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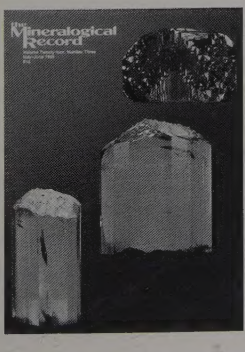
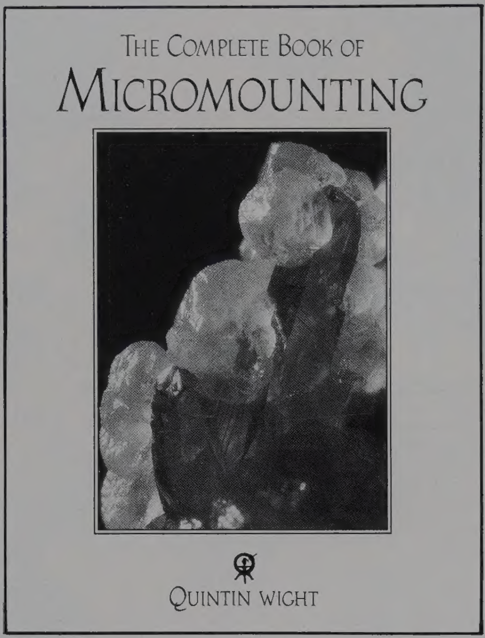
Articles

Columns



COVER: ZOISITE ("Tanzanite") crystal, 3 x 4.4 x 5.5 cm and flawless, shown from three different directions to demonstrate the trichroism; from Merelani, Umba Valley, Tanzania. F. John Barlow collection; photo by Harold & Erica Van Pelt.

notes from the EDITOR



Micromounting Book!

Many years ago the late Neal Yedlin began gathering material for a comprehensive book on micromounting. Neal, as many people know, was the original author of the *Mineralogical Record*'s microminerals column (called "Yedlin on Micromounting") from 1970 to 1976. Before that he wrote a column (called "The Micromounter") for *Rocks & Minerals*. To just about everyone in the hobby Neal was known as "Mr. Micromounter," the principal guru to countless micromineral enthusiasts.

Neal's career was sadly cut short by a stroke. Before passing on in 1977 he gave over the files he had assembled to Paul Desautels, then curator of minerals at the Smithsonian Institution. Paul was himself a long-time micromounter, not to mention one of the most influential mineral connoisseurs of our time. Paul's original intent was to put the finishing touches on Neal's manuscript and see it through to publication in Neal's name. However, it turned out that Neal had not gathered or written nearly enough to make into a book. So Paul decided eventually to write his own book on micromounting, using Neal's notes as resource material. Following Paul's retirement from the Smithsonian he got to work in earnest, and wrote several complete chapters. He approached me about having the Mineralogical Record publish it, because he felt we would assure proper quality, and would have a sympathetic "insider's" understanding of the subject matter. We happily agreed.

Unfortunately, Paul saw that he too was destined to die before completing the task. As it happens, Paul learned that another prominent micromounter, Quintin Wight of Ottawa, was working independently on a micromounting book of his own, unaware of the slowly progressing Yedlin/Desautels work. Paul and Quintin got together and saw, after comparing notes, that there was little duplication in their work thus far . . . they had each started with different subject chapters. Paul therefore elected to formally turn his and Neal's materials over to Quintin, in the hope that someday the Great Work would finally be completed.

Quintin proved to be the ideal author. With determined dedication he assimilated Neal's and Paul's materials and created a remarkably broad, detailed and complete manuscript with a large number of interesting illustrations: the ultimate book on micromounting.

Chapters cover the history of micromineral studies and collecting from the 17th century to the present; trading and field collecting methods; specimen preparation, identification, mounting and conservation techniques; microscopes; micromineral photography; micromounting symposia worldwide; the Micromounters Hall of Fame; and a wide range of tools and equipment useful to the micromounter. There is even an appendix listing over 300 species that are water-sensitive. Lastly, there is a color album of 165 beautiful micromineral photographs taken by some of the world's most highly skilled photomicrographers.

The book (hardcover only, 283 pages) is entitled *The Complete Book of Micromounting*. It is sure to stand for many years as the micromounter's bible, the one work that anyone with even a passing interest in studying or collecting microminerals will have to read and refer to.

To order your copy send **$62** plus **$3 postage** in the U.S. ($5 postage to all other countries) to the Mineralogical Record, P.O. Box 35565, Tucson, AZ 85740.

The standard wholesale quantity discount will apply only to *bona fide* dealers for resale. We cannot offer a group discount to clubs or other organizations, because practically every serious micromounter *is* a club member, and we'd simply end up selling *all* copies at wholesale. We did not scrimp on quality in the production of this book, knowing that it would be treasured for many years by micromounters. So we have considerable expenses to cover, and need to sell a significant portion at retail. We're sure that micromineral enthusiasts will get their money's worth in *The Complete Book of Micromounting*.

WHAT'S NEW!

Our annual Munich Show report usually goes in the March-April issue but, owing to the lengthy Greenland article which precluded the inclusion of columns, it was bumped back to this issue for 1993. May-June is also when we present our Tucson Show report, so these two major market reviews, plus a report on the Pasadena Show and several others, are here combined. The Tucson Show saw the appearance of at least half a dozen finds qualifying as world's best for the species, and many people considered it to have been one of the best shows of all time for quality minerals. We have accordingly allotted plenty of space and color photography for these reports . . . so much so that it has been jokingly suggested we should dub this the "What's New Issue." In any case, as I said in our Twentieth Anniversary Issue, we are living in a "Golden Age" of mineral collecting; that statement is well supported by these recent shows.

NOTICE

Died, Anne Vossbrinck, 74, of Merrick, Long Island, New York. She and husband Karl started as mineral dealers from their home and were soon selling at many mineral shows throughout the U.S. and Europe. They operated their business, under the name of "The Silver Pick," for 40 years, and attended the Tucson Show for 25 years. During their early years they made some major tourmaline discoveries in Maine. In the Limecrest quarry they uncovered dravite crystals over a meter in length. Anne and Karl were among the organizers of the Nassau Mineral Club, and remained active members; Anne taught classes in crystallography.

UPDATE ON THE MINERALOGY OF THE MAJUBA HILL MINE, PERSHING COUNTY

NEVADA

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Interest and collecting activity at the Majuba Hill mine have increased since the publication of the initial article on the locality (Jensen, 1985). Information on new discoveries at the mine, as well as on certain aspects that were left vague earlier, is presented here. As of October, 1991, access to the mine is tenuously unrestricted.

INTRODUCTION

Several companies have held the Majuba Hill property in Pershing County, Nevada, since Gulf Chemical relinquished it, hoping that it could be *in-situ* leached for its silver values. With the increase in environmental controls in recent years, however, combined with the decrease in silver prices, the target has become less attractive. Thus, the only real activity at Majuba has been that of mineral collectors, the locality having become very popular lately.

Three different but interrelated general topics are covered in this update discussion: (1) the status of mine access, (2) minerals previously unreported from the locality, and (3) further information on previously reported minerals, including significant new discoveries.

As noted above, access to the mine is possible. Until just recently, the doors to both the lower and middle adit portals, as well as the gate on the main road, were open and unlocked. On a visit made to the middle adit in August, 1991, however, other collectors were working in the mine, even though the door now had a fresh lock. My subsequent visit to the mine (in October, 1991) was startling, in that the locked door to the middle adit had been ripped apart in two pieces and was now open, hanging only on its hinges. This type of action is unnecessary and will undoubtedly lead to severe reaction from the current property owners. There is now, however, no longer a caretaker below the mine. Dick Bailey, the last caretaker, moved away at least five years ago. The cabin which he occupied has also been burned and leveled, a sight occurring more and more often at old Nevada mining camps and ghost towns. In addition, the immediate region surrounding Majuba has become a very popular area for bird and deer hunters at various times of the year, and it is not uncommon to see up to a dozen other campers and groups around during these periods. The mine itself is being visited on a regular basis by mineral collectors; on almost any weekend now, one should not be surprised to be joined by others.

Since the publication of the mineral species list in the *Mineralogical Record* in 1985, 31 new species for the locality have been added, bringing the total from 52 up to 83. The current list, although accurate, is probably incomplete, for it is likely that still other species will continue to be discovered and studied from the site. Fortunately, many of the newly described species are probably already represented in most collections, having been either overlooked in the past (such as langite, sphalerite, or atacamite) or occurring in crystals too small to be seen without the aid of at least a binocular microscope. In this latter category, methods such as reflected-light ore microscopy, scanning electron microscopy (SEM) with energy dispersive spectrometer (EDS) X-ray chemical microanalysis, or X-ray diffraction (XRD) have been utilized to verify mineral phases.

The summary which follows has been compiled over a period of many years and has been gathered during the examination of many hundreds of kilograms of material. Representative specimens of all newly verified species have been donated to the Mackay School of Mines museum. I also maintain a fine and complete collection of minerals from the Majuba Hill mine, and all specimens are available for examination by qualified investigators.

All locations for specimens, which are given in coordinates in the

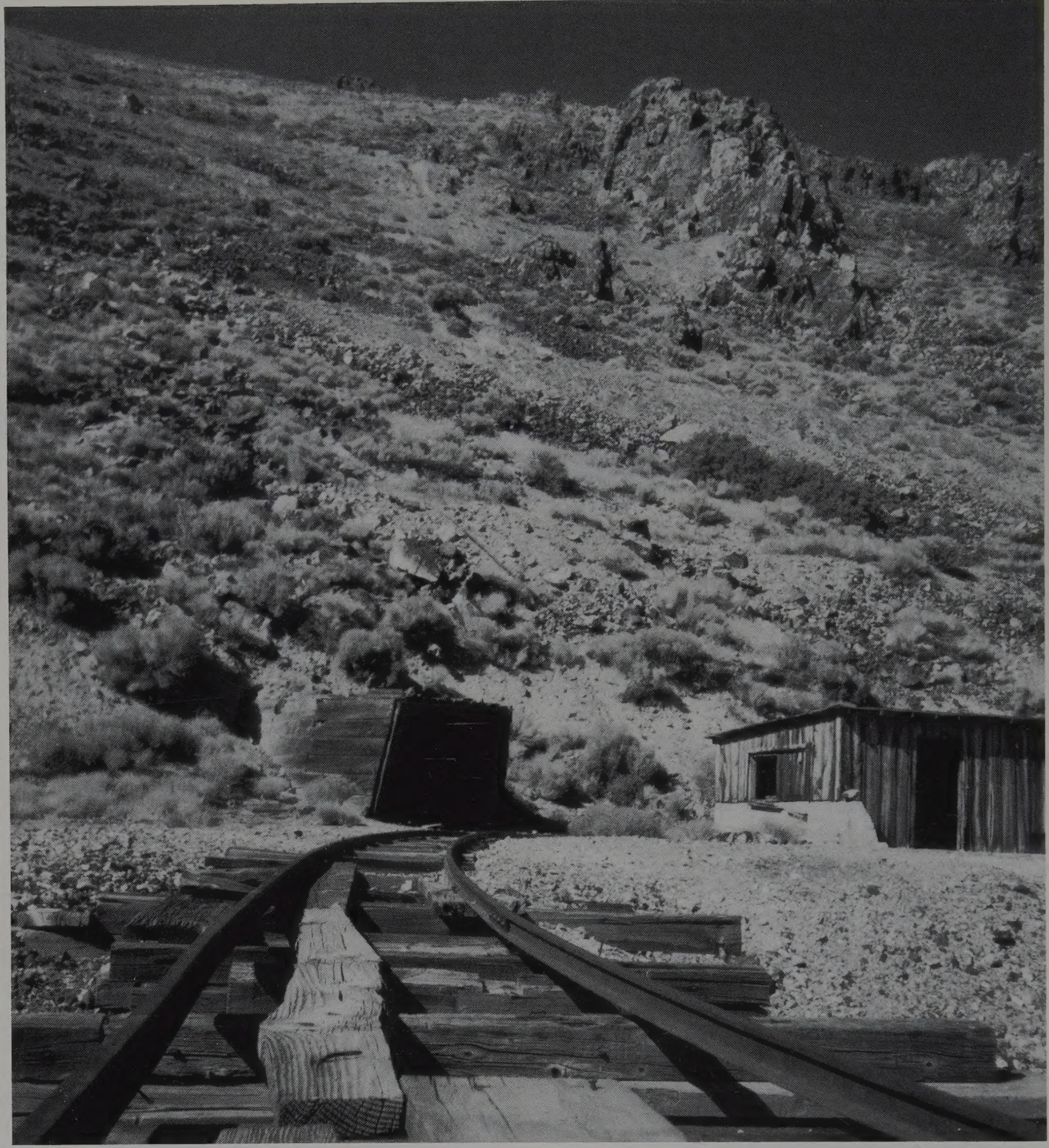

Figure 1. **Entrance to the middle adit portal, Majuba Hill mine, 1991. Very little has changed here since the last mining occurred in the 1950's, especially the beautiful view and tranquil silence. M. Jensen photo.**

text, are in reference to the excellent and detailed mine map included as Plate 9 in the paper of Trites and Thurston (1958). (Since this reference uses English units for measurement, this format has been followed for the locations only. Otherwise, the more current metric units are used throughout). The map of Jensen (1985, Fig. 3) was taken from the M.S. thesis of Stevens (1971), and was slightly modified by Wise.

Throughout the current study of Majuba, certain observations have come to light which need comment. Today, with the widespread closure of mines, both abandoned and active, and the passing of many localities into archival references only, Majuba is beginning to stand out. It is now unusual to be able to drive to the portal of a locality, walk in, and have an excellent chance of collecting good material. Even more outstanding is the fact that, after many years of collecting, one can still discover new locations for good specimens, as exemplified by the excellent clinoclase discovery described below. Most localities that have been heavily collected are now either unproductive or require the use of blasting techniques. Fortunately, Majuba fits into neither of these categories. Perhaps the single most dangerous factor which could limit collecting at Majuba is the influence of environmentalists and lawyers with liability lawsuits—these are more likely to end collecting at the locality rather than is the depletion of fine mineral specimens.

At present, however, there is still a good supply of material available, both in the mine and on the market. To paraphrase, "Enjoy it while it lasts." For those who wish attractive specimens of only the more common minerals, they are obtainable. If one desires to "complete the suite" and have at least one example of each species known from the locality, this is also a possibility, and one which carries many rewards. There are few localities with such diverse mineralogy where this goal can be achieved. By so doing, the collector then has a very valuable record, both scientific and aesthetic, of the mineralogy of an important and complex ore-forming system. In fact, any locality with the mineralogical potential for producing such quantities of aesthetic and scientifically intriguing species and associations cannot help but arouse the intense interest of the true collector. The current study has been a continually entertaining and ultimately gratifying project, and it is hoped that other collectors will be able to enjoy similar rewards in their mineralogical pursuits.

Figure 2. **Cerium analog of agardite in groups, average diameter 0.8 mm, on quartz and goethite from the Tin stope, at coordinates 1965N, 515W, 15 feet above the level. M. Jensen specimen; J. Marty photo.**

MINERALS PREVIOUSLY UNREPORTED

Agardite, Cerium analog of $(Ce,Ca)Cu_6(AsO_4)_3(OH)_6 \cdot 3H_2O$

The cerium analog of agardite, as yet incompletely characterized, occurs sparingly in the Tin stope, at two locations: (1) at coordinates 1965N, 515W, 15 feet above the level, and (2) at coordinates 1980N, 530W, 25 feet above the level. As with mixite (which also occurs in the same locations), the cerium analog of agardite forms excellent sprays to 2 mm of radiating, delicate needles. The color is diagnostic (typically an odd, pale olive-green), as is the paragenesis, in which it was formed very early, being locally even included within quartz crytsals. It ranges in composition from a pure cerium/calcium member to a variety containing substantial aluminum and bismuth. Care should be used in cleaning because, unlike mixite, agardite fibers will clump if immersed in water.

Figure 3. **Radiating spray 1 mm across of agardite-(Y) crystals from coordinates 1695N, 370W, about 35 feet above the level, Copper stope. J. Marty specimen and photo.**

Agardite-(Y) $(Y,Ca)Cu_6(AsO_4)_3(OH)_6 \cdot 3H_2O$

Specimens of agardite-(Y) collected from a new occurrence on the rib of the Copper stope at coordinates 1695N, 370W, about 35 feet above the level, are very impressive when viewed under the optical microscope. The most pleasing samples consist of green drusy agardite-(Y) needles associated with, and locally resting upon, radiating clusters of prismatic, apple-green arthurite crystals. Spheres of pale green, terminated strashimirite needles may also be associated, as well as ubiquitous brown-black patches of tenorite mixed with manganese oxides. Agardite-(Y) is rare at the locality, although selected surfaces to 1 cm^2 totally covered with drusy coatings have been collected.

Atacamite $Cu_2Cl(OH)_3$

The largest exposure of atacamite is on the back of the drift by the "K" raise in the middle adit level below the Copper stope, although the species has also been observed elsewhere in the mine. It has formed subsequent to mining, most commonly on surfaces of heavily altered, bleached white, sericitized rhyolite and fault gouge. Atacamite is typically present as thin, pale green veneers that completely cover areas over 1 meter square in size. Crystals are very minute and are intimately associated with gypsum, both species being resolved only with the aid of the SEM.

Bismuth Bi

Native bismuth occurs quite commonly as isolated grains to 50 microns within felsite samples from deep drill holes. It is most prev-

Figure 4. **Connellite, 0.1 mm in diameter, on chrysocolla on arsenopyrite, from the Copper stope, coordinates 1740N, 415W, about 10 feet above the level. M. Jensen specimen; J. Marty photo.**

Figure 5. **Lavendulan, 1.0 mm across, on chrysocolla, from the Copper stope, at coordinates 1740N, 415W, about 10 feet above the level. M. Jensen specimen; J. Marty photo.**

alent in areas containing grains of molybdenite, chalcopyrite, and bismuthinite, and is verifiable with either the ore microscope or the SEM.

Bismuthinite Bi_2S_3

Bismuthinite is common within most samples of chalcocite from the Copper stope, but is present as extremely minute grains no larger than 10 microns. It occurs primarily as small inclusions within arsenopyrite grains, and is detectable only with the aid of the SEM. Larger examples, exhibiting cleaved, elongated grains to 0.15 mm, occur quite commonly in selected samples of drill core from deep holes in the felsite. Associated minerals include native bismuth, molybdenite, chalcopyrite and rhabdophane-(Ce).

Calcite $CaCO_3$

Calcite is present at Majuba along the ribs of the lower adit at a point 260 meters in from the portal. Individual crystals range up to 3 mm and occur as brilliant, glass-clear, simple rhombohedrons scattered on joint surfaces of the Triassic argillite.

Conichalcite $CaCu(AsO_4)(OH)$

Conichalcite at Majuba occurs as typical, apple-green, botryoidal coatings on massive white quartz from prospect pits on the north side of the dirt road which leads from the lower adit up to the middle adit. Associated minerals may include cuprite, azurite, malachite, goethite, muscovite and chrysocolla.

Connellite $Cu_{19}Cl_4(SO_4)(OH)_{32}\cdot 3H_2O$

Extremely attractive radiating spheres of deep blue connellite have been found within chalcocite pods from two occurrences in the middle adit: (1) at coordinates 1740N, 415W, about 10 feet above the level, and (2) in a pillar remnant at coordinates 1700N, 380W. The species is scarce, perhaps two dozen specimens having been recovered, and occurs in association with chrysocolla, brochantite crystals, pharmacosiderite cubes, minute balls of pale green malachite, and rare posnjakite crystals. Individual sprays of connellite may range up to 0.2 mm in diameter and are composed of lustrous, spear-shaped needles. Although the species has been found before in Nevada, this discovery represents the first documented occurrence.

Cubanite $CuFe_2S_3$

Cubanite occurs rarely, as small blebs to 20 microns, in intimate association with early chalcopyrite, both of which are enclosed within arsenopyrite grains. About 25% of samples of chalcocite from the Copper stope observed under the ore microscope exhibit this phase.

Devilline $CaCu_4(SO_4)(OH)_6\cdot 3H_2O$

Flat-lying, radiating aggregates 0.2 mm across of transparent, pale blue devilline crystals occur rarely on selected specimens of luetheite from the Copper stope. Considering the relative abundance of late-stage gypsum and other hydrated copper sulfates at the mine, it is surprising that devilline is not more common.

Iodargyrite AgI

Hexagonal tabular crystals of pure iodargyrite (no bromine or chlorine) up to 80 microns have been found sprinkled on clinoclase crystals and cornwallite from the Tin stope (at coordinates 1980N, 530W, 25 feet above the level). The iodargyrite crystals are lustrous and pale yellow in color, and tend to cluster along the {100} faces (the thin prism faces) of the clinoclase in an almost epitaxial manner. The specimens were produced from a narrow zone of small vugs and clearly represent a rather unusual paragenesis.

Langite $Cu_4(SO_4)(OH)_6\cdot 2H_2O$

Langite is found in the Copper stope, associated with cuprite and parnauite, in a zone located at coordinates 1760N, 370W, about 55 feet above the level. Common vugs to 3 cm are distributed irregularly

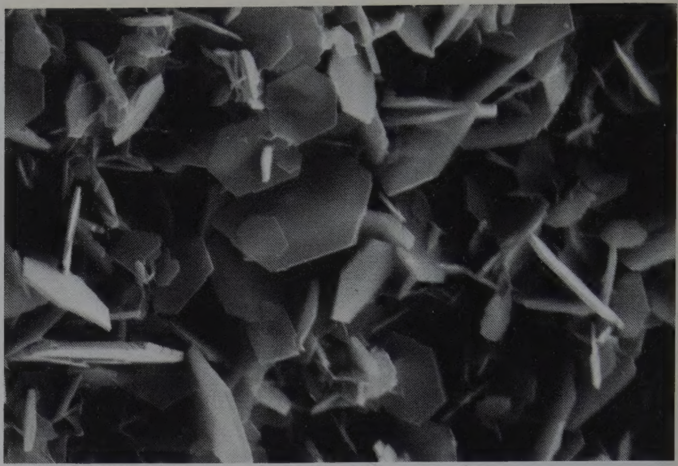

***Figure 6.* Turquoise-blue, pseudohexagonal twinned langite crystals to 9 microns, from the Copper stope. M. Jensen specimen and photo.**

throughout altered rhyolite and may locally be lined with thin, light blue to turquoise-blue, botryoidal coatings of langite encrusting red cuprite needles. Selected examples, when examined with the SEM, show ideal, pseudohexagonal, twinned crystals (to 10 microns) typical of the species. Undoubtedly the mineral has been mistaken in the past for chrysocolla, which it closely resembles.

Lavendulan $NaCaCu_5(AsO_4)_4Cl\cdot 5H_2O$

Lavendulan from Majuba has been offered by dealer Bruce Runner (*Mineralogical Record,* 1985, p. 100); he reportedly collected it from a boulder found on the dump of the middle adit. In addition to this occurrence, lavendulan has been collected *in situ* near the bottom of the Copper stope at coordinates 1740N, 415W, about 10 feet above the level. It is very rare and occurs as beautiful blue spheres to 1 mm and as massive vug fillings to 2 mm of somewhat flaky cleavages associated with minor chrysocolla and chalcophyllite. (This find may represent the first documented occurrence of the species from Nevada.)

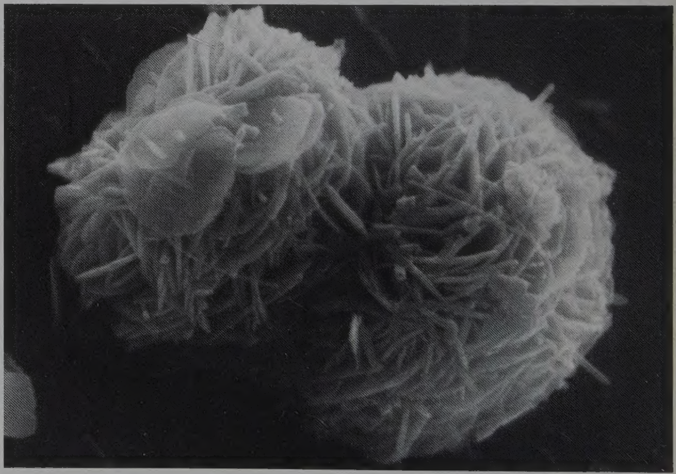

***Figure 7.* Tan spherical aggregates 10 microns across of tabular luetheite crystals from the Copper stope. M. Jensen specimen and photo.**

Luetheite $Cu_2Al_2(AsO_4)_2(OH)_4\cdot H_2O$

Unusual tan coatings on joint surfaces discovered at the foot of the large pillar in the Copper stope have been identified as an iron-bearing and light rare-earth-element-bearing luetheite (the aluminum analog of chenevixite). The identity has been confirmed by SEM with EDS, and by XRD (W. S. Wise, Santa Barbara, California), and may mark the second world occurrence of this species. The coatings, comprised of druses of spherical groups of thin-bladed crystals, are earlier than the associated crystals of pharmacosiderite, arthurite, scorodite, chenevixite and zeunerite which occur sprinkled on the luetheite.

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

Crude crystals of magnetite to 20 microns have been noted in small vugs of porphyritic rhyolite samples from the Majuba Fault Zone exposed 460 meters back in the lower adit. Better examples of the species occur as inclusions in transparent quartz crystals from the Tin stope, middle adit (at coordinates 1965N, 515W, 15 feet above the level).

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

Montmorillonite is present in the same vicinity and environment as calcite in the lower adit, and occurs as bright pink to white powdery coatings and joint fillings to 1 cm in thickness.

Posnjakite $Cu_4(SO_4)(OH)_6 \cdot H_2O$

In addition to brochantite, chalcanthite and langite, another hydrated copper sulfate, posnjakite, also occurs at Majuba. Crystals of posnjakite from the Copper stope, confirmed by SEM and XRD methods, are the first reported examples of this mineral from Nevada. The finest specimens have been produced from vuggy chalcocite pods collected at coordinates 1740N, 415W, about 10 feet above the level. Here, posnjakite occurs as lovely deep blue, transparent, lustrous, platy to elongated crystals to 0.1 mm, either resting upon pharmacosiderite crystals, or as an associated mineral on specimens with connellite crystals.

Pyrolusite MnO_2

Pyrolusite is present at Majuba as typical black dendrites to 1 cm on joint surfaces of gray Triassic argillite exposed along the ribs of both the middle and lower adits.

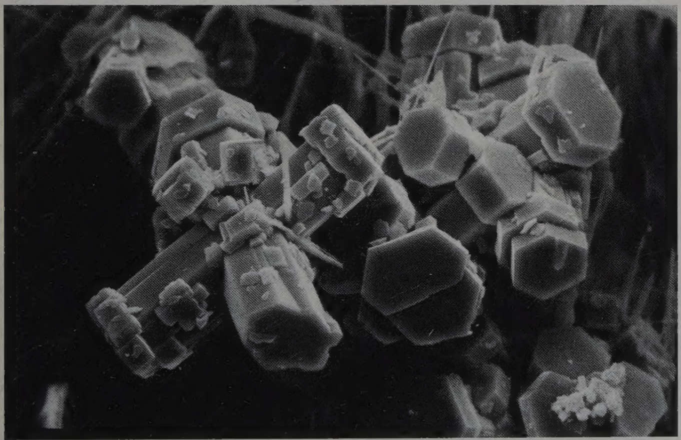

Figure 8. **Cluster of rhabdophane-(Ce) crystals associated with schorl needles, from crosscut 216, middle adit; width of view is 90 microns. M. Jensen specimen and photo.**

Rhabdophane-(Ce) $(Ce,La)(PO_4) \cdot H_2O$

An interesting occurrence at Majuba, and for Nevada, is the euhedral rhabdophane-(Ce) crystals in vugs from two locations: (1) the Majuba fault zone exposed in the lower adit, and (2) the rib of crosscut 216 in the middle adit. Although small and best observed with the aid of the SEM, rhabdophane-(Ce) crystals occur quite commonly. Attaining sizes of up to 30 microns, specimens from the middle adit location are superior, especially when found in combination with the abundant anatase crystals which also occur there.

Sphalerite ZnS

Grains to 18 microns of zinc sulfide (with minor iron) had been noted rarely in porphyritic rhyolite samples from the Tin stope. But these were considered anomalous until actual, verifiable grains were found, some quite commonly, within chalcocite pods from the Copper stope. Sphalerite occurs as cores to 150 microns (0.15 mm) surrounded by chalcocite rims to 20 microns, and as very attractive stellate exsolution features in late-generation chalcopyrite. Widely distributed, it contains about 20% Fe and minor Cd, and is present in the majority of polished sections examined.

Stannite Cu_2FeSnS_4

Stannite has been identified in selected samples of chalcocite pods from the Copper stope. It is present as grains to 100 microns commonly rimmed by later chalcocite. Determinations were made by SEM with EDS and confirmed by reflected-light characteristics under the ore microscope.

Tenorite CuO

Selected fracture surfaces exposed throughout the upper portions of the Copper stope may exhibit sooty black patches and coatings of tenorite mixed with varying percentages of unidentified manganese oxides and local concentrations of cobalt (unidentified phase). The species occurs strictly on joint and fracture surfaces, and may be locally abundant.

Thenardite Na_2SO_4

The "epsomite" previously reported as a post-mining efflorescence (Jensen, 1985) is instead thenardite. The identity has been ascertained both by SEM with EDS and by X-ray diffraction on material from coordinates 1920N, 210W in the northeast workings of the middle adit level. This is an unexpected and unusual occurrence, the species occurring as an efflorescence on mine openings, and it is doubtful if this occurrence has ever before been documented. As for epsomite, none has been confirmed, nor has any other Mg-bearing efflorescent mineral anywhere else in the mine.

Xenotime YPO_4

Xenotime, as with zircon and rhabdophane-(Ce), is a minor accessory mineral within the intrusive rhyolite. Its occurrence is widespread and it has been noted in all rhyolite samples thus far examined. It forms euhedral, tetragonal, flattened crystals in vugs, the largest crystal yet seen being 60 microns. As a constituent of the host rock, it is interesting, and one is tempted to speculate that it was this phase which provided the Y found in agardite-(Y) and goudeyite.

Zircon $ZrSiO_4$

Zircon is also a common accessory mineral in the intrusive rhyolite exposed throughout the Majuba Hill mine workings. It has been noted in samples from both the lower and middle adits, where it typically occurs as well-formed tetragonal crystals to 50 microns. Individual crystals occur in small vugs and may locally appear to be metamict.

MINERALS PREVIOUSLY REPORTED—NEW DATA

Anatase TiO_2

Anatase was originally reported by Wise (personal communication) as being distributed throughout altered rhyolite (Jensen, 1985). The mineral is widespread, but is difficult to find without knowing what to look for and where. Perhaps the most abundant and finest crystals are found along the rib of crosscut 216 (at coordinates 1855N, 470W) in a zone of intensely altered rhyolite. Forming replacements after feldspar phenocrysts, extremely unusual vugs, often containing spherical radiating sprays of schorl needles with hollow centers lined with quartz crystals, give the bleached white rhyolite a speckled appearance. Anatase occurs in about 10% of the vugs, either as singles to 0.1 mm, or as clustered groups to 1 mm of lustrous, black, equant crystals. Abundant, but extremely minute rhabdophane-(Ce) crystals are typically associated with the anatase.

Figure 9. **Black anatase crystals to 0.1 mm associated with a radial aggregate of schorl needles and a central core of quartz, from crosscut 216, middle adit. M. Jensen specimen and photo.**

Arsenopyrite FeAsS

Crystals of arsenopyrite have been found at coordinates 1740N, 415W, about 10 feet above the level, in the Copper stope. Individuals vary in size from 1 mm up to a maximum of about 6 mm, and commonly exhibit complex forms, none being simple prismatic crystals. They may occur either frozen within rhyolite, in which case they are very lustrous, or as crystals in pods and vugs, where they are commonly coated with a thin veneer of chenevixite and are somewhat dull. Along with rare pyrite crystals, these represent the only euhedral crystallized sulfides yet known from the deposit.

Arthurite $CuFe_2^{+3}(AsO_4,PO_4,SO_4)_2(O,OH)_2\cdot 4H_2O$

In the Tin stope, at coordinates 1965N, 515W, 15 feet above the level, arthurite occurs very sparingly as typical yellow-green spheres to 0.5 mm resting on finely crystallized scorodite. Prior to the discovery of this occurrence, the species had been known only from the Copper stope.

Brochantite $Cu_4(SO_4)(OH)_6$

In slabs that have fallen from the back of the Copper stope, no brochantite has been seen, thus casting doubt on the statement that the species occurred there in abundance (Jensen, 1985). Brochantite has been found in minor amounts, however, as extremely attractive crystals from the fault zone on the floor of the Copper stope at coordinates 1760N, 370W, about 55 feet above the level. Here, it occurs within vugs to 3 cm as lustrous and perfectly formed radiating, needle-like, deep green crystals to 1 mm. For the collector, this location has furnished the finest examples of this mineral yet encountered from the mine.

A second habit, and a much more recent growth of brochantite, typified by pale green to green, translucent to transparent microcrystalline crusts, is present throughout much of the area exposed by the lower reaches of the Copper stope. Here, the species appears to be occurring as an efflorescence. It is found encrusting fracture surfaces in the rhyolite, admixed with chalcanthite in the "chalcanthite winze," as a coating on crystallized arsenates within chalcocite pods, and even on fracture surfaces of broken chalcocite.

Brookite TiO_2

In addition to the single specimen of brookite found by Wise and reported in Jensen (1985), additional crystals have since been discovered in the Tin stope. The occurrence is at coordinates 1965N, 515W, 15 feet above the level, where the species is found very rarely, resting on colorless, euhedral quartz crystals. Single brookite crystals seen so far are dark brown to black, no larger than 0.1 mm, and might at first be mistaken for "needle tin" cassiterite, which also occurs in this zone. By painstaking examination of material from this location, the species can be found. However, brookite will remain one of the most difficult species for the collector to acquire from the locality.

Chalcanthite $CuSO_4\cdot 5H_2O$

Inside the "K" raise on the middle adit level below the Copper stope, actual crystals (not fibrous growths) of blue chalcanthite have precipitated rather abundantly on the wood and splinters. Crystals up to 8 mm have been collected in what amounts to a rather unusual occurrence for this species as natural crystals.

Chalcomenite $CuSeO_3\cdot 2H_2O$

The single known specimen of chalcomenite described by Wise (personal communication) in Jensen (1985), collected by J. L. Parnau from the dump of the middle adit, has also been examined as part of this study. The matrix consists of brecciated and silicified porphyritic rhyolite and is coated by a varying thickness of sericite muscovite and chrysocolla. The only sulfides observed consist of small grains to 0.5 mm of chalcocite. Chalcomenite occurs as deep blue glassy blebs to 5 mm, very similar in appearance to chalcanthite, distributed randomly on the surface of the specimen. Judging from the mineralogical characteristics of the sample, it is not from the Tin stope, but could have originated from any other exposures of the Majuba fault where there is mineralization. Although additional examples of this species have not yet been found, it is hoped that the above description may help others in locating it in the future.

Chalcophyllite $Cu_{18}Al_2(AsO_4)_3(SO_4)_3(OH)_{27}\cdot 33H_2O$

Exceptional chalcophyllite specimens have been discovered at two locations in the Copper stope: (1) at coordinates 1720N, 400W, about 20 feet above the level, and (2) at coordinates 1740N, 415W, about 10 feet above the level. Within pockets to 5 x 5 cm, lustrous, transparent, deep green, hexagonal, platy crystals to 7 mm have been observed. In selected instances during collecting, the crystals were found so large and thick that they appeared to be almost black. All specimens have subsequently become opaque and turquoise-blue upon exposure to the typical dry Nevada climate. It also seems odd that no one has yet described the mineral that results from this dehydration process, similar to the alteration of torbernite to metatorbernite.

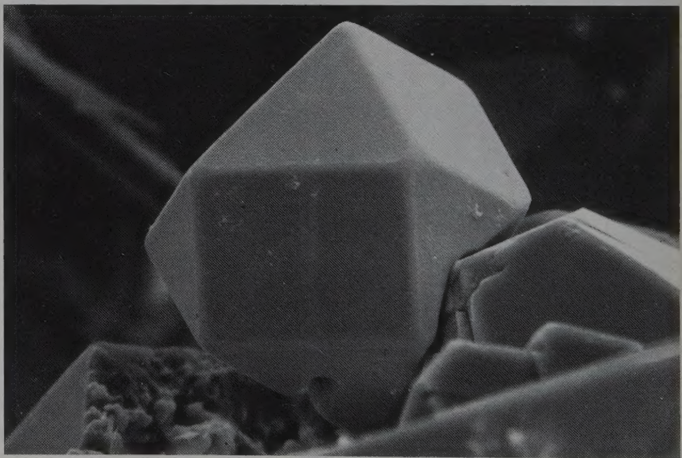

Figure 10. **Cuboctahedral chlorargyrite crystal, 40 microns across (typical habit for the locality), resting on scorodite crystals, from coordinates 1965N, 515W, 15 feet above the level, Tin stope. M. Jensen specimen and photo.**

Chlorargyrite AgCl

Chlorargyrite from Majuba had been tentatively identified on a specimen of native silver collected by R. W. Thomssen from the dump of the middle adit (Jensen, 1985). An actual, verifiable, *in-situ* occurrence for the species has now been discovered, which produces lustrous, euhedral crystals in relative abundance. In the Tin stope at coordinates 1965N, 515W, 15 feet above the level, a zone of mineralogically very interesting material is exposed. Portions of this zone consist of spongy, finely crystalline scorodite pods to 40 cm, while other areas are characterized by hydrothermally rounded cobbles of silicified rhyolite set loosely in a matrix of considerably abundant powdery black schorl. Isolated crystals of chlorargyrite occur sporadically throughout this zone, either within the porous scorodite masses, or as larger crystals on fracture surfaces of silicified rhyolite cobbles. Specimens with areas up to 3 x 3 cm liberally sprinkled with excellent crystals have been found. Crystals are typically brown-green cubes modified by the octahedron. All examples yet seen contain substantial amounts of bromine (about 2:1 chlorine to bromine). Individuals range in size from 0.05 mm up to a maximum of about 2 mm and are easily observable with a hand lens. Flat-lying olivenite crystals, which sporadically occur on joint surfaces in this area, almost always exhibit associated chlorargyrite, a feature which is attractive as well as useful in locating the species.

Chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$

There is such a wide variation in the colors of chrysocolla at Majuba that it is helpful to describe the species a bit further. Rarely, if ever, is the species present in its characteristic "robins-egg-blue" color. Instead, the more common colors include green, avocado-green, brown, white, and even colorless. The most reliable feature to aid in identification is the ubiquitous presence of numerous random cracking lines, similar to a broken auto windshield.

Clinoclase $Cu_3(AsO_4)(OH)_3$

A major discovery of clinoclase was made recently and represents probably the single most exciting development in many years at this locality. By digging down through muck in an area in the Copper stope centered at coordinates 1760N, 370W, about 55 feet above the level, a very large area was uncovered which produced considerable material, some of very fine quality. The zone consisted entirely of loose rock, as if it had been broken up and moved, but only less than a meter or two. This feature served greatly to facilitate collecting, as all material could be gathered by hand.

Clinoclase was found to occur commonly, both within vugs as well as on joint surfaces, and matrix specimens to 30 cm were obtained. All clinoclase is lustrous and occurs as deep blue-black curving crystal aggregates up to 7 mm. Rare, but exceptional, hemispherical, ball-like groups were also found, which range up to 1.1 cm in size. Olivenite, as very pale blue powdery coatings and patches, is a common associated mineral, with deep green cornwallite being rarer. With clinoclase resting upon the latter, a very pleasing and classic association resulted.

Based upon the quality of the material of this find, truly outstanding specimens must have been produced during the days of active mining, although it sadly appears that none were preserved.

Clinoclase crystals associated with strashimirite needles have also been discovered at the top of the Copper stope on the opposing rib of the small stope where excellent olivenite crystals were produced (Jensen, 1985). Neither species here attains sizes larger than 2 mm, but the association with one another, both occurring in well-formed crystals, provides attractive specimens.

Copper Cu

Although Wise (personal communication) stated native copper to be very rare and to occur only on the dump of the upper adit (Jensen, 1985), the species appears to be much more common. Material similar to that found on the dump of the upper adit is present in the Copper stope; a number of massive specimens (up to 15 cm) of cuprite were collected from this opening underground and later examined in the laboratory. By cutting flat and grinding smooth any surfaces of the most coarse-grained cuprite, abundant native copper can easily be seen; samples of the more compact and fine-grained cuprite do not seem to exhibit the copper nearly as well.

Covellite CuS

Covellite crystals have been found within muck from an ore pass at coordinates 1780N, 340W, in the middle adit. The mineral occurs as recent growths, a phenomenon that has also been observed on Comstock Lode specimens more than a century old in the Mackay School of Mines Museum collections. It is present on exposed surfaces of ore fragments as black spots to 5 mm of thin, platy, hexagonal crystals to 10 microns. This occurrence is in addition to the relatively common covellite which is present in almost all chalcocite pods from the Copper stope. By polished section examination, the indigo-blue covellite is easily seen, most specimens having at least some of the mineral as a constituent.

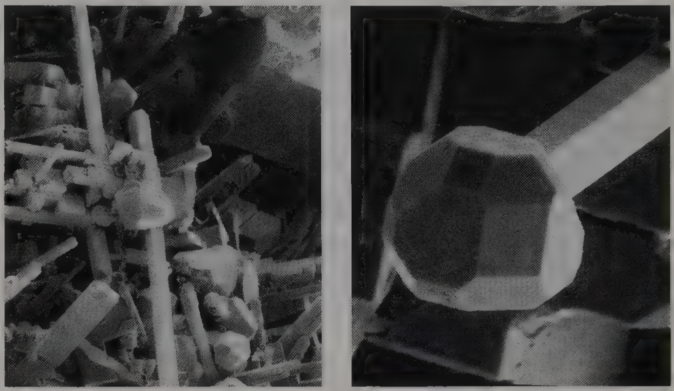

Figure 11. *(left)* Red to black cuprite crystals, two generations, from the Copper stope; width of view is 18 mm. M. Jensen specimen and photo. *(Right)* Cubic cuprite, modified by the {111} octahedron and {110} dodecahedron, about 30 microns across, on top of elongated cubic cuprite crystal, from the Copper stope. M. Jensen specimen and photo.

Cuprite Cu_2O

Very fine euhedral and lustrous cuprite crystals have been found at coordinates 1760N, 370W, about 55 feet above the level, in the Copper stope. Two different variations have been observed: (1) lustrous,

Figure 12. Mixite, 0.5 mm across, on quartz crystals from the Tin stope, coordinates 1965N, 515W, 15 feet above the level. M. Jensen specimen; J. Marty photo.

transparent, deep-red, sharp octahedrons to 3 mm, and (2) more common, highly elongated, black, spike-like crystals that form intricate networks of reticulate growths. Overall, this second type of crystallization is more visually appealing, forming truly spectacular specimens when viewed under both the optical and scanning microscopes.

Enargite Cu_3AsS_4

After an in-depth, comprehensive and exhaustive ore microscopy study, no enargite has been found from the locality. The original reference to this species (MacKenzie and Bookstrom, 1976) describes enargite as occurring in minor amounts in pods of chalcocite from the Copper stope, but the occurrence of this phase at the locality has not been verified. Thus, the species must be relegated to being reported, but unconfirmed.

Fluorite CaF_2

Euhedral crystals of fluorite have now been found at Majuba. In addition to the earlier description of anhedral grains (Jensen, 1985), there occur small but attractive crystals in the extreme northeast workings of the middle adit level (at coordinates 1920N, 210W) in a zone with considerable crystallized malachite and azurite. Here, purple, lustrous, cubic crystals to 1.5 mm are found sprinkled on black, heavily iron-stained rhyolite joint surfaces. Locally the purple cubes may be aesthetically associated with small tufts to 2 mm of bright green malachite.

Fluorite crystals have also been found sparingly in the Tin stope, at coordinates 1965N, 515W, 15 feet above the level, as slightly corroded, pale green to purple octahedrons to 1 cm resting on quartz crystals.

Gypsum $CaSO_4 \cdot 2H_2O$

In addition to its association with atacamite, gypsum occurs as white, silky efflorescent fibers and groups to 2 mm irregularly distributed on fault surfaces and gouge exposed at various locations at the bottom of the Copper stope.

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

Jarosite from Majuba was reported by Wise (personal communication) as occurring in the upper levels of the mine (Jensen, 1985). Indeed, the species occurs sparingly on the dump and in the upper adit, but superior examples can be found in the Tin stope (at coordinates 1965N, 515W, 15 feet above the level), and at the top of the raise leading to the 153 stope. Jarosite from the Tin stope is fine-grained and bright yellow in color. It formed late in the paragenetic sequence. In the raise to the 153 stope, open fractures in heavily iron-stained and altered rhyolite may be locally lined with brilliantly lustrous, transparent orange jarosite crystals to 0.2 mm. Crystal-coated rock surfaces to 10 cm across constitute the best examples of the species from Majuba Hill.

Mixite $BiCu_6(AsO_4)_3(OH)_6 \cdot 3H_2O$

Within the Tin stope, two specific occurrences for mixite have been located, although the species is difficult to recognize at first because of its small size. It is, however, locally abundant and occurs only as needle-like crystals. Two locations have been confirmed: (1) at coordinates 1980N, 530W, 25 feet above the level near the clinoclase zone, and (2) at coordinates 1965N, 515W, 15 feet above the level. The species occurs only as beautiful radiating sprays (similar in appearance to aurichalcite) up to 1 mm composed of delicate, fibrous crystals ranging in color from white through pale blue to blue-green. Chemically, it is not a pure bismuth mixite, but instead has minor substitutions of aluminum and calcium. Positive correlation between color variation and composition has not been established. Hand-size specimens (10 x 10 cm) liberally dusted with crystals have been recovered, although much smaller pieces are the rule. Associated minerals may include crystals of quartz and olivenite, powdery goethite, and rarely chlorargyrite (second locality).

Methods of cleaning, including water washing, or brief ultrasonic cleaning, do not cause the fibers to clump together and may be considered safe.

Molybdenite MoS_2

Further examination of material from Majuba Hill has clarified the occurrences of molybdenite. The best examples are seen in drill core from deeper intervals where "moly paint" is present on fracture surfaces to at least 20 cm in diameter. The species has also been verified, however, as rare grains to 0.1 mm within chalcocite from the middle adit level at coordinates 1700N, 380W.

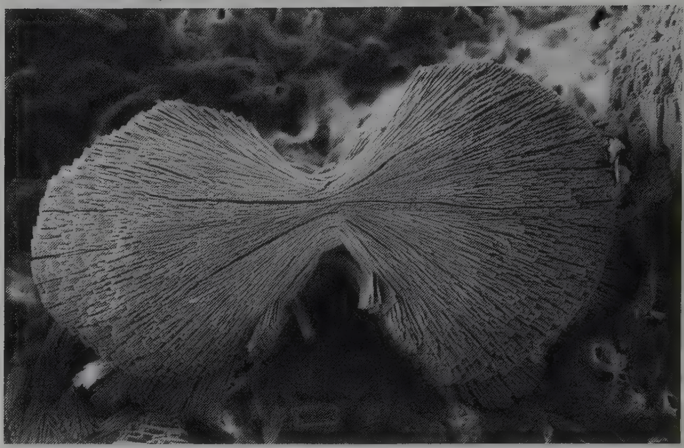

Figure 13. **Dark forest-green, bow-tie group 0.5 mm across of parnauite crystals from the Copper stope. M. Jensen specimen and photo.**

Parnauite $Cu_9(AsO_4)_2(SO_4)(OH)_{10} \cdot 7H_2O$

Exceptional parnauite specimens have been recovered from a zone of altered rhyolite in the center of the Copper stope at coordinates 1760N, 370W, about 55 feet above the level. These consist of clusters of very dark green, lustrous, spherical aggregates to 3 mm of excellent crystals. (In the original description of the species, Wise (1978) reported crystals and groups to 1 mm). Although the species is common at the locality, these large groupings are the finest examples of the species known.

As an added note, the SEM photo of parnauite shown in Figure 19 of Jensen (1985) is incorrectly labeled; it is, instead, a photo of goudeyite.

Pyrrhotite $Fe_{1-x}S$

Although previous reports have stated that pyrrhotite is relatively common at Majuba, it appears to be decidedly rare within sulfide pods (chalcocite) from the Copper stope. It may be much more common in samples from drill holes or from other areas of the mine, but there has been very little yet seen, at least in the samples from the Copper stope used in this study.

Tyrolite $CaCu_5(AsO_4)_2(CO_3)(OH)_4 \cdot 6H_2O$

Tyrolite has been verified from a zone at the base of the large monolith at coordinates 1760N, 370W, about 55 feet above the level, in the Copper stope. Its color is a distinctive blue-green. It is crystalline, micaceous, and forms spheres (in open spaces) and flattened radiating sprays (to 5 mm) on joint surfaces where it has grown across. Parnauite may be similar in appearance, but does not exhibit the porous and micaceous texture of tyrolite.

DISCUSSION

Sulfide Mineralogy of the Copper Stope

I have made a detailed examination of a wide range of "chalcocite" samples collected over a protracted period of time from various locations in the Copper stope. Standard ore microscopy (reflected light)

Table 1. **Revised list of species known from the Majuba Hill mine(s), Pershing County, Nevada.**

Agardite-(Ce)	Jarosite
Agardite-(Y)	Kaolinite
Albite	Langite
Anatase	Laumontite
Arsenopyrite	Lavendulan
Arthurite	Luetheite
Atacamite	Magnetite
Azurite	Malachite
Bismuth	Metatorbernite
Bismuthinite	Metazeunerite
Bornite	Mixite
Brochantite	Molybdenite
Brookite	Montmorillonite
Calcite	Muscovite (sericite)
Cassiterite	Olivenite
Chalcanthite	Orthoclase (adularia)
Chalcocite	Parnauite
Chalcomenite	Pharmacosiderite
Chalcophyllite	Posnjakite
Chalcopyrite	Pyrite
Chamosite	Pyrolusite
Chenevixite	Pyrrhotite
Chlorargyrite	Quartz
Chrysocolla	Rhabdophane-(Ce)
Clinoclase	Rutile
Clinozoisite	Sanidine
Conichalcite	Schorl
Connellite	Scorodite
Copper	Silver
Cornubite	Spangolite
Cornwallite	Sphalerite
Covellite	Stannite
Cubanite	Strashimirite
Cuprite	Tenorite
Cyanotrichite	Thenardite
Devilline	Titanite
Digenite	Torbernite
Fluorite	Tyrolite
Goethite	Xenotime
Goudeyite	Zeunerite
Gypsum	Zircon
Iodargyrite	

techniques, combined with SEM and EDS, were employed. During the study, a number of phases new to the locality were found, in addition to verifying those already known.

The most immediate conclusion to be made from the analyses is that, in the majority of "chalcocite" pods, it can be assumed that the following assemblage is present: arsenopyrite, chalcocite, digenite, covellite, chalcopyrite and pyrite. If specimens greater than 1 cm in size are available, they almost certainly will have these constituents. Minerals present in significantly lesser amounts—sphalerite, stannite, bismuthinite and cubanite—would need to be verified analytically in any particular sample.

A rarer sulfide/sulfosalt phase, noted in two different sections, has not yet been fully characterized due to its small size. Grains are gray-white in reflected light, range up to 60 microns, are early (being totally enclosed within arsenopyrite), and are chemically a copper bismuth sulfide with lesser iron, arsenic, silver and selenium. The latter element is of interest as it provides a possible source for the very rare secondary mineral chalcomenite. In addition, other uncharacterized sulfides occur rarely and are either potential new minerals or extremely rare species. It may be that the sulfide/sulfosalt mineralogy of Majuba will prove to be almost as complex and varied as the secondary assemblage.

Sulfide Mineralogy of the Tin Stope

The only sulfides yet found in the Tin stope are those preserved as small grains and inclusions in quartz. Panning loose material from breccia zones to yield concentrates for SEM examination discloses only olivenite, chlorargyrite and cassiterite, and a total lack of any sulfides whatsoever. Oxidation in this area may have been particularly intense, possibly obliterating all of the paleo-exposed sulfide minerals. In fact, the only sulfides seen to date in the Tin stope have come from one small area at coordinates 1965N, 515W, 15 feet above the level. These occur as disseminated grains to 1 mm distributed throughout quartz and include the following species: arsenopyrite, chalcopyrite, sphalerite and pyrite. Surely, other phases must be present as well, but these will require significantly more analytical time to discover.

Mineralogy of the Country Rocks

Petrographic thin section examination by Stevens (1971) of the various rocks exposed throughout the mine workings at Majuba has fully characterized their mineralogy. These species are here included simply for the sake of completeness, and almost any sample of the specific rock types is likely to contain all of the respective minerals. Within the Triassic argillite, the following constituents are present: quartz (to 40%), chamosite, sericitic muscovite, heavy minerals less than 1% (rutile, titanite and schorl), carbonate to 5% (calcite), and clay minerals. The rhyolite exposed throughout most of the mine workings (older rhyolite of Stevens, 1971) consists of the following: quartz (10 to 15%), sericitic muscovite, sanidine (0.5 to 1-mm grains), albite (0.5 to 1-mm grains), schorl and clay minerals.

At local exposures of the Triassic argillite along the ribs of the lower adit, small, thermally metamorphosed pods to 10 cm have been noted. These possess assemblages characteristic of contact environments; they consist of granular chamosite, fibrous laumontite, rare clinozoisite crystals, quartz and clays.

Revised List of Unconfirmed Minerals

In addition to the species listed as unconfirmed earlier (Jensen, 1985), several other minerals have been mentioned by others, but have either not been detectable as part of the current study or are unavailable for examination and verification. These include the following: halloysite (Bruce Runner advertisement, *Mineralogical Record,* 1985, p. 100), hematite replacing arsenopyrite in the Tin stope (Stevens, 1971), and enargite as a minor constituent of chalcocite pods from the Copper stope (MacKenzie and Bookstrom, 1976). The three species listed as unconfirmed earlier (Jensen, 1985), cornetite, libethenite and rosasite, remain so.

Rumors, and that is all that they can be called, of grandiose crystals and specimens of various species from the locality continue to be spread. Stories describing balls to 2.5 cm of clinoclase from the Copper stope, and pharmacosiderite cubes to the same size, are totally unfounded and utterly incorrect. The sizes for all species reported in the original article on the locality, as well as this update, should be considered accurate and realistic. These are the dimensions best used for future reference.

ACKNOWLEDGMENTS

Assistance from a number of individuals has been given and is greatly appreciated. First and foremost, Dr. Eugene E. Foord is thanked for all his efforts in studying, testing and describing the various minerals he has examined. Dr. Bill Wise provided XRD data and confirmation of luetheite. Sharon Cisneros, Juanita Curtis and Dave Lehecka all generously provided specific expertise and exemplary specimens for examination. In addition to editorial and collecting assistance, Madson Doggrell provided numerous and highly varied contributions. Craig Gibson aided with ore microscopy examination of many polished sections. Melissa Forson typed the manuscript.

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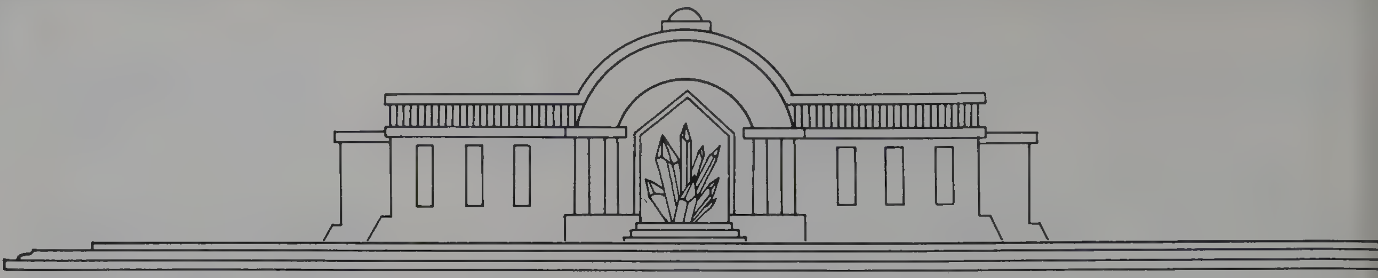

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Minerals of the Sawtooth Batholith, Idaho

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The Sawtooth batholith in south-central Idaho is relatively inaccessible and not well known to collectors. However, in recent years it has produced a steady stream of excellent specimens from miarolitic cavities and pegmatite dikes in granite.

INTRODUCTION

The Sawtooth Batholith is in the Sawtooth Wilderness, part of the Sawtooth National Recreation Area, in south-central Idaho. Much of the batholith offers good collecting, which generally requires a several-day backpacking trip. Collecting is mostly on steep talus slopes and on accessible slabs and cliff faces, and requires significant and sometimes difficult off-trail travel.

Elevations range from 2,300 to 2,900 meters; snow cover restricts access to the higher areas to the two-month period between mid-July and mid-September. During this time the weather is generally good, with clear skies and warm daytime temperatures, but afternoon or evening thunderstorms can be frequent, particularly after mid-August. Access is possible only by foot or horseback from three main directions. Most collectors have used one of several trailheads on the east side, along Highway 75 south of Stanley. Trails also run from Grandjean on the west up the South Fork of the Payette River, and on the south side from the Atlanta area up either the Middle Fork of the Boise River or the Queens River.

Since the creation of the Sawtooth National Recreation Area in 1972, restrictions have been placed on collecting. The combination of difficult access, rugged terrain and short collecting season also restricts activity, but increasing numbers of determined collectors have been visiting the area since the mid 1970's. This article is based on the collecting experiences of the authors during the period 1977–1990, with information from other northwest collectors who have spent time in the area.

GEOLOGY

The Sawtooth Batholith is one of over 40 anorogenic Tertiary granite plutons in Idaho (Bennett and Knowles, 1985). Many of these plutons are K-Ar dated at 38–50 million years old, making them part of the Challis volcanic-plutonic episode (Armstrong, 1978; Bennett and Knowles, 1985). They are associated with volcanic caldera complexes, and often intrude genetically related volcanic rocks. Anorogenic igneous activity occurs in areas of incipient continental rifting, such as the East Africa rift zone. Other anorogenic plutons include the Pikes Peak Batholith, Colorado (Muntyan and Muntyan, 1985; Foord and Martin, 1979), the Golden Horn Batholith, Washington (Boggs, 1984), the Lake Gjerdingen Granite, Oslo region, Norway (Raade, 1972; Raade and Haug, 1980), and possibly the Baveno granite, Italy (Albertini, 1983). Many well-known nepheline syenite deposits such as Mont Saint-Hilaire, Quebec (Horváth and Gault, 1990) are also related to anorogenic igneous activity.

The Sawtooth Batholith is one of the largest of Idaho's anorogenic plutons; it intrudes older Cretaceous granitic rocks of the Idaho Batholith and pre-Cretaceous sedimentary and metamorphic rocks. Tschanz *et al.* (1974) provide estimated ages of 44 and 88 million years for the Sawtooth Batholith and the part of the Idaho Batholith it intrudes. This dates the intrusion toward the end of the Challis episode.

Following uplift, the Sawtooth Batholith became exposed along several steeply-dipping faults. The most prominent is the Sawtooth Fault that forms the steep east face of the range bordering the upper Salmon River Valley. These faults and a vertical joint system, com-

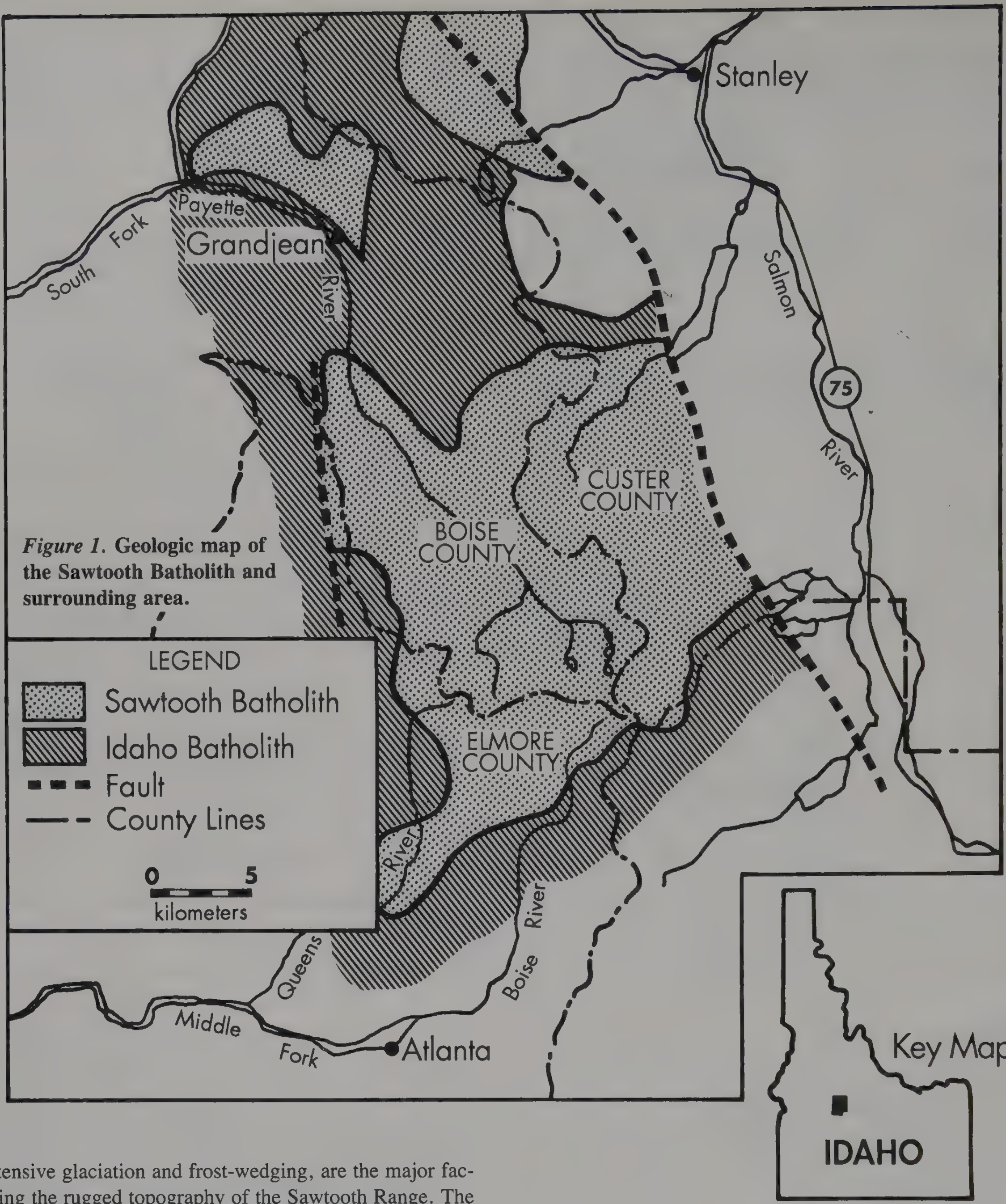

Figure 1. **Geologic map of the Sawtooth Batholith and surrounding area.**

bined with extensive glaciation and frost-wedging, are the major factors in producing the rugged topography of the Sawtooth Range. The area is sculpted into a combination of high, jagged peaks and talus slopes with many lakes in intervening glacial valleys and cirques. This combination of high elevation, vertical jointing and extensive glaciation has also produced abundant exposures of fresh rock, both in-place and as talus. Other Idaho Tertiary plutons host crystal-bearing cavities (Bennett, 1980). However, the Sawtooth Batholith appears unique from a collector standpoint in both the areal extent and the potential productivity of the collecting terrain (L. R. Ream, personal communication, 1990).

No economic mineralization has been found within the Sawtooth Batholith, and no significant mining has taken place, although several gold mines are near the boundaries in adjacent rocks of the Idaho Batholith. These deposits probably derive from a hydrothermal circulation system driven by the heat of the Sawtooth Batholith (Taylor, 1977; Bennett, 1980).

The batholith was surveyed for its beryllium potential in the 1960's (Reid, 1963; Pattee *et al.*, 1968). Some claims have been staked and, at least in one case, worked many years ago for aquamarine. A subsequent extensive geochemical sampling program (Kiilsgaard *et al.*, 1970) showed elevated trace concentrations of the so-called "tin suite" elements that are common to many mineralized granites. These elements include tin, molybdenum, niobium and uranium and tend to be more concentrated, along with beryllium, in the central region of the batholith. Rare earth concentrations also occur in alluvium. In addition, molybdenum and manganese are enriched in several prominent, iron-stained, hydrothermally altered zones. Bennett and Knowles (1985) also note the high fluorine and iron content of the granite. Many of the above elements are evident to varying degrees in the specimen mineralogy, which is rich in iron, manganese, beryllium and fluorine species.

Reid (1963) identified seven groups of non-pegmatitic, tertiary dikes. Of these, diabase is the youngest, the most evident and to date the only group of mineralogical interest.

Mineral Occurrences

The minerals of interest to collectors occur, in decreasing order of importance, in miarolitic cavities, small pegmatite dikes and pegmatitic segregations. The host rock throughout is a medium-grained, pinkish gray to pale gray, leucocratic granite.

Table 1. **Minerals of the Sawtooth Batholith.**

Species	*Formula*	*Pocket Type*[1]	*Occurrence*
SULFIDES			
Molybdenite	MoS_2	altered zones	rare?
Pyrite	FeS_2	2, 3, 5	uncommon
OXIDES			
Anatase	TiO_2	3, 5	very rare
Cassiterite	SnO_2	3, 4	very rare
Columbite-Tantalite	$(Fe^{2+},Mn^{2+})(Nb,Ta)_2O_6$	4	rare
Goethite	$Fe^{3+}O(OH)$	2, 3, 4, 5	common
Hematite	Fe_2O_3	3, 4, 5	uncommon
Magnetite	$Fe^{2+}Fe_2^{3+}O_4$	2, 3	very rare
Pyrophanite	$Mn^{2+}TiO_3$	5	very rare
Rutile	TiO_2	2	very rare
Wodginite	$(Ta,Nb,Sn,Mn,Fe)_{16}O_{32}$	4	very rare
HALIDES			
Fluorite	CaF_2	1, 2, 3, 4, 5	uncommon
CARBONATES			
Bastnäsite-(Ce)	$(Ce,La)(CO_3)F$	3	very rare
Calcite	$CaCO_3$	2	very rare
Siderite	$Fe^{2+}CO_3$	3, 4, 5	rare
SULFATES			
Gypsum	$CaSO_4\cdot 2H_2O$	2	very rare
PHOSPHATES			
Fluorapatite	$Ca_5(PO_4)_3(F,OH)$	3, 5	very rare
Monazite-(Ce)	$(Ce,La,Nd,Th)PO_4$	3	very rare
MOLYBDATES			
Ferrimolybdite	$Fe_2^{3+}(Mo^{6+}O_4)_3\cdot 8H_2O$?	altered zones	rare?
SILICATES			
Albite	$NaAlSi_3O_8$	essentially all	very common
Bertrandite	$Be_4Si_2O_7(OH)_2$	3, 5	uncommon
Beryl	$Be_3Al_2Si_6O_{18}$	1, 3, 4?, 5	uncommon
Biotite	$K(Mg,Fe^{2+})_3(Al,Fe^{3+})Si_3O_{10}(OH,F)_2$	rock-forming, 3	common
Carpholite	$Mn_2^{2+}Al_4Si_4O_{12}(OH)_8$	3	very rare
Fayalite	$Fe_2^{2+}SiO_4$	massive pegmatites	common
Helvite	$Mn_4^{2+}Be_3(SiO_4)_3S$	4, 7	uncommon
Laumontite	$CaAl_2Si_4O_{12}\cdot 4H_2O$	3	rare
Masutomilite	$K(Li,Al,Mn^{2+})_3(Si,Al)_4O_{10}(F,OH)_2$	4, ?	?
Microcline	$KAlSi_3O_8$	essentially all	very common
Muscovite	$KAl_2(Si_3Al)O_{10}(OH,F)_2$	4, ?	uncommon?
Opal	$SiO_2\cdot nH_2O$	2, ?	uncommon
Orthoclase	$KAlSi_3O_8$	rock-forming, 3	very common
Phenakite	Be_2SiO_4	4, 5	very rare
Quartz	SiO_2	essentially all	very common
Spessartine	$Mn_3^{2+}Al_2(SiO_4)_3$	4, 5, 6	uncommon
Stilbite	$NaCa_2Al_5Si_{13}O_{36}\cdot 14H_2O$	3, 5	rare
Topaz	$Al_2SiO_4(F,OH)_2$	3, 4, 7	common
Uranophane	$Ca(UO_2)_2[(SiO_3)(OH)]_2\cdot 5H_2O$	3	very rare
Zinnwaldite	$K(Li,Al,Fe^{2+})_3(Si,Al)_4O_{10}(F,OH)_2$	2, 3, 4, 5, 6, 7	common
Zircon	$ZrSiO_4$	3, 4, 5	rare

[1]KEY TO POCKET TYPES

1	Smoky Quartz	common
2	Feldspar	uncommon
3	Smoky Quartz-Feldspar	most common
4	Topaz	locally common
5	Aquamarine	uncommon
6	Spessartine-Quartz	uncommon
7	Helvite	rare

	Quartz	Albite	Microcline	Orthoclase	Biotite	Muscovite	Zinnwaldite	Masutomilite	Spessartine	Carpholite	Potassium Carpholite	Helvite	Beryl	Bertrandite	Phenakite	Topaz	Fluorite	Fluorapatite	Pyrophanite	Rutile	Anatase	Hematite	Magnetite	Goethite	Pyrite	Siderite	Fayalite	Cassiterite	Columbite-tantalite	Wodginite	Monazite-(Ce)	Bastnäsite-(Ce)	Molybdenite	Ferrimolybdite	Zircon	Uranophane	Laumontite	Stilbite	Calcite	Gypsum	Opal
Quartz																																									
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Masutomilite	■	■	■				■																																		
Spessartine	■	■	■				■	■																																	
Carpholite	■	■	■				■																																		
Potassium Carpholite	■	■	■				■																																		
Helvite	■	■	■				■																																		
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Phenakite	■	■	■										■																												
Topaz	■	■	■			■	■	■	■		■	■	?		■																										
Fluorite	■	■	■				■	■	■				■			■																									
Fluorapatite	■												■																												
Pyrophanite	■	■					■						■	■																											
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Anatase	■	■	■				■		■								?																								
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Zircon	■	■	■		■		■						■			■													■			■									
Uranophane	■	?	■																																						
Laumontite	■	■	■																																						
Stilbite	■	■	■										■					■																							
Calcite		■	■				■																																		
Gypsum		■	■																																						
Opal		■	■				■																																■		

Table 2. **Mineral associations in the Sawtooth Batholith.**

Note that: (1) The table is arranged to emphasize the number of minerals containing Mn (8), F (8), and Fe (11). The shading highlights the principal members of these groups. There are also four Be minerals. Collectively these account for close to 60% of the current total of 41 species. (2) Associations are generally shown only for the best-crystallized forms of minerals. In a few cases these are coatings (calcite, gypsum, opal) or replacements (goethite). All of the rock-forming minerals also occur as crystals in at least one pocket. In particular, orthoclase may have wider associations than shown. (3) Associations shown for masutomilite correspond to the single topaz pocket from which it was confirmed. It probably has many of the same associations as for zinnwaldite. (4) "Potassium Carpholite" is the proposed new carpholite-group mineral with essential K and Li.

All pockets are found open, and most if not all originally appear to have contained well-crystallized minerals. The majority have long since been emptied by glaciation or weathering, and others contain only fractured remnants of the original crystal contents. Faded smoky quartz crystals adhering all too solidly to the pocket walls are common. Thus it is a rare pocket that produces intact, good-quality, collectable specimens. Typically such pockets are found collapsed, with contents including single crystals, groups and plates consolidated to varying degrees with pocket debris in dirt or mud.

Evidence for zoning of pocket minerals is generally lacking due to pocket collapse, but there are a few cases where crystals remain attached to the walls. In these pockets, larger crystals of quartz and microcline (and possibly aquamarine and topaz) appear to have been on the roofs, with plates consisting of smaller crystals of quartz, microcline and albite (with occasional spessartine, topaz and aquamarine) on the floors. Many pockets show signs of continuing crystal growth or regrowth, usually by quartz, after pocket collapse.

The description of some of the larger, more interesting pockets later in this article will provide more detail on occurrences.

Miarolitic Cavities

Miarolitic cavities produce most of the good specimens. Cavities range in size from microscopic to (rarely) more than a meter in all dimensions. One example was over 20 meters high, but unfortunately was found to be devoid of any crystallization. Most collectable cavities or pockets are in the 10 to 50 cm range, and tend to be lenticular or tubular. Usually they are isolated, with little or no indication of their presence in the adjacent granite, but a few have a thin rim of coarser, pegmatitic granite.

The miarolitic cavities can be further classified according to their major mineral assemblages as follows, although there is some overlap.

(1) *Smoky quartz pockets* contain mostly smoky quartz with few or no other minerals. Minor amounts of feldspars, often altered, may also be present.

(2) *Feldspar pockets* contain microcline (usually pink) and albite. Rarely mica and/or a few small quartz crystals are also present.

(3) *Smoky quartz-feldspar pockets,* which are the most common, contain smoky quartz, usually with microcline, albite, zinnwaldite

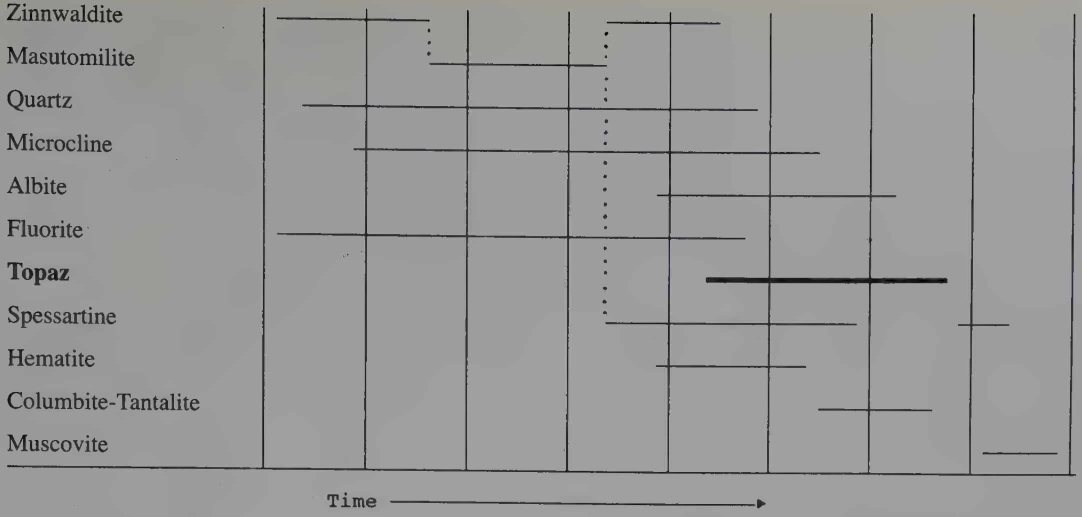


Figure 2. (above) **Generalized crystallization sequence for topaz pockets. Note the crystallization of the micas masutomilite and zinnwaldite relative to spessartine. The mica starts as zinnwaldite and with increasing fluid Mn content grades into masutomilite. When spessartine begins crystallizing it preferentially incorporates Mn, causing an abrupt change in mica composition back to zinnwaldite.**

and rarely spessartine or fluorite.

(4) *Topaz pockets* contain smoky quartz, feldspars and topaz. Mineral associations can include spessartine, zinnwaldite-masutomilite, muscovite and rarely hematite or fluorite.

(5) *Aquamarine pockets* contain smoky quartz, feldspars and aquamarine. Associated minerals can include zinnwaldite, spessartine, bertrandite, hematite and goethite after pyrite.

(6) *Spessartine pockets* contain mainly spessartine and smoky quartz.

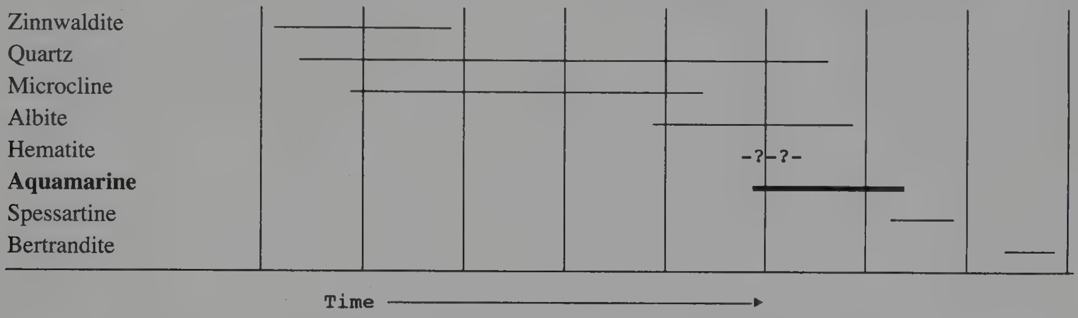


Figure 3. **Generalized crystallization sequence for aquamarine pockets.**

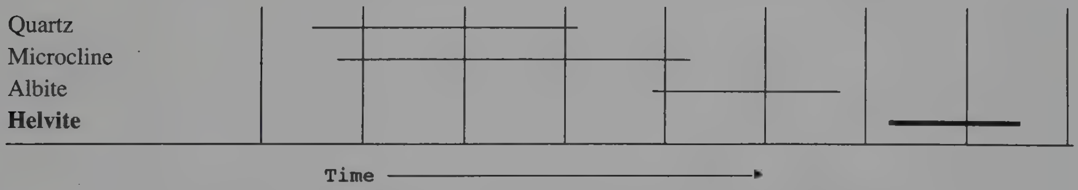


Figure 4. **Generalized crystallization sequence for helvite pockets.**

(7) *Helvite pockets* are rare; they contain smoky quartz, feldspars, zinnwaldite, helvite and rarely topaz.

The above pocket types represent the major assemblages found to date, but each pocket is unique in some respect and other assemblages certainly remain to be found. Figures 2 through 4 show the inferred crystallization sequences for the more complex pocket types (numbers 4, 5 and 7).

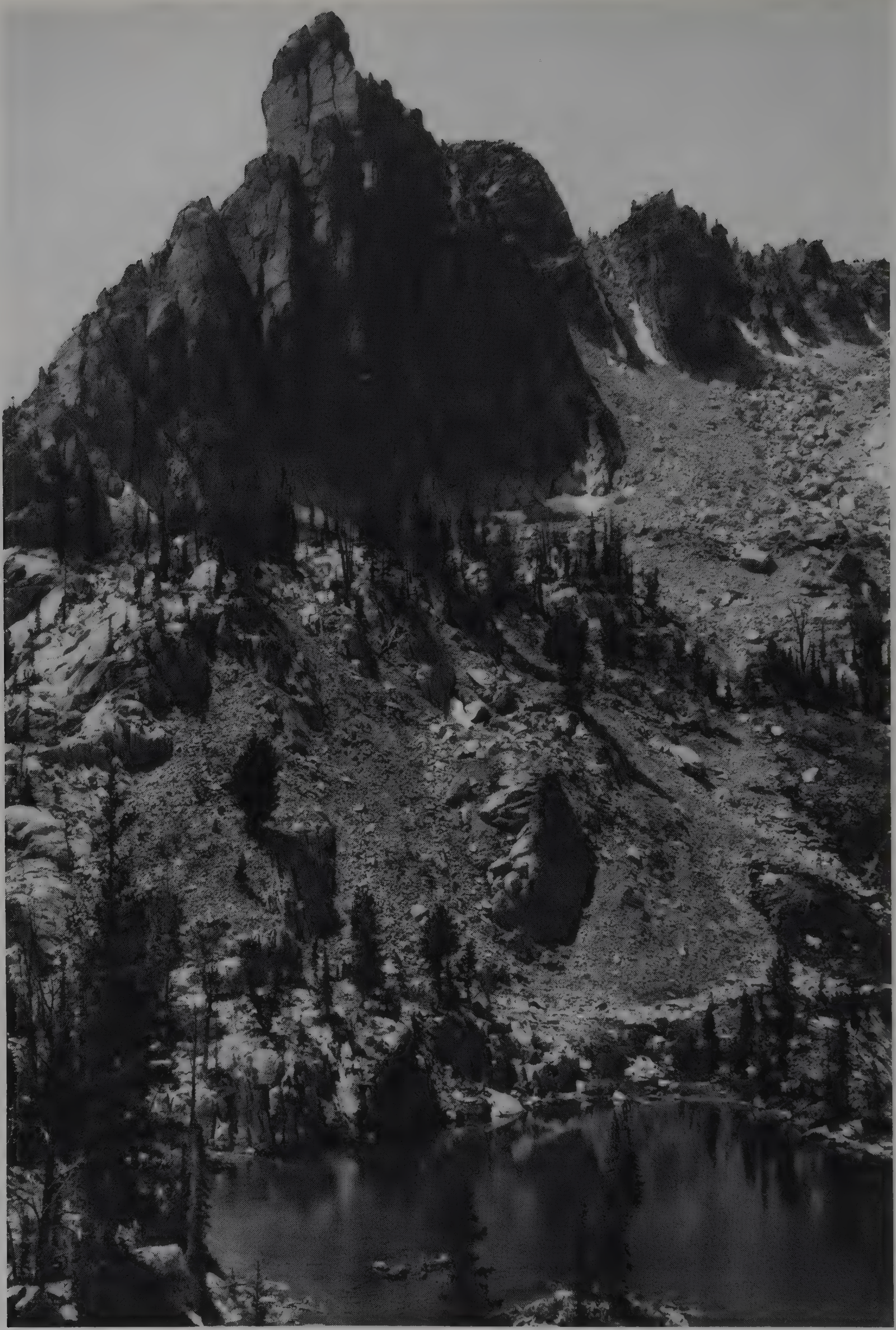
Some additional observations can also be made. Aquamarine and topaz are not generally associated, although individual pockets of each are found within a few meters of each other; the only exception to date is Ream's (1989) report of what appear to be microcrystals of aquamarine, along with helvite, both included in topaz crystals from a single pocket. Spessartine occurs with a wide range of other minerals but is most common in spessartine-quartz pockets. Many of the assemblages are manganese-rich compared with those from comparable plutons.

Pegmatite Dikes

Only one small pegmatite dike of mineralogical significance has been found. It is a complex, zoned body about 1 meter thick and 12 meters long, the core of which consists mainly of quartz (estimated at 95%) with lesser amounts of aquamarine and hematite. Near the core margins there are small pockets containing crystals of quartz, aquamarine, bertrandite and rarely spessartine and fluorite, along with minor feldspar. One small crystal fragment of purple fluorapatite and a well-formed, 2.5-cm crystal of topaz were found in dump material.

Pegmatitic Segregations

Pegmatitic segregations and thin dikes localized along joint planes are quite common in limited areas and consist of quartz, albite and pink microcline. Such segregations rarely reach up to several meters across and often contain crude crystals of fayalite. The smaller bodies often have small pockets with crystals of quartz and feldspars,



and occasional topaz. Larger segregations, which seldom have pockets, frequently contain large, milky, terminated quartz crystals up to 50 cm across frozen in feldspar.

Segregations or dikes consisting mainly of aquamarine occur in some central parts of the batholith. These range in size from small, spherical masses a few centimeters across to thin dikes up to 10 cm thick and a few meters long. The latter often cover joint surfaces and can be very striking, with blue aquamarine and sometimes red spessartine. However, they are generally devoid of pockets, with the aquamarine in tightly intergrown, small crystals rather than good, displayable specimens.

Figure 5. **Finger of Fate granite spire, Custer County, rising above an unnamed lake, showing vertical jointing, sawtoothed ridge line and large talus. Photo by MAM.**

Figure 6. Ridge between Edna Lake (foreground) and Ardeth Lake, Boise County, showing typical cliffs and ledges, plus early September snow! Photo by RCB.

Figure 7. Loose aquamarine crystal in partially excavated pocket (#21a). Photo by RCB.

MINERALS

The required mineral identifications were performed by X-ray diffraction and/or electron microprobe analysis. For the two species containing rare-earth elements essential to their crystal structures, the dominant element was determined by electron microprobe to be cerium in both cases. This is the basis for the Levinson REE suffix designation (Ce).

Albite $NaAlSi_3O_8$

Albite occurs in most pockets as sharp, white or more rarely bluish to purplish, comb-like crystal aggregates to 1.5 cm. Paragenetically it is later than but intergrown with quartz and microcline. Plates of albite often form the matrix for some of the showiest specimens. Albite commonly has a high luster and is found in better condition than microcline.

Anatase TiO_2

Anatase has been identified from two pockets as a few small clusters of 0.5-mm, steep, black, lustrous dipyramids. The first to be found was a quartz-feldspar pocket with spessartine, and the second contained aquamarine. Another feldspar pocket with fluorite contained what appear to be microcrystals of both anatase and columbite-tantalite.

Bastnäsite-(Ce) $(Ce,La)CO_3F$

One pocket contained a few poorly formed, yellowish crystals of bastnäsite-(Ce) under 1 mm in size. They are associated with quartz, microcline, columbite-tantalite and zircon.

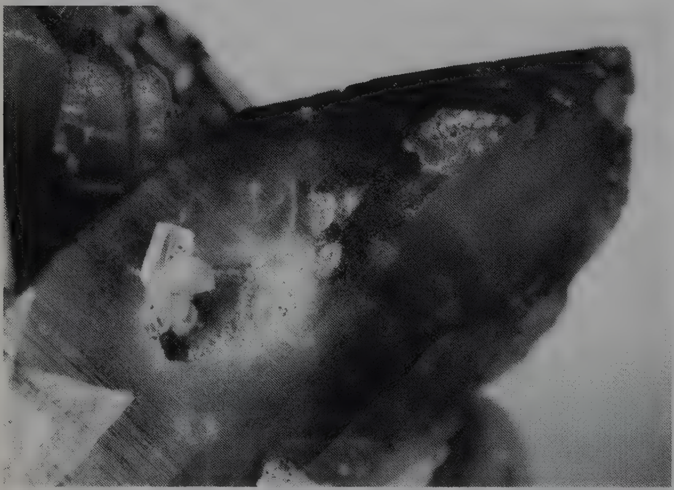


***Figure 8.* Gemmy bertrandite group, 4 mm, on smoky quartz. The bertrandite is growing on the side of the hexagonal cavity probably left by an aquamarine crystal which has subsequently dissolved. MAM specimen and photo.**

Bertrandite $Be_4Si_2O_7(OH)_2$

Bertrandite forms colorless to white, lustrous, tabular crystals to 3 mm. These commonly show simple, elongated orthorhombic habits with only the forms *a*{100}, *b*{010} and *c*{001}, though rare crystals show other modifying forms. Usually bertrandite occurs as a late-stage mineral in miarolitic cavities or pegmatite pockets with etched to badly-corroded aquamarine, which is the source of the beryllium. Crystals generally form on quartz, feldspar or aquamarine. Rarely bertrandite is found in pockets where aquamarine is apparently either unetched or absent.

Beryl $Be_3Al_2Si_6O_{18}$

Beryl (variety *aquamarine*) is most common in the south-central area in both massive and crystalline form, but crystals occur throughout much of the batholith. Pockets often contain a very high proportion of aquamarine; for example, a 10 x 10 x 20-cm pocket produced an estimated 2.5 kg of aquamarine. Crystals are pale to medium blue with little or no greenish tint, and tend to be simple, hexagonal prisms bounded by the forms *c*{0001} and *m*{10$\bar{1}$0}. A few specimens from the quartz-aquamarine-hematite pegmatite show more complex terminations, but the additional forms cannot be determined due to etching and rounding of the faces. Light to heavy etching is common, preferentially on the prism versus pinacoidal faces. This produces occasional scepter-like forms, and in one pocket created crystals with a "pagoda"-like habit. Unetched specimens are rare. Crystals rarely exceed 5 cm in length but reach 18 cm long by 3 cm in diameter. They are generally gemmy, but feathery flaws and cracks limit the maximum size of most cut stones that are reasonably clean to around 5 carats. Matrix specimens are rare. Associated pocket minerals are usually quartz, microcline and albite, with rarer bertrandite, spessartine, hematite, zinnwaldite and goethite-after-pyrite pseudomorphs. One pocket also contained fluorite.

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

Biotite is the rock-forming mica, and also occurs as a secondary mineral in pegmatitic segregations as a constituent of pseudomorphs after fayalite. It was also found in one pocket as unusual, altered, lath-like crystals that formed the framework for subsequent growth of microcline crystals.

Calcite $CaCO_3$

Calcite has been identified only as a constituent of white, poorly crystallized coatings, with opal, from a single feldspar pocket containing zinnwaldite.

Carpholite $Mn^{2+}_2Al_4Si_4O_{12}(OH)_8$

Carpholite-group minerals are very rare, having been reported from only five pockets. In one of these the mineral has been confirmed as carpholite, with at least two of the others hosting what appears to be a new mineral (Ream, 1989).

Carpholite occurs as pale yellowish brown, acicular, 1.5-mm crystals in radiating tufts. It coats small microcline crystals that occur with quartz, albite and zinnwaldite. This is apparently the first reported occurrence of carpholite in the United States.

The proposed new mineral is morphologically similar to carpholite and occurs as colorless to pale-yellow, acicular crystals to 1 cm. It is one of the last minerals to form in miarolitic cavities associated with quartz, albite and microcline. In one pocket topaz was also present. As distinct from carpholite, the mineral contains essential potassium and lithium, with the latter partially substituting for manganese. The chemical formula has been determined to be $K_x(Mn^{2+}_{2-x}Li_x)Al_4Si_4O_{12}(OH,F)_8$, and analytical work by one of the authors (RCB) is almost complete prior to submission for IMA approval as a new species. Apparently the same mineral was first described but not named by Chashka *et al.* (1973) as a potassium-rich carpholite from greisens in the "Ukranian schist belt."

Cassiterite SnO_2

One pocket contained cassiterite as brilliant, dark-brown crystals to less than 1 mm. They occurred in the vuggy, granular quartz and topaz matrix that replaces both microcline and albite crystals. Ream (1989) also reports cassiterite with columbite-tantalite from another pocket.

Columbite-tantalite $(Fe^{2+},Mn^{2+})(Nb,Ta)_2O_6$

Columbite-tantalite has been found in a few pockets as black, bladed crystals and radiating sprays to 1 mm. Crystals range from rough to sharp and lustrous and grow on and in both feldspars and quartz. Principal associations include quartz, feldspars, zinnwaldite-masutomilite, topaz and fluorite.

Figure 9. **Aquamarine crystals to 11 cm. Stan Esbenshade specimens.**

Figure 10. **Aquamarine crystals to 8 cm, showing the range of etching between different pockets. MAM specimens and photo.**

Fayalite $Fe^{2+}_2SiO_4$

Crude fayalite crystals to 10 cm, usually altered to a granular mixture of quartz, magnetite and biotite, occur frozen in pegmatitic segregations in some areas. Similar, large but unaltered, subhedral fayalite crystals are found at Baveno, Italy (Albertini, 1983) and in the Golden Horn Batholith, Washington (Boggs, 1984).

Ferrimolybdite $Fe^{3+}_2(Mo^{6+}O_4)_3 \cdot 8H_2O$?

Ferrimolybdite occurs as a yellow, powdery alteration product of molybdenite.

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

One 1-cm, medium-purple crystal fragment of fluorapatite was found in dump material from the quartz-aquamarine-hematite pegmatite. It shows some lustrous faces of the forms *c*{0001} and *m*{1010}. Ream (1989) reports fluorapatite from two other pegmatites. One of these contained subhedral crystals to 1.5 cm that are pink to purple with yellow zones, associated with quartz, feldspars, aquamarine and stilbite.

Fluorite CaF_2

Fluorite is generally rare in good crystals, but more common as grains in the coarse-grained pocket matrix. The crystals to 5 cm are generally yellow to green, sharp octahedrons with occasional cube faces. Colorless, generally cubic fluorite is rarer, except in a portion of the northeast corner of the batholith. In this area it occurs instead of topaz as the preferred fluorine-bearing species, and micas are also less common. A matrix specimen from another area shows an unusual, pink, somewhat weathered 2-cm cuboctahedron. Crystalline fluorite occurs with a range of minerals including quartz, feldspars, zinnwaldite-masutomilite, spessartine, topaz, hematite, siderite, columbite-tantalite, and rarely stilbite or aquamarine. Ream (1989) reports what appears to be a 4-mm octahedron included in the base of a quartz crystal.

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

Goethite of mineralogical interest replaces two other minerals. It occurs as pseudomorphs after siderite, and also partially to completely replaces cubes of pyrite. Thin coatings of goethite produced by weathering of other iron species are also quite common.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum has been identified from a single pocket as a powdery white coating, likely a weathering product.

Figure 11. **Red-brown, penetration-twin helvite crystal, 1 cm, on albite matrix. RCB specimen and photo.**

Helvite $Mn^{2+}_4Be_3(SiO_4)_3S$

Helvite occurs as single or twinned, brown to dark red tetrahedrons. They are up to 2.5 cm and generally lustrous, although this may diminish as size increases. Smaller crystals generally show only the positive tetrahedron, *o*{111}, while many larger individuals also show the negative tetrahedron, −*o*{111}. Some crystals form penetration twins by reflection across *o*{111} (spinel law). Associated minerals are normally quartz and feldspars, and more rarely topaz.

Hematite Fe_2O_3

Hematite is found as lustrous, dark gray, tabular crystals and rosettes to 5 cm across, bounded by the forms *c*{0001} and *r*{1011} (?). Most are associated with aquamarine, although some occur in topaz or quartz-feldspar pockets. The quartz-aquamarine-hematite pegmatite contains abundant hematite crystals frozen in quartz with good crystals in the pockets.

Laumontite $CaAl_2Si_4O_{12} \cdot 4H_2O$

White prisms of laumontite to 1 cm are known from only a few pockets (Ream, 1989). Associated minerals include quartz, microcline and albite.

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

Magnetite is found very rarely as striated, black octahedrons to 7 mm with a dull to bright luster. In one feldspar pocket, which also contained pyrite, the crystals occurred partially embedded in microcline. Other associated minerals generally include quartz and albite. Magnetite also forms a constituent of pseudomorphs after fayalite.

Figure 12. **Pinkish double Baveno-twin microcline crystal, 5 cm. MAM specimen and photo.**

Microcline $KAlSi_3O_8$

X-ray diffraction analysis shows the pocket potassium feldspar generally to be microcline. Orthoclase, the rock-forming potassium feldspar, has been identified so far from only one pocket. Microcline occurs in most pockets, in crystals that are usually in the 1 to 5-cm size range, but some reach 15 cm. The luster is dull to porcelaneous and the color varies from pink to cream to white, but is uniform within a particular pocket. Although generally sharp, many crystals show pitting and corrosion and, unfortunately for the collector, the cleavage is well-developed. Baveno twinning is quite common, followed in frequency by much rarer Manebach and Carlsbad twinning. One pocket produced interesting twins (several Baveno and one Manebach) that are elongated along the twin plane and have oriented overgrowths of

Figure 13. **Pseudomorph of topaz and quartz after microcline, 5.5 cm, from pocket #1982-03. The surface of the specimen is covered with hundreds of water-clear, colorless topaz crystals to 5 mm. MAM specimen and photo.**

Figure 14. **Manebach-twin microcline crystal, 13 cm. This specimen is unusual because of its size and its overgrowth by albite. RCB specimen and photo.**

white albite. Microcline is also probably present, as massive material in pegmatitic segregations.

Molybdenite MoS_2

Molybdenite has been found as tabular, metallic crystals and radiating aggregates to 1 cm. These have formed in open spaces between and as inclusions in crude, intergrown, milky quartz crystals. Ferrimolybdite is also present as a yellow alteration product. The occurrence is in a quartz segregation at the edge of one of the mineralized, altered zones. Molybdenite is probably more common than suggested by this single occurrence, since altered zones have received little collector attention due to their apparent absence of miarolitic cavities.

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

One pocket contained a few 2-mm clusters of yellow, tabular monazite-(Ce) crystals, associated with quartz, albite, microcline, zinnwaldite and spessartine. These clusters appear to be pseudomorphs after an unidentified mineral.

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

Muscovite occurs in some pockets as small rosettes of colorless to pale green crystals to 1 cm. It is associated with, and appears to have formed as a secondary mineral at the expense of, etched topaz. Ream (personal communication, 1991) indicates that analysis of the greenish, scaly coatings that form on quartz and feldspars in many pockets shows them to be "mica-group, likely muscovite." It is not readily apparent whether this is primary or secondary. Thus primary muscovite has yet to be verified.

Opal $SiO_2 \cdot nH_2O$

Opal has been identified as a constituent, with calcite, in white, poorly crystallized coatings in one feldspar pocket with zinnwaldite. In addition, a disfiguring opaline coating on specimens is quite common. This can be removed by careful chemical cleaning with dilute hydrofluoric acid, or with ammonium bifluoride (a safer alternative for the collector). Other collectors prefer hot, concentrated sodium hydroxide solution, which does not attack feldspars.

Orthoclase $KAlSi_3O_8$

An orthoclase mesoperthite is the rock-forming potassium feldspar in the granite (Reid, 1963), but to date orthoclase crystals have been verified by X-ray diffraction analysis from only one pocket (Ream, 1989). Crystals showing an adularia habit were found in another pocket and are probably orthoclase. However, crystals of this habit can range from sanidine to microcline at other localities (Černý and Chapman, 1986).

Phenakite Be_2SiO_4

Phenakite occurs very rarely as prismatic, colorless crystals to 2 mm with rhombohedral terminations. Crystals are found growing on quartz associated mainly with microcline, albite and topaz. In other pockets phenakite forms on the terminations of aquamarine crystals. It is much rarer than either aquamarine or bertrandite. As distinct from bertrandite, even when it is associated with aquamarine, phenakite does not appear to be a secondary mineral.

Pyrite FeS_2

Pyrite is a late-stage mineral that is quite common in limited areas. It occurs as striated cubes up to 15 cm, often altered to goethite. One pocket produced a highly-altered group of large, intergrown cubes; another contained a rare, unaltered, 2-cm cube. In addition, a well-formed, 4-mm crystal was found with altered fayalite frozen in a pegmatitic segregation. Associated minerals commonly include quartz, feldspars, aquamarine, and rarely fluorite or magnetite. Pyrite does not seem to occur with topaz or spessartine.

Figure 15. **Topaz crystal, 8 mm, on matrix of pink microcline and albite. The microcline is unusually sharp and well-preserved and the pocket is distinctive for its absence of quartz. MAM specimen and photo.**

Pyrophanite $Mn^{2+}TiO_3$

Pyrophanite has been identified from a single pocket as an inner zone in tabular hematite crystals to 5 mm. Associated minerals include quartz, albite, zinnwaldite, aquamarine and bertrandite.

Quartz SiO_2

Quartz occurs in most pockets as sharp, often gemmy, smoky crystals. However, prolonged exposure to sunlight completely removes the smoky color, as noted by Bennett (1980). Crystals are commonly lustrous, although many are slightly to severely frosted from etching. This usually occurs preferentially on three of the adjacent prism and rhombohedral faces, leaving the others lustrous. Sizes are commonly up to around 10 cm, but reach at least 45 cm long by 20 cm in diameter, and crystals to around 60 cm are reported but unverified. Most are prismatic and show the common forms *m*{1010}, *r*{1011} and *z*{0111}, with a few rare individuals modified by generally small *s*{1121} and *x*{5161} faces. Fully terminated crystals are common and include doubly-terminated prisms, crystals with rehealed bases, and complex, fully faced shards. Rare re-entrant terminations may also have resulted from earlier crystal breakage and rehealing. Milky quartz rarely forms late-stage overgrowths on smoky crystals. Many of the more elongated crystals show slight twisting around the c-axis; Ream (1989) reported a crystal with a twist of 17°.

Inclusions in quartz are uncommon, the most frequent being spessartine in several pockets. Needle-like inclusions of topaz were found in one pocket, and prisms of aquamarine and elongated crystals of columbite-tantalite and zircon are known from others. Ream (1989) also reports zinnwaldite, helvite, a carpholite-group mineral, and what appear to be fluorite and rutile. At least one inclusion remains unidentified.

Figure 16. **Complex smoky quartz crystal, 9 cm. This gemmy crystal is fully terminated, the base having re-grown after earlier separation from the matrix. MAM specimen and photo.**

Figure 17. **Rounded red crystals of spessartine to 5 mm on a matrix of microcline, albite, quartz and mica. The smoky quartz has been mostly decolorized by exposure to sun. MAM specimen and photo.**

Figure 18. **Multiple topaz crystal, 5 cm, of typical habit, with minor spessartine, from pocket #10. RCB specimen and photo.**

Figure 19. **Pale blue topaz, 1.5 cm, with typical etched termination, intergrown with smoky quartz, microcline and albite. Blue topaz is rare from the area. MAM specimen and photo.**

Rutile TiO_2

Rutile has been confirmed in one pocket as black, platy, twinned aggregates of 0.5-mm crystals on the back of albite plates.

Siderite $Fe^{2+}CO_3$

Siderite occurs as disc-like, flattened rhombohedral crystals to 7 cm, altered to goethite. These crystals are well-formed but have no clearly defined faces, and are dull in luster. Ream (1989) also reports small, similarly altered rhombs of more normal habit. Associated minerals include quartz, feldspars, zinnwaldite, aquamarine, bertrandite, topaz and fluorite from one pocket.

Spessartine $Mn_3^{2+}Al_2(SiO_4)_3$

Spessartine occurs infrequently, but is locally more common in some areas. It forms crude to sharp trapezohedrons, usually from 1 to 5 mm but up to 2 cm. Most often it forms on and is included in quartz; more rarely it is associated with topaz or aquamarine. Crystals are commonly deep-red, but the color can range all the way to yellow. Fracturing is common and the material is seldom gemmy. Specimens from one pocket show spessartine as sharp, striated, orange-yellow trapezohedrons to 1 mm densely coating all other minerals including topaz, and also as inclusions in quartz crystals.

There is another interesting occurrence in vuggy granite revealed after blasting of what appeared to have been a small pegmatite close to the quartz-aquamarine-hematite pegmatite. Two generations of spessartine are present in small cavities with quartz, microcline and zinnwaldite. Poorly crystallized, deep-red grains preceded late-stage, distinctly yellow crystals. Analysis of the latter showed them to be very close to end-member spessartine.

Stilbite $NaCa_2Al_5Si_{13}O_{36}\cdot14H_2O$

Bladed stilbite crystals to 4 mm have been found in several pockets in a pegmatite, and also lining irregular cavities along joint surfaces (Ream, 1989). Associated minerals in the pegmatite include quartz, feldspars, aquamarine and subhedral fluorapatite.

Topaz $Al_2SiO_4(F,OH)_2$

Topaz generally forms simple, stubby to elongated crystals usually bounded by the prisms *m*{110} and *l*{120} and terminated by *f*{011}. More complex crystals show *d*{101} and *o*{111} faces, and more rarely the forms *c*{001}, *b*{010}, *k*{130}, *t*{023}, *u*{021}, *e*{103}, *p*{112} and *q*{113} (?). Crystals are usually 5 mm to 2 cm in length but some reach 12 cm. They range from colorless to light sherry or yellow (with these shades apparently unstable to light), and rarely light blue. Crystals range from translucent to gemmy. Lustrous crystals are common, although many are slightly to severely etched, showing etch figures, rounded faces, or deeply etched terminations.

Color zoning is common with a colorless center and outer sherry zones parallel to *a*{100}. Very similar zoning is seen in topaz from other localities including the pegmatites of Volhynia, Ukraine, and Shigu Prefecture, Japan. In some pockets, particularly from the area where aquamarine is most prevalent, the colorless crystal centers may show bright yellow fluorescence that is particularly strong under longwave ultraviolet light. The colorless zones are also markedly less resistant to etching, with some etched crystals showing a cavernous center. In one pocket this has progressed to complete removal of the centers, leaving only etched, sherry-colored fragments that retain the general crystal form. Analysis across zoned, fluorescent crystals failed to show any significant compositional differences, including in trace elements, that might provide explanations (E. E. Foord, personal communication, 1989).

In some pockets, crystals are on matrix, generally of albite, but sometimes quartz or microcline. One plate contains around 20 topaz crystals to 1 cm. In two pockets topaz shows a tendency toward fibrous growth, especially at the terminations. This results in quite well-formed, striated crystals with more or less sharply defined white caps. The reason is not known, but a similar habit is noted in some topaz from Adun Chilon, Transbaikalia, Russia. Another rare occurrence is topaz (and quartz) replacing microcline and albite. Rare inclusions of spessartine, helvite, hematite, and in one case an unidentified, acicular mineral, are known.

Uranophane $Ca(UO_2)_2[(SiO_3(OH)]_2\cdot5H_2O$

Radiating groups of yellow, acicular crystals of uranophane to about 1 mm are reported from one small pocket with quartz, microcline and possibly albite (Ream, 1989).

Wodginite $(Ta,Nb,Sn,Mn,Fe)_{16}O_{32}$

Wodginite was found in one pocket as a few small, black, prismatic crystals less than 0.5 mm long. Associated minerals include quartz, feldspars, zinnwaldite and topaz.

Zinnwaldite $K(Li,Al,Fe^{2+})_3(Si,Al)_4O_{10}(F,OH)_2$
Masutomilite $K(Li,Al,Mn^{2+})_3(Si,Al)_4O_{10}(F,OH)_2$

Zinnwaldite appears to be the most common mica in the miarolitic cavities. It occurs as greenish gray to almost black, tabular to barrel-shaped crystals to 7 cm associated with most other minerals, although micas are less common with aquamarine than with topaz. Most specimens are found in poor condition due to weathering.

In one topaz pocket, analysis confirms zoned crystals of zinnwaldite

Table 3. **Compositional variation across a crystal of zinnwaldite-masutomilite mica.**

Distance in from rim of crystal in millimeters	*0*	*10*	*16*	*21*	*26*	*31*	*36*	*51*	*56*	*76*
SiO_2	44.38	43.96	43.21	44.05	46.12	43.60	43.57	42.83	42.35	42.97
TiO_2	0.15	0.26	0.39	0.31	0.37	0.33	0.36	0.42	0.46	0.33
Al_2O_3	20.22	21.22	21.57	21.54	26.43	21.67	21.88	21.85	22.05	21.16
FeO*	8.85	9.39	7.63	5.52	4.17	5.19	5.85	7.47	8.08	9.36
MnO	4.94	6.21	7.64	9.09	5.31	9.37	8.77	8.22	7.80	5.98
MgO	0.37	0.60	0.14	0.06	0.02	0.03	0.03	0.00	0.03	1.10
CaO	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01
BaO	0.00	0.03	0.00	0.03	0.01	0.04	0.03	0.01	0.00	0.03
K_2O	10.40	10.40	9.19	9.05	10.58	9.13	9.12	9.28	9.33	10.19
Na_2O	0.00	0.12	0.15	0.17	0.25	0.19	0.21	0.23	0.33	0.15
Li_2O**	2.01	2.01	1.97	2.35	2.35	2.35	2.35	2.18	2.18	2.18
H_2O	6.96†	3.62†	7.08†	6.15†	3.40†	6.05	5.67†	3.75‡	3.75‡	3.75‡
F	2.97	3.76	3.50	2.90	1.71	3.55	3.71	3.14	2.77	3.37
Sum	101.25	101.58	101.47	101.22	100.72	101.50	101.56	99.38	99.13	100.58
−0=F	1.25	1.58	1.47	1.22	0.72	1.50	1.56	1.32	1.17	1.42
Sum	100.00	100.00	100.00	100.00	100.00	100.00	100.00	98.06	97.96	99.16

*Total Fe as FeO
**Li_2O by AA Spectroscopy on four zones in crystal (as shown by repeated values)
†H_2O by difference
‡H_2O by loss on ignition

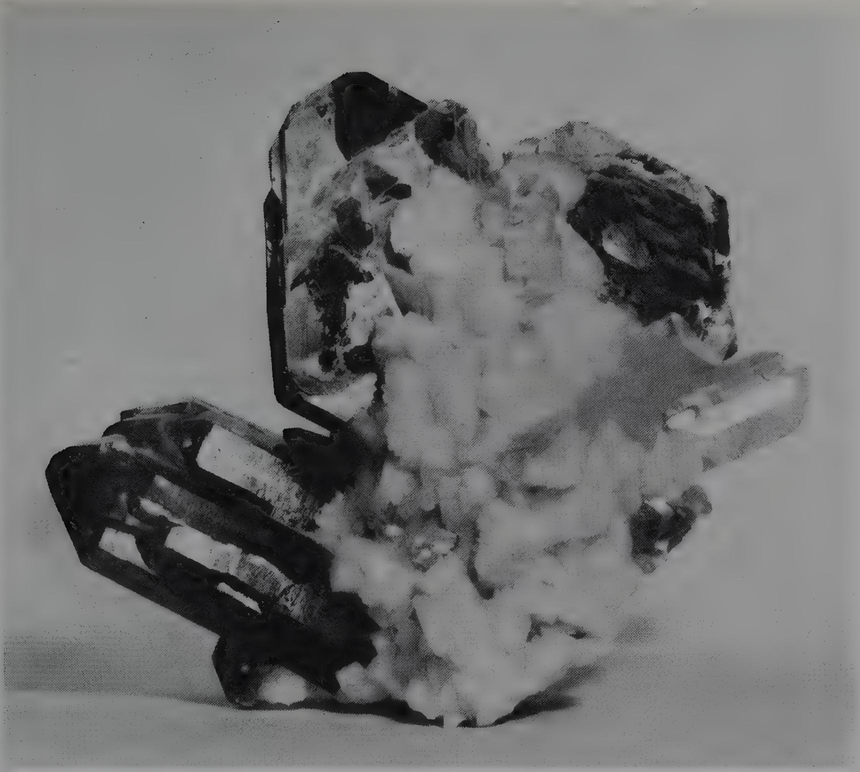


Figure 20. **Unusually lustrous, dark greenish brown mica "fan" on albite with smoky quartz and very pale sherry-colored topaz (at right). The specimen, which measures 7 cm across, is from pocket #1981-02. MAM specimen and photo.**

with masutomilite (the manganese analog). The color varies from dark green zinnwaldite in the center through an amber intermediate zone of masutomilite, with a final, abrupt transition back to a dark green to brown outer rim of zinnwaldite. Table 3, based on electron microprobe analyses, shows this compositional variation. This is only the fourth reported occurrence of masutomilite. It has been described from the type locality and one other in Japan (Harada *et al.*, 1976), and from a pegmatite in Czechoslovakia (Němec, 1983). The maximum MnO content of 9.37% in Table 3 represents the most Mn-rich masutomilite yet reported, although Mn:Fe ratios are higher from other localities.

Some micas from other pockets show zones of amber color and may contain masutomilite. Ream (1989) reports the results of flame and bead tests on many specimens that confirm the correlation between green to black color for zinnwaldite versus golden to brown for masutomilite. He suggests that zinnwaldite is dominant with aquamarine, but that masutomilite or zoned zinnwaldite-masutomilite is dominant with topaz. Verification awaits further analyses, currently in progress by one of us (RCB).

Zircon $ZrSiO_4$

Zircon has been found as red-brown, singly and doubly terminated prismatic crystals to 2 mm, both in and on albite in two quartz-feldspar pockets. It also occurs as inclusions. One of the above pockets contained zircon as stubby crystals surrounded by halos, along with altered biotite, both included in microcline. Elongated prisms included in quartz occurred in at least one other pocket. Other associations include aquamarine, topaz and columbite-tantalite (Ream, 1989).

Table 4. **Summary of observed inclusions and hosts.**

Host	*Inclusion*
Microcline	Biotite, Zircon
Quartz	Aquamarine, Carpholite-group mineral, Columbite-tantalite, Fluorite?, Helvite, Kalicarpholite, Rutile?, Spessartine, Topaz, Zinnwaldite, Zircon
Topaz	Aquamarine?, Helvite, Hematite, Spessartine

Other species

A few additional crystallized minerals have been reported more recently from the granite of the Sawtooth Batholith. Ream (personal communication, 1990) notes clinozoisite and fibrous dravite (both confirmed by X-ray diffraction analysis), and epidote. The clay-group mineral, montmorillonite, and possible chabazite, are also reported (Ream, 1989). A number of other minerals have yet to be identified and may represent additional species.

Notable Pockets

The following descriptions of a few of the more notable pockets found by the authors provide more detail on mineral occurrences and associations. These represent the more exceptional pockets out of thousands examined, but otherwise span the range from representative to highly unusual or unique.

Pocket 1981-02 (MAM)

This pocket, measuring around 30 x 30 x 60 cm, in the side of a 6-meter talus boulder, was the first major topaz find by one of us. It contained numerous sharp, lustrous topaz prisms to 1.5 cm, showing zoning from colorless to light sherry. Topaz is generally on a matrix of quartz and albite, along with some pink microcline and a few tabular zinnwaldite groups to 2.5 cm. Minor columbite-tantalite and fluorite are also present. The combinations are particularly aesthetic. Fully terminated, rehealed quartz crystals to 9 cm were abundant among the densely packed assemblage of collapsed pocket contents. Some pocket zoning was evident, with topaz-albite-zinnwaldite toward the center, large quartzes to the rear, and microcline grading off into cleavages to 6 cm toward one side.

Pocket 1982-03 (MAM)

This unique, highly altered pocket was around 30 cm long. It was found fully open on one side of a small talus boulder, which hosted two small, unaltered quartz-feldspar pockets on the other side. The pocket contents were highly altered, likely from attack by late-stage hydrothermal fluids, and were heavily coated with iron oxides. The original feldspars had been replaced by a white, granular mixture of quartz and topaz that preserved the original crystal forms. These pseudomorphs were then coated with a dense druse of sharp, elongated,

Figure 21. **A collector excavating a large smoky quartz pocket (#19), with crystals piled around the periphery. Photo by RCB.**

water-clear topaz crystals to 5 mm. A few open areas contain pale smoky quartz crystals to 1 cm. The granular material also forms the matrix for a 2.5-cm cleavage fragment of opaque topaz with some lustrous faces that presumably survives from an earlier generation of topaz. Needle-like inclusions of topaz also occur in larger, presumably later-stage quartz crystals to 6 cm. Although many pockets show etching of topaz, this is the only apparent case of topaz recrystallization. The pocket also contained profuse, lustrous, dark brown microcrystals of cassiterite, generally within the granular matrix and exposed on the bottom of the specimens. Some microcrystals of secondary muscovite are also present, presumably generated from the breakdown of primary topaz.

Pocket 1983-01 (MAM)

This unique, 15 by 25-cm pocket was found collapsed, partially spilled and rather weathered. From the limited exposure in the talus it appeared to represent an opening in a thin pegmatitic segregation. Topaz was found as stubby prisms to 2.5 cm with white, striated, almost fibrous terminations. There are also some highly elongated, parallel-growth, contact-terminated microcrystals of what appears to be topaz, perhaps representing a second generation. Smoky quartz (including doubly terminated and rehealed crystals) and microcline were also recovered, along with albite, which was coated with and possibly altered to an unidentified greenish mineral. Lustrous, yellow-orange, 1-mm trapezohedrons of spessartine complete the assemblage, forming a sparse to dense druse on the topaz, feldspars and quartz, as well as inclusions in quartz crystals.

Pocket 2: August 16, 1982 (RCB)

This was among the first major aquamarine pockets found by one of us. It was notable in that the contents were mostly crystals of severely etched aquamarine up to 8 cm long by 3 cm in diameter. This 15 x 20 x 20-cm pocket yielded about 2 kg of aquamarine, along with a few small quartz crystals and books of zinnwaldite.

Pocket 10: September 5, 1984 (RCB)

This pocket, which extended upward into a cliff face for about a meter from a 10 x 20-cm opening, had a maximum cross-section of 30 x 50 cm. The opening was plugged with several quartz-feldspar plates detached from the walls. Once these plates were removed and the opening enlarged, it was possible to begin removing additional plates and other pocket material. After collecting for about an hour, it appeared that the pocket contained only smoky quartz, albite and microcline. However, shortly afterward a 3-cm loose topaz crystal appeared. As collecting continued, additional topaz crystals were recovered, both as sharp, transparent singles to 5 cm, some doubly terminated, and as smaller crystals to 2 cm on albite matrix. The pocket also yielded well-formed crystals of zoned zinnwaldite-masutomilite to 5 cm across, crude trapezohedrons of spessartine to 2 cm, and minor fluorite and hematite. Several Baveno twins of microcline were also recovered. All the larger topaz crystals were found loose, apparently because the microcline crystals that had formed their matrix had weathered to a pile of cleavage plates. Due to its position and orientation, this pocket was exceptional in not containing any clay or dirt.

Figure 22. **Excavated pocket (#1983-01) showing opening from pegmatitic vein at upper left, with specimens piled at right side. Photo by MAM.**

Pocket 19: August 18, 1985 and August 9, 1986 (RCB)

This large, in-place pocket, measuring about 1 x 1.3 x 3 meters, was discovered independently by three collecting parties. It is estimated to have contained over 325 kg of smoky quartz crystals that ranged from 5 to 25 cm in length and to 10 cm in diameter. Generally they are lustrous, although some show slight frosting on three of the prism faces. Most crystals are transparent except for some internal fractures and one contained a small, included crystal of aquamarine. During the following summer additional crystals were removed. These included single crystals of quartz and matrix plates of quartz on albite, some with zinnwaldite plus minor microcline and spessartine. The plates came from two 50-cm extensions off the main pocket, one downward from near the mid-section and the other back from the rear. Sticky clay covered both stacked matrix plates and interspersed single crystals.

Pockets 21a, 21b: August 19, 1985 (RCB)

These two aquamarine pockets, with similar mineral assemblages, were found within a distance of 30 meters. The first was about 20 x 20 x 25 cm and yielded around 700 grams of aquamarine crystals to 8 cm long by 2 cm in diameter. The second produced about 1 kg of generally smaller crystals to 1.5 x 6 cm, from a 30 x 30 x 70-cm pocket. All of the aquamarine is moderately to severely etched, producing secondary, 1 to 2-mm bertrandite crystals, growing on both the aquamarine and smoky quartz. Spessartine occurred in both pockets. The first contained a few crystals on and included in smoky quartz crystals; the second yielded many small, 1 to 5-mm crystals, generally on smoky quartz. Unfortunately these latter specimens are not showy due to loss of luster on the quartz crystals.

Minerals of the Diabase Dikes

At least one diabase dike has mineralized cavities, to around 5 cm. Although further study is required, crystallized minerals identified visually include epidote, prehnite, pyrite and quartz.

COLLECTING STATUS AND CONDITIONS

As collector numbers have increased in recent years, collecting has attracted growing controversy. Through 1990 the Sawtooth National Recreation Area authorities continued to permit the collecting of reasonable quantities of minerals for personal use, but prohibited commercial collecting or use of explosives. Removal of larger quantities was allowed for scientific purposes but required a Special Use Permit. A subsequent study by the authorities concluded that they had the authority to permit collecting only for scientific purposes. This resulted in a decision in June 1991 to enforce the prohibition of all other, general collecting activity (J. Davis, personal communication, 1991). Thus collectors should assume that the area is closed to collecting, unless contact with the authorities confirms a change in policy.

Hopefully at some point in the future, general collecting will again be permitted. Although little virgin area remains, the areal extent of good collecting exposures provides the potential for continuing success for the determined collector for many years to come. Collectors should be experienced backpackers well-prepared for a relatively arduous trip at higher elevations, with the risk of rapid changes in weather conditions, particularly early or late in the short collecting season. Access to the collecting areas in the wilderness portion of the Sawtooth National Recreation Area is allowed only on foot or horseback.

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Secondary Minerals from Ashburton Downs, Western Australia

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Ashburton Downs, the type locality for ashburtonite and gartrellite as well as several new species yet to be described, is a treasure-house of secondary microminerals. Species found as attractive microcrystals include aheylite, carminite, clinoclase, connellite, cornubite, cumengite, diaboleite, and dozens of others.

INTRODUCTION

There are a number of mineral occurrences on the Ashburton Downs pastoral station (the Australian version of a cattle ranch) in the Pilbara region of northwestern Western Australia that have produced a wide variety of secondary minerals. The main occurrences are the Anticline and Bali Lo prospects, as well as a few others.

The Ashburton Downs area is in a rugged part of the North West Division of the Pilbara region known as the Capricorn Range. Because of low rainfall, the area can be regarded as semi-desert, but access can be very difficult at times, with local roads and "bush tracks" washed out by occasional cyclonic storms that sweep across the area.

A brief description of a few of the minerals from Bali Lo prospect has been given by Bridge and Pryce (1978), but their report only "scratches the surface"; a more comprehensive account will be given in this paper. Surface specimens were collected from the prospects at Ashburton Downs by B. J. Gartrell in four collecting trips between 1985 and 1990. In all, between 2,000 and 3,000 specimens have been collected, and about 500 examined in detail. Most of the collected material came from the Anticline prospect, with lesser amounts from the other prospects.

The mineralogical examinations were carried out by one of us (EHN) in the CSIRO laboratories at Floreat Park, Western Australia. The main methods of identification were qualitative X-ray energy-dispersion spectrometry (EDS) using a scanning electron microscope (SEM), and X-ray powder diffraction. Most of the illustrations are SEM micrographs obtained in the backscattered-electron mode. The specimen numbers given in the photo captions are catalog numbers from the collection of the Westaus Mineral Museum, Beverley, Western Australia, maintained by B. J. Gartrell.

HISTORY

The occurrence of secondary minerals at the surface has led to a considerable amount of prospecting activity. One of the early prospectors in the area was an Aboriginal called Owen Dingo who was employed by the Ashburton Mining Company, owner of the Anticline prospect in the early 1960's. A small amount of secondary ore (129 tons, grading 8.8% copper) was mined between 1962 and 1963 (Marston, 1979), after which the property passed on to Westfield Mining. They found a "virgin lead deposit" in 1963, and gave it the name Anticline. The company excavated an inclined shaft to a vertical depth of 29 meters, and from this put in a crosscut and short drives; some shallow surface pits were also dug. Mineralization encountered by the shaft was reported to be disseminated pyrite, galena, chalcopyrite, bornite, digenite, covellite, tetrahedrite, skutterudite and a Cu-Sb sulfide (Marston, 1979). Between 1966 and 1968, Pickands Mather and Company International took an interest in the property, and put down two diamond-drill holes which encountered mainly pyrrhotite. In more recent years, the prospect came under the control of Barrack Mines, which engaged in some surface exploration. In spite of this activity by various mineral exploration companies, the prospects have not been proven to be sufficiently promising to warrant their large-scale exploitation.

Figure 1. **General view of the country in the vicinity of the Anticline deposit. Photo by B. J. Gartrell.**

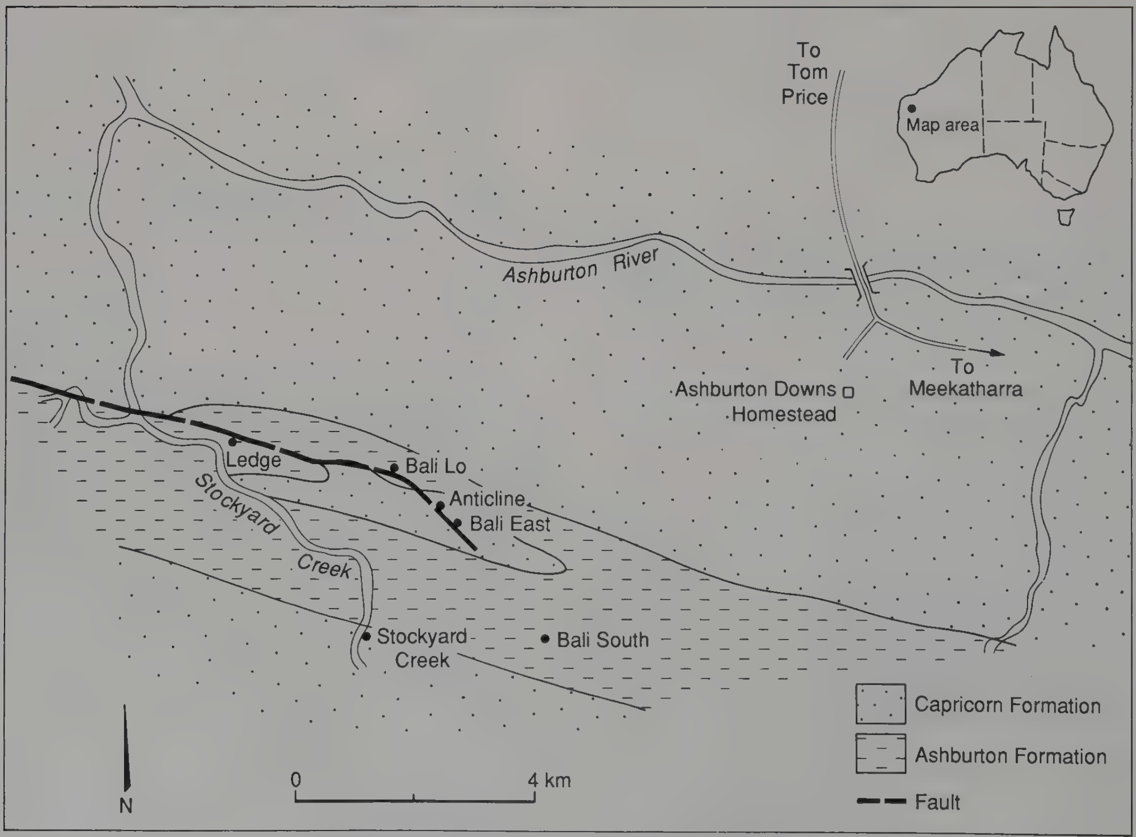

Figure 2. **Sketch map showing the location of some of the mineral prospects containing secondary minerals.**

Figure 3. **The outcrop of the mineralized shear zone at the Anticline prospect. The deposit is just below the top of the ridge, and parallel to it. Photo by B. J. Gartrell.**

GEOLOGY

The rocks at Ashburton Downs are represented by sediments—mainly greywackes and shales—of the Capricorn and Ashburton Formations of Lower Proterozoic age (Blockley, 1971; Marston, 1979). The underlying rocks of the Ashburton Formation are brought to the surface by a WNW-trending anticlinal structure from which the name of the Anticline prospect has been derived (other names by which this prospect is known are Bali Hi and Bali High). The Ledge, Bali Lo (also known as Casleys and Bali Low), Anticline and Bali East (also known as Bali Hi East) prospects are situated along a sheared fault zone near the contact of the Ashburton and Capricorn sediments, which may possibly extend westward to the Ledge deposit, and beyond. The other deposits mentioned in this paper, Bali south and Stockyard Creek, appear to be located on other fault zones.

At the Anticline prospect, the average width of the mineralized shear zone at the surface is about a meter, with variations between 30 cm and 2.5 meters. The shear zone is marked by the presence of white alunitic clay and abundant secondary ore minerals. The mineralization in the shear zone commonly exhibits irregular banding, possibly a relict of the original ore texture. In places, the assemblage is compact and massive, but in others it is porous and friable, with frequent vuggy cavities in which crystals of secondary minerals can be found. The crystals in these cavities are generally too small to be clearly discerned with the naked eye, but larger crystals also occur. A significant feature of the mineralogy of the Anticline material is the abundance of minerals of the alunite-beudantite-crandallite group.

Specimens from the Bali Lo prospect share many of the features exhibited by those from Anticline, but there are some differences in mineralogy, and the secondary minerals tend to be more coarsely crystalline. A particularly striking feature of some of the specimens is a coarse sponge-like boxwork resulting from the oxidation of tennantite.

The secondary mineral assemblage at Bali South is distinguished from the Anticline and Bali Lo prospects mainly by the absence of beudantite and other members of the alunite-beudantite-crandallite group, and by the presence of antimony-rich minerals.

The mineralogy of the Ledge deposit differs from that of the other deposits by the relatively high proportion of secondary phosphate minerals.

A few remnants of primary minerals were found in some of the specimens—arsenopyrite, pyrite, marcasite, galena and tetrahedrite in specimens from the Anticline prospect, and tennantite and chalcopyrite from Bali Lo and Bali East.

SECONDARY MINERALS

Over 80 different species of secondary minerals have been found at Ashburton Downs. In the following descriptions, the minerals are discussed in alphabetical order for ease of reference. The distribution of the minerals among the different prospects is shown in Table 1, in which all the minerals and their chemical formulae are grouped into categories based on their main anionic components.

Adamite $Zn_2(AsO_4)(OH)$

Adamite forms a solid-solution series with olivenite, and intermediate members of the adamite-olivenite series are quite common in the assemblage. However, the relatively pure zinc end-member was found in only a few specimens from the Anticline and Bali Lo prospects. In one specimen from the Anticline prospect it was observed as clear, faintly tan-colored crystals up to 0.3 mm in diameter. In the other specimens it was observed as rather nondescript white to pale tan concentrations. Increasing copper content gives the mineral a light blue color.

Table 1. **Secondary minerals found at Ashburton Downs.**

Mineral	Chemical Formula	Deposit*
SULFIDES and ALLOYS		
Amalgam	(Ag,Hg)	BE
Chalcocite	Cu_2S	A, BL, BS
Cinnabar	HgS	A, BE
HALIDES and SULFIDE-HALIDES		
Atacamite	$Cu_2Cl(OH)_3$	A, BL, BE, SC
Chlorargyrite	AgCl	A, BS
Cumengite	$Cu_{20}Pb_{21}Cl_{42}(OH)_{40}$	A
Diaboleite	$CuPb_2Cl_2(OH)_4$	A
Laurionite	PbCl(OH)	A
Paralaurionite	PbCl(OH)	A
Paratacamite	$Cu_2Cl(OH)_3$	A, BL, BE, SC
Perroudite	$Ag_4Hg_5S_4(Cl,I,Br)_4$	BL
Unknown	Ag,Hg,Cl,S	A
OXIDES		
Bindheimite	$Pb_2Sb_2O_6(O,OH)$	A
Chalcophanite	(Zn,Fe,Mn)-$Mn_3O_7\cdot 3H_2O$	A
Coronadite	$PbMn_8O_{16}$	A, BL
Cryptomelane	KMn_8O_{16}	A
Goethite	FeO(OH)	A, BL, BS, BE, SC, L
Groutite	MnO(OH)	A, BL
Hematite	Fe_2O_3	A, BL, BS, BE, SC, L
Partzite	$Cu_2Sb_2(O,OH)_7$	BS
Plattnerite	PbO_2	A
Pyrolusite	MnO_2	BL
Tenorite	CuO	A
Tripuhyite	$FeSb_2O_6$	A, BL, BS, BE, SC
CARBONATES		
Aurichalcite	$(Zn,Cu)_5(CO_3)_2(OH)_6$	A
Azurite	$Cu_3(CO_3)_2(OH)_2$	BL, BS, SC
Cerussite	$PbCO_3$	A, L
Hydrozincite	$Zn_5(CO_3)_2(OH)_6$	A, BL
Malachite	$Cu_2(CO_3)(OH)_2$	A, BL, BS, BE, SC, L
Rosasite	$(Cu,Zn)_2CO_3(OH)_2$	A
Siderite	$FeCO_3$	A
SILICATES		
Ashburtonite	$HPb_4Cu_4Si_4O_{12}$-$(HCO_3)_4(OH)_4Cl$	A
Chrysocolla	$(Cu,Al)_2H_2Si_2O_5$-$(OH)_4\cdot nH_2O$	A, BL, BS, BE, SC, L
Hemimorphite	$Zn_4Si_2O_7(OH)_2\cdot H_2O$	A
Kaolinite	$Al_2Si_2O_5(OH)_4$	A, BL, BS, BE, SC, L
PHOSPHATES, SULFATE-PHOSPHATES and VANADATES		
Aheylite	$(Fe,Zn)Al_6(PO_4)_4$-$(OH)_8\cdot 4H_2O$	BL
Corkite	$PbFe_3(PO_4)(SO_4)(OH)_6$	BL
Libethenite	$Cu_2PO_4(OH)$	A, BL
Metatorbernite	$Cu(UO_2)_2(PO_4)_2\cdot 8H_2O$	BL
Mottramite	$Pb(Cu,Zn)VO_4(OH)$	A
Plumbogummite	$PbAl_3(PO_4)$-$(PO_3OH)(OH)_6$	L
Pseudomalachite	$Cu_5(PO_4)_2(OH)_4$	A, BL, BE
Pyromorphite	$Pb_5(PO_4)_3Cl$	A, L
ARSENATES and SULFARSENATES		
Adamite	$Zn_2(AsO_4)(OH)$	A, BL
Arsentsumebite	$Pb_2Cu(AsO_4)$-$(SO_4)(OH)$	A
Bayldonite	$(Cu,Zn)_3Pb(AsO_4)_2$-$(OH)_2\cdot H_2O$	A, BL
Beudantite	$PbFe_3(AsO_4)$-$(SO_4)(OH)_6$	A, BL
Carminite	$PbFe_2(AsO_4)_2(OH)_2$	A
Ceruleite	$Cu_2Al_7(AsO_4)_4$-$(OH)_{13}\cdot 12H_2O$	BL
Chenevixite	$Cu_2Fe_2(AsO_4)_2$-$(OH)_4\cdot H_2O$	A, BL, BS, BE, SC
Clinoclase	$Cu_3AsO_4(OH)_3$	BL, SC
Conichalcite	$CaCuAsO_4(OH)$	BE
Cornubite	$Cu_5(AsO_4)_2(OH)_4$	BL, BE
Cornwallite	$Cu_5(AsO_4)_2(OH)_4$	BL, BS, BE, SC
Duftite	$PbCu(AsO_4)(OH)$	A, BL, L
Gartrellite	$Pb(Cu,Fe)_2(AsO_4,$-$SO_4)_2(CO_3,H_2O)_{0.7}$	A, BL
Hidalgoite	$PbAl_3(AsO_4)$-$(SO_4)(OH)_6$	A, BL
Lavendulan	$NaCaCu_5(AsO_4)_4$-$Cl\cdot 5H_2O$	A, BL
Luetheite	$Cu_2Al_2(AsO_4)_2$-$(OH)_4\cdot H_2O$	BL
Metazeunerite	$Cu(UO_2)_2(AsO_4)_2\cdot$-$8H_2O$	BL
Mimetite	$Pb_5(AsO_4)_3Cl$	A, BL, L
Olivenite	$Cu_2AsO_4(OH)$	A, BL, BS, BE, SC
Pharmacosiderite	$KFe_4(AsO_4)_3(OH)_4\cdot$-6–$7H_2O$	A
Philipsbornite	$PbAl_3(AsO_4)$-$(AsO_3OH)(OH)_6$	A, BL
Scorodite	$FeAsO_4\cdot 2H_2O$	BL
Tsumcorite	$Pb(Zn,Fe)_2(AsO_4)_2$-$(OH,H_2O)_2$	A
Unknown	$BaAl_3(AsO_4)$-$(AsO_3OH)(OH)_6$ (?)	BL
Unknown	$Cu_5(AsO_4)_2(OH)_4$ (?)	BL
Unknown	Cu,Ca,Na,Cl,P,As	A
Unknown	Cu,Al,Fe,As	BL
SULFATES, CARBONATE-SULFATES, CHLORIDE-SULFATES and MOLYBDATES		
Alunite	$KAl_3(SO_4)_2(OH)_6$	A, BL, BS
Anglesite	$PbSO_4$	A
Antlerite	$Cu_3(SO_4)(OH_4)$	A
Barite	$BaSO_4$	BL, BS, BE
Beaverite	$PbCuFe_2(SO_4)_2(OH)_6$	A, BL
Brochantite	$Cu_4(SO_4)(OH)_6$	A, BL, BS, BE, SC
Caledonite	$Pb_5Cu_2(CO_3)$-$(SO_4)_3(OH)_6$	A, BL
Connellite	$Cu_{19}Cl_4SO_4(OH)_{32}\cdot$-$3H_2O$	A, BE, SC
Gypsum	$CaSO_4\cdot 2H_2O$	A
Jarosite	$KFe_3(SO_4)_2(OH)_6$	A
Linarite	$CuPb(SO_4)(OH)_2$	A
Osarizawaite	$CuPb(Al,Fe)_2$-$(SO_4)_2(OH)_6$	A, BL, L
Plumbojarosite	$PbFe_6(SO_4)_4(OH)_{12}$	A
Wulfenite	$PbMoO_4$	L
Unknown	$PbAl_3(SO_4)_2(OH)_6$ (?)	A

*Abbreviations used for the deposits are: A = Anticline; BE = Bali East; BL = Bali Lo; BS = Bali South; L = Ledge; SC = Stockyard Creek.

Table 2. **Minerals of the alunite-beudantite-crandallite group found at Ashburton Downs.**

Predominant elements in the formula $AB_3C_2(OH)_6$	A	B	C
Sulfates			
Alunite	K	Al	SO_4
Jarosite	K	Fe	SO_4
Plumbojarosite	Pb	Fe	SO_4
Beaverite	Pb	Fe,Cu,Al	SO_4
Osarizawaite	Pb	Al,Cu,Fe	SO_4
Unknown	Pb	Al	SO_4
Arsenates			
Philipsbornite	Pb	Al	AsO_4,AsO_3OH
Unknown	Ba	Al	AsO_4,AsO_3OH
Arsenate-sulfates			
Beudantite	Pb	Fe	AsO_4,SO_4
Hidalgoite	Pb	Al	AsO_4,SO_4
Phosphates			
Plumbogummite	Pb	Al	PO_4
Phosphate-sulfates			
Corkite	Pb	Fe	PO_4,SO_4

Aheylite $(Fe,Zn)Al_6(PO_4)_4(OH)_8\cdot 4H_2O$

Aheylite, the iron analog of turquoise, was found in several specimens from the Bali Lo deposit, where it occurs as pale green "starbursts" of radiating prismatic crystals up to about 5 mm in size.

Alunite $KAl_3(SO_4)_2(OH)_6$

Although alunite is difficult to distinguish from the clay minerals in hand specimen, alunite appears to be a common mineral in the kaolinitic groundmass in many specimens from the Anticline deposit; EDS spectra of the groundmass frequently exhibit peaks due to K and S. In specimens in which it was positively identified, alunite is soft and earthy like the clay minerals, with a color that varies from white to pale cream. Although positively identified only in specimens from the Anticline, Bali Lo and Bali South prospects, it is probably present in the other prospects, as well.

Anglesite $PbSO_4$

Anglesite has been recognized in a few of the specimens from the Anticline prospect, but it may have been overlooked in others because of its similarity to other white minerals and the difficulty of distinguishing its EDS spectrum from that of cerussite ($S_{K\alpha}$–$Pb_{M\alpha}$ overlap). It is generally white and granular, although in several specimens it is present as a thin, colorless coating.

Antlerite $Cu_3(SO_4)(OH)_4$

Antlerite, in the form of blue-green crystals, was identified in only one specimen from the Anticline prospect; consequently it must be considered as a rare mineral at Ashburton Downs. However, considering that it is very similar in appearance to brochantite and pseudomalachite, other occurrences may have been overlooked.

Arsentsumebite $Pb_2Cu(AsO_4)(SO_4)(OH)$

Arsentsumebite appears to be relatively rare in the Anticline assemblage, and was not found at the other prospects, but there is a possibility that other occurrences may have been overlooked because of its similar appearance to duftite and members of the adamite-olivenite series. It occurs mainly in the form of tiny pale green, yellowish green to pale olive-green crystals with a distinctly rhombohedral aspect. Arsentsumebite has also been observed as cryptocrystalline pale green to yellowish green masses, very similar in appearance to osarizawaite.

Figure 4. **Arsentsumebite crystals (SEM micrograph) from the Anticline prospect; the largest crystal is about 30 µm on a side. Specimen no. 6441; photo by E. H. Nickel.**

Ashburtonite $HPb_4Cu_4Si_4O_{12}(HCO_3)_4(OH)_4Cl$

Ashburtonite, a complex new mineral recently described by Grice *et al.* (1991), occurs as striking blue prismatic crystals in a substantial number of specimens from the Anticline prospect. The crystals, which are up to 0.4 mm in length, tend to occur in radial clusters up to about 1 mm in diameter. Ashburton Downs is the type locality and source of the name.

Atacamite/Paratacamite $Cu_2Cl(OH)_3$

Atacamite and paratacamite are dimorphs which here cannot be differentiated by their appearance, and can be distinguished only by their X-ray diffraction patterns. Both minerals are present in the Anticline assemblage; patterns corresponding to both minerals were obtained, but it has not been possible to determine which of them predominates. These minerals are fairly common, not only in the Anticline material, but also in the Bali Lo, Bali East and Stockyard Creek prospects. Atacamite and paratacamite occur as massive green to bluish green aggregates, veinlets and fracture coatings, with a luster varying from dull to vitreous. They are similar in appearance to some of the other bluish green minerals such as bayldonite, pseudomalachite and brochantite.

Aurichalcite $(Zn,Cu)_5(CO_3)_2(OH)_6$

Aurichalcite is apparently quite rare; it was found in only one specimen, as greenish blue flakes, from the Anticline prospect.

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

Azurite occurs as bright blue crystals up to about 2 mm in size at the Bali Lo and Bali South prospects, and in radiating bluish black crystal clusters up to about 1 cm at the Stockyard Creek prospect.

Barite $BaSO_4$

Barite was identified in a number of specimens from the Bali Lo, Bali South and Bali East prospects where it occurs as colorless to white crystals, sometimes stained bluish or brownish.

Bayldonite $(Cu,Zn)_3Pb(AsO_4)_2(OH)_2\cdot H_2O$

Bayldonite is fairly common in the Anticline and Bali Lo prospects, where it was observed in the form of porous dull green to blue-green masses and as vitreous emerald-green crystalline aggregates. Although the emerald-green color is similar to that of malachite, the bayldonite can be distinguished by the habits of its crystals, which are generally equant or bladed, in contrast to the more prismatic malachite.

Figure 5. Ashburtonite crystal clusters to 0.3 mm from the Anticline prospect. Specimen no. 7648; photo by E. H. Nickel.

Figure 6. Yellow laurionite flakes from the Anticline prospect; the flakes average about 1 mm across. Specimen no. 6501; photo by B. J. Gartrell.

Figure 7. Libethenite in green pseudo-octahedral crystals from the Anticline prospect; the crystals average about 0.15 mm in diameter. Specimen no. 4541; photo by B. J. Gartrell.

Figure 8. Metazeunerite crystals from the Bali Lo prospect; the crystal in the center of the field is 8 mm to a side. Note the perfect orthogonal cleavage. Specimen no. 7869; photo by B. J. Gartrell.

Figure 9. Clusters of yellow tsumcorite crystals from the Anticline prospect; the clusters average about 0.15 mm in diameter. Specimen no. 7182; photo by B. J. Gartrell.

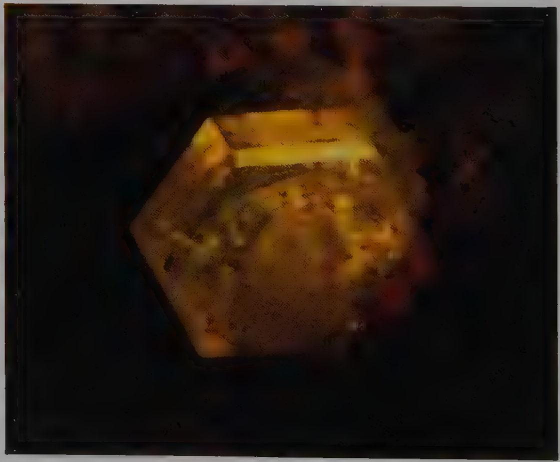

Figure 10. Yellow hexagonal crystal of mimetite from the Ledge prospect; the crystal is about 4 mm across. Specimen no. 5135; photo by B. J. Gartrell.

Beaverite $PbCuFe_2(SO_4)_2(OH)_6$

Aluminian beaverite was found in one specimen from Bali Lo as tiny brownish yellow crystals. Tiny yellow crystals of beaverite were also found in a few specimens picked from dumped material from the Anticline shaft excavation.

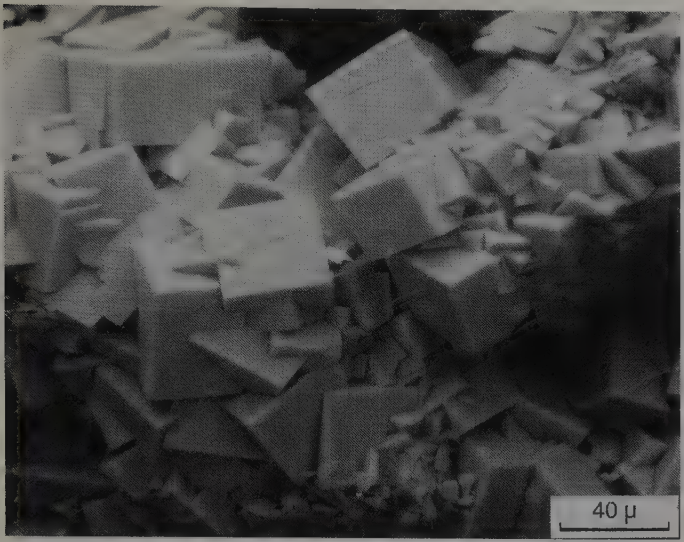

Figure 11. **Beudantite (SEM micrograph) in pseudo-cubic crystals from the Anticline prospect; the average crystal size is about 40 μm. Specimen no. 6457; photo by E. H. Nickel.**

Beudantite $PbFe_3(AsO_4)(SO_4)(OH)_6$

Beudantite is one of the most common secondary minerals in the Anticline and Bali Lo assemblages. It occurs as fine-grained earthy powder varying in color from yellow to greenish yellow to tan, and as tiny yellow, greenish yellow, orange and brown crystals. Under the SEM, the crystals are commonly seen to be in the form of pseudo-cubic rhombohedra. Some of the specimens contain appreciable aluminum, indicating solid solution with philipsbornite [$PbAl_3(AsO_4)(AsO_3OH)(OH)_6$] or hidalgoite [$PbAl_3(AsO_4)(SO_4)(OH)_6$]. Others exhibit a low sulfate/arsenate ratio which suggests compositions tending toward a sulfate-free arsenate analog of beudantite or an iron analog of philipsbornite, with a composition approximating $PbFe_3(AsO_4)(AsO_3OH)(OH)_6$. One specimen from the Anticline prospect was found to contain a substantial amount of zinc.

Bindheimite $Pb_2Sb_2O_6(O,OH)$

Bindheimite was observed in only one of the Anticline specimens, where it occurs in the form of buff powder coating fracture surfaces.

Brochantite $Cu_4(SO_4)(OH)_6$

Brochantite was identified from all the prospects with the exception of Ledge. It occurs chiefly in the form of clear, vitreous, emerald-green to bluish green crystals and, to a lesser degree, as green to bluish green powder. The crystals are prismatic, not unlike those of malachite. Brochantite is therefore easily mistaken for malachite, which is generally much more abundant. The color of brochantite is also very similar to those of pseudomalachite and bayldonite, but brochantite can generally be distinguished from these minerals by its prismatic morphology.

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

Caledonite is a relatively common mineral in both the Anticline and Bali Lo assemblages, although it was not found at the other prospects. It occurs predominantly as clusters of tiny blue, greenish blue to green crystals in cavities. The crystals vary in shape from tabular to bladed, some of which have an unusual ribbed texture.

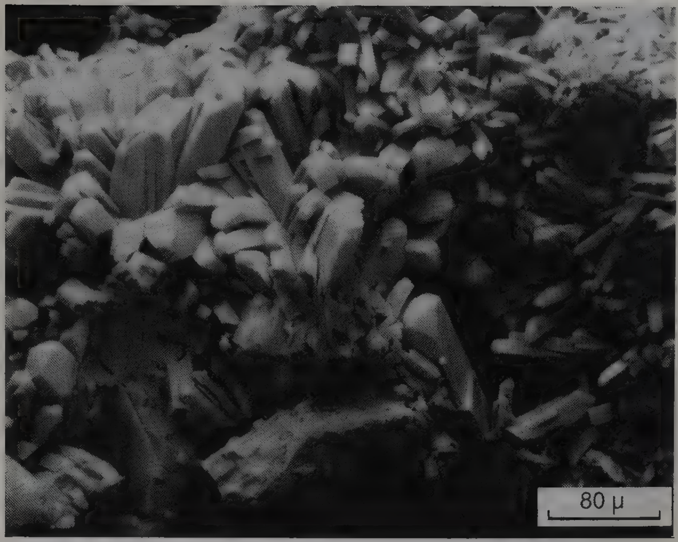

Figure 12. **Brochantite (SEM micrograph) in prismatic crystals from the Anticline prospect; the largest crystals measure about 30 by 120 μm. Specimen no. 6439; photo by E. H. Nickel.**

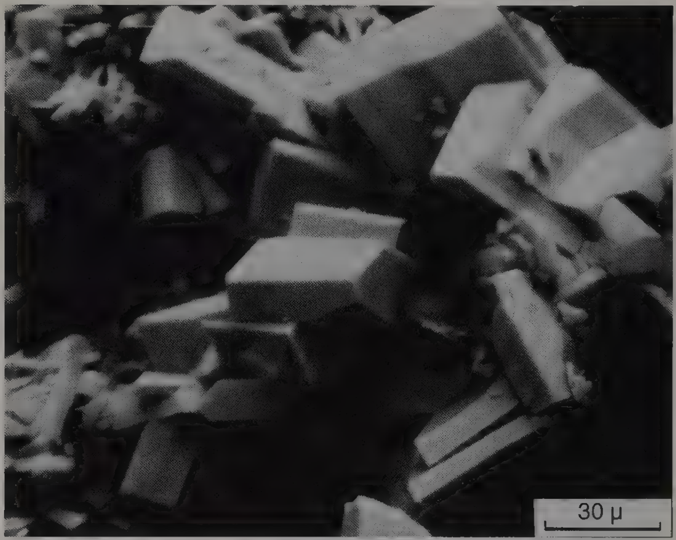

Figure 13. **Caledonite (SEM micrograph) in tabular crystals from the Anticline prospect; the crystal in the center of the field measures 20 by 35 μm. Specimen no. 6531; photo by E. H. Nickel.**

Caledonite also occurs as massive blue to bluish green veinlets and coatings, some of which have a distinctly waxy appearance.

Carminite $PbFe_2(AsO_4)_2(OH)_2$

Carminite is common in the Anticline assemblage, but was not observed in material from the other prospects. Its typical occurrence is as vitreous reddish brown masses, although it was also observed as brick-red powder and as tiny red to brownish red prismatic crystals. Carminite is similar in appearance to its recently-described dimorph, mawbyite (Pring *et al.*, 1989). The two minerals can, however, be distinguished by their crystal shapes, the carminite occurring as elongated prisms in contrast to the "dog-toothed" mawbyite crystals. The X-ray diffraction patterns of the two minerals are also appreciably different, and a number of diffraction patterns taken of this mineral from different specimens all proved to correspond to carminite. In its massive form carminite is difficult to distinguish from iron oxides and some of the more deeply colored cerussite and mimetite.

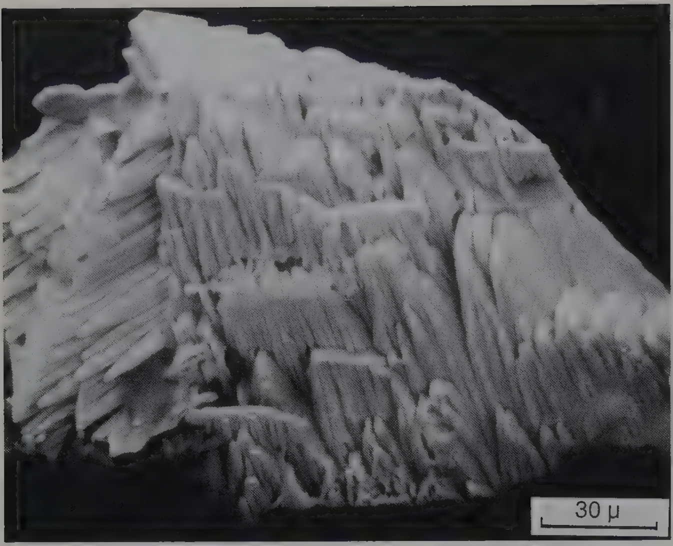

Figure 14. **Caledonite (SEM micrograph) showing a pronounced ribbed texture, from the Bali Lo prospect; the photographed fragment measures about 85 by 120 µm. Specimen no. 7868; photo by E. H. Nickel.**

Figure 15. **Carminite (SEM micrograph) in prismatic crystals from the Anticline prospect; the large crystal in the center of the micrograph measures 65 by 28 µm. Specimen no. 6494; photo by E. H. Nickel.**

Ceruleite $Cu_2Al_7(AsO_4)_4(OH)_{13}\cdot 12H_2O$

Ceruleite, found only in the Bali Lo assemblage, was observed as pale blue powder in patches up to 3 cm across, on fracture surfaces on two specimens.

Cerussite $PbCO_3$

Cerussite is ubiquitous in the Anticline material, being found in virtually all the specimens from that prospect; it was also found in a few of the Ledge specimens. Cerussite has a distinctive vitreous to adamantine luster that helps to distinguish it from some of the other minerals of similar appearance. It occurs most commonly as massive concentrations varying from colorless to a wide color range including pale blue, yellow, tan, grey, brown and black, but is also found as relatively large colorless crystals in cavities.

Chalcocite Cu_2S

Chalcocite was found in the Anticline, Bali Lo and Bali South prospects, where it indicates the incomplete oxidation of the primary sulfides. It is sooty black to bluish black. In the Anticline specimens it appears to have resulted from the oxidation of chalcopyrite, whereas in the Bali Lo specimens it appears to have been produced from the oxidation of tennantite. Polished sections of chalcocite from the Bali Lo occurrence show that chalcocite formation represents an intermediate phase in the conversion of primary tennantite to the final chenevixite boxwork. There is no clear indication of the chalcocite precursor in the Bali South specimens.

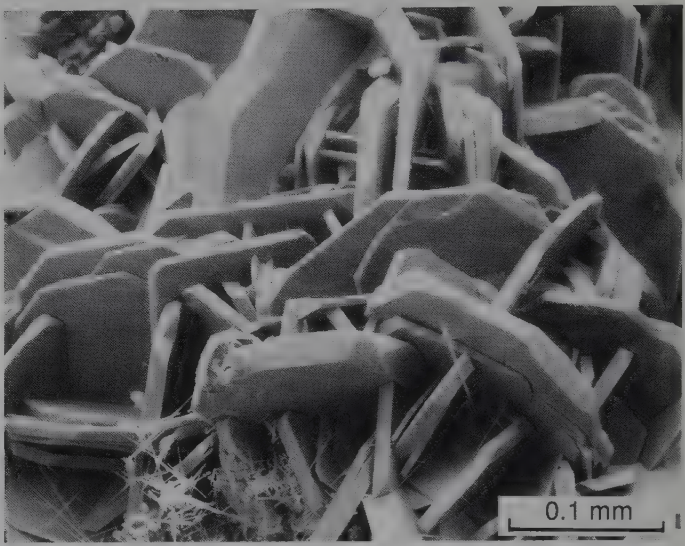

Figure 16. **Chalcophanite (SEM micrograph) in tabular crystals from the Anticline prospect; the largest crystal is about 0.2 mm in largest dimension. Specimen no. 6841; photo by E. H. Nickel.**

Chalcophanite $(Zn,Fe,Mn)Mn_3O_7\cdot 3H_2O$

Chalcophanite was found in a few Anticline specimens as a coating of superb black tabular crystals up to 2 mm in diameter; it was not observed in material from the other prospects.

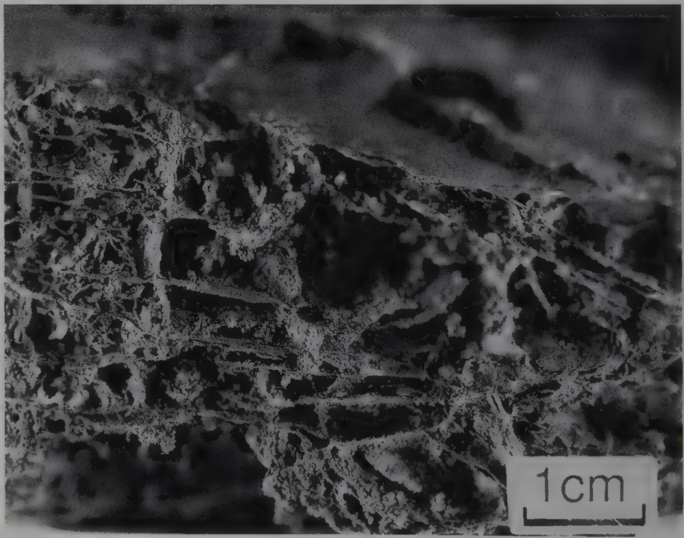

Figure 17. **Chenevixite boxwork resulting from the oxidation and dissolution of tennantite at the Bali Lo prospect; the largest cavities are about 1 cm in size. Specimen no. 7726; photo by B. J. Gartrell.**

Chenevixite $Cu_2Fe_2(AsO_4)_2(OH)_4 \cdot H_2O$

Chenevixite is particularly common in the Bali Lo prospect, and has also been found at the Anticline, Bali South, Bali East and Stockyard Creek prospects. At Bali Lo, the chenevixite, generally grass-green in color, is generally the major component of the cell walls of the boxwork produced from the oxidation of tennantite, and sometimes contains tennantite remnants. In places the chenevixite is brown due to the presence of ferric iron. Where the replacement of tennantite by chenevixite is complete the latter can be quite massive. In places, the chenevixite also occurs as a nodular precipitate and, less commonly, as yellowish green powder or tiny grass-green crystallites.

Chlorargyrite AgCl

Chlorargyite was found mainly in specimens from Bali South, where it occurs as yellow crystals up to 0.5 mm in size, which change to gray after exposure to light. Smaller black crystals of chlorargyrite were seen in a specimen from the Anticline prospect.

Chrysocolla $(Cu,Al)_2H_2Si_2O_5(OH)_4 \cdot nH_2O$

Chrysocolla was found in specimens from all the Ashburton Downs prospects. It is particularly prominant in material from Bali South where it occurs mainly as bright blue concretionary masses and coatings. Elsewhere it was noted as massive concentrations and fracture coatings varying in color from pale blue to greenish blue, and with a dull to waxy luster. It has also been observed as greenish blue spherules and as prismatic crystals, probably pseudomorphs after malachite.

Cinnabar HgS

Cinnabar is quite common in the Anticline and Bali East assemblages, but was not found in the others. Cinnabar occurs mainly as fine-grained red powder, but has also been observed as tiny red crystals.

Clinoclase $Cu_3AsO_4(OH)_3$

Clinoclase was found in a few of the specimens from Bali Lo and Stockyard Creek as well-developed dark blue to bright greenish blue crystals several millimeters in size; it has previously also been reported from Bali Lo by Bridge and Pryce (1978). The blue color of the mineral must be stressed here, because the color is given as green in some compilations, e.g. Fleischer and Mandarino (1991). The blue color of clinoclase has also been confirmed by examination of specimens from the type locality in Cornwall, England.

Conichalcite $CaCuAsO_4(OH)$

Conichalcite was found as a thin lime-green coating on a few specimens from the Bali East prospect; it was not observed at the other prospects.

Connellite $Cu_{19}Cl_4SO_4(OH)_{32} \cdot 3H_2O$

Connellite was found in the Stockyard Creek, Bali East and Anticline prospects as blue prismatic crystals. Although connellite is relatively rare at Ashburton Downs, the Stockyard Creek prospect is probably the best locality for this mineral.

Corkite $PbFe_3(PO_4)(SO_4)(OH)_6$

A mineral intermediate in composition between corkite and its aluminum analog, hinsdalite, was found in one Bali Lo specimen in the form of tiny bluish gray crystallites coating a fracture surface. The possible further presence of corkite in surface coatings of iron oxides in Anticline specimens is indicated by Pb and P in some EDS spectra of the oxides.

Cornubite $Cu_5(AsO_4)_2(OH)_4$

Cornubite was observed in specimens from the Bali Lo and Bali East prospects as relatively rare bluish green crystals, varying in shape from equant through tabular to acicular; the equant crystals tend to be pseudo-octahedra.

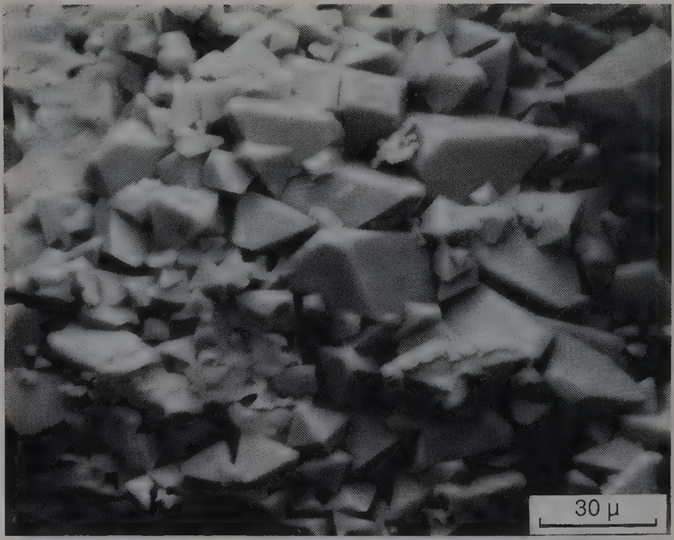

Figure 18. **Cornubite (SEM micrograph) in pseudo-octahedral crystals from the Bali Lo prospect; the largest crystal measures about 40 μm in greatest dimension. Specimen no. 7732; photo by E. H. Nickel.**

Cornwallite $Cu_5(AsO_4)_2(OH)_4$

Cornwallite, a relatively rare mineral at Ashburton Downs, was identified in a few specimens from the Bali Lo, Bali East, Bali South and Stockyard Creek prospects. It occurs as bright green crystal clusters up to about 0.2 mm in size.

Coronadite $PbMn_8O_{16}$

Coronadite is quite common in the Anticline and Bali Lo assemblages, where it occurs as black spots, patches and coatings. In appearance it is identical to the other manganese oxides, but is distinguished from them by the Pb peak in its EDS compositional spectrum.

Cryptomelane KMn_8O_{16}

Cryptomelane was identified in a few of the Anticline specimens, but because of its similar appearance to other black manganese oxides, it may be more common than it appears to be. It is distinguished compositionally from the other manganese oxides by its potassium content.

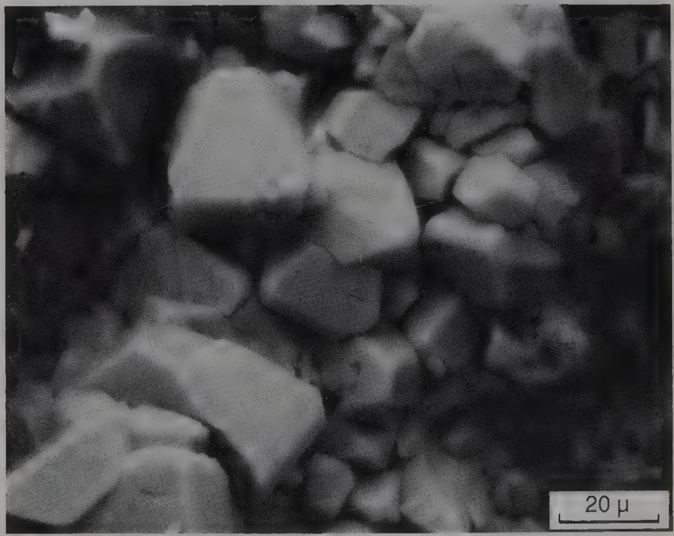

Figure 19. **Cumengite (SEM micrograph) in pyramidal crystals from the Anticline prospect; the largest grain is about 35 μm wide. Specimen no 6515; photo by E. H. Nickel.**

Cumengite $Cu_{20}Pb_{21}Cl_{42}(OH)_{40}$

Cumengite is a common mineral in specimens from the Anticline deposit where it occurs in both massive and crystalline forms. Its color is generally more greenish than that of diaboleite, but in some specimens the two minerals are difficult to distinguish. Under the SEM, the crystals tend to be equant, commonly with pyramidal facets.

***Figure 20*. Diaboleite (SEM micrograph) in a cluster of prismatic crystals from the Anticline prospect; the largest crystal is about 50 by 150 µm. Specimen no. 5904; photo by E. H. Nickel.**

Diaboleite $CuPb_2Cl_2(OH)_4$

Diaboleite is also a common mineral in the Anticline assemblage. It is mainly azure-blue in color, with variations ranging over dark blue, violet blue, greenish-blue and pale blue. It occurs mainly as massive fracture fillings and coatings, but also as crystals, usually with prismatic morphology, but occasionally tabular. In a few specimens it was observed in the form of bright blue powder.

***Figure 21*. Duftite crystals (SEM micrograph) from the Bali Lo prospect; the largest crystal is about 0.2 mm in length. Specimen no. 7868; photo by E. H. Nickel.**

Duftite $PbCu(AsO_4)(OH)$

Duftite is abundant at Anticline and Bali Lo, and was also found in specimens from the Ledge prospect. The mineral is generally present as tiny vitreous crystals varying in color from pale green through yellowish green and olive green to bright green, with yellowish green being the most common. The color is quite similar to that of some members of the olivenite-adamite series, but their crystal shapes are different. The duftite crystals, which can be up to about 1 mm in size, are generally equant, with well-developed crystal faces, sometimes dipyramidal, and sometimes more multi-faceted. The olivenite-adamite crystals, on the other hand, exhibit a greater tendency toward elongated prisms. Duftite also occurs as fine-grained, pale green powder, similar in appearance to chenevixite, and as fine-grained pale green to olive-brown masses.

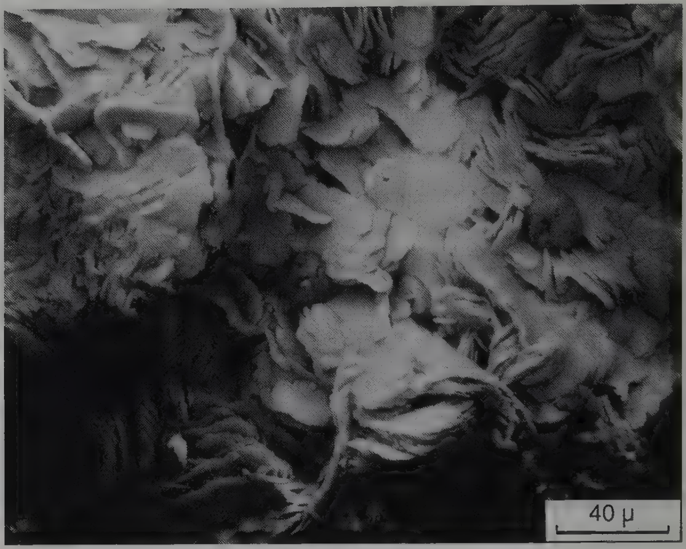

***Figure 22*. Gartrellite flakes (SEM micrograph) from the Anticline prospect; the largest flakes are about 40 mm in diameter. Specimen no. 5911; photo by E. H. Nickel.**

Gartrellite $Pb(Cu,Fe)_2(AsO_4,SO_4)_2(CO_3,H_2O)_{0.7}$

Gartrellite is a new mineral that was recently discovered at the Anticline prospect (Nickel *et al.*, 1989), where it is relatively common, and has also been seen in specimens from Bali Lo. It generally occurs in the form of a soft yellow to greenish yellow powder. Under the scanning electron microscope it is seen to have a flakey morphology. Gartrellite is similar in color to beudantite, with which it may be confused in hand specimen, but differs in appearance under the SEM, as beudantite tends to occur as equant crystals.

Goethite $FeO(OH)$

Goethite is a ubiquitous mineral in all the prospects, and is the major cause of the brown color of many of the specimens. In one specimen from the Anticline deposit it was observed as small, doubly terminated crystals up to 0.8 mm in size, probably pseudomorphs after siderite.

Groutite $MnO(OH)$

Groutite is indistinguishable in appearance from the other black manganese oxides, and has a similar mode of occurrence. Although it has been positively identified in only a few of the Anticline and Bali Lo specimens, it may be more abundant than this would indicate.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum, which is very similar in appearance to anglesite and barite, was identified in only a few of the Anticline specimens where it occurs mainly as white crystals. In one specimen it has a greenish blue hue which can be attributed to the presence of copper minerals.

Hematite Fe_2O_3

Hematite is a ubiquitous mineral at all the prospects. Together with goethite, it is largely responsible for the reddish brown appearance of many of the specimens.

Hemimorphite $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

Hemimorphite is a fairly common mineral in the Anticline assemblage. It occurs mainly as well-developed prismatic crystals up to about 1 mm in length, usually colorless, but sometimes reddish brown or salmon-colored, usually associated with hydrozincite and rosasite. It has also been observed as hard, massive aggregates varying in color from orange to brown and dark reddish brown, the darker colors being due to the presence of iron.

Hidalgoite $PbAl_3(AsO_4)(SO_4)(OH)_6$

Hidalgoite is a member of the alunite-beudantite-crandallite mineral group, with the ideal chemical formula shown above, but can tolerate complete substitution of Al by Fe_3^{+3}, and SO_4 by AsO_3OH, giving beudantite and philipsbornite, respectively. The Al and Fe_3^{+3} end-members are readily distinguished by their EDS spectra, but it is difficult to differentiate between the SO_4 and AsO_3OH end-members in the absence of a chemical analysis because the $S_{K\alpha}$ and $Pb_{M\alpha}$ peaks on the EDS spectrum are superimposed. Furthermore, the X-ray diffraction patterns of these minerals are virtually identical. However, careful measurement of the diffraction patterns of some yellowish crystallites from the Anticline and Bali Lo specimens have shown that the most intense reflection is intermediate between that of hidalgoite and that of philipsbornite, so it appears that these crystallites may represent an intermediate member of the hidalgoite-philipsbornite series. However, because of uncertainties inherent in this identification, the mineral may be closer to the philipsbornite end-member.

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

Hydrozincite is fairly common in the Anticline and Bali Lo material, where it occurs as granular, sometimes chalky masses varying in color from white to pink and pale blue, and as colorless acicular prismatic crystals similar to those of hemimorphite.

Jarosite $KFe_3(SO_4)_2(OH)_6$

Jarosite was found in a few of the Anticline specimens, generally as small orange to brown crystals which, under the SEM, are seen to be pseudo-cubes. It has also been observed intergrown with carminite, the mixture having a brick-red color.

Kaolinite $Al_2Si_2O_5(OH)_4$

Kaolinite is ubiquitous in specimens from all the prospects, and represents one of the main components of the matrix in which the secondary ore minerals are found. It is generally white in color, except where stained by iron and copper minerals, and is generally intermixed with quartz and alunite. The kaolinite probably represents the altered residuum of the sheared sedimentary rock that comprises the wallrock.

Laurionite/Paralaurionite PbCl(OH)

Laurionite and paralaurionite are another pair of mineral dimorphs that cannot be readily distinguished. They are considered to be very rare minerals, originally found as alteration products of submerged lead slags at Lavrion (Laurium), Greece, and subsequently reported from natural occurrences at Cornwall, England, the Turkmenian Republic of the USSR, Chile and Morocco. Laurionite and paralaurionite were found in only a few of the Anticline specimens, and therefore must be considered to be quite rare in the Ashburton material. They occur as earthy aggregates, sometimes with the outward form of flakes or crystals which probably represent pseudomorphs of pre-existing secondary minerals. The color ranges from white to pastel shades of cream, tan and green, the colors probably being due to intermixtures with other minerals.

Lavendulan $NaCaCu_5(AsO_4)_4Cl \cdot 5H_2O$

Lavendulan was observed in material from the Anticline and Bali Lo prospects, but only in small amounts. It occurs as bright blue powder on fracture surfaces.

Libethenite $Cu_2PO_4(OH)$

Libethenite is a rare mineral in the Anticline and Bali Lo assemblages, where it has been observed as isolated green pseudo-octahedral crystals, some of which attain 0.3 mm in size, and as an alteration product of pseudomalachite. The alteration product is pale green and pulverulent. Some crystals retain cores of the darker pseudomalachite, giving the grains a "fish-eye" appearance.

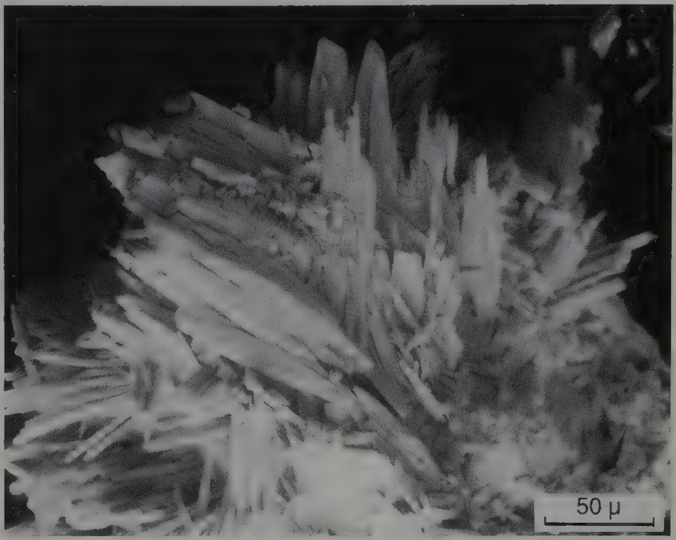

Figure 23. **Linarite (SEM micrograph) in prismatic crystals from the Anticline prospect; the largest crystals measure about 0.13 mm in length. Specimen no. 5896; photo by E. H. Nickel.**

Linarite $CuPb(SO_4)(OH)_2$

Linarite occurs in some of the Anticline specimens as bright blue crystals up to 0.5 mm in size, with variations toward greenish blue and dark blue. The crystals vary from tabular to prismatic. Some massive linarite was also seen.

Luetheite $Cu_2Al_2(AsO_4)_2(OH)_4 \cdot H_2O$

Luetheite, the aluminum analog of chenevixite, was found in a few specimens from the Bali Lo deposit as a pale blue powder. An emerald-green to pale green mass in one specimen was found to be an intermediate member of the chenevixite-luetheite series.

Malachite $Cu_2(CO_3)(OH)_2$

Malachite is a common mineral in all prospects, and occurs as massive bright green concentrations and as fine crystalline aggregates. The crystals are generally in the form of elongated prisms or needles, occasionally forming small spherules of radiating crystals.

Metatorbernite $Cu(UO_2)_2(PO_4)_2 \cdot 8H_2O$

Metatorbernite, one of two uranium-bearing minerals in the Bali Lo assemblage, was found in several of the specimens from that deposit. It occurs as transparent green, tabular crystals up to about 5 mm in size, on fracture surfaces. These crystals exhibit a pronounced orthogonal cleavage which gives them a rather micaceous appearance.

Metazeunerite $Cu(UO_2)_2(AsO_4)_2 \cdot 8H_2O$

Metazeunerite is the arsenate analog of metatorbernite, and was found in several of the Bali Lo specimens. It is pale green and very similar in appearance to metatorbernite. However, they can be distinguished by their EDS spectra, metazeunerite showing the presence of arsenic, and metatorbernite, phosphorus.

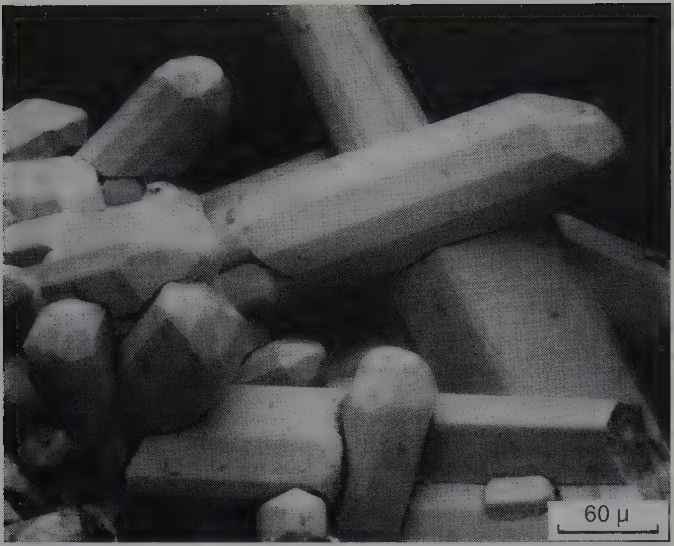

Figure 24. **Mimetite (SEM micrograph) in hexagonal crystals from the Anticline prospect; the large crystal near the center of the micrograph is 0.25 mm long. Specimen no. 6614; photo by E. H. Nickel.**

Mimetite $Pb_5(AsO_4)_3Cl$

Mimetite is a common mineral in the Anticline assemblage, and was also found at Bali Lo and Ledge. It frequently occurs in the form of small prismatic crystals which vary from colorless and white through a great color range from yellow to yellowish green, light brown, reddish brown and dark brown. Mimetite is also common as massive colorless, gray and brown material, similar in appearance to some of the massive cerussite and carminite. Some specimens exhibit overgrowths of coarse brown crystals several millimeters in diameter.

Mottramite $Pb(Cu,Zn)VO_4(OH)$

Mottramite is a rare mineral in the Anticline assemblage, and was not encountered in specimens from the other prospects. It occurs as tiny, equant, creamy crystals perched on the surfaces of other secondary minerals such as duftite and pseudomalachite.

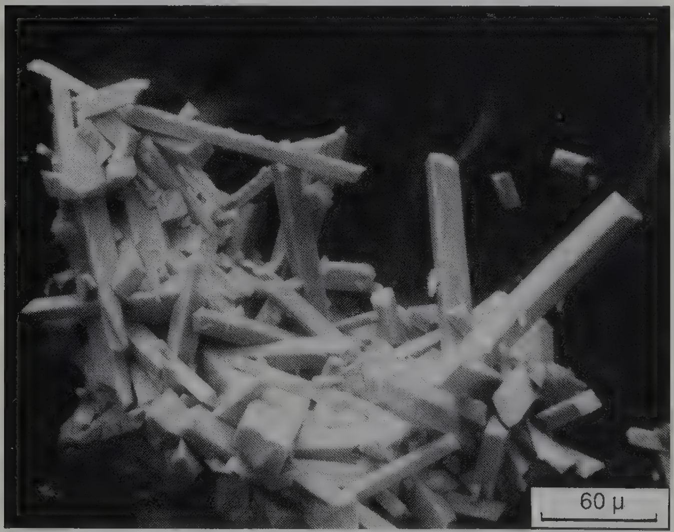

Figure 25. **Olivenite (SEM micrograph) in prismatic crystals from the Bali Lo prospect; the longest crystal in the micrograph is about 130 by 20 μm. Specimen no. 7732; photo by E. H. Nickel.**

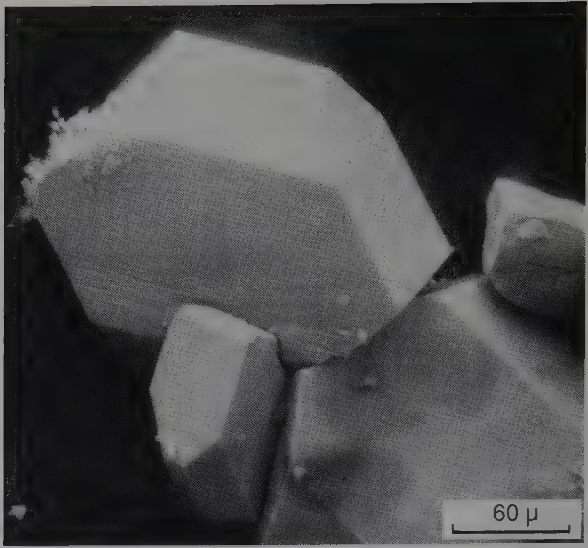

Figure 26. **Olivenite (SEM micrograph) in tabular crystals from the Bali Lo prospect; the large crystal is about 0.2 mm long. Specimen no. 7866; photo by E. H. Nickel.**

Olivenite $Cu_2AsO_4(OH)$

Olivenite is commonly found as crystals in the cells of the chenevixite boxwork, as well as in other cavities in all the prospects with the exception of Ledge. The crystals, which can be up to about 1 cm in size, tend to be prismatic, sometimes with a fibrous aspect, but in other specimens they are more equant or tabular. The color of the crystals is typically olive-green, sometimes tending towards pale brown, grayish green or pale green. Compositional EDS spectra of most specimens demonstrate the presence of appreciable zinc, which sometimes approximates the copper content; this indicates a wide range of solid solution with adamite, the zinc end-member of the olivenite-adamite solid-solution series. The paler colors tend to represent the zinc-rich members. Olivenite also commonly occurs in the form of a soft, chalky powder varying in color from pale green to buff and pale brown. In at least one specimen the olivenite was found to contain a substantial amount of iron; this olivenite is in the form of yellow powder, virtually indistinguishable from other yellow pulverulent minerals such as beudantite and gartrellite. Olivenite has also been observed in the form of massive bluish green veinlets.

Osarizawaite $CuPb(Al,Fe)_2(SO_4)_2(OH)_6$

Osarizawaite is a rare mineral in the Anticline and Bali Lo assemblages, and was observed in a few of the specimens as pale green massive material and veinlets. In one specimen it was seen as superb pale green pseudo-cubic crystals up to 0.1 mm in diameter. In appearance, osarizawaite is virtually indistinguishable from arsentsumebite.

Partzite $Cu_2Sb_2(O,OH)_7$

Partzite was observed as tiny yellow crystals closely associated with olivenite in a specimen from the Bali South prospect; it was not found in the other assemblages.

Perroudite $Ag_4Hg_5S_4(Cl,I,Br)_4$

Perroudite was recently described for the first time (Sarp *et al.*, 1987). It was found in a few Bali Lo specimens as small clusters of red prismatic crystals.

Pharmacosiderite $KFe_4(AsO_4)_3(OH)_4{\cdot}6\text{–}7H_2O$

A relatively rare mineral in the Anticline assemblage, pharmacosiderite was observed as pale yellowish green translucent crystals up to 0.2 mm diameter.

Figure 27. **A cluster of perroudite crystals (SEM micrograph) from the Bali Lo prospect; the largest crystal is about 85 µm long. Specimen no. 7722; photo by B. J. Gartrell.**

Figure 28. **Philipsbornite (SEM micrograph) in tabular crystals from the Bali Lo prospect; the largest crystal is 90 µm in diameter. Specimen no. 7735; photo by E. H. Nickel.**

Philipsbornite $PbAl_3(AsO_4)(AsO_3OH)(OH)_6$

Philipsbornite is present in a number of Anticline and Bali Lo specimens, and is generally in the form of massive aggregates, frequently soft and earthy. The color ranges from white through creamy yellow and greenish yellow to pale green, brown, and even pink, depending on composition and grain size. The yellow and greenish varieties can therefore be confused with gartrellite, duftite and chenevixite in hand specimen. However, the crystal morphology, as seen under the SEM, serves to distinguish philipsbornite from these other minerals. Most of the crystallites are pseudo-cubes, essentially identical to those of beudantite, but others occur as tabular crystals with rhombohedral facets, or as dipyramids.

As noted above under hidalgoite, a few of the specimens identified as philipsbornite may be closer to the hidalgoite end-member, but for the sake of simplicity, such specimens are referred to here as philipsbornite.

Plattnerite PbO_2

Platternite is a fairly common mineral in the Anticline assemblage,

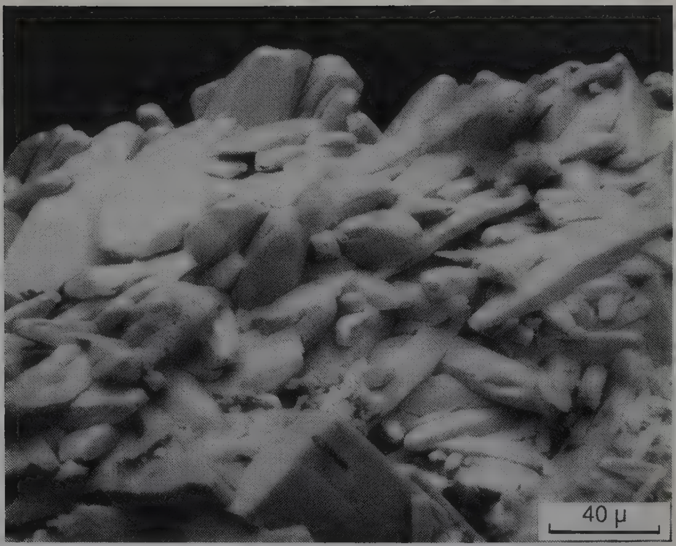

Figure 29. **Plattnerite crystals (SEM micrograph) from the Anticline prospect; the long crystal at the right-hand side of the photograph is 90 µm long. Specimen no. 6496; photo by E. H. Nickel.**

but was not found at the other prospects. It occurs in the form of shiny black crystals and as massive black concentrations and coatings; in its latter form it is virtually indistinguishable from the manganese oxides. In several specimens plattnerite was observed in fish-scale-like habits, possibly pseudomorphs of a pre-existing mineral. Sheaf-like aggregates were also observed.

Plumbogummite $PbAl_3(PO_4)(PO_3OH)(OH)_6$

Plumbogummite was found only in the Ledge prospect, as a yellow powder thinly coating some fracture surfaces.

Plumbojarosite $PbFe_6(SO_4)_4(OH)_{12}$

Plumbojarosite was found in several specimens from the Anticline prospect; in one of them it occurs as a brown powder; in another, as brown tabular crystals.

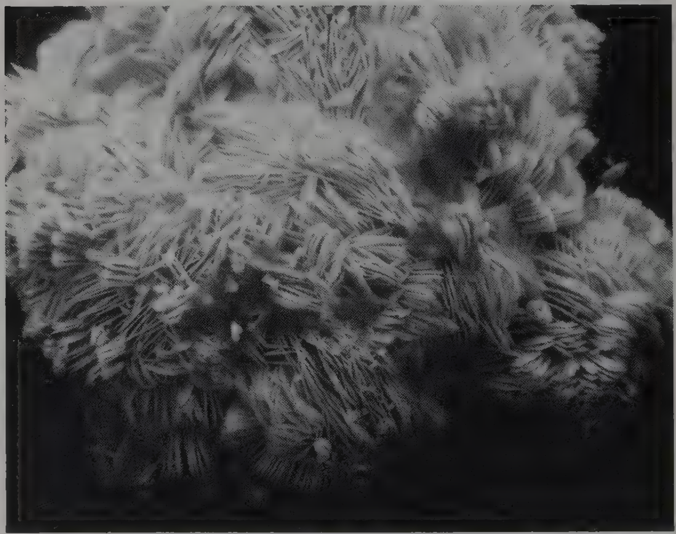

Figure 30. **Pseudomalachite (SEM micrograph) from the Bali Lo prospect, illustrating the flaky morphology; the individual flakes average about 60 µm in greatest dimension. Specimen no. 7736; photo by E. H. Nickel.**

Pseudomalachite $Cu_5(PO_4)_2(OH)_4$

Pseudomalachite occurs in the Anticline, Bali Lo and Bali East assemblages as patchy surface coatings, generally botryoidal, and commonly encrusted by tiny crystallites which generally have a flaky morphology, although the more normal prismatic forms have also been observed. Pseudomalachite is generally dark green to blue-green in color, and has been seen to alter to pale green libethenite. The Anticline and Bali Lo prospects are probably the best locations for pseudomalachite in Western Australia.

Pyrolusite MnO_2

Pyrolusite, a black botryoidal mineral, was identified in a specimen from the Bali Lo deposit. In appearance it is indistinguishable from the other black manganese oxides, and may therefore be more common than its identification in only one specimen implies.

Pyromorphite $Pb_5(PO_4)_3Cl$

Pyromorphite was found in specimens from the Ledge deposit as hexagonal crystals, commonly barrel-shaped, and varying in color from white to creamy, yellow and buff. It also occurs there as yellow to white botryoidal coatings. Pyromorphite was also found in one Anticline specimen where it occurs in the form of colorless hexagonal prisms.

Quartz SiO_2

Quartz is another of the ubiquitous minerals. It is a component of the kaolinitic mixture, and probably represents one of the residual minerals of the sheared sedimentary rock. It also occurs as a secondary mineral, frequently forming crystalline coatings on cavity walls.

Rosasite $(Cu,Zn)_2CO_3(OH)_2$

Rosasite is fairly common in the Anticline assemblage, and generally occurs as radiating clusters and spheroids of greenish blue to pale blue needles.

Scorodite $FeAsO_4 \cdot 2H_2O$

Scorodite is a rare mineral at Ashburton Downs, and was found only in a few specimens from the Bali Lo prospect as tan flakes up to 0.5 mm diameter.

Siderite $FeCO_3$

Siderite also appears to be a rare mineral at Ashburton Downs, and was identified only from the Anticline deposit where it occurs as dark brown crystals up to 5 mm diameter, coating quartz.

Silver (Ag,Hg)

Amalgam was found in several specimens from Bali East in the form of a porous black precipitate.

Tenorite CuO

Tenorite is another rare mineral at Ashburton Downs, and was identified in only one specimen from the Anticline deposit, where it is present in the form of irregular black patches, similar to those of the manganese oxides.

Tripuhyite $FeSb_2O_6$

Tripuhyite has been found in a few of the Anticline and Bali Lo specimens as yellow gel-like coatings and in fractures.

Tsumcorite $Pb(Zn,Fe)_2(AsO_4)_2 \cdot (OH,H_2O)_2$

Tsumcorite was found in only a few specimens from the Anticline prospect. It occurs as bright yellow crystal aggregates up to 0.3 mm in size. Under the SEM, the aggregates are seen to have a delicate feathery texture.

Wulfenite $PbMoO_4$

Wulfenite was found in only one specimen from the Ledge deposit, where it occurs in the form of small yellow crystals.

Uncharacterized Species

The arsenate analog of gorceixite. This material, believed to have a composition corresponding to $BaAl_3(AsO_4)(AsO_3OH)(OH)_6$, was found as clear, pale bluish green crystals in a specimen from the Bali Lo prospect. The crystals are pseudo-cubic in shape, similar to those of other members of the beudantite-crandallite group.

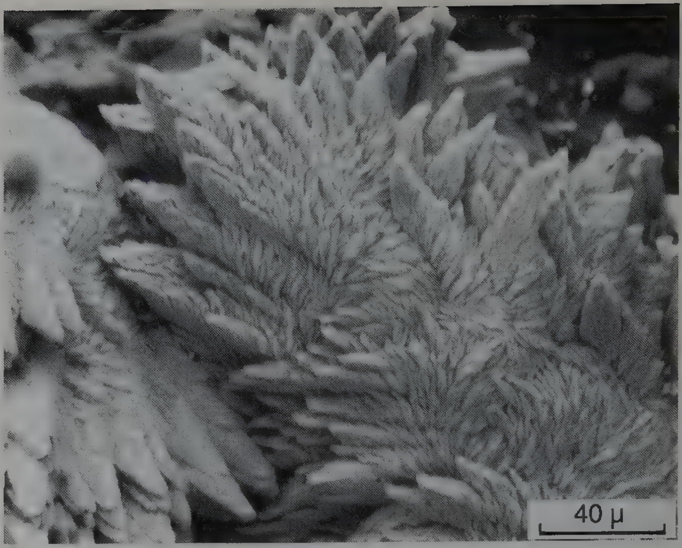

Figure 31. **Tsumcorite (SEM micrograph) in feathery aggregates from the Anticline deposit; the main cluster is about 0.15 mm in width. Specimen no. 7182; photo by E. H. Nickel.**

The arsenate analog of pseudomalachite. Material believed to have a composition corresponding to $Cu_5(AsO_4)_2(OH)_4$, was seen as nodular, mamillary coatings of a greenish blue color in specimens from Bali Lo. The X-ray diffraction pattern of this mineral is virtually indistinguishable from that of pseudomalachite, but its EDS spectrum shows that arsenic predominates over phosphorus. This mineral will be described in more detail elsewhere.

The Pb analog of alunite. This mineral was observed as a pale yellow powder on one specimen from the Anticline prospect. Its X-ray diffraction pattern is similar to that of alunite, but the EDS spectrum indicates the presence of lead instead of potassium. The mineral is therefore likely to be the Pb analog of alunite (or the Al analog of plumbojarosite), with a presumed composition of $PbAl_3(SO_4)_2(OH)_6$. Such a mineral has not yet been reported in the mineralogical literature.

Unknown Sulfide-Chloride of Ag and Hg. A few tiny grains similar in appearance to chlorargyrite, and containing major amounts of Hg, Ag, S and Cl were found in several of the Anticline specimens. The X-ray diffraction pattern of this mineral is similar to that reported for the ill-defined tocornalite, reportedly an iodide of silver and mercury. This unknown mineral therefore appears to be crystallographically related to tocornalite, but the small amount of material available precludes a detailed investigation.

Others. Several other unidentified arsenates were observed. One, containing Cu, Ca, Na, Cl, P and As, was found as a pale blue powder on two specimens from the Anticline deposit. The X-ray diffraction pattern of the mineral is characterized by an intense reflection at 10Å. No mineral combining these features is known.

Another unknown arsenate, this one from the Bali Lo deposit, occurs as concentrations of tiny, poorly developed, greenish blue crystallites in one specimen; the main chemical elements, as determined from its EDS spectrum, are Cu, Al, Fe and As, but its X-ray diffraction pattern could not be identified.

CONCLUSIONS

Although little is known about the primary mineralogy of the deposits at Ashburton Downs, some inferences can be drawn from the secondary minerals now found at the surface. The large number of minerals containing lead, copper, iron, zinc, arsenic and sulfur in-

(Continued on page 218)

Arizona Dealers

Dioptase—Ray mine

Bitner's, Inc.
42 West Hatcher
Phoenix, Arizona 85021
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Wholesale Minerals &
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pound or flat, since 1945

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Em's Gems Plus Three
Em & Ogle Love
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specimens for collectors
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Shows only.

Fosters
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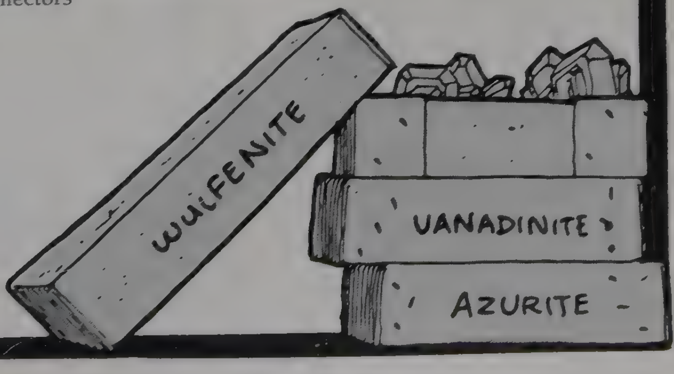
& Wayne Richards
1511 E. Edgemont Ave.
Phoenix, Arizona 85006
(602) 265-1567
No List. See us at
Major Shows.

Kino Rocks & Minerals
6756 S. Nogales Highway
Tucson, Arizona 85706
9-11:15/Noon-5:30
(Closed Sun.)
(602) 294-0143
No Catalog—No List

David Shannon Minerals
David & Colleen
6649 E. Rustic Drive
Mesa, Arizona 85205
(602) 985-0557

Maudine & Bob Sullivan
3202 Saguaro
West Trail
Tucson,
Arizona 85745
(602) 743-0081
See us at the major
shows only



ASHBURTON DOWNS *(Continued from page 216)*

dicates a primary mineralogy dominated by sulfides and arsenides of lead, iron, copper and zinc. Carbonate ions may well have been derived from the wallrock, and chlorine from saline groundwater.

The extraordinarily large variety of secondary minerals indicates a complex weathering history for the deposits, as equilibrium conditions must have undergone many changes. Rapidly changing equilibrium conditions are probably also responsible for the fact that no consistent correlations could be observed among co-existing minerals, and no paragentic sequence could be discerned. The relatively fine grain size of the secondary minerals may also have been the result of rapidly changing equilibrium conditions, but may also indicate a rapid dropping of the water table, giving insufficient time for large crystals to grow from solution. It is quite possible, however, that larger crystals of some of the secondary minerals will be found at depth where stable conditions could be expected to prevail for longer periods.

Another notable aspect of the secondary assemblages is the relatively large number of compositional variants of the alunite-beudantite-crandallite group. The general formula for minerals of this group can be expressed as $AB_3C_2(OH)_6$, where A can be represented by one or more of the cations K, Na, Ag, Ca, Sr, Ba, Pb, Ce, Th, Bi, H_3O or NH_4; B by Al, Fe or Cu; and C by the anions SO_4, AsO_4, AsO_3OH, PO_4 or PO_3OH. Other substitutions could probably be added to this list. Minerals of this group recognized in the Ashburton Downs assemblage, particularly in the Anticline and Bali Lo prospects, are listed in Table 2. This list demonstrates the extraordinary stability of this mineral group in a weathering environment, a feature that has already been recognized (e.g. Scott, 1987). By the same token, minerals of this group can be regarded as sensitive indicators of the chemical environment at the time of their crystallization. The chemical variations found among these minerals at Ashburton Downs provides ample evidence for frequent changes in the composition of the solutions percolating through the assemblage during the weathering process.

ACKNOWLEDGMENTS

We would like to thank Grant James, manager of Ashburton Downs pastoral station, and the management of Barrack Mines, for their cooperation in permitting the collection of specimens from the various deposits under their control.

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What's New in Minerals?

Pasadena Show

by Jeffrey A. Scovil

[November 28–29, 1992]

The annual Pasadena Show, sponsored by the Mineralogical Society of Southern California, has long had the reputation of being a high quality show. I had never attended the show, and decided that it was a good excuse to head over to California, do a little business while in the area and see what the show was all about.

The show was held, as it has been for many years, at the Pasadena Center, a spacious, modern, carpeted (much easier on the feet) hall. Both days of the show included lectures on a number of mineral localities as well as a meeting by the Geoliterary Society. On Sunday there was a symposium on "Collecting and protecting: Your rights as a collector under the law," sponsored by the Friends of Mineralogy, California Chapter. The presentations centered around the various laws and controversial amendments to those laws that could seriously affect our rights as collectors.

The quality of the exhibits overall was excellent. It is always enlightening to go to a show and see local minerals displayed that rarely make it out of the state. Besides local goodies shown by club members, there were exhibits by a number of the dealers and also by four museums. These were the Natural History Museum of Los Angeles County, Pasadena City College H. Stanton Hill Museum, San Bernardino County Museum, and the California Division of Mines and Geology. The one exhibit that stands out most in my memory was a single specimen (from the Al Ordway collection) of smoky quartz crystals on rich blue-green amazonite from Colorado. The piece is over 30 cm high, with superb color and form.

There were lots of good minerals to be had from the 44 retail dealers and ten wholesale dealers, but not a lot that was truly new. There were a few surprises though.

A pleasant surprise at the booth of *Primary Gems of California, Inc.* (1802 E. "G" St. #A, Ontario, CA 91764) was yellow **beryl** crystals from near Skardu, Pakistan. The crystals are up to 15 cm in length and a pleasing pale yellow color. Prices range from $75 to $400. The owner, Ernie Webber, had just received a new lot with a slight lime-green tint. Ernie says that he has been getting these crystals for about a year. There has been some concern expressed that these crystals are actually heat-treated aquamarines, but Ernie says he is sure they have not been tampered with.

A number of dealers had fine material from the former Soviet Union, with Bryan Lees of the *Collector's Edge* having the largest. *The Collector* (Fallbrook, CA) displayed several fine **silvers** from Dzhezkazgan, Kazachstan, and superb **axinites** from Puiva, Northern Urals, Russia. The latter are sharp, lustrous crystals with no matrix, from thumbnail to miniature in size. The big surprise at their booth, though probably passed over by many, was the **augite** from Thormalce, Pakistan. The specimens are actually subparallel aggregates of crystals forming very pleasing step-like groups. One specimen is associated with epidote, and another with quartz, but the others are free of matrix. Specimens are sharp and lustrous and may be the best of their kind. The black crystals average 6 cm long.

Ken Roberts of *Roberts Minerals* had a very impressive selection of **apophyllite** on stilbite from Jalgaon, India. The crystals are a beautiful green and blocky to prismatic in habit, nestled in a bed of pale peach-colored stilbite with an occasional heulandite.

A new find from California is *stibnite* in loose sprays of lustrous, thin crystals. Les Presmyk of *De Natura* told me that a single pocket of stibnite was found at the McLaughlin mine, Napa County, and he managed to get most of the lot. The McLaughlin mine is an open-pit gold mine, and the pocket was uncovered in late September, producing about 70 pieces. Specimens were available from small miniature to small cabinet size at $50 to $350.

Only two dealers were selling the Sweet Home mine **rhodochrosites** that caused such a stir at the Denver Show in September. Cal Graeber and *IKON Minerals* both had a nice selection of loose and matrix specimens from thumbnail to miniature in size. Cal also had the other specimen that really impressed me at the show. It is an 8.5-cm matrix group of **grossular** crystals from the Jeffrey mine, Asbestos, Quebec. There are only two crystals on the matrix, but they are a lustrous, gemmy orange. The matrix is covered with a fine druse of pale green vesuvianite crystals that contrast nicely with the orange of the grossular. Cal also had several thumbnail and miniature-size specimens for sale.

The finest **azurites** and **malachite** pseudomorphs after azurite to come out of Morenci, Arizona, were available from Wayne Thompson (1723 E. Winter, Phoenix, AZ 85020). Specimens consist of clusters and druses of azurite crystals on a very aesthetic matrix coated with chrysocolla. The azurite ranges all the way from quite blue and unaltered, to total malachite replacement. The new material was found just before the show and was available in a wide range of sizes.

Another exciting new find is the **zoisites** from near Skardu, Pakistan. The color is lighter and a little greener than the more familiar material from Tanzania, but they are very clean, gemmy and lustrous. They also tend to be more prismatic, with the longest crystal being 8 cm!

By now, all the mineral world is used to seeing the superb etched heliodors from Ukrainia, but you seldom see any of the other minerals the locality produces. I was surprised to see several fine, etched, sherry colored **topaz** crystals in the booth of Mark Rogers. There were no sharp faces left, just the typical interesting etch patterns of topaz on crystals up to 8 cm across.

In the wholesale room, *California Rock and Mineral* was serving more of the fine **vivianites** from Morococala, Bolivia. Tony had 6 flats of the material. He also had some very good quality **crocoites** from Dundas, Tasmania, which he had been keeping under cover for some time. There were single crystals to 5 cm in length, and also subparallel clusters. Still available were 12 flats of the Guererro **amethysts** that showed up about a year earlier. Last, but not least, was a flat of thumbnail-size **cerussites** from the Magnet mine, Tasmania. All specimens are loose singles of an attractive pale yellow color.

Tucson Show 1993

by Thomas Moore

[February 1–14]

Well—if this is the first half of February, then this must be Tucson. As I begin to write this in my room at the Executive Inn (once more the lone hotel in town seriously enriched in fine mineral dealers), the weather is breezy and partly cloudy, with intermittent light showers and temperatures in the 60's. But to reach the Providence airport from eastern Connecticut a few mornings ago I had to drive through a predawn blizzard, over slickenside roads, with temperatures in the 20's. So, pressed for time as I am (must finish this report before going home to snow, work, and reality), I will compress my usual introductory ramblings simply to observing that my room's sliding doors giving onto the balcony are standing wide open, and I am comfortable in short sleeves, and a mockingbird is loudly singing outside—so this *must* be Tucson.

Figure 1. **Green fluorapophyllite crystal (4.8 cm) on stilbite from Jalgaon, India. Roberts Minerals specimen; Jeff Scovil photo.**

Figure 2. **Augite crystals in parallel growth (6.2 cm), with quartz, from Thormalce, Pakistan. The Collector (Pala International) specimen; Jeff Scovil photo.**

Figure 3. **Beryl crystal (4 cm) from near Skardu, Pakistan. Primary Gems specimen; Jeff Scovil photo.**

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Figure 4. **Azurite crystal group, 7.5 cm, from the Morenci mine (Northeast Extension, 4750-foot level), Arizona. Mark Hay collection.**

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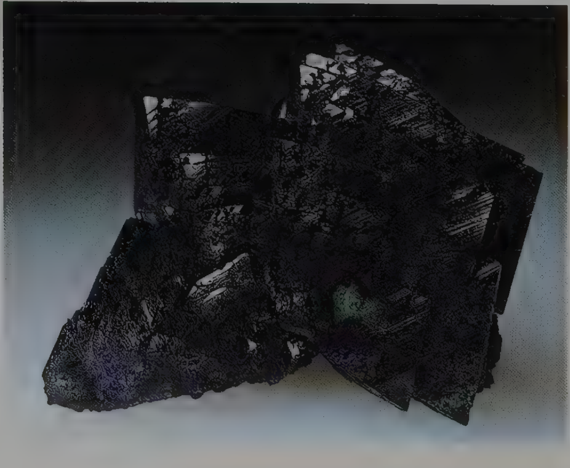

Figure 5. **Azurite crystal group, 4.3 cm, from the Morenci mine, Arizona. George Godas collection.**

Figure 6. Vanadinite, parallel crystal group, 2.8 cm, from the Ramsey mine, La Paz County, Arizona. George Godas collection.

Figure 7. Malachite after azurite pseudomorphs with a second-generation overgrowth of azurite, 8.8 cm, from the Morenci mine, Arizona. Dick Morris collection.

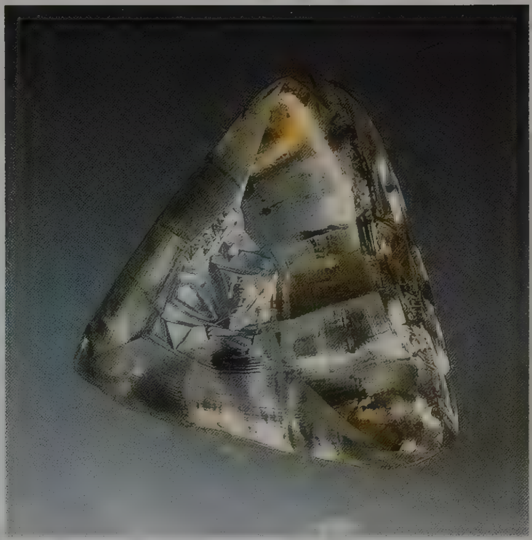

Figure 8. Diamond crystal (a spinel-law twin or "macle"), 1.2 cm, from northwestern Hunan province, China. D. J. Parsons specimen.

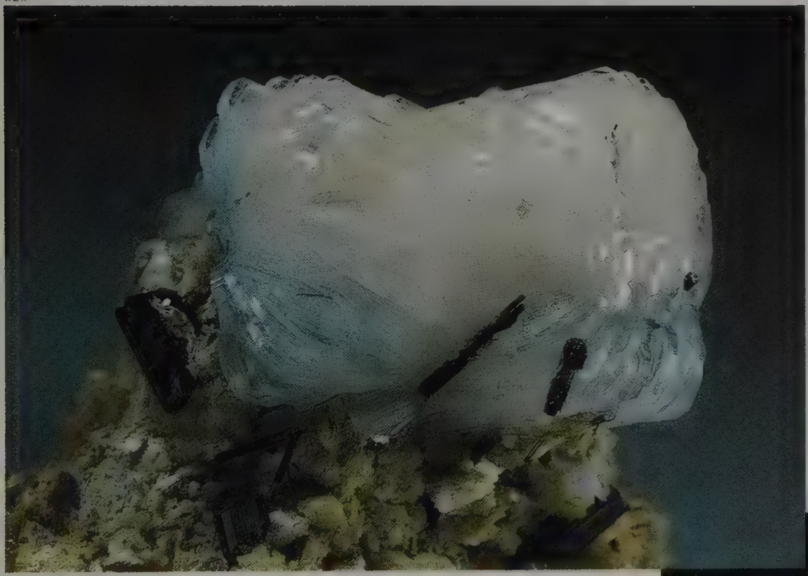

Figure 9. Bertrandite crystal sheaf, 3.3 cm, on pegmatitic muscovite matrix with dark green elbaite crystals, from Conselheiro Pena, Minas Gerais, Brazil. Edson Endrigo specimen, now in the Julio Landmann collection.

Figure 10. Scheelite, 6 cm, with pale blue beryl crystal, from Hunan, China. Mike Bergmann specimen.

Pre–Convention Center dealing is, of course, chugging right along. The crowds of hall-creeping buyers, tourists and curiosity seekers seem perhaps a bit thinner than they did last year at this point, and some of the dealers are grumbling a bit about slow business, but, all token pessimism aside, the Executive Inn show is again the mineral-rich experience that it is meant to be. And we have the occasional brief evening's juncture when free beer is offered outside by the pool to make us look up from our work. One can also take time out to view the actual Car That Got Hit By A Meteorite (recently in Peekskill, New York)—on display just outside the hotel's front entrance. But now the weather, I see, is dynamically clearing, that mockingbird is getting even louder, and my sore feet are glad that I am sitting down for awhile at last. So, relaxed, becalmed and balmed, I'll get to the matter of minerals without further delay, beginning with the:

Executive Inn ("Arizona Mineral and Fossil") Show

Two and a half months ago, an **azurite/malachite** pocket at the Morenci open pit, Morenci, Arizona, produced some of the best examples yet of this classic Arizona material. There are sharp small groups of unaltered midnight-blue azurite crystals, larger clusters of more rounded, also unaltered azurites, and other groups of this same style but with some or all of the azurite altered to green malachite. The collecting partnership of George Godas, Mark Hay and Dick Morris ("Arizona Minerals") is responsible for bringing out about 50 of these fine pieces. The same group may take credit also for some dazzling clusters (in assorted sizes) or small red/brown/greenish **vanadinite** crystals from the Ramsey mine, La Paz County, Arizona.

Another Western discovery of interest is a recent find of very nice **stibnite** from the McLaughlin mine, Napa County, California. Originally a mercury mine when it started up in the mid-1980's, the McLaughlin is now worked for disseminated gold in a geothermally deposited sulfide mass of considerable complexity (there are also silver minerals, very rare As, Sb and Ge sulfides, and hydrocarbons). The stibnites were available as swarms of thumbnails, as two very large matrix pieces, and as delicate loose jack-straw groups averaging 6 x 6 cm. The crystals are too acicular to show decent terminal faces, but are quite bright; some are dusted with what look like lint specks but are in fact perfect microscopic dolomite rhombs. These specimens were being offered by Jay and Christine Buscio of *Dry Creek Minerals,* Sacramento, CA (Tel. 916-366-0535).

Tom Wolfe Minerals (P.O. Box 9791, Fountain Valley, CA 92728-9791) again had a large assortment of mostly thumbnail **fluorite** from a variety of U.S. localities, but he also had something new: about 50 specimens, in all sizes, of very pale purple **creedite** from the Hall mine, Nye County, Nevada. The crystals are only about 2 mm at best but are sharp, and form very pretty sparkling druses over white matrixes; they do not compare to Mexican or Kazakhstan creedites but are likable both for aesthetics and price (a good thumbnail averaged $25); besides, they are an old hoard, the mine having closed in 1984.

I will say something later about the already renowned Colorado rhodochrosite rush of this past year; otherwise, in terms of Colorado material, the fine thumbnail **phenacite** newly found at Mt. Antero, Chaffee County, is of top interest. *Dave Bunk Minerals* (9240 W. 49th Ave., #317, Wheat Ridge, CO 80033) had a stashed-away flat (stashed away from display lamps because, Dave said, color alteration from exposure to light might possibly be a problem) with about ten thumbnail phenacites all priced around $100. Some of these loose crystals are single rounded rhombs, others twins, others greatly elongated "prismatic" rhombs of the Anjanabonoina, Madagascar, type. They are translucent to transparent, with colors ranging from a milky dull yellow to a high-lustered pale yellow-orange; they are in general near the top of the scale for Antero phenacite specimens of this size.

One does not want to dwell too much on yet another roomfull of **copper and silver** specimens from the Michigan copper country, as this region, especially the White Pine mine, has been fairly prolific in recent years. But some of the White Pine pieces being shown by *Red Metal Minerals* (Hwy. 203, P.O. Box 45, Hancock, MI 49930) were indeed exquisite. The copper occurs as demented-looking boxy mazes of tiny stacked cubes, all right-angle jerks and turns; the best silvers tend to be the more familiar, delicate branching groups with occasional white calcite crystals in the interstices. A few of the coppers are partly coated with an earthy, bright blue or blue-green substance believed to be calumetite, though definitive determination has yet to be made. The White Pine mine reportedly is almost finished now, with lower-level workings producing these extraordinary small specimens from vugs in a faulted and brecciated zone.

The Dixie delegation may be spoken for by Jennings "Beau" Gordon of *Jendon Minerals* (P.O. Box 6214, Rome, GA 30162-6214), who had some attractive examples of a find made last August at Cold Water Creek, Rock Branch, Elbert County, Georgia: pale **amethyst** crystals on milky quartz crystals on a weathered granitic saprolite. There are singly implanted amethysts, small groups and almost-scepters sitting nicely on the milky quartz; the color is pale, but the amethysts can reach 5 cm across. Also from Georgia, a bulletin: organized groups are now being allowed to collect again, after many *verboten* years, at the famous Graves Mountain locality, and Gordon had some nice large **rutile** crystals to prove it. Word is that the most attractive specimens recently dug here are actually iridescent black turgite (though none of these were on hand at Tucson).

Finally in the U.S., Gary Stacy (*The Lone Prospector,* 148 Rowley St., Gouverneur, NY 13642) filled his room with hundreds upon hundreds of the cubic **magnetite** specimens (briefly mentioned in an earlier report) from the 2500-foot level of the Zinc Corporation of America's #4 mine near Balmat, Saint Lawrence County, New York. These were collected last year from a pocket zone now exhausted (although, since this is an active mine, more strikes are certainly possible). The sharp, bright, black magnetites can come embedded in white calcite/anhydrite matrix, but vastly more common are loose groups or singles, with crystals reaching 2 cm on a cube edge. They are extremely lustrous, either unmodified cubes or showing shallow bevels of other forms. There is some damage on almost all of the specimens, but when this is hidden by intelligent display-orientation, the specimens are quite impressive-looking in their brightness and weird (for magnetite) morphology. Prices for the best thumbnails ranged up to $75; one spectacular 8 x 8-cm matrix group with aesthetically placed 1.5-cm cubes was priced in four figures.

And now on to foreign lands:

To begin with a bang: Carlos Barbosa, Brazil's Grand Old Man of specimen mineralogy, had, hidden lovingly away in a drawer in his bedside table, what are unquestionably (by an order of magnitude or so) the best **bertrandites** ever found anywhere, not even excepting the new ones from Kazakhstan. The locality is the Golconda mine, 30 km from Governador Valadares, Minas Gerais, Brazil—a place whose bertrandites heretofore were only of microscopic size. In the new pocket, struck last year, 15 specimens were found with white glassy bertrandite crystals to 5 cm long, arranged in parallel "sheaves" slightly pinched at the waists; at first glance one's thought is of Indian stilbite, although the next glance shows that luster and associations here are quite otherwise. Those associations include white albite, small muscovite books, and gemmy dark green elbaite prisms which stick up out of the sides of the sheaves; bright luster and the presence of chevron-arranged terminal faces on the ends complete the aesthetic presentation. Carlos (Rua Cel. Roberto Soares Ferreira, 586 CEP 35030, Governador Valadares, M.G., Brazil), had only six specimens left when I saw him, the other nine having already gone to major collections; of these last six, the $800 thumbnail will always have a place in my memory banks (file under Regret).

Switching now to the top end of the New World, there were, generally, good Canadian things around: respectable showings of Mont Saint-Hilaire and Rapid Creek minerals of the familiar kinds, some interesting resurrections of older occurrences, and some really new things too. *Grenville Minerals* (P.O. Box 453, Kingston, Ontario, Canada, K7L 4W5) had a dozen large and fine cabinet specimens of vitreous, partially transparent, green-purple **apatite** crystals, doubly terminated and to 12 cm long, in the familiar cleavable orange calcite, from the Yates mine, Sandy Creek, Quebec. The host vein, once well exposed, is now underground, and major bench blasting will be required to reach it again, so these classic brutes may be gone again for a while from the market. Also, at the same dealership, a few really good specimens, mined in October 1992, of the old-time glassy dark brown flattened **titanite** crystals from Bear Lake Road, Monmouth Township, Ontario, were on show. About every ten years, the field men say, this old locality coughs up more fine titanites; this time about 2,000 pieces in all sizes were recovered. They are flattish groups 5 cm long on the average; one single 6-cm crystal is penetrated by a euhedral black 2.5-cm hornblende. At Grenville Minerals, too, for rare-species fans, there were some miniatures of acicular **kermesite** and **valentinite** on massive **native antimony** from the Lac Nicolet mine, Ham Sub Township, Quebec. The flat-lying sprays of bright maroon kermesite look much like the Pezinok, Slovakia, ones, and the shiny off-white tufts of valentinite, though small, are attractive in a minor-keyed way.

Tyson's Minerals (10549-133 St., Edmonton, Alberta, Canada, T5N 2A4) had a large lot of vividly bright black **manganite** in tight crusts of small crystals with quartz crystals filling seams in massive iron oxides from the Caland Pit, Atikokan, Ontario. Also with the Tysons were some quite lovely long stalactitic groups of milky white **halite** cubes, individuals 1–2 cm on edge, stalactites to a foot long, from the P.C.S. Rocanville mine, Rocanville, Saskatchewan. And here I learned how promising for good **sphalerite and galena** specimens is the brand-new Sa Dana Hess lead-zinc mine (the name is an adaptation from an indigenous Indian language) at Watson Lake, Yukon: the 2 to 4-cm sphalerites are very sharp (though dull-lustered, coated thinly with something or other), and the galenas which cling to them *are* brightly lustrous. Noteworthy too is the Tysons' lot of **edingtonites** from the Ice River, British Columbia, locality, with thousands of small white prisms densely covering vug openings in sometimes huge hunks of felsic rock.

And now to revisit, at least in this distant mineralogical sense, old Europe:

Spain this year continues to provide fine **fluorite** of many hues, and enough cubic **pyrite** groups to sink the *Bismarck*, but the one noteworthy new Spanish occurrence I saw was of the homely-but-interesting variety. Jordi Fabre (C/Arc de Sant Martí 79 Local 09032, Barcelona, Spain) offered eight cabinet pieces, the matrix of which consisted of a densely packed, silvery muscovite and the crystals—grayish-pink blocky ones to 8 cm long—of **andalusite.** The crystal edges are fairly sharp, and their sides are splotched and smeared with more of the muscovite gruel. They certainly are excellent large crystallizations of a common mineral rarely seen in presentable specimens; the locality is Sierra Albarrana, Cordoba Province.

Dramatically sexier, though, as well as far more recognizable, were two flats of classic English **fluorite** in the custody of Mike Bergmann (713 S. Bench St., Galena, IL 61036). One flat held a few large matrix plates (one a foot long), each plate populated to just the aesthetically right extent with 2-cm penetration-cube twins, from the Rogerley mine, Weardale, England; their color is the stunningest possible deep oily green, glowing faintly purplish in the ultraviolet from the sunlight coming in through the window. The other flat featured more and smaller fluorites of the same general aesthetic style but of a gray-violet transparent color, equally gorgeous, from Frazer's Hush mine, Rookhope, Durham. Very seldom at shows, even in Europe, have I seen better old English fluorites than these, or less damaged, cleaner ones. We will hear from Mike Bergmann again, later in this report.

The best European surprise, though, was a fresh yield from another old classic locality: La Combe de la Selle, St. Cristophe en Oisans, Iseré, France. You guessed it: glowingly translucent lime-green **prehnite** in spheres and rounded coxcombs, with minor yellow-green epidote and "asbestos"; these were collected in August 1992, and surpass, for general class, all other French prehnites I remember having seen for sale. The handler was Michel Jouty (231 Route des Nants, 74400 Chamonix, France), who told me of how this mountain (*combe*) rises picturesquely and very steeply from the tiny village of St. Cristophe to a glaciated peak at 3000 meters. A respectful hat-tip, thus, to the field collector, Patrick Hallier of Grenoble, who had to rappel down the cliffside, then drill into very hard amphibolite to get at the mineralized fissure. His reward was a 1.5-meter cavity from which about 100 prehnite specimens, 20 of them of highest quality, were extracted; of these, 12 miniatures and large thumbnails were available in Jouty's room, priced (very reasonably, I think) between $100 and $250.

While I am still in Jouty's room I will pass on a what's-new-type flash from him: loose, subhedral, 1-cm octahedrons of **native lead** were found last December at El Dorado, Gran Sabana, Venezuela—a bit north of the gold-mining region in the southern, jungly, part of the country. Confirmation of the identity has been provided by the Geneva Museum of Natural History. They are dull-lustered and, well, lead-gray, and Jouty had two; a few others may be kicking around in Europe, and, of course, more may emerge in time.

From Germany there was a random scattering of Freiberg and Erzgebirge **wire silvers** in various rooms, but the only saliently active locality seems still to be the Pöhla mine near Crottendorf, in the Saxon Erzgebirge. Besides the fine (now quite familiar) orange barites and dendritic silvers on arsenic, this mine has lately been giving up a few monumental specimens of **nickeline** in tarnished bronze metallic balls of distinct cubic crystals over a crumbly (unstable, one fears) pyrite matrix. What's probably the world's best nickeline of this type is a 25-cm specimen owned by Manfred Schwarz of Aue, displayed at the lobby stand of Tideswell Dale Rock Shop (Commercial Road, Tideswell, Derbyshire, England).

Although Tsumeb now seems moribund, and the N'Chwaning/Wessels mine complex has nothing new to add to its statements of last year, Denis Gravier of the French dealership *Le Mineral Brut* (Chemin de Ronde, Ambronay, France 01500) was showing some interesting things gathered lately in Madagascar by his partner Fabrice Danet. The best of them was **rhodizite** (a rare borate long known from some Madagascar pegmatites) from the Sahatany Valley, as bright yellow to milky white dodecahedrons, either loose or in matrix, to 2 cm across. The matrix is a chowdery lithium pegmatite with coarse areas of feldspars, spodumene, and even fractured red elbaite, all this busyness threatening to upstage the yellow embedded rhodizites; a good thumbnail of this sort could be had for around $30. Also, Gravier had some quite beautiful, yellow, gem-clear **orthoclase** in slightly rounded, pitted crystals, selling for $4/gram.

Having now surrounded the ex-Soviet Union on most sides, we are almost ready to move in on it, but first, on the way, we must look at a bit of what's new in the People's Republic of China.

For what could seem newer than a fine, Chinese, 1.25-cm, 7.5-carat "macle" **diamond**? Doug Parsons (1119 S. Mission Road, Suite 243, Fallbrook, CA 92028) had only the one crystal, which came from an area of active alluvial diamond mining in northwestern Hunan Province; in fact, Doug says, there are two or three presently active Chinese diamond mines which have been productive of gems for about five years now. So when government-sanctioned import/export activities now in the planning stage indeed commence, we can reasonably expect to see more Chinese diamonds. This one, meanwhile, is a fine example of the flattened octahedron twins called macles; it is colorless and of cutting quality, though there are some black carbonaceous inclusions.

And then there's Mike Bergmann (again), with his outstanding Chinese **scheelite** crystals, and just as outstanding Chinese **aquamarines** from the same occurrence, and even one piece showing

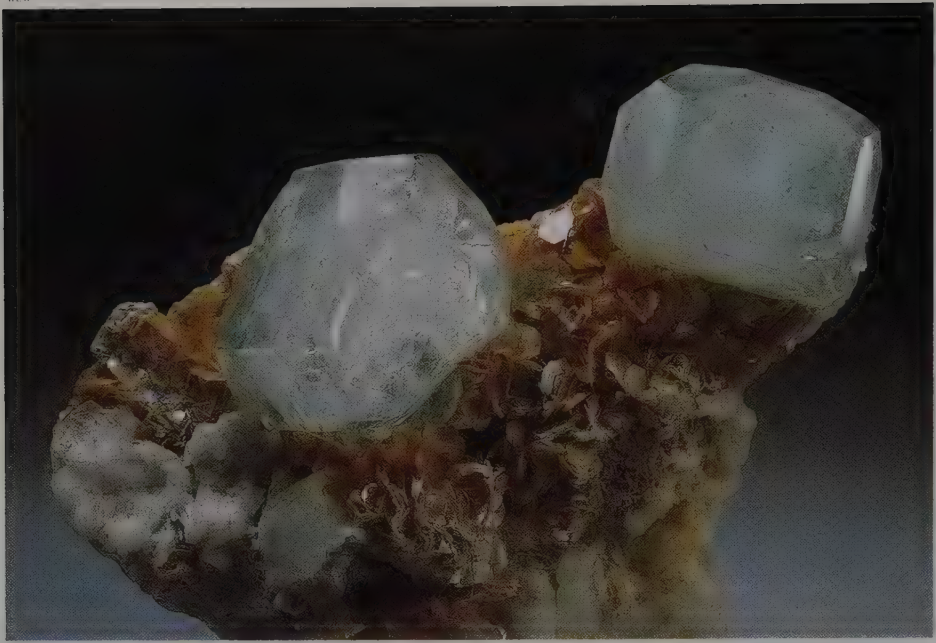

Figure 11. Beryl crystals to 3.2 cm on matrix, from Hunan, China. Mike Bergmann specimen.

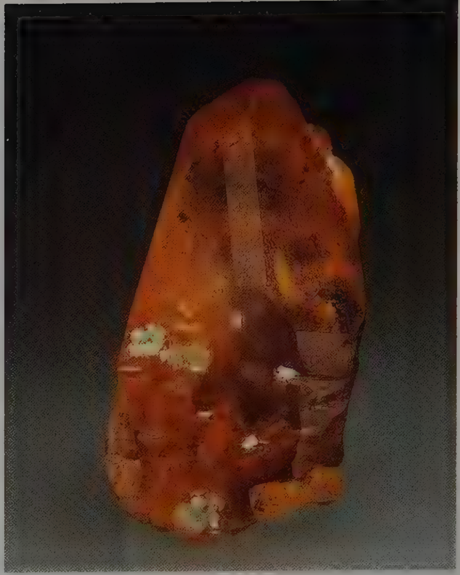

Figure 12. Clinohumite crystal, 1.9 cm, from Kukh-i-Lal, Pamir Mountains, Tajikistan. Syntaxis specimen; Jeff Scovil photo.

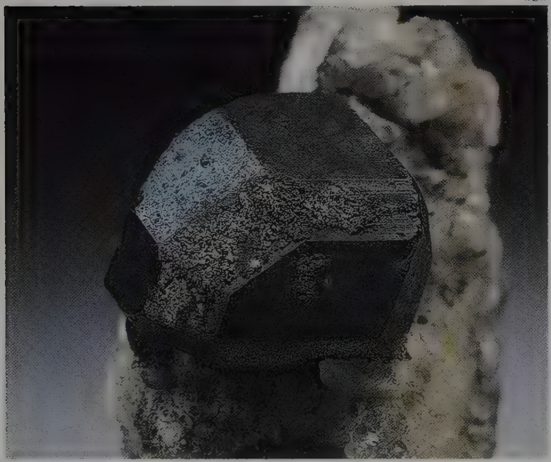

Figure 13. Tennantite crystal, 1.2 cm, from Dzhezkazgan, Kazakhstan. Falko Baatz specimen, now in the Tom Moore collection.

Figure 14. Pyrochlore crystals to 8 mm, from Veshnovogorsk, vein no. 140, middle Urals, Russia. Pljaskov-Van Scriver specimen.

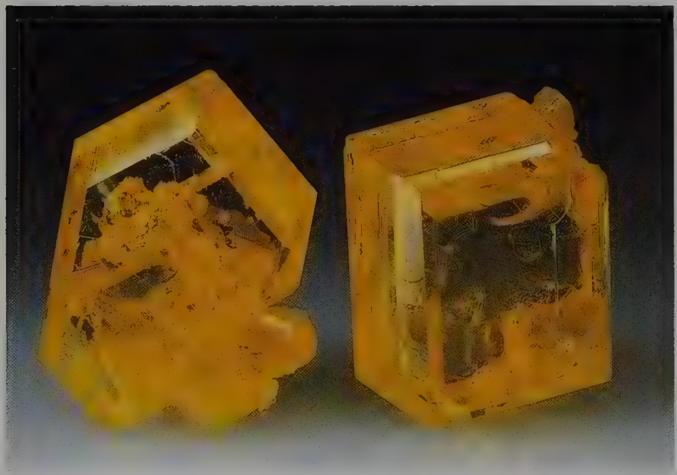

Figure 15. Sulfur crystals to 2.9 cm, from Yazovskoye, near Novoyavorovsk, L'vov region, Ukraine. Pljaskov-Van Scriver specimen.

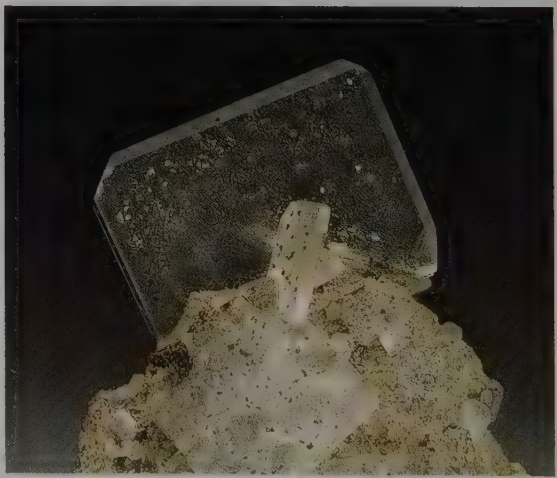

Figure 16. Fluorapophyllite crystal, 1.5 cm, with chalcopyrite, from the Belfast granite quarry, Belfast, Transvaal, South Africa. Clive Queit specimen; Jeff Scovil photo.

Figure 17. Platinum penetration twins to 1.2 cm, from Konder, near Nelkan, Ajano-Maiskiy region, Khabarovsk Kraj Oblast, Russia.

Figure 18. Unknown lindgrenite-like mineral, in bright green sheafs to 2 cm, on drusy yellow-green powellite, from near Tia Maria, Chile. Terry and Marissa Szenics specimen, self-collected ten days before the show.

Figure 19. Brazilianite crystal, 8.9 cm, from Baixo, Guandu, Minas Gerais, Brazil. Syntaxis specimen; Jeff Scovil photo.

Figure 20. Powellite pseudomorph after molybdenite crystal group, 7 cm, from near Tia Maria, Chile. Terry and Marissa Szenics specimen.

Figure 21. Stibnite with calcite, 14.5 cm, from Kadamdzhai, Osh Oblast, Kirghizia. Petr Korbel specimen; later Western Minerals specimen.

aquamarine *and* scheelite improbably growing together—this locality reportedly also somewhere in Hunan. The scheelites are orange-brown, occasionally gemmy orange in small areas at the pyramidal tips, and reach 12 cm; they greatly resemble the Far Eastern Russian ones. Mike reports that only about five good aquamarines have surfaced so far, and the one he had in his room speaks well of the rest, certainly. It's a feldspar matrix of about 10 cm, with small druses of end-on muscovite plates, and, perched nicely, two stubby 4-cm prisms of aquamarine with many modifying faces. There is some fracturing in the crystals but they are of good medium-aqua color and possess bright, glassy luster.

As the 60's, mineral-wise, belonged to Mexico, the 90's seem destined to belong to Russia—this is the opinion of more than one mineral person at Tucson. At least a third of all mineral dealers in the Executive Inn had at least some Russian (in which term I include the other ex-Soviet republics) material, and while much, of course, was dross, much also was superlative, and a great deal was (or at least somehow still seemed) absolutely new. Before mentioning specific dealers' stocks I'll attempt a general survey:

The Far Eastern locality of Dal'negorsk continues to yield a motley assortment of species all in fine crystallizations, including wonderful, large, pale bluish-green **datolite**; large, bright, stacked **pyrrhotite**; world-standard-setting black **ilvaite**; fine **danburite** and **axinite**; and a type of cubic **fluorite** so sharp and ice-clear that when I glanced at a loose one I took it for a vacant plastic specimen pedestal! Last year's "Polar Urals" axinites continue to be available, and the locality, whose fuller designation is the Pouyva deposit, near Saranpaul (village), Tyumen Oblast, Russia, has also given up some fine large smoky quartz groups. The best of these, just acquired by the Smithsonian from *Pljaskov-Van Scriver Minerals* (12700 N. Bandanna Way, Tucson, AZ 85737), is a gemmy *gwindel* 23 cm across on a matrix of white quartz, the tallest smoky crystal 10 cm high.

Siberia's Tagil Norilsk deposit continues to yield small (but for the species, of course, gigantic) **sperrylite** crystals embedded in a dense matrix of exotic sulfides (there will be many new-species descriptions soon from Russian mineralogists); and the old Nikitovka, Ukraine, locality for **cinnabar** and stibnite is spilling litters of loose, tiny, vivid red twinned cinnabar rhombs.

Nidym in the Tura region of Siberia is producing fine zeolites, most notably **thomsenite** and **stellerite.** And very large and sharp **analcime** on matrix comes from the Tunguska River region, Krasnojarskij Kraj, Russia. The already famous wire **silver, bornite** and **chalcocite** occurrence at the great copper mine at Dzhezkazgan, Kazakhstan, shows no sign of slowing down; I saw (and purchased) a surprising thumbnail of **tennantite** from here—its handler was Falko Baatz (Franz-Schubert Str. 7, 4020 Halle, Germany).

Who would have thought ten years ago that fine deep green **dioptase** from the old Dana locality of Altyn-Tube, Kazakhstan, would one day be something close to a drug on the market? But yes, dozens of dealers offered matrix pieces with crusts of crystals over white limestone (some with calcite vein fillings partially etched away), and loose thumbnail crystal clusters. It must be said that individual dioptase crystals from here almost never reach Tsumeb levels of size and sharpness together, and finding a piece without significant damage is hard. But a good search can yield a miniature or cabinet piece with very nice 5-mm crystals essentially free of dings: my thumbnail of this general description cost only $10.

Kola Peninsula oddities, too, are around, as are even **topazes** from Mursinka, and **emeralds** and **alexandrites** in mica schist matrix from the old Ural locality, the Malysheva mine, Takovaya—although really excellent pieces of any of these last three are still extremely elusive. Unpredictable one-of-a-kinders and show-stoppers from Russia were lurking everywhere. As a single example I'll mention the loose 2-cm **clinohumite** crystal belonging to Michael Brame of *Syntaxis* (7544 37th Ave. NE, Suite 1, Seattle, WA 98115): it is sharp, yellow-brown, and partly gemmy, quite plausibly world's-best if one knows how dull-looking the old Franklin, New Jersey, subhedra are. The locality here is Kukh-i-Lal, Pamir Mountains, Tajikistan.

Figure 22. **Antique Saxon *Barte* or ceremonial miner's axe, probably dating to the 17th or 18th century. David Crawford specimen.**

I have mentioned the Pljaskov-Van Scriver dealership before, whose father-and-son team, Brad and Star, with their partner Evzen Pljaskov, must be judged among the champion procurers of the most exciting of the new Russian materials. In their room, for example, were several giant cabinet specimens of the calcium niobate **pyrochlore** from a niobium mine at Veshnovogorsk, Vein #140, Veshnovogorsk City, Middle Urals, Chelabinsk Oblast, Russia. The sharp, gleaming, 2-cm octahedrons are tightly clustered in open seams (whose original calcite fillings have been dissolved out) in a granitic matrix. The color is a fiery red-brown like that of good cassiterite, and the matrixes reach 25 cm; the best of these has gone to the Sorbonne collection. From the same locality come fine, rounded, loose (occasionally matrix) crystals of **zircon,** mimicking dodecahedrons in form, and of an odd mottled bluish-whitish-brown color.

There is also magnificent **stibnite** (I'm still in the Pljaskov/Van Scriver room here: more precisely, in the bathroom, bending over the bathtub, where some of the flats of the best things are) with thick, lustrous, well terminated prisms in groups overlain by grayish white calcite rhombs, in small cabinet sizes, from Kadamdzhai, Osh Oblast, Kirghizia. From Yavokskoye near Novoya Vorovsk, Lvov Region, Ukraine, come the most beautiful small native **sulfurs** I have ever seen: vivid yellow, transparent and gemmy, jewel-like, loose singles to 2.75 cm, and one 5-cm cluster of parallel crystals. From the Frolobskiy mine, Tourinsk, Bogoslovskiy District, North Urals, Russia, come native **copper** miniatures and thumbnails in even more flamboyantly spiky arrangements than the Michigan stuff at its best. And finally in this sub-sub-sub-category (fine native elements from new Russian localities from the bathtub), The Russian Connection had *crystals* of **native platinum**: loose alluvial ones but hardly at all rounded. In fact they are sharp and fresh-looking penetration-twinned gray-white cubes. I saw three, all close to the same dimensions, but the largest and best is 1.5 cm across. Under microscopic examination they show adhering bits of magnetite/limonite matrix, and fine-scale surface features in the deep cracks (thus are surely not non-mineral furnace products or castings), and one has a fair amount of native gold also adhering. The locality here is Konder, near Nelkan, Ajano-Maiskiy Region, Khabarovsk Kraj Oblast, Russia.

To complete the list of surprising, extraordinary items at the Executive Inn, there was Dave Crawford's exceedingly rare *Barte* or ceremonial Saxon miner's axe, complete with ivory-inlaid wooden handle. *Barten* of this general type, mostly dating from the 17th and 18th centuries, are among the most highly sought after German mining antiques, always commanding prices of several thousand dollars.

Other Motel Shows

Over in the Discovery Inn, Terry Szenics was helping out in the rooms of Aurora Mineral Corporation. Terry had just returned from some months in Chile buying and collecting minerals; as it happened, he struck it really big just ten days before boarding a plane for Tucson. While nosing around a small, seemingly insignificant mining operation near Tia Maria, he and his wife Marissa noticed an attractive green mineral on the dump and traced it to a vein. There they dug out more crystals, groups and matrix pieces. The occurrence is in a copper-molybdenum deposit, and the bladed green crystals to more than 2 cm resemble lindgrenite $[Cu_3^{2+}(MoO_4)_2(OH)_2]$, so that was Terry's guess as to their identity (although these would have been by far the finest examples of the species). Some quick tests by Carl Francis at the Harvard Mineralogical Museum, however, confirmed Cu and Mo but *not* the lindgrenite X-ray pattern; so at this early juncture it appears to be a **new species.** Terry immediately removed all the specimens from the market so that mineralogists would have the maximum amount of material for examination; but in due course most of them should be available for sale.

The probable new species has aspects of appearance which resemble "primary" malachite and torbernite. Associations include thick druses of apparently cupriferous green **powellite** resembling the green smithsonite from Arizona's 79 mine. There is even a remarkable pseudomorphic crystal group of powellite after molybdenite! Watch future issues of the *Mineralogical Record* for more information on this remarkable find as it becomes available.

For his impressive array of old and new Broken Hill, New South Wales, Australia, minerals, I was pleased to discover Mike Newnham of *Down Under Minerals* (10 Heyington Close, Croydon, Victoria, 3136 Australia) in his lonely room at the Travelodge—now a kind of outback for mineral folk. Here were two flats of fine rootbeer-colored **spessartines** in sharp dodecahedrons in massive galena, and blocky deep red **rhodonites** in the same matrix. Shining gray-white **smithsonite** in globular dewdrops over black coronadoite, and nice Bad Ems-like brown **pyromorphite** groups, and winning transparent greenish-white **anglesite** crystal clusters . . . these three were dug from the Kintore open cut 18 months ago. Further, Mike had **alabandite** in dull black branching forms, and black velvety groups of chisel-shaped crystals of **cerussite** pseudomorphs after anglesite overlain by goethite. But I've saved the best here for last: a much rarer habit of Broken Hill rhodonite than the blocky deep red crystals are the thin, transparent rose-pink bladed ones with (unlike the blockies) excellent terminations; and Mike had a few matrixless thumbnails of these, found 20 years ago on the 19th and 21st levels of the great mine.

Hallelujah Junction is a place in the Petersen Range, right on the Nevada/California line—a place already known for its enormous **amethystine quartz** scepters. *Krystal Tips Mining* (P.O. Box 1317, Sparks, Nevada 89432) had a wide selection of these in a room at the Desert Inn. Specimens can be quite dramatic, especially if points are awarded for size; prism shafts, which tend to be smoky, are commonly a foot long, while the base of the amethyst scepter is generally about twice as wide as the incoming prism. Luster tends to be dull, and the purple color (and/or sometimes yellow, "ametrine" as it's called) is rarely deep, but still these are very handsome "museum" pieces.

This completes at last the motel show portion of this show report. But hold on, now, for yet more minerals, and a bit of high drama, at the Convention Center:

Tucson Gem and Mineral Show

By now, I assume, even those who could not make it either to Tucson or to last fall's Denver show have heard something about Bryan Lees' new bonanza strike of **rhodochrosite** at the Sweet Home mine, near Alma, Park County, Colorado. The fame of this place for world-class rose-pink to deep red rhodochrosite rhombs of giant proportions stretches back into the last century, and in 1966 some extensive work at the mine yielded the famous "Bancroft" rhodochrosite specimen, regarded for some years as the world's best for its species. Bryan's treasure from his summer 1992 assault on the Sweet Home was reported in the January-February issue by George Robinson in his review of the 1992 Denver show; pictured there was a stupendous specimen which Bryan had at Denver: a great matrix piece, with three 10-cm rhombs, instantly then considered world's best. The preliminary buzz this year at Tucson concerned Bryan's promised offer of even better specimens and in his Executive Inn room, briefly, about a hundred pieces were shown, mostly as a teaser for the unveiling of the top 200 examples at the main show.

As it turned out, there was not just one unveiling, but two. Everyone expected the second: the presentation of wondrous specimens at Bryan's "Collectors Edge" stand on Thursday, the first official show day—but no one, it seems, foresaw the Event of the last half-hour of the Wednesday afternoon "set-up" period. It was about 6:00, all the stands were ready, the doors were about to close, dealers and exhibitors were wearily heading out . . .

But suddenly there was a noise and a stir, a rapidly coagulating crowd, a fast-reflexed flashing of camera strobes, and diverse cries of joy and alarm behind me, about halfway back down the hall, by one of the big exhibition cases. Bryan had just placed two specimens on custom-carved wooden stands in that case. One, which a sign designated as the "Alma King," is a flattish matrix plate two *feet* tall and 1.5 feet wide at its widest, solidly blanketed with clear quartz crystals, sprinkled with 1.5-cm black sphalerites, and a belt of modified-cubic purple fluorites, also averaging 3 to 4 mm, across the front. Neatly centered on this immense slab is a perfect, undamaged, translucent deep red (with some internal cleavage planes aesthetically showing) rhodochrosite rhomb 15 cm across; and a 6.5 cm rhomb just like it lies slightly off to the northwest. The other specimen (an unnamed one which some people seemed to prefer aesthetically to "the King") is a 1.5-foot matrix plate strewn with about equal helpings of quartz, fluorite and sphalerite, but also with scattered areas of opaque yellowish 2-cm calcite crystals; here, five huge rhodochrosite rhombs march down the middle, the top three intergrown in an 18 x 18-cm cluster, the bottom rhomb's outward-looking face largely covered with the yellowish calcites. The rhodochrosite crystals on both specimens glow red as vividly as if backlit; their color fairly leaps out at the gawker, as quickly leaps into his mind, too, the realization that these specimens excel even the one revealed in Denver. It was rare to see so many jaded old mineral mavens (curators, dealers, top collectors, and even editors) dumbfounded by the sight of a couple of mineral specimens. Mixed in with the general awe is some degree of amazement that Bryan actually managed to keep these two giants a secret

Figure 23. The "Alma King" rhodochrosite specimen, about 2 feet tall, on exhibit at the Tucson Gem and Mineral Show. The white drusy quartz matrix is sprinkled with black sphalerites and purple fluorite crystals; note especially the band of fluorite to the lower-right from the big crystal. From the Sweet Home mine near Alma, Colorado; Bryan Lees specimen.

Figure 24. **The second largest Alma rhodochrosite, on exhibit in the same case. It measures about 1½ feet tall, and has yellow calcite in association.**

Figure 25. **A single crystal of Alma rhodochrosite about 2.5 cm across; Bryan Lees specimen.**

Figure 26. **Main crystal from the "Alma King," photographed underground moments after it was found detached in the pocket by Bryan Lees. (Photo courtesy of Bryan Lees.)**

Figure 27. Chrysoberyl twins, 4.1 cm and 3.3 cm, from Teixeira da Freitas, Bahia, Brazil. Roberts Minerals specimen.

Figure 28. Chrysoberyl twin, 4.5 cm, on matrix, from Medeiros Neto, Bahia, Brazil. Russell Behnke specimen; Jeff Scovil photo.

Figure 29. Zoisite crystals to 1.6 cm, from Alchuri Village, Pakistan. Herb Obodda specimens.

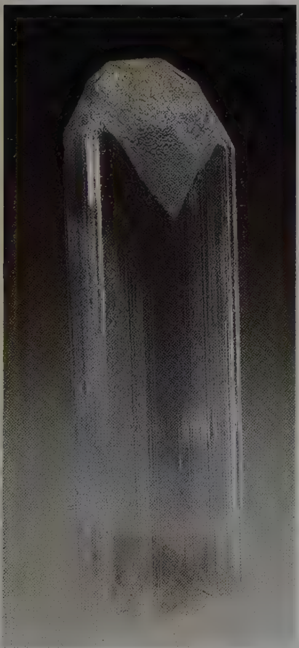

Figure 30. Sillimanite crystal, 1.8 cm, from Rakwana-Deniyaya, Sabaragamuwa province, Sri Lanka. Mountain Minerals International specimen, now in the Ralph Clark collection.

Figure 31. Zoisite crystals to 3.9 cm, from Alchuri village in the Shigar Valley north of Skardu, between Shigar and Dassu, Baltistan, northern Pakistan. Mountain Minerals International specimens.

Figure 32. Zoisite crystal, 5 mm wide, on matrix, from Alchuri Village, Pakistan. Herb Obodda specimen.

until just before opening day at Tucson! On that day they drew predictably dense crowds, and my favorite overheard comment from members of the general public was "why didn't they cut those things up and make *stones* out of them?" Well, as a matter of fact, they *did* cut some; a middle pedestal between the two great plates displayed a few huge faceted rhodo gems.

The story here is an adventurous one. Bryan deliberated for a year about whether to risk the capital necessary to force the Sweet Home into major-specimen production again, then, having decided to go for it, found four major financial backers. Work (clearly expert mining/exploratory work, it should be added) commenced in May 1991, and by June 1992 more than $300,000 had already been spent, with no pockets yet hit. No wonder that the first important one got named the "Cash Flow" pocket, whose yield encouraged Bryan, then, coming into midsummer, to press on. Soon there came the "Museum Pocket," from which the Denver specimen came, and the "Rainbow Pocket," the "Colorado Springs Pocket," etc., etc. The Alma King and the other beast unveiled at Tucson came respectively from the hanging wall and the foot wall of the Rainbow Pocket, after more than a half million dollars had been invested in the mining venture.

It would of course be presumptuous, tasteless, and otherwise tactless to talk here of values, prices, and buyers for the three greatest pieces, even if I had any relevant facts; but Bryan does say that the Denver piece is now "spoken for," and the ones at the Collectors Edge stand were selling briskly, so it seems safe to say that Bryan has won his great gamble. He is fairly sure, anyway, that this summer he'll have both the will and the means for another go at the Sweet Home, although he also thinks that this will be his last attempt, at least for a while.

Showgoers who wished to see the "lesser" pieces, the ones with price tags on them, at the Collectors Edge stand, did *not* have to wait for hours with tickets in hand this time. There was a roped-off line to stand in, to be sure, and the gawking, once one got in, was carefully timed, but we were briskly admitted in groups of ten, and the waiting period was short. Bryan Lees and Dave Bunk were resplendent in black tuxes with red (what else?) bow ties and cummerbunds, and Bill Smith played timekeeper at the entrance. A counter that separated the viewing area from the main floor sported bouquets of red and white roses, and plates of little rhodochrosite-red candies. No, the procedure/production did not seem pretentious, just sort of democratically dignified, and Bryan and his assistants bent down willingly, from their orbits near the Moon, to answer questions courteously and in quiet voices. Of course, the egalitarian admissions policy irked many who fancied that, for one reason or another, *they* deserved "first pick," but it was in fact a rare victory for even-handed fairness.

As to the specimens themselves, well, they range from small thumbnails for around $35 to two 20-cm clusters of extravagantly grouped 5-cm rhombs with small matrixes; these two fabulous specimens are priced at $25,000 and $35,000. Between the extremes, there are mostly loose single rhombs of various sizes and groups consisting of two or three rhombs, some with small matrixes but most without. Inevitably, some are chipped a bit, and some of what at first glance seem crystal faces are in fact cleavages, but, everything considered, the inroads on value by damage were held to a decent minimum by (what has obviously been) exceedingly careful collecting and specimen preparation. And one more time: the color consistently is deep, flowing, glorious red or rose-pink, and many smaller pink rhombs are quite transparent. Associations—generally sparse—include, again, sphalerite, purple fluorite, calcite, a bit of tetrahedrite; a few small mostly unremarkable specimens of these species by themselves are also available. Is this enough said? Somehow, for what Rainer Bode and Dieter Klaus called "the find of the century," it doesn't *seem* enough wordage. From here on it ought to be fun to "track" loosely the travels of these great specimens through collectors' and dealers' hands; and then there's the deeper "fun" of awaiting news from the renewed work at the Sweet Home next summer.

When one's head had cleared enough to get past the Rhodo Phenom at the main show, there was still, of course, much other fine and new material to look at. For instance, Ken and Rosemary Roberts (Twain Harte, California) had many fine minerals including some superb **chrysoberyls** from a locality given as Teixeira da Freitas in the state of Bahia, Brazil. The thick crystal twins measure 3 to 4 cm across, are rather flat, and quite a beautiful transparent yellow-green. These bear some resemblance to Russ Behnke's chrysoberyl labeled as coming from Madeiros Neto, also in Bahia. Russ also had a beautiful **brazilianite,** resembling the old Corrego Frio crystals, but from a locality called Baixo in Minas Gerais.

Also interesting, and probably qualifying as world's finest for the species, were the delicate, limpid, palest sapphire-blue terminated gem prisms of **sillimanite,** a rock-forming species heretofore practically unknown in anything but lumpish fibrous masses. The locality is Rakwana-Deniyaya, Sabaragamuwa Province, Sri Lanka, and the seller was Dudley Blauwet of *Mountain Minerals International* (P.O. Box 302, Louisville, CO 80027-0302). Dudley brought out ten crystals in all, small matrix-free thumbnails, one doubly terminated. Six were at the main show, priced at $25 to $75, but easily the best I saw had been purchased several weeks earlier from Dudley by four-star thumbnail collector Ralph Clark: it is a lovely 1.75-cm gem-blue crystal.

At this dealership also were the best of the new transparent dichroic **zoisites** of which I saw a few elsewhere (Herb Obodda, Wayne Thompson, etc.) as well. They come from Alchuri Village in the Shigar Valley north of Skardu, Pakistan. They are lightly striated vertically, have complete terminations, are gemmy, and are the color of fine epidote down one axis, the color of fine vivianite down another. Matrix-free crystals were priced around $400 to $500. Honorable mention goes to Dudley's brilliant floater brown-green **dravites** (shaped just like the older Australian ones, but radically prettier), 3 to 5 cm long, from Gujarkot, Bheri Zone, West Nepal.

At the Executive Inn, many dealers' rooms flashed with brilliant, sometimes very large, galena specimens from the Madan Orefield, Rhodope Mountains, Bulgaria—obviously an up-and-coming specimen locality, destined perhaps to replace Trepča, Serbia, of whose similar mineral suites, by the way, I saw almost nothing at all in Tucson this year (though sanity must add that this has to be the *very* least of Serbia's woes these days). The Madan galenas can be almost unbelievably bright and sharp, and can come as simple cubes, like well-behaved galena, but can also take bizarre trips into uncharted realms of flattening, twinning, hoppering, and skeletal growth. Associated with them are highly lustrous, yet transparent demantoid-green to brown-green sphalerites to 3 cm, good chalcopyrites, and quartz. Many, many flats of small specimens and some huge glittering pieces were offered at the main show by Ernesto Ossola (8 Rue du Luxembourg, 30140 Anduze, France), who surely was the show's champion dealer in this material.

Less spectacular, but in fact more mineralogically remarkable, are Ossola's blue **sapphirine** crystals in matrix from Androy, Madagascar. Quite sharp (i.e. only slightly rounded) teardrop-shaped sapphirines to 4 cm are liberally strewn through a very peculiar coarse-grained matrix consisting largely of calcite, phlogopite and crude pale brown scapolite crystals. Mostly miniatures, these specimens were priced from $50 to $700. Though dull-lustered blue on the outside, the sapphirines are glassy, clear, almost gemmy, on broken surfaces, and must be the most attractive crystals ever found of this rare species.

Bolivian **vivianite,** as we know, doesn't have to work as hard to be attractive. Over in the wholesale section, Tony Jones of *California Rock and Mineral* (P.O. Box 896, Fallbrook, CA 92088) was presiding over a new find surpassing last year's fine, large, transparent sea-green vivianites from Morococala, Bolivia; the new specimens have 25-cm long, incredibly clean, largely undamaged subparallel fans of

(Continued on page 237)

Letter from Europe

Munich Show

by Michael P. Cooper

[October 30–November 1, 1992]

You know when you've been staring through a camera for too long: a black rectangle dances round every mineral specimen you look at and the focusing grid in your viewfinder floats in the darkness whenever you close your eyes. I felt that way at the end of my second day in Munich. Luckily, I ran out of film on the fourth day, shortly before I ran out of strength, and so was able to make the trip back to the airport without collapsing under the weight of photographic gear. But I'm getting ahead of my story.

For several years now I've been getting invitations to the Munich show but have, for one reason or another, been unable to attend. But as European Correspondent for the *Mineralogical Record* one just *has* to go to this greatest of all the European shows, so this year everything else was set to one side. The 200-page show catalog doesn't prepare you for the scale and variety to be seen. You can count the number of dealers (over 500) and see the size of it all (5 large hangar-sized halls), but there's no indication of what you might find (almost anything) or what chance you have of seeing it all (almost none). I traveled over with Chris Stanley of the Natural History Museum, London, who brought a few precious type specimens for the show's "Tsumeb" theme exhibit. We had an uneventful flight into Munich's brand new airport and bussed our way into town to find our hotel. As you all know, the British pound is having a hard time on the currency markets, and its poor performance against the German mark ("*German* Deutschmarks" as the foreign desk teller in my bank insisted on calling them) meant that impoverished Brits had to look for inexpensive accommodations. Our hotel, chosen almost randomly by price from a brochure, was convenient for the airport bus and the tube, and was situated on a street that seemed to sell only three things: computers, accommodation, and fantasies—there were a remarkable number of *Erotik Bars* squeezed between the hotels and shops. We stuck to the accommodation; after all, PCs are too heavy for airplane hand-luggage.

Set-up day at Munich is Wednesday, so by the time we arrived, late on Thursday afternoon, most stands were already bulging with minerals, gems, fossils and worked stones. We were in plenty of time for Chris to add the NHM's tsumebite, ludlockite and schultenite to the case of type specimens in the "Tsumeb" display (of which more later) before the opening ceremony. Show organizer Johannes Keilmann led these proceedings, followed by several other dignitaries, museums curators and translators. Thanks were made, awards were presented, and to the ear-popping strains of a live brass band we were wished *Glück Auf!* and encouraged to don yellow hard hats. We then entered the inner sanctum of Hall One. Here, special museum displays had been mounted, their centerpiece being a darkened chamber containing a selection of fine Tsumeb minerals from museums and collections around the world. This exhibit had been put together to mark the publication of Georg Gebhard's marvelous book on Tsumeb, copies of which were prominently displayed, but, sadly, the English translation hoped for at Munich in my last "Letter" remains elusive. Georg explained that it should be out in the new year. Fingers crossed.

The Tsumeb display consisted of seven tall, six-sided glass show cases (i.e. appropriately mimetite-shaped) containing, respectively, smithsonite, aragonite and calcite; malachite; cerussite and other lead minerals; type specimens; oddities; azurite; and more oddities. There was also a wall case of superb pieces from the collection of Richard Baldauf (1848–1931), now housed at the State Museum of Mineralogy and Geology in Dresden, including outstanding specimens of malachite after azurite with cerussite, and azurite with bayldonite. In the seven hexagonal cases were world-beating examples of (in no particular order): an exceptional schneiderhöhnite; a globular mass of alamosite over 5 cm across; a selection of very large leadhillite crystals; a tabular wulfenite crystal some 8 x 6 cm; and a remarkable paradamite. From the marvelous collection of the Houston Museum of Natural Science there was a stottite (a deep purple bipyramid 1–1.2 cm on edge!) and a gorgeous, and probably unique, dioptase specimen 16 cm long, decorated with a lenticular cerussite twin perched on one side (see the Houston Museum supplement in *Mineralogical Record,* vol. 23, no. 1). In the cerussite display there was one embarrassing exhibit: a lovely multiple twin scattered with small rhombic dolomite crystals. Behind it was the appropriate page from *Tsumeb* book showing the same specimen, but inverted! When will layout artists learn that fidelity comes before design? (Another Houston specimen, it was printed the right way round in the above mentioned *Mineralogical Record* supplement.) But what was worse was that this delicate specimen had lost one of the arms of the twin between photograph and display. A sad demonstration of the fragility of fine minerals.

Elsewhere in Hall 1 were several showcases of institutional displays. Among these interesting and historic exhibits Paul Pohwat of the Smithsonian had brought over the specimens used in both sets of the U.S. Post Office's mineral stamps (1974 and 1992), displaying them together with the first-day covers; the State Museum of Mineralogy and Geology, Dresden, showed some fine silver minerals from Saxony, including their incredible "silver corkscrew"—33 cm of spiral wire silver on a matrix of solid silver—found at Freiberg in 1900; and the Mineralogical Museum of the University of Rome ("La Sapienza"), Italy, in an understated exhibit, showed some very fine specimens of grossular and diopside from Val d'Ala, Piemonte, scattered almost casually in the case with their original collection labels. Much of the remaining space in the Hall was taken up with old wooden models of mining and ore processing equipment, cases of superb silver minerals, and examples of miner's equipment and ritual all from the ancient mining centers of Saxony.

On the walls of the hall were[1] displays of the detailed watercolors of (Saxon) mineral specimens by Eberhard Equit and a selection from the 4,500 postcards featuring mining in the collection of Günter Grundmann of the Technical University of Munich. Some of these contain quite remarkable images and constitute fascinating subjects for the historian.

Hall 2 is regarded as the most prestigious dealer's hall; it contained most of the bigger and better-known names. But it takes more than

[1] The expression *among other things* should be taken as read throughout this article.

Figure 1. Beryl crystals (two specimens, one leaned against the other) from Jos, Nigeria. The total weight of the two is 730 grams (1.6 pounds); height 16 cm. Gebruder Henn specimens; photo by Hiltrud and Jürgen Cullmann.

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Figure 2. Scheelite, a glassy, deep orange 4-cm bipyramid from Guizhou, China. Frédéric Escaut specimen.

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Figure 3. Zoisite, a 9.5-cm square-section prism, from Pakistan, viewed from one corner to show the strong and beautiful dichroism. François Lietard specimen.

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Figure 4. Calcite, an 11-cm group of crystals to 5.5 cm from Rudnui, Kazakhstan. François Lietard (*Minerive*) specimen.

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Figure 5. Realgar, two doubly-terminated crystals, the largest 10.5 cm long, from Hunan, China. Frédéric Escaut specimen.

a good name for fine minerals to get a stand here; newcomers generally have to work their way up from the comparative obscurity of halls 3 to 6. So, although there are more small or down-market dealers in these other halls, some of their stands crammed willy-nilly with unpriced, unlabeled specimens, there are still many classy displays throughout the show from dealers on the way up. Munich is dominated by minerals but there are numerous stands belonging to dealers in fossils, gems, worked stones, collector's equipment, mining memorabilia and antiques, books and magazines. Here you will find superb examples of the arts of fossil preparation, stone carving and gem cutting, and the profusion of excellent German mineral texts and photography.

On Friday morning I began my examination of the displays in earnest. Johannes Keilmann had set me up with a small darkroom in the center of the show which I shared with another photographer, Holger Freese, one of the organizing committee of the *Munich Mineralientage* and leader of the Photography Working Group of the *Münchener Mineralienfreunde*. During the next few days we talked of minerals and the problems of photographing them, compared techniques (Holger uses tungsten light whereas I was using flash), and occasionally swapped specimens: when I had borrowed a fine Kazakhstan wire silver Holger couldn't resist taking a shot of it, and I just had to have a slide of "his" Eagle's Nest gold. Time passed quickly and a lot of fine minerals passed through that small room.

Almost the first dealer I met in Munich was a friend from France, Frédéric Escaut (*Ostrea Locations,* Route de Huitres, 17550 Dolus, France), who accosted me in the aisle on my first evening and invited me to see his latest arrivals from China. Such minerals are his forte. Here was an amazing **scheelite** crystal from Guizhou Province, half of a loose bipyramid 4 cm across of a gemmy transparent deep orange color. A remarkable color and quality for such a large crystal. Frédéric told me his Chinese contact was claiming that matrix pieces were available—watch this space! Also on the stand was a superb Chinese **realgar** specimen composed of a pair of intergrown terminated crystals, the largest 10.5 cm, the best of a batch of high quality pieces just in from Hunan, and some very nice **fluorite,** most of it the now familiar purplish color and cube-dodecahedron habit, but one different, large cabinet piece from Fuyan, Hunan, with a royal purple cube 5 cm across clinging to a group of terminated quartz prisms. Over the aisle from Fréddie I was struck by a large selection of good **senarmontite** specimens on the stand of Marianne Jentsch (Im Busche 1, D-4923 Extertal 4, Germany). These were from the classic (type) locality of Djebel Hamimat, Constantine, Algeria. The dull gray octahedra reach 1 cm or so on edge and were available in groups on matrix up to 8 cm across. Not the prettiest of specimens but extremely interesting rarities and very good for the species.

Close to the center of Hall 2 was one of the most stylish stands in the show—that of the Henn Brothers (Hans-Jürgen Henn, Mainzer Strasse 60a + b, D6580 Idar-Oberstein 2, Germany), now into their fourth generation as dealers in cut and carved stones and their second in high-quality display minerals. Free-standing vertical showcases ringed their display area within which the atmosphere was distinctly calmer than the surrounding aisles. Notable among their fine specimens was an excellent selection of Tsumeb material, the result of several years accumulation by an African dealer. The display contained some fine sprays of **azurite** (in blades over 10 cm long), a few choice **dioptases,** bevelled plates of brown **wulfenite** to 3 cm on edge, a large **cerussite** snowflake, and a good selection of rarer species. They also had one flat of curious specimens of **cuprian adamite** with bright splashes of native **silver** among the green (see illustration in *Mineralogical Record,* **23**, 431). In another cabinet there was an astonishing display of **aquamarine** crystals collected in Nigeria at the end of last year. These crystals are of an extremely deep blue, which, I was assured, is a natural color, it being impossible to "burn" such specimens to enhance the color for fear of them exploding as a result of boiling the numerous fluid inclusions they contain. Nearby were some Nigerian **emerald** crystals of comparable quality and equally distinctive color. Other rough gem species included some very large **spessartine** crystals from the Shagar Valley, Pakistan. These reach nearly 10 cm across and exhibit a remarkable metallic schiller when viewed down a cube axis, as if myriad incipient cube faces had been plated with silver.

Considering how many visitors there are at any one time in a show this size (30,000 passed through the gate during the show), it's remarkable how often I would meet the same people as I wandered from stand to stand or tried to find my way to my photographic "studio" bearing specimens which I'd promised to bring back to their owner in "half an hour or so." Some of those half-hours were very long ones, stretched out by conversations in which someone inevitably said "have you seen so-and-so on such-and-such a stand?" and off we'd go to see the largest Dal'negorsk fluorite crystal in Munich, or a fleet of new apophyllite crystals, or the latest Morococala vivianites. Thus I roamed the show with several different guides and companions, each eager to show me their favorites. In a chance meeting with Henri-Jean Schubnel of the Natural History Museum in Paris I found he had bought for the collection several specimens that I had already photographed, including the Guizhou scheelite mentioned above. Another was from the stand of Gilbert Gauthier: a splendid Madagascar (no more precise locality was known) **ferrotantalite** crystal 7 cm long

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Figure 6. **Ferrotantalite, a remarkably well-terminated 7-cm crystal from Madagascar. Gilbert Gauthier specimen.**

with an exceptionally fine termination. But the most remarkable acquisition was a unique **zoisite** crystal from Pakistan brought to the show by French dealer François Lietard (*Minerive*). François had several specimens of this material, but the best, and that now in the Paris collection, is a square-section prism 9.5 cm long and 1.5 cm square. But although its size is notable it is its fine color(s) and powerful dichroism that turns it into a world class specimen: viewed from one side the crystal is grass-green, but twisted through 90 degrees it is a rich russet brown. [See the cover photo on this issue for a view of the same property in Tanzanian zoisite. Ed.] Other specimens are much smaller (2–3 cm) and there was also one matrix piece with a 2.5-cm terminated crystal in a cavity. Later, François produced for me a couple of attractive new **calcite** specimens from Rudnui, Kazakhstan. These are honey-brown complex rhombs 5 to 6 cm long, in groups to over 12 cm across, on matrix of altered rock and sulfides. Rudnui, by the way, is also the locality for some beautiful wire **silver** which I saw on the stand of Falko Baatz (Franz-Schubert-Strasse 7, D-4020 Halle/S, Germany). These specimens display delicate tangles of fine pinkish wires on matrix, Falko's best being 7 x 8 cm with the display face completely covered in silver. Apparently, a strike of this material was made some years ago but little reached the specimen market: the 200-kg haul was sent straight to silversmiths to be worked!

Falko also had some new **calcite** from the mines at Dal'negorsk, Russia. He had written to me before the show to say he had some interesting information on this distant locality (Dal'negorsk means "the far mountains" in Russian), but although I made several attempts to arrange a rendezvous early in the show, it took me so long to catch up with Falko that the best of these new calcites was sold before I saw it. Nevertheless, those remaining were nice enough to be added to my imaginary museum (all the pieces I would buy if I didn't have to eat or pay my bills). They are of relatively simple scalenohedral habit, essentially colorless with a superb luster, reminiscent in quality of the finest old-time Cumberland calcites. Those I saw reach 14 cm long and are available as doubly terminated singles and as matrix pieces associated with another generation of calcite in milky white frosted spires up to several cm long; a nice combination.

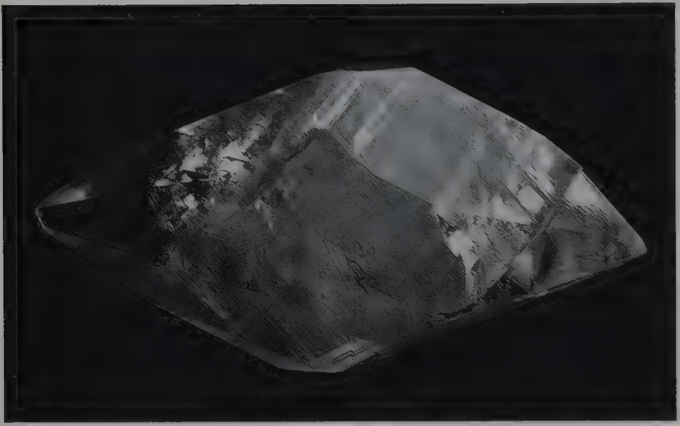

Figure 7. **Calcite, a 14-cm scalenohedron from Dal'negorsk, Primorsky Kraj, Russia. Falko Baatz specimen.**

I talked with Falko for some time about the history of mining at Dal'negorsk. He has visited the area and obtained a great deal of information from the local museum, including some historic mining photographs, copies of which he very kindly gave to me. Dal'negorsk was once known as Tetiuhe, a Chinese name of unknown origin (sometimes spelled "Tetjhe") which is occasionally seen on modern specimen labels (for example as "Tetiuhe mine, Dal'negorsk"). The mines were leased from the Czar in the 1890's by a German company which worked them until the revolution, when the English *Tetiuhe Mining Company*, took them up. They eventually sold everything back to the Russians in the 1930's. Tetiuhe was renamed Dal'negorsk in the aftermath of the 1960's Russian-Chinese confrontation. There are now two metal mines there (the First Soviet and the Nikolai, or Nikoleyev), and to the south of them, on the other side of the valley, is a large openpit worked for boron. It is from this site that the now familiar **datolite** has been coming. This occurrence also produces **danburite** crystals over 30 cm long. I saw none of the latter at Munich but there was some good datolite including one crystal the size of a large fist, and zoned in pale green and orange-brown, on the stand of Jirí Simek (*Min-Geo*, Pardubická 734, Hradec Králové 500 02, Czechoslovakia). He also had a few other large-scale pieces: the biggest Paiva **axinite** I'd seen—a single blade over 15 cm across (but repaired)—and the corner of a huge **fluorite** crystal from Dal'negorsk. This specimen, collected 25 years ago, is about 35 cm on edge and a very attractive translucent deep sea-green, quite different from the relatively insipid material currently available. Jirí knew of only three others like it. In a glass case on the other side of his stand was a fine group of tapering **aragonite** crystals from Podrecany, Slovakia. Individuals reached 20 cm, and, but for the group being about 30 cm across, were almost indistinguishable at first sight from aragonite of similar habit from Frizington, Cumbria, England, even down to the "*limonite*" staining at the base. This is not exactly new material, but I'd not remarked it before. Another interesting look-alike was some deep blue botryoidal **hemimorphite** from Yunan, China on the stand of Willy Beck (Berghütte 7, 4049 Rommerskirchen, Germany). It encrusts an altered rock matrix and side by side with hemimorphite from Roughton Gill, Cumbria is a very good match, except that its matrix is distinctly browner than the Cumbrian classic. The other major difference was in the price—a factor of ten might separate them now.

On my way back to my "studio" from the nether reaches of Hall 6, I passed a display that immediately grabbed my attention. It contained only one kind of specimen: a couple of dozen large pieces of rock encrusted with what seemed to be glistening black resinous crystals. It was a find of excellent **pyrochlore** from the "Sour Cherries vein" at Vishnevy Gory, Mont Visnov (the Cherry Mountains), near Miass in the Urals. The dealer, Eduard Lehrieder (Danziger Strasse 11, 8510 Fürth, Germany) told me that some 60 pieces had been found and that the locality was host to about 250 species of minerals which, if an accurate estimate, would place it high in the world's top ten species-rich sites. Unfortunately, full documentation on the site, though promised, was not yet forthcoming from Russia so Eduard could not tell me more. In the meantime the specimens have to speak for themselves: octahedral pyrochlore crystals dominate the display side of these specimens, covering rock fragments to 20–25 cm, where they have been etched out of veins of granular calcite. The octahedra are a rich reddish brown on close examination under a bright light and average 8–10 mm with some larger individuals to 1.2 cm or so. An important find for the species.

Jordi Fabre can be relied upon to take the pulse of current affairs in Spain. At Munich he excitedly showed me specimens from a large strike of **barite** in the Moscona mine, Solis, Asturias (see the article on this area in *Mineralogical Record*, **23**, 69–76), where a cavity several meters across had been broken into and found to be lined with large glassy gray-blue to pinkish barite crystals up to 10 cm long and almost as thick. Unfortunately for the collector, a second generation of white, finely granular barite (Jordi described it as "colloidal") had been deposited in the cavity, covering all the upward-facing surfaces and leaving only material from the roof of this large occurrence suitable for the cabinet. The finest piece is a large plate (about 45 cm square) of intergrown lustrous crystals, some over 7.5 cm thick. Smaller groups and single crystals were also available. The mine closed in August but it is hoped to reopen in November.

Of course, I'd not gone to Munich purely as an observer. There were a couple of items I wanted for my own collection. One of these wants I'd learned about from the last "Annual world summary of mineral discoveries" in the *Mineralogical Record* (**23**, 423–437)—invaluable reading before setting out to a major show. Being especially interested in unusual crystal forms I could not resist the peculiar **galena** crystals from the Esperance level, Les Malines, St Laurent le Minier, Gard, France, offered by Christophe Dubois (31 Avenue Picaud, 06400 Cannes, France). This material features six-sided prisms of galena in three-dimensional reticulated frameworks intergrown with small globular masses of zinc sulfide (probably mostly wurzite). I guess these crystals are dodecahedra elongated along a three-fold axis. Christophe also had some excellent examples of the extraordinary globular **fluorite** from Buxier-Les-Mines, Allier, France. Here, yellowish to purple fluorite forms frosty spheres to 1 cm scattered on rock. They make intriguing companions for specimens of the botryoidal fluorite found near Canyon City, Colorado, a few years ago and are good for taxing the deductive powers of collectors unfamiliar with them.

Which leads me to yet another unusual fluorite specimen. (If fluorite makes a regular appearance in this column it is purely because it's so plentiful in fine specimens—it's not a specialty of mine as a collector and scores low as a photographic subject, being often the victim of blind spots in color film emulsions.) The stand of gem mineral specialist Andreas Weerth (Hochfeldstrasse 37, D-8180 Tergensee, Germany) contained many products of Pakistan's pegmatite mines, localities little known as producers of fluorite and then rarely in specimens fit for display. Nevertheless, Andreas boasted a fine crystal of **fluorite** sitting on a mica-encrusted matrix—a pale green octahedron 7 cm on edge plated with pale pink surface zones. And still in the Indian sub-continent, I must comment on a recent batch of zeolites from Jalgaon, India. Cabinet specimens have been coming from here for a few years now but a fine display of new material by *Wilke-Mineralien* (Hans-Jürgen and Ilse Wilke, Händelstrasse 5, D6116 Eppertshausen, Germany) proved very popular at Munich. These excellent groups feature doubly terminated crystals up to 12 cm long with pink stilbite, calcite and other species. The **apophyllites** are a pale yellow-green with colorless terminations (see illustration in *Mineralogical Record,* **22**, 389). Most specimens in the Wilkes' display were flawless and very aesthetic, highgraded from a huge batch of material the majority of which was fit only for sale by weight.

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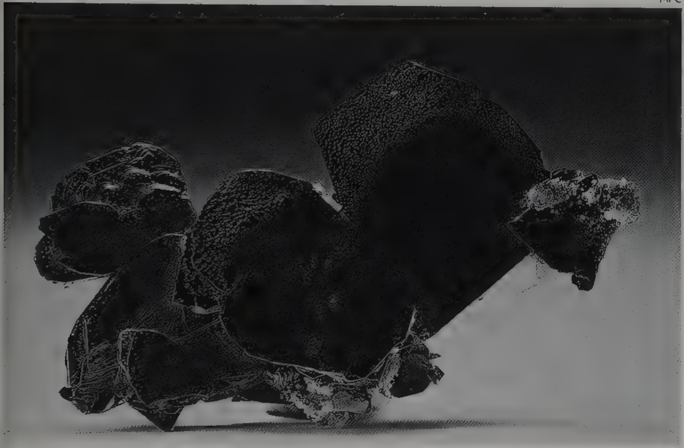

Figure 8. **Hematite, an 11-cm group of thin plates from Djebel Nador, Algeria. Eric Asselborn specimen.**

Almost the last thing I photographed in Munich was an interesting specimen of **hematite,** one of several belonging to Eric Asselborn (c/o Mineralien und Fossilien Galerie, Fahrgasse 88, D-6000 Frankfurt 1, Germany). These specimens come from Djebel Nador, Algeria, and form thin delicate black plates several centimeters in diameter, as singles or small groups free from matrix. Nice sculptural crystals and, I was glad to note, easy to photograph. Holger and I were feeling a bit jaded by now, having overshot by a considerable margin our original intention to spend only a day taking pictures. It's surprising how enervating mineral photography can be, especially when time per specimen is so short!

On Sunday afternoon, after bidding farewell to Johannes Keilmann, I packed up all my stuff and headed back to England. My flight had been designated as high security, and I was taken apart at the airport. Checking my case full of wires, transformers, blocks of metal from my lighting stand, and collection of mysterious and heavy cardboard boxes, must be a security guard's nightmare (or dream?). You know you're in for it when everybody clusters round the X-ray screen and scratches their heads. But other than that all went well.

I was sorry I didn't get my hoped for copy of *Tsumeb* at Munich, but, a little while back, I did get a copy of another book mentioned in my last "Letter": Pierre and Nelly Bariand's superb *Minéraux Passion*. It is everything that you might expect from such a knowledgeable and skilled couple: informative, inspiring, and beautiful. Go and buy it. I hope I will be able to say the same about another pending publication that I heard about in Munich: a Russian mineral magazine *World of Stones,* due to appear in the near future. The publishers, Plus Ltd., had a stand in Munich where I met the enthusiastic Vladimir Khapaev, eager to encourage good contacts between his country's collectors and dealers and the rest of the world. The first issue of the new magazine will be in Russian only, but subsequent numbers will be bilingual, English and Russian. It is described as a "magazine for friends of minerals and jewellery art as well as for mineral dealers and for everyone interested in Russian minerals and gemstones and their occurencies *[sic]* in Russia and in former Soviet republics." It will be illustrated in color and will contain articles on Western mineral occurrences also, so forming a two-way bridge between East and West. For further information contact Dr. Vladimir Khapaev, Plus Ltd., 103050 Moscow, Box 162, Russia.

So, goodbye till next time, and thanks to everybody in Munich who helped me out, lent me specimens, showed me treasures from under the table, spun me stories, and told me their secrets (they're still safe).

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Post-Munich Notes

[The following notes on recent finds were kindly supplied in December by Dr. Georg Gebhard, author of the new book on Tsumeb. Ed.]

Tsumeb

On the 44th level several occurrences of leiteite and reinerite were found. **Leiteite** specimens consist of magnificent crystals up to 15 cm in size, well terminated and translucent. These are, without question, the best known examples of the species. A probable new mineral is associated; investigations are pending. The **reinerite** crystals are green and gemmy, up to 2 cm in size.

Goudeyite, a species not previously known from Tsumeb, has been found recently as yellow-green sprays to 1 cm in cavities. Twenty to 30 specimens have been recovered, and probably represent the best for the species. This is also the first known occurrence of a rare-earth mineral at Tsumeb.

Phosgenite has been found once more, but this time in superb specimens that rank among the best in the world. Two examples recovered have crystals 10 cm long and 5 cm across, transparent, and smoky-violet in color.

Other Namibian Localities

Prehnite has been found in some of the finest examples known for the species, at Brandberg, a well-known old locality. The well-crystallized sea-green spheres reach 10 cm! Colorless quartz, analcime and (rarely) amethyst are associated.

Tuperssvatsiaite, a sodium-iron silicate formerly known only as acicular sprays from Greenland, has been found in much better specimens at a quarry near Windhoek. Sprays up to 2 cm, free-standing in cavities, contain both green and brown crystals. Investigations regarding their precise composition are under way.

Torino Show

[October 9–11, 1992]

[The following notes on the Torino and Prague shows were kindly provided by Forrest and Barbara Cureton.]

Torino was generally a good and well-attended show, though no exciting new finds were to be seen.

Dealers seemed to feel that attendance was normal but sales were, generally, down. Sales quoted to us ranged from "better than last year" to off 30% from last year.

Of particular note was a find of approximately 20 specimens of superb, glassy brown **grossular** crystals to 2 cm combined with glassy green **diopside** crystals to 4.5 cm, as undamaged groups to 6 x 7 cm. They were dug and offered by A. Filipao, T. Giuseppe and N. Giantiero (professional collectors from Torino). Collecting was down in the summer of 1992. Along with those noted above, an additional 200 or so lesser specimens were removed and offered for sale. The location is Susa Valley, Alpe Delle Frasse, Piemont, Italy.

A few specimens of the very rare mineral **cascandite** were offered from a new find at the original locality (Cava Diverio, Baveno, Italy). The specimens show a pale lavender crystalline coating on feldspar crystals. All specimens are microcrystals.

Also offered were small but nice specimens of **simonite.** This occurs as red-orange microcrystal grains, associated with **rebulite** and **parapierrotite** on realgar. The simonite was identified during a re-examination of the Allchar, Macedonia, deposit.

During the past year or so **zincite** has been offered as faceting material from Poland. We questioned its origin. During the Torino show we saw the material offered for sale. One locality offered was Poland, the other Tuscany, Italy. Both were the same material and are certainly furnace products. Pieces to 8 cm were offered, showing glassy orange crystals to 7 mm. Prices were quite low, starting at $.80. Three weeks later, at the Munich show, more of this material was offered by a Polish dealer. The crystal groups range from glassy pale green through glassy red with crystals to 1 cm and groups to 10 cm. The quality is very good. He confirmed the zincite to be a furnace product from Poland.

Prague Show

[October 23–24, 1992]

The show was held in its 4th location in 4 years causing some confusion, mostly among foreigners.

General attendance seemed down a bit from past years. There were approximately 150 dealers ranging from amateurs with 1-meter tables (most were in this class) to one fine, large, 4-meter, well-lighted sales booth by the Casagrandes of Livorno, Italy.

One difficulty lay in the fact that the show ran from noon until 5 p.m. on Friday and 10 a.m. until 5 p.m. on Saturday. The problem was that the hall was used as a "disco" on Friday and Saturday nights. So, all dealers had to break down and move out of the halls by 5 p.m. Friday night and return and set up again on Saturday morning, and then be out again by 5 p.m. In all it was taken very well by almost everyone. However, quite a few dealers decided not to set up at all on Friday because of this problem.

We saw few new minerals. Dr. Petr Sztacho of *Inges & Plus Company* (Prague, Czechoslovakia) had a small but very nice selection of purple octahedral **fluorite** crystals to 2 cm on smoky quartz with quartz crystals to 10 cm. Specimens range from 3 x 7 cm to 12 x 20 cm. Prices were moderate. The location was given as Kara-Oba, Middle Asia.

David Kalat of Prague, Czechoslovakia, had a good selection of green **fluorapatite** crystals in pale orange calcite from Sludyanka, Baikal, Russia. The fluorapatite crystals ranged from 2 to 4 cm, and specimens ranged from 3 to 17 cm, with prices low to moderate. The specimens in general are very similar to the Ontario and Quebec specimens which are so well known. A major difference is that the fluorapatite crystals are quite glassy and contain areas of facet quality.

A Russian scientist who asked not to be named had a very large lot of outstanding **pyrochlore** crystals on matrix. The crystals are brilliant brown octahedrons to 1.5 cm, both singles and intergrown, covering the rock surface. They had been etched from calcite and had very little damage. The location is in the Ural Mountains, Russia. Prices were very fair.

A number of rare species were offered. Eastern European scientists now come forward with their own materials and, in some cases, with materials supplied by their colleagues. Some **new or rare** minerals offered included rorisite, bystrite, tounkite, armstrongite, mongolite and tsaregorodtsevite.

Moldavites (tektites) were very much in evidence. They are now being commercially mined. Some fine specimens, as well as jewelry grade material, are being provided at very fair prices.

The Prague show is held the weekend before the Munich show and is well worth attending. One person who can be a great help to anyone interested in attending is Dr. Petr Sztacho in Inges & Plus Company, Lohniskeho 849, 152 00 Praha 5, Czechoslovakia. Petr can help with hotel reservations, guide services, and connections with both Czech and Russian mineral dealers.

Prague is one of the most beautiful cities in Europe and is one of the last fairly priced cities as well. We advise a visit there.

Bilboa and Barcelona Shows

[October 2–4 and 9–11, 1992]

[Miguel Calvo of Zaragoza has kindly provided the following report on these important Spanish shows.]

The 15th annual Bolsa International Exposition of Minerals in Bilboa, Spain, drew an estimated 35,000 people, and the show in Barcelona (called *Expominer-92*) the following weekend attracted large crowds as well. These are the two largest mineral shows in Spain.

There were some new things to see in Spanish minerals at both shows, the most notable being the fine **barite** specimens from a single new pocket found on the 150-meter level of the Moscona mine, Villabona, Asturias, in July of 1992. The crystals are large, up to 10 cm, with a distinctive blue-gray color. The mine has been closed since August 1992 because of a decline in the market price of fluorite, but this important specimen-producing locality is expected to reopen soon. Armando Silva (Gijon, Asturias) and Jordi Fabre (Barcelona) had specimens for sale, including matrix crystal groups up to 35 cm square, with individual crystals to 8 cm.

Agustin Cobos, a private collector from Bilboa, has collected **goethite** specimens for many years in the mines of the La Arboleda area in Vizcaya. He had specimens for sale at the Bilboa show, ranging from very lustrous black botryoidal pieces to examples with a velvet texture. Unfortunately the specimen-producing iron mines in this area are now closed, and finding new goethite pockets in old workings is becoming increasingly difficult. So the outlook for the future of this locality is not very good.

The pegmatite veins seen in roadcuts near Franqueira, on the Franqueira-to-Sendin road, have continued to yield **emerald** specimens as they have in past years. However, Manuel Mesa of Oviedo was offering **phenakite** and **chrysoberyl** from this occurrence at the Bilboa show. The paragenesis of the deposits are apparently very similar to that of the famous Takovaja locality in the Ural Mountains, Russia. The phenakite crystals are rather crude, colorless to white, and measure up to 2 cm in size. They occur embedded in phlogopite. The chrysoberyl (as at Takovaja) is of the *alexandrite* variety. Cyclic twins of chrysoberyl, many with near-perfect shape, are typically only about 2 mm in size, but examples up to 1 cm across have reportedly been found.

In February and again in May of 1992, two 2-meter pockets were discovered in an old exploration adit under the abandoned opencut workings of the La Viesca mine at La Collada, Asturias. These cavities were found to be lined with transparent, pale blue **fluorite** crystals to 10 cm, having the typical cubic habit with edges truncated by *en echelon* growth approximating dodecahedron modifications. The cube faces are slightly frosty, and the crystals are color zoned but without the dark edge-zone common to earlier-found examples. Jordi Fabre obtained most of the best pieces from this find, large crystal groups without matrix, and offered them for sale at the Barcelona show.

Also available at Jordi Fabre's booth were some of the finest Spanish **andalusite** specimens to be collected in many years. The large crystals, up to 5 x 10 cm, are blocky in habit and have an intense pink color.

Groups to more than 20 cm, with muscovite, were found this past summer in one of the old quarries of the Sierra Albarrana area in Cordoba province . . . more precise locality information was unavailable.

Juan Viñals of Barcelona had specimens of **amicite** (a zeolite) showing fine microcrystals in vesicular basalt. The locality is a quarry near the city of Ciudad Real in central Spain. Associated species include natrolite, gonnardite; philipsite and tobermorite. Viñals also had some nice **cornwallite** specimens (botryoidal crusts) from Mazarrón, in Murcia province.

Jose Javier Savra of Cartagena (Murcia) had **barite** crystals in a variety of habits from some small, abandoned mines and prospects near Cartagena. The best examples have yellow, tabular crystals to 5 cm, partly coated by pyrolusite; these were found at a manganese prospect near the Portman golf course, Murcia. Other interesting variations include blue crystals in parallel growth resembling pine trees. Saura also had an old-time **amethyst** specimen from the Emilia mine, La Unión (Murcia) showing characteristic color zoning.

The Victoria mine, Navajun, La Rioja and the Fuentes de Ebro alabaster quarries near Zaragosa continue to produce the fine cubic **pyrite** and water-clear **gypsum** for which they have, respectively, become famous.

With regard to specimens from outside of Spain, the most important finds include the fine groups of translucent **cassiterite** crystals from Viloco, and the well-known **vivianite** crystals from Morococala, Bolivia. *Gea* (Ferraz 92, Madrid) had specimens available at the Bilboa and Barcelona shows. Nicolás Mesas, a fossil dealer from Zaragosa, brought to the Barcelona show some fine velvety blue crusts of **plancheite** from the Sanda mine, Mindouli, Congo; they lack matrix, and measure up to 8 cm across, with tiny dioptase crystals in association. The Italian prospector Giuseppe Agozzino was apparently the original source for these.

What's new in Minerals?

(Continued from page 230)

vivianite. This lot differs from the earlier one mainly in having better luster and in the iridescent drusy pyrite coating the matrix; the best ones cost over $1000.

Harvey Gordon Minerals (1002 S. Wells Ave., Reno, NV 89502) and *Genesis Epoch* had newly dug batches of beautiful **fluorite** from the mine at Okarusu, Namibia (not very far southwest of Tsumeb). Of about 100 specimens in Harvey's lot, the least were small miniatures, the best a couple of 15-cm clusters. The crystal habit is cubic, the color less easy to put a finger on: call it a very deep, transparent, zoned purple-blue-green.

Always with the sense of drama, I've saved the **gold** for last: for indeed there was much really fine gold around, having the bad luck to be upstaged by the rhodochrosites. First, German collector Christian Rewitzer of Furth im Wald recently bought from an old Romanian miner, who had been hoarding them for 50 years, about ten old Verespatak, Romania, gold miniatures with twisted leaves filling seams in, and sometimes rising up out of, white matrix; in some specimens there is more gold than matrix. The leaves have a bronze-like iridescence unusual in Verespatak gold, and prices ranged from a modest $150 for a nice thumbnail up to $3,900 for an 8-cm piece. These were being marketed by Christian Weise's *Kristalldruse* (Oberanger 6, D-8000 München 2, Germany).

But even such nice leaf gold as that, I'm afraid, looked minor in comparison with the giant specimens in the special showcase put in by Wayne and Dona Leicht of *Kristalle* (332 Forest Ave. #8, Laguna Beach, CA 92651). These are from a bonanza occurrence discovered on Christmas of last year (and thus called, in the extensive coverage that followed in California newspapers, the "Christmas Pocket") at the Crystalline-Alabama Claim of the Jamestown mine, Tuolumne County, California. The specimens, the Leichts' flyer said, came from a fault zone separating black graphitic slate from talc sericite near an old glory hole mined 100 years ago. The story goes that the masses of leaves were headed down the mine's conveyer belt toward the crusher, but were rescued at the last moment when a miner saw them going by and hit the "stop" button. So what is arguably the greatest California strike of crystallized leaf gold in decades was saved for the Leichts, who lovingly prepared some specimens for display here (most are still being processed, and did not appear). The patriarch among the dozen or so in the case was a tremendous 30-cm piece consisting of bright, whitish yellow leaves rising skyward in parallel crests, like slightly crumpled tinfoil stood on end. (See photo on inside front cover.) About 35 ounces of gold are in this ore specimen. All pieces in the lot were sold to one buyer, but more are being cleaned up for sale.

Back at their stand, the Leichts also had almost a hundred very bright, very well crystallized dendritic golds, including six quartz-matrix ones from 8 to 15 cm high, from the Eagle's Nest mine, Placer County; and further good ones from other California localities; and even a few nice thumbnails from Mt. Kare, Enga Province, Papua New Guinea.

And speaking of gold mining, Keith Williams (*Williams Minerals*) had an interesting document for the collector of historical-mineralogical correspondence: a letter "from the Laboratory of Thomas A. Edison, Orange New Jersey," dated January 3, 1896. It reads:

> Mr. W.[infield] S.[cott] Stratton
> Cripple Creek, Colorado
>
> Dear Sir,
>
> I have considerable curiosity to see samples of the average ore from your famous mine,—and also to add them to my mineral collection; you would oblige me greatly by sending some small samples, charges collect:— Thanking you in advance for your kindness, I am
>
> Yours very truly,
> Thomas A. Edison

So how can anyone, after looking at all this, go on to look appreciatively at great mineral specimens in institutional and other special display cases too? Only we gluttons understand.

Exhibits

This year's featured mineral (more properly, mineral group) was garnet, so many exhibit cases consisted exclusively of variations on the garnet-theme. My favorite was the American Museum of Natural History (New York) selection, for its inclusion of the "Subway Garnet," a brown, reasonably sharp dodecahedron as large as a sizable cantaloupe, found in 1886 during subway construction at Broadway and 35th St.

John Barlow showed 29 magnificent pieces, including several you'd recognize from *Mineralogical Record* covers and other widely distributed photos, e.g. his big Chamonix, France, smoky quartz covered with large rose-pink fluorite octahedrons* (seen on the cover of vol. 23, no. 3).

The Houston Museum of Natural History showed Perkins Sams collection pieces recently pictured in the *Mineralogical Record*'s portfolio of this collection, and now I *know,* as when I read the issue I

* Some friends played a little joke on John by secretly placing a *loose* fluorite octahedron near the foot of his piece, as if it had just fallen off!

couldn't quite figure out from the photos, which one I'd "pick"—the great 5 x 6 x 9-cm Chañarcillo, Chile, proustite.

Of the big-museum displays, though, I particularly liked the Leningrad (the sign didn't yet say "St. Petersburg") Mining Institute's case, with many amazing *old* Russian pieces, the whole, however, dominated by an immense plate of rosette azurite from Bisbee.

There were a great many cases devoted to the mineral suites of single localities: at least one case each for the Sunnyside mine, Colorado; Eden Mills, Vermont; the Blanchard mine, Bingham, New Mexico; Striegau, Silesia, Poland; Big Fish/Rapid Creek, Yukon; Bisbee; Tsumeb; and others. In the Pakistan/Afghanistan gem pegmatite case, the boulder-sized specimen with both an 18-cm, gemmy, deep pink morganite crystal *and* a sharp, thick, terminated 5 x 8 x 10-cm lilac kunzite, had to be seen to be believed (and even *then* . . .).

It is not just my idle and personal speculation, but the feeling of many other mineral people present here, that this was the best—the richest in exciting mineral matter—show held anywhere in the last, say, 25 years. Rhodochrosite, gold, Chinese diamond, prehnite, bertrandite, scores of Russian wonders (ah, those platinum crystals!) . . . returning on my plane to snow, work, and reality, I will at least have in my head memories, images, new knowledge, and mineralogical friendships that no future bad weather can quench.

Tom Moore
15 Lakeview Drive
Niantic, CT 06357

Awards

The Carnegie Mineralogical Award for 1992 was presented to Dr. Carl A. Francis, associate curator at the Harvard Mineralogical Museum in Cambridge, Massachusetts. Established in 1987 by the Carnegie Museum of Natural History and underwritten by the Hillman Foundation, the Carnegie Mineralogical Award annually salutes an individual or group whose contributions in mineralogical preservation, conservation and education match the ideals embodied in the museum's Hillman Hall of Minerals and Gems. Dr. Francis's lifelong interest in minerals began with a small collection at age seven, and continued through his formal education in geology at Amherst College in Massachusetts, and Virginia Polytechnic Institute in Blacksburg. He is a member of numerous professional organizations, a frequent lecturer on mineralogy at Harvard University, and a well-known author.

Nominations for the 1993 award should be sent to the Mineral Museums Advisory Council Selection Committee, c/o **Jean F. DeMouthe,** California Academy of Sciences, Golden Gate Park, San Francisco, CA 94118, or to **Marc L. Wilson,** Section of Minerals, the Carnegie Museum of Natural History, 4400 Forbes Avenue, Pittsburgh, PA 15213-4080.

The Desautels Trophy, awarded by the Tucson Gem and Mineral Show and considered to be the highest award in mineral collecting, was presented this year to F. John Barlow. Barlow won the McDole Trophy (predecessor of the Desautels Trophy) in 1976, and is now among the few holders of both awards.

W.E.W.

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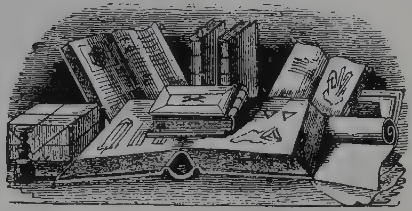

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Letters

MORE ON THE YUKON BOMB

The "Yukon Bomb" being held by Al Kulan (vol. 23, no. 4, p. 8), is one type of very sensitive detector used for airborne geophysical surveys. Explorationists actually do call these units "bombs" in reference to their appearance!

The bomb is hooked to a helicopter by a cable about 30 feet long, like the one in Al Kulan's hand. The cable supports the bomb, and connects it to recorders inside the helicopter. The helicopter is then flown 100 to 150 feet above the ground along a series of parallel flight lines, and readings are taken.

The size and shape of this bomb indicate that it was likely used for airborne magnetic surveys. They detect the magnetic intensity of the ground below them. Other airborne geophysical surveys include electromagnetic (EM), and radiometric surveys. EM surveys locate zones of electrical conductivity near the Earth's surface in much the same way metal detectors find buried coins, while radiometric surveys identify areas with high levels of radioactivity. All these surveys help find new ore deposits.

On a personal note, I had the pleasure of knowing Al Kulan professionally. In addition to being an avid mineral collector, he was a very successful prospector. He was part of the team that discovered the Cyprus Anvil lead-zinc-silver deposit now being mined by Curragh Resources at Faro, Yukon. His thirst and enthusiasm for mineral collecting and prospecting affected everyone who came in contact with him. I had the misfortune of being one of the people present the night Al was murdered in Ross River in 1977.

My wife Ruth's job took her to the Rapid Creek and Big Fish River areas a few years after Al Kulan's discovery of the phosphate minerals. For her, it was one of the most beautiful, rugged, and at times dangerous, localities she has worked.

Ed Debicki
Sudbury, Ontario

RODALQUILARITE

I was interested to see the mention of a rodalquilarite specimen from Chile and thought a little further information might be useful. The actual locality is the Wendy pit, Tambo, which feeds the El Indio mill but is situated 6 km south of El Indio and about 195 km east of La Serena, Chile.

Rodalquilarite $[H_3Fe_2^{3+}(Te^{4+}O_3)_4Cl]$ was first recognized there in 1983, by geologists. It occurs as green material found in association with high-grade gold ore in a rhyolitic breccia also containing barite and alunite. Specimens of rodalquilarite were encountered commonly in the Wendy Breccia, associated with native gold.

Sidney A. Williams positively identified the rodalquilarite while on a consulting trip to El Indio in 1983.

I myself worked in the El Indio district for four years before being transferred, coincidentally, to the Rodalquilar mine in Spain, type locality for the species. During three years at Rodalquilar I never encountered a single specimen of rodalquilarite.

Jack Crawford
Recursos Americanos
Argentinos, S.A.
Mendoza, Argentina

PHOSGENITE AND MATLOCKITE

Readers of Peter Burr's excellent article on the history of the discovery of phosgenite and matlockite in Derbyshire (*Mineralogical Record* **23**, 377–386) might be interested in the following stories surrounding the 1851 finds. They have been gleaned from original letters from two of the principals, Robert Phillips Greg and William Garrow Lettsom (of the *Manual of the Mineralogy of Great Britain and Ireland,* 1858), preserved in the correspondence archives of the Natural History Museum in London. These letters describe part of the story of discovery that Burr does not mention, and shed a somewhat bleaker light on specimen acquisition and rivalry among Victorian collectors than that presented in his paper. I am indebted to NHM archivist John Thackray for access to them (in the *Mineralogy Correspondence Books*) and for permission to quote from them.

Greg's father owned the fine mineral collection of wealthy banker Thomas Allan, but little was done to extend it until Robert took an interest. By 1848 Greg jr. was desperate to add to the Allan collection a specimen of *Horn Lead* (phosgenite) from Derbyshire, specimens of which he had admired in the British Museum. In October of that year he made his first contact with Charles Konig, Keeper of Minerals at the Museum, and, in a wheedling letter, he tried to persuade Konig to exchange a specimen to him by extolling this method of acquisition: "It is often chiefly by *Exchange* that private collections grow into celebrity," he said. But Konig was not swayed: "It is with regret I have to [inform] you in reply that there is an order that none of these specimens are to be parted with, not only because many similar applications have of late been made, but also because . . . there are no duplicates." Undeterred, Greg tried again: "In private collections the system of exchange is exceedingly advantageous, and especially as regards specimens which are not to be bought by money . . . I merely write now to make an offer which, however likely it is to be rejected, is I am sure you will *personally* acknowledge a fair one." He offered several rare and fine specimens from his collection, but to no avail.

A few years later a better opportunity presented itself. In 1851, Lettsom obtained by chance a clue to the whereabouts of some old phosgenite specimens in Derbyshire, and dispatched the mineral dealer Bryce Wright in search of them. Wright obtained five specimens, "among them a very good one," and Lettsom naturally expected first choice. "But no [he wrote in August 1851], Mr. Greg, who knew of the whole transaction, who knew I had been the means of disinterring these specimens, took the best for himself without saying a word to me." Greg's version of events was slightly different: "Researches which *Mr. Lettsom & I have put on foot in Derbyshire* [my italics] have ended in finding 5 fine cristals of the Murio Carbonate [of] lead of the olden time. They were found in an old basket belonging to an old man living near Matlock. We have also found sulphate tri-carbonate associated with it."

Yet more disappointment awaited Lettsom. Recognizing that an unknown mineral was associated with some of Wright's material, Lettsom sent some to Germany for analysis. This may have been from that collected underground after the above discovery, although the "sulphate tri-carbonate" (a synonym of leadhillite, another thin platy lead mineral) mentioned by Greg may have been the same species. Greg also had the mineral analyzed, and published it shortly after as matlockite. "He certainly had the legal right to do so," wrote Lettsom from Madrid, "but as he was aware that I had sent some fragments . . . to [Prof. Karl F.] Rammelsberg . . . it was hardly fair for him to take the wind out of the Professor's sails, by employing someone else to analyse this mineral, & publishing the analysis before I received Rammelsberg's. However, legally speaking he has a right to do as he has done, but his great mineralogical eagerness leads him to do things which I do not think he would approve of in others." Despite these disappointments, Lettsom concludes—perhaps demonstrating why he chose an overseas diplomatic career rather than remaining a collector (he sold his collection to William Neville) or becoming Keeper of Minerals at the British Museum (he was offered the job in 1857)—"To a collector all is fair."

Mick Cooper
Managing Editor
UK Journal of Mines and Minerals

FUTURE OF PUBLIC EXHIBITS

I refer to the interesting editorial, vol. 23, no. 6, by Alan Goldstein which gave many of us an "insight" on the thinking of latterday museum administrators. As one who has previously confessed opposition to the relegation of systematic exhibits, I am at the same time able to recognize the laudable intentions behind the progression of "re-vamps." However, I am still in serious doubt about the merits of current policy aimed at public participation by the creation of "interactive" exhibits. One might well ask a leading question—What proportion of public museum visitors wish to be "educated" and to what degree? My own guess would be a very small proportion. I think that those who even bothered to look at them would probably consider them as mere curiosities which would be dismissed from the mind after a short period of time. There is not, in my opinion, much chance of an "educative" element striking home unless a latent interest already exists—and in which case, a systematic exhibition would serve a better purpose and to greater effect.

Alan Goldstein's reference to "disneyization" I thought to be singularly significant in that people in general are seeking amusement and "divertissement"—they are not by and large seeking enlightenment (education). It might therefore be an idea to also abandon the title of "museum" with all its erstwhile connotations and think up a new name for such establishments, along with porticos decorated by multi-colored flashing lights and which would convey a sense of fun and amusement—if that is what current museum administrators are hell-bent on providing.

J. R. Knight
Manchester, England

THE CURT SEGELER COLLECTION

The report of my participation at the 1992 Springfield Mineral Show (Tom Moore, "What's New in Minerals?," vol. 23, no. 6, p. 499) first brought a deep-throated chuckle, but was quickly followed by an icy cringe of future meetings with my erstwhile friends who would be sure to mention that they would never forget what they read. Although Larry Conklin, many years ago, told me: "It doesn't matter what they say about you as long as they are talking about you," I feel that some response is necessary. In a "Lord Giveth/Lord Taketh Away" approach, Moore used words concerning the booth such as: "dustily disorganized," "mesmerizing," "gratified," and "enticingly." I am not normally a mineral dealer, but my respect for Curt made me a temporary one. Several additional facts should be noted.

Curt Segeler was one of my best friends and he influenced me greatly concerning mineralogy. I offered to help the family to decide on the fate of the collection when that time came. The larger specimens in the collection were moved out of New York, by the family, after the micromount collection was distributed to members of the Queens Mineral Society, a club Curt worked diligently for. The Segeler family asked me to sell the rest of the collection for them. The first sales opportunity was at the Gilsum, New Hampshire, show and swap. At this show most of the New England specimens were sold, including about 90 terminated triphylite crystal specimens from Newport, New Hampshire. At the Syracuse, New York, show, the entire booth was sold to Mohawk Minerals, which is re-selling the specimens. The Springfield show had hitherto unexposed specimens for sale. The dealer of record was Cross Avocations (Nancy Cross) with whom I have been a frequent partner. The late Larry Cross and I graduated together from the University of Maine.

At the Springfield Show, the bulk of the Segeler collection was sold, specimen by specimen. At several times, the booth resembled a convention of army ants. The specimens were displayed in their original trays (yes, dustily) all assembled in flats with the finer specimens in a well-lighted Allstate display case. Several inferior specimens which did not have trays were evident, but every specimen was labeled and priced (not particularly disorganized, but not attractively placed in white cotton-lined boxes, etc.). (Several of the "high-roller" dealers passed by the booth, wondering what the activity was all about, as there was little activity at their own booths. They would look at the absence of wulfenite, dioptase and rhodochrosite, shake their heads in wonderment, and walk optimistically back to their own booths hoping the masses would discover them as well. Note: there *were* three excellent wulfenites from Mies in the Segeler collection [one of which was stolen from the dealer who acquired them for re-sale].) The remnants of the Segeler collection were sold at the Franklin, New Jersey, Satellite Show (i.e. The Pond).

For the record, there were about 5000 specimens, including mounted micromounts in the Segeler collection that actually were sold. Perhaps 5000 additional mounted micromounts, more or less, were given away by the family. The best segelerite in the collection was retained by the family. The most expensive specimen was a Swiss smoky quartz V-cluster of crystals. The most important specimens were canaphites from Great Notch quarry, Great Notch, New Jersey, with a notation that the original specimens were collected in 1967 by Sid Steriss. The strength of the collection was in two categories: phosphates and low-priced teaching specimens. Individual sub-collections were sold to specialists: Tsumeb, Lengenbach, Hagendorf, Clara mine, New York, New Hampshire, Maine, and Connecticut, as well as two major portions of the micromounts. There were practically no specimens from Franklin, even in micromount, but there were numerous Prospect Park quarry and Upper New Street quarry specimens. One Franklin micromount sold for $500, however. (Incidentally, I believe I set a world record price for a micromount in 1986 when, while working for Ward's, I sold a Franklin specimen for $1,000.) A blue sales label was generated for the sale, in addition to any other labels present with the specimen. (Curt had several different personal labels and examples have been donated to the Mineralogical Record Library via Ron Bentley.) The personal correspondence, consisting of the last ten years of activity, was sold to the premier collector of mineralogical correspondence. The small book collection and scientific instruments were distributed by the family.

Vandall T. King
Rochester, New York

Thank you for those historically valuable (and what would otherwise have been ephemeral) details on an important collection and its final disposition. Ed.

PERUVIAN REFERENCE

It may interest *Mineralogical Record* readers to know that *El Peru Minero*, a multi-volume set by Mario Samame Boggio, is now available directly from the author. Although a few volumes of this amazing and useful work remain to be printed, most are currently in print and several may be purchased in an English version. They are as follows:

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Readers may also be interested to know that a special issue of the Mineralogical Record *devoted entirely to the mines and minerals of Peru is in preparation. Ed.*

DIRECTORY OF MICROMOUNTERS

The 16th edition of the *International Directory of Micromounters* will be published at the 1993 Paul Desautels Memorial Micromount Symposium, which will take place this coming September. We wish to take this opportunity to thank those who have already provided information for inclusion in the coming edition. We greatly appreciate such support and look forward to receiving additional information from other sources. This information must be received by June 1, 1993. The information we need is as follows:

1. The full name and address (including postal code) of active micromounters who would like to be listed in the coming edition of the Directory.
2. Names and current addresses of those who have moved to new addresses (including former addresses).
3. Names and current addresses of those who have changed their names (including former names and addresses).
4. Names of organizations in which there are five or more active micromounters and the name and address of one micromounter willing to serve as a contact for the others.
5. Any additional useful information will also be appreciated, such as the special line of information, which may be of help in making appropriate contacts with other micromounters.
6. Finally, names of dealers with the names and addresses of their firms and some idea of what they sell (e.g., plastic boxes).

The above information should be sent to:

International Directory of
Micromounters
c/o Roy I. Grim, Editor
9155-A Hitching Post Lane
Laurel, MD 20723-1531 U.S.A.

Since the postal rates are expected to remain the same through 1994, the postpaid price for the 16th edition will remain the same as for the 15th edition: $3.50 excluding postage. **Add** $2.25 first class postage to the U.S., $2.50 for airmail to Canada, $4.50 for airmail to Western Europe, or $5.50 for airmail to Australia, New Zealand and South Africa. Payment in U.S. dollars only (cash accepted; no foreign bank checks please).

Congratulations to

Dr. Carl A. Francis

1992 Recipient

Carnegie Mineralogical Award

The Carnegie Mineralogical Award was established in 1987 to recognize outstanding contributions which promote mineralogical preservation, conservation and education, ideals embodied in the Carnegie Museum's **Hillman Hall of Minerals & Gems.** The award is open to individuals, groups, organizations and institutions. Private mineral enthusiasts, collectors, educators, curators, and mineral clubs and societies, as well as museums and universities, are all eligible. The award, consisting of a certificate of recognition, a cast bronze medallion, and a $2500 cash prize, is presented each February during the Tucson Gem and Mineral Show.

The Mineral Museums Advisory Council administers the award and oversees the selection process. Nominations for the **1993 Carnegie Mineralogical Award** may be submitted, until December 31, to either of the following addresses.

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California Academy of Science, Golden Gate Park, San Francisco, CA 94178 (Tel: 415-750-7094)

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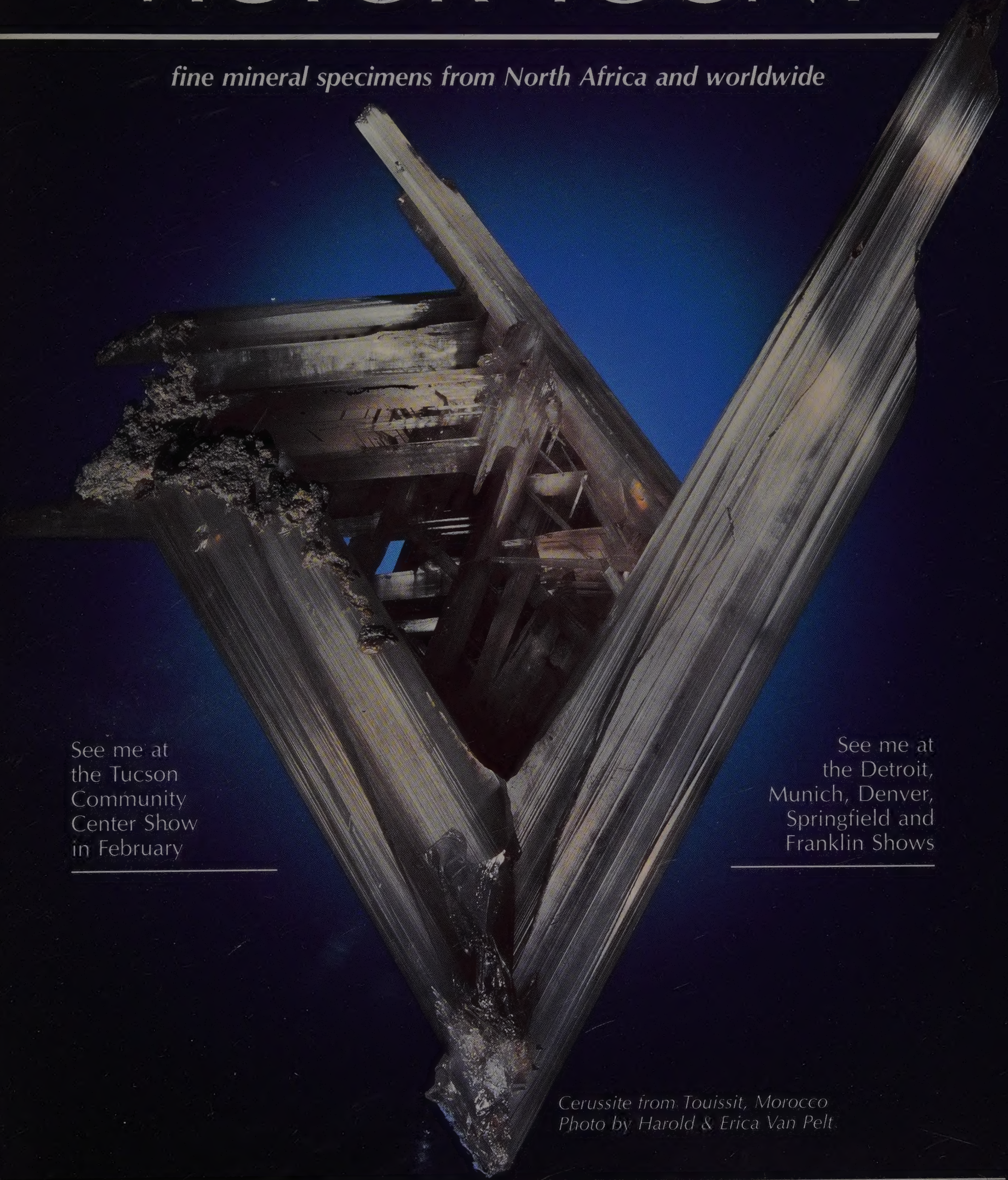

Cerussite from Touissit, Morocco
Photo by Harold & Erica Van Pelt