 1968).

Sporadic activity characterized much of the 1970's and 80's, when quartz, hydroxyl-herderite, cookeite and columbite-tantalite crystals were found. The next significant mining activity began in the spring of 1989 when brothers Ron and Dennis Holden leased the mine and began mining operations (Holden, 1990). As many as 100 pockets, ranging from 30 cm to 1 meter in diameter, were found throughout the course of the first summer.

On October 7, 1989, a large pocket 3 meters long by 2 meters wide and 2 meters deep was discovered; it contained one of the largest and finest gem morganites ever collected from the New England pegmatite region. Nicknamed "The Rose of Maine," the crystal was 23 cm long and approximately 30 cm across the basal pinacoid. The color was orange-pink when found, but faded to a violet-pink color upon exposure to sunlight. It was situated on a matrix of giant quartz crystals, cookeite, and a large microcline crystal, the total weight of the "Rose" amounting to roughly 23 kg. Smaller morganites were also found in adjacent pockets (Thompson, 1989). The large morganite crystal has since been broken up for gem material.

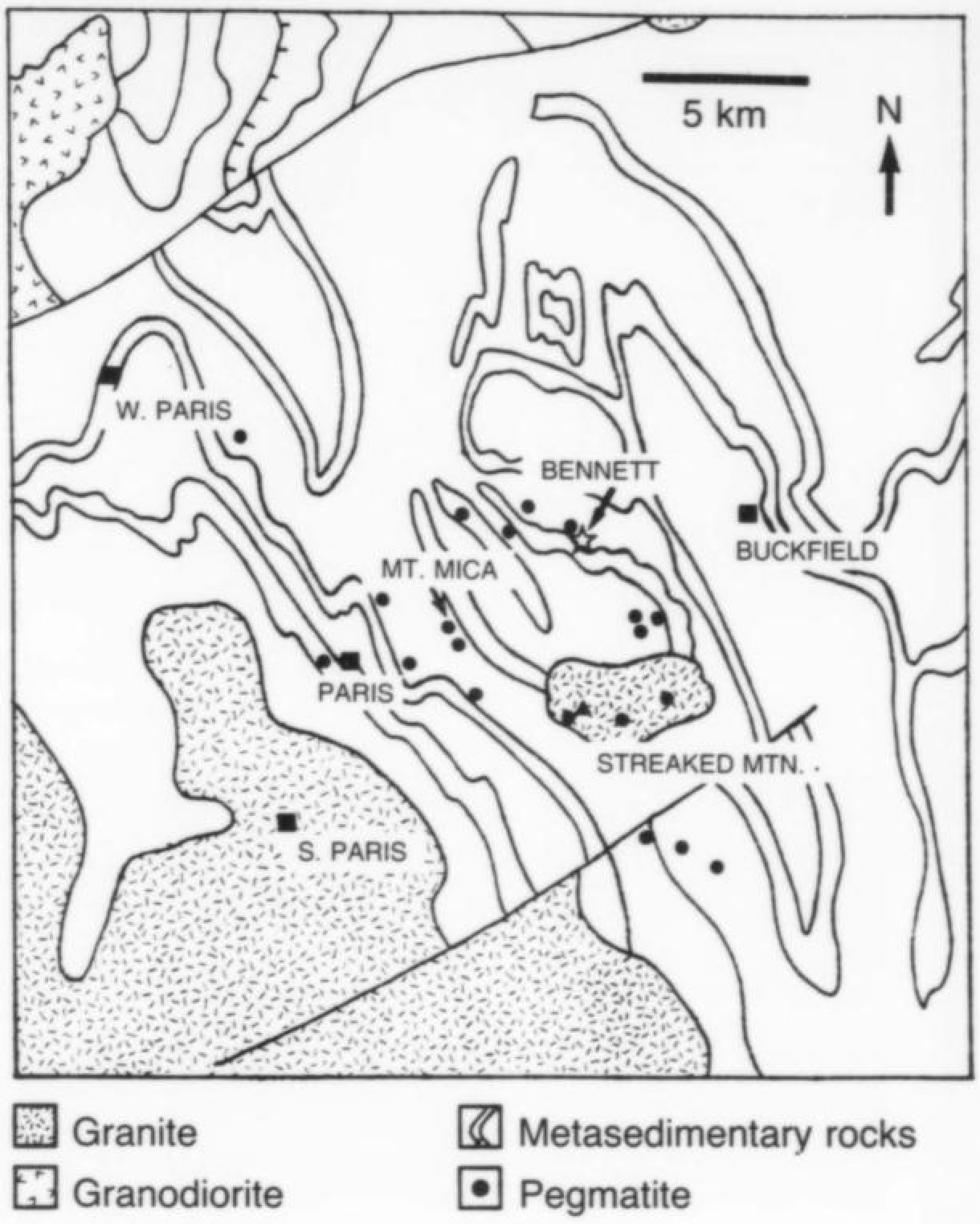

Figure 1. **Location and generalized geologic map of the Bennett quarry area.**

GEOLOGY

The pegmatite is located approximately 5 km west of Buckfield and 7 km northeast of Paris, just off Paris Hill Road, in Oxford County, Maine. The world-famous Mt. Mica mine is approximately 5 km west of the Bennett quarry along the same road. The geology in the vicinity of the Bennett pegmatite has been mapped by Warner (1967), Pankiwskyj *et al.* (1976) and Osberg *et al.* (1985) as a sequence of interbedded metasandstone, metapelite and limestone of Silurian age. The metamorphic grade of the rocks hosting the pegmatites of the area is upper amphibolite facies (Guidotti, 1989). These rocks have been intruded by the Carboniferous age (325 million years) Sebago Batholith, essentially a two-mica granite, the Streaked Mountain pegmatitic granite (Devonian ?) and numerous pegmatite bodies (Osberg *et al.*, 1985).

Landes (1925) concluded from surface exposures and early open cuts that the pegmatite was exposed in a strip approximately 200 meters wide, bounded by granite on the north and gneiss to the south. Landes describes the granite as a "fine-grained aplitic" rock with "occasional splotches of black tourmaline" upon which "quartz encroaches . . . extensively." A sample of the "granite" collected by Landes near the footwall of the pegmatite, and now stored in the Harvard Mineralogical Museum collection (HMM #14410), was examined by one of us (M.W.) and found to be identical to aplite bodies found within the pegmatite during this study.

The pegmatite crops out irregularly over a distance of approximately 380 meters and is roughly 200 meters wide at its maximum (Landes, 1925; Cameron *et al.*, 1954). It strikes east-west, dips 67–75° to the south, and is hosted by interbedded quartz-biotite schist, amphibolite and gneiss.

Internal Structure of the Bennett Pegmatite

The Bennett pegmatite is coarse-grained to very coarse-grained, well-zoned and mineralogically diverse. Cameron *et al.* (1954) provided the first detailed description of the internal zonation of the pegmatite. They described an aplitic border zone containing garnet, biotite, fluorapatite and schorl, a plagioclase-quartz-perthite wall zone, a quartz-perthite intermediate zone and a central body of quartz which may represent the true core. Miarolitic cavities, aplite and replacement units were also noted (Barton and Goldsmith, 1968), but their relationship to the primary zones was not adequately addressed. Recent mining at the quarry has provided an excellent opportunity to map the internal structure of the pegmatite in greater detail. A detailed geologic map of the Bennett pegmatite produced from this study is shown in Figure 4. Our study shows the internal zonation of the Bennett pegmatite to consist of a wall zone, two intermediate zones, a core-margin zone, a core and an aplitic unit. Much of the primary zonation in the western part of the quarry has been obscured by a cleavelandite-rich replacement unit. Our study of the pegmatite also shows that the zones as described by Cameron and co-workers are oversimplified,

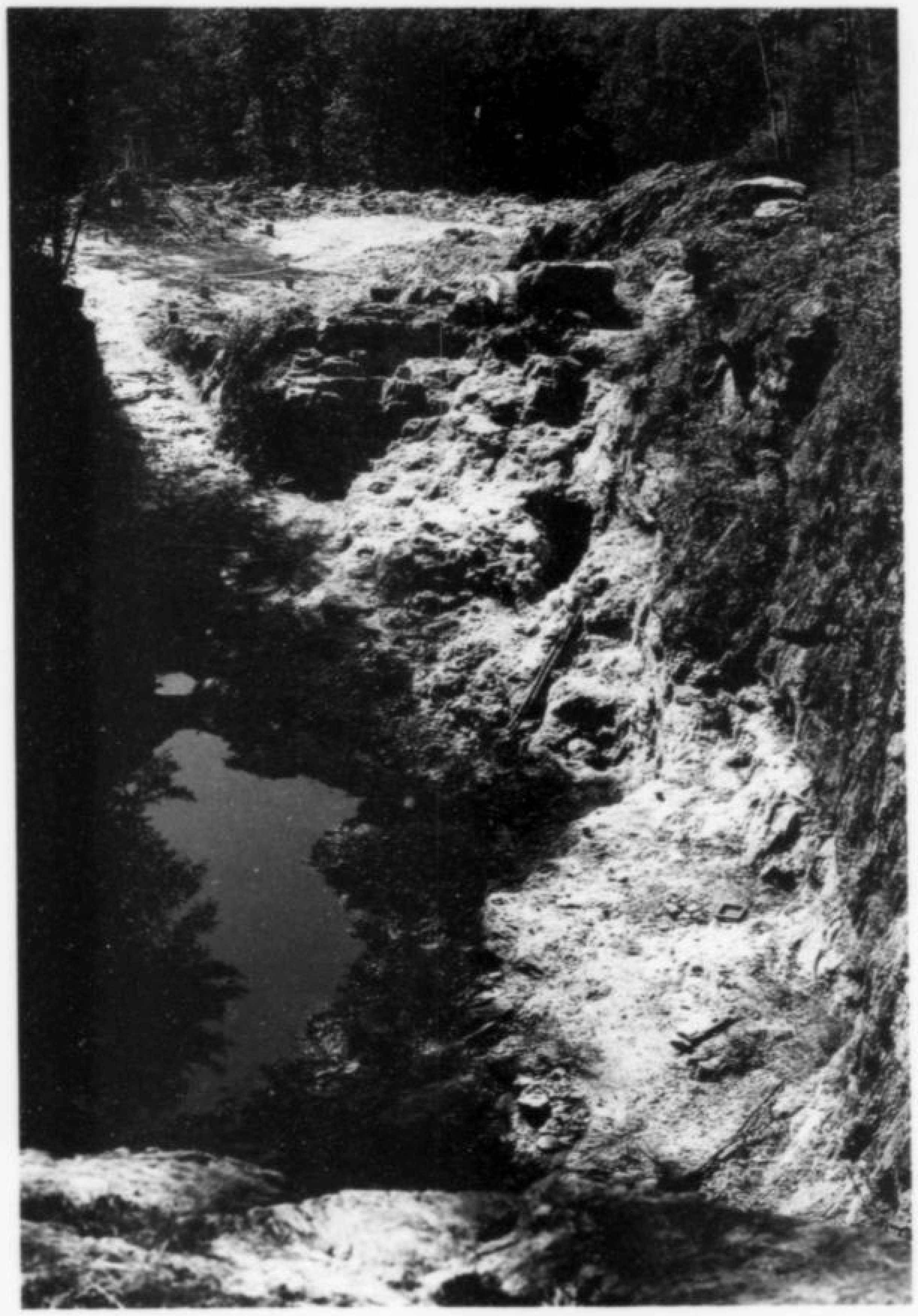

***Figure 2.* View of the Bennett quarry as it appeared in 1990. Photo by M. Wise.**

schist contact. Accessory reddish brown garnet occurs locally with biotite.

The wall zone grades into a first intermediate zone which is marked by the occurrence of abundant black tourmaline. This medium-grained to coarse-grained zone is dominated by plagioclase, sub-graphic K-feldspar and quartz. Biotite is generally absent in this zone, but does occur in association with xenoliths of quartz-biotite schist. The biotite blades are commonly oriented subnormal to the contact of the xenolith. Reddish brown garnet, which occurs in greater abundance than in the wall zone, is found disseminated throughout the zone and along the edges of biotite blades. Fine-grained flakes of muscovite are rare. Green fluorapatite crystals, typically less than 1 mm in diameter, occur sporadically throughout the zone.

The second intermediate zone consists largely of very coarse-grained blocky perthite, quartz, muscovite and accessory black tourmaline and green fluorapatite. Greenish to blue-green beryl is locally abundant. This zone has been partly replaced by the cleavelandite-rich unit in the west end of the quarry.

Blocky microcline, quartz, plagioclase and spherical green fluorapatite comprise the bulk of the core margin zone. Fluorapatite crystals reach a maximum dimension of roughly 10 cm, but are typically only 1 to 2 cm in diameter. Minor anhedral schorl, and columnar yellow-green beryl crystals up to 15 cm long are also found. Medium-grained muscovite plates are scattered throughout, and columbite-tantalite blades are rare.

The lens-shaped core is approximately 30 meters long, and consists of milky quartz and very coarse-grained, blocky, gray to tan perthitic microcline. Cleavage faces on some microcline crystals vary in size from 20 cm to 2 meters in length. Coarse-grained books of muscovite occur locally. Masses of arsenopyrite, up to 10 cm across, and blue-green beryl are rare.

A gray aplitic unit occupies the central portion of the pegmatite, and a second aplitic unit was found in contact with the first intermediate zone near the entrance of the quarry. They are both elongated along the long axis of the pegmatite body and are separated by the replacement unit. Smaller lenses and blocks are also found scattered within the pegmatite. The aplite consists of fine-grained equigranular quartz, albite, garnet and mica with abundant pea-sized poikilitic black tourmaline intergrown with quartz. Locally, the aplite becomes pale gray in color due to changes in the color and amount of muscovite. Fine-grained plates of muscovite, typically 0.5 mm long, vary in color

***Figure 3.* Excavated beryl-bearing pockets in the cleavelandite replacement unit along the north wall of the quarry.**

which may have simply been a result of the different level of exposure available at the time of their mapping. The internal zonation of the Bennett pegmatite observed during this study is described in detail below.

The wall zone consists of fine-grained to medium-grained plagioclase, with subordinate quartz, biotite and K-feldspar. Numerous xenoliths of quartz-biotite schist and gneiss occur throughout this zone. No tourmalinization of the xenoliths was observed along the pegmatite-

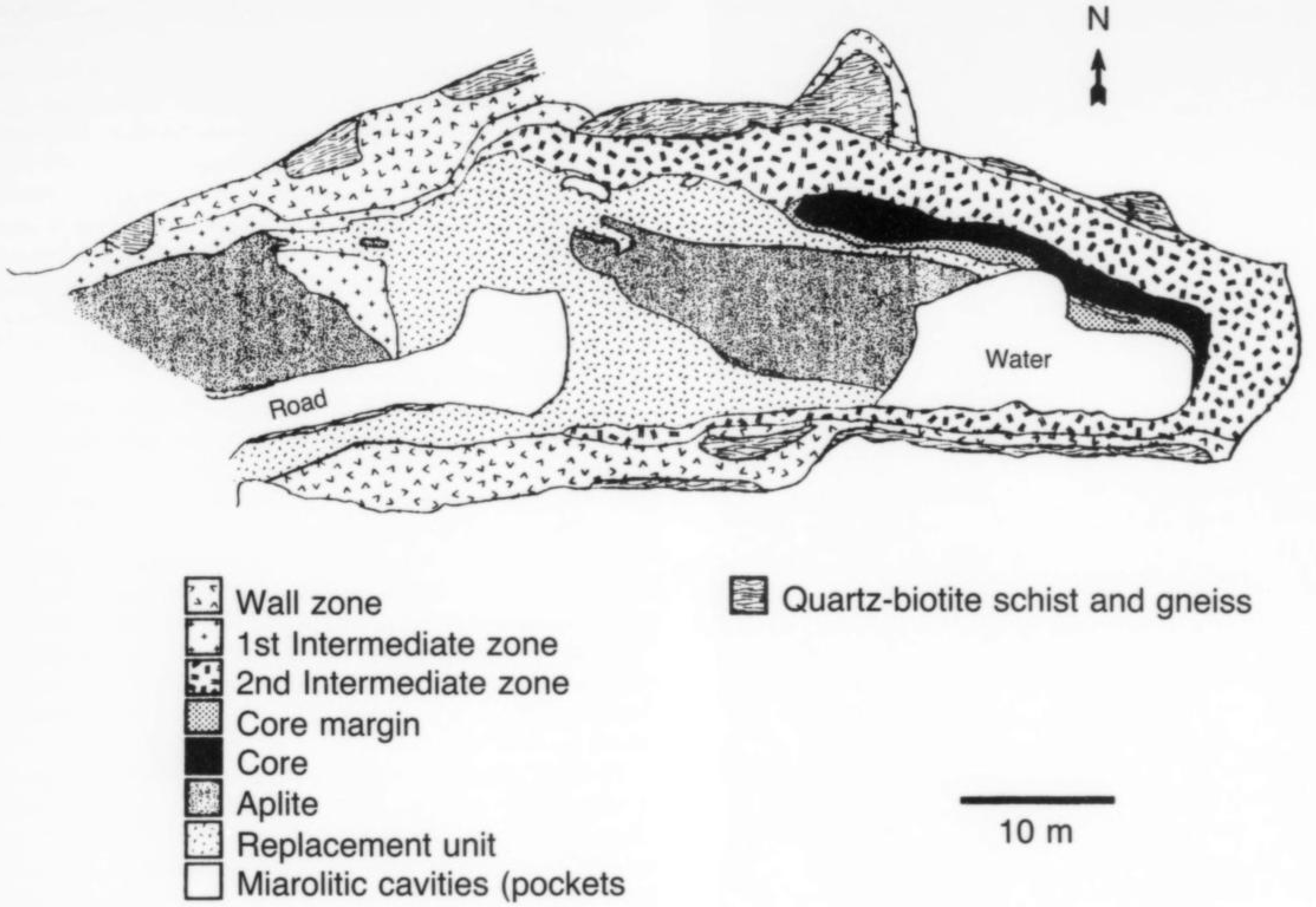

Figure 4. **Geologic map of the Bennett pegmatite.**

from silver to pale reddish brown. The garnets are generally less than 1 mm in diameter and are reddish brown to pink in color. Rare pale green fluorapatite is sparsely distributed throughout the unit.

The replacement unit consists of medium-grained to coarse-grained cleavelandite (albite) with accessory schorl, beryl, quartz, fluorapatite, muscovite and lepidolite. This unit can be seen cutting both intermediate zones and the aplite. Large crystals of yellow to greenish beryl up to 6 cm in diameter, as well as perthite crystals up to 30 cm long, occur within the replacement unit where it replaces the second intermediate zone. Isolated patches of pink montmorillonite occurs throughout the unit. A discontinuous band of large subhedral schorl crystals, some reaching 13 cm in diameter, occur along the contact of the replacement unit and the aplite and second intermediate zone. In all cases, however, the tourmaline is found only in the cleavelandite.

A "zone" of large pockets striking nearly east-west occurs near the contact of the replacement unit and the second intermediate zone in the west-central portion of the pegmatite (Fig. 4). The pockets vary in size from 2 to 4 meters long. All contain cleavelandite, cookeite and colorless, transparent to smoky quartz crystals; some are partly filled with clay or fine-grained to medium-grained fragments of pocket minerals ("pocket sand"). Pink or colorless beryl occurs in some pockets. Green to blue fluorapatite crystals up to 2 cm in length and 1 cm across, and manganotantalite crystals to 1 cm are restricted primarily to the morganite-bearing pockets. A layer of cookeite typically covers the bottom of pockets and contains numerous molds of an unknown bladed or prismatic mineral with diamond-shaped cross-section and longitudinal striations. Numerous small pockets, averaging roughly 30 cm in diameter by 15 to 20 cm deep, containing cleavelandite, lepidolite, cookeite, "pencil" elbaite, hydroxyl-herderite, rare columbite-tantalite, and pink clay; these pockets are usually restricted to cleavelandite veins cutting aplite.

Table 1. **Minerals found in the Bennett pegmatite, Oxford County, Maine.**

Sulfides	***Phosphates***	***Silicates***
Arsenopyrite	Autunite	Albite
	Carbonate-	Beryl
Oxides/Hydroxides	hydroxylapatite#	Biotite
Cassiterite	Eosphorite#	Chlorite
Columbite group:	Fairfieldite#	Cookeite
Manganocolumbite	Fluorapatite	*Garnet group:*
Manganotantalite	Gorceixite	Almandine
Ferrotapiolite	Goyazite*	Spessartine
Manganite (?)	Hureaulite	Kaolinite
Psilomelane#	Hydroxyl-herderite	Lepidolite
Romanechite (?)	Landesite	Microcline
Uraninite*	Lithiophilite#	Montmorillonite
Wodginite	Montebrasite#	Muscovite
	Reddingite#	Pollucite#
Carbonates	Roscherite+	Quartz
Calcite*	Triphylite#	*Tourmaline group:*
Rhodochrosite#		Schorl
Siderite		Elbaite
		Spodumene#
		Topaz#
		Zircon+

Minerals denoted by (#) were reported by Landes (1925), (+) by Morrill (1959) and (*) by Seaman (1975). Hureaulite was reported by P. Heaney (written communication, 1987). Gorceixite was reported by M. Brownfield (personal communication, 1991); landesite was reported by V. King (personal communication, 1992).

MINERALOGY

A thorough description of the Bennett quarry mineralogy has been given by Landes (1925); since that study only a few new species have been found. The mineralogy of the Bennett pegmatite is quite similar to a number of pegmatites in western Maine, particularly Mt. Mica. Table 1 provides a list of the minerals identified by us during this study and by previous authors. Many of the minerals described by Landes were not observed by us *in situ*; however, the original material collected by Landes was made available to us courtesy of the Harvard Mineralogical Museum. The following descriptions are based on our study of this material and on observations made in the field.

Albite $NaAlSi_3O_8$

Albite is a major constituent of the pegmatite, comprising the bulk of the replacement unit and aplite. Coarse-grained, white to gray cleavelandite ($Ab_{98}Or_1An_1$) occurs within the replacement unit and pocket areas of the pegmatite as platy, radiating and reticulated aggregates. Individual plates vary in thickness, typically less than 3 mm but up to 8 mm. Within the aplite, albite occurs as subhedral to anhedral grains less than 0.5 mm across. An analysis of albite from the aplite gave a composition of $Ab_{98.4}Or_{0.5}An_{1.1}$. Albite lamellae up to 1 mm thick can be observed in blocky microcline from the second intermediate zone, core and core margin of the pegmatite.

Electron microprobe analyses of fluorapatites from the Bennett pegmatite show variable concentrations of Mn and Fe (Table 2). The dark green varieties contain up to 9.2% MnO and 0.2% FeO (HMM #14440) while blue, aqua and pale green crystals from pockets have typically less than 0.5% MnO and practically no Fe. Fluorapatite inclusions from the aplite are only slightly more enriched in Fe (0.4% FeO) with minor Mn (1–2% MnO).

Carbonate-hydroxylapatite occurs as dark yellowish green encrustations and overgrowths on fairfieldite and eosphorite. Its occurrence appears to be restricted to the rhodochrosite-eosphorite-fairfieldite assemblage.

Arsenopyrite FeAsS

Arsenopyrite occurs as rare silver-gray masses with muscovite in the core of the pegmatite. A twinned crystal was found in chlorite.

Beryl $Be_3Al_2Si_6O_{18}$

Beryl is abundant in the second intermediate zone and core margin of the pegmatite but is rare in the core and pocket zone. Beryl from the second intermediate zone and core margin varies in color from yellow to green. Aquamarine can be found rarely in the core and near the pocket zone. The crystals are prismatic and have well-developed pinacoid faces.

***Table 2*. Representative electron microprobe analyses of fluorapatite from the Bennett pegmatite.**

Zone	*Color*	*CaO*	*MnO*	*FeO*	P_2O_5	*F*	Σ	*O=F*	*Total*
Core Margin (HMM #14440)	Dk. green	45.79	9.17	0.19	41.26	3.76	100.17	1.58	98.59
Pocket I	Green	54.81	0.17	0.04	41.89	4.26	101.17	1.79	99.38
	Blue	54.47	0.34	0.04	41.96	3.60	100.41	1.52	98.89
Pocket II (HMM #14477)	Lt. green	55.51	0.17	0.04	42.09	3.50	101.31	1.47	99.84
Pocket III	Aqua	55.97	0.08	0.05	42.21	3.19	101.50	1.34	100.16
Aplite	—	55.47	1.85	0.36	40.92	n.d.	98.81	—	98.81
Replacement Unit	Gray	54.60	0.82	0.04	41.28	4.31	101.05	1.81	99.24
HMM #14455)	White	54.97	0.60	0.04	42.41	3.81	101.83	1.60	100.23

Amblygonite-Montebrasite $LiAlPO_4(F,OH)$

Amblygonite-montebrasite occurs as rare fine-grained gray masses and white nodules within the pegmatite. The zone from which this material was collected is unknown. The fine-grained material is associated with microcline or rhodochrosite. The white nodules are rimmed by beige kaolinite and are associated with cleavelandite and lepidolite.

Apatite

Fluorapatite $Ca_5(PO_4)_3(F,OH)$

Carbonate-hydroxylapatite $Ca_5(PO_4,CO_3)_3(OH)$

Fluorapatite is a major component of the core margin and is locally abundant in the intermediate zones, replacement unit and in some pockets of the pegmatite. Fluorapatite occurs as dark green, nearly spherical, subhedral to anhedral grains in the core margin zone and replacement unit. Some grains have bluish or white rims which fluoresce yellow-orange under ultraviolet light. Fluorapatite occurs as rare, isolated grains and inclusions in tourmaline and garnet within the aplite.

Stubby blue to pale green fluorapatite crystals occur as rare constituents in some pockets where they are associated with cleavelandite, quartz, columbite and herderite. Some crystals are zoned yellow, colorless, green or blue parallel to {0001}. Fluid and solid inclusions are common in pocket fluorapatites. These fluorapatites also show yellow-orange fluorescence, but not as intense as those described above.

Pale pink to orange-pink beryl (morganite) is a rare occurrence in the pocket zone of the pegmatite. These beryl crystals vary in habit from columnar to stubby. In late 1989, one pocket was found that yielded several stubby morganites, the largest reaching 8 x 10 cm. Another pocket only a few meters away contained the "Rose of Maine," a blocky, 23 x 33-cm, columnar morganite, probably the finest ever found in Maine. About 117,000 carats of morganite were recovered from the two pockets for gem-cutting purposes. Unlike the beryl from the main portion of the pegmatite, pocket beryls typically show well-developed prism faces, basal pinacoids and bipyramid faces. Colorless to milky white beryl occurs infrequently in the pocket zone as small tabular crystals with etched bipyramid and prism faces.

Biotite $K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)$

Biotite occurs primarily as black flakes in the wall zone but may also be found as elongated blades up to 10 cm long near the margins of schist xenoliths. Books of biotite up to 5 cm thick are rare.

Cassiterite SnO_2

Black to dark reddish brown masses of cassiterite, up to 90 kg, occur in pockets with quartz and cookeite. A single sharp pyramidal crystal was observed by Landes (1925) in cleavelandite. Twinned crystals are present, but rare.

Cookeite $LiAl_4(Si_3Al)O_{10}(OH)_8$

Cookeite occurs in pockets, as greenish to beige crusts coating tourmaline, microcline, albite, muscovite and lepidolite. Cookeite

Figure 5. Pale blue fluorapatite crystals from a small pocket in the replacement unit. Photo by Russell Feather.

Figure 6. Radiating aggregate of manganotantalite, 3 cm, from the pocket zone. Ron Holden, Jr. specimen. Photo by Chip Clark.

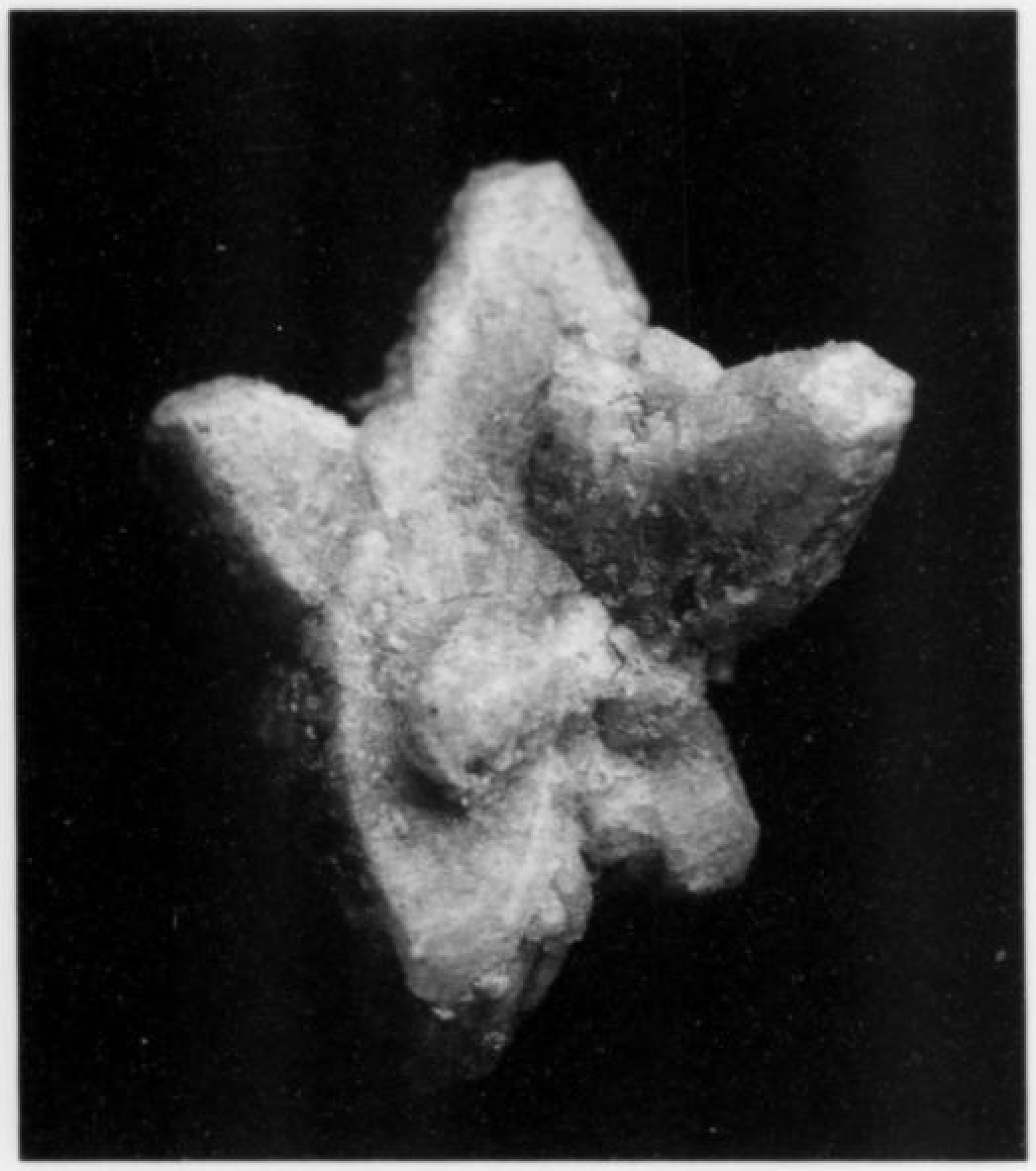

Figure 7. Cluster of hydroxyl-herderite crystals, 2.5 cm, from the "Rose of Maine" pocket. Ron Holden, Jr. specimen. Photo by Chip Clark.

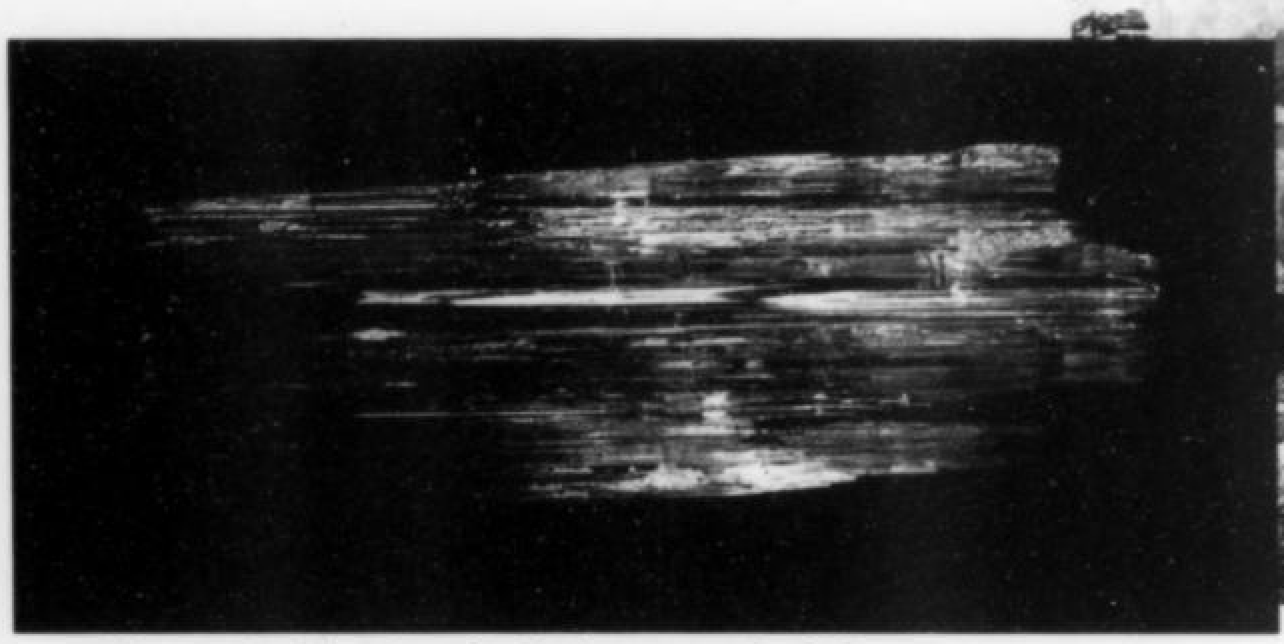

Figure 8. Bi-colored elbaite crystal, 2.3 cm, from the Bennett pegmatite. Woodrow Thompson specimen. Photo by John Poisson.

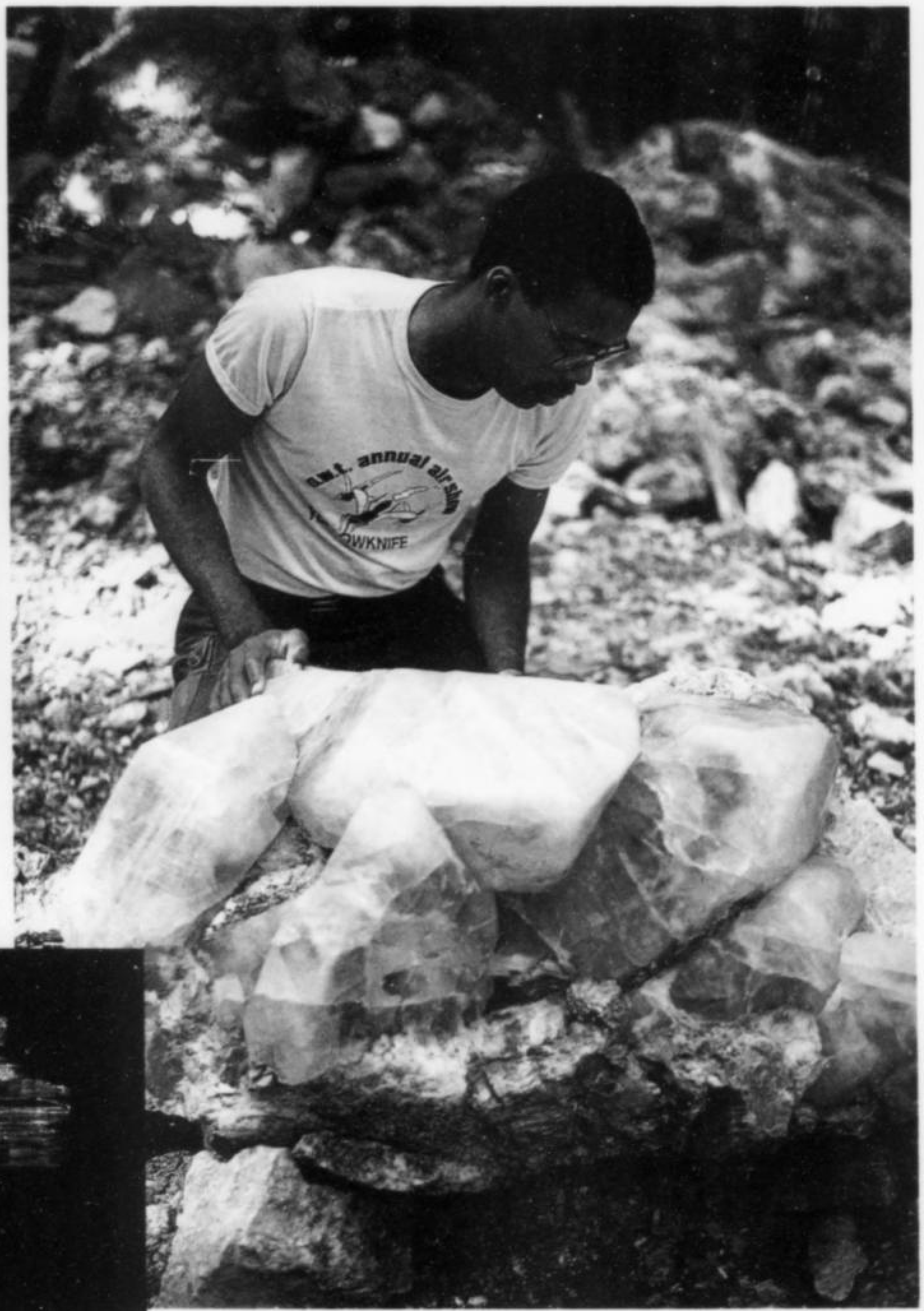

Figure 9. Giant milky quartz group weighing approximately 275 kg. Photo by T. R. Rose.

Figure 10. **The "Rose of Maine" morganite before removal from the pocket. Photo by Wayne Flanders.**

from some pockets has drusy quartz crystals on the surface. A brownish pink to brownish green fibrous cookeite was observed in the replacement unit, presumably a late alteration of primary spodumene.

Eosphorite $MnAl(PO_4)(OH)_2 \cdot H_2O$

Well-developed honey-colored, acicular to prismatic crystals of eosphorite occur intimately associated with rhodochrosite. Eosphorite crystals are typically striated along their length and may reach a maximum dimension of 1.5 cm. The crystals often are found as reticulated or radial aggregates.

Fairfieldite $Ca_2(Mn,Fe)(PO_4)_2 \cdot 2H_2O$

Fairfieldite occurs as transparent and colorless to yellowish crystals when fresh, and becomes chalky white when slightly altered. It occurs with rhodochrosite and eosphorite on albite and muscovite.

Garnet

Almandine $Fe_3Al_2(SiO_4)_3$

Spessartine $Mn_3Al_2(SiO_4)_3$

Garnet is uncommon throughout much of the pegmatite, but is

Figure 11. **Beryl and fluorapatite from the core margin of the Bennett pegmatite. Photo by R. Bentley.**

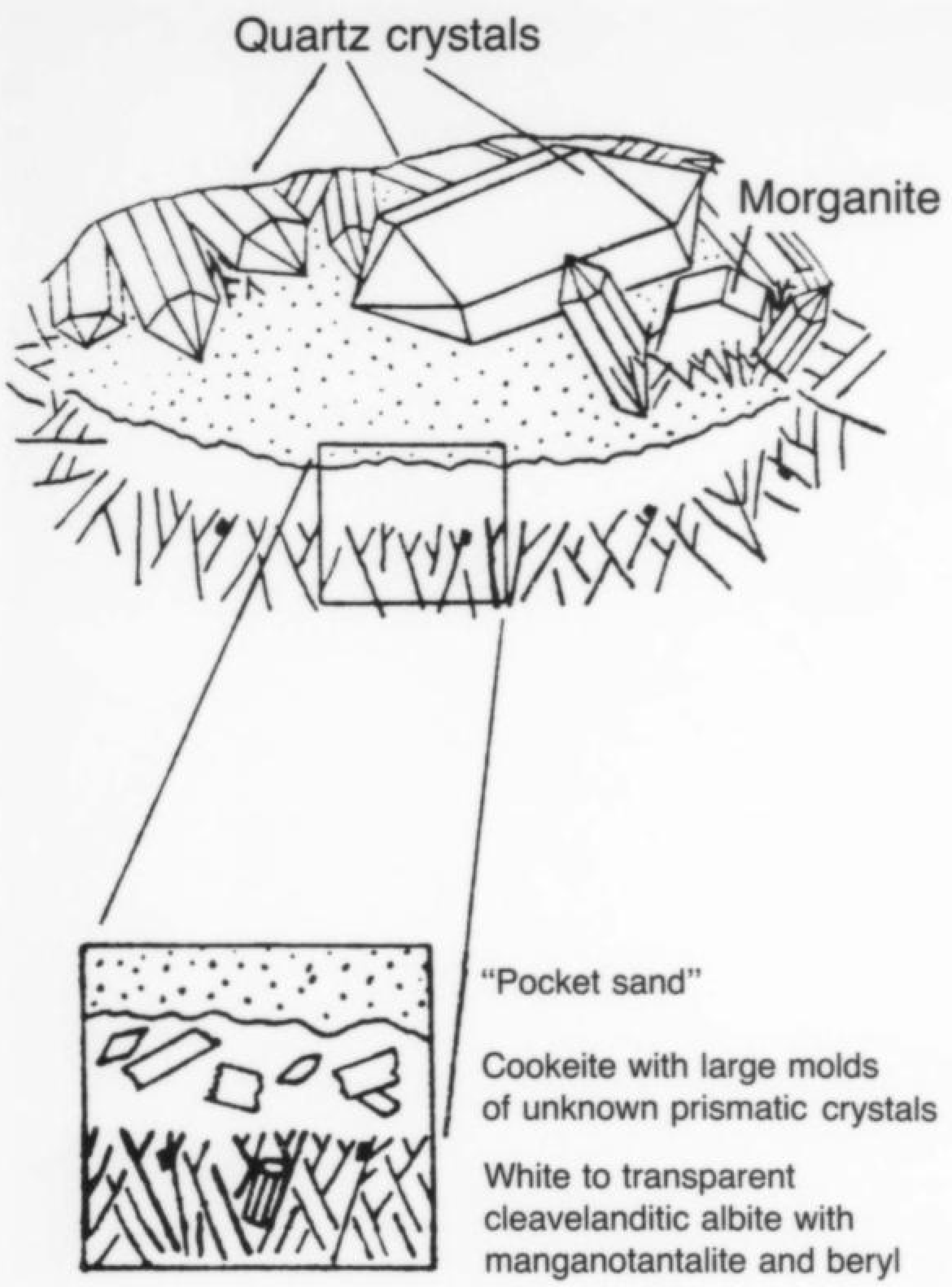

***Figure 12*. Schematic diagram of a large pocket. The pocket is entirely within the cleavelandite replacement unit. Height of pocket is approximately one meter.**

locally abundant in the wall and first intermediate zone, the aplite, the replacement unit and the xenoliths of quartz-biotite gneiss. The garnets are euhedral to subhedral in shape and reddish brown to pink in color. The grain size is fairly uniform, generally 1 mm across and rarely larger than 3 mm. Rare pink garnets, less than 0.5 mm across, were observed in cleavelandite and cookeite pocket material.

Garnet compositions range from predominantly almandine in the outer zones toward spessartine near the pocket zone. The average garnet composition from the wall zone is about $Alm_{77}Spess_{23}$. A mass of reddish orange (pocket?) garnet (HMM #14442) collected by Landes (1925) is strongly enriched in the spessartine component ($Spess_{60}Alm_{40}$). Garnets from the primary zones show little compositional zoning. In contrast, garnets from the aplite and replacement unit are strongly zoned; compositions from a single crystal can vary from $Alm_{76}Spess_{24}$ in the core to $Spess_{60}Alm_{40}$ in the rim.

Hydroxyl-herderite $CaBe(PO_4)(OH)$

Yellowish crystals of hydroxyl-herderite up to 3 cm long occur in the pocket zone of the pegmatite and in some solution cavities. They are usually found on quartz crystals, but also occur on crusts of cookeite and fine-grained lepidolite that coat pocket quartz and albite.

Lepidolite $K(Li,Al)_3(Si,Al)_4O_{10}(F,OH)_2$

Silvery to lilac-colored lepidolite is found in the second intermediate zone, in the replacement unit and in pockets. Coarse-grained books commonly show curved faces and are often intergrown with muscovite. Zoned muscovite-lepidolite crystals are rare. In isolated occurrences, crystals of muscovite can be seen grading into lepidolite over an area of a few centimeters.

Fine-grained purple lepidolite forming leafy veins and ridges was collected by Landes (1925). This material is apparently a replacement of an earlier phase. It has been observed as veins in pollucite and altered spodumene (Landes, 1925).

Manganocolumbite-Manganotantalite $MnNb_2O_6$-$MnTa_2O_6$

Crystals of manganocolumbite-manganotantalite occur primarily in the pocket zone of the pegmatite and rarely in the replacement unit. Although most appear black and opaque in a hand sample, many are actually a translucent, dark reddish brown color. Color zoning (black rims, reddish cores) is evident in some crystals. The luster of most crystals is submetallic, with a bluish iridescent oxidation coating. The crystals show euhedral to subhedral, platy and blocky habits, are up to 5 cm in length, and occur with cleavelandite, quartz, fluorapatite and lepidolite of the pocket assemblage. The entire assemblage is typically coated by cookeite. Manganocolumbite-manganotantalite crystals from the replacement unit occur embedded in coarse-grained cleavelandite associated with quartz, yellow beryl and zircon. The crystals are generally bladed and sometimes form radiating aggregates.

Electron microprobe analyses show a strong concentration of Mn relative to Fe with variable Nb/Ta ratios. The structural formulas based on 12 oxygens range from: $(Mn_{1.80}Fe_{0.15})_{\Sigma 1.95}(Nb_{2.20}Ta_{1.74}Ti_{0.09})_{\Sigma 4.03}O_{12}$ to $(Mn)_{1.97}(Ta_{3.41}Nb_{0.54}Ti_{0.02})_{\Sigma 4.01}O_{12}$.

Microcline $KAlSi_3O_8$

Microcline is the second most abundant mineral next to quartz in the Bennett pegmatite. It is found in all zones, but is most prevalent in the second intermediate zone and core where subhedral crystals up to 2 meters long have been found. Microcline from the core is subhedral, blocky and coarsely perthitic. It varies in color from white to pale brown, and contains inclusions of muscovite and fluorapatite. Microcline from the second intermediate zone is also perthitic and contains coarse-grained blebs of gray to white quartz, while the first intermediate zone microcline is significantly more graphic, less perthitic, and is intergrown with tourmaline and blocky plagioclase.

Euhedral crystals of gray microcline can be found within some pockets. They are perthitic and are often overgrown with late cookeite and quartz. Occasionally, the microcline is found heavily corroded.

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

Books of silvery muscovite are common in the intermediate zones and around the margins of the core. The books often show a diamond-shaped habit with curved faces. Near pockets in the replacement unit, muscovite grades into lepidolite. Within the aplite, muscovite occurs as fine-grained, pale brown flakes. Preliminary microprobe analyses of muscovite from the aplite show elevated Fe contents.

Quartz SiO_2

Quartz is ubiquitous throughout the entire pegmatite. It occurs within the wall and first intermediate zones as anhedral, colorless, gray or smoky colored sub-graphic intergrowths with K-feldspar. Massive milky quartz forms a large portion of the quartz and microcline core. The aplite contains gray to colorless, anhedral quartz.

Well-developed crystals of milky, smoky and smoky-citrine quartz are found only in the pockets of the pegmatite. Specimens found recently reach a maximum dimension of several centimeters, although crystals up to 300 kg were recovered in the 1920's. The crystals may be attached to the pocket walls, or may be completely surrounded by pocket clay. They are commonly flattened along the *c*-axis or found in parallel groups. Drusy quartz crystals are common as late overgrowths on earlier formed pocket minerals, particularly cookeite, tourmaline and early quartz.

Reddingite $Mn_3(PO_4)_2 \cdot 3H_2O$

Dark reddish brown to orange crystals and veinlets of reddingite cutting lithiophilite occur as part of a late secondary assemblage which includes rhodochrosite, quartz, fairfieldite and manganese oxides. The crystals are typically less than 1 cm long and are commonly striated along their length.

Rhodochrosite $MnCO_3$

Rhodochrosite was described by Landes (1925) as anhedral masses up to 10 cm across and as rare small crystals associated with eosphorite. Rhodochrosite also occurs as medium-grained pink rhombohedrons on quartz or amblygonite. Veinlets of rhodochrosite cutting earlier minerals have also been observed.

Spodumene $LiAlSi_2O_6$

No fresh spodumene was observed in the pegmatite; however, several cookeite pseudomorphs showing spodumene crystal outlines were found by Landes (1925) and during recent mining. The pseudomorphs occur in the replacement unit near pockets.

Tourmaline

Schorl $NaFe_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$

Elbaite $Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$

Tourmaline is a common accessory phase in the Bennett pegmatite and is found in most zones of the pegmatite, as well as in the aplite and replacement unit. Schorl is typical of the first and second intermediate zones and replacement unit of the pegmatite, ranging in size from a few millimeters long in the first intermediate zone to several centimeters in the replacement unit. Zoned tourmaline crystals, with black cores and greenish rims, are sometimes observed in the second intermediate zone. Within the aplite, poikilitic schorl is common, giving the aplite a "spotted" appearance.

Dark to pale green and pink elbaite is restricted primarily to the pocket assemblage associated with the cleavelandite-rich replacement unit. These tourmalines are usually slender "pencils" less than 1 cm in diameter. "Watermelon" (green rim, red core) and "cucumber" (green rim, white core) tourmalines are rare. Water-clear elbaite occurs as overgrowths on green "pencil" elbaite in some pockets. The pocket tourmalines are often partially coated by cookeite and clay.

Triphylite-lithiophilite $Li(Fe,Mn)PO_4$

Lithiophilite was observed by Landes (1925) as rare salmon-pink to pink masses in quartz and cleavelandite. Considerable Mn-oxide alteration crusts occur at the lithiophilite-quartz interface. A single mass of dark bluish gray triphylite was also identified by Landes (1925). The zone(s) in which these minerals occur is unknown.

Electron microprobe analyses of triphylite-lithiophilite show a considerable range of Mn/(Mn + Fe) ratios for the series. Triphylite (HMM #86789) is notably Fe-rich (Mn/(Mn + Fe) = 0.38), while the lithiophilite (HMM #88599 and #86792) approaches the end-member composition (Mn/(Mn + Fe) = 0.91).

Zircon $ZrSiO_4$

Zircon is sparingly present as isolated, euhedral to subhedral brown crystals intimately associated with cleavelandite, tourmaline, manganocolumbite and fluorapatite in the replacement unit. The crystals vary in size from 3 mm to 1 cm long and show well-developed first-order pyramids and partially formed first and second-order prisms.

Other Minerals

Other minerals worth mentioning from the quarry include **pollucite**, $(Cs,Na)_2Al_2Si_4O_{12}\cdot H_2O$, which was observed by Landes (1925) as rare, glassy grains veined by fine-grained lepidolite. A single white, but slightly altered, crystal of **topaz** approximately 7 cm long was also found by Landes. **Hureaulite**, $Mn_5(PO_4)_2[PO_3(OH)]_2\cdot 4H_2O$, was not observed by the authors, but was identified by Dr. Peter Heaney (unpublished data of Heaney, 1987). This material is stored in the collection of the Harvard Mineralogical Museum.

Electron microprobe studies of niobium-tantalum oxide minerals from the Bennett pegmatite revealed microscopic inclusions of **wodginite**, $(Mn,Fe)Sn_2Ta_2O_8$, in manganotantalite from pockets. Electron microprobe analyses show that the wodginite contains nearly 20% SnO_2.

Greenish-gray **chlorite** was identified from the eastern portion of the quarry by X-ray powder diffraction. Microscopic examination of this material showed the presence of elongated grains of **siderite** interlayered with chlorite.

PEGMATITE GENESIS

The origin of the Maine pegmatites has been the subject of much speculation and little scientific study. It is generally assumed that many of the pegmatites of western Maine (particularly those of the West Paris, Greenwood and Mt. Apatite areas) are related to the Carboniferous-age Sebago granitic batholith (Guidotti *et al.*, 1986; King, 1987). Much of this speculation is based on the close proximity of the pegmatites to the granite. There is little evidence at present to support or reject a Sebago granite-pegmatite genetic relationship. However, preliminary field observations suggest that a pegmatitic granite on Streaked Mountain, approximately 2.5 km south of the Bennett pegmatite, might also be a possible parent for at least the pegmatites to its immediate north and west. These pegmatites include not only the Bennett, but also the Mt. Mica, the pollucite-bearing Westinghouse and General Electric pegmatites and a number of other beryl-bearing and columbite-bearing pegmatites.

The Bennett pegmatite appears to have crystallized from a geochemically evolved, hydrous silicate melt enriched in Be, Nb, Ta, B and F. Following emplacement of the pegmatite, crystallization occurred from the outer zones inward toward the core. The timing of the aplite crystallization is difficult to ascertain at this time, although the presence of aplite blocks in the first intermediate zone suggests that the aplite formed during the early stages of pegmatite consolidation. There is no question that the cleavelandite-rich replacement unit was a late crystallization event, as it is observed replacing most of the intermediate zones in the western part of the quarry, transecting the aplite and to a lesser extent replacing parts of the core.

The formation of pockets such as the "Rose pocket" appears to have coincided with the formation of the replacement unit and may have been triggered by a late stage of tourmaline crystallization. Following this stage, the residual fluid was enriched in incompatible elements (Nb, Ta, Sn, Rb, Cs, Li), volatiles (B, F) and water. As boron was removed from the solution by tourmaline crystallization, large quantities of aqueous fluid exsolved from the sodium-rich, silicate melt while alkali aluminosilicates and oxide minerals precipitated (London, 1986). This is strongly supported by the abundance of large quantities of tourmaline, beryl and columbite-tantalite in the replacement unit.

The pockets occur wholly within the replacement unit or at its contact with primary zones. They are generally boron-poor as evidenced by the general paucity of gem tourmaline. Many of these "gem pockets" contain abundant quartz with accessory morganite or herderite, which reflects their general enrichment in Be and Cs. Manganapatite, and manganocolumbite-manganotantalite are often found in the walls and floor of these pockets. Conversely, pockets containing appreciable gem tourmaline contain abundant lepidolite and, in general, lack the above-mentioned minerals. Still, other pockets are only quartz-bearing.

Many of the primary pocket minerals show signs of pocket rupture and chemical corrosion. Crystals of tourmaline, hydroxyl-herderite and manganocolumbite-manganotantalite found in the floor of the pockets are often broken, shattered or highly fractured. Beryl crystals and occasionally pocket microcline are commonly etched. Overgrowth of a later generation of the same species are also evident (e.g. colorless elbaite on green elbaite, drusy quartz crystals on flattened quartz crystals). Cookeite generally occurs as coatings on all earlier-formed pocket minerals.

CLOSING REMARKS

The Bennett pegmatite is in many respects typical of the rare-element granitic pegmatites found in western Maine. It shows well-developed internal zonation and is marked by a diverse array of mineral assemblages. As in many of the area's other pegmatites, gem-quality and specimen-quality tourmaline and beryl highlight the mineralogy. The Bennett pegmatite is exceptional in that it contains abundant aplite, unlike most of the other rare-element pegmatites in Maine, and it is also one of the few Maine pegmatite localities to display extensive replacement of primary zones.

The present data are insufficient to adequately address the problems of pegmatite evolution and genetic relationships with its parental granitic intrusion. Detailed mineralogical and geochemical studies aimed at solving these problems are currently in progress.

ACKNOWLEDGMENTS

The authors wish to thank Mr. and Mrs. Paul Bennett, of Bennett Brothers Farms, Inc. and Sugar Hill Minerals for unlimited access to the pegmatite. We also wish to thank and acknowledge the help of Dr. Carl Francis of the Harvard Mineralogical Museum for providing specimens to study.

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The Prospect intrusion is a small, differentiated dolerite laccolith containing shrinkage cavities and miarolitic cavities lined with a variety of interesting minerals including prehnite, pectolite, analcime, albite and pyroxene.

HISTORY

The first mention made of Prospect Hill was in 1789 when Captain Tench observed the barrier of the Blue Mountains to the west from its summit. The area was attractive to farming due to the richness of the soil and a two-square-kilometer grant was taken up by Lt. William Lawson in the late 18th century.

The outcropping chilled margin of basalt was noted by Charles Darwin in 1836 and it was mentioned in his writings on the voyage of the *Beagle*. The columnar nature of the basalt exposed in a small quarry was pointed out to J. D. Dana by geologist Rev. W. B. Clarke when the American Fleet moored in Sydney Cove in 1839 (Dana, 1849).

Road surfacing material has been obtained from Prospect Hill since the early 1830's, long before Government Geologist C. S. Wilkinson reported on the economic potential of the deposit in 1879. Prospect quarry itself was opened as the Emu quarry in 1883 by Sperring and Partner, who were bought out by Emu and Prospect Gravel and Road Metal company in 1900. The latter company was in turn taken over in 1919 by New South Wales Blue Metal and the name changed to New South Wales Associated Blue Metal Quarries. Blue Metal Industries was formed in 1954 and this company was recently bought out by Boral Resources (N.S.W.) Pty. Ltd., who continue to operate the Prospect quarry on a large scale (Clark, 1976).

GEOLOGY

The intrusion forms a prominent landmark which rises to 60 m above the surrounding country and 122 m above sea level. It is 2.4 km long and 1.4 km wide. The periphery of the intrusion has been exposed by erosion and this, together with its proximity to the rapidly expanding city of Sydney, 29 km to the east, led to its early exploitation as a source of construction material.

The Prospect Intrusion is a Jurassic doleritic laccolith emplaced concordantly between Triassic deltaic Hawkesbury Sandstone and the overlying lacustrine Ashfield Shale member of the Wiannamatta Group, also of Triassic age. Thin remnants of the Ashfield Shale underlie the intrusion in some areas.

The igneous body was intruded at shallow depth, as indicated by the prominent chilled margins of basalt produced by high heat differential between the relatively cool (and probably wet) sediments and the magma. Maximum contact temperature appears to have been around 500–600° C (Nashar, 1967). Despite the initial high temperature of the magma indicated by the mineralogy of the intrusion (900–1000° C), the shales above and below have reached only very low levels of metamorphism and show superficial alteration to a fine quartz hornfels with virtually no increase in grain size. The development of any significant metamorphic aureole was prevented by minimal escape of heat and volatiles beyond the insulating chilled margins. The retained heat also allowed very slow cooling, during which differentiation of the basaltic magma occurred, producing a layered intrusion composed of at least seven distinct rock types, with analcime dolerite (teschenite) and picrite forming the bulk of the intrusion.

The abundance of analcime in the rocks toward the top of the intrusion indicates significant retention of magmatic water during crystallization. During the final stages of magma crystallization, residual hydrothermal fluids become concentrated adjacent to the upper chilled margin and were localized in horizontal lenticular shrinkage fissures, often extending laterally for tens of meters within the coarse analcime dolerite. Here the abundance of free water, high temperatures and resultant ease of element diffusion promoted the formation of pegmatite bodies composed of anhedral to subhedral pyroxene, hornblende, plagioclase and analcime crystals to over 2 cm in diameter, analcime being the last of the minerals to form. Other shrinkage cavities deeper within the coarse analcime dolerite were occupied by

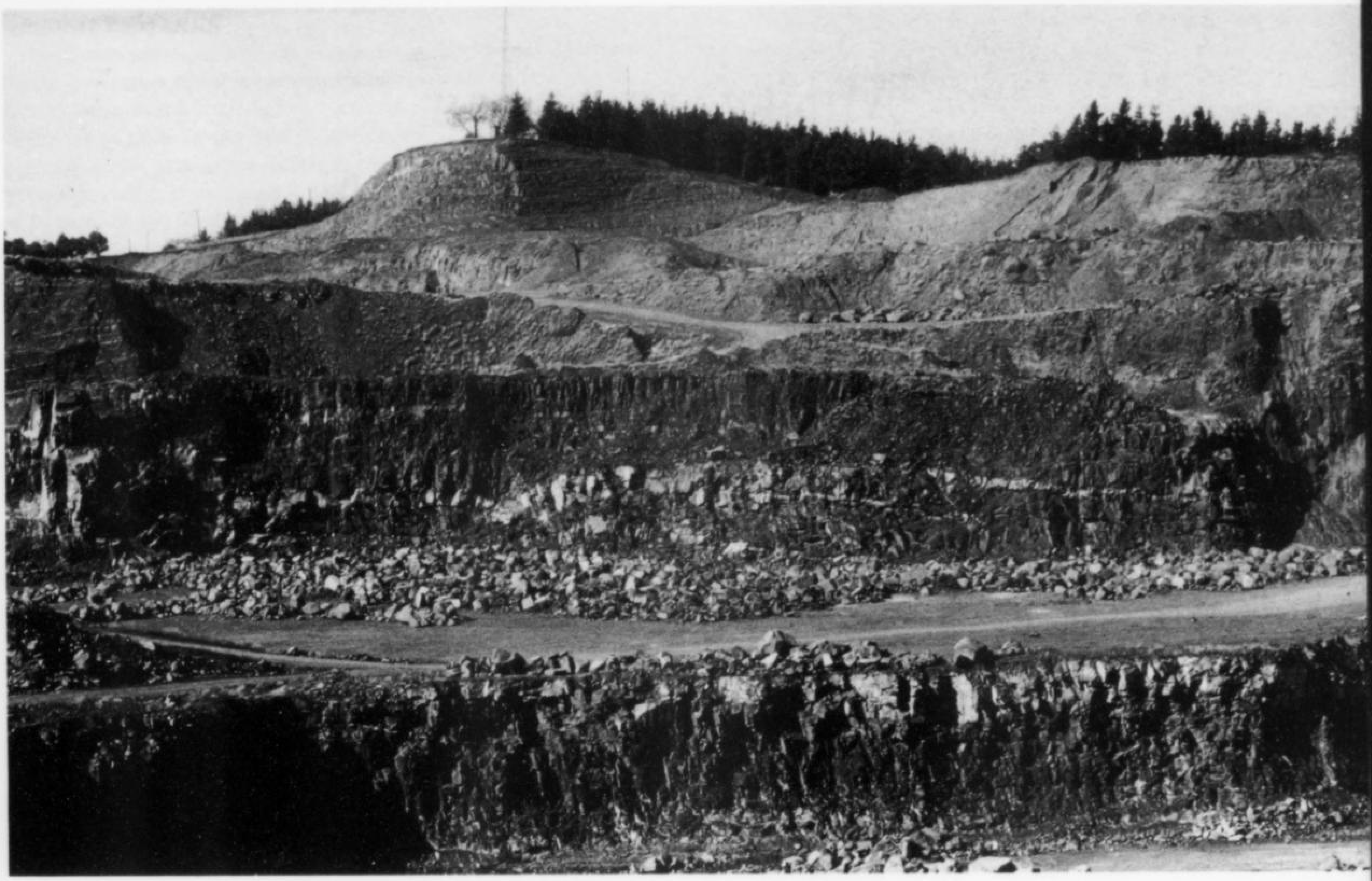
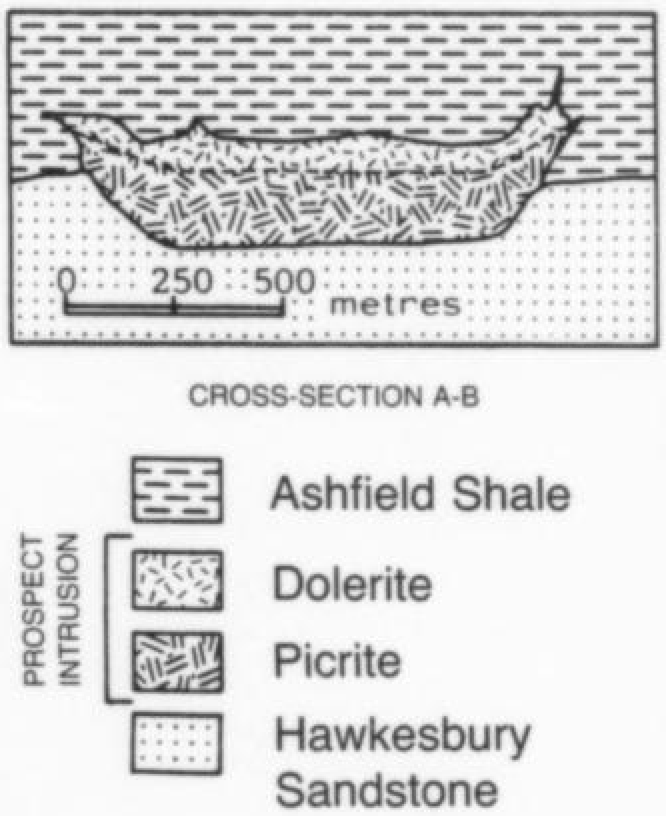
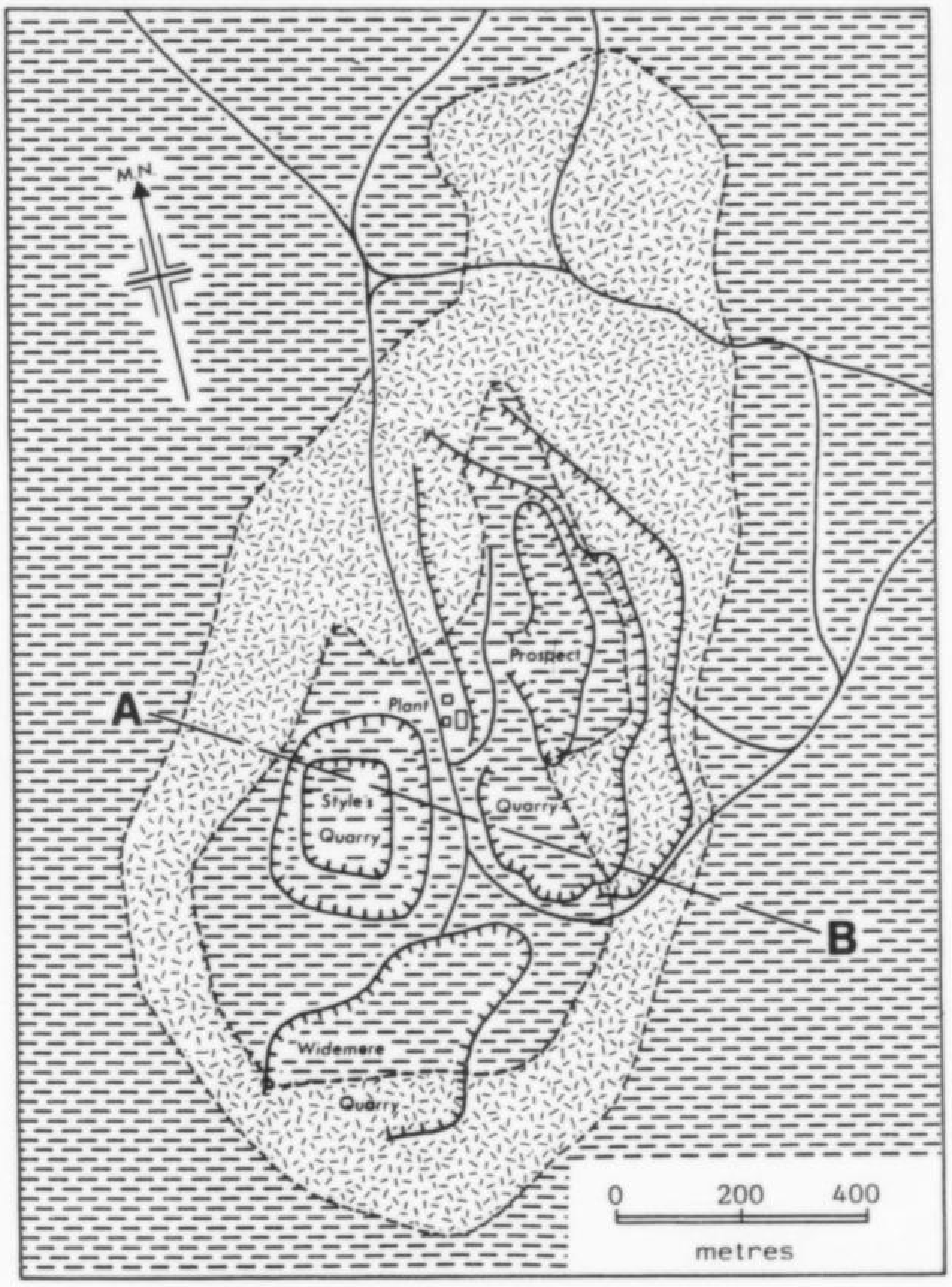


Figure 1. **Panoramic view of the eastern face of Prospect quarry in October of 1981. The dark chilled basalt margin and pegmatite/microdolerite schlieren are clearly visible. Lower level of the quarry is in picrite. Photograph by the author.**

Figure 2. **Geological plan of the Prospect intrusion showing the location of the principal quarries (modified from Branagan and Packham, 1967).**





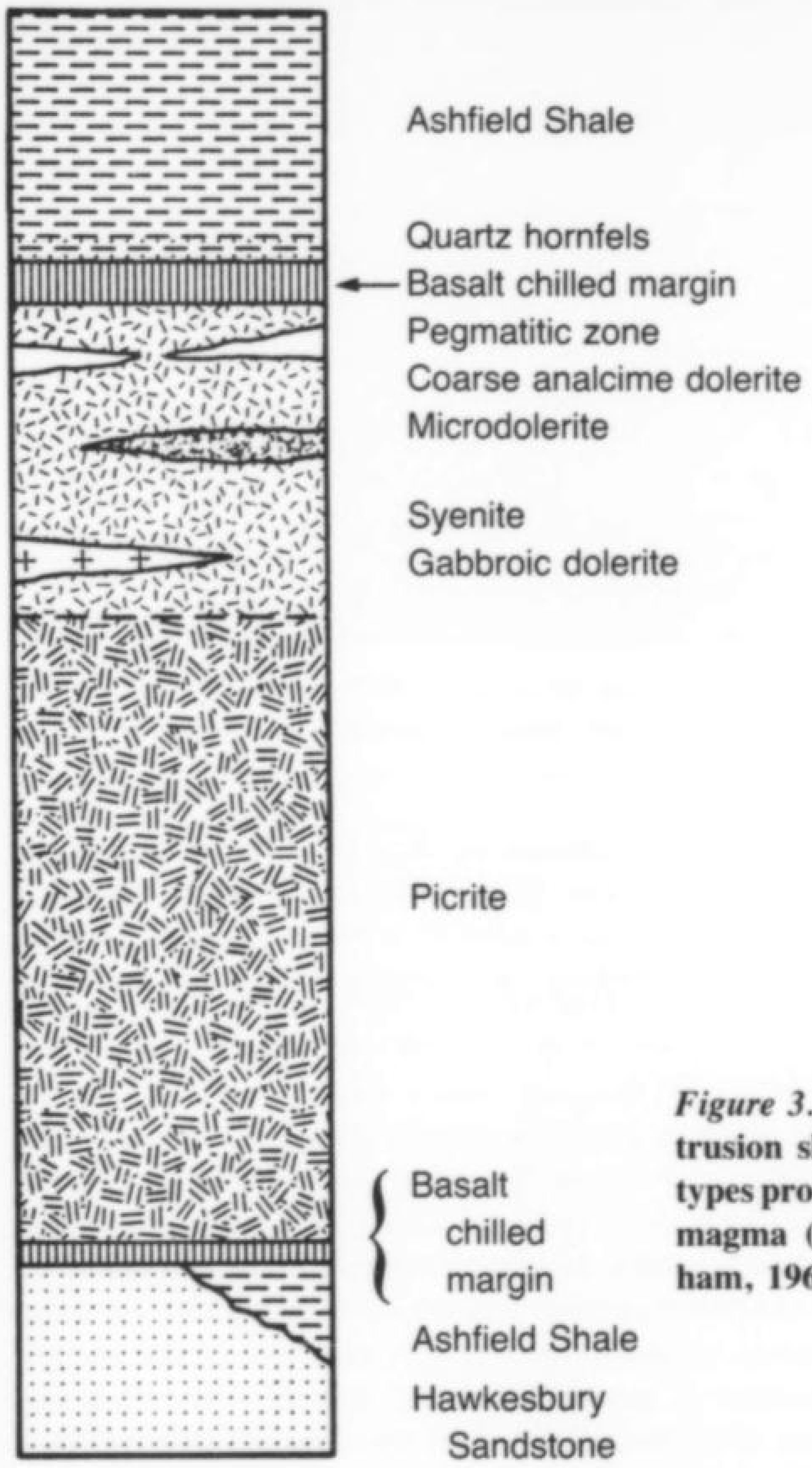


Figure 3. **Idealized section of the Prospect intrusion showing the sequence of igneous rock types produced by differentiation of the basaltic magma (modified from Branagan and Packham, 1967).**

crystallizing residual magmas which produced microdolerite and syenite lenses. These features are clearly visible in the working faces of all the Prospect Hill quarries.

It is principally along secondary shrinkage fissures within the microdolerite and pegmatite lenses (schlieren of Joplin, 1964) that the wide range of minerals found at Prospect crystallized from residual hydrothermal fluids during the final stages of cooling.

Retention of magmatic water within the crystallizing magma by the immediate development of a thick, chilled, impervious margin was the critical factor in the development of the hydrated minerals at Prospect. Had venting of the hydrothermal fluids into the surrounding sediments occurred the wide range of unusual rock types and associated late-stage minerals would not have developed.

The intrusion itself is thought to have been an indirect result of tension fracturing of the continental crust down to the upper mantle during development of the rift divergence zone which preceded the separation of the Australian and Antarctic continental masses in the mid-Cenozoic. These fractures acted as conduits for basaltic magma from the mantle region and one or more of these may have acted as feeder dikes for the Prospect intrusion, with the magma rising to a zone of density equilibrium within the surface rocks. The feeder dike system at Prospect has not yet been exposed by quarrying nor located by diamond drilling.

Minerals of the Miarolitic Cavities

Small irregular cavities no larger than 10 cm in diameter formed by the expulsion of volatiles from the magma during crystallization are relatively common throughout the coarse analcime dolerite and are also present in the pegmatite schlieren. They appear to be genetically related to the larger shrinkage fissures containing the late-stage mineral suite, representing an earlier phase of volatile expulsion. These miarolitic cavities commonly contain well crystallized plagioclase and pyroxene, the principal components of the host dolerite. Crystals project directly into the cavities from the surrounding rock matrix.

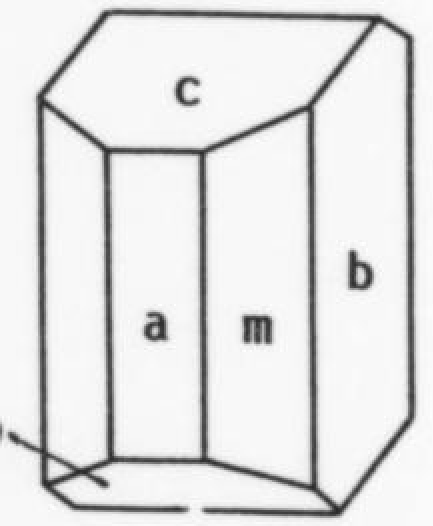


Figure 4. **Idealized crystal of diopsidic augite from Prospect showing the forms *a*{100}, *m*{110}, *b*{010}, *c*{001} and *p*{$\bar{1}$01}. Drawing by the author from specimens in the Australian Museum collection.**

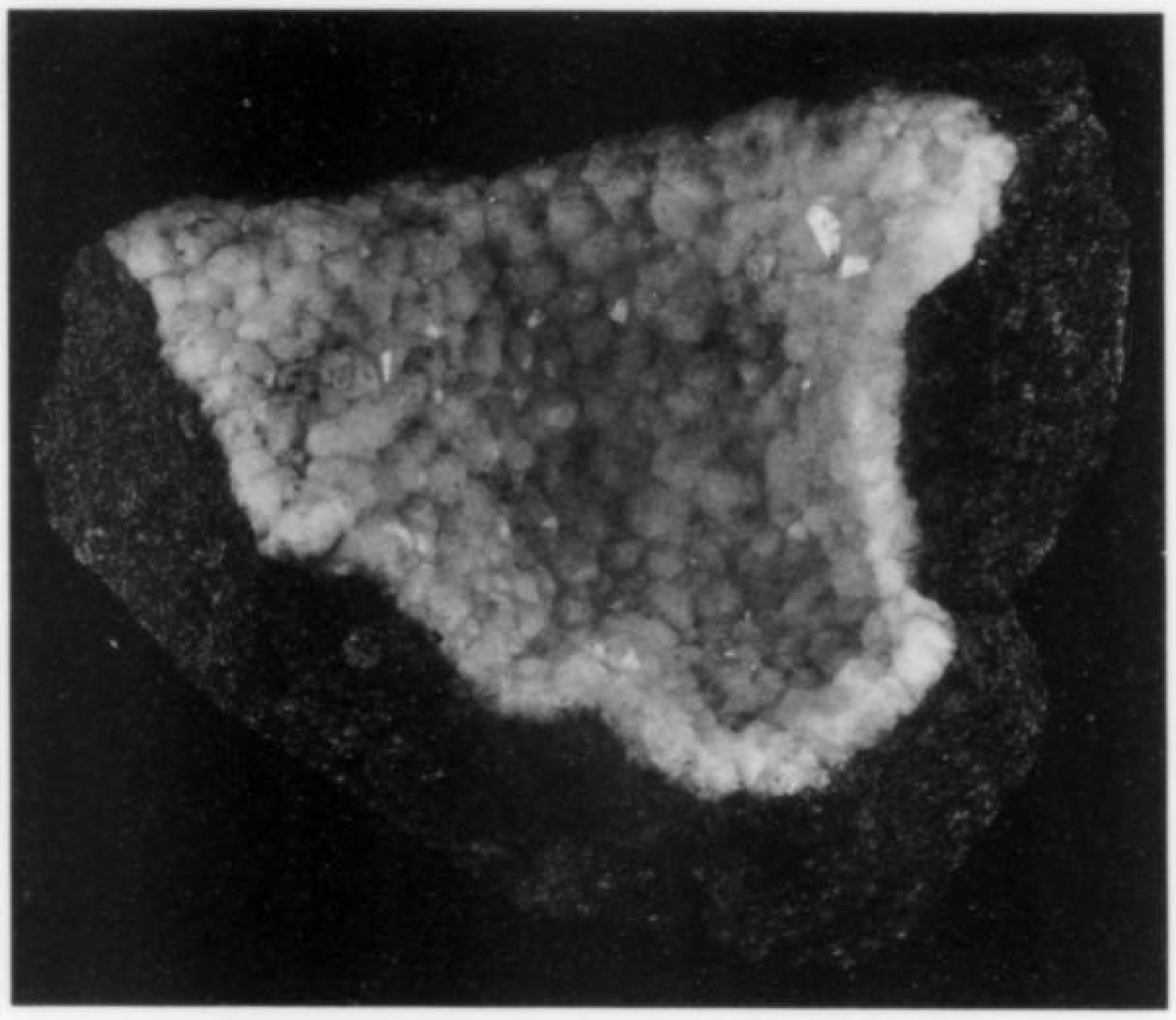


Figure 5. **Trapezohedral analcime crystals thickly encrusting the walls of a vug in microdolerite. The specimen is from the Barry Cole collection and is 13 cm across. Photograph by the author.**

Pyroxene $(Ca,Na,Mg,Fe^{2+},Mn,Fe^{3+},Al,Ti)_2(Si,Al)_2O_6$

Simple black prismatic crystals of titaniferous diopsidic augite (Joplin, 1964) reaching 5 mm in length are occasionally observed in the miarolitic cavities associated with the pegmatite schlieren. Typical morphology of the crystals is shown in Figure 4, but skeletal pseudo-octahedral crystal groups are also known.

Plagioclase $NaAl(Al,Si)Si_2O_8$

The occurrence of crystallized plagioclase is confined to the miarolitic cavities where it usually occurs alone, only rarely being associated with pyroxene crystals or the late-stage mineral suite. Crystals are white to colorless, lustrous, and vary in size from a few millimeters to over 2 centimeters. Most crystals are tabular on *b*{010} and show both repeated albite twinning and parallel growth. Scanning electron microscropy (SEM) and quantitative energy dispersive X-ray analysis (EDS) has shown this plagioclase to be pure albite.

Specimens showing groups of simple, prismatic, compositionally zoned crystals of plagioclase comprising the three triclinic pinacoids and reaching 1 cm in length were found in the early years of quarrying at Prospect.

Minerals of the Pegmatite and Microdolerite Schlieren

Within the large schlieren parallel to the upper margin of the intrusion there is considerable development of vugs which are lined with well formed crystals of a variety of late-stage minerals crystallized from residual hydrothermal solutions.

An observed paragenetic sequence of these minerals, based on the close examination of several hundred specimens in the collections of the Australian Museum, Albert Chapman, Barry Cole and George Dale (all of Sydney), is presented in Table 1.

Analcime $NaAlSi_2O_6{\cdot}H_2O$

Analcime is the only zeolite found in any abundance at Prospect and forms an essential component of the coarse analcime dolerite (teschenite) comprising the upper part of the intrusion. However, the analcime in the dolerite itself forms only small anhedral masses characteristic of late-stage deposition in cavities between the earlier crystallized species and it is only in vugs that specimens of interest to the collector occur.

Prospect analcime usually forms simple white trapezohedrons reaching a maximum diameter of 4 cm, although most are less than 1 cm. Crystals usually occur thickly encrusting vug walls or, more rarely, as scattered individuals on dolerite matrix. Since it was the first of the late-stage minerals to crystallize, analcime is rarely found alone in vugs. Crystals are often overgrown by later minerals (especially prehnite) and hence good specimens are relatively uncommon. However, specimens of analcime showing only minor subsequent crystallization of prehnite, natrolite, spherulitic siderite, or honey-yellow calcite have been found.

Microcrystals of analcime to 50 μm in diameter have also been found deposited on prehnite and, when present on the *b*{010} faces, these crystals appear to have been preferentially nucleated along incipient {001} cleavages.

Apophyllite $ACa_4Si_8O_{20}(Z){\cdot}8H_2O$

Apophyllite is relatively uncommon in the Prospect intrusion. It is usually associated with pectolite as crystals showing at least two distinctly different habits and is often very pale pink in color.

Aragonite $CaCO_3$

Aragonite is the least common of the carbonate species in the Prospect intrusion. Specimens in the Australian Museum collection show small, violet, columnar masses of strontian aragonite infilling prehnite-lined vugs, or deposited on analcime. No crystals have been observed.

Barite $BaSO_4$

Barite was the last of the minerals to crystallize in the vugs. It is very rare and specimens are only found very occasionally. It has been observed as tabular white crystals in parallel groups to 1 cm across on drusy siderite (Australian Museum specimen D35330), rosettes of pale brown, transparent, tabular crystals to 4 mm across on white calcite (Australian Museum specimen D38535) and similar rosettes on drusy marcasite (George Dale collection) from the sheared gabbroic dolerite exposed between the Widemere and Prospect quarries.

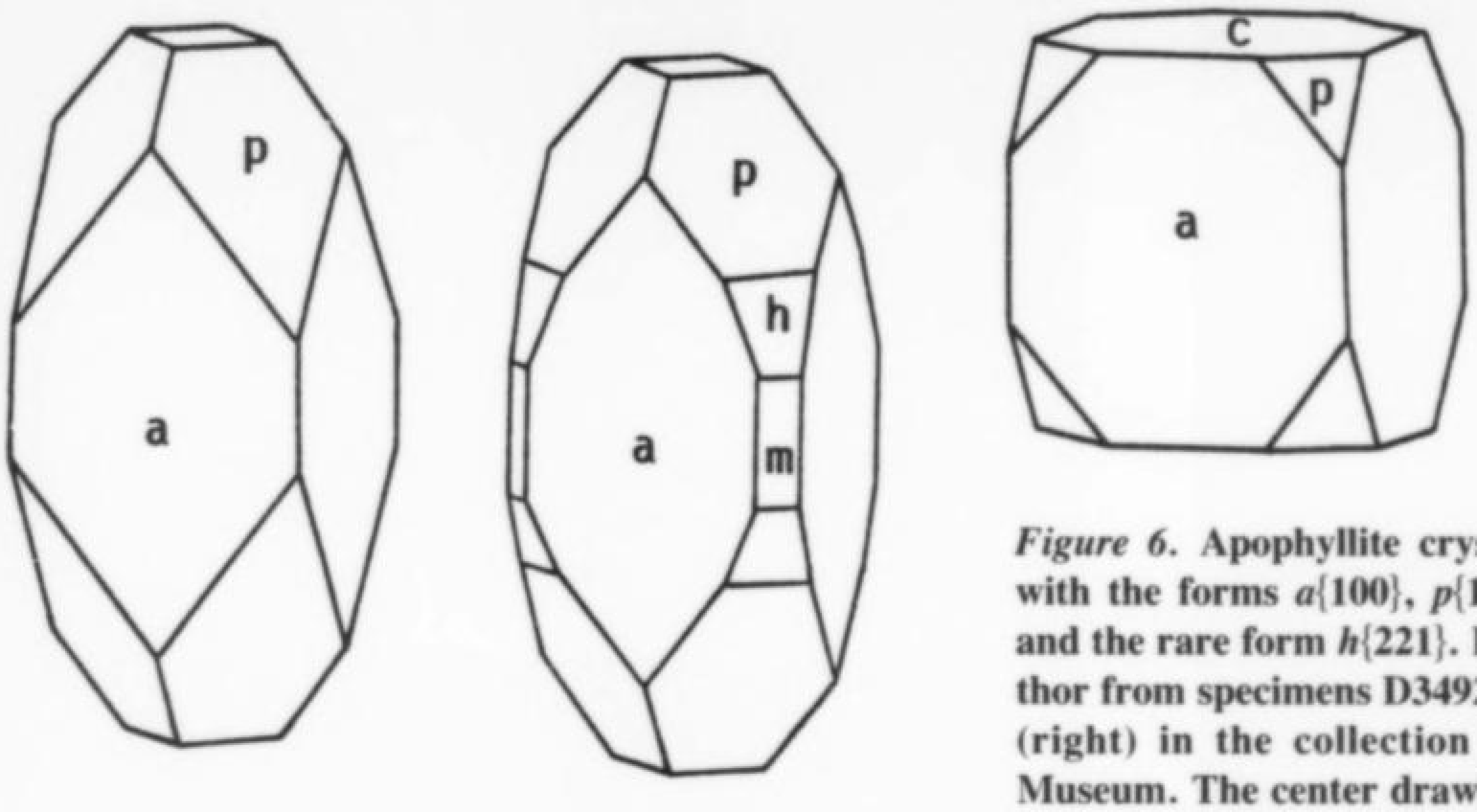


Figure 6. **Apophyllite crystals from Prospect with the forms *a*{100}, *p*{111}, *c*{001}, *m*{110} and the rare form *h*{221}. Drawings by the author from specimens D34921 (left) and D39653 (right) in the collection of the Australian Museum. The center drawing was constructed from a partial drawing in Hodge-Smith (1943).**

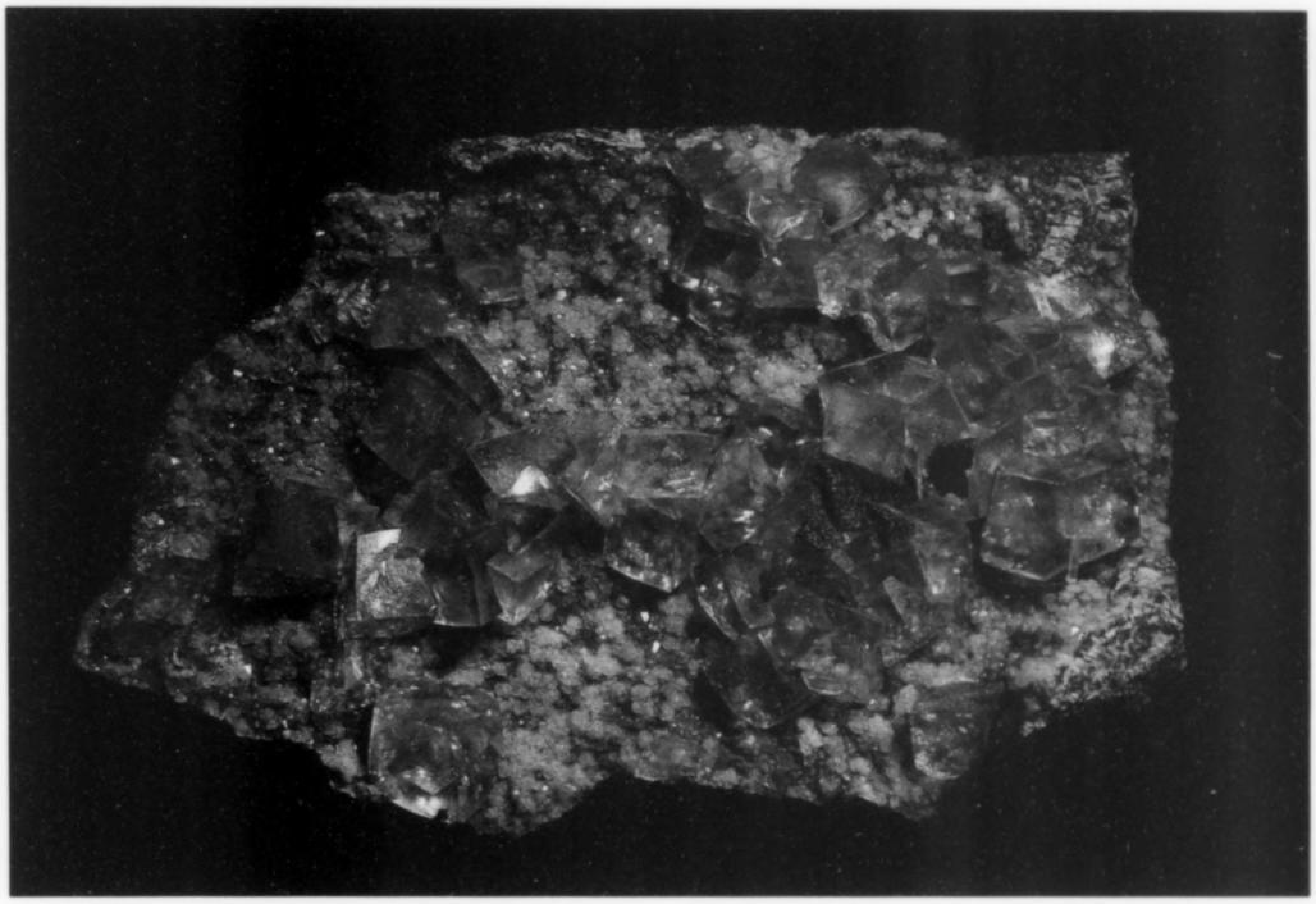


Figure 7. **Pale yellow calcite rhombohedra on drusy analcime. Specimen is 12 cm in length. Australian Museum specimen D38601. Photograph by John Fields, Australian Museum.**

Calcite $CaCO_3$

Apart from prehnite, calcite is the most common of the late-stage minerals in the Prospect intrusion. It is common as vein and joint fillings which occasionally extend into and even beyond the chilled basalt margin. However, calcite is most spectacular as crystallizations on earlier minerals in vugs in the schlieren, where both habit and color vary considerably.

In the vugs calcite is most abundant as simple rhombohedra of the form $r\{10\bar{1}1\}$, to 1 cm in diameter, often with slightly convex faces and varying in color from white to colorless and occasionally pale yellow, the latter usually associated with analcime. Roughly surfaced, cream-colored rhombohedra to 3 cm, showing internal color-zoning parallel to the crystal faces, have been found implanted on prehnite. These are among the largest calcite crystals known from Prospect.

More specifically associated with prehnite are white rhombohedra of the form $e\{01\bar{1}2\}$ reaching 1.5 cm in diameter. These crystals characteristically show incipient spherulitic development, as indicated by rounding of the edges of the crystal and/or development of smaller peripheral crystals in near-parallel growth, producing an attractive serrated fringe around the main crystal. Spherulitic development in calcite is produced by splitting of the rhombohedral crystals along the $r\{10\bar{1}1\}$ cleavage directions during growth due to sectorial enrichment in magnesium and iron carbonates along these planes (England, 1984). As a result, each crystal is composed of several individuals in near parallel growth and the corners of the rhombohedra curl alternately up and down about the *c*-axis, to a degree which depends on the amount of carbonate impurity present.

Small, equant, colorless crystals showing the rhombohedron $e\{01\bar{1}2\}$ and rough pseudo-prism faces formed by growth oscillation

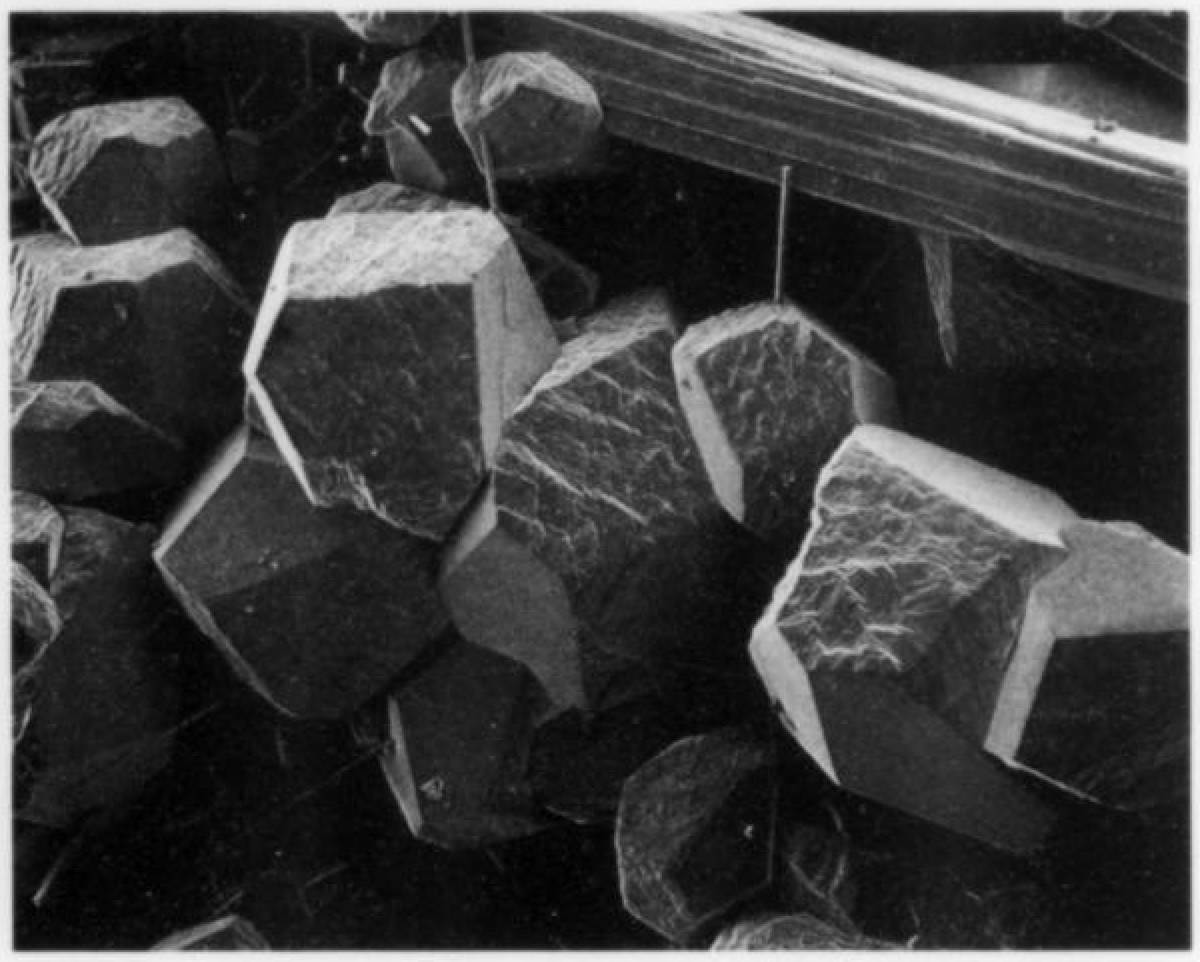


Figure 8. **Calcite crystals consisting of the rhombohedron $e\{01\bar{1}2\}$ and rough pseudoprism faces, with natrolite on prehnite. Field of view is 2.5 mm in length. Scanning electron micrograph. Author's specimen and photograph.**

between positive and negative rhombohedra have been found in association with natrolite on prehnite.

Very occasionally, specimens have been found in which small white rhombohedra of the form $e\{01\bar{1}2\}$ have formed groups in parallel growth, retaining the trigonal symmetry of calcite and resembling oriental pagodas to 3 cm in length.

Groups of small, dark brown, lusterous rhombohedra resembling $M\{40\bar{4}1\}$, to a maximum of 5 mm in diameter, occurred in the Widemere quarry, partially overgrown by larger white to colorless rhombohedra of the more common $r\{10\bar{1}1\}$ form.

Masses of white or pale yellow transparent calcite commonly completely fill vugs lined with analcime and/or prehnite. In specimens of this type, removal of the calcite by judicial use of dilute acetic or hydrochloric acid often reveals superb undamaged crystallizations of the earlier secondary minerals. In fact, many of the finest specimens of prehnite in major collections have been revealed in this way. Unfortunately however, prolonged acid treatment results in gelatinization of the analcime and hence the use of this technique with heavily coated specimens is usually unsuccessful.

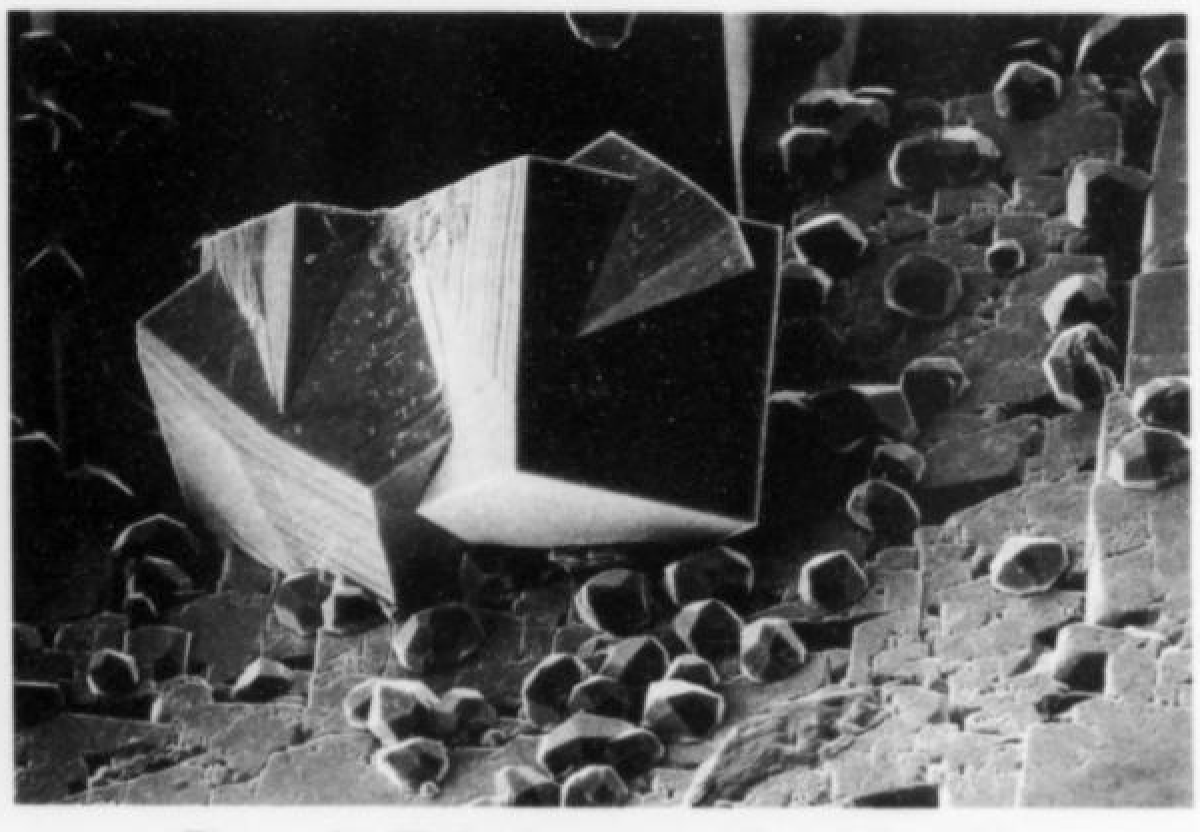


Figure 9. **Chabazite penetration twin with trapezohedral analcime on golden brown prehnite surface. Chabazite group is 0.15 mm in diameter. Scanning electron micrograph. Author's specimen and photograph.**

Chabazite $CaAl_2Si_4O_{12}\cdot 6H_2O$

Chabazite is very rare but has been observed as small (less than 1 mm) white rhombohedra on botryoidal prehnite. Interpenetrant twins with the *c*-axis as the twin axis are common.

Chlorite Group $A_{4-6}Z_4O_{10}(OH,O)_8$

Chlorite is relatively common, usually forming small moss-green coralloidal masses to 5 mm on analcime or occurring as small, dense, lenticular bodies enclosed by prehnite adjacent to the walls of the vugs.

Occasionally, microcoralloidal masses to several centimeters across and containing radiating acicular cavities after pectolite are found on and partially enclosed by prehnite.

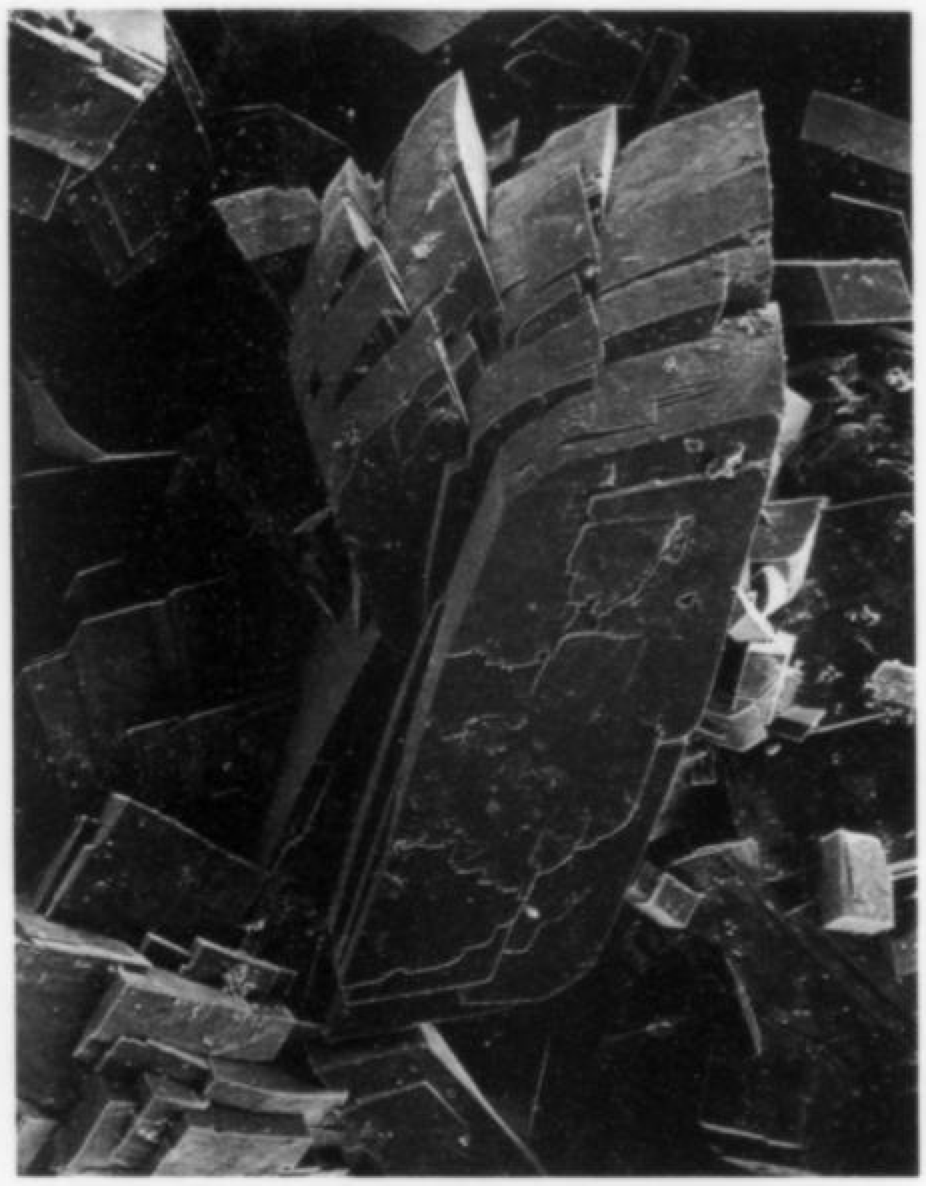


Figure 10. **Divergent group of heulandite crystals. Field of view is 0.5 mm in height. Scanning electron micrograph. Author's specimen and photograph.**

Heulandite $(Na,Ca)_{2-3}Al_3(Al,Si)_2Si_{13}O_{36}\cdot 12H_2O$

Pearly white microcrystals resembling heulandite have been found associated with chabazite, analcime and chlorite on the crystallized surface of botryoidal prehnite vug linings. The crystals show obvious monoclinic symmetry with faces approximating the heulandite forms $c\{001\}$, $b\{010\}$, $t\{101\}$ and $s\{10\bar{1}\}$ with occasional contact twinning on $b\{010\}$. Parallel growth is characteristic, and repeated splitting of crystals during growth has produced divergent and often stellate groups.

SEM/EDS revealed major calcium, aluminum and silicon, with minor potassium and magnesium and only a trace of sodium. This suggests partial substitution of Mg^{2+} for Ca^{2+} and almost complete substitution of K^+ for Na^+ in the heulandite lattice. Insufficient sample was available for the identity of specimens to be confirmed by X-ray powder diffraction (XRD).

Laumontite $CaAl_2Si_4O_{12}\cdot 4H_2O$

No specimens of laumontite were located during the present study. However a single specimen in the collection of the Australian Museum shows well formed prismatic crystals of laumontite with the forms $m\{110\}$ and $e\{\bar{2}01\}$, completely replaced by prehnite.

Marcasite FeS_2

A large remnant of gabbroic dolerite between the Widemere and

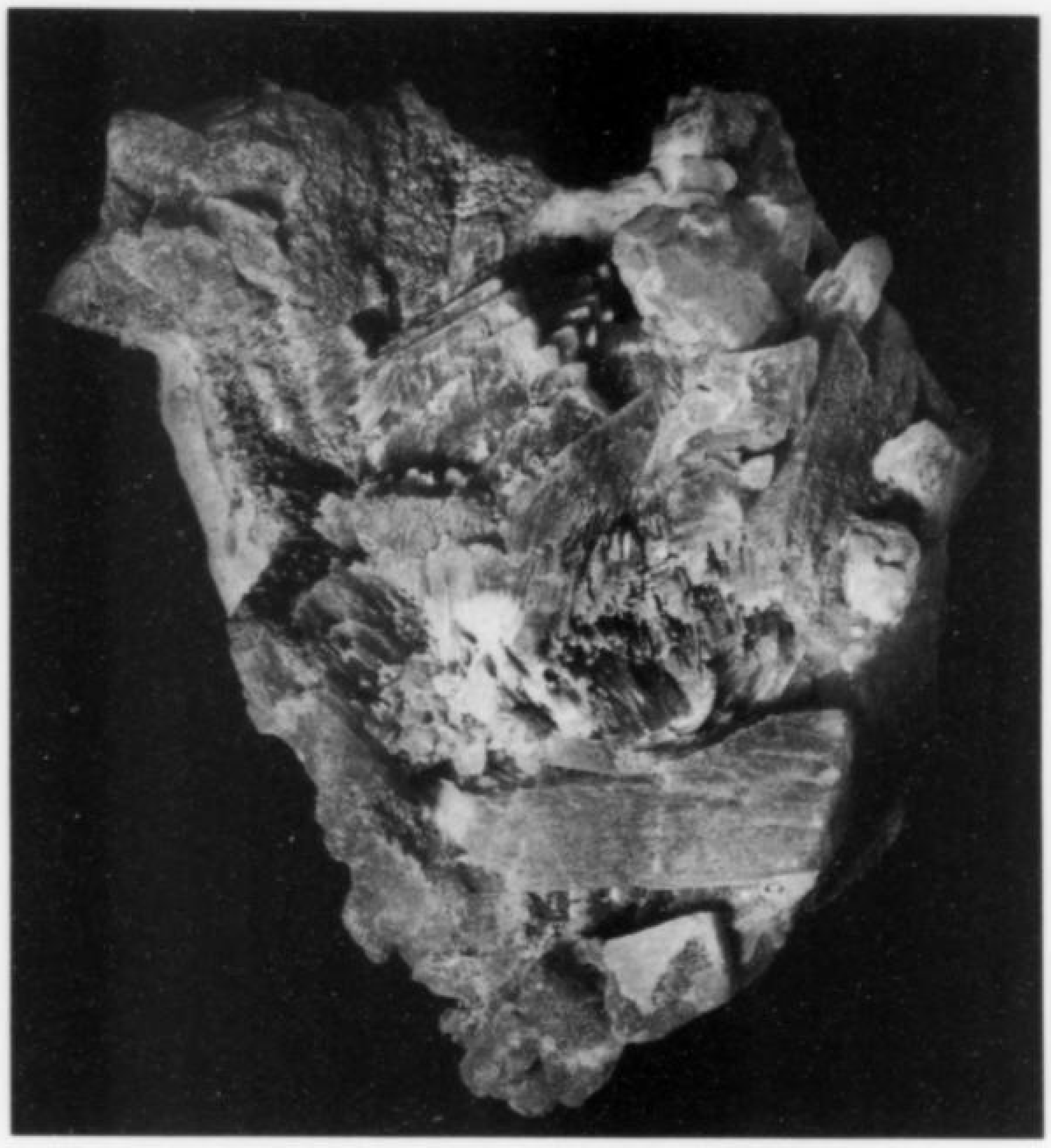


Figure 11. **Pale green prehnite pseudomorphs after prismatic crystals of laumontite. Specimen is 6 cm high. Australian Museum specimen D47887. Photograph by John Fields, Australian Museum.**

Prospect quarries contains a significant proportion of sulfides as veins and segregations in which marcasite is the principal species. The outcrop is made conspicuous by brightly colored sulfide weathering products, but these are of little interest to the collector. This local abundance of sulfides may be the result of a final pulse of sulfide-rich magmatic water which penetrated fractures in a prominent shear zone and partially altered the host rocks (Branagan and Packham, 1967) or low-temperature groundwater alteration of pyrite originally present in the gabbroic dolerite.

Within the shear zone angular cavities to several centimeters across are lined with crusts of crystallized marcasite, often colloform in appearance. Crystals typically show orthorhombic bipyramids and rarely exceed 2 mm in diameter. Unfortunately, the material is very unstable and few specimens have survived.

Montmorillonite $(Na,Ca)_{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$

In the Widemere and old Emu quarries large masses of tan montmorillonite replacing dense radiating pectolite were common. Prehnite masses replaced by white to buff montmorillonite and associated with unaltered pale yellow calcite rhombohedra have also been found.

Natrolite $Na_2Al_2Si_3O_{10} \cdot 2H_2O$

In the old Emu quarry spectacular specimens of radiating terminated crystals to 2 cm long were found lining vugs to 15 cm in diameter within the schlieren. Natrolite also occurred as jackstraw masses of thin prismatic crystals to 9 cm across. Crystals show the forms *a*{100} and *b*{010}, terminated by what appear to be the dome forms *D*{101} and *e*{011}.

Occasionally groups of radiating needles to 1 cm in length are found partially overgrown by a thin crust of pale green prehnite. Natrolite has also been found associated with analcime and white calcite.

Opal $SiO_2 \cdot nH_2O$

Large masses of white to blue-gray common opal infilling pectolite-lined vugs to 20 cm in diameter have been found in both Style's and Widemere quarries.

Pectolite $NaCa_2Si_3O_8(OH)$

While spectacular specimens have been found in the past, pectolite is relatively uncommon in the Prospect intrusion. It usually occurs as large, compact masses of radiating fibrous crystals to 12 cm in length completely filling vugs in the schlieren. Sprays of individual terminated crystals are rare but may reach 10 cm in length. Apophyllite is a common associate.

Color varies from white to tan; partial to complete replacement by pale brown montmorillonite is common. Some early specimens of white radiating pectolite turned dull brown on the surface after a few months exposure (Hodge-Smith, 1943). Although the cause of this color change is unknown, investigation of a specimen of brown pectolite (D38667) in the Australian Museum collection by SEM/EDS revealed the presence of coatings and intergrowths of porous talc. Reports of a barian pectolite could not be confirmed by analysis of a number of specimens in the Australian Museum collection.

Leached, acicular to thin columnar, radiating molds in pale green prehnite masses were probably originally occupied by pectolite.

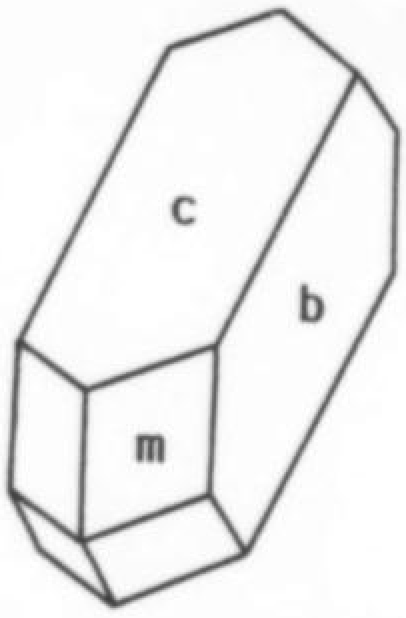


Figure 12. **Typical morphology of phillipsite from Prospect, showing the forms *c*{001}, *b*{010} and *m*{110}. Drawing by the author from a specimen in the Australian Museum collection.**

Phillipsite $(K,Na,Ca)_{1-2}(Si,Al)_8O_{16} \cdot 6H_2O$

Phillipsite, like most of the other zeolite species at Prospect, is never conspicuous. It occurs as prismatic crystals to 2 mm in length scattered on the botryoidal surfaces of prehnite masses.

Prehnite $Ca_2Al_2Si_3O_{10}(OH)_2$

Prehnite is the most abundant and visually the most spectacular of the late-stage minerals in the Prospect intrusion. It forms mammillary to botryoidal crusts of compact, radiating platy crystals to almost 1 m in diameter. Color variation between vugs is striking, with white, buff, pale to apple-green, bright yellow-green, honey-yellow, reddish brown, deep golden brown and even black varieties being recorded. Deeply colored varieties display a diffuse color zonation, with a white or colorless zone adjacent to the dolerite and becoming darker toward the crystal terminations. Some indication of the range of color can be seen here in the color photographs.

Surfaces of the prehnite masses may be smooth and lustrous with no discernible crystal faces. However, more characteristic is the development of either randomly oriented or sub-parallel *b*{010} faces to 4 mm in length or globular masses of striated lenticular crystals to 4 cm in length, the latter predominating in the paler colored varieties. Distinct, well formed crystals are rare but occasionally blocky euhedral crystals to 1 cm protrude from peaks of the globular prehnite masses.

Prehnite always predominates in the vugs in which it occurs, but

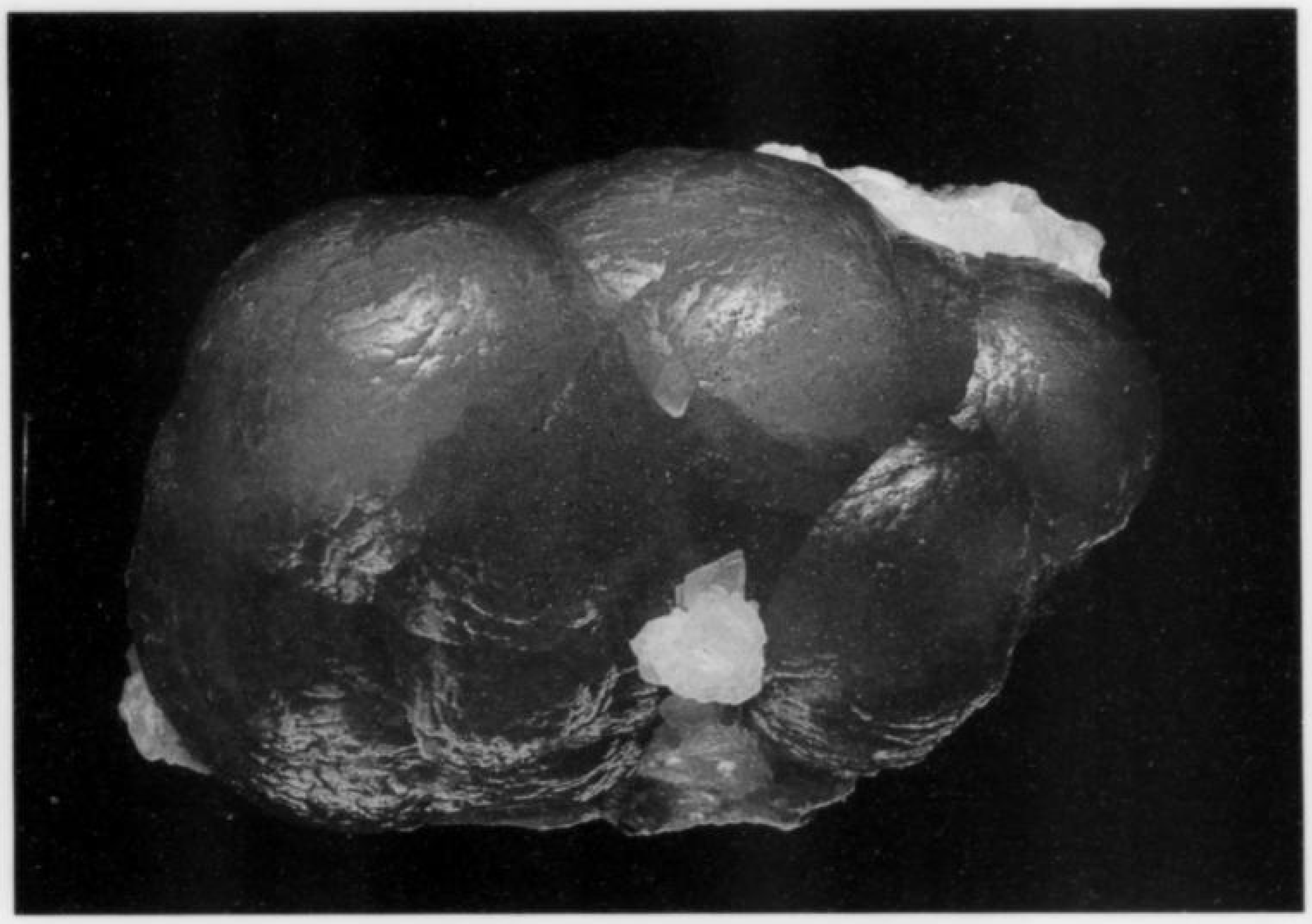


Figure 13. Botryoidal pale yellow-green prehnite with light dusting of pyrite crystals and later calcite. Specimen is 9 cm across. Barry Cole collection. Photograph by the author.

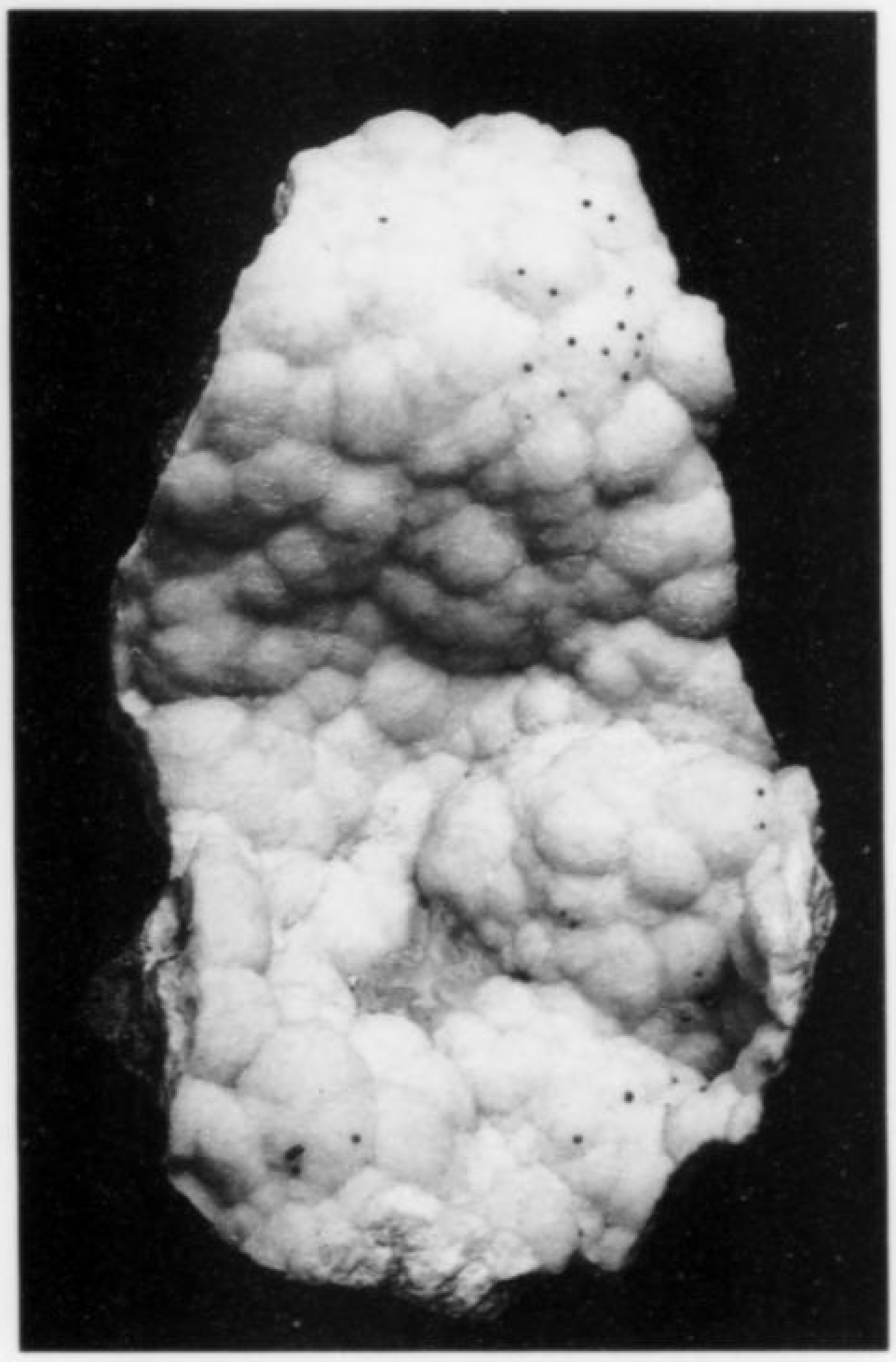


Figure 15. Bright yellow-green botryoidal prehnite. Specimen is 21 cm in length. George Dale collection. Photograph by the author.

Figure 14. (above) Botryoidal mass of green prehnite associated with chlorite. Specimen is 13 cm in diameter. George Dale collection. Photograph by the author.

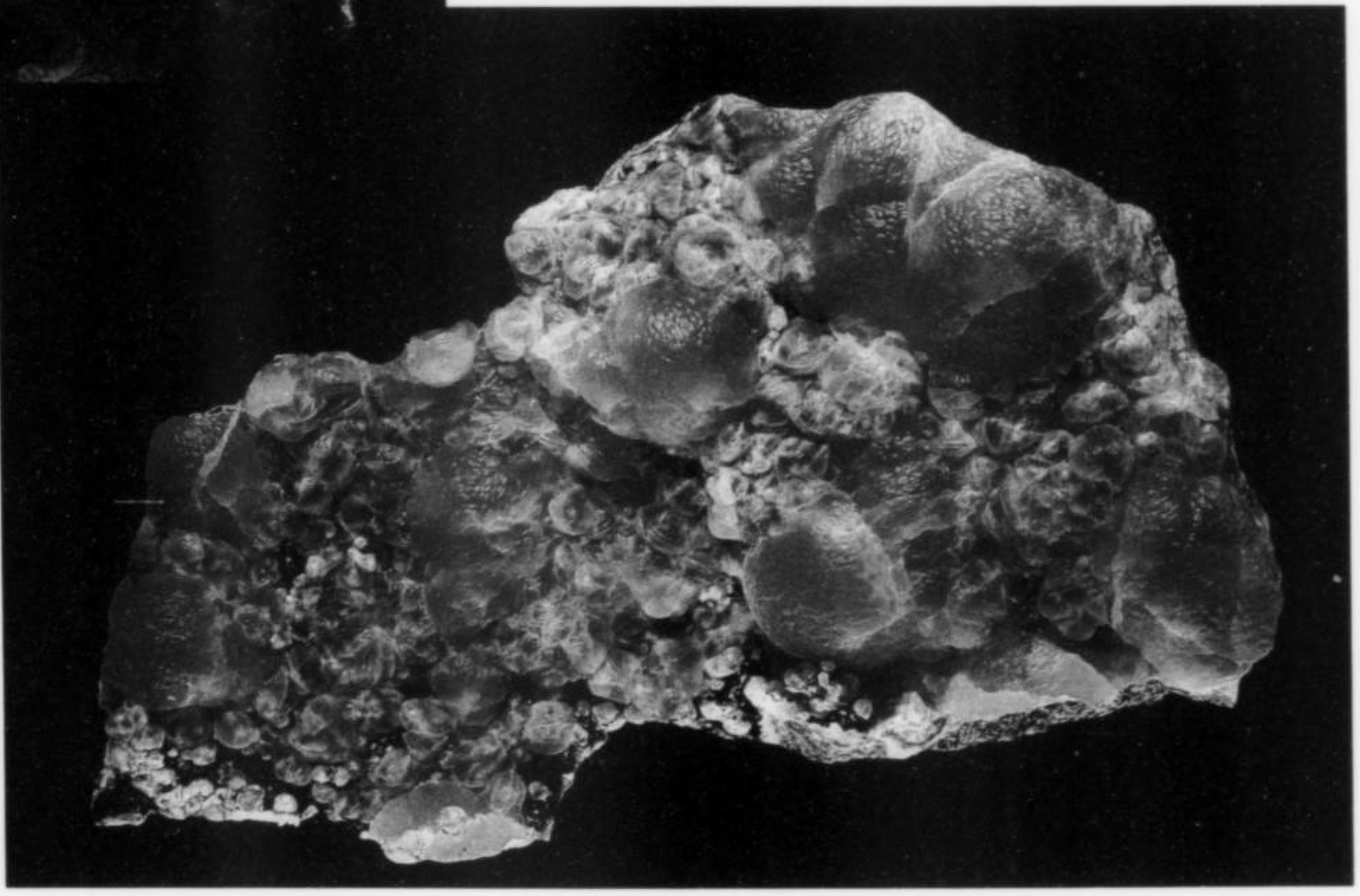


Figure 16. Pale apple-green botryoidal prehnite specimen 19 cm across. Barry Cole collection. Photograph by the author.

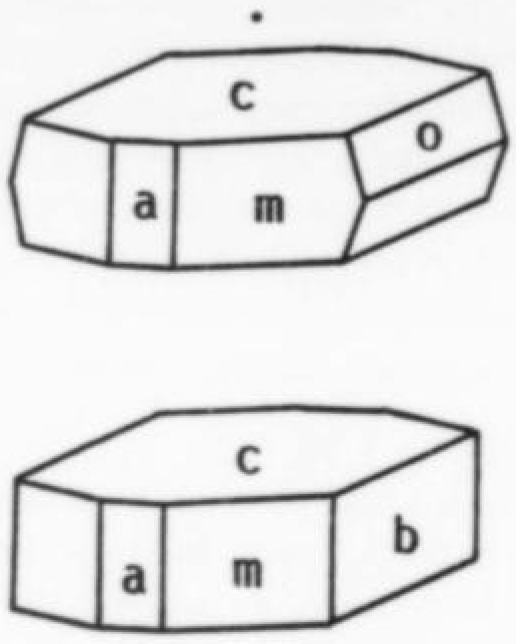


Figure 17. **Prehnite crystals from Prospect showing the forms *a*{100}, *b*{010}, *o*{011}, *m*{110} and *c*{001}. Drawings by the author from specimens in the Albert Chapman collection.**

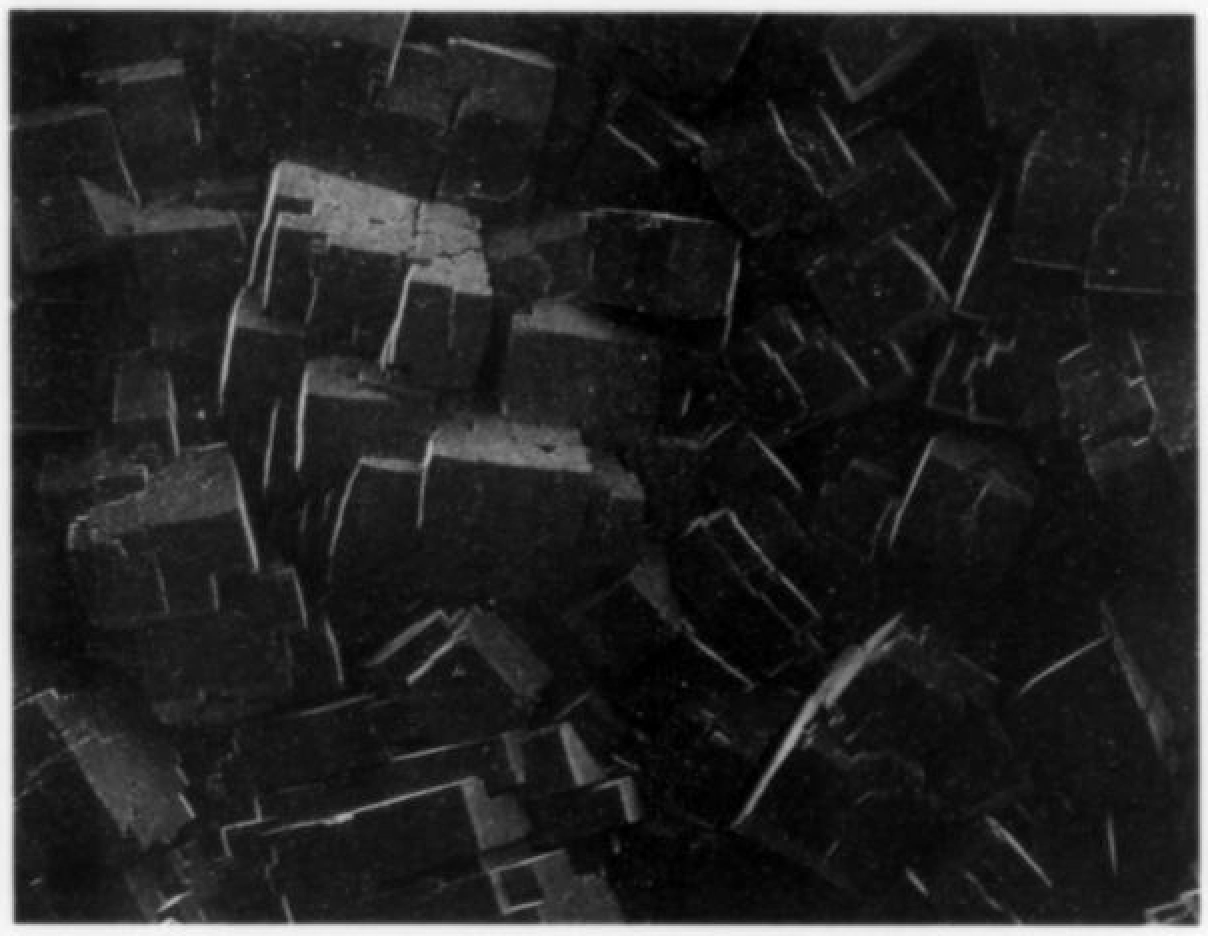


Figure 18. **Pale green prehnite crystals showing the forms *b*{010}, *c*{001} and *m*{110} and forming the surface of a botryoidal mass. Field of view is 2 mm in length. Scanning electron micrograph. Author's specimen and photograph.**

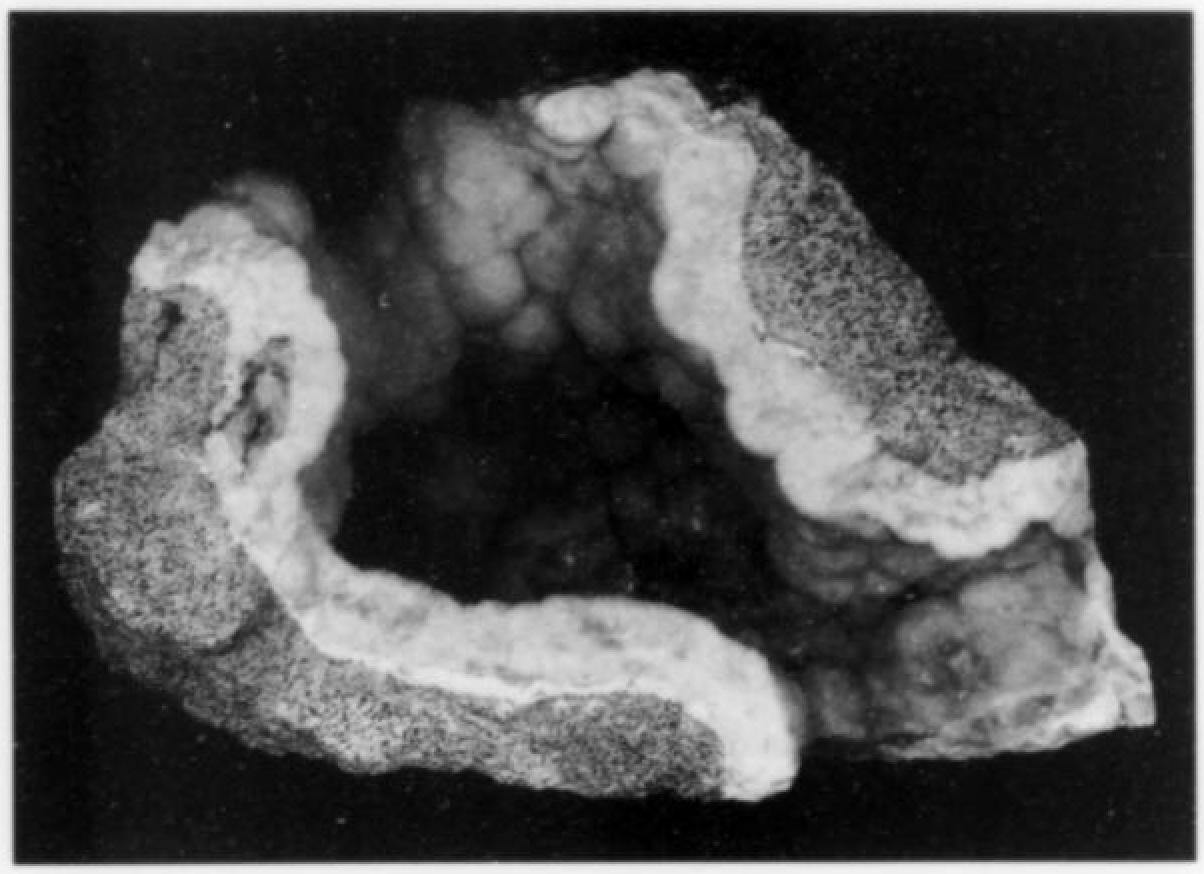


Figure 19. **Creamy yellow botryoidal prehnite lining a vug in microdolerite. Specimen is 23 cm high. Author's specimen and photograph.**

Figure 20. **Golden brown botryoidal prehnite in vug with microdolerite. The surface of the prehnite consists of sub-parallel groups of *b*{010} faces. Specimen is 22 cm in height. Barry Cole collection. Photograph by the author.**

may also be associated with other late-stage minerals including analcime, chlorite, pyrite, calcite, and more rarely minerals of the zeolite group. One unusual specimen in the George Dale collection shows colorless to white calcite rhombohedra to 4 cm across coated with a pale green prehnite crust several millimeters thick.

Particularly abundant in the collection of the Australian Museum are curious masses of pale green prehnite containing closely spaced, radiating, acicular to thin columnar euhedral cavities. These are probably molds after pectolite sprays which crystallized prior to prehnite deposition and were subsequently removed, probably via hydrothermal alteration. In fact, prehnite is only rarely associated with unaltered pectolite, suggesting that dissolution of the pectolite may have provided at least some of the calcium and silicon required for crystallization of the prehnite overgrowths, with the sodium released into solution and absorbed in the subsequent crystallization of zeolite species either within the same vug or elsewhere.

A rare occurrence, represented by a single specimen in the Australian Museum collection, is prehnite pseudomorphs after well-formed prismatic crystals of laumontite to 3 cm in length. Prehnite has also been observed partially replacing pectolite crystals.

Pyrite FeS_2

Although the amount of pyrite present in the schlieren is very small, it is ubiquitous throughout the vugs. It usually forms very small, cubic crystals slightly modified by *o*{111} and rarely exceeding 1 mm across, scattered on prehnite surfaces and occasionally encrusting calcite. It has also been observed as microcrystals on albite in the miarolitic cavities. Spherulitic forms are also known.

Irregular masses of pyrite to several millimeters across are commonly scattered through the fabric of the analcime dolerite and occasionally it forms veins to a few millimeters in width.

A section of the Ashfield Shale exposed in the floor of the old Emu quarry (which later became the Prospect quarry) in the early 1900's produced roughly spherical groups of pyrite crystals to 7 cm in diameter. Specimens preserved in the George Dale collection show cuboctahedral crystals with concave and distorted faces reaching 4 cm on edge, arranged in sub-parallel groups.

***Figure 21.* Pyrite crystal group from the Ashfield Shale exposed in the floor of the old Emu quarry in the early 1900's. Specimen is 7 cm in diameter. George Dale collection. Photograph by the author.**

Quartz SiO_2

The plagioclase of the analcime dolerite adjacent to the vugs in the schlieren commonly shows partial replacement by analcime, which occurred during the final phase of magma crystallization (Joplin, 1964). The small amount of silica released by this reaction was probably the source of the occasional thin coatings of drusy colorless quartz found on analcime crystals in vugs. Similar coatings have also been observed on prehnite, but only where zeolite species are absent. Quartz also occurs as colorless microcrystals lining thin veins in the analcime dolerite.

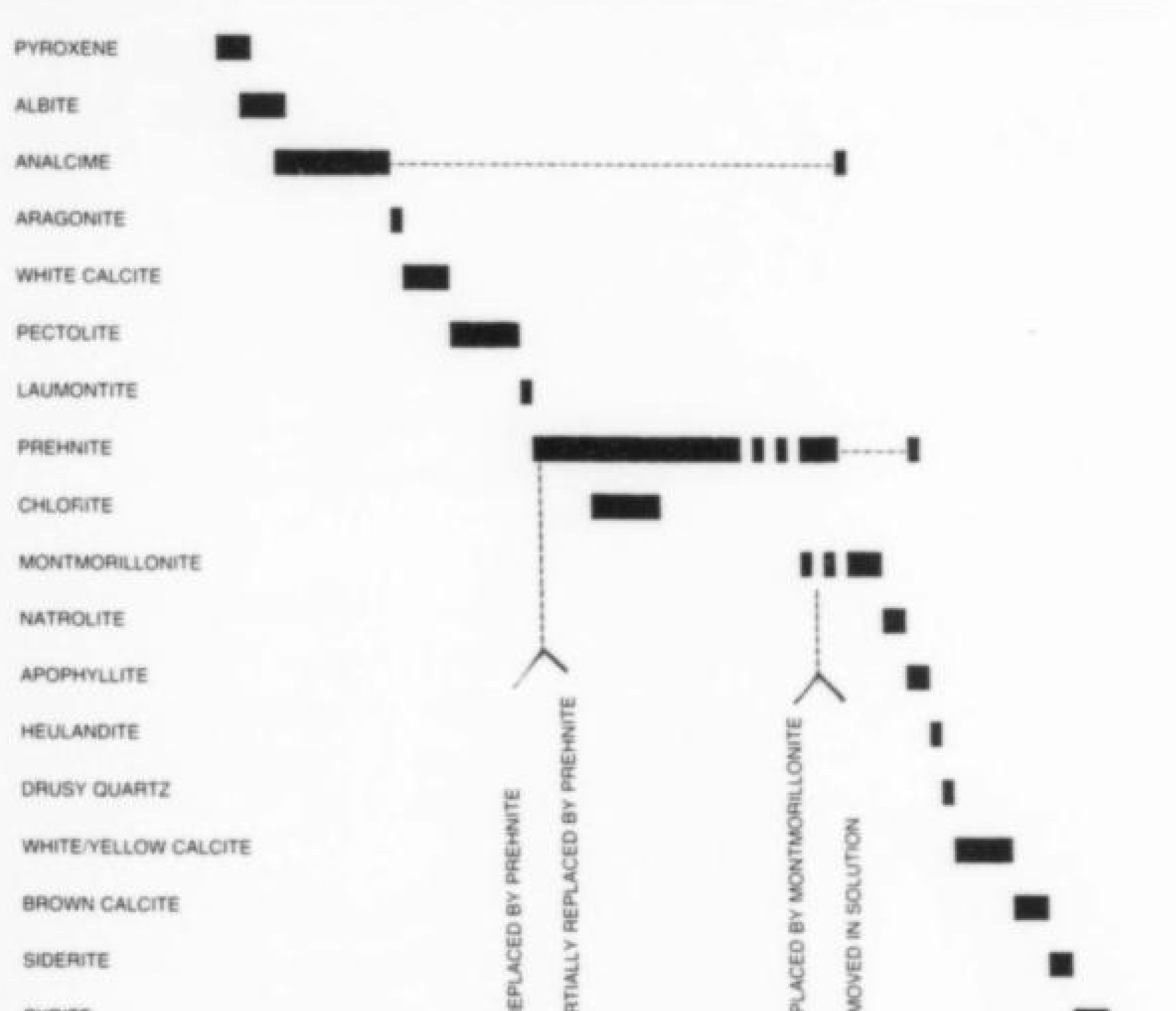


***Table 1.* Observed paragenetic sequence in the Prospect Intrusion.**

A single specimen of heulandite microcrystals associated with earlier prehnite from the Chris Parkinson collection was found, on close examination, to contain late-stage spherulites of unknown fibrous crystals to 3 mm in diameter. Qualitative EDS revealed the presence of major silicon, with only trace amounts of calcium and aluminum (probably from the underlying prehnite). XRD was attempted but there was insufficient material available to obtain a conclusive result. The morphology and composition suggest α-quartz.

Siderite $Fe^{2+}CO_3$

Siderite is considerably less abundant than calcite, but is conspicuous because of its lustrous, tan to brown microcrystals and bright iridescent surface tarnish caused by incipient alteration to hematite. It occurs as simple rhombohedral crystals to 5 mm in diameter, as spherulites, or as small, complex, parallel groupings scattered over the surface of analcime or prehnite crusts. Small masses of siderite containing trigonal molds after calcite were occasionally found in the Emu quarry.

CONCLUDING REMARKS

Although quarrying at Prospect is continuing on a large scale, operations have reached their maximum lateral extent as governed by lease boundaries. As a result, the coarse analcime dolerite and associated schlieren containing the vugs lined with secondary minerals have virtually been mined out. Extraction is continuing on unmineralized gabbroic dolerite and picrite.

However, although the likelihood of further specimen discoveries in the quarries themselves appears limited, there is a wealth of fine material in both public and private collections.

ACKNOWLEDGMENTS

Appreciation is expressed to the management of B.H.P. Research, Newcastle Laboratories, for the use of the equipment and resources of the laboratories. Final prints of the author's photographs were produced by Murray McKean of the photography group.

The Australian Museum, Sydney, gave the author access to the extensive range of Prospect specimens in the collection. Ross Pogson of the Earth Science Department provided extensive and invaluable assistance. Photographs of specimens in the collection were made by former Museum Photographer John Fields. Copyright on these photographs is retained by the Trustees of the Australian Museum.

Appreciation is also expressed to Barry Cole, Albert Chapman, Chris Parkinson and the late George Dale (all of the Sydney region) who gave the author access to their extensive collections of Prospect minerals and permission to use selected specimens for illustrative purposes.

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Copper Roses from The Rose Mine

near San Lorenzo, New Mexico

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7844 South L Street
Tacoma, Washington 98408-2927

In 1889 a unique mineralogical occurrence came to light in the New Mexico Territory: native copper "roses," composed of copper crystals similar in habit to azurite. But, were they pseudomorphs? If so, how did they come to be? Early investigators envisioned volcanic gases spewing up from the bowels of the earth, reducing azurite to native copper. Recent geochemical theories regarding supergene enrichment have shed new light on their true origin.

LOCATION

The Rose mine is located in the Mimbres mining district, Grant County, New Mexico 3.25 miles southwest of the village of San Lorenzo in the SE ¼ of Section 35, T17S, R11W, NMPM, at an altitude of 6440 feet (see the U.S.G.S. "San Lorenzo" provisional 7.5-minute quadrangle, 1985).

HISTORY

The first claim filed over the copper rose deposit was located February 2, 1882, by Milton R. Brown. The claim was known as the "McGregor mine." Later it was referred to as the "old McGregor copper mine" when Jack Clark, James A. Lucas, J. J. Avery and Dr. B. G. Gutherie relocated it as the now famous "Copper Glance" and "Potosi" claims on December 19, 1887 (Yeates, 1889; Snow, 1893).

The first published record referring to the "copper roses" appeared in 1889 in the *American Journal of Science* (Yeates, 1889). Mr. Lucas of Silver City had sent eight specimens to the United States National Museum during April of that year, with this note:

> From the "Copper Glance" and "Potosi" copper mines, Grant Co., New Mexico. This ore is found in all imaginable shapes and sizes from 1 oz. to 70 lbs.

William F. Hillebrand, a renowned mineralogist, was visiting Georgetown, New Mexico, just prior to Lucas's first letter and may have encouraged his first contact with the National Museum. F. W. Clarke, Honorary Curator, received the letter and specimens. He re-

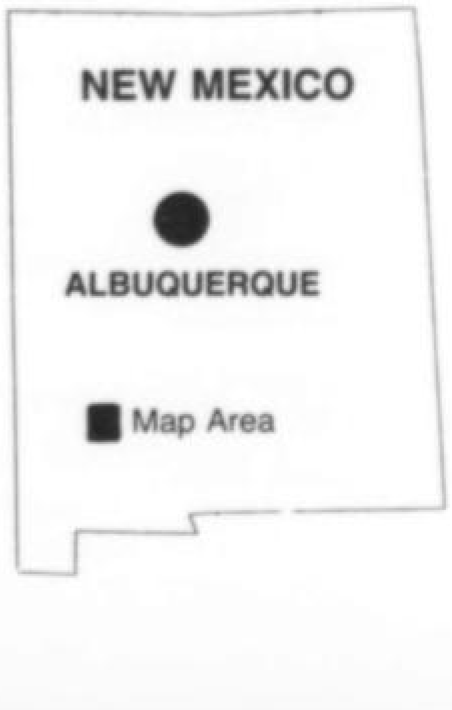

Figure 1. **Location of the Rose mine with major highways in the Georgetown mining district, Grant County, New Mexico.**

ferred one specimen to W. S. Yeates for identification. Yeates (1889) wrote:

> It had the appearance of copper; but it was very brittle, and its specific gravity was much too low for ordinary copper, a fragment yielding only 4.15 [gm/cc]. The surface was, in part, made up of what appeared to be tabular crystals, reminding one, in general form, of the azurite crystals from the Copper Queen mine, in the adjoining county of Cochise, Arizona. With dental instruments, the writer exposed a fine [crystal group from the kaolinite], the most prominent crystal being almost perfect. By measurement with a contact goniometer, the angle between the broad plane and an adjacent plane, on the copper crystal, was found to be identical with that of -1·$\bar{i}$2 on a fine Copper Queen azurite crystal in the [U.S. National] Museum collection. If the copper was, as it appeared, a pseudomorph of copper after azurite, the latter must have lost its carbonic acid and water in the presence of some reducing agent, probably volcanic gases thrown up from below, leaving the copper in a

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Special Announcement.—We have just purchased the entire mineral collection of Mr. NORMAN SPANG, of Pittsburg, Pa., numbering between 5,000 and 6,000 specimens, and offer it for sale for $10,000. If not disposed of as a whole by November 15th, it is our purpose to break it up and sell it at retail. The complete collection will be placed on exhibition in our Philadelphia salesrooms about November 1st, and will fill seventeen cases—193 drawers and eight glass-front cases, the latter containing many large, showy and magnificent museum specimens. Representing, as it does, the pick of many celebrated European collections, as well as the result of personal visits to many of the best localities throughout the world during the past thirty or forty years, it is uncommonly rich in extra fine examples of the old finds of minerals which it would be impossible to duplicate at the present time. A RARE OPPORTUNITY is presented to a Museum or private collector to secure one of the leading collections of the country, at a low price. We will be pleased to correspond with possible purchasers prior to November 15th.

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***Figure 2.* George L. English advertisement which appeared in *The American Geologist* in November of 1890. Note at the bottom the "copper pseudomorphs after azurite" from the Rose mine.**

Claim Located Copper Rose, April 1st 1893
Native Copper, April 1st 1893

Mineral Survey № 1068

L.O.T. №
Las Cruces Land District.

PLAT

OF THE CLAIM OF

James B Gilchrist

KNOWN AS THE

Copper Rose Group

IN Mimbres *MINING DISTRICT,*
Grant *COUNTY,* N.M.
Containing an Area of 40.286 *Acres.*
Scale of 300 *Feet to the inch.*
Variation 12°32'E.
SURVEYED March 24-27, 1900. *BY*
W. W. Jones
U.S. Deputy Mineral Surveyor,

The Original Field Notes of the Survey of the Mining Claim of James B. Gilchrist
known as the

Copper Rose & Native Copper Lodes

from which this plat has been made under my direction, have been examined and approved, and are on file in this Office; and I hereby certify that they furnish such an accurate description of said Mining Claim as will, if incorporated into a patent, serve fully to identify the premises, and that such reference is made therein to natural objects or permanent monuments as will perpetuate and fix the locus thereof.

I further certify that Five Hundred Dollars worth of labor has been expended or improvements made upon said Mining Claim by claimant or his grantors, and that said improvements consist of "on Copper Rose": Disc. Shaft No 1, 4'×6'×8' deep, Val. $80.00, Shaft No 2, 4'×6'×6' deep, Val. $20.00, Shaft No 3, 4'×6'×12' deep, Val. $100.00, Shaft No 4, 4'×5'×6' deep, Val. $20.00, Shaft No 5, 4'×6'×60' deep, Val. $1800.00
"on Native Copper": Disc. Cut No 1, 6'×7'×6' long, Val. $20.00, Shaft No 2, 4'×6'×60' deep, Val. $600.00, Shaft No 3, 4'×6'×30' deep, Val. $250.00, Level No 4, 4'×7'×30' long, Val. [illegible], Level No 5, [illegible] long, Val. [illegible], Level No 6, 4'×7'×[illegible] long, Val. $2000.00, Shaft No 7, 4'×6'×18' deep (underground) Val. $100.00, Crosscut No 8, 4'×6'×[illegible] long (underground) Val. $300.00, Crosscut No 9, 4'×7'×30' long (underground) Val. $300.00, Crosscut No 10, *that the location of said improvements is correctly shown upon this plat, and that no portion of said labor or improvements has been included in the estimate of expenditures upon any other claim.*

And I further certify that this is a correct plat of said Mining Claim made in conformity with said original field notes of the survey thereof, and the same is hereby approved.

U.S. Surveyor General's Office Quimby Vance
Santa Fe, N.M. *U.S. Surveyor General for*
April 20, 1900 New Mexico

***Figure 3.* From the plat map for the Rose mine, 1893.**

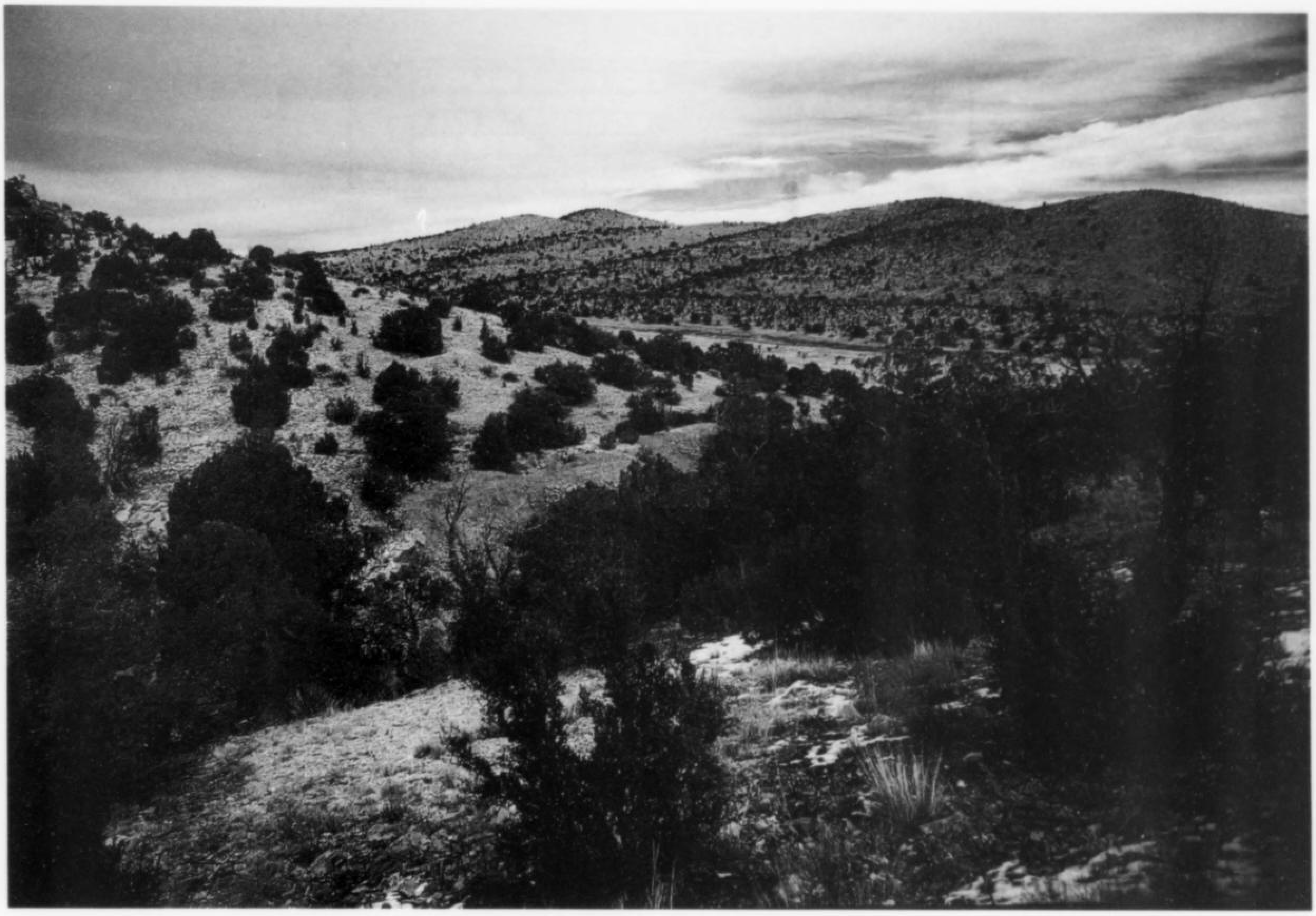


***Figure 4.* Rose mine area viewed from the northeast. Photo by Tim Hanson.**

spongy state, upon which the kaolin was deposited, and forced by pressure, while in a soft, semi-liquid condition, into the pores of the sponge.

The next published account came when George L. English & Company advertised copper pseudomorphs after azurite in the March and November 1890 issues of *The American Geologist*. The advertisement was never repeated, not because of a lack of interest, but because of a shortage of specimens.

Charles H. Snow of New York City delivered a paper in June of 1892 at the Plattsburgh [Mineralogical Society?] Meeting in Lake Champlain, regarding his visit to the claims. In his treatise he reviewed Yeates's observations and added his own regarding the geology and hydrology.

On April 1, 1893, the "Copper Glance" and "Potosi" claims where relocated as the "Copper Rose" and "Native Copper," respectively, by former claimants Avery and Lucas, in addition to John M. Clark. They held these claims until March of 1899. By November 1899 they had sold all their interests for $5000 each directly and indirectly to James B. Gilchrist.

Gilchrist filed for patent in March of 1900. The patent was granted January 8, 1901. On April 12, 1902, Gilchrist sold his interest for one dollar to Gilchrist and Dawson, Inc., a company in which he was the president and major stockholder.

On June 24, 1909, a Mr. W. G. Swart of the American Zinc Corporation visited the "Copper Rose mine" with the idea of purchasing it. Mr. P. G. Fierro, alleged owner, was asking $20,000 for the claims. Mr. B. F. Baker, a former partner of Fierro's, rode horseback out to the claims with Swart and found a Mr. Hull working alone. Hull had piled about 20 tons of shipping-grade carbonate, oxide and native copper ore that ran nearly 30% copper. By working half days, Hull claimed he was earning $4 to $5 per day, (Swart, 1909).

Eventually, the claims became part of the Gilchrist, Herdon and Culberson estate. During 1943 the claims were sold to Kennecott Copper Corporation. In 1982 they were transferred to Chino Mines Company. Chino Mines Company is now a subsidiary of the Phelps Dodge Corporation.

Mining activity probably ceased shortly after 1913. A Barber quarter dated 1913 in near mint condition was found exposed on a dump in 1971 by William Worthington when he and Robert Eveleth visited the site, (Eveleth, Worthington, personal communication, 1991).

Since the Rose mine's rediscovery, most mineral collectors and metal detector enthusiasts have stuck to the dumps (Craft and Hanson, 1981a). The upper workings offer little chance of finding copper roses, though cuprite roses were obtainable. They also offer unseen hazards such as rattlesnakes, whip scorpions and imminent collapse.

The lower workings appeared inaccessible in 1980; however, during the summer of 1991 a rumor was circulating that local collectors were recovering specimens from underground backfill. At this time the author examined well over 100 newly mined and superbly cleaned pseudomorphs. Considering their recent appearance and the fact that the dumps have seen 20 years of thorough collecting, this rumor is likely true.

WORKINGS, PRODUCTION and GRADE

The original McGregor Copper mine workings lay along a limestone ledge 3.7 meters west of what became the discovery shaft of the

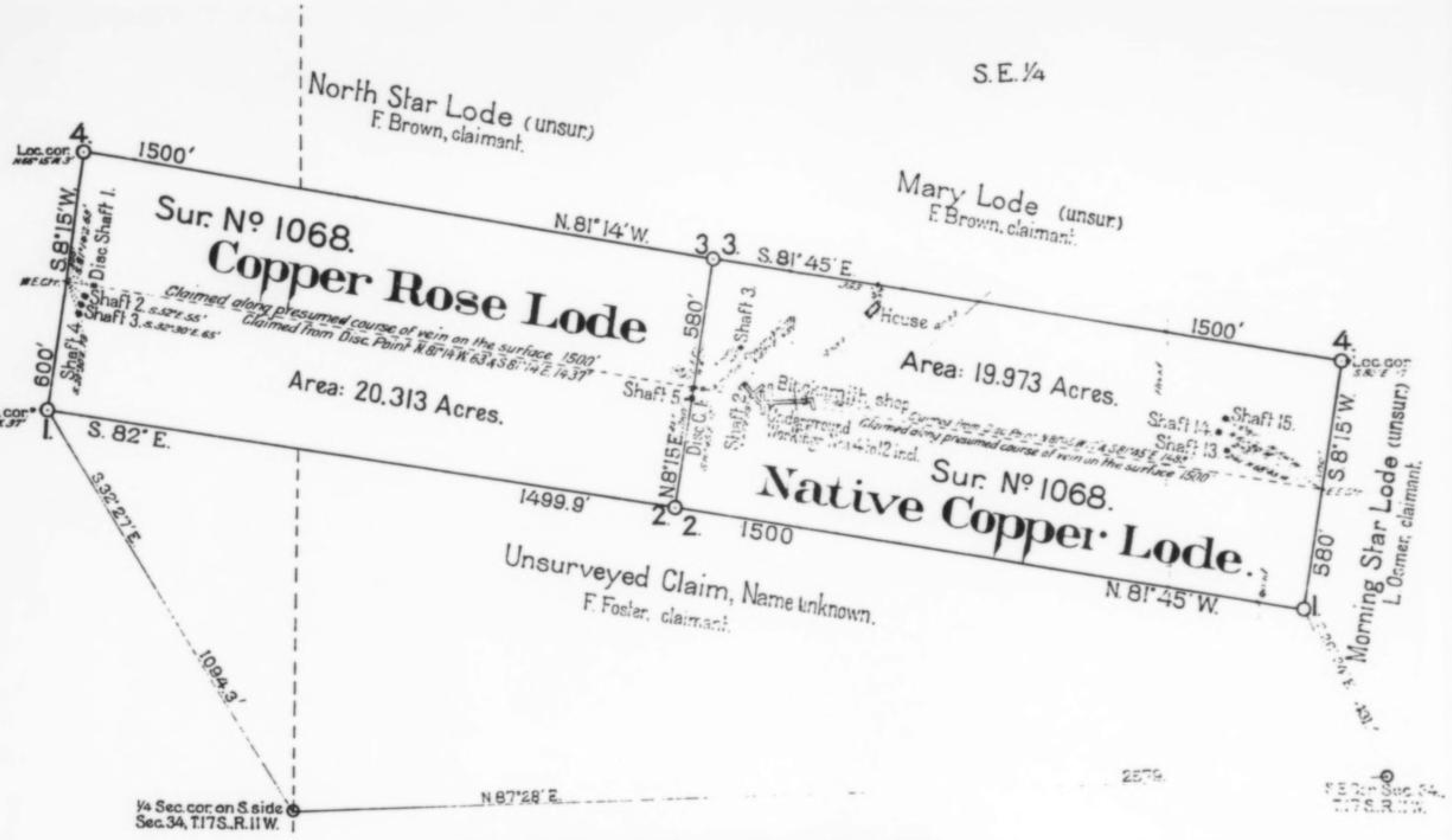


Figure 5. **Plat map for the Rose mine, 1893.**

Copper Glance and Potosi mining claims. During Swart's visit he wrote:

> Surface work only, gophering in the lime. One winze to water level, about 70' below the surface. Several shallow shafts, drifts, etc. and much irregular work. All together about 300' long by 100' wide, all showing ore with plenty in the bottom.

A detailed drawing of the workings are shown on Mineral Survey Plat No. 1068 (1900). At the time of Swart's observations in 1909 only insignificant development had occurred. Since this original period, all workings have fallen into disrepair, with openings becoming partially to totally collapsed. No buildings remain.

Swart (1909) reports that the overall copper grade ranged from 3% to 4%. Production as of June 24, 1909, was held at $30,000. These figures equate to a production of nearly a quarter of a million pounds of copper at 13.25 cents per pound (*Engineering and Mining Journal*, 1904). Carrying calculations further, the average copper rose weighs 13.6 grams, which equates to 120 roses per cubic foot, 63,450 cubic feet excavated and 7.6 million roses mined! At today's retail price of around $25.00 per rose, that would equal $188,000,000 worth. But of course, if even 100,000 copper roses were placed on the specimen market today, their price would become severely depressed. By world standards, the original (unaltered) azurite rose deposit was sizable. Since its unusual metamorphism it has become unparalleled.

GEOLOGY, HYDROLOGY and PSEUDOMORPH ORIGINS

The claims are situated in a region containing world-class copper porphyry mineralization. Five miles to the west lies the Santa Rita stock and copper porphyry deposit of Tertiary age. It seems likely that a hypogene solution circulating around this or another related intrusion deposited a copper sulfide mineral assemblage in or near the Rose mine vein. After a period of uplift and erosion supergene enrichment occurred. When copper-rich solutions entered the carbonate environment of the Rose mine vein, azurite roses formed; syngenetically, Paleozoic shaley limestone adjacent to the vein developed into kaolin under acid attack.

With a rise in the water table, the azurite roses were plunged into a high-pH and oxygen-poor environment. As a consequence, the azurite roses moved toward a stable equilibrium with an enveloping aquifer rich in calcium carbonate and sulfate. This resulted in azurite altering to pseudomorphs of native copper and calcite.

$$\text{Azurite} + \text{Water} + (\text{Gypsum})_{aq} \Rightarrow \text{Copper} + \text{Calcite} + \text{Sulfuric Acid} + \text{Oxygen}$$

$$2(Cu_3(CO_3)_2(OH)_2 + 2(H_2O) + 4(CaSO_4)_{aq} \Rightarrow 6Cu^{\circ} + 4(CaCO_3) + 4(H_2SO_4)_{aq} + 3(O_2)$$

The Copper Rose and Native Copper claims' location shaft was sunk 30 meters. Here, cuprite roses and malachite were found to a depth of 15 meters. From a depth of 15 meters to 30 meters copper roses were encountered. At 22 meters water was struck (Snow, 1893; Swart, 1909).

At the time of Swart's visit of June of 1909, the water table is thought to have imposed three geochemical regimes on the Rose mine deposit. The lower portion, constituting the aquifer, was oxygen-poor. The transitional capillary zone was high in carbon dioxide at its surface and low in oxygen throughout. The upper portion was oxygen-rich. As a result, the copper rose pseudomorphs after azurite contained in the aquifer remained unaltered. At the top of the capillary zone, the roses altered back to azurite (Lucas, 1889b). From this point to the surface they oxidize to cuprite and malachite. (I would call these *retrograde-pseudomorphs*. This term implies that the copper after azurite pseudomorphs are in an intermediate state of altering back towards their parent mineral or beyond to malachite.) The result, is a stratified pseudomorph assemblage that coincides with current geochemical theories (Anderson, 1983).

Structurally, the Rose mine vein strikes N82°W and dips 68.5° SW along an arroyo. The vein contains a sporadically mineralized kaolin. Predominantly, the mineralization consists of copper and cuprite roses. Occasionally, crystalline copper, azurite and turquoise are present. The kaolin forms the hanging wall of at least 370 meters of vein. The vein's width varies from 15 cm to 2 meters (Snow, 1893; Swart, 1909). It is normally faulted along N32°W-dipping limestones of the

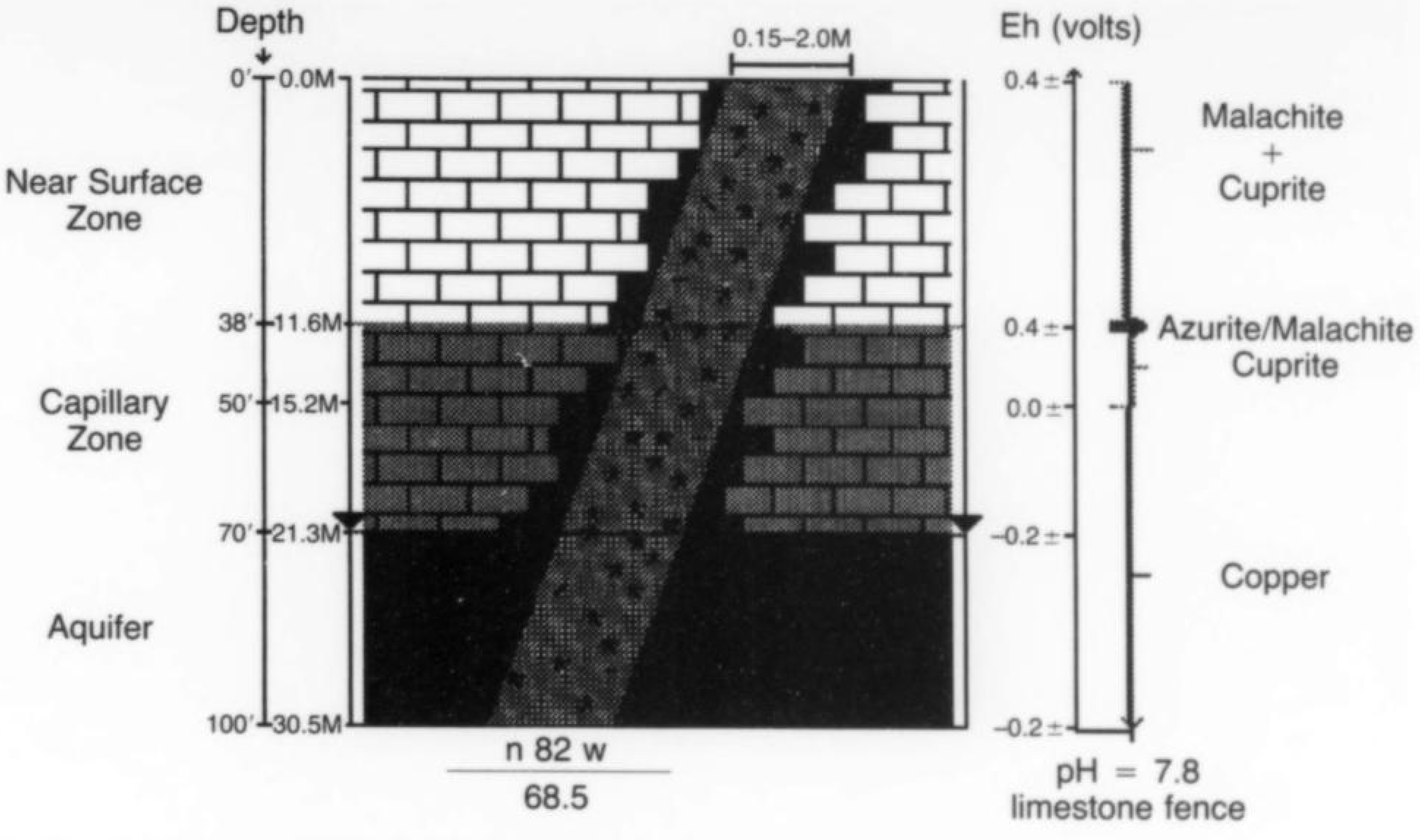


Figure 6. **Cross section of the Rose Mine vein representing a consolidation of historical records and current geochemical theory, Anderson (1983), Krumbein and Garrels (1952), Lucas (1889b), Nataraja & Garrels, (1957), Peters (1987), Snow (1893), Swart (1909), Yeates (1889).**

Lower Mississippian Lake Valley formations to the northeast and the Upper Pennsylvanian Magdalena Group to the southwest.

MINERALOGY

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

Azurite, "blue copper," is reported to have occurred just above the copper rose zone (Lucas, 1889b). I have seen azurite staining associated with a retrograde malachite pseudomorph recovered from the Rose mine dump.

Calcite $CaCO_3$

Calcite is ubiquitous and not of collector quality. It occurs as a pore filling within copper roses and cuprite-malachite retrograde pseudomorphs. Calcite also encases scant native copper crystals and fills veinlets in limestone.

Chrysocolla $Cu_2H_2Si_2O_{10}(OH)_8$

Chrysocolla is found with malachite and kaolinite that encrusts retrograde pseudomorphs.

Copper Cu

Copper-after-azurite pseudomorphs ("copper roses") are the most sought after specimens from this locality. They are typically found in nodules of white to brown clay. As a result, they are difficult to spot with the unaided eye. However, with the advent of metal detectors, a collector's ability to find these metallic targets has been greatly enhanced. Modern metal detectors can typically sense to depths of 25 cm or more for quarter to half-dollar-sized objects. Copper pseudomorphs are of the same cross-sectional diameter, ranging from 1.2 to 5.0 cm for roses (Snow, 1893) and 1.2 to 3.8 cm for rhombs and monoclinic shaped tablets. As anticipated, they are found to the same depth.

Occasionally pseudomorphs are found attached to fossiliferous limestone or have crinoids attached to them. A small proportion of the rhombs and roses show attachment points without any matrix. The parent mineral, azurite, more often than not appears to have nucleated and grown while suspended in clay.

Copper pseudomorphs after malachite and crystalized copper are also present. Blebs of native copper are occasionally found on the surfaces of the roses and tablets. They are interpreted as being copper pseudomorphs after malachite. The crystalized copper occurs as rough tetrahexahedrons (M. Wilson, 1991, personal communication). Arborescent groups have been measured to 3.7 cm, single tetrahexahedrons to 8.1 mm and spinel-law twins to 1.8 cm.

Roses are not the homogeneous substance they appear to be in hand specimens. Polished sections under magnification reveal arborescent groups of native copper nucleating along the pseudomorph faces. The arborescent groups show distinct size and directional growth into calcite and void-filled channels. Generally speaking, the channels track from the most acute surface intersections and parallel the faces. This is probably the result of stress-fracturing caused by a theoretical 4% volume increase during metamorphoses.

A gravimetric study shows that the average density of 95 pseudomorphs measured is 3.99 g/cm^3. The theoretical density was calculated at 4.166 g/cm^3 after the 4% volume increase (excluding voids). This value is only 0.02 g/cm^3 higher than what Yates (1889) determined for a select portion of a pseudomorph. Nevertheless, the difference between the theoretical and average density is thought to be a consequence of:

(1) voids being created during alteration, and

(2) mobility and overall loss of copper.

All the polished sections showed minor amounts of voids within the calcite-filled channels. This fact makes sense. Without voids and permeability the metamorphic process would be retarded. One would expect to see only surface alteration otherwise. This is not the case, though. Not one specimen was limited to surface alteration, or for that matter had any primary azurite.

I would speculate that, overall, copper was depleted from the copper pseudomorphs. The gravimetric study shows 82% of the roses are below the theoretical density and only 15% are greater. A mass bal-

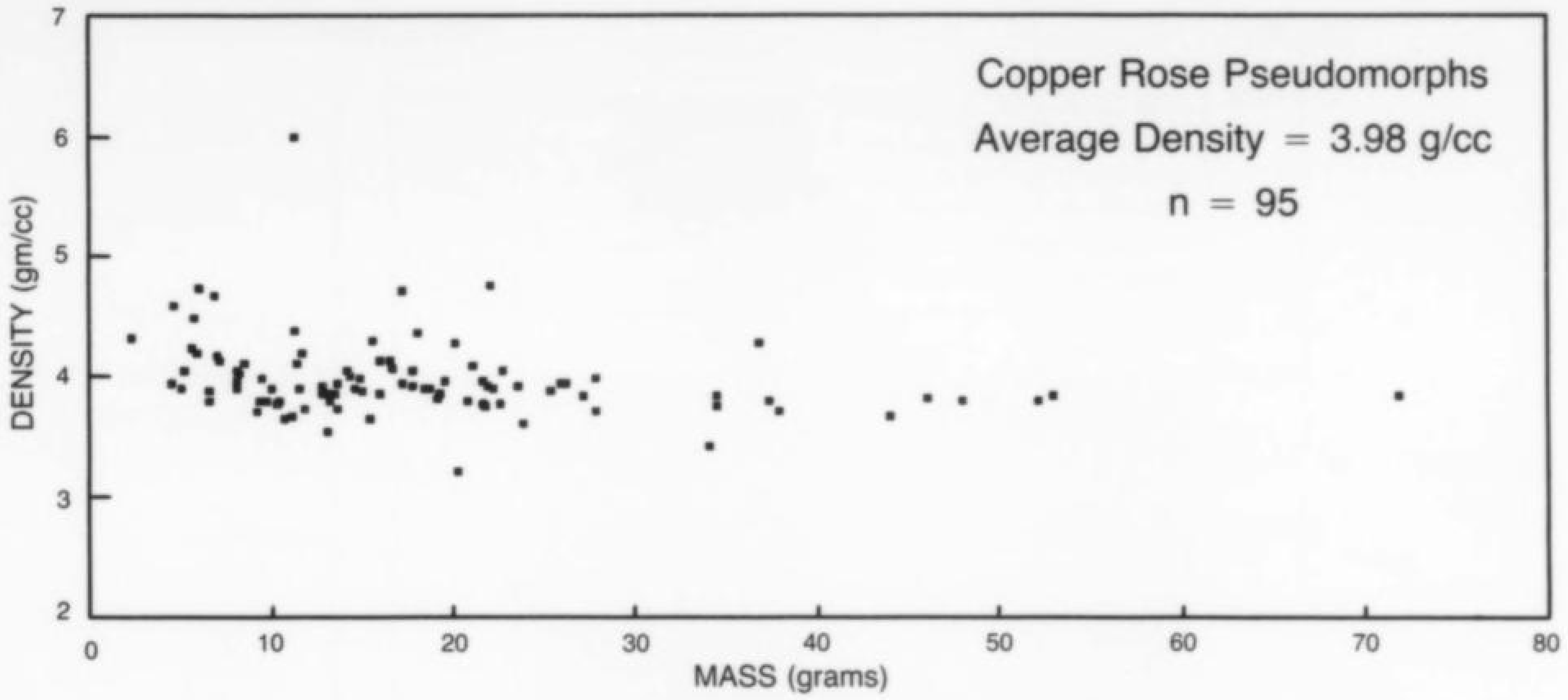


Figure 7. **This figure shows the density versus mass for a population of 95 copper roses recovered from the Copper Rose Mine, Grant County, New Mexico, USA. (New Mexico Bureau of Mines specimens.)**

Figure 8. **A copper "rose" pseudomorph, 2.5 cm, set on typical matrix (not attached). Photo by Tim Hanson.**

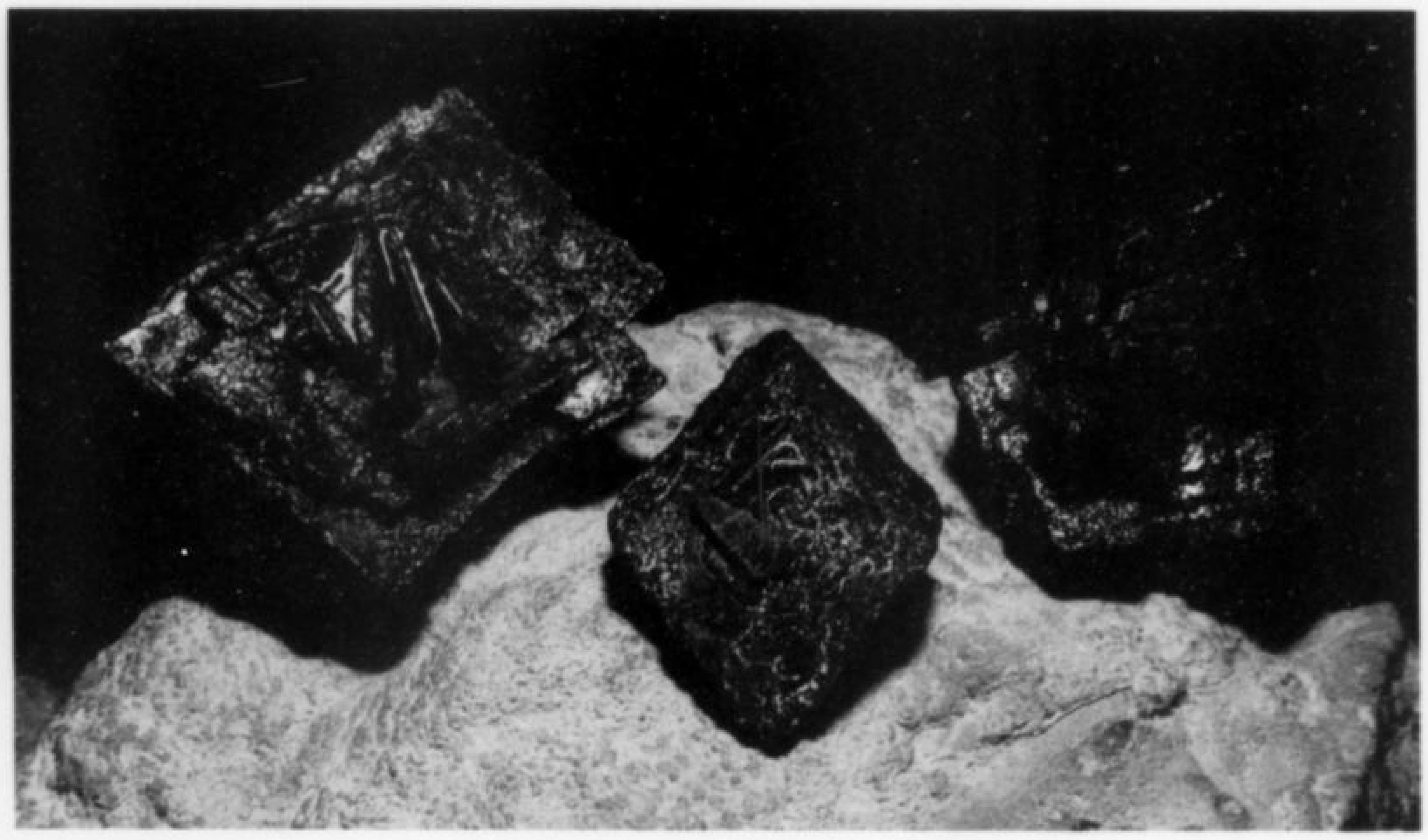
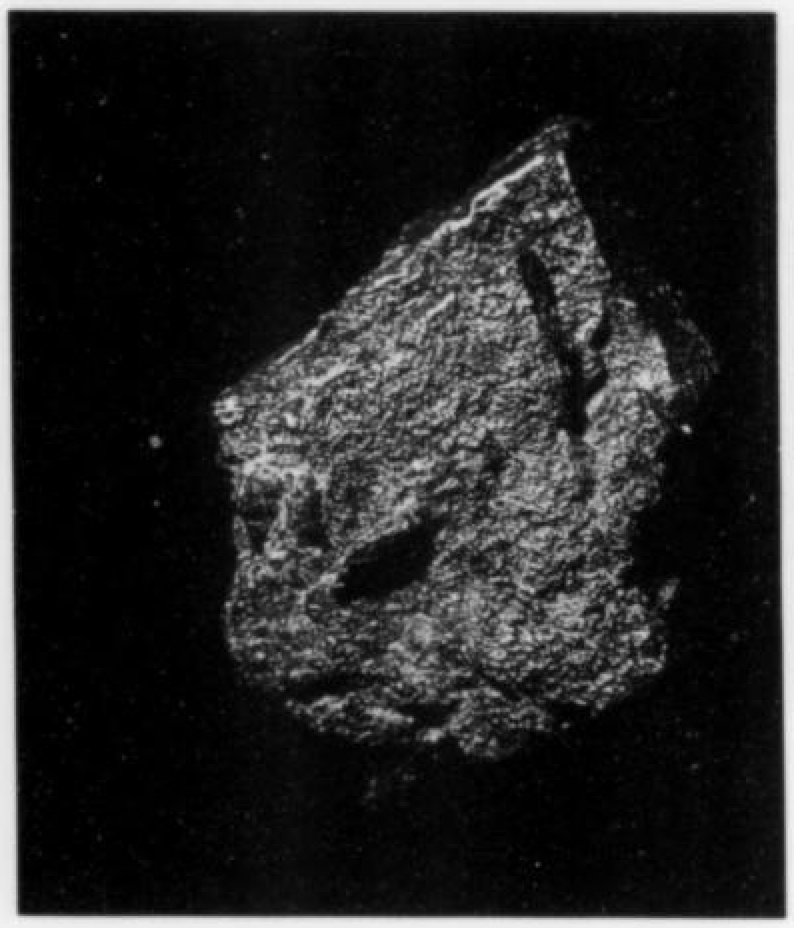


Figure 9. **Copper pseudomorphs to 1.9 cm, set on typical matrix (not attached). Photo by Tim Hanson.**



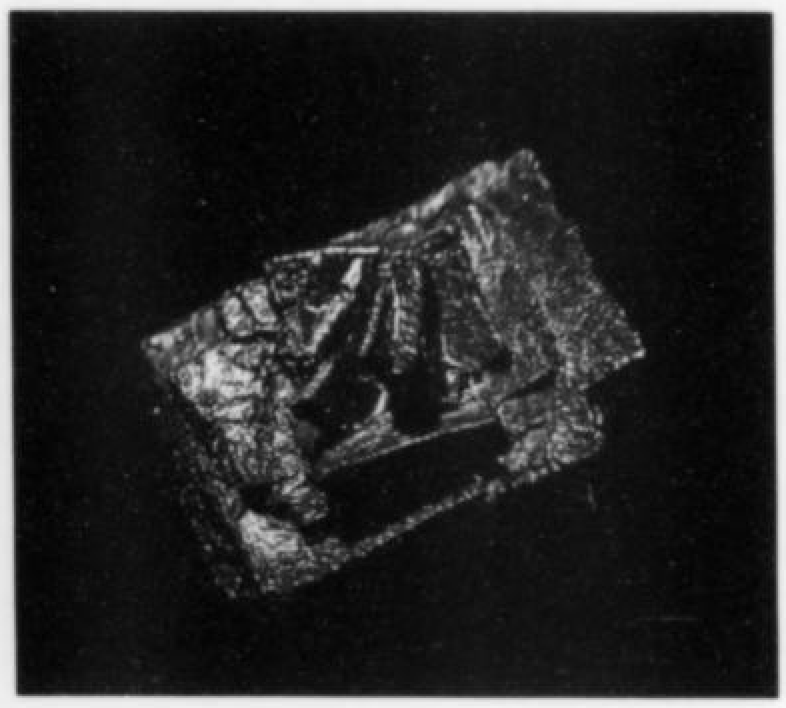


Figure 10. (left and far left) **Copper pseudomorphs, 2.8 and 2.2 cm. Photo by Tim Hanson.**

ance, comparing the amount native copper found to the number of copper pseudomorphs found suggests the depleted copper may have formed the scant native copper found with the roses. In addition, the depletion and enrichment process that occurred seems to have been buffered. The largest specimens show the least variability in density.

Cuprite Cu_2O

Cuprite-after-copper-after-azurite retrograde pseudomorphs are similar to copper-after-azurite pseudomorphs in form. In polished sections, pseudomorphs range from being totally free of cuprite to being totally replaced by cuprite. The cuprite appears to form anhedral grains against pitted copper. (For simplicity, cuprite retrograde pseudomorphs should be defined as such if more than 50% of the copper is in the form of cuprite.)

Cuprite is typically a retrograde replacement after native copper

Figure 11. **Searching for copper pseudomorphs with a metal detector. Photo by Tim Hanson.**

after azurite, but not entirely so. Cuprite replaces the scant crystalline copper to a greater or lesser degree.

Halloysite $Al_2Si_2O_5(OH)_4 \pm H_2O$

Kaolinite is reported to occur as a pore filling within the copper roses (Yeates, 1889). Polished sections show clay filling gaps between blades while calcite, voids, copper and cuprite replace azurite. Marc Wilson reports the clay consists of halloysite with minor amounts of quartz and calcite (personal communication, 1991). The vein-fault filling is a light tan to brown-stained halloysite. It probably formed when acid attacked the surrounding limestone and shale during supergene enrichment.

Malachite $Cu_2(CO_3)(OH)_2$

Malachite stains outcrops and boulders. It also occurs as retrograde pseudomorphs after cuprite. Roses which have undergone nearly complete alteration to malachite have decrepitated to an indefinite rose form. Only in cross section can the true origin be ascertained.

Quartz SiO_2

Quartz is reported as occurring as waterworn pebbles in the near surface ores (Snow, 1893).

Turquoise $Cu(Al,Fe)_6(PO_4)_4(OH)_8 \cdot 4(H_2O)$

Turquoise is rare, occurring as surface coatings of less than 0.5 mm thick on copper roses (Eveleth, 1991).

CLEANING PSEUDOMORPHS

In the past, cleaning roses was an arduous task by dental pick, wire brush and quick acid baths. With the advent of miniature sandblasters, which the paleontologic community uses for fossil preparation, subtle differences in hardness between the clay and calcified copper can be taken advantage of to achieve excellent separation.

LAND STATUS

The Copper Rose and Native Copper are patented mining claims.

Figure 12. **Inclined shaft entering the vein. Photo by Tim Hanson.**

They are held by Chino Mines Company, a subsidiary of Phelps Dodge Corporation. Their address is:

Chino Mines Company
P.O. Box 7
Hurley, NM 88043-0007

Approval to visit the Rose mine property must first be obtained prior to entry. Management, in the past, has forbidden mineral collecting. Trespassers should expect to be prosecuted for felony trespass. Collectors are encouraged to respect the mine and surrounding land owners' property rights.

ACKNOWLEDGMENTS

I would like to thank Bob Eveleth, New Mexico Bureau of Mines and Mineral Resources, for his help locating historical records, and Marc Wilson, Carnegie Museum of Natural History, for allowing me to examine and analyze the New Mexico Bureau of Mines Mineral Museum's collection of copper roses while he was curator there.

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The Phosphate Analog of Molybdofornacite

from Whim Creek, Western Australia

Ernest H. Nickel
and
Greg J. Hitchen
CSIRO Division of Exploration and Mining
Wembley, WA, 6014, Australia

A new unnamed mineral, the phosphate analog of the rare mineral molybdofornacite, has been found as small greenish yellow tufts in gossan specimens collected at the Whim Creek mine in northern Western Australia.

INTRODUCTION

The Whim Creek Cu-Zn-Pb-Ag deposit in the Pilbara region of northern Western Australia is a gently dipping stratiform sulfide body which has been mined intermittently between the 1880's and 1964. Weathering of this body has produced an extensive gossan capping that is exposed at the surface for a length of about 5 km. The mineralogy and geochemistry of this gossan have been described by Nickel (1982), who noted the occurrence of a number of secondary ore minerals including malachite, azurite, chrysocolla, pseudomalachite, cerussite, alunite, jarosite, plumbojarosite, osarizawaite, plumbogummite, duftite, mimetite, fornacite, wulfenite, mottramite, iodargyrite, native silver and a silver-mercury amalgam.

More recently, Mr. David Vaughan of Perth, Western Australia, has collected some of the gossanous material at Whim Creek and noted a mineral in one specimen that did not fit the description of any of the published minerals. This mineral was brought to our attention, and we studied it in an attempt to identify it. We were not able to correlate all of its properties with those of any existing mineral species, and are therefore of the opinion that it may be a new mineral species. Unfortunately we do not have sufficient material at our disposal to characterize it adequately for a submission to the IMA Commission on New Minerals and Mineral Names, but we think that its description, though incomplete, should be published so that the mineral can be recognized by other collectors.

PHYSICAL and OPTICAL PROPERTIES

The mineral occurs very sparsely as small tufts of greenish yellow crystals in some of the gossan cavities. One of the largest of these tufts, measuring about 1 mm in size, is shown in Figure 1. The individual crystals that make up these tufts are prismatic in shape and up to about 0.3 mm in length and a few μm in width.

It was not possible to separate individual crystals of sufficient size to determine all the optical properties of the mineral. However, it was noted that the crystals are length-slow and have high birefringence and high refractive indices. The refractive index parallel to the long axis is substantially above 2.0, and normal to the long axis is slightly above 2.0.

The specific gravity could not be measured because the individual crystals are too small; if aggregates are used, air is trapped between the crystals in the tufts, giving an erroneously low value. The density calculated from the chemical composition and unit-cell parameters (see below) is 6.18 g/cm^3.

CHEMICAL COMPOSITION

The composition of the mineral was determined by electron microprobe analysis of several tufts embedded in plastic, then sectioned and polished. The analyses were done on a Camebax SX-50 electron microprobe operating at an accelerating voltage of 20kV and a specimen current of 20 nA. The analyses were done in wavelength-dispersive mode using the following standards: copper (Cu), PbS (Pb), molybdenum (Mo), chromium (Cr), GaP (P and Ga), and InAs (As). The results, shown in Table 1, when calculated on the basis of Cu + Pb = 3, and assuming one OH unit per formula, give a chemical formula corresponding to $Pb_{2.03}Cu_{0.97}Mo_{0.79}As_{0.06}Cr_{0.06}Ga_{0.01}P_{0.99}$-$O_{8.67}H_{1.00}$, or $Pb_{2.03}Cu_{0.97}(Mo,As,Cr,Ga)_{0.92}(PO_4)_{0.99}O_{3.71}(OH)$. This is close to the probable ideal formula $Pb_2Cu(Mo,As,Cr)O_4(PO_4)(OH)$, which can be regarded as the phosphate analog of molybdofornacite, $Pb_2Cu(Mo,Cr)O_4(As,P)O_4(OH)$.

X-RAY CRYSTALLOGRAPHY

The small size of individual crystals precludes single-crystal X-ray

Table 1. **Results of electron microprobe analysis.**

	Weight %		Number of Atoms**
PbO	61.2%	Pb	2.03
CuO	10.5	Cu	0.97
MoO_3	15.4	Mo	0.79
As_2O_5	1.0	As	0.06
CrO_3	0.8	Cr	0.06
Ga_2O_3	0.1	Ga	0.01
P_2O_5	9.5	P	0.99
H_2O*	1.2	H	0.98
		O	8.68
Total	99.7		

The weight percentages are the averages of 14 spot analysis.

* H_2O calculated from the assumed OH content in the ideal formula.

** Normalized to Cu + Pb = 3.

Table 2. **X-ray powder diffraction pattern.**

I(est.)	*d*(meas.)	*hkl*	*d*(calc.)	I(est.)	*d*(meas.)	*hkl*	*d*(calc.)
1	8.3	002	8.318		—	$\bar{4}04$	1.997
2	4.81	012	4.817		—	400	1.895
1	4.47	$\bar{1}12$	4.481	3	1.895	304	1.894
2	4.16	004	4.159		—	$\bar{1}32$	1.894
1	3.76	112	3.748		—	$\bar{4}12$	1.894
1	3.414	014	3.401		—	108	1.852
10	3.308	$\bar{2}12$	3.309	1	1.852	$\bar{1}33$	1.852
1	3.084	202	3.079		—	027	1.852
5(B)	2.950	020	2.955		—	216	1.849
	—	$\bar{1}06$	2.944		—	$\bar{2}31$	1.767
4	2.814	114	2.826	2(B)	1.765	$\bar{2}32$	1.767
	—	212	2.731		—	$\bar{1}28$	1.767
4	2.726	203	2.729		—	019	1.764
	—	105	2.727		—	$\bar{2}35$	1.657
3	2.332	220	2.330	2	1.656	412	1.656
	—	008	2.079		—	$\bar{4}22$	1.656
2	2.076	312	2.077		—	$\bar{4}24$	1.654
	—	107	2.077		—	420	1.595
	—	$\bar{2}26$	2.000	1	1.595	324	1.595
2	1.995	$\bar{3}17$	2.000		—	$\bar{2}36$	1.595
	—	$\bar{4}02$	1.999				

CuKα radiation; 114.6 mm Debye-Scherrer camera; intensities estimated visually.

(B) = broad line.

diffraction studies. The X-ray powder diffraction data for the mineral, listed in Table 2, are quite close to the data published for molybdofornacite which has a = 8.100, b = 5.946, c = 17.65Å, and β = 109.17° (Medenbach *et al.*, 1983). These parameters were therefore used as the basis for indexing the reflections of the Whim Creek mineral. Least-squares calculation of the indexed reflections gives a monoclinic unit cell with a = 8.05, b = 5.91, c = 17.67Å and β = 109.7°. The *d*-values calculated from these unit-cell parameters (Table 2) are in good agreement with the measured values, suggesting that the parameters are essentially correct. Assuming 4 formula units per unit cell (Z = 4), as in molybdofornacite, the calculated density is 6.18 g/cm^3.

Figure 1. **A 1-mm tuft of the phosphate analog of molybdofornacite from Whim Creek. Photo by E. H. Nickel.**

DISCUSSION

The chemical composition and X-ray diffraction pattern of the Whim Creek mineral strongly suggest that it is the phosphate analog of molybdofornacite, with the phosphate ion occupying the structural site predominantly occupied by the arsenate ion in molybdofornacite.

A closely related mineral is vauquelinite, with the ideal chemical formula $Pb_2Cu(CrO_4)(PO_4)(OH)$, which immediately suggests an analogy with the formulae of fornacite, molybdofornacite, and the Whim Creek mineral. However, crystal-structure analyses of fornacite (Cocco *et al.*, 1967) and vauquelinite (Fanfani and Zanazzi, 1968) have shown that, although the packing of the atoms in the structures of the two minerals is essentially identical, there are differences in the coordination of the atoms around Pb, and in the arrangement of symmetry elements (Fanfani and Zanazzi, 1968). Fornacite and vauquelinite are therefore not perfect structural analogs. An attempt was made to index the diffraction pattern of the Whim Creek mineral on a vauquelinite-type unit cell, but was unsuccessful. It appears, therefore, that the Whim Creek mineral is more likely to be the analog of molybdofornacite than of vauquelinite.

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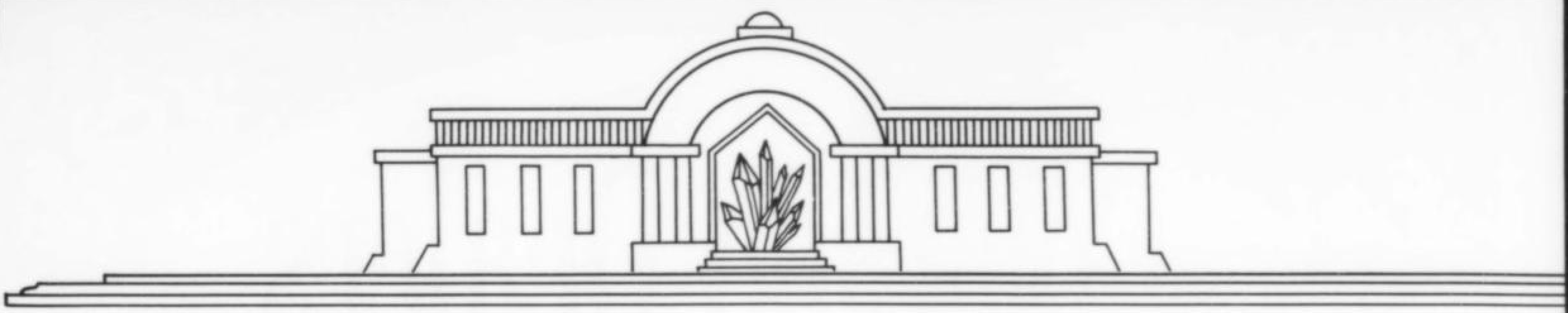

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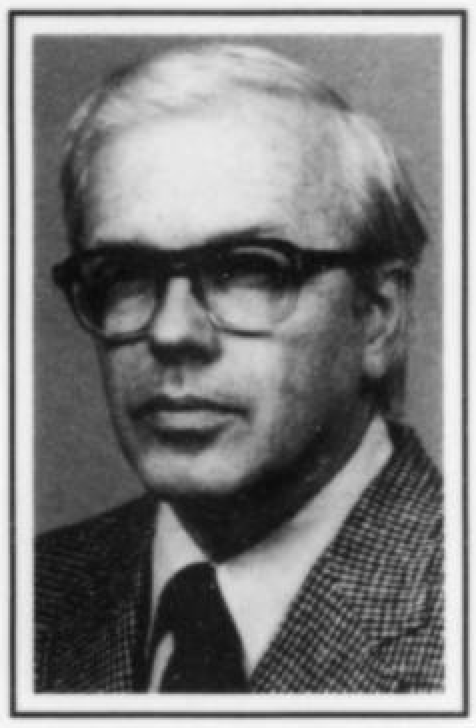


Microminerals

by **Bill Henderson**

Miscellany from France, the Eifel district, and Mont Saint-Hilaire

The Eifel volcanic district of Germany is home to a variety of fantastically beautiful and, in many cases, very rare and well crystallized microminerals. Their attractiveness is made very evident by a cursory inspection of the many color and black and white photos in Gerhard Hentschel's book, *Die Mineralien der Eifelvulkane*. His index of species lists such less-than-common minerals as barytolamprophyllite, brownmillerite, cuprorivaite, hannebachite, jasmundite, tangeite, and (ahem) willhendersonite. I highly recommend the book.

Without much trouble and over several years, I have accumulated 97 species from the Eifel district, mostly by exchange. Recently, I have purchased a number of very fine Eifel micromineral specimens at very reasonable prices from Bernd Ternes (Bahnhofstrasse 45, 56727 Mayen-Hausen 14, Germany). Bernd is a very active collector, specializing in the Eifel, and has a list of species available, with prices and descriptions. A few of the specimens obtained are shown here. The first (Fig. 2) shows golden brown cordierite crystals with associated pale violet mullite, crystobalite and sanidine. The sanidine crystals are superb as well. In Figure 3 are shown red-brown melilite crystals with euhedral crystals of nepheline, leucite, apatite and pyroxene. The very nice zircon specimen shown in Figure 4 also shows excellent, twinned nosean crystals plus a jet-black, very sharp allanite crystal on the reverse side. My namesake mineral, willhendersonite, is now known from at least two localities besides the type one in Italy. They are Steiermark in Austria and Bellerberg in the Eifel district. Willhendersonites found by Bernd are by far the finest yet for size, good crystal definition, and nice twinning. Because the mineral photographs poorly, readers will have to be satisfied with the superb sketch of this material sent to me by Garry Glen (Fig. 1).

Two French collectors have recently sent me exchange material which shows that their country cannot be ignored as a source of excellent microminerals. They are Jean-René Legris (Résidence Bel Ombrage, 15 Avenue Malacrida, F13100 Aix-en-Provence, France)

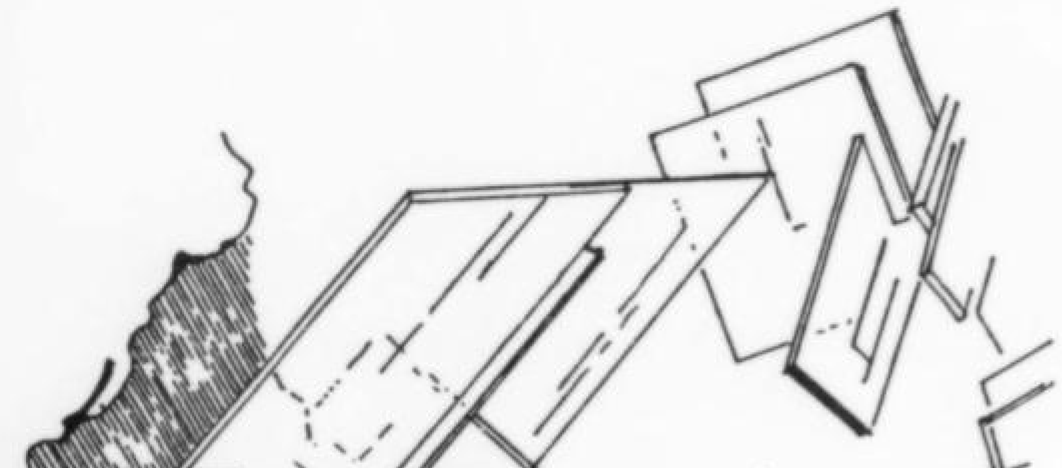


Figure 1. **Square, tabular, colorless, transparent single crystals and twins of willhendersonite to 0.3 mm, from Bellerberg, Eifel district, Germany. Sketch by Garry Glen.**

Figure 2. **Golden, tabular cordierite crystals on sanidine from Bellerberg, Eifel district, Germany. Largest crystals = 3 mm.**

Figure 3. **Orange-brown melilite crystals to 1 mm with nepheline, leucite, apatite and pyroxene from Kallenberg, Eifel district, Germany.**

Figure 4. **A pink, 1.5-mm zircon crystal with twinned white nosean crystals, from Mendig, Laacher See, Eifel district, Germany.**

Figure 5. **Green cornubite on wad, from the Cap Garonne mine, Cap Garonne, Var, France. Field of view = 3.5 mm.**

Figure 6. **Deep orange perroudite from the Cap Garonne mine, Cap Garonne, Var, France. Size of crystal group = 0.15 mm.**

Figure 7. **Yellow, radiating calcurmolite and red spherules of umohoite from Rabéjac, Herault, France.**

Figure 8. **Radiating, yellow crystals of seelite from Rabéjac, Herault, France. Field of view approximately 4 mm. G. Favreau specimen and photo.**

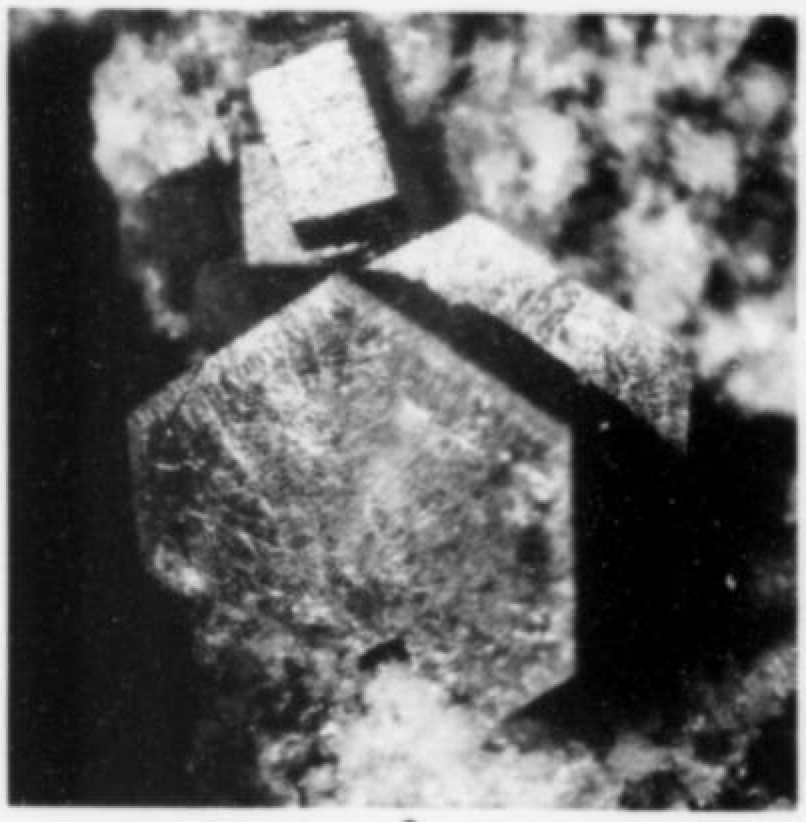
Figure 9. **Transparent 1.5-mm crystal of allanite on dolomite from Trimouns, Ariege, France.**

Figure 10. **A 1.7-mm group of tan, hexagonal crystals of bastnaesite from Trimouns, Ariege, France.**

Figure 11. **A deep orange, 1.2-mm crystal of monazite on dolomite, from Trimouns, Ariege, France.**

Figure 12. **Ilmenite crystal, 7 mm across, on analcime, from the Poudrette quarry, Mont Saint-Hilaire, Quebec. Photo by Dan Behnke.**

Figure 13. **Thick, euhedral slab of colorless elpidite epitaxial on the side of a bright orange 1.2-mm labuntsovite crystal with gaidonnayite on analcime, from the Poudrette quarry, Mont Saint-Hilaire, Quebec.**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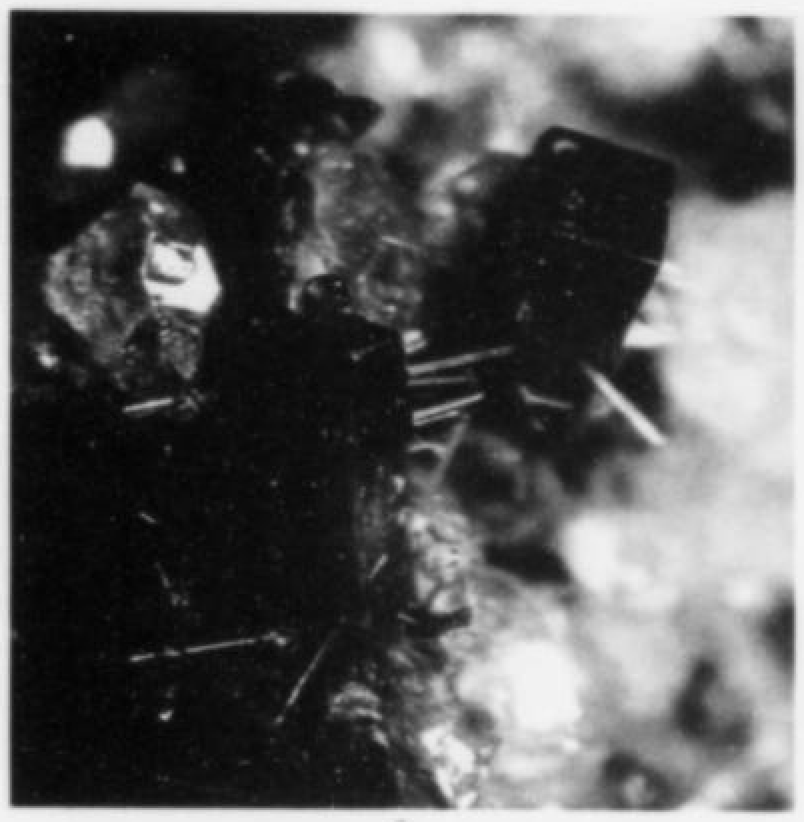
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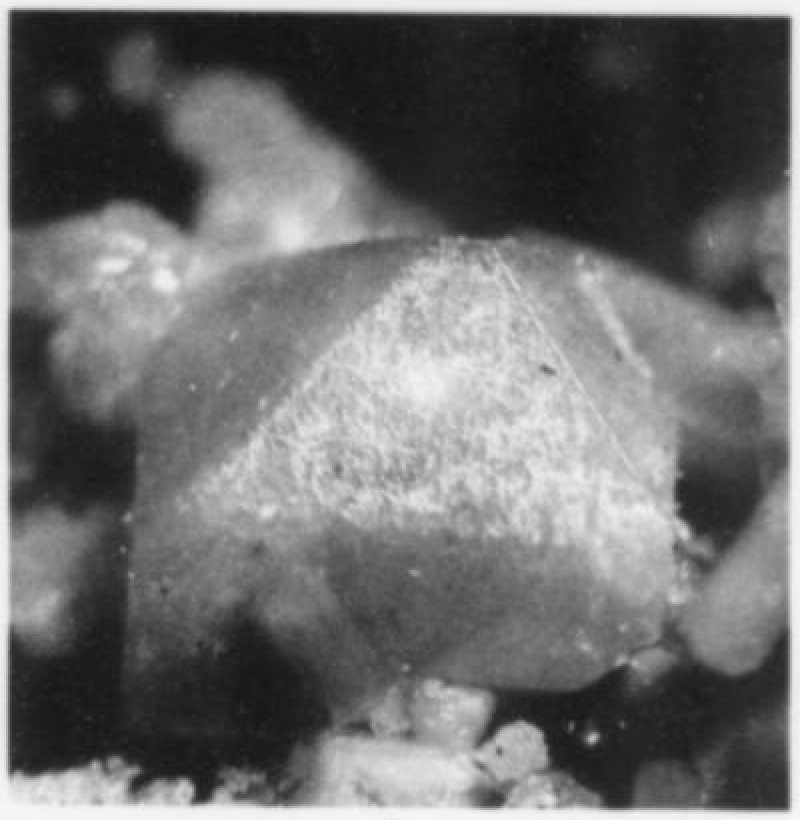
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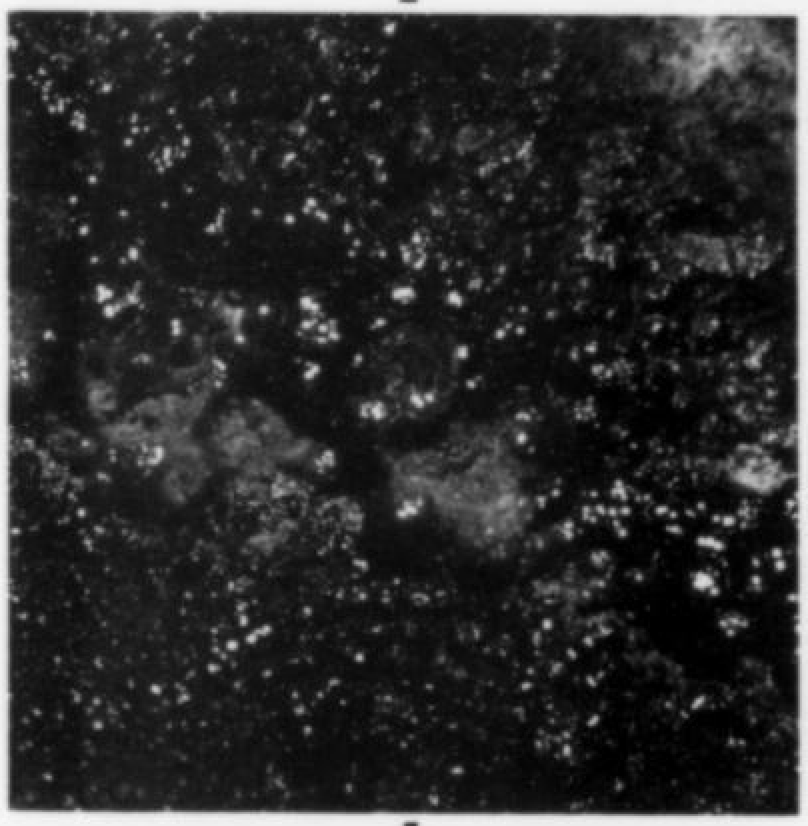
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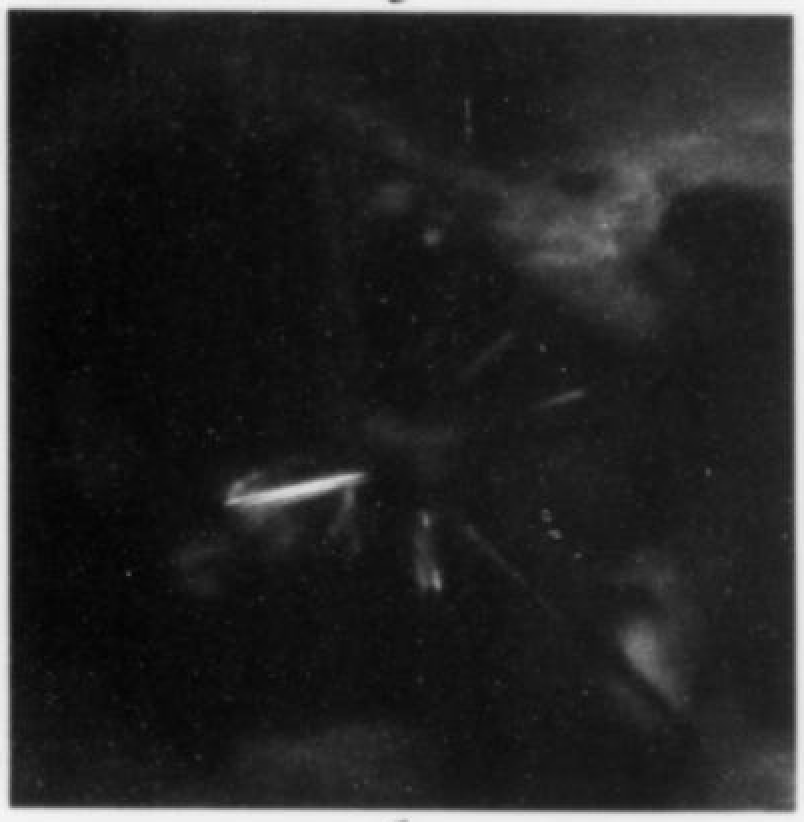
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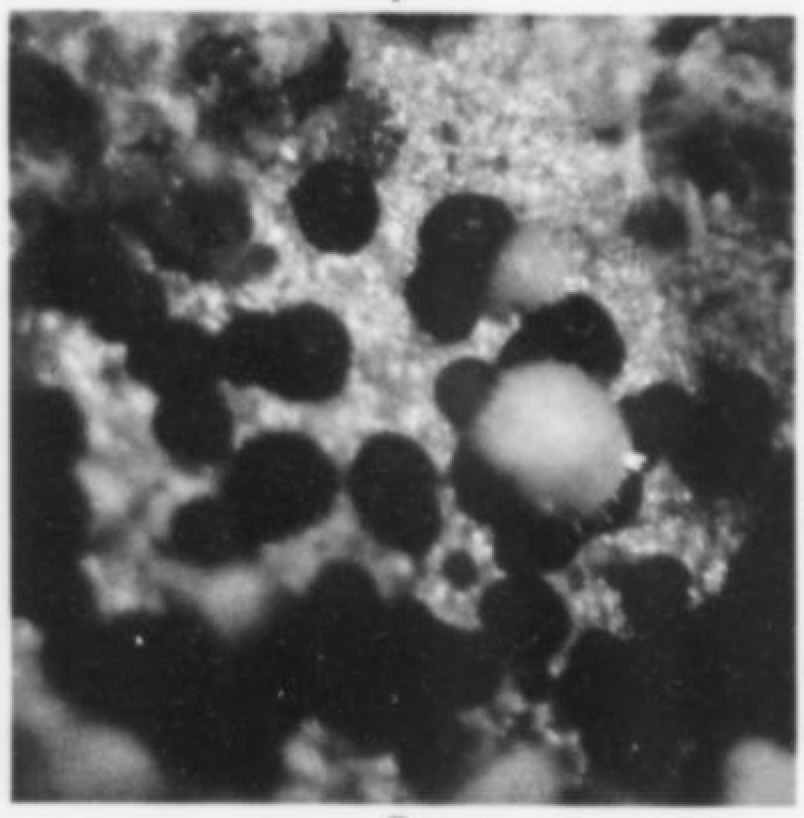
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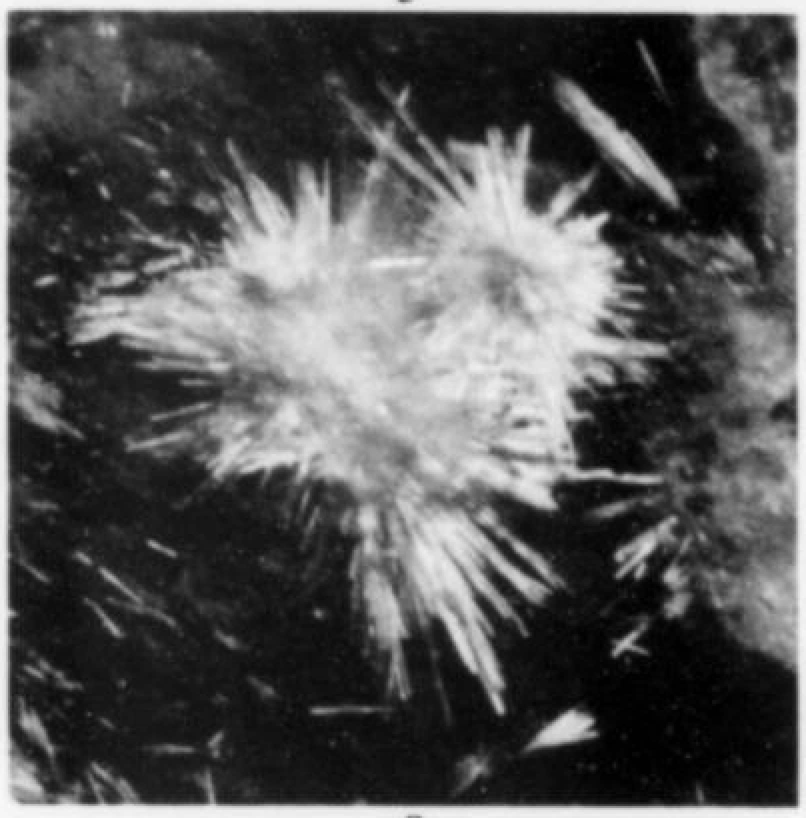
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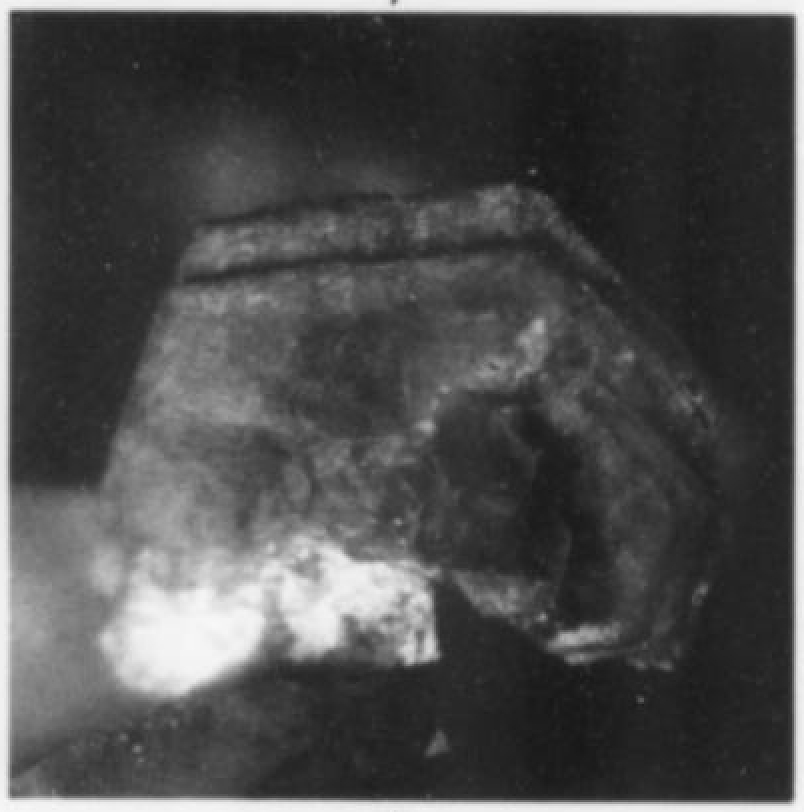
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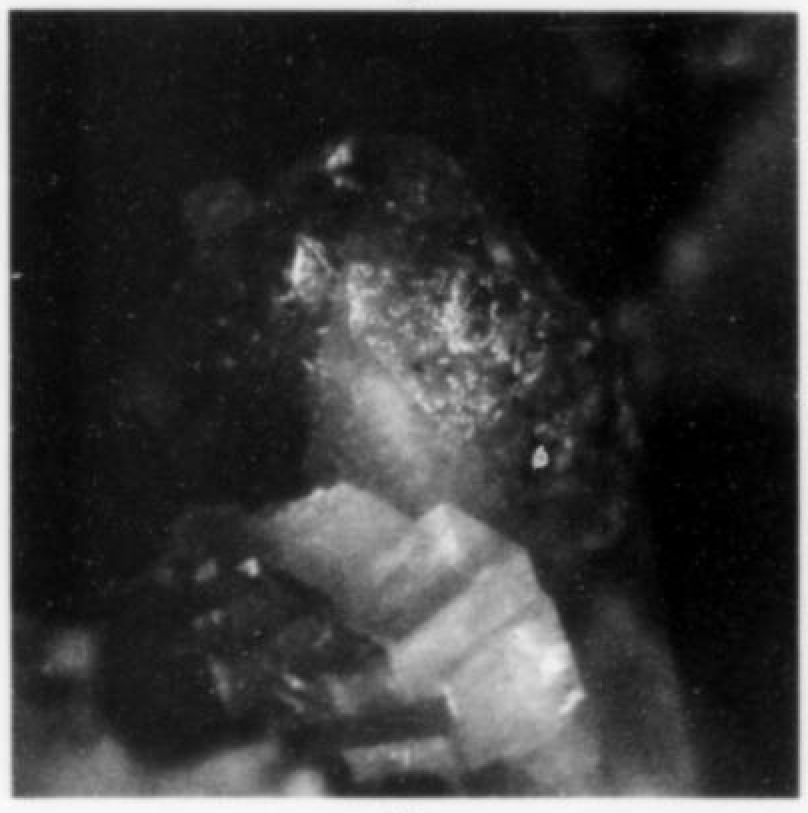
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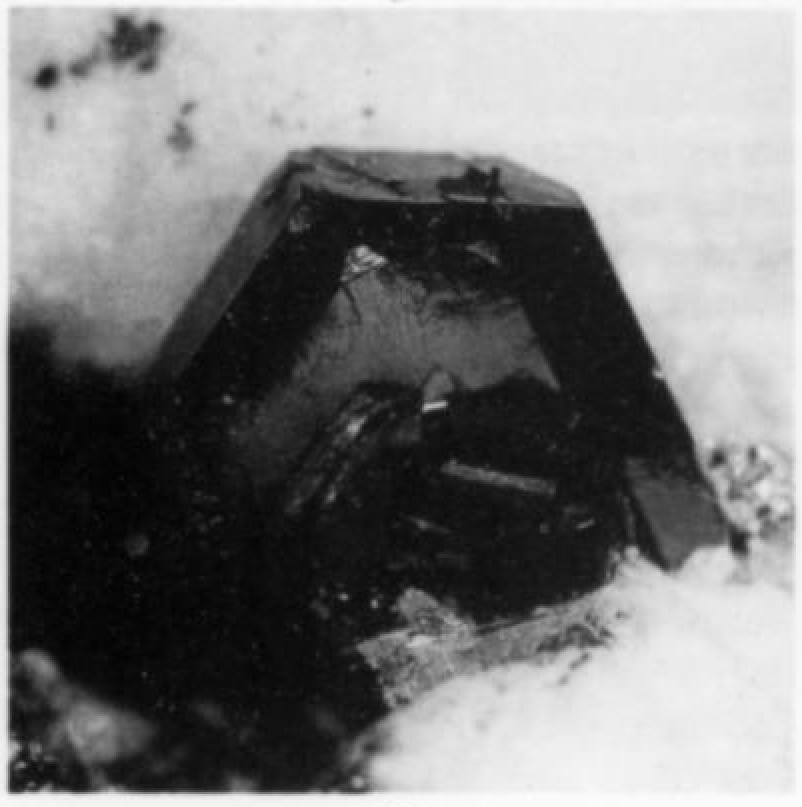
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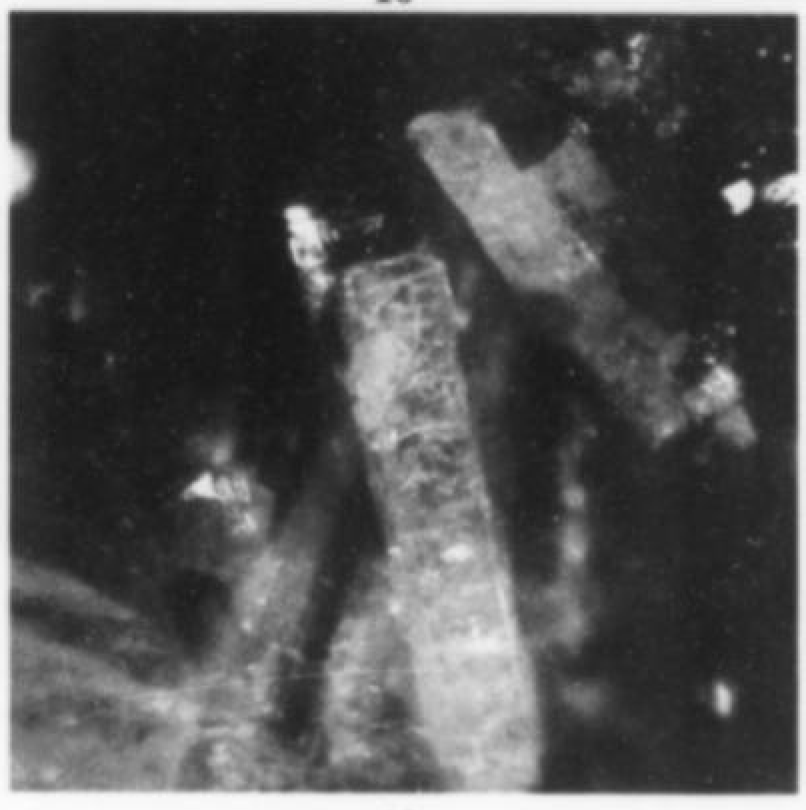
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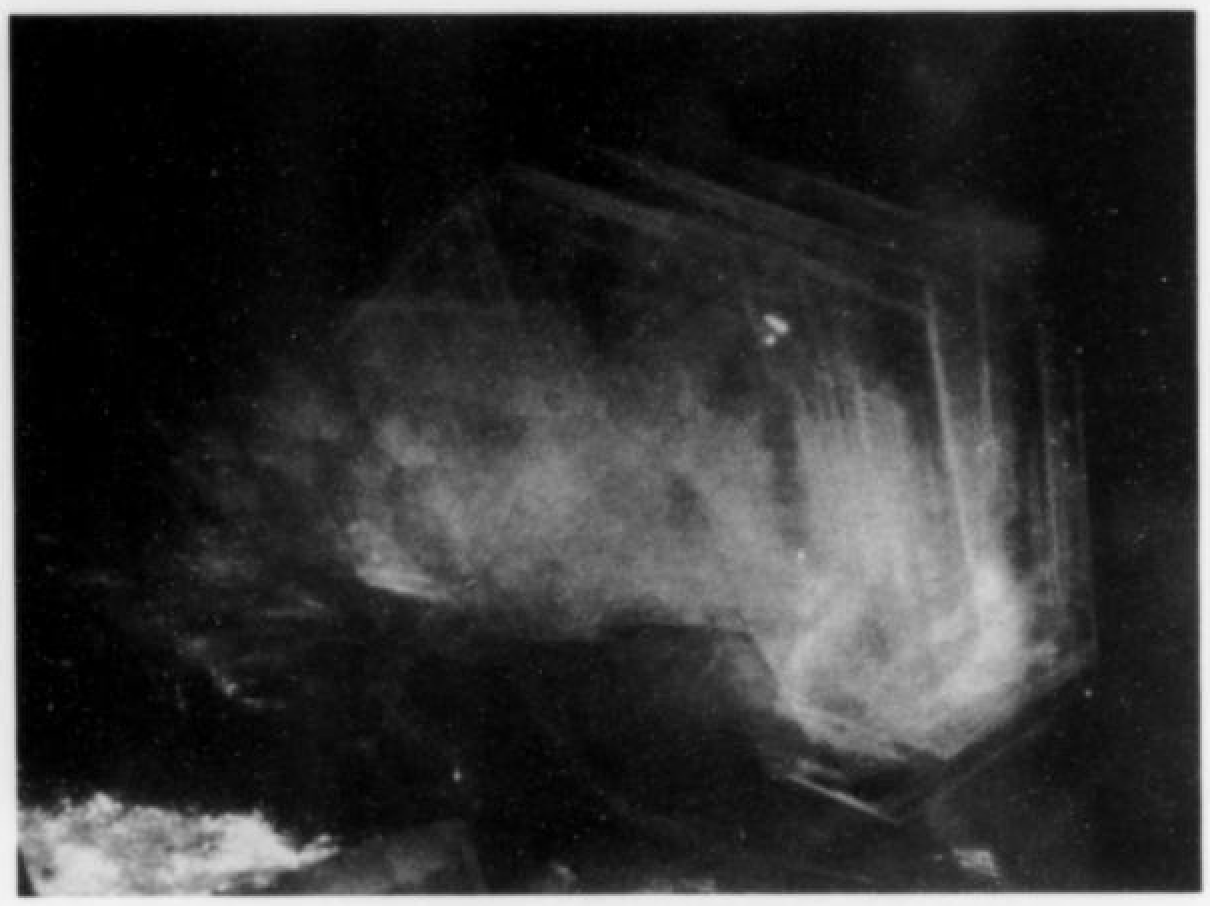


Figure 14. **Tabular, pseudo-hexagonal dickite crystals to 1.5 mm on dolomite, from Mas D'Alary, Lodève, Herault, France. G. Favreau specimen; photo by J. G. Prigent.**

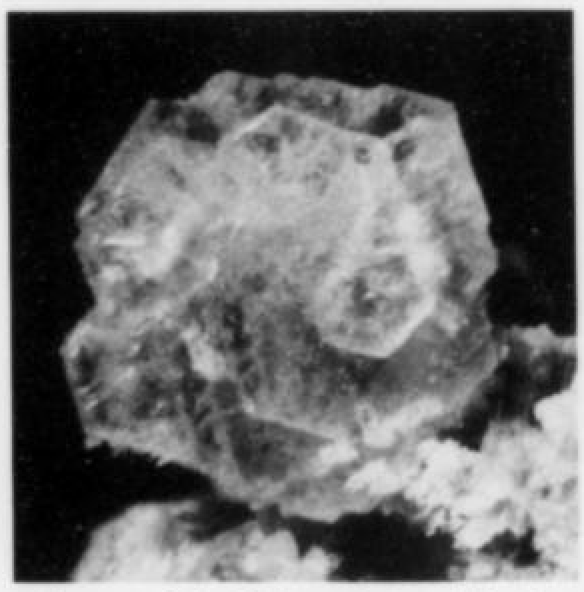


Figure 15. **Pale pink, tabular crystals of friedelite to 1 mm, from Costabonne, Pyrenees Orientales, France. G. Favreau specimen and photo.**

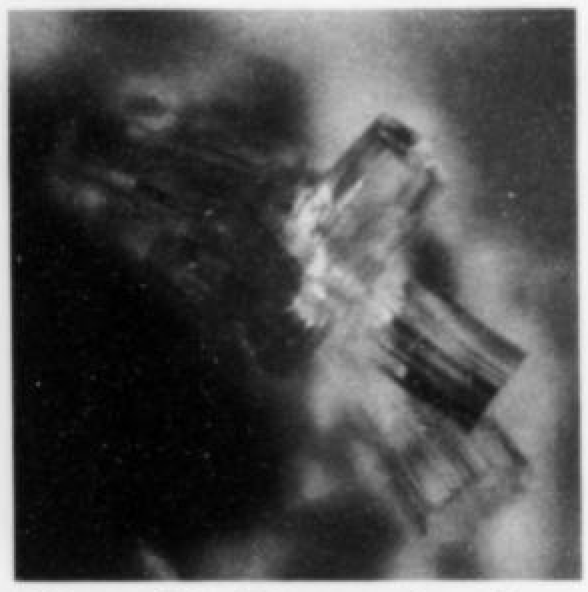


Figure 16. **Hexagonal, columnar crystals of ettringite/thaumasite from Saint-Maime, Alpes de Haute Provence, France. Field of view = 3 mm. G. Favreau specimen and photo.**

Figure 17. **Colorless, euhedral, single crystals of gaidonnayite to 2.3 mm on analcime, from the Poudrette quarry, Mont Saint-Hilaire, Quebec.**

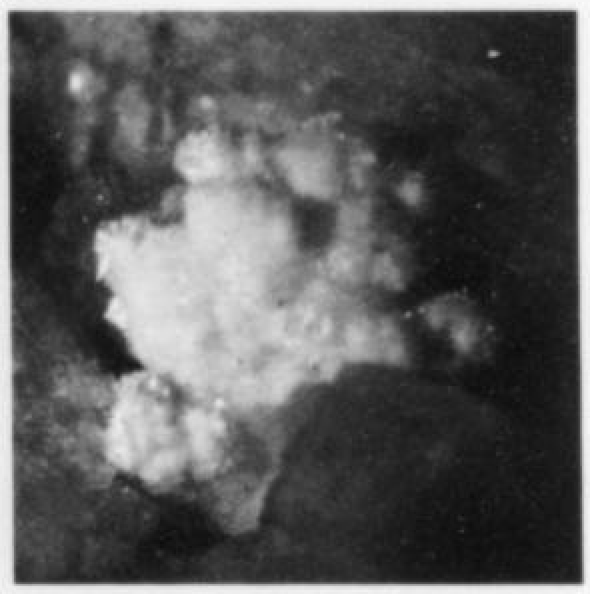


Figure 18. **Puff balls of cream-colored, radiating crystals of franconite, with honey-colored siderite, on dawsonite, from the Poudrette quarry, Mont Saint-Hilaire, Quebec. Field of view, 5.5 mm.**

and Georges Favreau (Rés. Châteaudouble Bât. 8 E3, Av. Jean Monnet, F13090 Aix En Provence, France). Both are interested in nice microminerals and rare species, and both have extensive lists of minerals for exchange. Some of the localities listed are: La Verrière and Cap Garonne (rare lead, copper and arsenate secondaries such as cornubite, parnauite, arthurite, perroudite and even capgaronnite); Trimouns (nicely crystallized rare earth minerals); Lodève (many rare uranium minerals including liebigite, rutherfordine, umohoite, zellerite, rabejacite and phosphuranylite); and Padern/Montgaillard (theisite and arseniosiderite).

Photos of a few goodies obtained from the above follow. Figures 5 and 6 show deep green cornubite on wad, and bright orange perroudite, respectively, both from Cap Garonne. The latter (a mercury-silver sulfide-halide!) occurs in very tiny radiating groups; hence, the poor quality and lack of depth of field of the photo. Figure 14 shows remarkably large and well-formed, snow-white crystals of dickite, a clay mineral, on dolomite. From Rabéjac, one of the uranium mineral localities, comes the specimen of calcurmolite (yellow ball) and umohoite (red spheres) shown in Figure 7. Both, of course, are very rare. Also from Rabéjac is the superb seelite shown in Figure 8. Mr. Favreau has sent me specimens similar to the tabular, pink friedelite from Costabonne shown in Figure 15, and the beautifully formed, colorless, columnar crystals of thaumasite/ettringite from Saint-Maime in Figure 16. Finally, from Trimouns, come the three rare earth minerals shown in Figures 9–11: allanite as a transparent (!), sharp, pale brown crystal; bastnaesite as tabular, sand-colored crystals; and a bright orange crystal of monazite, respectively. Also available from this locality are excellent xenotime and parisite crystals.

Readers can easily expand their selection of European microminerals by trading with or purchasing from the three people listed above. If you offer to trade, remember that you cannot expect silken purses for sows' ears. Offer good quality for good quality.

Moving closer to home, my wife, Audrey, and I enjoyed a very good trip to Mont Saint-Hilaire last May. Abundant (but hard to remove!) miarolytic cavities were available. Audrey found the lustrous and very sharp ilmenite crystal group in Figure 12. In previous years, tiny orange "lollypops" of labuntsovite epitaxial on elpidite appeared (see Henderson, 1979). Subsequently, equally small groups of elpidite on labuntsovite ("inverse lollypops") were found. In both habits, the long axes of the two species are parallel, and one grows from the tip of the other. This year, a few specimens showing colorless elpidite growing as thick slabs on the *sides* of orange labuntsovite crystals were found (Fig. 13). In addition, excellent, separated, very well-formed, apparently untwinned crystals of gaidonnayite (Fig. 17) were obtained in miarolytic cavities. Not shown but also found in these cavities were cherry-red, equant, striated crystals of nenadkevichite, and numerous specimens of mckelveyite-(Y), as lemon-yellow or gray-blue cone-shaped crystals.

In addition, excellent specimens of dawsonite were abundant. Sharp, transparent, striated, tabular to columnar crystals of the mineral were found scattered in vugs in matrix composed largely of dawsonite. Occasionally, fine groups of franconite on dawsonite such as that in Figure 18 were also found. Another very interesting mineral found sparingly in the vugs is anatase as tiny, bright blue, extremely thin crystals with an outline like that of a four-leaf clover. Of course, there were the usual number of unknowns plus many of the more common species.

I turn now to correct an error on my part. In the *Microminerals* columns in the July-August 1993 issue of the *Mineralogical Record*, I inadvertently ascribed the specimen of marcasite in calcite in Figure 15 to my own collection. The specimen belongs to Edward Clopton.

I thank Garry Glen for his sketch of willhendersonite, and Dan Behnke, G. Favreau and J. G. Prigent for their photos.

REFERENCE

HENDERSON, W. A., Jr. (1979) Oriented overgrowths of labuntsovite on elpidite from Mont. St. Hilaire, Quebec, Canada. *Mineralogical Record*, **10**, 97.

Wm. A. Henderson, Jr.
47 Robin Ridge Drive
Madison, CT 06443

What's New in Minerals?

Tucson Show 1994

by Tom Moore

All right—the weather was rainy and everything soggy in Tucson for too many days of show week: one morning I awoke to find my hotel room's ceiling leaking in two or three places, and a gossan-colored rivulet making its way down one wall, and toe-curling dampness in one wide spot on the carpet. But we who had come from parts of the country where we'd spent, oh, every third day or so of January trimming our houses out from enclosing hardrock ice matrixes, couldn't complain—so with *that* predictable observation on climatic contrasts I'll leave weather chitchat behind.

The social/commercial in-house weather at the Executive Inn, anyway, was busy and balmy enough. Although unfortunately this show was distinctly down in the what's-new-in-minerals department from last year's, one could still admire plenty of recurring old-faithful mineral occurrences, strong second-year encores, quirkily fabulous one-of-a-kinders, and some interesting (even if not show-stopping) new discoveries too.

This year, Marty Zinn's Executive Inn empire, in full bloom of expansionist health, annexed the whole ground floor of the nearby Quality Inn—just across the street and down a block. Here the dealers' rooms open onto a lush inner courtyard, so that on bright, sunny days the denizens could lazily luxuriate out from their rooms' open doors and onto that wide lawn, with its waving vacationy palms, swimming pool, and laid-back tents where you could get tacos, Philly cheesesteak sandwiches, and beer-battered hand-dipped cholesterol-free onion rings. The conscientiously mineral-minded, however, could not linger long to eat lotus, since the Quality Inn belonged, with but few exceptions, to the fossil merchants.

Yet since Quality, in the abstract, is as it is, even I, even here, I feel, ought to offer up some superlatives to the display hall in the Quality Inn where there was gathered what some of the knowledgeable were calling the most dramatic array of (commercial) fossil specimens and related materials ever assembled in one chamber. This "Fossil Hall" was sentineled at its opposite ends by complete cast-replica skeletons of, let me check those notes, an *Edmontosaurus annectens* (duckbill) and a *Tuojiangosaurus multispinus* (stegosauresque) dinosaurs—with lots of other dinos in other compelling styles of replication between; a counter display of precise bronze sculptures of foot-long raptors in bristling stasis was one special favorite of my uninformed taste.

In Fossil Hall one could also Feel Small in facing immense sandstone slabs with minutely detailed low-relief carbonaceous phantoms of monstrous fishes, sea turtles, palm fronds (much like those outside, soughing by the pool), and huge icky trilobites and eurypterids. There were great gonglike ammonite discs, and ravening crocodile skulls, and lithified unknown-brute vertebrae in rock "matrix"; there were some lovely wall-sized red and metallic black polished slabs of hematite/quartz replacing Precambrian algal colonies (one with a vug with a quartz crystal in it); and a 20-foot mosasaur and a matching crypto-amphibic fishlike nightmare; even huge amber hunks enclosing bugs; even bugs, some a foot long, pinned, in that brittle, slightly macabre entomologists' way, in glass-fronted, framed collectors' cases. Well, OK, enough—but I would imagine that for the relevant people *this*, and no other, must have been, at least in its display aspect, the Tucson Show Of All Time.

For a change, I will try conflating my accounts of the Executive/Quality Inn show (with a side glance or two at the Desert and Day's Inns) and of the "Main Show" at the Tucson Convention Center, running a single grand, looping race through the world, with Arizona, as usual, as starting gate.

Les and Paula Presmyk of *De Natura* (P.O. Box 1273, Gilbert, AZ 85234) tell me that Arizona's most interesting action during this past year was Graham Sutton's mining out an old pillar at the Grand Reef mine, Klondyke (known for linarite), recovering four flats of fine **cerussite** specimens in all sizes. These are lustrous, translucent white crystals showing themselves in just about all the main cerussite habits, the nicest being 1.5-cm cyclic twins, some slightly yellowish. The matrix is a vuggy, weathered trachyte, and the cerussite twins, single blades, and jumbled groups can be very pretty when you look down on them in the deep vugs in hand-sized pieces.

A couple of big paces north, in Nevada, David Malmquist of *D & M Rock & Gem* (Vista, CA, tel. 619-941-2848) did some very successful collecting two and a half years ago at the Majuba Hill mine in Pershing County, waiting until now to show us the resulting handful of excellent small specimens of **clinoclase.** There are about 10 thumbnails and miniatures, with open seams in weathered ore filled with glittering, deep blue-green druses of crystals to 2 mm: aesthetically they are more than the equals of the oldtime radial spheres from Cornwall.

And then there are Tom Wolfe and Carolyn Seitz (*Tom Wolfe Minerals*, P.O. Box 9791, Fountain Valley, CA 92728-9791), who once again, as last year, had a large stash of pretty **creedites** from the Hall mine, Nye Co., Nevada. This mine is *still* closed but plenty of creedite from it can still be had in your choice of sizes; the pale purple, glassy, 2-mm crystals form solid druses and/or little flower-sprays in seams in a greenish white felsic rock.

From California there is a nice new lot of **neptunite/benitoite** specimens in the familiar muriatic-acid-treated white natrolite in greenschist, from the Benitoite Gem mine, San Benito County. Although mostly non-thrilling lots from this venerated occurrence regularly appear at big shows, this was a far above average one, collected last spring on some old dumps and in old alluvium by William C. Forrest (P.O. Box 25001, Fresno, CA 93729), and shown by him in his Executive Inn room. The starring role was played by the neptunite, in ideally sharp, bright, black, terminated prisms to 3 cm long, but three or four good thumbnails with "triply terminated" though non-gem benitoites were available too. The specimens come in a range of sizes.

Wayne Thompson (1723 E. Winter Drive, Phoenix, AZ 85020) was offering no more of the nice **cerussite** from the Bunker Hill mine, Idaho, which he brought to Denver, but he (and other dealers) did have some newly mined pyromorphite specimens of the familiar bright yellow-green spectacular sort. The crystals, some strongly cavernous, reach 1.5 cm, and present themselves either in loose groups or as densely coated matrix specimens to 20 cm across. Since the reports some ten years ago of the final demise of this locality were (as Mark Twain would say) greatly exaggerated, the general market is now rather rich in these fine pyromorphites. Price scales vary considerably from dealer to dealer: Wayne specializes in the highest qualities and largest sizes.

What's a show report these days without at least a respectful nod to Kathryn and Bryan Lees (*Collectors Edge*, P.O. Box 1169, Golden, CO 80402), midwife and midhusband respectively to the stupendous **rhodochrosites** from their recent work at the Sweet Home mine, Alma, Colorado? At their stand at the Main Show I saw perhaps 75 fine-to-

Figure 1. Zircon crystal group, 3.4 cm across, from the Kipowa Rare Earth Complex, Kipowa, Quebec. Dave Bunk specimen; Jeff Scovil photo.

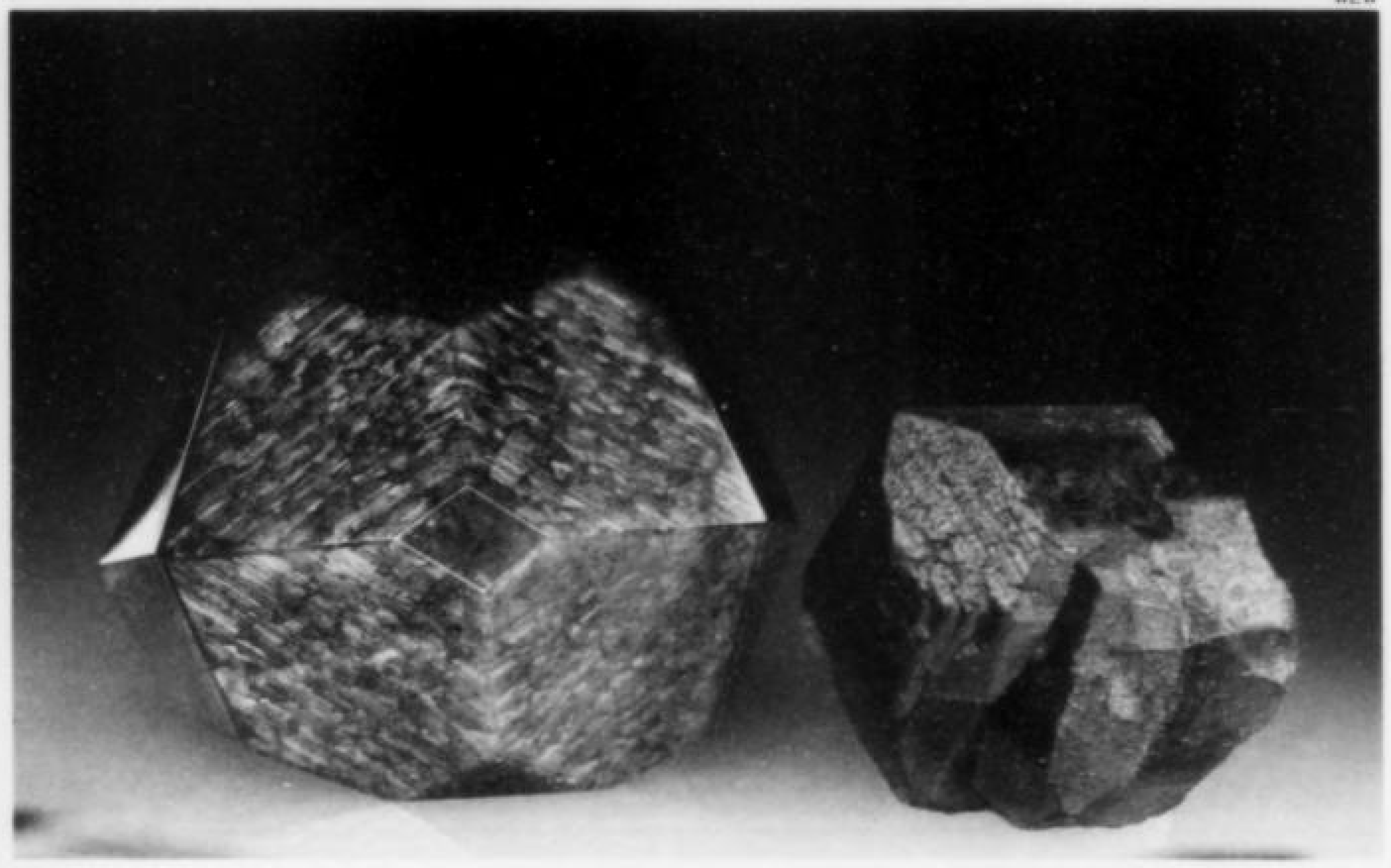


Figure 2. Andradite crystals to 2.2 cm showing iridescence just underneath the trapezohedron faces (polished on the left crystal). Rainbow Garnets Inc. specimens.

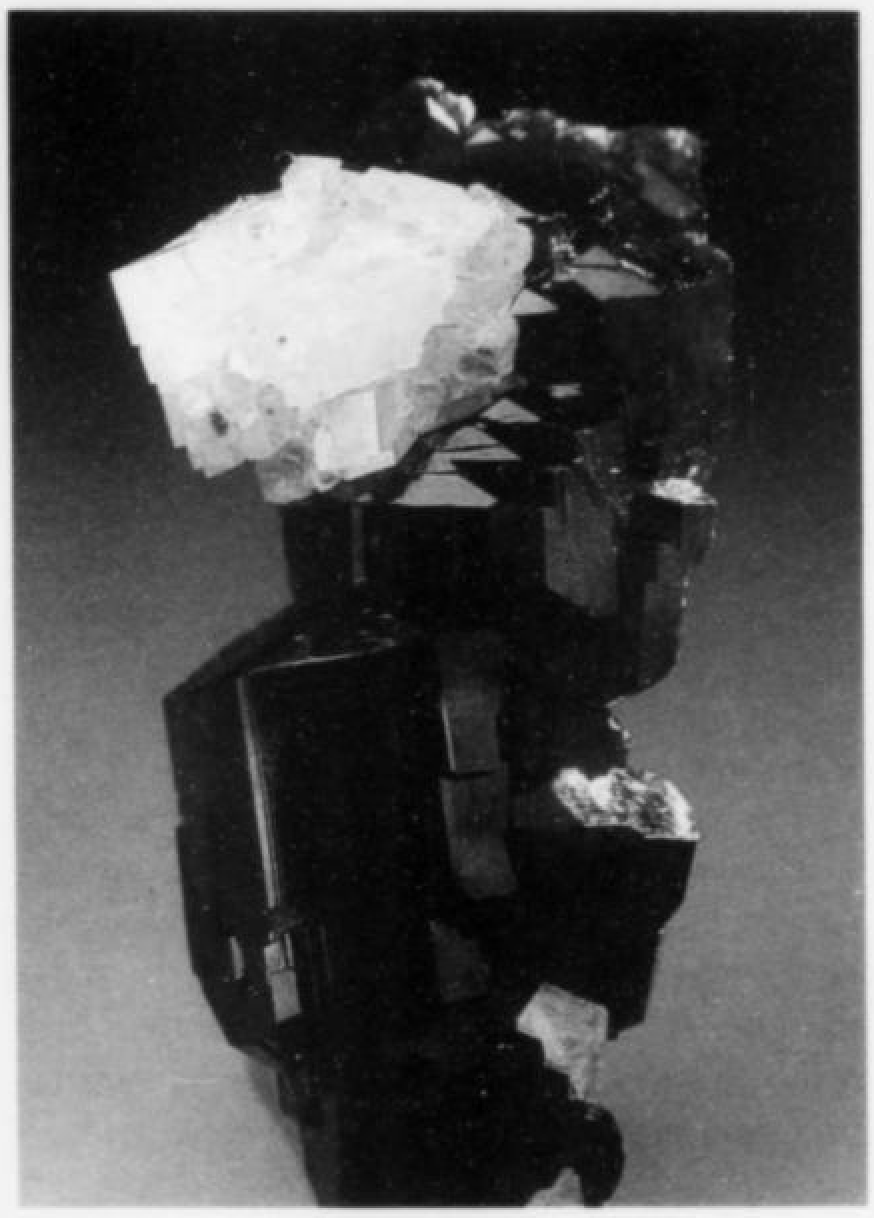
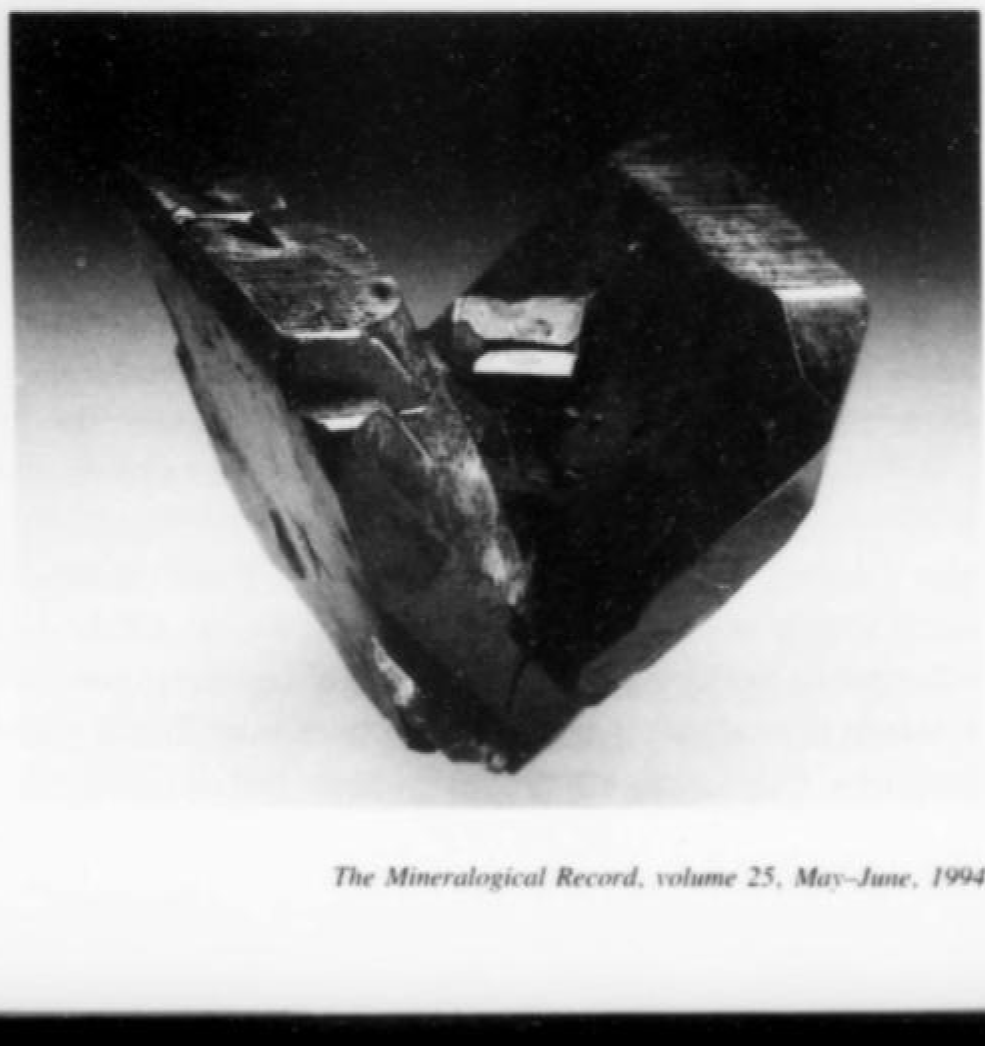


Figure 3. Uvite crystal group, 4.1 cm, with white magnesite, from Brumado, Bahia, Brazil. Valadares Minerals specimen; Jeff Scovil photo.

Figure 4. Ferberite crystals, 4.1 cm, from the Quechisla mining district, Potosí, Bolivia. Jewel Tunnel Imports specimen; Jeff Scovil photo.



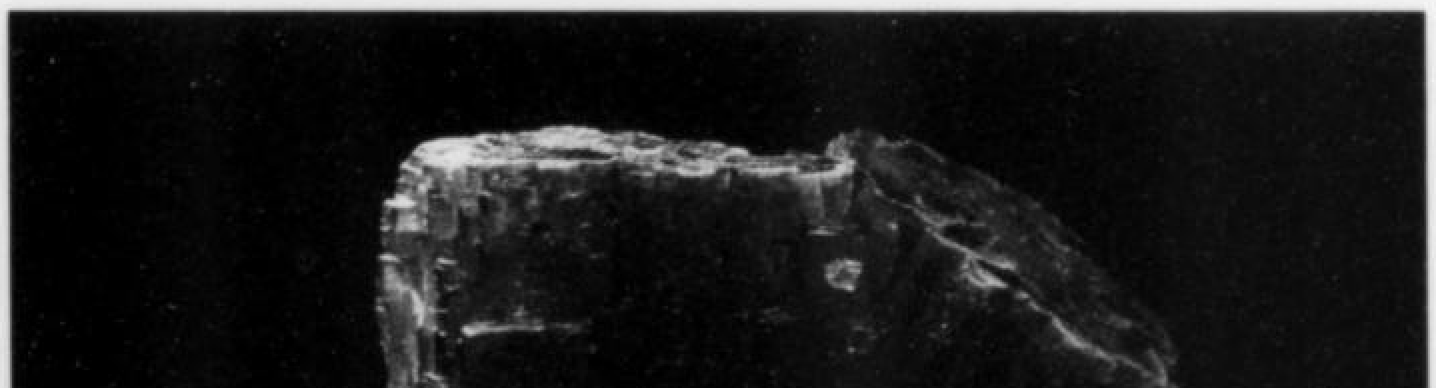


Figure 5. Lepidolite crystal group, 7.5 cm, from Virgem da Lapa, Minas Gerais, Brazil. Julio Landman collection; Jeff Scovil photo.

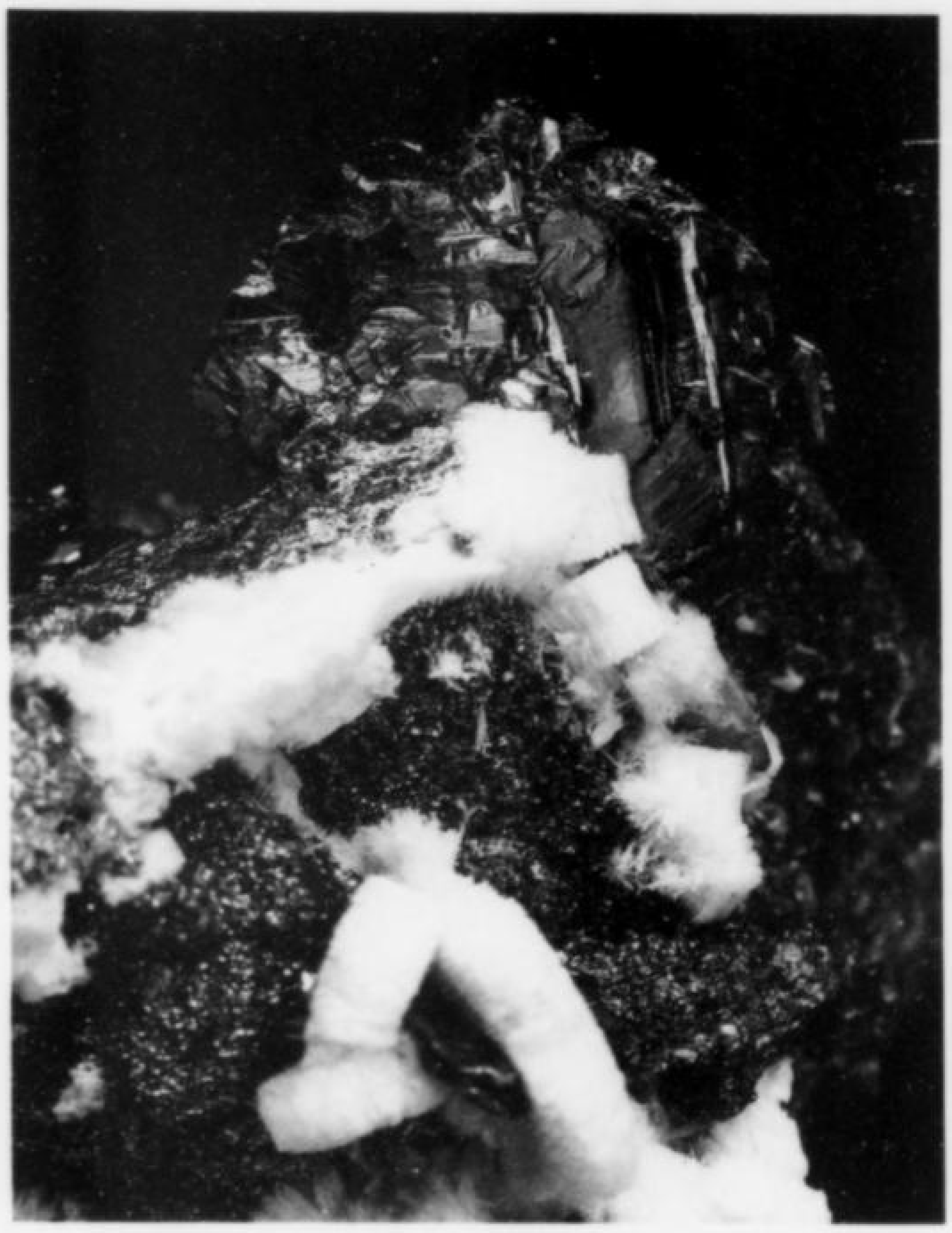


Figure 6. Pearceite crystal, 1.4 cm, from the Reyes mine, Guanajuato, Mexico. Dave Bunk specimen; Jeff Scovil photo.

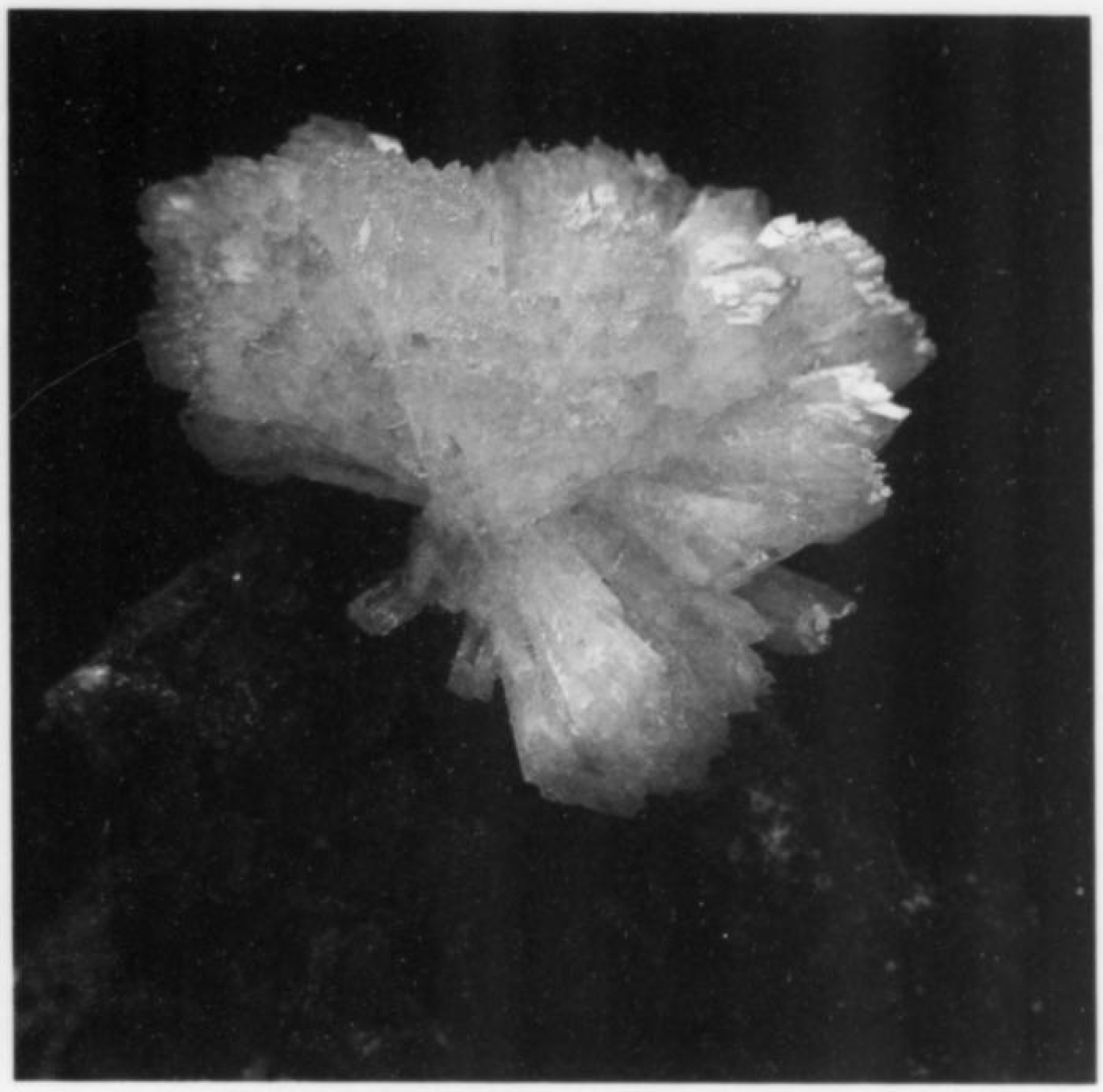


Figure 7. Legrandite crystal group, 2.5 cm wide, on limonite matrix, from the Ojuela mine, Mapimi, Mexico. Not a new specimen, it was probably mined in the 1960's, but came back on the market at the Tucson Show. It was acquired by Kerith Graeber; Jeff Scovil photo.

Figure 8. Hausmannite crystals to 1.6 cm on matrix, from the N'Chwaning mine, South Africa. Helmut Brückner specimen; Jeff Scovil photo.

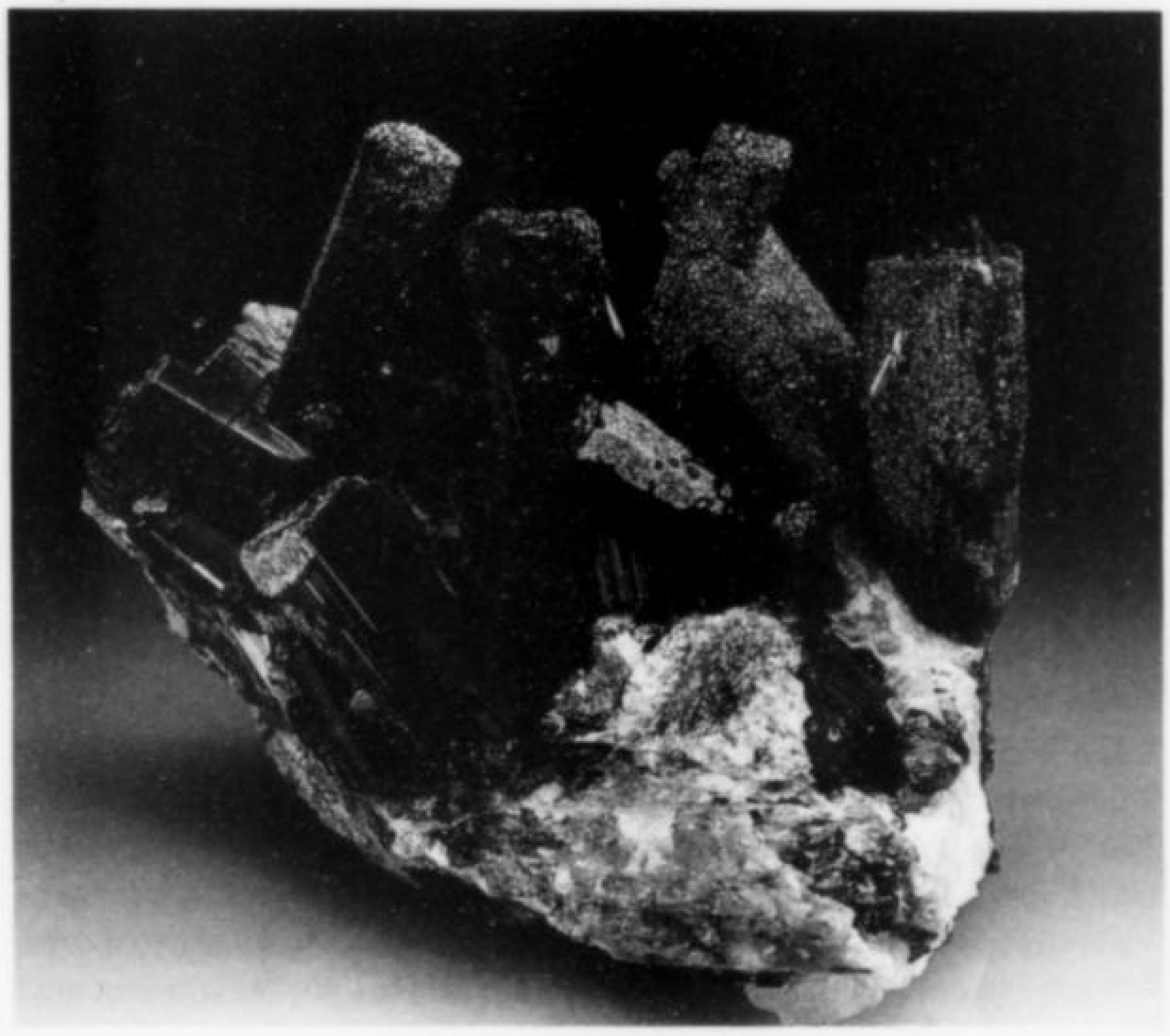


Figure 9. Elbaite crystal group, 9 cm, partially coated by drusy pyrite, from Lavra de Pederneira, Minas Gerais, Brazil. Herb Obodda specimen; Jeff Scovil photo.

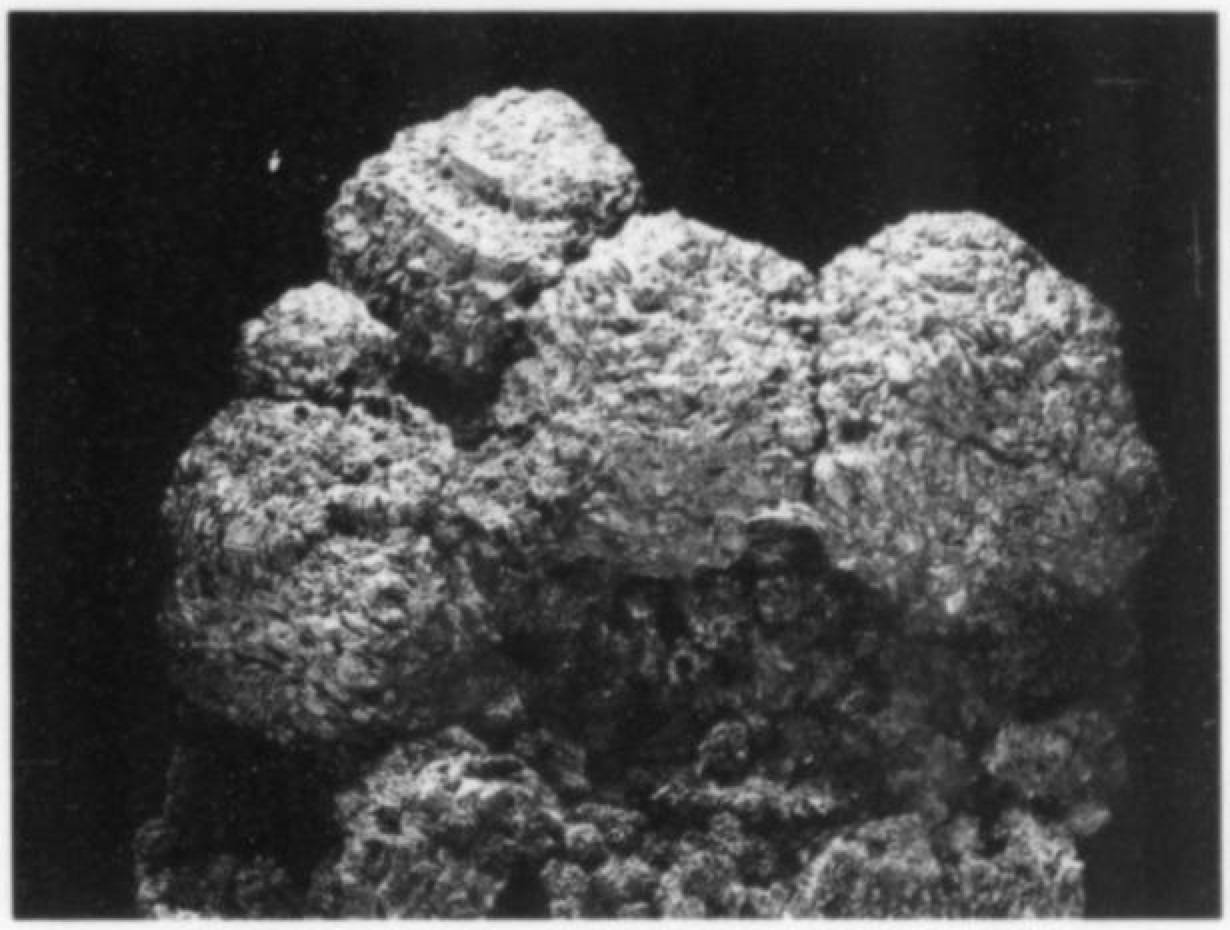


Figure 10. Nickeline crystal aggregates, 13.8 cm across, from the Pöhla mine, Saxony, Germany. Manfred Schwarz specimen; Jeff Scovil photo.

super, thumbnail-to-cabinet-size rhodochrosites, some from the 1992 "Cash Flow" and "Rainbow" pockets, and some too from a new pocket, the "Red and Blue," dug this past summer in the tetrahedrite stope. In these "Red and Blue" pieces, the rhodochrosite rhombohedrons—small and large, translucent to transparent, and often glowing, as we know—rest on rich blue-purple crusts of small modified-cubic **fluorite** crystals with interspersed needle quartz and solid backings of massive chalcopyrite/tetrahedrite.

Another pocket, dubbed the "Blueberry" pocket (because of the many blueberry-like fluorite crystals it contained), was also found in 1993. This pocket's discovery was exciting as a first success and vindication of a new, still experimental technology for radar probing of underground structures, such that crystallized pockets may be spotted where they lurk; we'll probably read more of this in the future, in some more appropriate space.

As a last note on western U.S. minerals, I'll commend particularly *Mercer Minerals* (P.O. Box 1335, Katy, TX 77492) for their most civilized handling of a 30-year-old collection they recently bought. Prices on these semi-antique pieces were generally so reasonable that there can hardly have been much markup over whatever the original collector paid for whatever he didn't dig up himself. In this Executive Inn room I got a much-needed education on what places like Butte, Bisbee, Tri-State, and various Colorado mines could do on their good days—and there were even a few very good eastern U.S. old-timers, e.g. Bristol, Connecticut chalcocite and Walpoint, New York sphalerite.

Wright's Rock Shop (3612 Albert Pike, Hot Springs National Park, AR 71913) had flats upon flats of excellent thumbnails and miniatures of radial green **wavellite** in shale from Mauldin Mountain, Montgomery County, Arkansas. Yes, it's another instance of long-familiar material coming back strongly. The wavellite was available elsewhere as well, to be sure, but Wright's had the most and the best, dug, reportedly, just days before the show. Once cleaned a bit, the sparkly spheres glow a translucent apple-green to deep green; aesthetically one chooses between the specimens with wavellite spheres sitting apart on the flat gray matrixes and those consisting of pure grapy clusters.

Recently, if you'll recall, we were told that Graves Mountain, Georgia **rutile,** likewise, would soon have a renaissance—and here it was, at Beau and Marion Gordon's *Jendon Minerals* (P.0. Box 6214, Rome, GA 30162-6214), in a myriad of nice pieces. Since I came late in the show to this room (at the Executive Inn) I missed the best and the brightest, but I did see about 30 shining, slightly rough, loose thumbnail singles and several cabinet-sized clusters, as well as singles to 8 cm across, all these showing good red-brown internal highlights. Here too was what's said to be the largest **lazulite** crystal ever found at Graves Mountain: a loose, sharp, light sandy blue one 3.5 cm across. And in December of 1993 there were collected at the Williams Prospect, Coosa County, Alabama, some 20 hand-sized chunks of brown altered phosphate pegmatite matrix with bright purple areas of microcrystals of **phosphosiderite,** plus other rare phosphate secondaries. This is the first production of specimens from this locality since around 1976, when a full article on the place appeared in the *Mineralogical Record* (vol. 6, no. 2).

Ernie Schlichter (Box 193, Sudbury, MA 01776) was offering some dignified-looking cabinet-sized matrix specimens of cubic **magnetite** from the Zinc Corporation of America's mine #4 at Balmat, New York—these far exceeding in quality, while somehow also undercutting in price, the general run of pieces shown during the last year and a half or so. In the past, the devil's finger of damage has almost always been apparent, but Ernie's specimens were miraculously mostly *un*damaged, and very bright black, with lightly modified cubes up to 2 cm on edge, and the matrixes reaching 17 cm across.

Mike Haritos of *STD Minerals* had two bona-fide what's-new surprises. First, there was Eden Mills, Vermont **clinozoisite,** in slender, matrixless, tight subparallel sprays, with good terminations on individuals, to 6 cm long. The color is greenish brown, and the specimens sanely priced at $40 to $150. They came from an asbestos seam dug last November at this classic locality. Second surprise: a small handfull of loose, bright black **uraninite** crystals averaging 2 cm across, with very sharp edges, and cube and octahedron forms developed about equally. The locality here is a granite pegmatite at Standpipe Hill near Topsham, Maine.

Figure 11. **Uraninite crystal, 2.3 cm, from Standpipe Hill, Topsham, Maine. Canadian Museum of Nature specimen; Jeff Scovil photo.**

As usual, Rod and Helen Tyson of *Tysons' Fine Minerals* (10549-133 St., Edmonton, Alberta, Canada T5N 2A4) had a roomfull of Canada's recent mineralogical best. The Mt. Brussilof mine near Radium, British Columbia, is an old open pit one that sits up on a mountainside, but that just this past year has made something of itself, specimen-wise. Because it is a calcareous replacement deposit much like that of Eugui, Spain, the mineralogy is similar. Thus Tysons' had about 12 fine miniatures each of **dolomite** and **magnesite,** the dolomite crystals in penetration twins, sometimes flattened, to 4 cm on edge in clusters or in groups of two or three. The magnesite crystals look much like the dolomite, except that they tend sometimes to make rounded fans of parallel rhombohedrons with individuals to 2 cm. These specimens are, of course, white, but bright, translucent, and appealing.

At Tysons', further, were many fine thumbnails, mostly of smallish size (i.e. less than 2 cm for crystals plus matrix) of sharp, black, simple octahedrons of **spinel** on gray-green subhedral **forsterite** crystals, from the Parker mine, Notre Dame de Laus, Quebec—precise, elfin things that typically cost only about $15. And finally the York River skarn zone near the old nepheline syenite quarries near Bancroft, Ontario, has begun to produce what are certainly promising **grossular** specimens, with bright red-orange dodecahedrons to 3 cm across. They are gemmy only in tiny areas, but are sharp, mostly in aesthetic miniature groups with minor dark green diopside.

Gilles Haineault (*Collection Haineault,* 2266 Rue St-Alexandrie, Longueuil, Quebec, Canada) had a room in which one could linger long without necessarily being a Mont Saint-Hilaire specialist (but it helped). There were no large knockout pieces, but instead many Saint-Hilaire rarities in little shard-like swarms in greenish white, beige, gray, and occasional pink; closer inspection revealed some excellent small-thumbnail **catapleiite, narsarsukite, donnayite, nepheline, serandite, genthelvite, rhodochrosite,** etc., etc. specimens.

In Mexico these days the biggest hard-luck hard-mining story seems to be Ed Swoboda's three-year (and counting) assault on the famous San Francisco mine, Sonora, in quest of more of the wonderful **wulfenite** for which the place is known. At last, some pockets were recently hit whose dazzling contents ended up with Wayne Thompson: a shelf-full of fine miniatures to small cabinet specimens paying court to a single huge thing in the center—a flamboyant 15- by 20-cm cluster of bright yellow-orange thin tabular crystals to 4 cm on edge, with small orange mimetite globules attached. The smaller groups have nice, transparent, fragile wulfenite crystals averaging 2 cm. Another shelf held about 25 specimens of essentially loner tabs or flat parallel groups of two or three, these "toenails" priced around $50.

Rainbow Garnet (P.O. Box 42617, Tucson, AZ 85733) had some interesting **andradite** crystals from an undisclosed locality in the Sierra Madre Mountains of Sonora, Mexico. Their room at the Desert Inn was filled with little else, and they also put in an exhibit at the Convention Center. The olive-green dodecahedral to trapezohedral crystals are unremarkable except for one aspect: a bright flash of iridescence just under the surface on phantom trapezohedron faces. The flash varies from yellow to orange in most crystals, but is blue to green in others. Crystal size reaches about 2 cm. [Ed. note: The sellers did state that the occurrence has been known since 1954. Panczner's *Minerals of Mexico* lists only one Sonoran locality for andradite, near the Tapueste Ranch in the Municipio de Alamos, but mentions no iridescence.]

In the Day's Inn (formerly the Travelodge), Reo Pickens of *Pickens Minerals* (610 N. Martin Ave., Waukegan, IL 60085) had a good selection of Peruvian things, especially **rhodochrosite** in all sizes from the Uchuchqua mine, Ancash, and a few excellent "sleeper" thumbnails of **bournonite** from the Pachapaque mine, Ancash.

Brazil, it seems, is having itself another strong Brumado year. Ken and Rosemary Roberts of *Roberts Minerals* (P.O. Box 1267, Twain Harte, CA 95383) had a fresh slew—several hundred—of **uvite** specimens from the Brumado mine, Bahia, including top-echelon pieces, mostly thumbnails, which fairly dazzle with clean, sharp forms, gorgeous colors, and, well, general Quality. There are dark orange-red, rootbeer-brown, and oily green glassy crystals, all with large, flat, trigonal faces and short prisms, some as loose floaters, some as stacked poker-chip groups, and others in disorganized aggregates. The best are gemmy, and many are dusted with 2-mm **magnesite** rhombohedrons or sit on magnesite crystals to 2 or 3 cm. Then there is a small number—fewer than 10—of thumbnails of uvite of a radically different habit which I'd never seen before: bicolored red-green elbaite-like prisms in jumbled groups, one end of each prism having a sharp flat termination, the other tapering off into brushy fibers. All these uvites, according to Ken, are new, collected within the past year. Brumado **hematite** was here too, in a few top-class pieces, from thumbnails to 8-cm flat plates or parallel groups, black, with highest luster, one with a faint epitaxial rutile accent.

Now there is sad news from Panasqueira, Portugal, and from what seemed an outlying stope of its mine—the Executive Inn room of Ana Arruda (Rua Francisco Baia, 10-1 D, 1500 Lisboa, Portugal). This great locality will be producing no more: the tungsten mine, faced with competition from the Chinese ores, falling tungsten prices, etc., ceased operations in December 1993; nor does the mining company intend to do any routine maintenance to keep it in mineable condition for some future and brighter day. Meanwhile, Ana had an impressive roomfull of last gleanings, e.g. **apatite, wolframite, cassiterite, arsenopyrite**—the material is familiar, and the quality here, in all sizes, was high. And highest of all is one 10-cm stunner: a terminated quartz prism with eight pale purple transparent apatite crystals, single hexagonal prisms all about 3.5 cm long, intergrown beautifully on the front side of the quartz. Not everyone knew it, but they were looking at a newborn classic piece.

A **boracite** update from England: the Boulby potash mine near Cleveland in Yorkshire is still operating (barely) and the general quality of these lovely pale green sparkling boracite druses is up from the time of the last Denver Show. The main handlers are still Jim Walker and Mary Fong/Walker of *IKON* (P.O. Box 2620, Fallbrook, CA 92088-2620), who had about a hundred fine pieces at the Main Show, although honorable mention goes to David Malmquist, who had a few more, equally nice examples in his room at the Quality Inn. The prices have climbed noticeably but I still got a winning thumbnail from David for only $25.

Jordi Fabre, the affable Catalan-in-charge of *Fabre Minerals* (C/ Arc de Sant Marti 79 Local 08032, Barcelona, Spain) graced the Main Show with some very good miniatures consisting of massive white dolomite matrixes with 1-cm honey-brown **bästnasite** blades, and others with 1.5-cm translucent brown **allanite** prisms, from the Tremorius mine in the French Pyrenees. Jordi says that they are all older than 1992; no new specimens of note have been collected since then at this, France's most remote major mineral site.

I got to chat a bit *auf deutsch* (with alarmingly decreased competence) with Manfred Schwarz of *Annemarie & Manfred Schwarz Mineralienhandel* (Brünlasberg 19, 08280 Aue, Germany), and learned from him that the Erzgebirge's Pöhla mine is just about finished as well. But Manfred showed me—and John Barlow bought—an astonishing Pöhla **chloanthite** which has to be world's best for the species. While normally this mineral makes rounded isometric crystals in sometimes quite handsome, steely gray clusters, this new piece, from an isolated, narrow ore pocket, shows chloanthite growing in sharp arborescent fern-aggregate forms, the ferns densely covering a 20-cm matrix of the massive mineral. John Barlow certainly has good taste.

Italian mineral prospector Giuseppe Agozzino (Via Porta Soprana 13/3 16123 Genova, Italy) went very dangerously poking around this past January in an abandoned (closed around 1955) copper/iron mine with intriguingly ancient (Etruscan) traces: the Libiola mine, Sestri Levante, Genova, Italy. And he found there some excellent crystallized **botryogen** which had formed as a post-mining alteration product in small areas between old timbers and the mine walls. The specimens of this rare hydrated Mg and Fe sulfate are vivid orange, brightly glassy, and come as delicate groups of complex crystals to 2 mm. But (on Giuseppe's honor) there was one doubly terminated single 3.5 cm long. Associations include other rare secondary sulfates, especially pickeringite; thoughtfully, all specimens have been reinforced by spraying. There are three flats of them in all, specimen sizes ranging from thumbnails up to one 10-cm piece.

New show dealers John and Jane Baron of *Baron and Beale* (15600 Murphy Ave., Morgan Hill, CA 95037) got off to a good start in the Executive Inn with a nice selection of minerals from Romania. Standouts included milky and faintly amethystine **quartz** in large stately groups (from Cavnik), attractive gray-white glassy **barite** (from Baia Sprie), **stibnite** and **tetrahedrite** (Cavnik), **"black calcite"** (i.e. spheres of calcite crystals blackened by included sulfides—from Herja), and, also from Herja and most unusual, some bright, metallic, black, whiskery acicular groups of **berthierite** in sizes up to 15 cm long.

Mineralogical Africa is a barbell with uneven weights: a notable swelling in the north, in Morocco, and a greater one in the south, in Zaire, Namibia and South Africa. Ken and Rosemary Roberts are our hosts for the north, as these folks had, from Nador, Morocco, about 20 specimens of what must be considered among the best **hematite** in the world. The incredibly brilliant, razor-edged, mirror-faced crystals are mostly flattened rhombohedrons with some skeletal areas—like monstrous magnifications of the petite gas-pocket hematite groups from the German Eifel. If it were not for the fact that a few of them show convincing small quartz matrixes, one would think that these

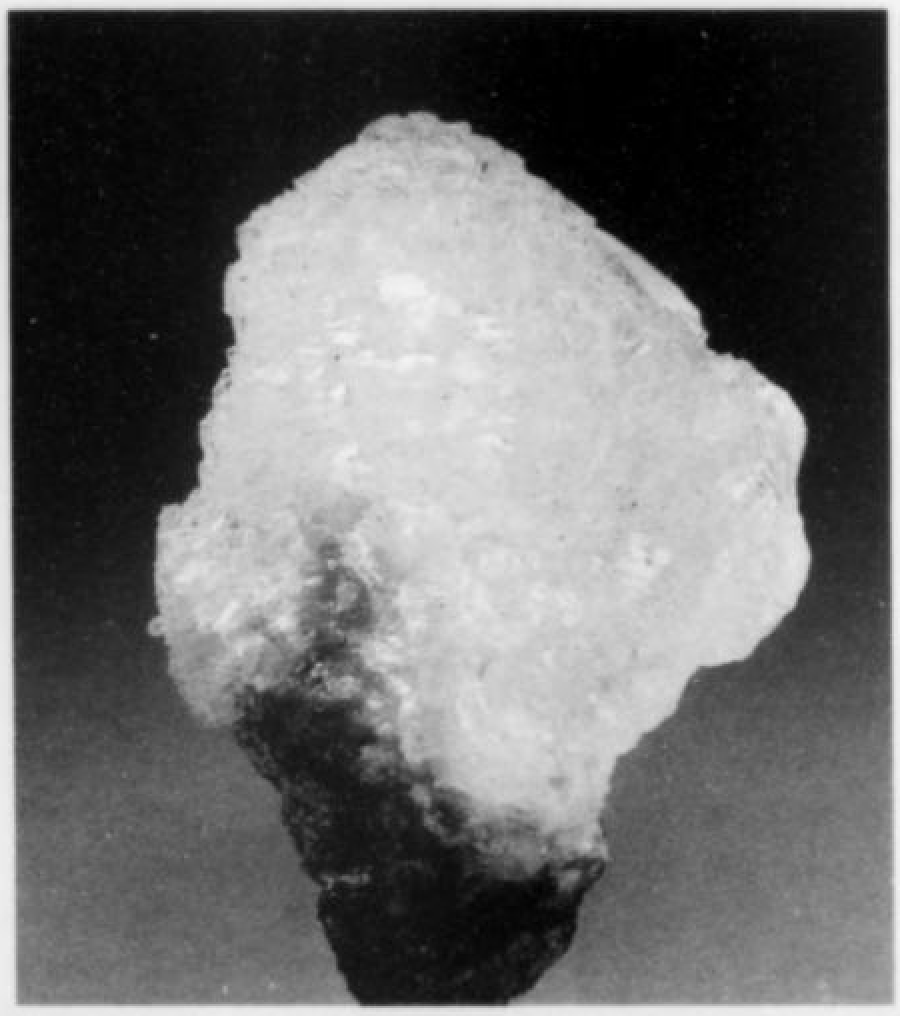


Figure 12. **Quietite crystal on matrix, 2.2 cm, from Tsumeb, Namibia. John Barlow collection; Jeff Scovil photo.**

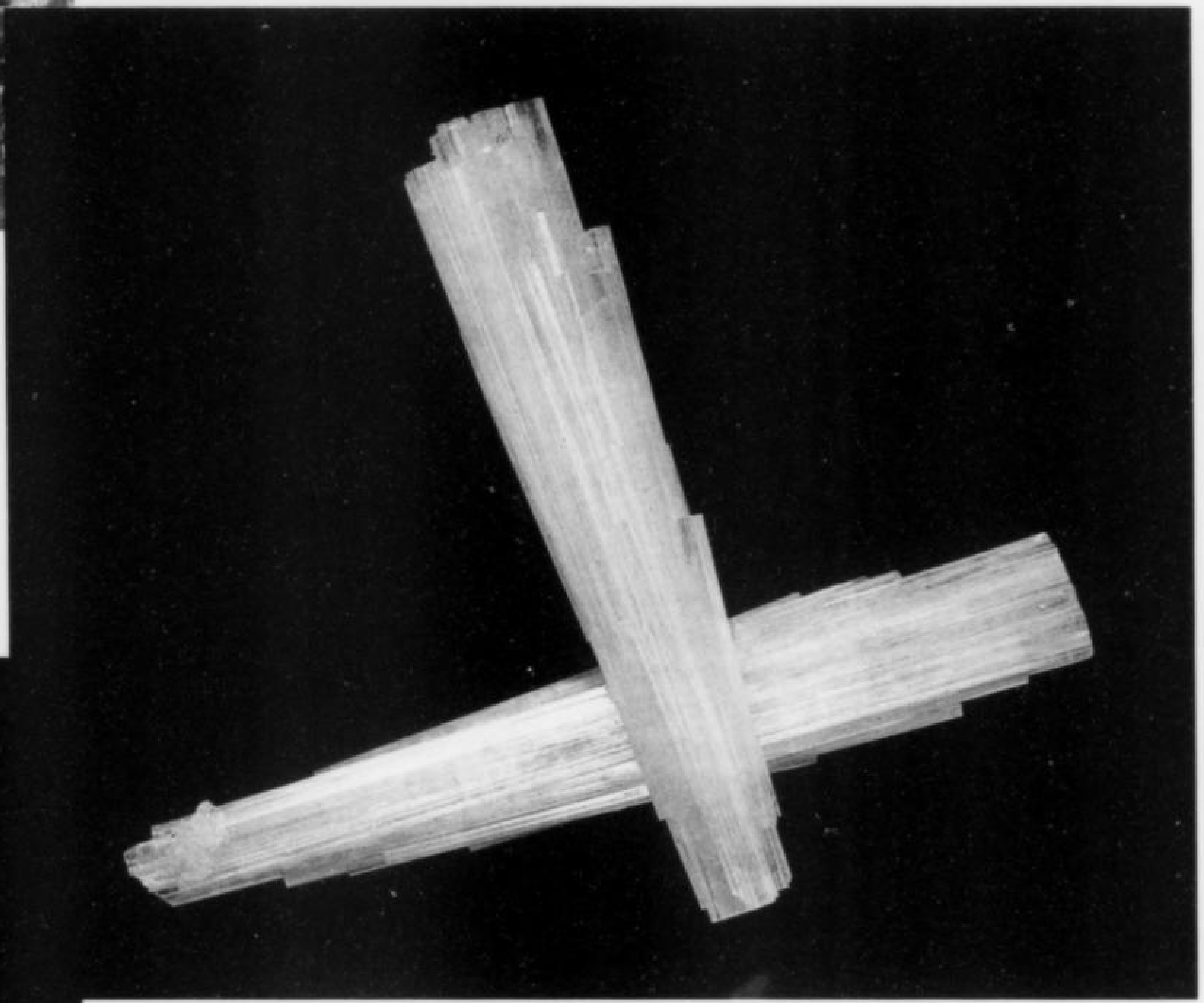


Figure 13. **Mimetite crystals, 5.6 cm, from Tsumeb, Namibia; from the collection of the late Tsumeb mine geologist, John Innes, being sold by Blair Gartrell of the Westaus Mineral Museum. Jeff Scovil photo.**

Figure 14. **Smithsonite crystal group, 3 cm, with rosasite and duftite, from Tsumeb, Namibia; from the collection of the late Tsumeb mine geologist, John Innes, being sold by Blair Gartrell of the Westaus Mineral Museum. Jeff Scovil photo.**

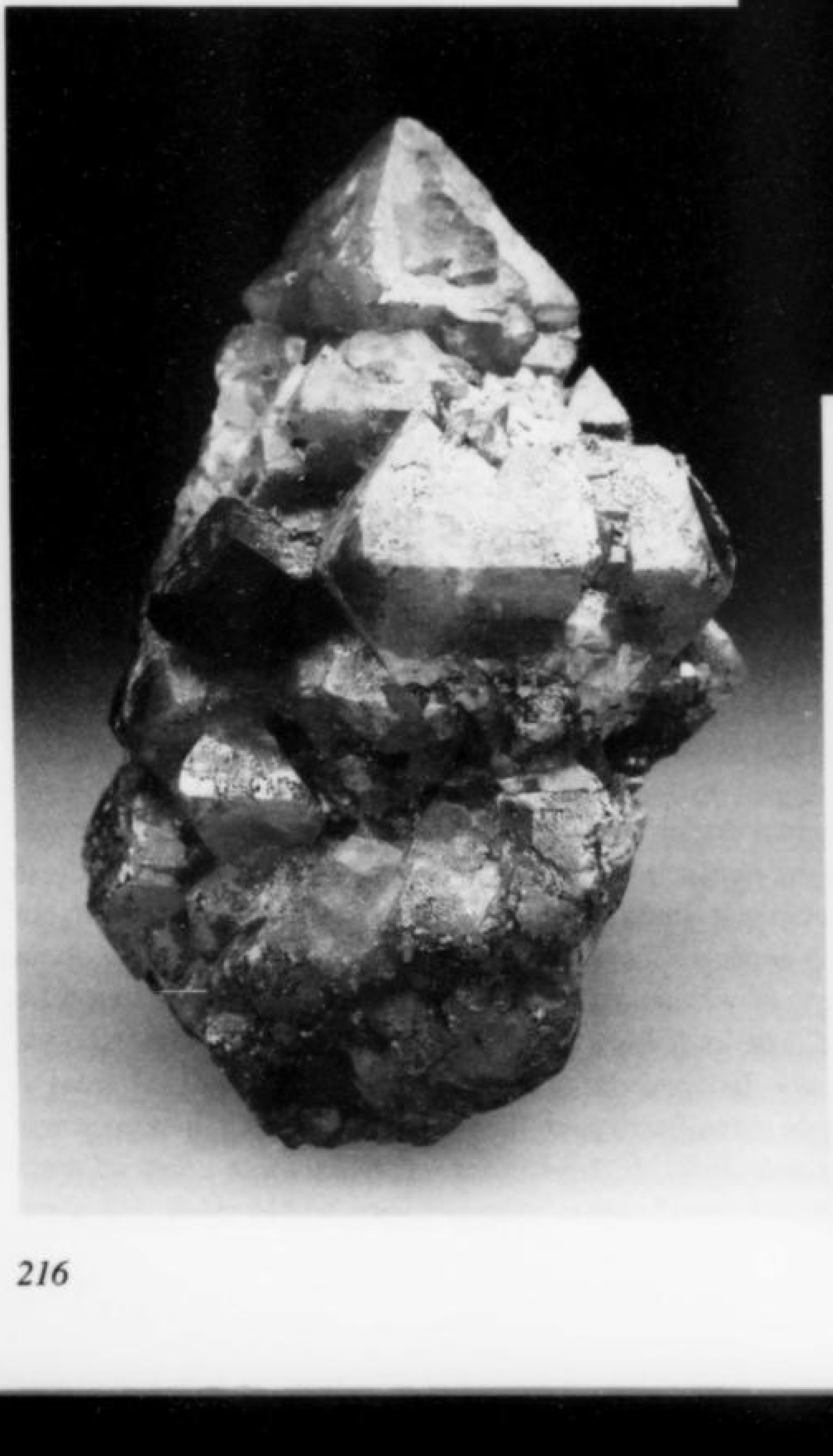


Figure 15. **Scheelite crystal group with cassiterite, 6.5 cm, from Chukotka, Russia. Syntaxis specimen; Jeff Scovil photo.**

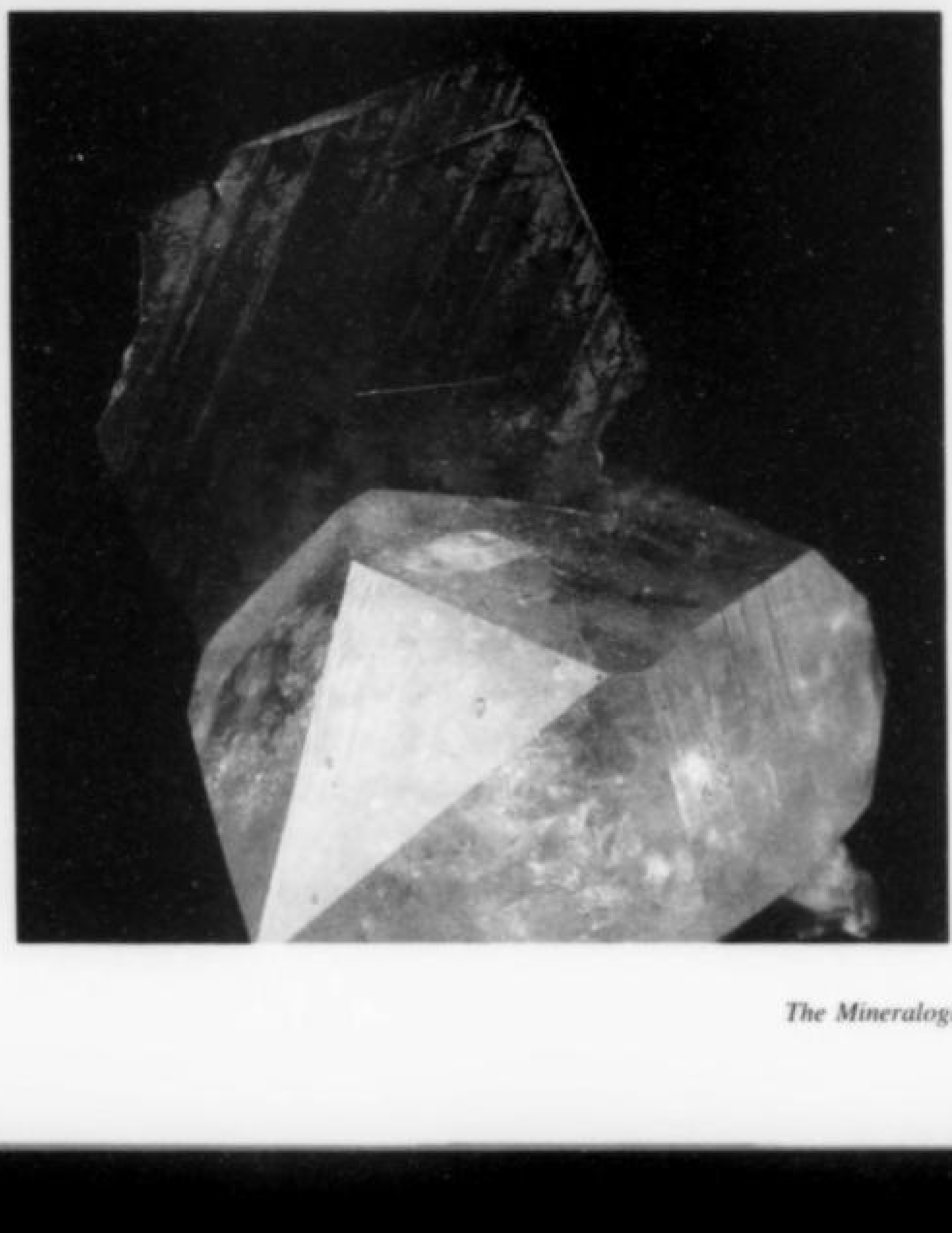


Figure 16. **Brookite crystal, 2.5 cm, on quartz, from the Dodo mine, Saranpaul, Polar Urals, Russia. Mingeo specimen; Jeff Scovil photo.**

Figure 17. Bornite crystal, 2.4 cm, on calcite from mine #57, 75-meter level, Dzezkazgan, Kazakhstan. Van Scriver/Pljaskov specimen; Jeff Scovil photo.

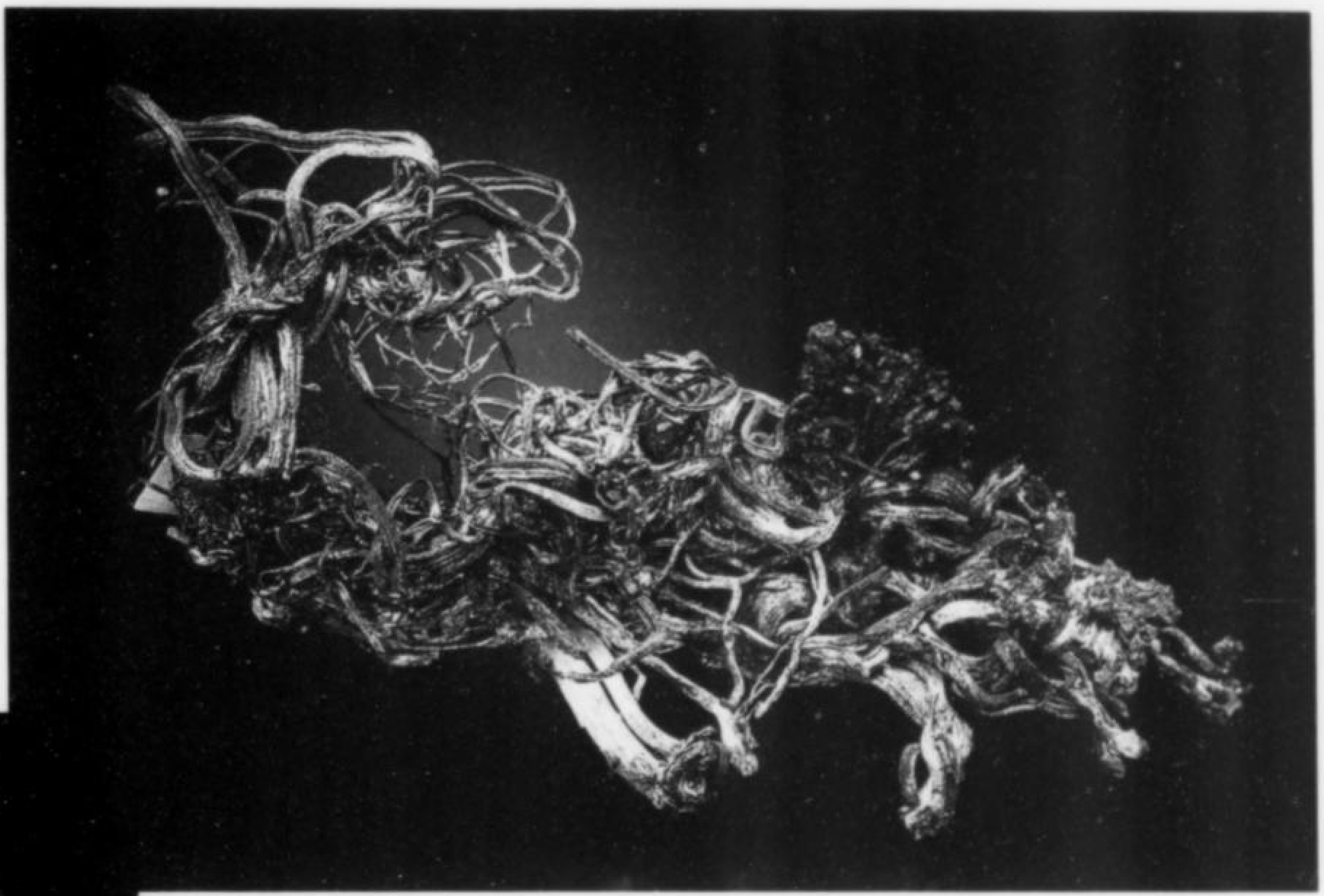


Figure 18. **Silver, 15 cm, from Dzezkazgan, Kazakhstan. Carnegie Museum of Natural History collection, acquired from Van Scriver/Pljaskov Minerals via Collector's Edge. Jeff Scovil photo.**

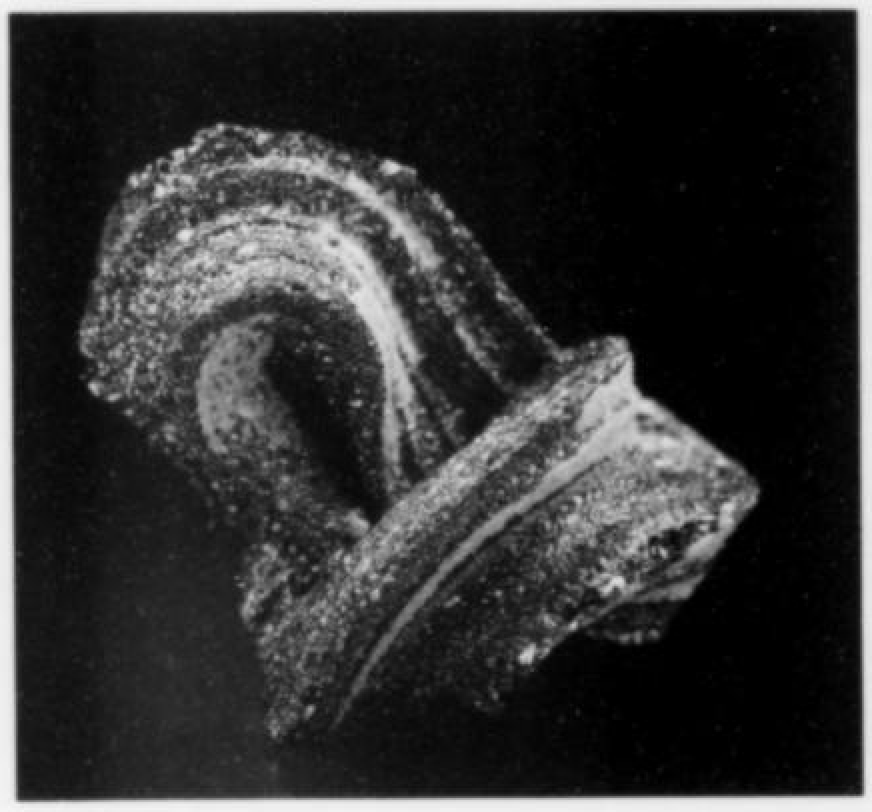


Figure 19. **Galena pseudomorph after wire silver, 3.5 cm, from Beriozava, Sverdlovsk oblast, Russia. Van Scriver/Pljaskov specimen; Jeff Scovil photo.**

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Figure 20. **Gold in quartz from the 16-to-1 mine, California. This specimen (dubbed "the Whopper") was drilled through by the miners before being extracted and acid-etched to remove some of the enclosing quartz; the drill bit has been laid back in after specimen preparation. The piece (excluding drill bit) contains 141 ounces of gold. It was exhibited by Jerry Wentling of Pala International in conjunction with the mine operators.**

wonderful branching groups and flat plates are furnace products; also, vivid red microcrystals of **garnet** can occasionally be spied in the tiny pits on some faces. Watch for more of this stuff, which is sparsely "around," but watch, if you're a perfectionist, for the best, which is probably better than you can even imagine.

Gilbert Gauthier showcased about a half dozen of the gorgeous, deep blackish-green **metatorbernite** specimens which have come for several decades from the Musonoi mines in Shaba, Zaire. In these cabinet pieces (and two $300 thumbnails) the thin 1.5-cm blades and parallel groups are packed densely, but not too densely for individuals to stand up clearly edgewise and show their transparent fringes. Gilbert also had much beautiful, deep green, reniform **malachite** in huge heavy groups and stalactites, their surfaces faintly glittering; oh yes, and miniature-sized matrix pieces with pretty flat-lying sprays of acicular yellowish green **cuprosklodowskite** also from Musonoi.

Tsumeb devotees swarmed thickly in the Executive Inn room where Blair Gartrell, curator of the *Westaus Museum* (P.O. Box 116, Beverley, W.A. 6304, Australia) was selling off oldish Tsumeb pieces from the collection of the late John Innes, senior mineralogist at Tsumeb for 14 years. Some superfine, enormous **cerussites** were sold before I got there, but when I arrived the room still held some excellent small fishtail cerussites from both the Tsumeb and Kombat mines, Namibia, some fine Tsumeb **calcite** rhombohedron specimens with green duftite inclusions, a couple of super Tsumeb **wulfenite** thumbnails, and many rarities for the specialized specialist, e.g., **bayldonite, hydrocerussite, ludlockite, schneiderhöhnite** (!) and **molybdofornacite.** One terrific miniature showed mimetite in a little-known habit: palest yellow, deeply striated prisms with flat terminations, two of these crossed at almost 90 degrees without matrix.

At the Main Show, David Mansfield of the *House of Gems* (P.O. Box 3013, Windhoek 9000, Namibia) was just in from "the Nam" (no, not what you may have thought: just Namibian for Namibia), with more Tsumeb pieces, these collected over the past three years. The best of them are the **dioptase** specimens, in miniature-sized clusters with lustrous 1.5-cm crystals; many have the white calcite matrix which sets off dioptase green so well.

There were fair quantities of the new, pale green reniform **prehnite** from Brandberg, Namibia, but only Don Olson (P.O. Box 858, Bonsall, CA 92003) seemed to have specimens (a handful of miniatures) with smoky quartz crystals in association with this pretty prehnite.

Coming now to South Africa, we come also to what was by pretty general agreement the single most remarkable what's-new of this show: I'm talking about **hausmannite** from the famous N'Chwaning mine, Kuruman, South Africa. Two years ago in Tucson I mentioned in passing the gleaming, bright black, large stepped crystals which some dealers had; these are still around, notably with Don Olson, who this time had some dramatic pieces with the pointed, stairstep crystals stacked all across the fronts of massive black hausmannite matrixes. But of late a new pocket has been hit, with hausmannite of a radically different habit composing great matrix pieces which surely must be the world's ultimate (so far) for this uncommon manganese species. The crystals are sharp, equant, vaguely stickery-burr-looking things: really hard to describe, but they seem to be composite octahedrons with many oriented triangular faces pricking at fingers rubbed along each major face. Individuals of this form are rather uniformly about 1.5 cm along the octahedron edge; un-cleaned ones are dullish black and flecked with brown stains, but cleaned examples are brilliant, and make dynamite thumbnails when they sit up singly on their matrixes of white quartz or of mashed aggregations of tiny red garnet crystals. Cabinet specimens can reach 30 cm, and on these there may be 20 or 30 of the burrlike black crystals spread over the matrix or marching in lines across it. The best large piece at the show was probably the 25-cm matrix specimen chaperoned by Helmut Brückner (Postfach 1342, 79373 Müllheim 16, Germany), but Brad and Star Van Scriver had several more almost as good.

Speaking of the Van Scrivers—more specifically, of the dealership of *Van Scriver-Plyaskov* (P.O. Box 10, 199 00 Praha 9-Letnany, Czech Republic), there was not as much *new* from Russia and Kazakhstan as at earlier shows, but the three miniature matrix **bornites** from Dzezkazgan, Kazakhstan, in the Van Scriver room were not shabby. Come to think of it, they were among the finest Dzezkazgan bornites I have yet seen, with sharp, slightly bulging octahedrons to 3 cm along an edge, clean, attractively tarnished a light bronze in places, on drusy quartz matrix. Then there were magnificent cabinet specimens of pale green **datolite** from Dalnegorsk, Primorsky Kraj, Russia; ideally sharp 4-cm fishtail twins of **titanite** from the Dodo mine, Polar Urals, in singles and large groups; a few 6-cm to 8-cm clusters of highly lustrous black octahedral **magnetite** from the Sokolovskaya-Sarbayskaya mine, near Rudniy, Kustin Oblast, N. Kazakhstan; about 25 *first-class* **ilvaite** specimens, in single vivid black prisms or clustered groups, from Dalnegorsk; and a fabulous, 3-cm one-of-a-kind galena pseudomorph after wire silver from Beriozava near Sverdlovsk, Middle Urals. Without even breaking the paragraph, let me adjourn to the room of Irina Kominz of *Syntaxis,* where Michael Brame (Dept. of Linguistics GN-40, Univ. of Washington, Seattle, WA 98195) toured me through yet more Russian miscellany. Here were about 10 excellent **chrysoberyl** (var. *alexandrite*) sixling twins from the Malysheva mine, Middle Urals, all showing sharp form, not quite gemmy but glowing prominent purplish under the lamp. And here were *much* better **sphalerites** from Dzezkazgan than the ones I described from Denver: flat plates of quartz with very sharp 1.5-cm translucent orange sphalerite crystals tinged bronze on some surfaces by pyrite (chalcopyrite?) dustings. The **uvarovite** on chromite from Sarany, Urals, seems capable after all of occasionally forming macroscopic crystals; a couple of the Syntaxis thumbnails have well individualized, half emedded, bright green 2-mm dodecahedrons. And here, and elsewhere, were fine orange **scheelite** and/or bright brown **cassiterite** from Chukotka in far eastern Siberia—rich orange, translucent scheelite pyramids to 5 cm, the best ones pseudo-octahedral floaters with smaller cassiterite crystals hanging on. Finally, even the humble zeolites shine in Kazakhstan: there are plentiful, very pretty miniature-to-cabinet-sized specimens of **gmelinite,** with flesh-colored rhombohedrons to 1 cm on dark matrix, as well as yellow-orange, shiny **stilbite** balls and sheaves, from Sokolovskaya.

A sharp single paragraph, at last, is merited for the occasional sharp single sandy-brown thumbnail floater octahedrons of the very rare **plumbomicrolite,** from the Kola Peninsula, Russia, which one saw kicking around: they are ugly but very fine for the species, and Jordi Fabre and the Fersmann Museum of Moscow share honors for having had the best.

Dudley Blauwet of *Mountain Minerals International* (Louisville, CO 80027-0302) reports much improvement on the Nepal **dravite** front. From Gujarkot, Bheri Zone, West Nepal come, much more abundantly now than before, very sharp, elongated trigonal crystals, dark brown-green floaters to about 3 cm long. Recent work, by the way, has shown this to be the purest dravite (most overwhelmingly Ca-dominant) yet found anywhere. And Dudley had a generous lot of brand-new **zircon** specimens from Bulbin, Wazarat District, Northern Areas, Pakistan—almost dead ringers for the well-known Seiland Island, Norway pieces. That is, they are red-brown tetragonal crystals with good but pitted glassy luster and some small gemmy areas within, on coarse-grained matrix consisting mostly of black biotite and gray-white feldspar. Good miniatures with sharp, 2-cm zircon crystals could be had for $100 to $300.

In the Pakistan zircon derby, though, another strong contender is *mein Freund* Andreas Weerth, who, with his wife Rebecca, continues to be industrious in extracting goodies from these wasteland mountains. Besides just as many and just as good **zircons** as Dudley had, the Weerths brought along some individual show-stoppers in very large sizes. For instance there was a sharp gray-white translucent **pollucite** 7 cm across, on matrix, from Paprok, Afghanistan; and a gemmy sherry-brown Gilgit, Pakistan **topaz** fully 12 cm high, on platy albite; an undamaged single **aquamarine** crystal weighing 9 kg. And his **analcime** from somewhere in central Siberia! It's an opaque, frosty, snow-white trapezohedron which, with its aesthetic belt of smaller analcime crystals around the base, fills fully a cubic foot of space, and it reminded me of something I might see at the end of my Connecticut driveway, almost any morning, when last night's snow flurry has dusted one of last week's iceballs. Andreas also showed me a gorgeous deep yellow-green chloritic fishtail **titanite** 5 cm long, which at first I assumed to be from Pakistan or perhaps from some remarkably beneficent Alp, but no, it is so far the only piece taken from a locality to watch for: Gamsberg, Namibia.

François Lietard of *Minerive* (Au Bourg, 42800 Tartaras, France) had a very intriguing what's-new from "China"—the sum, so far, of the available locality designation. It's **forsterite** (var. *peridot*) in six large matrix specimens and a handfull of miniatures: the subhedral rounded crystals are medium-green, translucent to almost gemmy (pretty when backlit), and reach 3 cm across; they are in a greenish white clayey matrix of dense fibrous pyroxene (?). And François had some of the Pakistani pseudo-Norwegian zircons too.

Far be it from me to conclude this survey by stoking a feud, but recently Mike Bergmann and Doug Parsons have been differing (through me in this space) about the province of China in which the new and remarkable **scheelite/aquamarine** specimens occur: Bergmann is for Hunan, Parsons for Sichuan. Both are knowledgeable in such matters while I am not; thus I wash my innocent hands of the business except to observe diplomatically that perhaps two different localities are involved (as the antagonists both readily agree). Anyway, this place(s) has/have been yielding some nice gemmy medium-blue aquamarine in apatite-style, form-rich *tabular* crystals to several cm across, available from both of these dealers and from a few others. And Mike and Sally Bergmann's *Galena Rock Shop* (713 S. Bench St., Galena, IL 61036) had yet another would-you-believe association piece: a flat 13 x 15-cm matrix blanketed with sharp, gray, edge-on mica books, and a good 3-cm orange scheelite crystal, and a brilliant, complete 2-cm pink *morganite* beryl of typical tabular form, with another, smaller morganite on the side.

Turning our attention now to what could only be longingly looked at and not bought: the most dramatic of the many outstanding **exhibits** at the Main Show concerned silver and silver minerals, this being Silver Year; I was transported back about seven years, to when I ogled the cases set up at the Munich Show for the 800th anniversary of silver mining at Freiberg. Indeed the Germans were appropriately well represented in Tucson, with a case from the *Bergakademie Freiberg;* a fascinating one on the Johanngeorgenstadt, Erzgebirge, silver deposit, with a magnificent 12-cm pyrargyrite specimen mined before 1763; and a case put in by the *Museum für Naturkunde,* Humboldt Universität zu Berlin, centered on a fantastic Freiberg wire silver, but graced as well with a 7-cm *wunderschöne* Aue proustite.

Next door to the Humboldt case, though, was the one that had everybody returning, circling back, returning to be awed again: silver minerals from the *Miguel Romero collection.* All 20 of these Mexican pieces were imagination-broadening, but a 20-cm acanthite from the Pedrazzini mine, Arizpe, Sonora, and a 15-cm red fireburst of a pyrargyrite from Fresnillo, Zacatecas, were the most other-worldly (least worldly?) of all. Also there was a very impressive case of Michigan silvers by the *Michigan Technological University,* and, of course, wonderful Kongsberg, Norway wire pieces were everywhere to be seen, especially in the case of the *Kongsberg Mining Museum.*

Among the private collections with reserves deep enough to persuasively fill whole casefulls with excellent silver-mineral specimens only, were those of *Terry Wallace, Bill and Carol Smith, John Barlow,* and *Barbara Cureton.* To my taste, though, the most drooly silver-lode case of them all was the best-in-show competition case in which various competitors placed individual pieces to have their (the pieces') charismas quantified. I especially admired a thumbnail of Chañarcillo, Chile, proustite and one of German stephanite, a couple of marvelous Mexican boleites, a Peruvian pyrargyrite toenail, and an astoundingly bright and graceful Schneeberg wire silver.

There were two classy cases of Russian and Kazakhstan pieces to further all our educations. Downstage center in the one put in by the *Carnegie Museum of Natural History* in Pittsburg posed the best wire silver yet found at Dzezkazgan—15 cm of loopy, part-tarnished part-bright thin wires most effectively composed (obtained just before showtime from the Van Scrivers). The other Russian case was an all-Dalnegorsk exhibit with about 45 uniformly superlative miniatures and cabinet pieces from the collection of Rene Triebl of Austria. There were many other equally fine cases.

On still other notes—I was wowed by the spread of 65 thumbnails from Germany by Sharon Cisneros; Gene Meieran's two big cases full of tourmaline-group specimens loaned by individual donors (this one well annotated by posters explaining tourmaline structures, species, sources of color, etc.); the *Natural History Museum of Los Angeles County's* epidote case, with an Untersulzbachtal, Austria, specimen (you have probably seen photos of it) to, as they say, die for; the Lees' "associations" case of Sweet Home mine specimens *besides* rhodochrosite; and Jim and Von Ceil Blees' intelligent case of small quartz specimens showing that species' many and colorful moods.

Does all this put *you* in a mood to come to Tucson next year? The featured mineral will be **topaz!**

Awards

Rukin Jelks won the Lidstrom Trophy for his superb stephanite miniature from Pribram, Bohemia. Everyone seemed to agree they had never seen a finer miniature-size example of the species from any locality. Jelks also carried off the Desautels Trophy for the finest case of minerals at the show.

The Carnegie Mineralogical Award this year was presented to Prof. Cornelius S. Hurlbut (making two in a row for the Harvard staff, following last year's award to Dr. Carl Francis). Hurlbut, a 1933 Harvard PhD, has spent most of his career there teaching, conducting mineralogical research and producing publications. His best known works include his many updated editions of Dana's *Manual of Mineralogy* and his famous "coffee-table" book, *Minerals and Man* (1968), which was perhaps the first of its kind. Now retired, Dr. Hurlbut has been turning his attention to gemology, designing tools for gem identification and serving as co-author of two editions of the textbook *Gemology.*

Nominations for the 1994 award (to be presented at the Tucson Show in February 1995) should be sent to Mr. Marc L. Wilson, Section of Minerals, Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, PA 15213-4080.

The Friends of Mineralogy Award for the Best Article of the Year in the *Mineralogical Record* went to Ole Petersen and Karsten Secher for the Greenland Issue.

On Exhibit in Tucson:

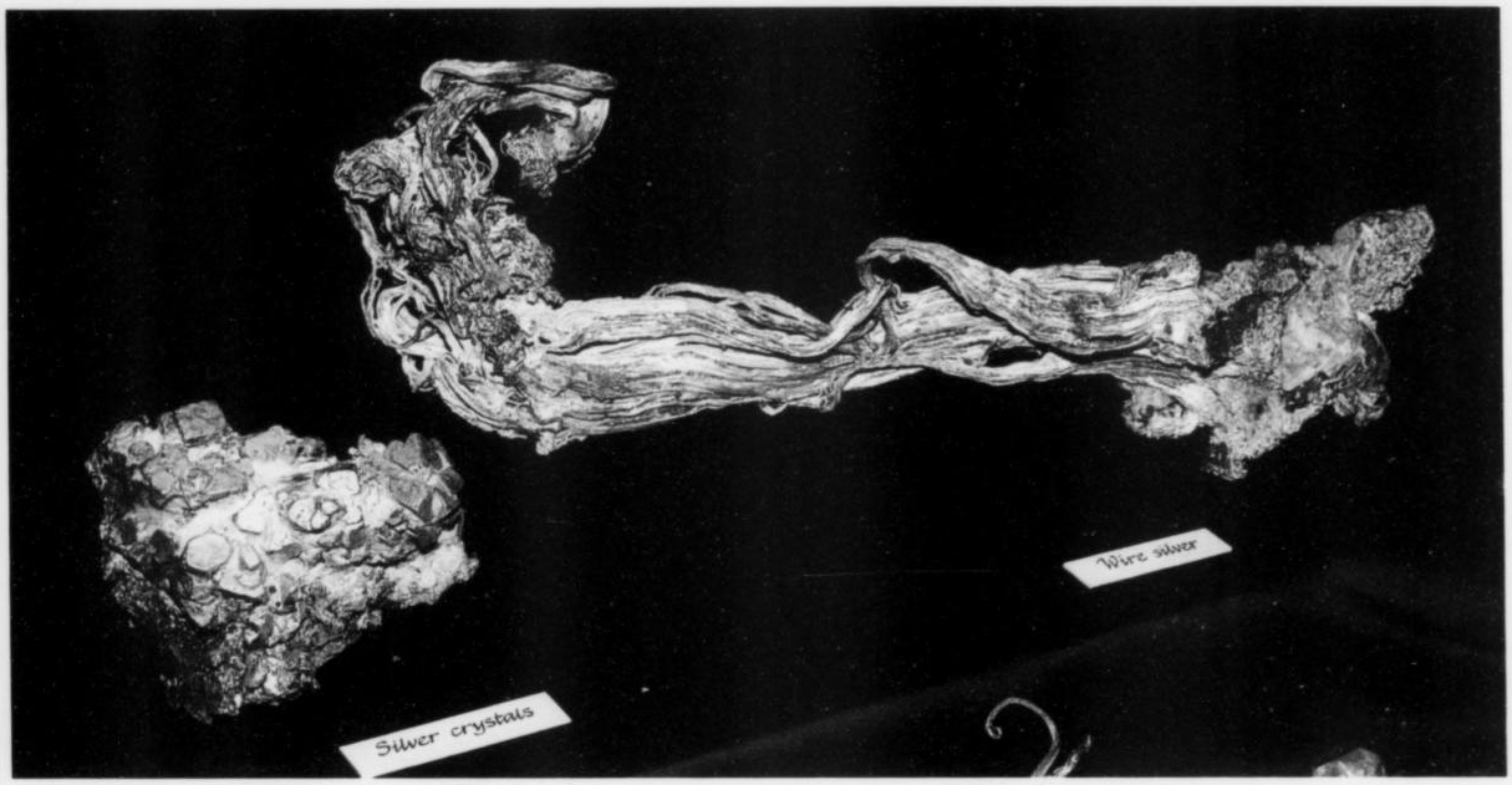

Figure 21. **Silver from Kongsberg, in cubic crystals to 2 cm (left) and a long mass of wire, exhibited by the Kongsberg Mining Museum.**

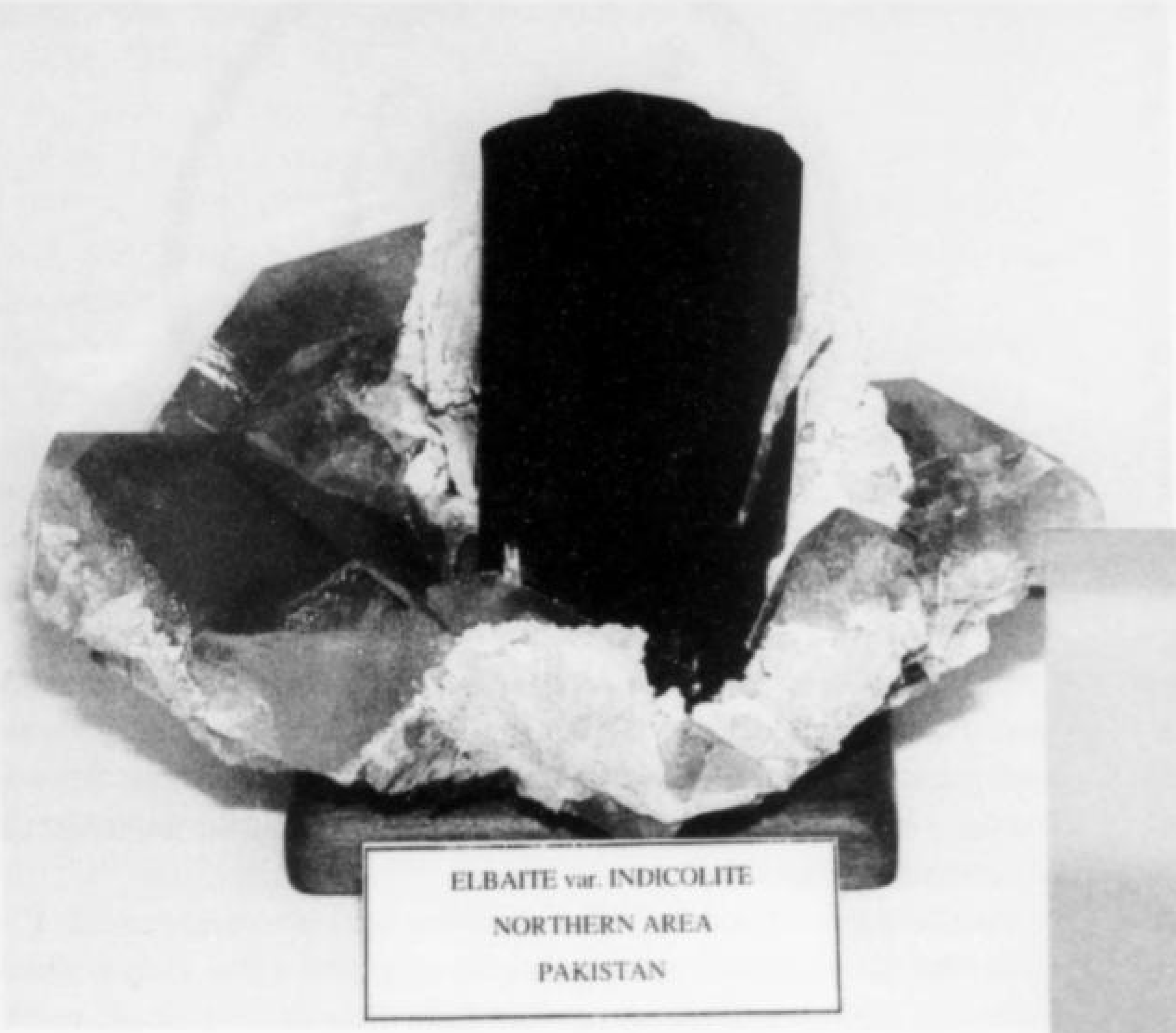

Figure 22. **Blue elbaite crystal, about 8 cm, with quartz from Pakistan. It was exhibited in the case of the Mineralogical Association of Dallas, which contained specimens selected from the collections of several members (owner not specified).**

Figure 23. **Elbaite crystals (very gemmy) on a large smoky quartz crystal about 16 cm tall, from Paprok, Afghanistan. It was exhibited in an extraordinary two-case display of tourmalines borrowed from major museums and private collectors by Gene Meieran and others.**

From the Terry Wallace Collection of Silver Minerals

Photos: WEW

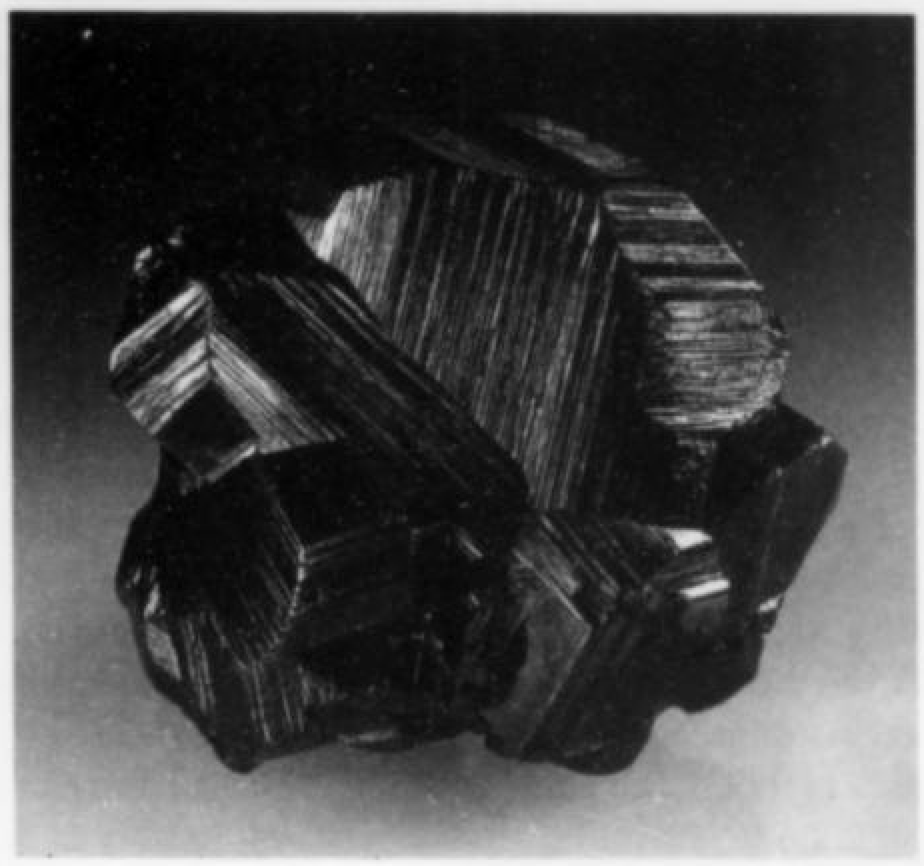

Figure 24. **Pyrargyrite, 2.8 cm, from the San Cristobal mine, Peru.**

Figure 25. **Pyrargyrite, 1.7 cm across, from Freiberg, Saxony.**

Figure 26. **Proustite, 3.6 cm, from Chañarcillo, Chile.**

Figure 27. **Aguilarite crystal group (perhaps the finest known miniature), 3.5 cm across, from Mexico.**

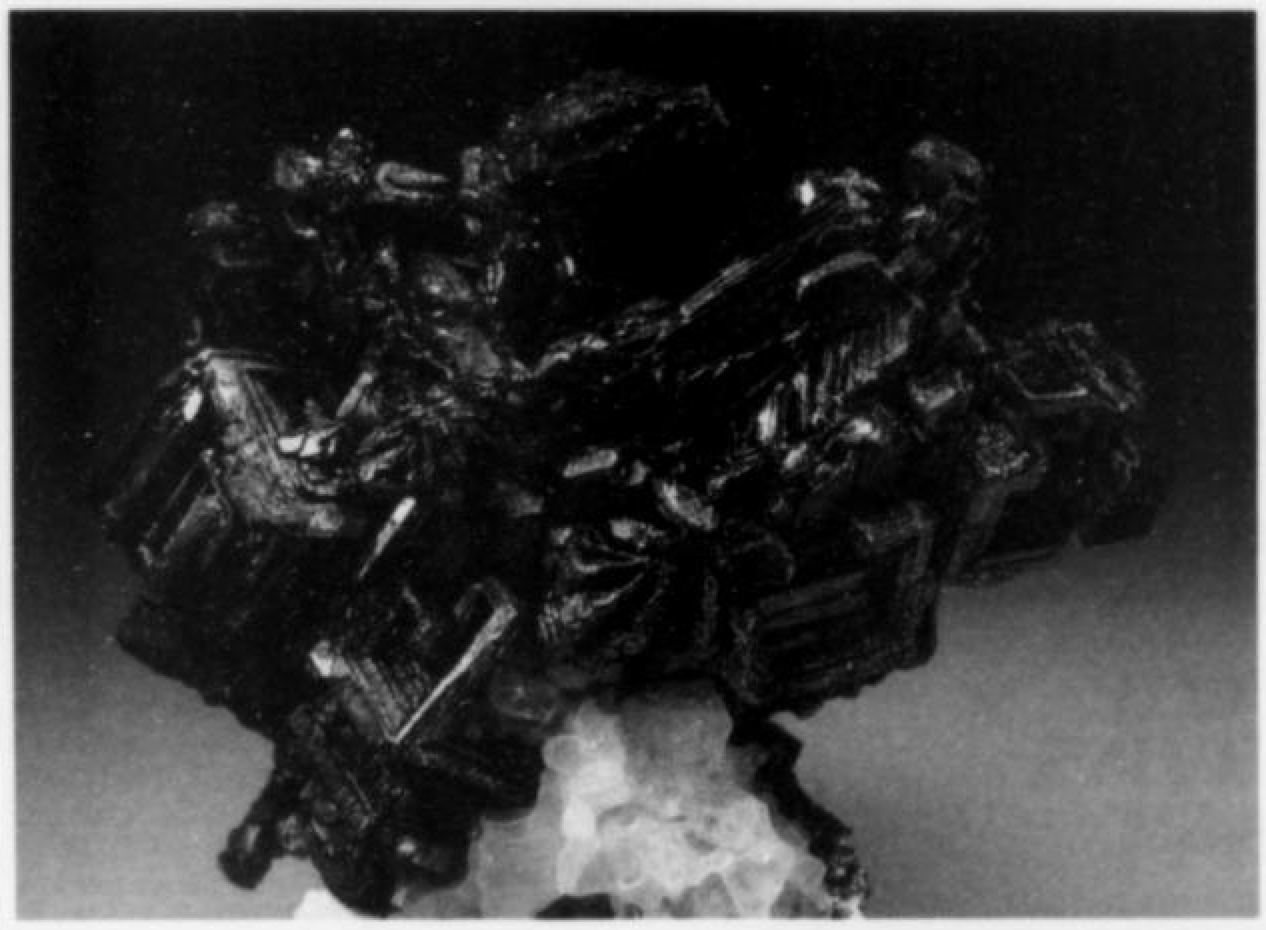

Figure 28. **Silver, 6.1 cm, from the Seneca mine, Michigan.**

Figure 29. **Andorite crystal, 3.7 cm, from Oruro, Bolivia.**

Figure 30. **Polybasite (perhaps the finest known miniature), 3 cm, from the Las Chispas mine, Sonora, Mexico.**

Bilbao and Barcelona Shows 1993

by Miguel Calvo

In October Spain's two principal mineral shows are held in Bilbao and Barcelona. The Bilbao Show usually comes first, and most new discoveries make their debut there, although a few may have been shown earlier at minor Spanish shows or at other European shows such as Sainte-Marie-aux-Mines, France.

A major discovery took place in Spain in February of 1993, when a truck-size cavity completely lined with **gypsum** crystals was found in an old mine near Gorguel, in the La Unión mining district, Murcia province. Over the course of about four months thousands of specimens were recovered in sizes from miniatures to cabinet. Most of the best examples were sold wholesale and retail by Jordi Fabre. Jordi also acquired about 50 **fluorite** specimens recovered from a landslide in the well-known La Cabaña quarry, Berbes, Asturias, Spain (see the article in vol. 23, no. 1, p. 69–76) in March of 1993. The pale blue crystals on quartzite matrix are up to about 2 cm in size.

This year the **barite** specimens from Cartagena in the La Unión district have been even more abundant than in previous years. Juan Peña of Seville had some fine examples at the Bilbao Show: groups of subparallel, tabular, 3-cm crystals which are translucent with a milky white zone along the edges.

Jose Javier Saura from Cartagena had other excellent **barite** specimens from various abandoned mines and prospects in the La Unión district. The best of these include some cabinet specimens (up to 40 cm) consisting of yellow, bladed crystals to 5 cm partially coated by pyrolusite. He also had cabinet-size groups of 3-cm blue crystals. Both of these types were found in unnamed prospects at El Sabinar, Portman, Murcia province.

Saura also had a selection of less common Spanish minerals, including **ludlamite** crystals to 5 mm (some with associated **vivianite** crystals) and groups of **cronstedtite** from the Brunita mine, La Unión district. Also available were some cauliflower-like groups of **chalcophanite** microcrystals to 2 cm with associated colorless and transparent calcite crystals; the color contrast makes for aesthetic specimens. These came from an unnamed prospect at El Sabinar. Finally, Saura had some **amethyst** groups from the Los Pajaritos mine in the La Unión district. The crystals, which reach about 4 cm, have a surface layer of second-generation parallel overgrowth resulting in a scaly appearance and a peculiar feel. The texture seems smooth if a finger is rubber over the surface in the direction of the termination, but rough if rubbed in the opposite direction.

In March of 1993 Francisco Pérez of San Sebastián found a large pocket of **dolomite** crystals at the famous Eugui quarry in Navarra (see the article in vol. 22, no. 2, p. 137–142). More than 200 specimens, with crystals up to 7 cm, were taken out. Many have the gray color which is so characteristic of this locality, and some show color zoning. Unfortunately only about 20 specimens were removed on matrix. Pérez also recovered some specimens of other species, including **malachite** pseudomorphs after chalcopyrite crystal groups to 6 cm (no matrix). Most of the Eugui specimens were sold by Jordi Fabre and Luis Miguel Fernandez at the shows in Bilbao, Barcelona and elsewhere.

Manuel Tomé of Zamora had at Bilbao some flats of **variscite** from a new locality in Spain: a roadcut between Palazuelos de las Cuevas and Bercianos de Aliste in Zamora province. He also had **wavellite** from Palazuelos de las Cuevas, perhaps the finest quality wavellite found in Europe for at least the last two years. Some of the wavellite groups are sprinkled with crude microcrystals of **turquoise**.

Ramón Gonzalez of Gijon had some **emerald** and **phenakite** crystals in matrix from a roadcut near Franqueira, La Coruña province, an occurrence now exhausted. He also had a very interesting old-time specimen: a large sharp, bright orange **scheelite** crystal 4.5 cm on an edge from Boal, Asturias province. This is extraordinary considering that pale, crude crystals to about 5 mm were typical of the locality. The specimen is said to have come from Manuel Mesa, a specialist in the minerals of Asturias.

At the Barcelona Show Juan Viñals had a large selection of uncommon microminerals from Spain, including **linarite**, **brochantite** and **beaverite** from Sierra de Prades, Tarragona province; **roselite** from Huercal Overa, Almeria province; and **lavendulan** and **cornwallite** from an unnamed mine in the Mazarrón area, Murcia province. These specimens were all collected some years ago by Antonio Barahona of Madrid, but have only recently been identified. The lavendulan specimens, consisting of radial crystal groups to 3 mm covering limonite matrix, are actually quite fine for the species.

Charles W. A. Herrmann (1801–1898) Mineralogist and Mineral Dealer

Lawrence H. Conklin
2 West 46th St.
New York, New York 10036

The history of early commerce in mineral specimens on a professional level in the United States has barely been touched upon. Most people, this writer included, long thought that it began, essentially, with Albert E. Foote, M.D., who was born in 1846, and did not become active until about 1870. Now we know there were professional dealers as far back as the 1820's and there may well have been earlier ones. The main difference between the business then and now is that *now* things have expanded enough to allow some dealers to specialize and to sell mineral specimens only; whereas *then* they probably were forced to offer fossils, shells and other natural history objects, in order to survive, in much the same way that some mineral dealers of today offer gemstones, beads and jewelry.

One mineral specimen dealer who was active in the 1850's was Charles Wilhelm August Herrmann of New York City. He was born in 1801 in Altwasser, Silesia, Germany, on the estate of Baron Richthofen, where his father was the supervisor of the Baron's 26 farms; he died in New York City in 1898. Herrmann studied mineralogy at the University of Breslau and then became Professor of Mineralogy there. He gave up this position after some years and undertook studies at Mecklenberg University for a time. When he left Mecklenberg, he returned to Breslau and opened a shop for the sale of minerals and shells.

It was a time of great political and economic upheaval in Europe, and Herrmann emigrated to America in 1853.[1] Herrmann stated, in a letter to Clarence S. Bement, that it was his intention to return to Germany, "but my wife was sick for seven years so I had to stay."

Herrmann brought with him a large collection of minerals which, he believed, was the very first imported into this country, but he was mistaken. It is recorded that Archibald Bruce (1777–1818), David Hosack (1769–1835), Col. George Gibbs (1776–1835) and possibly others, preceded him by many years. The mineral shop which he established at the corner of Broadway and Houston Street in New York City became his sole occupation until he could no longer run it in old age.

In 1857 Herrmann displayed mineral specimens at the Crystal Palace in New York City, and won the award for the best (and only?) display. The Crystal Palace, completed in 1853, was an elaborate, greenhouse-like exposition building made mostly of glass in an iron framework, with wood utilized only for floors, doors and sash. It was considered completely fireproof but it nevertheless caught fire in 1858 and was reduced to an incandescent pile of rubble in a period of twenty minutes! It was constructed for the first World's Fair held in the United States and was modeled after the original Crystal Palace in London. It stood on land now occupied by Bryant Park behind the New York Public Library, whose site, at that time, was occupied by the Croton Reservoir. This is the block bounded by 42nd and 40th Streets, 5th and 6th Avenues.

Herrmann made several buying trips to Germany, returning each time with new specimens for his clients, one of whom was "the millionaire Robert L. Stuart," (1806–1882), important philanthropist in New York City and president of the American Museum of Natural History from 1872 to 1881. Stuart was a serious mineral collector, and Herrmann sold him some of the choicest specimens in his collection. This collection went, upon Stuart's death, not to the A.M.N.H., as one might assume, but to the Lenox Library, because Stuart, who was a devout Presbyterian, vigorously opposed museums being open to the public on Sundays, and withheld donations from institutions with such a policy. Indeed, his widow revoked large bequests already made to the American Museum in her will. Stuart did give (during the time of his presidency) to the museum a collection of 140 mineral specimens, that illustrated the geology of Mont Blanc, Switzerland, on October 25, 1877. According to the *Dictionary of American Biography*:

> She [Mrs. Stuart] had no children, and after her death more than $4,000,000 [!] was distributed to various societies and institutions. The Stuart pictures [a significant collection] and books went [also] to the Lenox Library, later incorporated with the New York Public Library. By perpetual inhibition the room containing those collections is closed to the public on Sundays.

A few inquiries at the N.Y.P.L. turned up no one who ever heard of this "perpetual inhibition," but the question is moot because the library is not open on Sundays.

In 1883 Mrs. Stuart gave the American Museum a mesosiderite meteorite from Vaca Muerta, Chile, which fell before 1861; a Brazilian chalcedony enhydro in 1884; and in 1886 she gave a Japanese stibnite that she had purchased from Charles Herrmann and a specimen of gold crystals on quartz from Eldorado County, California.

On one of Herrmann's journeys he purchased, in Bavaria, a very important fossil icthyosaur which he sold to the City College of New York. I recall having seen it during my undergraduate days there in the 1950's and remember it as being about 12 feet long. Referring to that fossil, Herrmann said "I had great pain to get the fossil bones free of duty, [and] only because they went all to [the] college." Today there is no duty whatsoever on fossils or even the most valuable of

[1] Herrmann followed, by five years, a fellow mineralogist/countryman, Frederick A. Genth (1820–1893), who came to this country in 1848. Genth was twice honored with the naming of the mineral species *genthite* and *genthelvite*, but of course he chose to become an academic and not a mineral *dealer*.

mineral or rough gem specimens for that matter. Some things *are* better today than they were in the "good old days."

Most of the information in this article was gleaned from Herrmann's obituary and from a small group of his holograph letters sent to Clarence S. Bement and George F. Kunz between the years 1890 and 1892. This material is now in my own library, but it was once part of the very large file of letters to Kunz that is now at the American Museum of Natural History Library in New York. Herrmann's letters, which are in a scrawling hand, and now and then lapse into virtually indecipherable German words and phrases, are *very* difficult to follow, and remind one of the old expression "sie müssen never zwei languages zusammen speak," but one interesting statement sent by Herrmann to Bement on 8-20-1891 is as follows, edited where necessary:

> On the 5th of March 1875 Mr. Vaux wrote [me that]
> your [Herrmann's] experience with collectors is
> similar to my own and it does seem that in
> minerals, people will be dishonest when they
> will not be in other things.
> So wrote lawyer Vaux.
> N. cheated me [Herrmann] of $200.
> E. cheated me of $200.
> M. cheated me of $100. Mostly teachers.

In a later missive Herrmann told Bement that the people who cheated him were all *professors*.

I have heard complaints similar to Mr. Vaux's expressed by people in other collecting fields too, especially books. Perhaps Bement questioned Herrmann's quotation from the Vaux missive, because, in a letter dated a month later, 9-24-1891, Herrmann wrote: "Herewith I send the hand writing of the late Mr. Vaux, that you may see, I wrote the truth."

In 1891 Herrmann sent to Clarence S. Bement a copy of a book written by Lewis Feuchtwanger (1807–1876) which the author had presented to him. Since he mentions in the accompanying letter that "many minerals are painted [colored]" the book in question must have been *A Popular Treatise On Gems*, of the third or fourth edition. He told Bement that "Dr. Feuchtwanger came *every* Sunday afternoon to me even when ice was on the street, talking minerals."[2]

Herrmann further informed Bement that after Feuchtwanger died, when both of his daughters were in Paris, his mineral collection was stolen. It would seem that Feuchtwanger had a lot of bad luck with his collection. Canfield, in his *Final Disposition* (see vol. 21, no. 1, p. 41–46, 39) states that Feuchtwanger's . . .

> . . . daughters presented his collection to the Society of Ethical Culture of New York City, about 1900. It was a general collection. Many years ago, while this collection was exhibited in the Old Arsenal in Central Park, some of the specimens were stolen.

Perhaps they were both referring to the same event. The Arsenal was the first (and temporary) home of the American Museum of Natural History and was occupied by the museum from 1870 to 1879 while the great complex of buildings on Central Park West was under construction. It is still standing today.

If, indeed, Clarence Bement was one of Herrmann's clients, there is no evidence surviving with his collection at the American Museum to verify it. Bement was very careful in noting whom he bought his specimens from, but he did this on the reverse side of his specimen labels, and since all of these labels were glued to large cards in curator Louis Gratacap's time, and since these cards do no always record *all* of the information from the backs of the labels, such evidence may exist, but is, for now at least, unavailable.

We do know that in 1891 Bement got one specimen from Herrmann, but it came in the form of a gift. It was described by Herrmann as follows "A singular [sic.] Garnet Crystal, which came long ago to my hand, but was forgotten among my closets . . . *I never saw such before*, [italics added] and nobody has seen it."[3] This specimen was, presumably, sent to Bement as a thank-you gift for Bement's present to Herrmann of $50 cash "to help me along. This money will help me to move to better quarters." Fifty dollars was a *very* significant sum for the time. I currently have on hand Clarence Bement's Russian emerald specimen that today is worth several thousand dollars, and the price Bement paid for it in this same time period was $50!

Thank you to Charles Pearson and Joseph Peters for help in researching one-time president of the American Museum of Natural History Robert L. Stuart.

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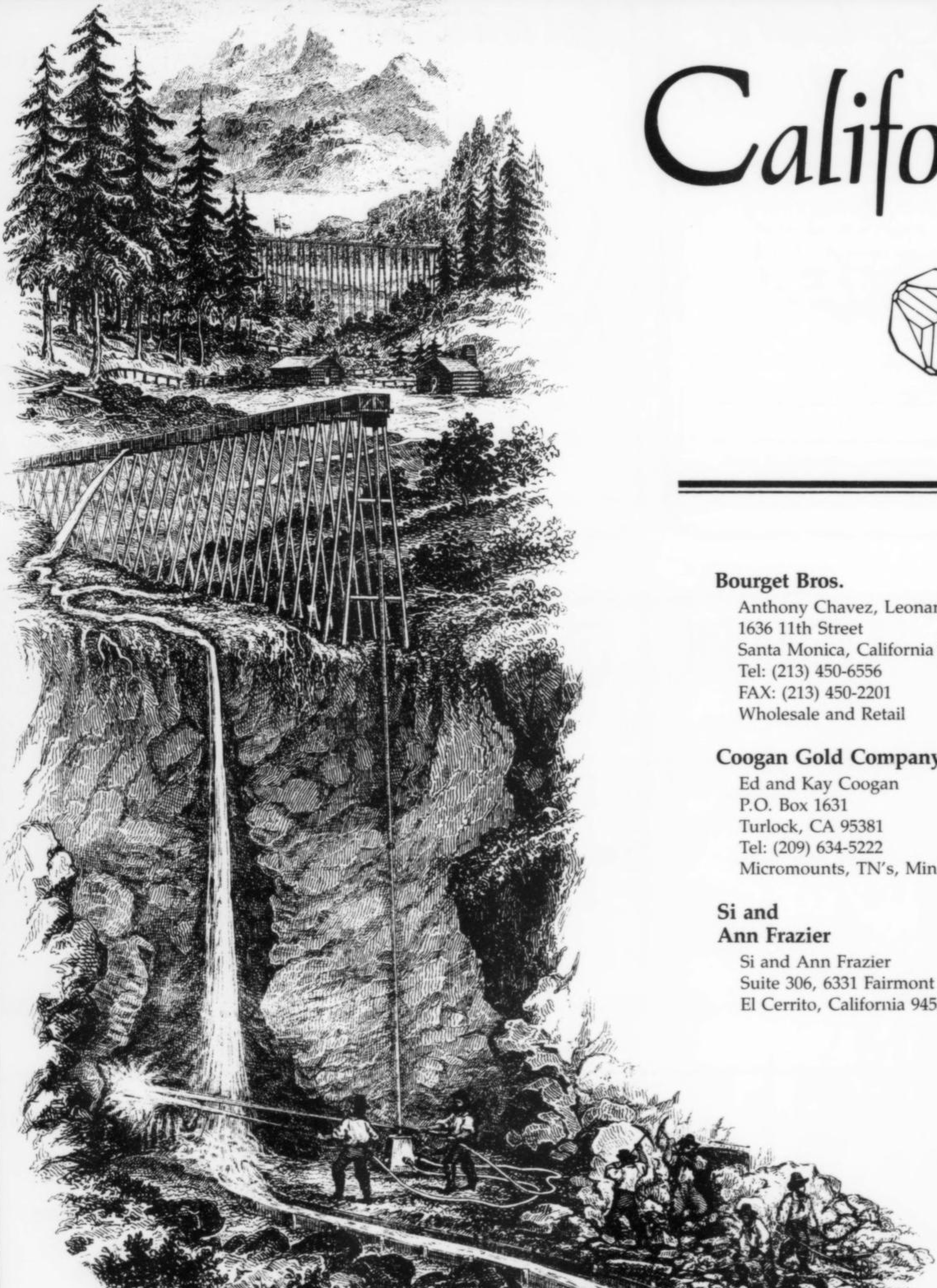
[2] Today virtually nothing is known of Clarence Bement's mineral-book library (unlike his general library of which much has been recorded), but the above information places one more gem or mineral title in bibliophile Bement's hands. We know of a total of only four! Unfortunately, as with the other three books, this copy cannot be located today.

[3] Was this an early version of the mineral dealers' joke used in describing a fine specimen?—"I never saw a better one," says the dealer, to which the cynics reply—"Yes, every time a better one was around you covered your eyes."



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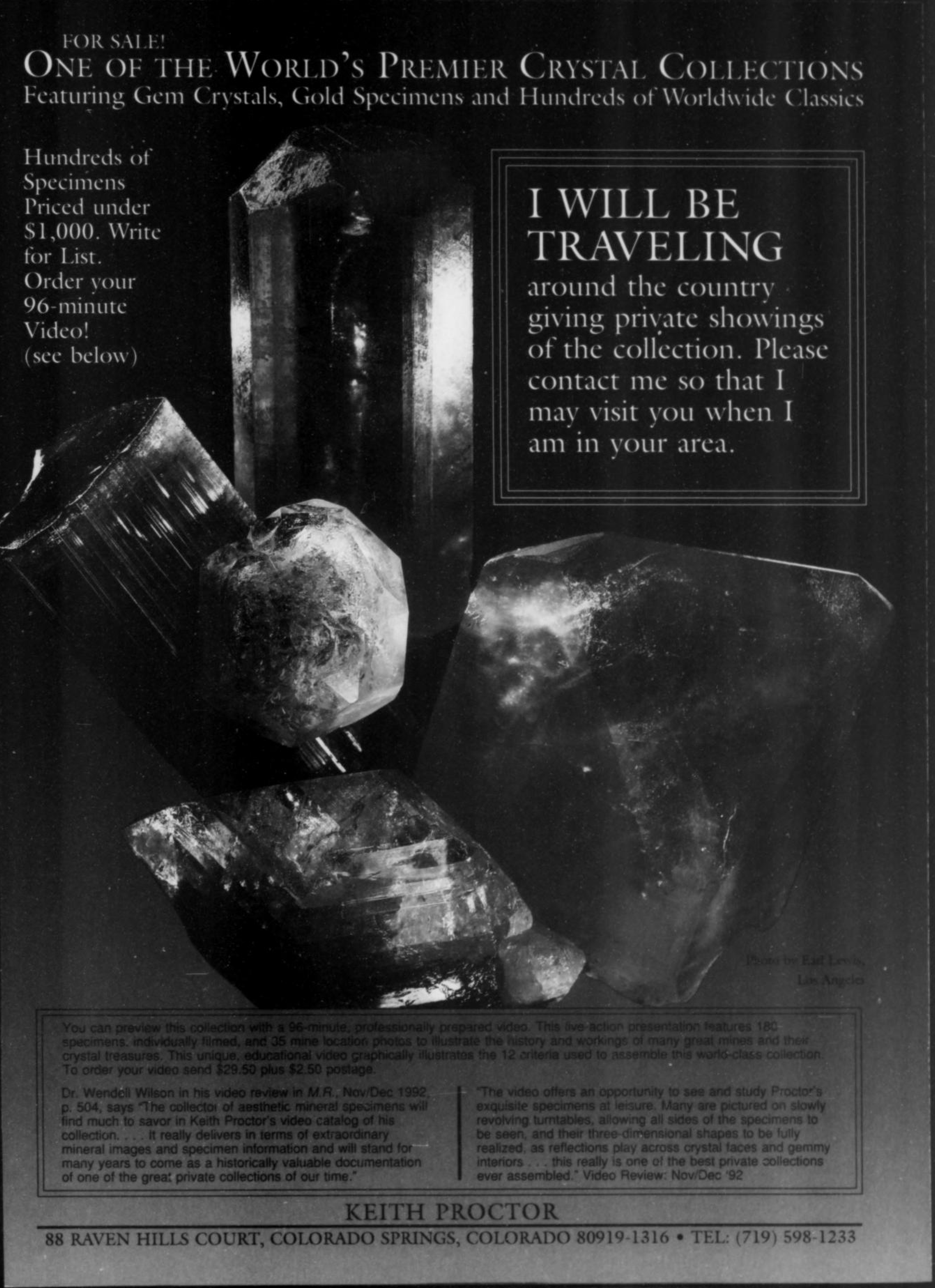

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