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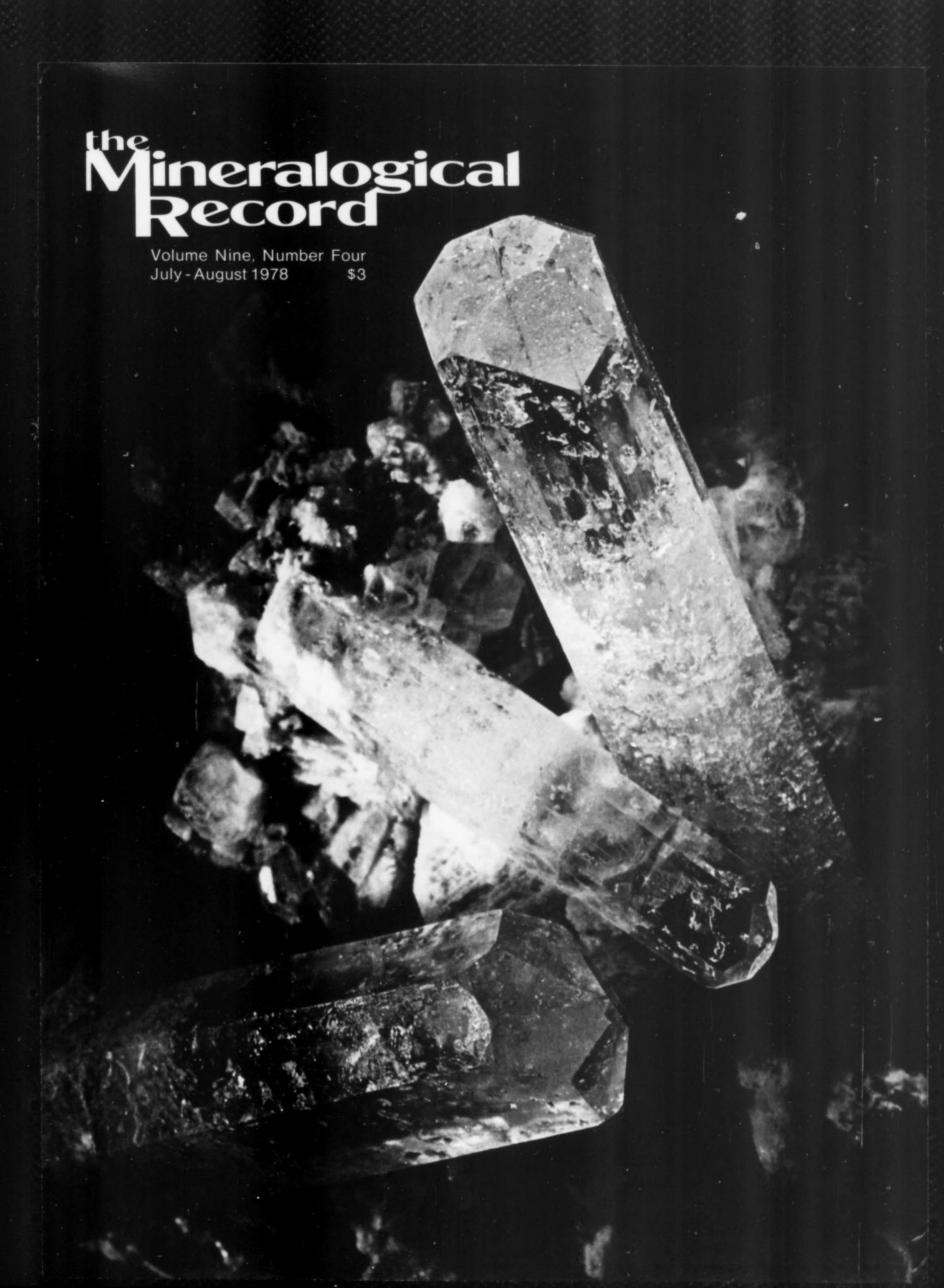

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Wayne and Dona Leicht, 332 Forest Ave. #8, Laguna Beach, Cal. 92651 [714]494-7695

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feature articles

departments

COVER: BERYL from Espirito Santo, Brazil; the large crystal is 3 cm in length. From the collection of the Sorbonne (University of Paris); photo by Nelly Bariand.

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notes from the EDITOR

THE LONE ARRANGER

As anyone knows who has ever prepared a display of minerals, half the fun is in arranging the beloved specimens in the most advantageous way. At home one can spend relaxing hours arranging and rearranging just for the joy of seeing them "react" visually in new ways as they are brought into different combinations. In competitive display the arrangement becomes more critical because judges will take off points for aesthetic errors in juxtaposition. Two reds together? Points off. A bright green overpowering the pastel green nearby? Points off. Big specimen in the front row blocking view of smaller one behind? (Here it comes again:) Points off. Try letting a friend arrange your specimens in his own way and you will begin to understand how very many possibilities there are.

As suggested above, there are a few basic rules: generally you shouldn't put two specimens of similar color together. This means that if your specimens are arranged on a checkerboard grid, there are eight specimens surrounding each specimen in the center zone, five around each specimen on an edge, and three around each corner specimen. If you have a red rhodochrosite in the middle, you will have to find eight non-red specimens with which to surround it, ideally, each of which is not next to another specimen of similar color. This eventually leads into a complex mathematical concept known among topologists as "the map problem" because it can be viewed from the standpoint of a mapmaker trying to color countries on a map without having two countries of the same color in contact. The question they pose is, what is the maximum number of colors he will need? The answer is four, although it was only recently (and with massive computer assistance) that this answer was conclusively proven correct.

The mineral collector, of course, must deal with additional variables. The color of the minerals, for instance, is never actually identical, but varies over infinite ranges of subtle hues, shades and tints. The sizes, even within a collection of minatures or of thumbnails, vary within limits. The shapes have infinite possible variety. Most collectors agree that the larger specimens should go nearer the back where they will be less likely to obscure the view of smaller specimens. An additional rationale is that the smaller items should be nearer the observer so they can be seen better.

A logical question at this point is, how many possible arrangements might there be to choose from? If you have four specimens in a row, it turns out that there are $1 \times 2 \times 3 \times 4 = 24$ different ways to arrange them; this is called *four factorial*, abbreviated as *4!* in mathematical notation. If you have 25 miniatures to arrange on a chosen grid pattern, it follows that the number of possible arrangements is *25!* How many is *25!?* Before the invention of the electronic calculator I would not have wanted to perform that calculation. However, through the wonders of *Texas Instruments*, I am able to tell you that the number of different ways in which you could arrange your 25 miniatures is roughly 15,511,206,000,000,000,000,000,000 (that is, about 15 septillion).

This serves to demonstrate that even if a few constraints are placed on the arrangements, there will probably be a *countless* number of options still remaining that violate no pre-set rules. We transcend the border between science and art. The collector finds a place for his own personality, his artistic expression, his attitude toward minerals and his taste in art to emerge. Even if he does not publicly display, he can rearrange his own collection in its case at home every night and find a beautiful and satisfying new creation every time. Try arranging them into pleasing sub-groups first: the perfect trio, or all the pastels together, for instance. Then combine the subgroups. Experiment with the distribution of sizes and shapes; you are actually composing a true sculpture in every sense. Alter your grid pattern and you introduce yet another variable.

If you find pleasure in this and want to read more on the subject, go to the library and select a book on color for artists, paying particular attention to the chapters explaining how colors affect each other when placed side-by-side. In fact, browse through a wide variety of books on sculpture and painting. See how the great artists use colors next to each other, and how the sculptors use shapes and space. Eventually you may develop a greater sensitivity to color, form and composition, as well as a greater skill in advantageously arranging your collection in its showcase. And ultimately you will enhance your enjoyment, in yet another way, of your collection.

A RECORD, BY ANY OTHER NAME, WOULD...

Some time ago the publisher suggested to me that we change the name of the *Mineralogical Record* slightly, to the *Mineral Record*, or perhaps simply *Minerals*. The advantages are that (a) it would be more concise, (b) it would be easier to pronounce, especially for Europeans, and (c) it would sound less technical and "elitist." I can think of no disadvantages aside from the fact that we have grown rather accustomed to the original name after all these years. Some may think this change will tend to degrade the image of technical quality; the only reply to that objection can be that the quality itself will not, in fact, deteriorate thereby. Surely no one concerned about our technical quality will drop his subscription because of a minor name change (we presume). In any case, we are not yet committed to this decision, and would first like to ask if any of you have objections. Perhaps there are drawbacks that have not yet occurred to us. Feel free to write to us if this change would, for some reason, be objectionable to you.

THE DECENNIAL INDEX

It has been occurring to more and more people lately to ask if we are planning a ten-year index for the end of 1979. The answer is, yes. At the current time our plans call for a highly detailed index and reader's guide to be included as a separate publication, mailed out with volume 10, number 6. We are quite aware that the annual indexes published at the end of issue number 6 each year are bare-bones coverages at best. The decennial index, however, will be minutely detailed and will be arranged to aid readers in quickly and easily locating any item. With this index, we fully expect the usefulness of the back issues to increase by an order of magnitude. As usual, reader suggestions regarding the compilation and structure of the decennial index are welcome.

A GUARANTEED TRADE-IN VALUE?

While at the Tucson Show I visited the display room of *Kahn Mineralien* (the German associate of *Nature's Treasures*, one of our advertisers). The Kahns deal primarily in Tsumeb minerals, and also carry various other Southwest African and South African species. I noted an interesting offer on their mineral list; it reads as follows:

> *"If you ever buy a specimen from us, keep the receipt! We accept any piece ever bought from us as part-payment at the original price of sale, if you ever want to buy a larger or higher priced specimen from us to 'up-grade' your collection."*

I would heartily recommend that all mineral dealers do the same, except for one problem. I cannot figure out how the Kahns know that a certain specimen is being presented with the *same receipt* issued for its purchase, especially if several years have elapsed since the sale. What is to prevent someone who has purchased several specimens of the same species from switching receipts and asking for $500 credit on a specimen for which he actually paid only $200, secretly keeping for himself the original $500 specimen? Also, how do the Kahns know the specimens are in the same condition as when purchased? I admire the Kahns for making their confident guarantee...it is certain to favorably impress their customers. I only hope their customers do not attempt to abuse the

privilege.

ERRATA

In the recent paper, "Uralolite from the Dunton Gem mine, Newry, Maine: a second occurrence" (vol. 9, p. 99-101), the entry in the first paragraph which states "...glucine (= beryllonite) is incorrect. Glucine is still a valid specis. The error is the responsiblity of the senior author who is indebted to Curt Segeler for calling it to his attention.

(Pete J. Dunn)

In the recent paper "Epitaxial wodginite and cassiterite from Lavra Jabuti, Baixio, Galilea, Minas Gerais, Brazil" (vol. 9, p. 14), Galilea is a misspelling; the correct spelling is *Galileia*.

(Richard V. Gaines)

THIRD INTERNATIONAL MINERALOGICAL SYMPOSIUM

Committee Proudly Presents

ZEOLITES:

October 5,6,7,8, 1978
At the RAMADA INN of Clark, New Jersey; Exit 135, Garden State Parkway

SYMPOSIUM PROGRAM (In the Camelot Room)

Saturday (October 7)
10-11 am: "Zeolites--an introduction" and "The zeolites of New Jersey" by Tom Peters, Paterson Museum
1-2 pm: "The zeolites of the Pacific Northwest" by Rudy Tschernich
2:30-3:30 pm: "Sedimentary zeolites" by Fred Mumpton, State University College, Brockport, New York
Sunday (October 8)
11-12 am: "Origin of zeolites in the Southwestern U.S. and Hawaii by William Wise, University of California
1-2 pm: "The zeolites of Northern Ireland and Scotland" by Rudy Tschernich
Pre-registration: $7.00 (2 days) or $4 (1 day)

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ANNUAL BANQUET--COACHMAN INN, Crawford, New Jersey
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famous mineral localities:

the Elmwood and Gordonsville zinc mines near Carthage, Tennessee

by

Lance E. Kearns and **F. Howard Campbell, III**

Department of Geology
James Madison University
Harrisonburg, Virginia 22801

In recent years, superb specimens of fluorite, calcite, sphalerite, barite and galena have been found at the Elmwood and Gordonsville zinc mines, near the town of Carthage, Smith County, Tennessee. Relatively little top-quality material from this locality is available on the commercial market, and demand for such specimens is far greater than the supply. Undamaged specimens appearing in limited quantities at a few mineral shows have commanded high prices. The calcite specimens may be the finest ever found in North America.

The towns of Elmwood and Gordonsville are located approximately 64 kilometers east of Nashville and 48 km south of the Kentucky-Tennessee border. The terrain east of Nashville is gently to moderately rolling, developed on middle and upper Ordovician carbonate rocks. This region is within the Central Basin physiographic province of the state. In the vicinity of Elmwood and Gordonsville, the Central Basin province grades into the Eastern Highland Rim province and the topography becomes quite rugged with a relief of 150 to 180 meters.

Figure 1. **Golden orange or "cognac" colored, twinned calcite from the Elmwood mine. The crystal is 14 cm in longest dimension. Smithsonian specimen; photo by WEW.**

HISTORY

In 1964, New Jersey Zinc Company made the decision to explore the lower Ordovician limestones along the Nashville structural arch for suspected zinc-lead-barite-fluorite deposits. Their decision to implement this search was based on prior knowledge that other widespread Lower Ordovician carbonates contained similar ore deposits, that many other zinc-lead-barite-fluorite deposits were associated with paleokarst topography developed by subsurface drainage systems, and that such features were often associated with broad, open uplifts and arches. The geology of the middle Tennessee area at Elmwood and Gordonsville indicated the presence of all three indicators.

Exploration drilling, following a random-walk search along the Nashville arch, penetrated 1.5 m of 16.5% zinc at a depth of 415.2 to 416.7 m in February, 1967 (Callahan, 1977). This was drill hole #79, and marks the initial discovery of the Elmwood deposit. Close-order-grid drilling confirmed the potential of the deposit by August of 1969. The Elmwood Project went into full production in August, 1975, and presently has a production rate of about 3,000 tons of ore per day. The present working level of the mine is between 100 and 113 m.

In the spring of 1976, development of a new mining operation began several kilometers to the southwest in the town of Gordonsville. When completed, the Gordonsville mine will probably be the largest zinc mine in the United States. Approximately 500 workers will be employed to attain the projected 9,000 tons/day production rate. The Gordonsville mine is nearing the completion of its development stage. Subsurface development of an inclined shaft will eventually form an underground link between the Gordonsville mine and the Elmwood Project. Production at the Gordonsville mine is slated to begin in August, 1978.

Ore concentrate from the Elmwood Project is presently running about 60% zinc and is shipped via railroad to New Jersey Zinc Company's smelting operation at Palmerton, Pennsylvania. To better accommodate the production capacity of the Elmwood-Gordonsville mines, a modern electrolytic zinc refinery is being constructed in Clarkesville, Tennessee. The new refinery will have an estimated capacity of 163,000 tons of zinc per year, and is expected to increase United States zinc production by 14% (Whittle, 1977). The size of the

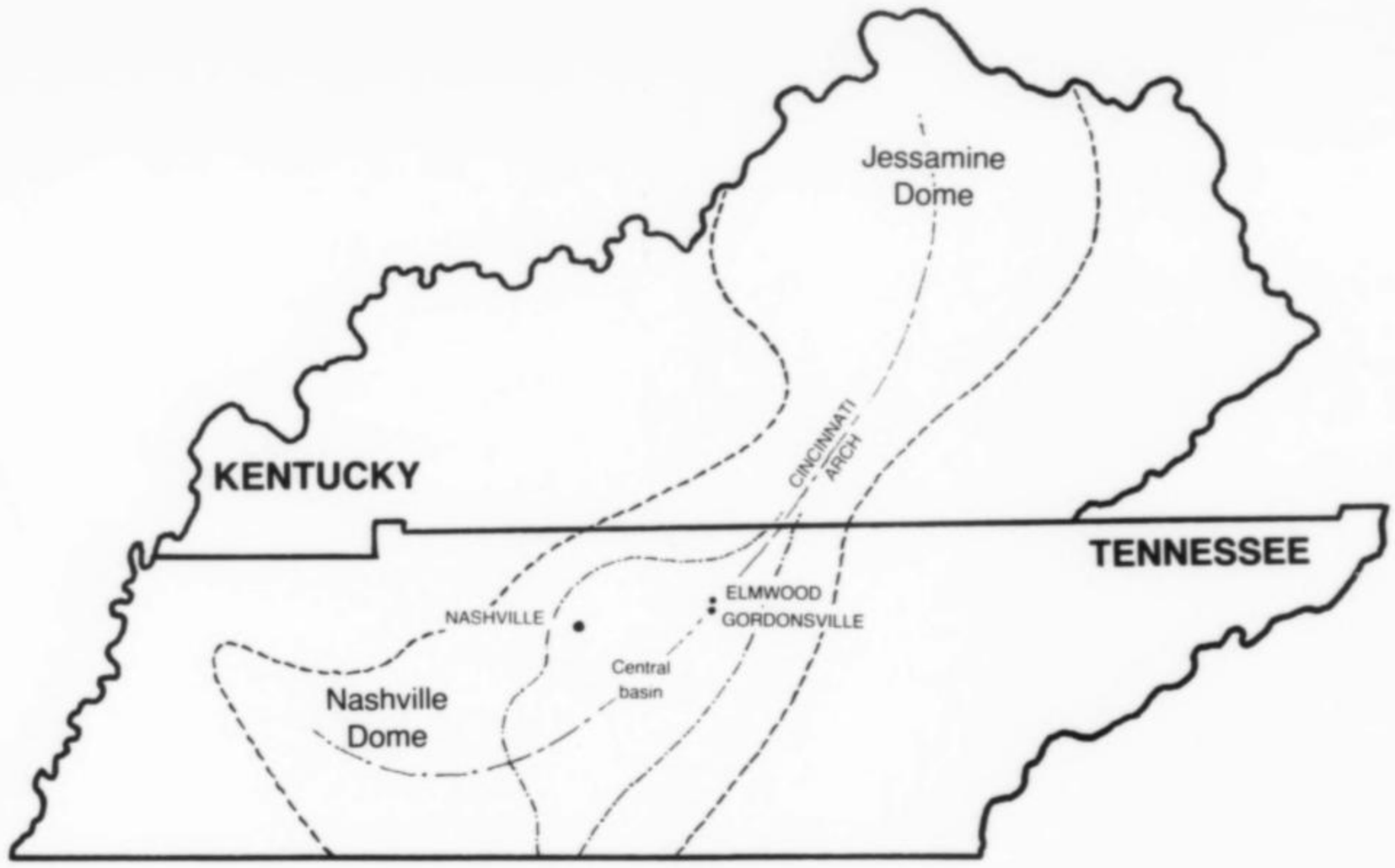

Figure 2. **Location map showing gross features of structure and physiography.**

ore reserves indicates that mining could continue under the proposed production rate for at least 25 years.

Development and production of this exceptionally rich zinc deposit is under the direction and ownership of Jersey Miniere Company which is a joint venture of Gulf Western Natural Resource Group (40%) and the Belgium-based corporation of Union Miniere (60%). Jersey Miniere Company has made an estimated 200 million dollar investment in the Elmwood-Gordonsville mines and Clarkesville refinery.

GEOLOGY

The Elmwood and Gordonsville mines are located on the northeastern flank of the Nashville dome, a doubly plunging anticlinal feature which constitutes the major structure of the southern portion of the Cincinnati arch (Fig. 2). The axis of the Nashville dome trends northeast-southwest and, according to Kyle (1976), the strata slope away from the crest at approximately 10 m/km. The mines are near the axis of the structure where it plunges into the Cumberland saddle that separates the Nashville dome from the Jessamine dome in central Kentucky. Minor folds of local extent are evident in surface exposure and were encountered in exploration drilling. Faults of small displacement were also evident in drill holes. However, neither the minor folds nor the faults have an appreciable effect on the regional structure and stratigraphy. The ore deposits lie in the upper and middle Mascot dolomite member of the Knox group.

The Cambro-Ordovician Knox group has a thickness of up to 914 m and is composed of the upper Cambrian Copper Ridge dolomite and three Ordovician units; the Chepultepec dolomite, Kingsport formation and Mascot dolomite. The top of the Knox is bounded by a major disconformity of regional extent with local relief of up to 38 m. The unconformity is interpreted to represent an ancient karst topography complete with an extensive subsurface drainage system. Below this paleokarst surface and related to it, stratabound collapse breccia bodies have developed within the Mascot dolomite and extend down into the underlying Kingsport formation (Fig. 3). The breccia occupies a complex system of dissolution cavities which extend more than 275 m below the unconformity (Gilbert and Hoagland, 1970). The Mascot is dominantly a sequence of finely crystalline dolostones interbedded with limestones and coarsely crystalline dolomitized equivalents of the limestones (Kyle, 1976). According to Stagg and Fisher (1970), two sandstone units are well-developed in parts of Smith County and adjoining areas. The average thickness of the Mascot, from drill hole information, is 200 m. The upper Kingsport formation consists dominantly of limestone equivalents interbedded with finely crystalline dolomites. Tentative correlation of the drilled portion of the upper Knox in Smith County is made with the ore-bearing Mascot and Kingsport formations of east Tennessee (Stagg and Fisher, 1970).

The ore bearing breccia bodies are determined to be one of two types (see Fig. 3): (1) solution collapse breccia related to karst topography, and (2) collapse structures resulting from the thinning of underlying beds by subsurface drainage (Callahan, 1977). Distribution of the breccias appears to follow a random pattern controlled by bedding planes and joint sets as is characteristic of a regional subsurface drainage system. The mineral deposits are typical Mississippi Valley type, hydrothermal ore bodies and are postulated by Callahan (1974) to be epigenetic because the mineralization is concentrated in subsurface erosion and collapse features developed beneath an unconformity.

Breccias in the upper Knox of central Tennessee are divided by Kyle (1976) into generally unmineralized early breccia systems and late breccia systems which contain the ore and related minerals. The minerals occur as cement between breccia fragments and as open space cavity fillings. The vugs, which sometimes reach enormous size, have provided handsome specimens of crystallized fluorite, sphalerite, calcite, barite and less commonly galena. Celestine, pyrite, anglesite and marcasite have also been reported, but are significantly less abundant.

The pockets and vugs are exceptional in size and appearance. Many could more accurately be described as crystal-lined caverns. The larger pockets measure 1 or 2 m in width and height and 40 to 55 m deep, large enough to accommodate many people within! In some of these large vugs the ceiling has collapsed into a pile of breccia 1 or 2 m deep on the floor. The minerals, primarily calcite, appear to have formed after this collapse, and have covered and penetrated the breccia pile (Charles Key, personal communication), as well as coating the walls. "Floater" crystals of calcite, without apparent points of attachment, are common.

MINERALOGY

Anglesite in white growths having a fibrous, ram's-horn habit several cm in size have been found but are very rare (Fig. 4). This habit is unusual, considering that secondary lead minerals are not common in

Mississippi Valley-type lead deposits and, where found, are usually thin, formless coatings on galena.

Barite (variety barytocelestine, $(Ba,Sr)SO_4$) forms white to cream-colored, frothy-appearing masses and nearly perfect hemispheres or spheres to 35 cm in diameter (Fig. 5). The individual crystals comprising the spherical aggregates are semi-oriented and have a peculiar, attenuated form with curved faces. The barite commonly occurs on a matrix of sphalerite and/or fluorite, and sometimes galena.

Calcite forms three distinct generations. The earliest phase (calcite I) occurs as white, simple scalenohedrons formed prior to crystallization of the sulfides. These early stage calcites are rarely observed on specimens from the Elmwood mine, but are found in relative abundance at the Gordonsville mine.

The second stage of calcite (calcite II) forms clear to milky scalenohedrons. The dominant habit is a simple scalenohedron with slight shortening along the *c*-axis, but contact twins on (0001) occur. The calcite II crystals are generally found in association with barite.

The third generation of calcite (calcite III), was one of the last phases to form within the mineralized cavities. The crystals are generally transparent and range in color from white and colorless through various shades of pale, golden yellow and, in some specimens, a remarkably rich golden orange or "cognac" color which has generated much excitement among collectors (Fig. 1). The large crystals are commonly zoned, with darker colors nearer the surface. Scalenohedrons contact twinned on (0001) comprise nearly all of the calcite crystals thus far recovered (Fig. 6, 7). Such a large occurrence of almost universally twinned calcite is unprecedented. The twins are easily recognized by the re-entrant angles near the middle of the scalenohedrons, three per crystal where perfectly developed. Some twin members appear to penetrate each other to a certain extent. A brilliant luster is characteristic of nearly all third generation calcite found.

These late-formed calcite crystals are remarkable for their size as well as their color, form and luster. Although superb specimens a few cm in size have been collected, crystals 20 to 25 cm in size are not

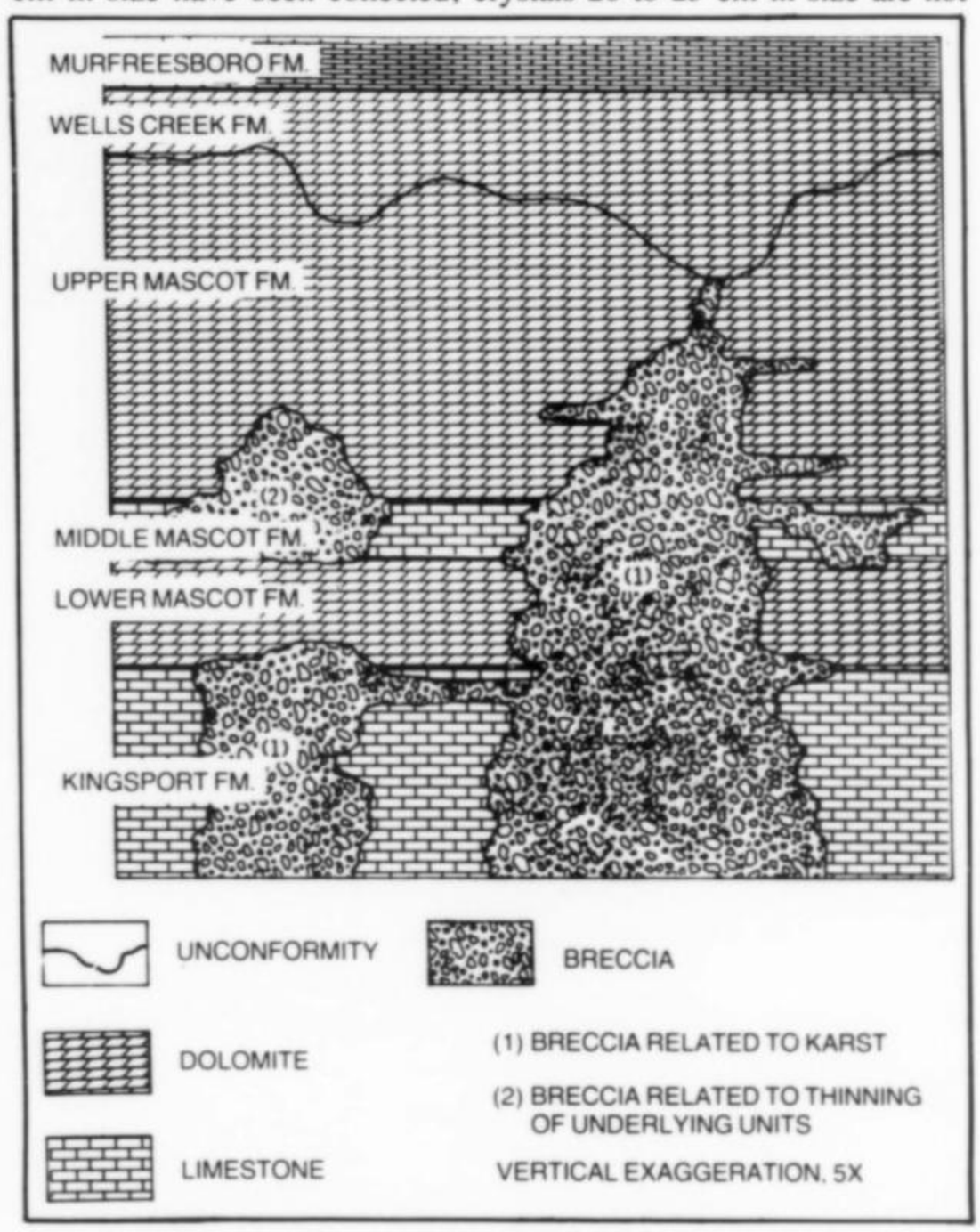

Figure 3. **Generalized sketch of the ore-bearing breccia bodies in central Tennessee (modified from Winslow, 1973, and Callahan, 1977).**

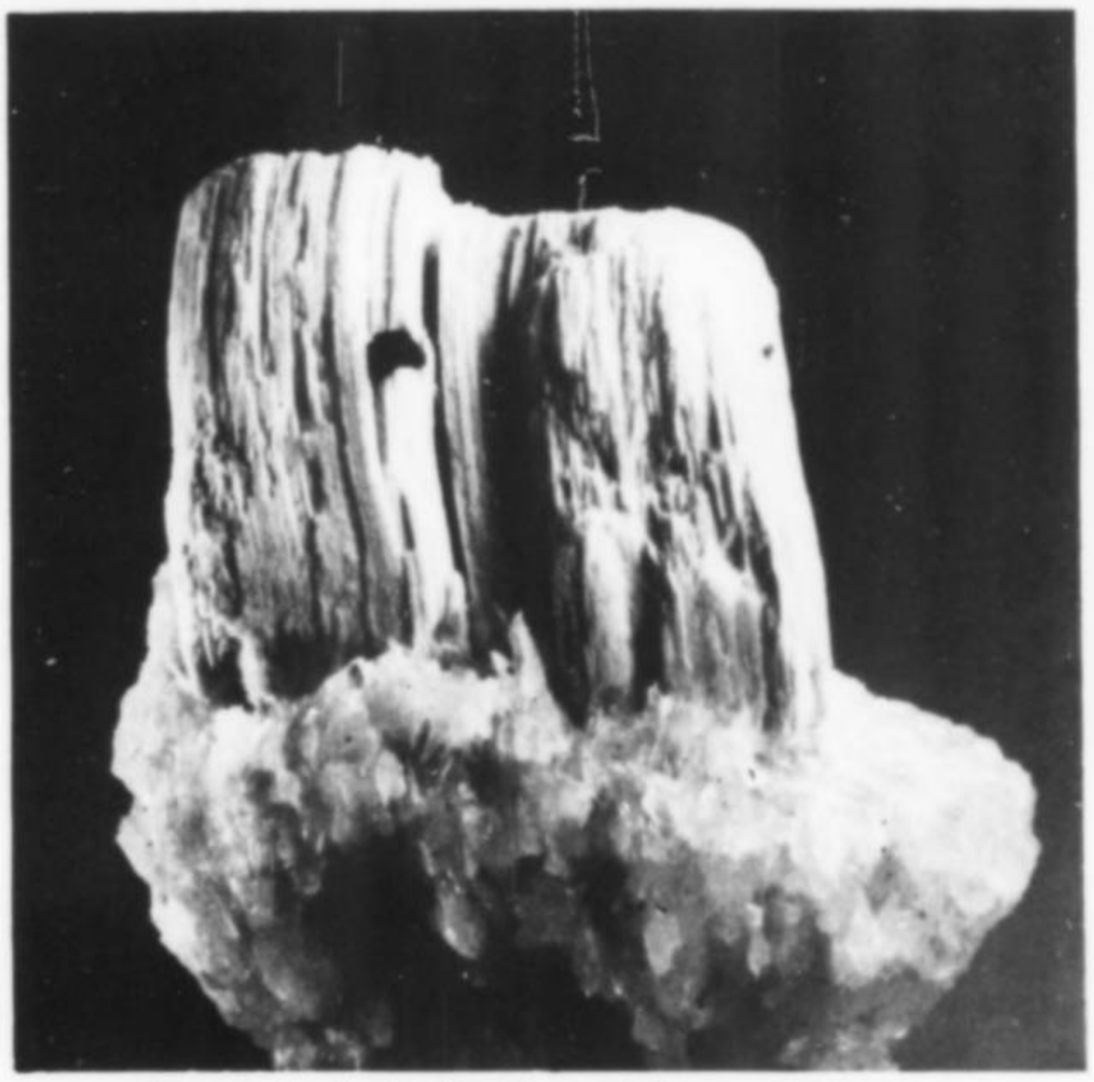

Figure 4. **Anglesite in a white, ram's-horn growth on barite crystals from the Elmwood mine. The specimen is about 6.7 cm tall. Smithsonian specimen #142547; photo by WEW.**

Figure 5. **A large sphere measuring 25 cm in diameter, composed of white barite crystals, on a matrix of sphalerite crystals, from the Elmwood mine. Photo by LEK.**

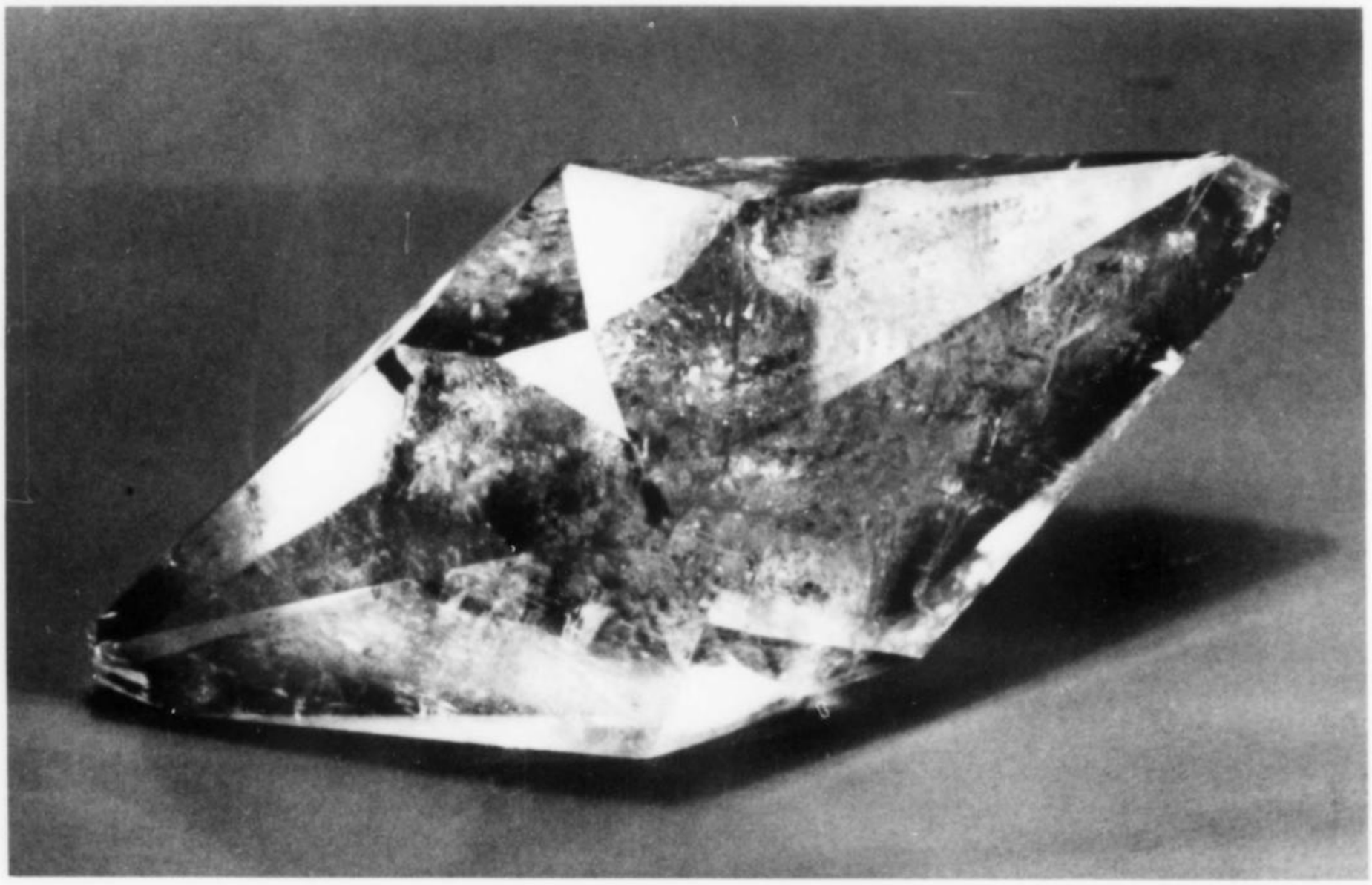

Figure 6. **A doubly terminated, yellow calcite crystal, twinned on (0001), from the Elmwood mine. The crystal measures 5.4 cm long. Smithsonian specimen #142558; photo by WEW.**

Figure 7. **Two golden yellow, twinned calcite crystals on matrix from the Elmwood mine. The group is 13 cm wide. Smithsonian specimen; photo by WEW.**

uncommon. A few crystals of enormous size have been recovered; the James Madison University has recently acquired a scalenohedron, twinned on (0001), which measures 47 cm from tip to tip, in parallel growth with a second twinned scalenohedron measuring 32 cm. These groups of twinned crystals apparently in parallel growth are also very common and may represent an additional type of twin, although this possibility requires further study.

These large, perfectly formed, beautifully colored, brilliantly lustrous twins are probably the finest examples of calcite known in the world.

Dolomite occurs as lustrous, curved, pearly-white crystals formed along joint surfaces or in small vugs (Fig. 10, 12), and is not commonly observed as a constituent in the larger crystal cavities. Dolomite is associated with small, colorless drusy quartz crystals, small purple fluorite cubes, and sometimes sphalerite. Small globules of bituminous material may be scattered over the dolomite.

Fluorite occurs in cubic cyrstals up to 25 cm across, and also as small, isolated crystals and crystal groups on massive or cyrstalline sphalerite and rarely calcite or galena. The larger crystals show only the cube faces, but some smaller crystals are modified by the tetrahexahedron{210}.

The colors thus far observed include gray-blue to purple, which is the

most common range, colorless, yellow, yellow-green and pink. The pink crystals are very distinct in color, similar to pink fluorite from Switzerland. The centers of the large purple crystals tend to be colorless, and the corner zones colorless to yellow. These corners are interesting, and apparently formed last, over what were originally corners truncated by octahedron faces (Fig. 8). The corners are typically very gemmy, and have been faceted into flawless yellow stones as large as 47 carats (Charles Key, personal communication). The entire crystals are sometimes covered by a thin, final layer of purple fluorite parallel to the cube faces, less commonly parallel to the octahedron faces, and rarely in irregular, swirling patterns.

The largest fluorite cyrstals are found as clusters and free-standing crystals on sphalerite (Fig. 9). Small, bright purple cubes have been found on cherty limestone with drusy quartz, pearly white, curved dolomite crystals (Fig. 10), and less commonly with twinned sphalerite crystals. The fluorite crystals, especially the larger ones, are composite crystals formed of many smaller domains which are very nearly (but not quite) perfectly oriented parallel to the planes of the overall "crystal."

One pocket encountered contained at least 50 specimens of galena with purple fluorite crystals perched on the galena crystals, especially on corners. The fluorite appears to be oriented parallel to the underlying

Figure 8. **A large, composite fluorite crystal from the Elmwood mine, yellow-green in color, measuring 12.5 cm square. Note the transparent, gemmy zones on the corners. Ireneé duPont Mineral Museum, University of Delaware. Photo by LEK.**

galena in a possible epitaxial arrangement (Fig. 11). The galena occurs as composite crystals like the larger fluorite crystals mentioned above, and the fluorite crystals do not always appear to be oriented exactly parallel to the galena host. However, this may be due to the composite nature of the underlying galena; the fluorite crystals may have begun forming in perfect epitaxial orientation, but later may have grown to surround other domains of slightly different orientation.

Galena. Good specimens of galena from the Elmwood-Gordonsville deposit are the most difficult to obtain. Galena, where present, was usually the first sulfide mineral to form in the cavity. The irregular, crystalline masses formed during the earliest period of crystallization seldom produce good specimens because they are totally encrusted by the later formation of sphalerite and fluorite.

Fine specimens of galena were formed during a later formational period that provides bright, free-standing cubes (1-3 cm) on slabs of

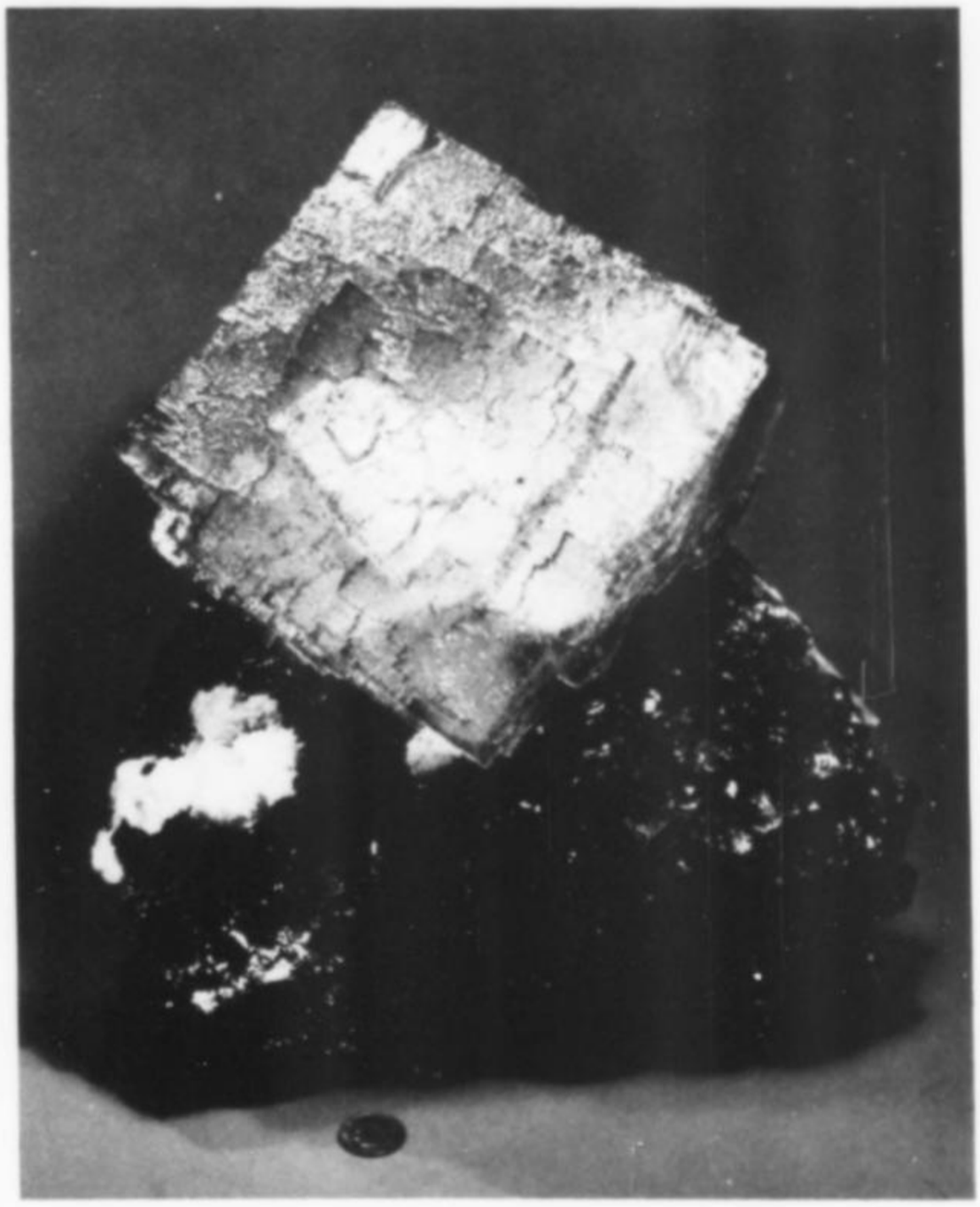

Figure 9. **A large purple crystal of fluorite from the Elmwood mine, 11.3 cm on edge, on black sphalerite crystal matrix with minor white barite (note dime for scale). Smithsonian specimen; photo by WEW.**

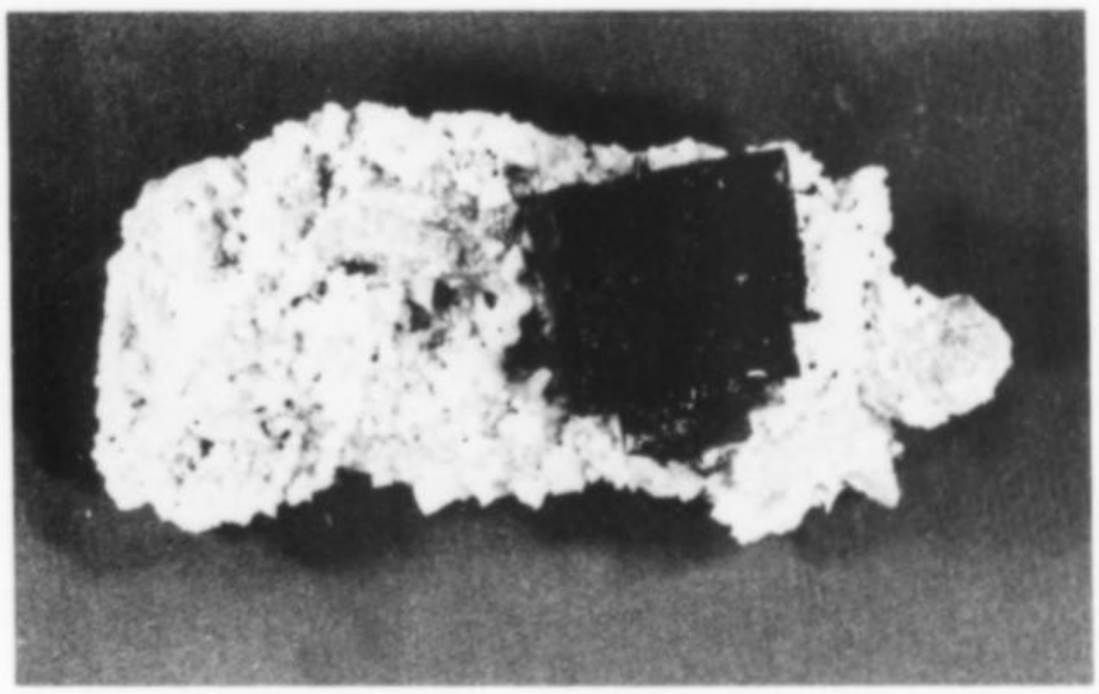

Figure 10. **Dark purple fluorite on dolomite-coated matrix from the Elmwood mine. The specimen measures 10 cm wide. From the James Madison University collection; photo by LEK.**

lustrous sphalerite crystals with deep purple fluorite cubes. The most highly prized galena specimens are the large skeletal cubes.

Sphalerite is the principal ore mineral at the Elmwood-Gordonsville mines. It occurs as large reddish brown masses and slabs with the free-space exposures covered with blackish, lustrous crystals up to 8 cm in size having red internal reflections (Fig. 12). Small, hollow globules of bituminous material are commonly found on the surface of the sphalerite masses and also more generally coating galena crystals. Toluene or carbon tetrachloride will remove it.

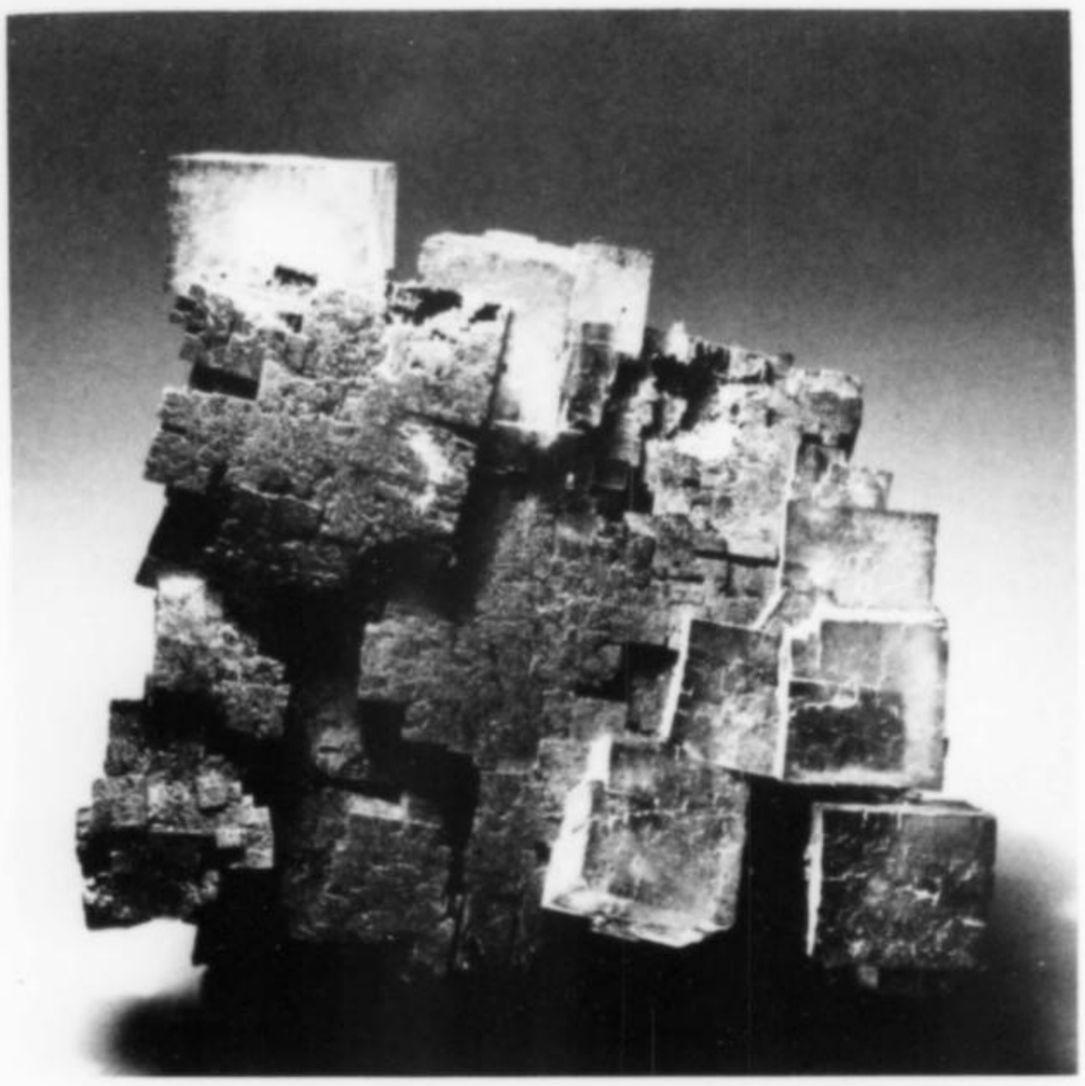

Figure 11. **Purple fluorite crystals in apparent epitaxial orientation on galena crystals. The galena is dark because of a coating of bituminous material. The group is 7.4 cm wide. Smithsonian specimen; photo by WEW.**

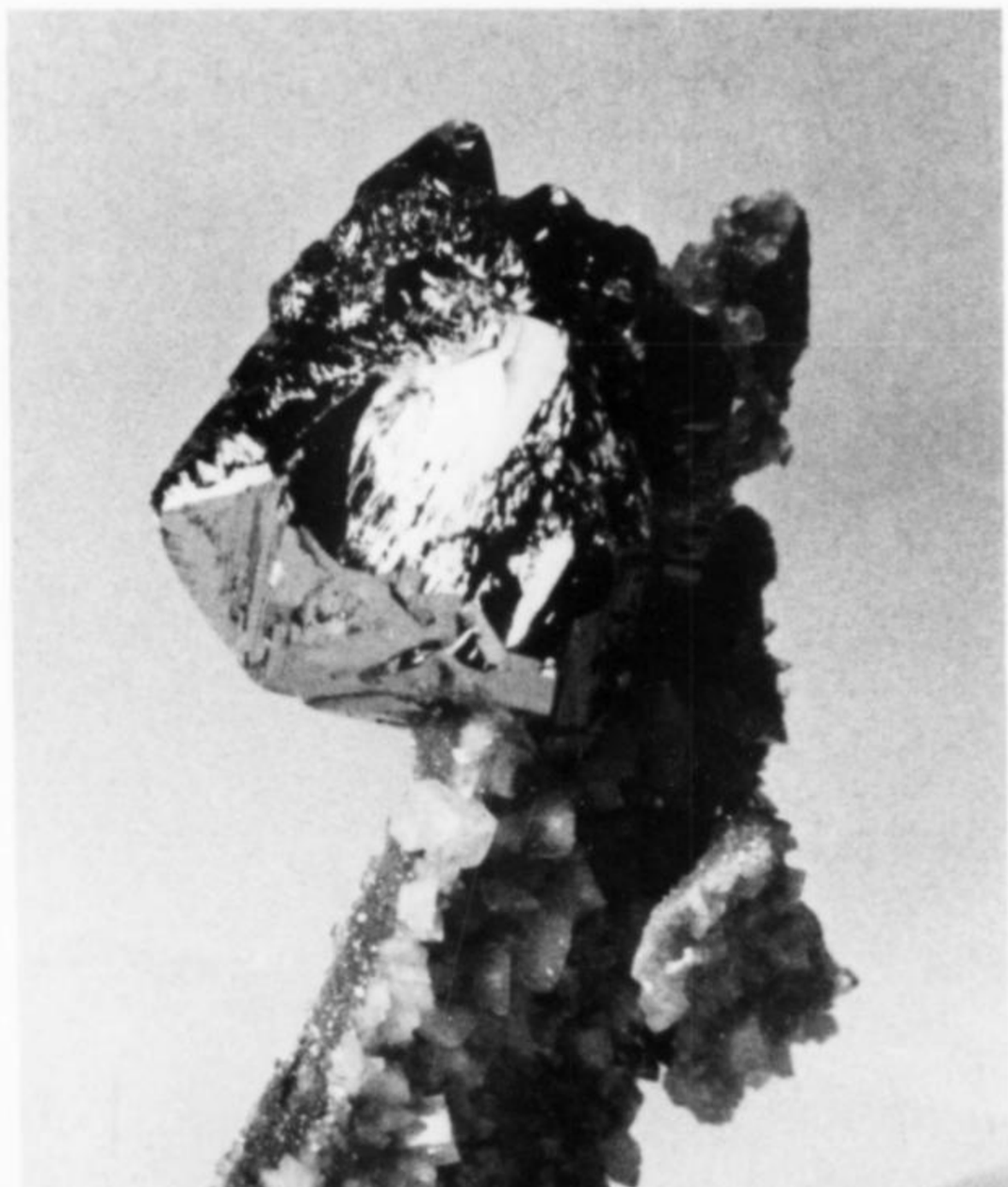

Figure 12. **Twinned sphalerite, black with red internal reflections, on a matrix of pearly white dolomite crystals. The sphalerite crystal measures 2 by 2.5 cm. Tom Gressman specimen; photo by Ross Fricke.**

CRYSTALLIZATION SEQUENCE AND PARAGENESIS

Examination of more than 100 specimens from the Elmwood-Gordonsville mining district suggests the order of crystallization shown in Figure 13. The mineral specimens available for examination were strongly biased toward those of the larger crystal-filled vugs. Only rarely was the complete mineral assemblage present on a single specimen. Smaller crystal-filled cavities have a markedly simpler mineralogy than the larger cavities. The sequence of crystallization in the smaller cavities is generally: (1) drusy quartz →*dolomite→ calcite; or, (2) drusy quartz→dolomite→fluorite (purple). Sphalerite crystals may accompany either assemblage following the formation of the dolomite.

Examination of fluid inclusions (Roedder, 1971) suggests that the minerals of Elmwood and Gordonsville were deposited from brine solutions containing 10-25% total salts. Fluid inclusion geothermometry from fluorite, sphalerite and barite indicates a temperature of formation within the 90°C to 120°C range (Roedder, 1971).

An earlier paper by Kyle (1976) has also discussed the sequence of crystallization of the minerals at Elmwood. The sequence presented in Figure 13 was determined independently of Kyle's study. Although similar, a major difference is in the sequential relationship of galena and sphalerite.

* → indicates "followed by."

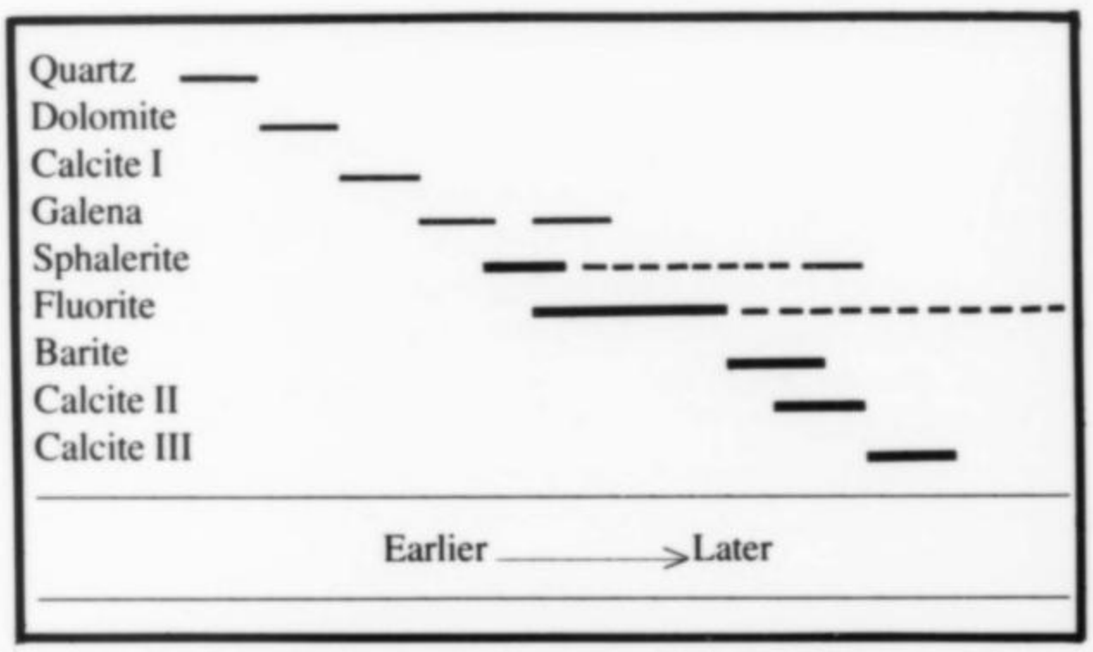

Figure 13. **Proposed sequence of crystallization in mineralized cavities at the Elmwood and Gordonsville mines. The heavy lines represent major occurrences; the thin lines represent minor occurrences.**

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The Crystal Forms of PYRITE

by Robert I. Gait
Department of Mineralogy and Geology
Royal Ontario Museum
100 Queens Park
Toronto, Canada M5S 2C6

with photographs by
the Photography Department
Royal Ontario Museum
and drawings by the author

Pyrite is a mineral well-known to collectors as bright, shiny crystals and crystal groups exhibiting a variety of different forms and combinations. Many localities throughout the world have yielded fine specimens, not a few of which are still easily available today. This article shows collectors how to recognize the common forms by simple inspection.

INTRODUCTION

Pyrite is a common mineral often found as bright shiny crystals and crystal groups; it also occurs in various other habits, such as concretions, radiating discs, hair-like crystals, etc., as well as its ubiquitous occurrence in most massive sulfide deposits. Good crystals are found at numerous world-wide localities, some of the best known being Rio Marina, Isle of Elba, Italy; Ambas Aguas, Logroño and Villarijo, Soria, Spain; Tuscany and Traversella, Italy; several localities in Peru and several in the USA, especially Montana, Colorado and, most recently, King County, Washington. Because good crystals of pyrite are easily obtained, and are a favorite of many mineral collectors, it was decided to prepare this article to help collectors identify the various forms on their pyrite crystals. The article will also serve to illustrate some of the complexities of this subject and give collectors a deeper insight into and appreciation for crystals of this common mineral.

A recent temporary exhibition at the Royal Ontario Museum in Toronto, entitled "Fool's Gold," displayed numerous well-formed crystals of pyrite from many world occurrences. Each specimen was accompanied by a label and drawing of a similar crystal on which the forms were identified. Subsequently, the exhibit was modified into a small traveling exhibit and it will be seen at many mineral shows in the next few years. Both exhibits were planned by the author with the invaluable assistance of Jack Satterly, who is a Research Associate in the Department of Mineralogy and Geology at the Royal Ontario Museum. This article is a direct outcome of the initial planning and thought which was applied to these exhibits, although its scope is considerably larger and more completely illustrated. And now to pyrite.

THE CRYSTAL SYMMETRY OF PYRITE

Pyrite belongs to the isometric crystal system and is in the diploidal class which has the symmetry $\frac{2}{m}\bar{3}$, which means that crystals in this class have 2-fold axes of rotation which are perpendicular to mirror planes ($\frac{2}{m}$), and also 3-fold inversion axes written as $\bar{3}$ and spoken as "bar three." The class has less symmetry than the normal or hexoctahedral class which has 4-fold axes of rotation, perpendicular to mirror planes ($\frac{4}{m}$) in addition to those described above. The full symmetry of the normal class is given as $\frac{4}{m}\,\bar{3}\,\frac{2}{m}$. The distinguishing feature between crystals belonging to these two classes is that the diploidal class lacks 4-fold symmetry. Figure 1 illustrates the positions of the 4-fold and 2-fold rotation axes relative to a plain cube (in the normal class) and a striated cube (in the diploidal class). Both of these classes possess three 3-fold inversion axes ($\bar{3}$) which are located from each cube corner to the opposite corner following a line which passes through the body center of the cube.

THE CRYSTAL FORMS OF PYRITE

Although quite a number of different crystal forms have been observed on pyrite crystals, only four are common. These are the ***cube*** (6 faces, Fig. 1), the ***pyritohedron*** ($\frac{2}{m}\bar{3}$ faces, Fig. 2) exhibiting the characteristic symmetry of the class ($\frac{2}{m}\bar{3}$), the ***octahedron*** (8 faces, Fig. 3) and the ***diploid*** (24 faces, Fig. 4) possessing the symmetry of the diploidal class. Other less common forms are the ***trisoctahedron*** (24 faces) and the ***rhombic dodecahedron*** (12 faces) which are seen on a few of the crystals used to illustrate this article. Any or all of these forms may be combined with one another and complex combinations have been recorded on crystals exhibiting over 100 faces. Examples of such crystals may be seen in Victor Goldschmidt's *Atlas der Krystallformen*, volume 6, published in 1920. This famous work contains 691 drawings of pyrite crystals, illustrating the simple forms, combined forms, twinned crystals, distorted crystals and crystal habits specific to certain localities. Goldschmidt's work was used extensively in the preparation of the exhibits as well as the notes for this article.

The symmetry of pyrite crystals is a direct consequence of the crystal structure of the mineral. In other words the iron and sulfur atoms are arranged in a three dimensional pattern which has the symmetry $\frac{2}{m}\bar{3}$, identical of course to the symmetry of the diploidal class. Figure 5 is a simplified version of the crystal structure projected onto a cube face. The important thing to note is that the pattern has 2-fold symmetry and

not 4-fold symmetry. The possible faces of crystals are parallel to planes of atoms in the three dimensional atomic arrangement and the commonest forms have faces which, in general, are parallel to those planes which contain the most atoms. Although this is rather vague it is important to realize that the morphology is totally dependent upon the crystal structure of the mineral.

It is impossible to enter a discussion on crystal forms without resorting to the use of *Miller indices*. These symbols are used to name each face of a crystal form and are indispensable. The Miller indices are given as three numbers derived from the position of a crystal face relative to the three crystallographic axes. It is not essential to understand them for the purposes of this article as they are used mainly as "labels" for the faces. The Miller symbols for the cube are written {100} and read aloud as "one zero zero." The curly brackets imply the complete set of symbols for all six of the cube faces which make the form; these are: (100), (010), (001) and $(\bar{1}00)$, $(0\bar{1}0)$ and $(00\bar{1})$. The octahedron has the symbol {111}, spoken as "one one one," and the commonest of the possible pyritohedra is designated {210}, "two one zero." The contact goniometer is most useful in identifying the faces on pyrite crystals by measuring the interfacial angles and comparing the results with published data. However this article will help to recognize most of the forms by simple inspection.

Many of the illustrations and photographs in this article have been prepared so that the viewer is looking along one of the $\bar{3}$ (or triad) axes, that is, looking directly onto the cube corner along a line that passes through the body centre of the cube to the opposite corner. Figure 6 shows how the striated cube and the octahedron would appear in this orientation. Note the three-fold symmetry of these sketches.

Descriptions of the four commonest forms follow, each one with some discussion as to its principal elements.

The Cube *(Fig. 1):* *6 faces, three sets of parallel pairs at right angles to each other. Miller indices {100}. Marked "c" on most of the drawings.*

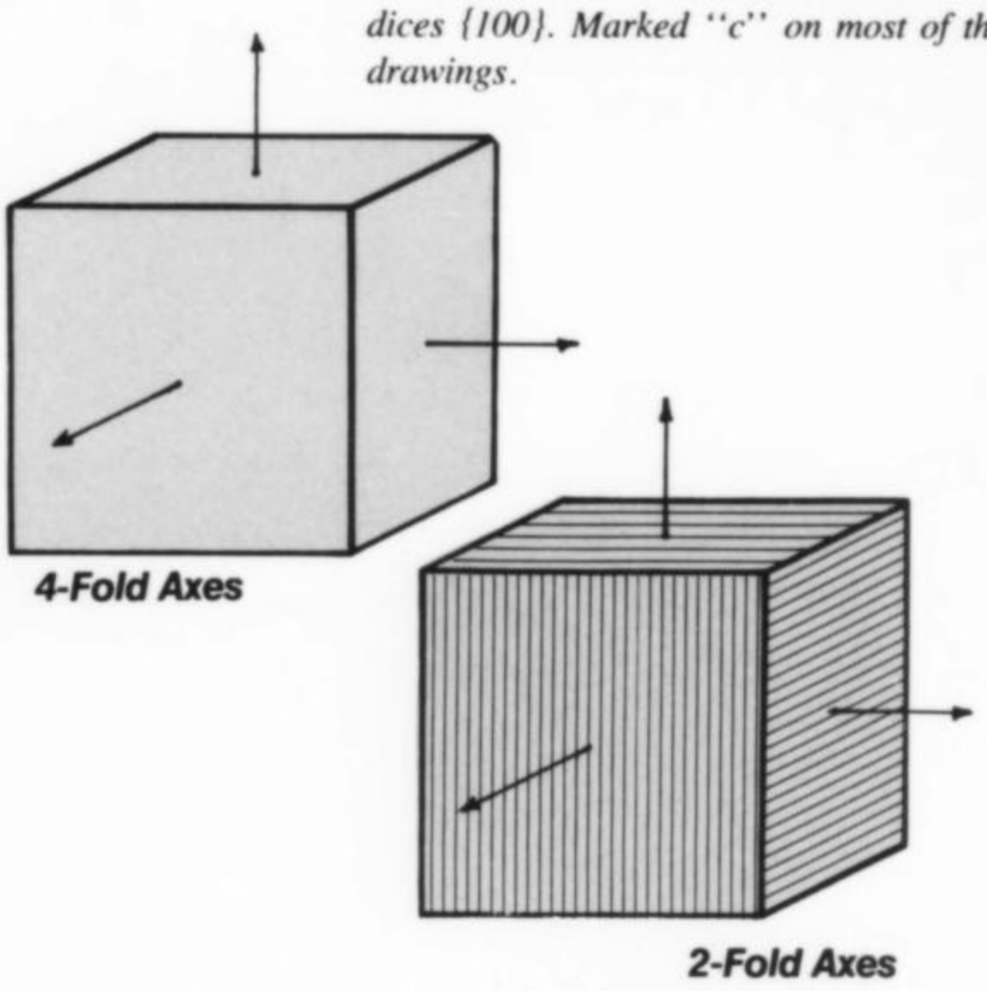


Figure 1. **2-fold and 4-fold symmetry axes.**

Cubes of pyrite superficially appear to have the full symmetry of the normal class, that is, they seem to have 4-fold axes. However, pyrite cube faces are almost always striated with fine lines which reduce the apparent 4-fold symmetry to 2-fold, placing it in the diploidal class. This is clearly illustrated in the sketches in Figure 1.

The striations on the faces of the pyrite cubes are a product of the oscillatory growth between the cube and the pyritohedron. It is like a combined form with both the pyritohedron and the cube striving for dominance, but neither succeeding. Figure 7 shows a drawing and a photograph of an actual crystal from Greece that is a textbook example

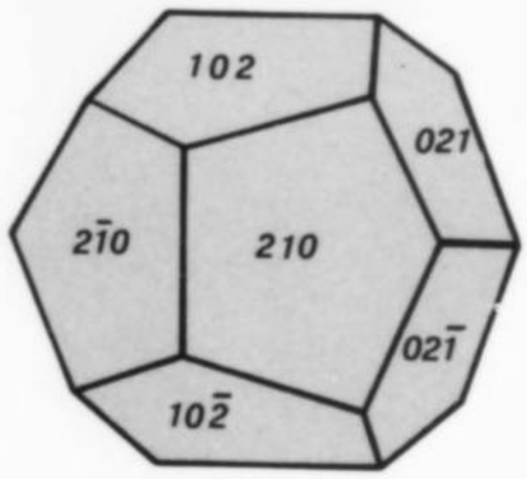


Figure 2. **The pyritohedron.**

Angles on Some Pyritohedra

410 ∧ 410	28° 4.5′
310 ∧ 310	36° 52.25′
520 ∧ 520	43° 36.25′
210 ∧ 210	43° 7.75′

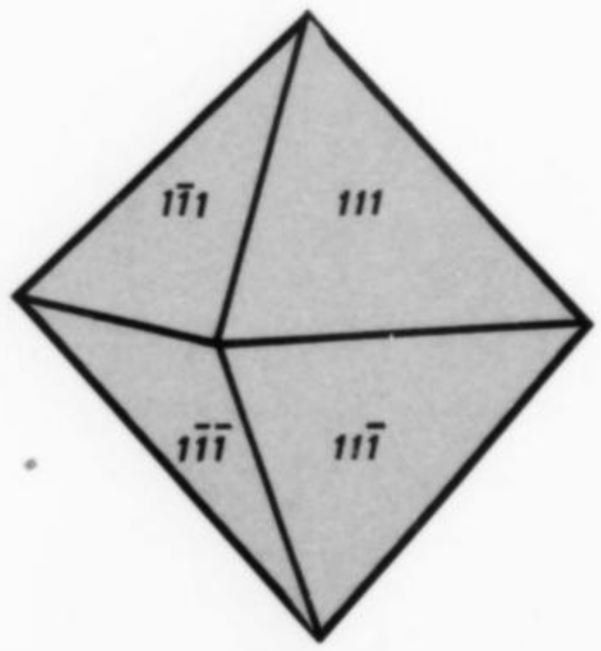


Figure 3. **The octahedron.**

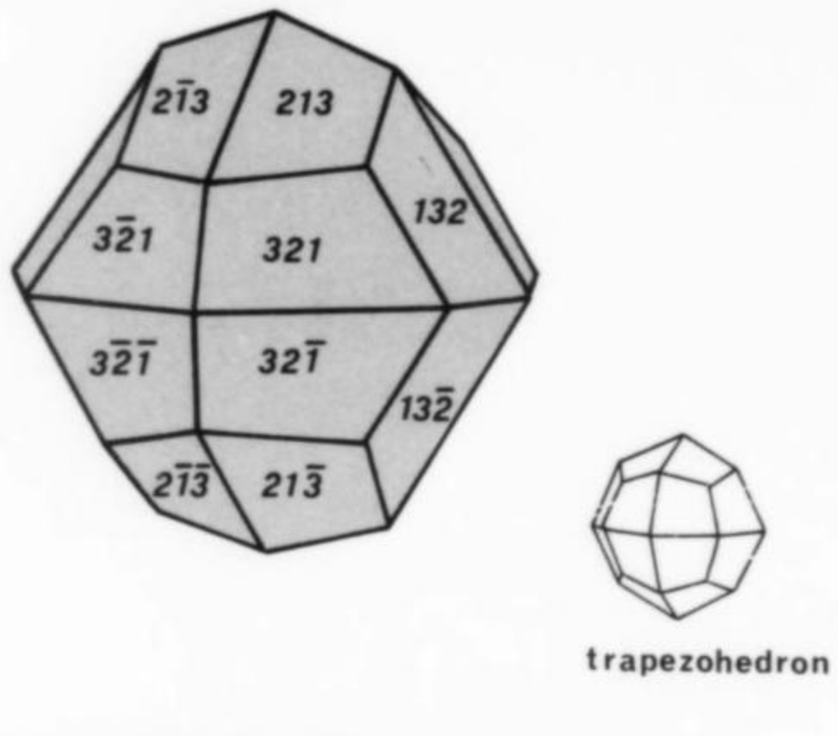


Figure 4. **The diploid, with a trapezohedron for comparison.**

Angles on Some Diploids

421 ∧ 421	51° 45.25′
532 ∧ 532	58° 14.5′
321 ∧ 321	64° 37.5′

of strong oscillations between the development of the pyritohedron and the cube. On the other hand, the famed perfect cubes from near Villarijo in Spain are almost featureless and the striae are delicate and difficult to see even with a hand lens (Fig. 8). Cubes from the recently discovered pyrite locality in King County, Washington, are clearly striated and leave no doubt as to their true symmetry (Fig. 9). Although pyrite cubes are sometimes found with perfect, mirrorlike, unstriated surfaces, the internal arrangement of the atoms still has the symmetry of the diploidal class. Even if there is no morphological expression of the true symmetry this can be revealed by X-ray diffraction studies.

However, striations are so common on the cube faces of most crystals that they can often be used as a clue to the proper orientation of a complex or incomplete crystal. Normally the cube is oriented so that the striations on the front face are vertical as shown in the sketch in Figure 1.

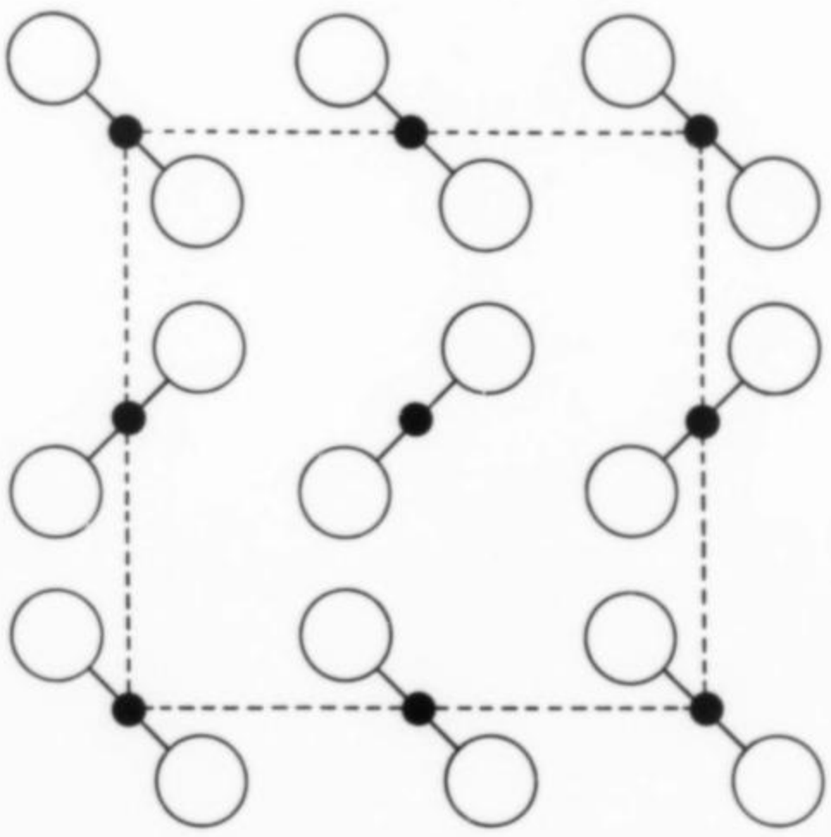


Figure 5. **The crystal structure of pyrite. The open circles represent sulfur atoms and the closed circles represent iron atoms.**

The Pyritohedron *(Fig. 2): 12 faces arranged as six pairs of five-sided (pentagonal) faces. The most common pyritohedron has the Miller notation {210}, less common are {310}, {410}, {320} and others. In the symbol two of the numbers are unequal and the third is a zero. Marked "p" on most of the drawings.*

This form is named for its common occurrence as crystals of pyrite. Because it consists of 12 five-sided faces, it is sometimes called the *pentagonal dodecahedron*. Each of the faces has one long edge and four shorter ones and these are located in 6 alternating pairs, each pair joined by one of the long edges. The pyritohedron is usually oriented with one of the long edges in the vertical position at the front of the crystal (Fig. 2). In this orientation the most common of the pyritohedra has the Miller symbol {210} and is said to be a positive pyritohedron. A rare occurrence is the negative pyritohedron, oriented with one of the long edges in the horizontal position at the front of the crystal; in this orientation the Miller symbol is {120}. Since the negative form is very rare on pyrite crystals any further reference to pyritohedra will be to the positive forms.

There are many different varieties of pyritohedra. The differences lie in the angles between the pairs of faces on either side of one of the long edges. The common form {210} has an angle of about 53° between the faces (210) and ($2\bar{1}0$). At least 8 other pyritohedra have been identified on pyrite crystals; {310}, for example, has an angle of about 37° between faces (310) and ($3\bar{1}0$), and {410} has an angle between (410) and ($4\bar{1}0$) of about 28°. These angles are measured between normals to the faces, in other words between imaginary lines perpendicular to the

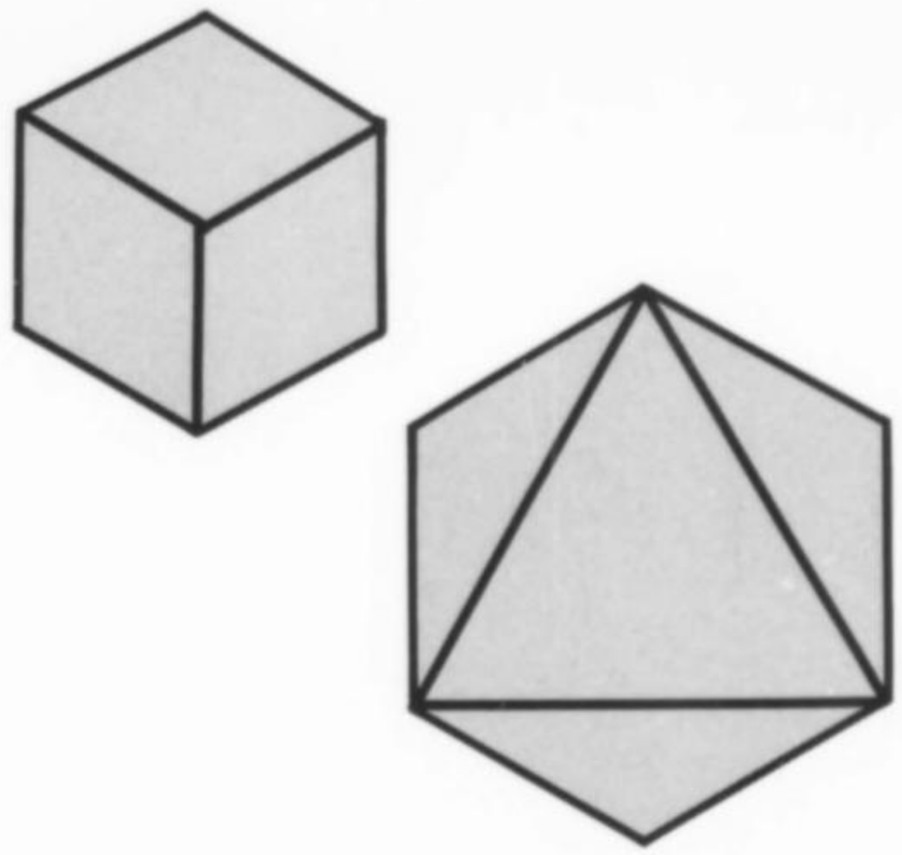


Figure 6. **The cube (top) and the octahedron (bottom) viewed along the 3-fold axis.**

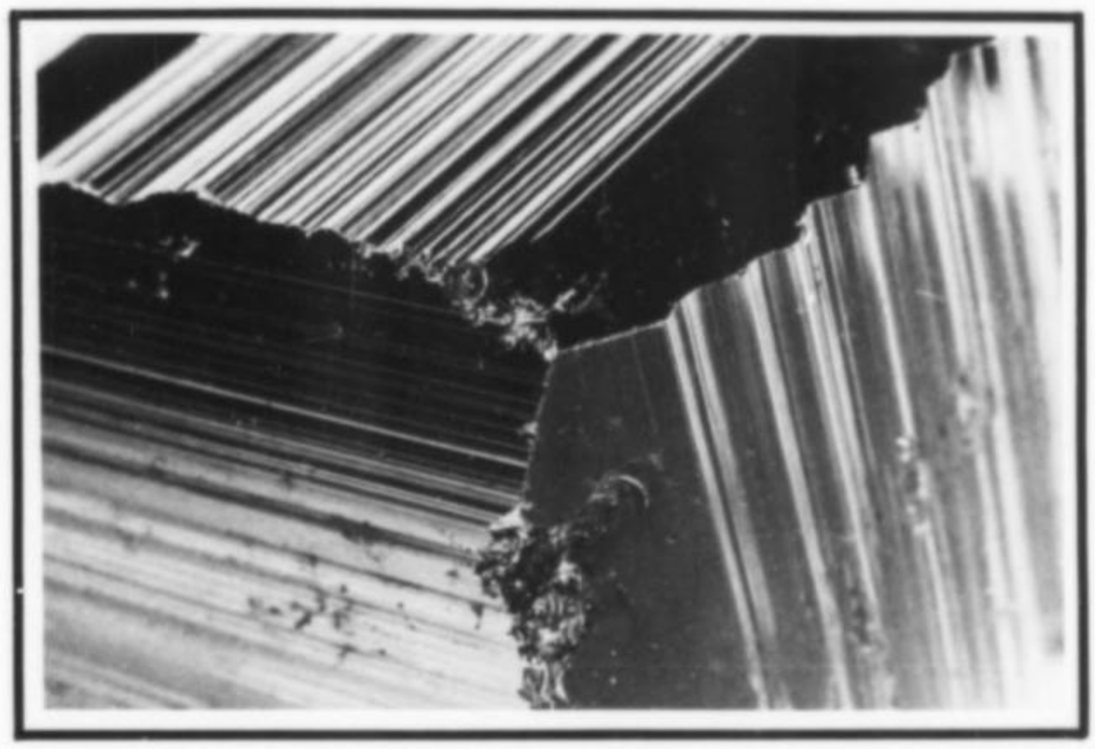
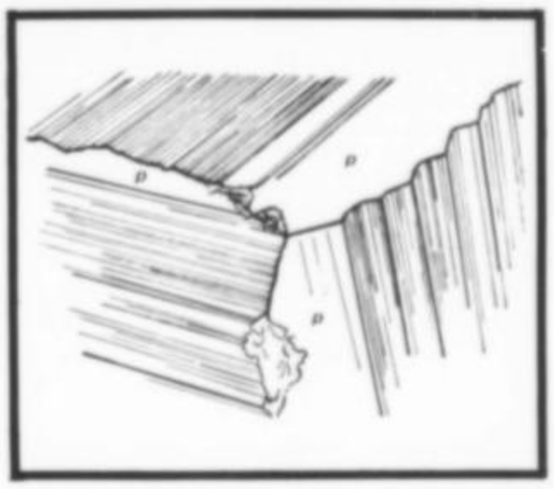


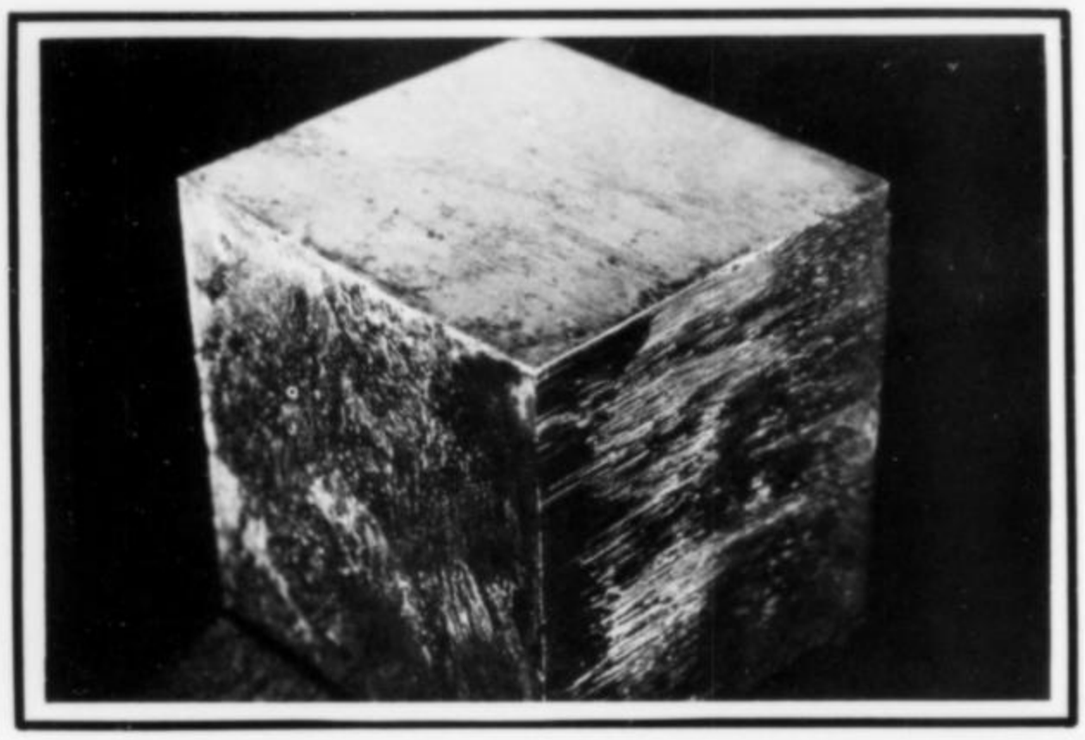
Figure 7. **Cube and pyritohedron (oscillatory growth). Kassandra Peninsula, Macedonia Region, Greece. Size: 6.5 × 6 × 5.5 cm (M35076).**



faces. This is because accurate measurements of interfacial angles are determined using the reflecting goniometer, an instrument that measures the angle between reflected beams of light from the faces of the crystal. The interfacial angles given in this article are the angles between the face normals, the actual internal angle between the faces is the complement of this (180° minus the angle)(see Fig. 10). The contact goniometer can be used to measure these angles. More than one pyritohedron may be present on one crystal, but without fairly accurate measurements with a goniometer it is difficult to determine their Miller symbols. Most collectors will be satisified by being able to recognize the presence of two or more different pyritohedra.

The Octahedron *(Fig. 3): 8 faces, equilateral triangles arranged like two four-sided pyramids placed base to base. Miller indices {111}. Marked "o" on most of the drawings.*

After the cube and the pyritohedron, the octahedron is the next most



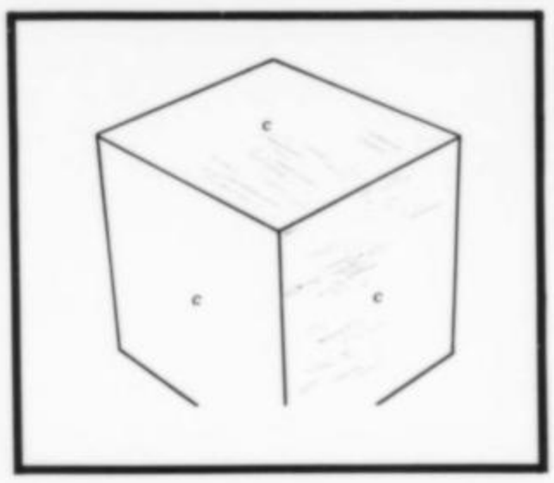


Figure 8. **Cube, from near Villarijo, Soria, Spain. Size: 3.9 x 3.7 x 3.5 cm (M34263).**

common form encountered on pyrite crystals. It is relatively uncommon as the sole form, and the crystals from Turkey are the best known among collectors. It is more common as a modifying form on cubes or pyritohedra. The octahedron alone exhibits the full symmetry of the normal class in the isometric system, but when developed on pyrite crystals the octahedra often show striations which reduce the symmetry to that of the diploidal class. Figure 11 is a photograph and sketch of the octahedral face on a crystal from Zacatecas, Mexico, showing striations that are not parallel to the octahedral edges and in effect reduce the symmetry as described above.

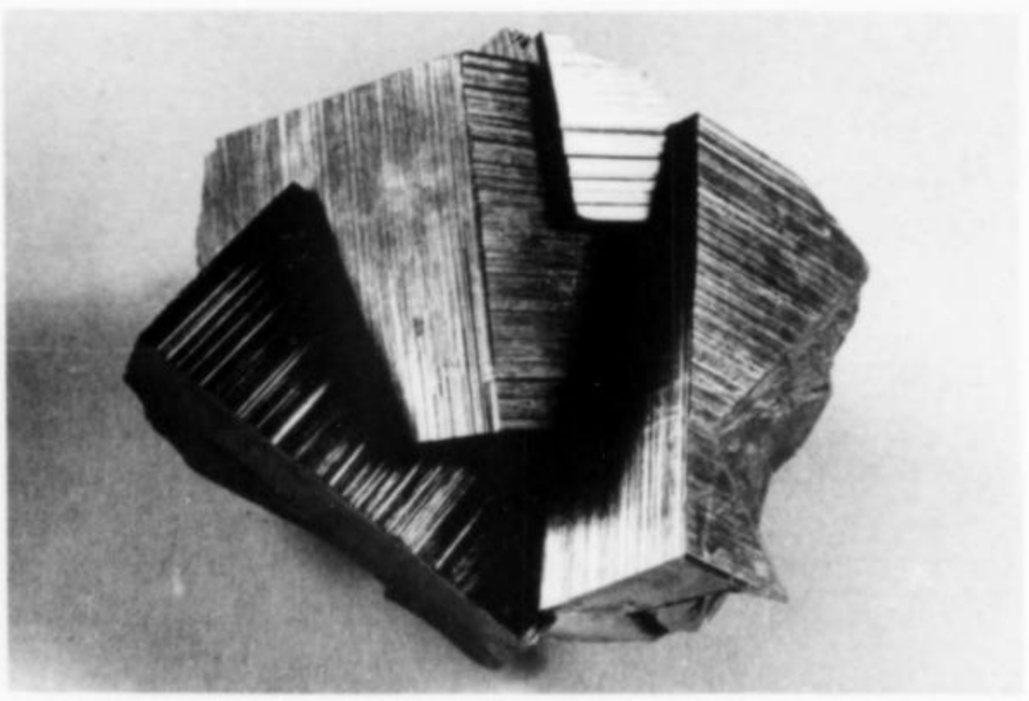


Figure 9. **Cubes, from King County, Washington. Size: 8 x 7 x 4 cm., overall (M35078).**

The Diploid *(Fig. 4):* *24 faces arranged in 12 pairs of four-sided faces. The most common variety has the Miller symbol {321}. Other possible diploids include {421}, {521} and 432}. All three numbers in the symbol are different and none of them is a zero. Marked "d" on most of the drawings.*

The diploid is sometimes called the *dyakisdodecahedron* and it has the characteristic symmetry of the diploidal class, $\frac{2}{m}\bar{3}$. Pyrite is one of the few minerals to exhibit this form, but unfortunately it is rarely dominant on crystals. Usually it is seen as sets of three asymmetric faces modifying cube corners or surrounding an octahedral modification. As can be seen from Figure 4, it has characteristics similar to the trapezohedron of the normal class, but its symmetry is lower.

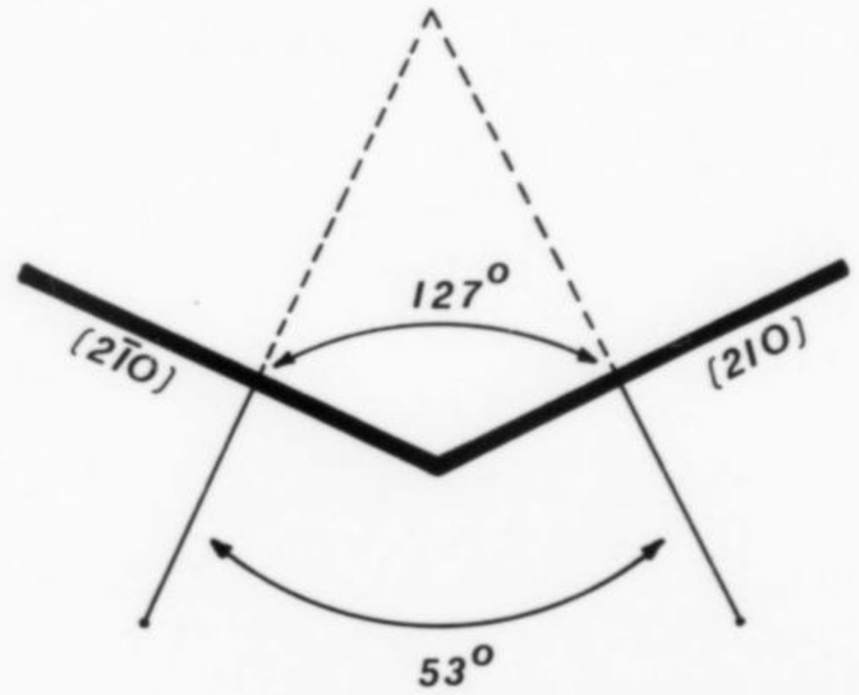


Figure 10. **The interfacial angle (53°) and the internal angle (127°) between the faces (210) and (210) of a pyritohedron.**

Figure 11. **Octahedron with diploid striations (insert: an ideal striated octahedron), from Concepción del Oro, Zacatecas, Mexico. Size: 4.5 x 3 x 3 cm (M35074).**

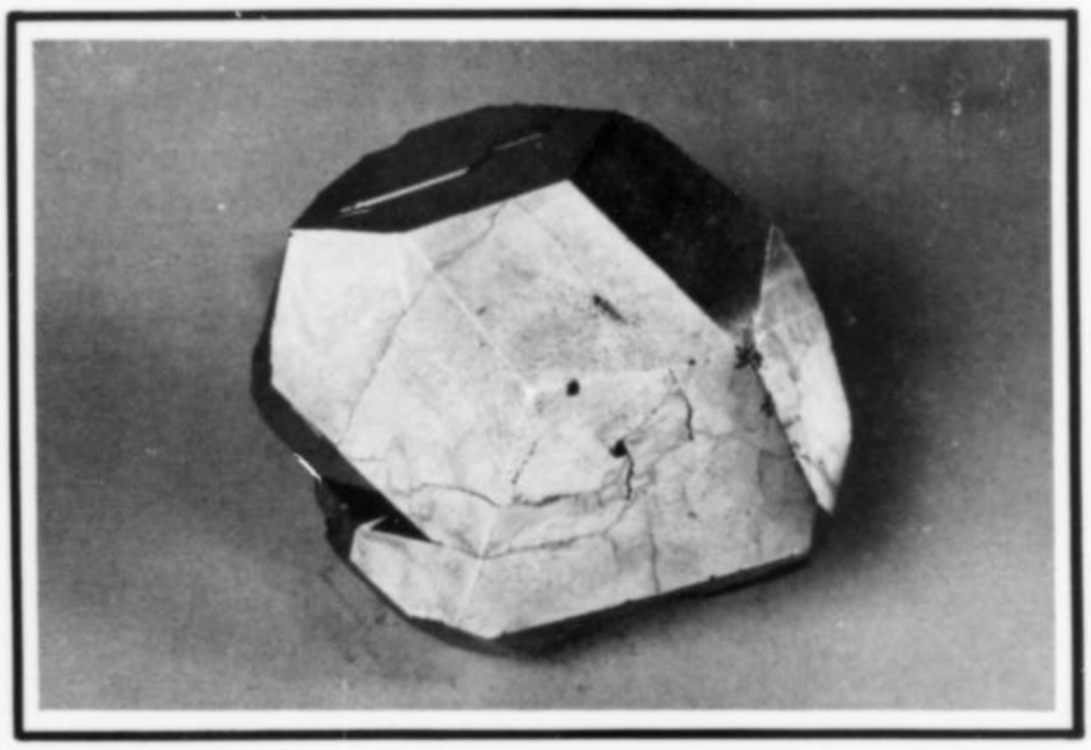
As in the pyritohedra it is possible to have several kinds of diploids. They can be distinguished by the different angles between the pairs of faces. The most common diploid is {321} and the angle between the faces (321) and (3$\bar{2}$1) is about 64½°, between (421) and (4$\bar{2}$1) it is about 52° and between (532) and (5$\bar{3}$2) it is about 58°. Without careful measurement different diploids cannot be identified and, as the faces are often very small, most collectors will be satisfied to identify the presence of a set of diploid faces without determining its Miller indices. Like the pyritohedral form it is possible to have more than one diploid on one crystal.

Diploids are rarely seen as a dominant form; of Goldschmidt's 691 drawings, only about 40 show dominating diploids. Figure 12 shows a photograph and sketch of an incomplete crystal from the Kassandra Peninsula in Greece on which the principal faces are the diploid {321}.

The tiny equilateral triangle at the intersection of the 3 diploid faces is an octahedral modification.

COMBINATIONS OF FORMS

Having briefly described the important elements of the four common crystal forms of pyrite, some of the combinations of forms can be discussed. This section is illustrated by idealized drawings of crystals viewed along the triad axes. The positions and shapes of these faces are important in learning to recognize them on real crystals.



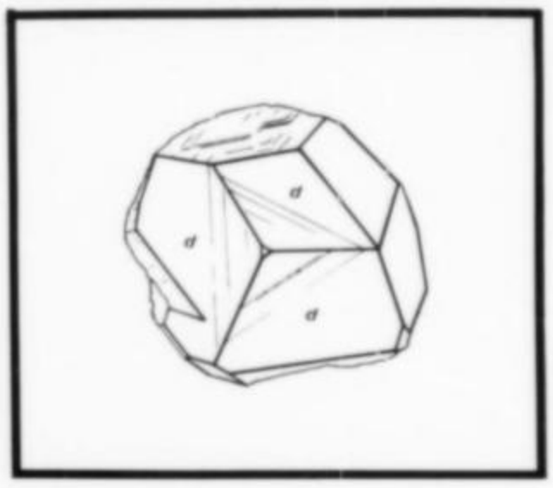
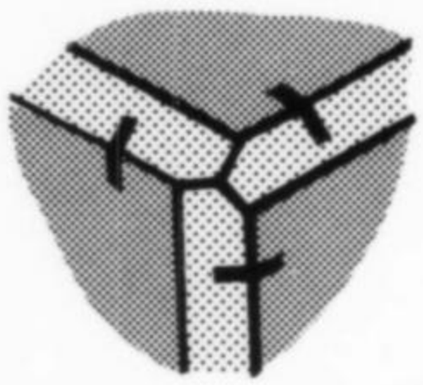


Figure 12. **Diploid, cube and octahedron from the Kassandra Peninsula, Macedonia Region, Greece. Size: 6 x 6 x 3 cm (M35071).**

The combination of the cube and the pyritohedron is probably most commonly encountered. The crystals from Logroño, Spain are classic examples. Figure 13 shows how the pyritohedral modification on a cube gives a bevelled edge. The upper sketch is of the combination between the cube and the *positive* pyritohedron. The bars on the upper sketch in Figure 13 mark the steep angles between the cube and the pyritohedral faces; not that the unmarked angles are much less steep. The lower



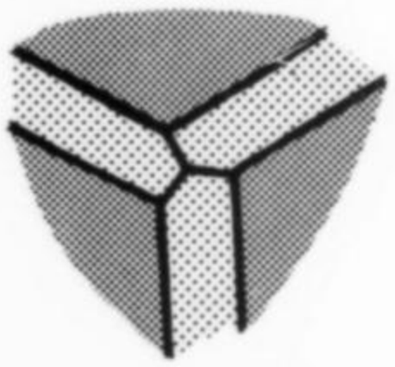
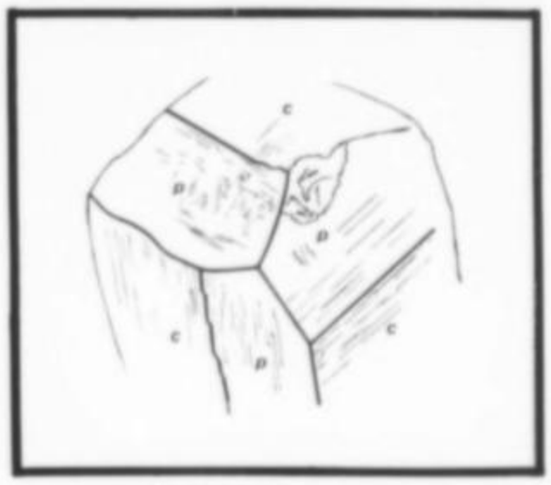


Figure 13. **Combination of the cube and the positive pyritohedron (top) and negative pyritohedron (bottom). Note the three steep angles marked by the solid bars alternating with the three less steep angles (unmarked).**

Figure 14. **Cube and pyritohedron from Rio Marina, Isle of Elba, Italy. Size: 1.5 x 1.5 x 1.5 cm (M16782).**



drawing shows the combination cube plus *negative* pyritohedron. Note the differences and especially the different orientations of the striations on the cube faces, neither can be turned around to become identical with the other. It has been explained before that the striations on the cube face are due to oscillatory growth between the cube and the pyritohedron, their relation should now be clearer from Figure 13. See also Figure 7. A crystal from Elba, Italy, showing the cube and the pyritohedron is shown in Figure 14.

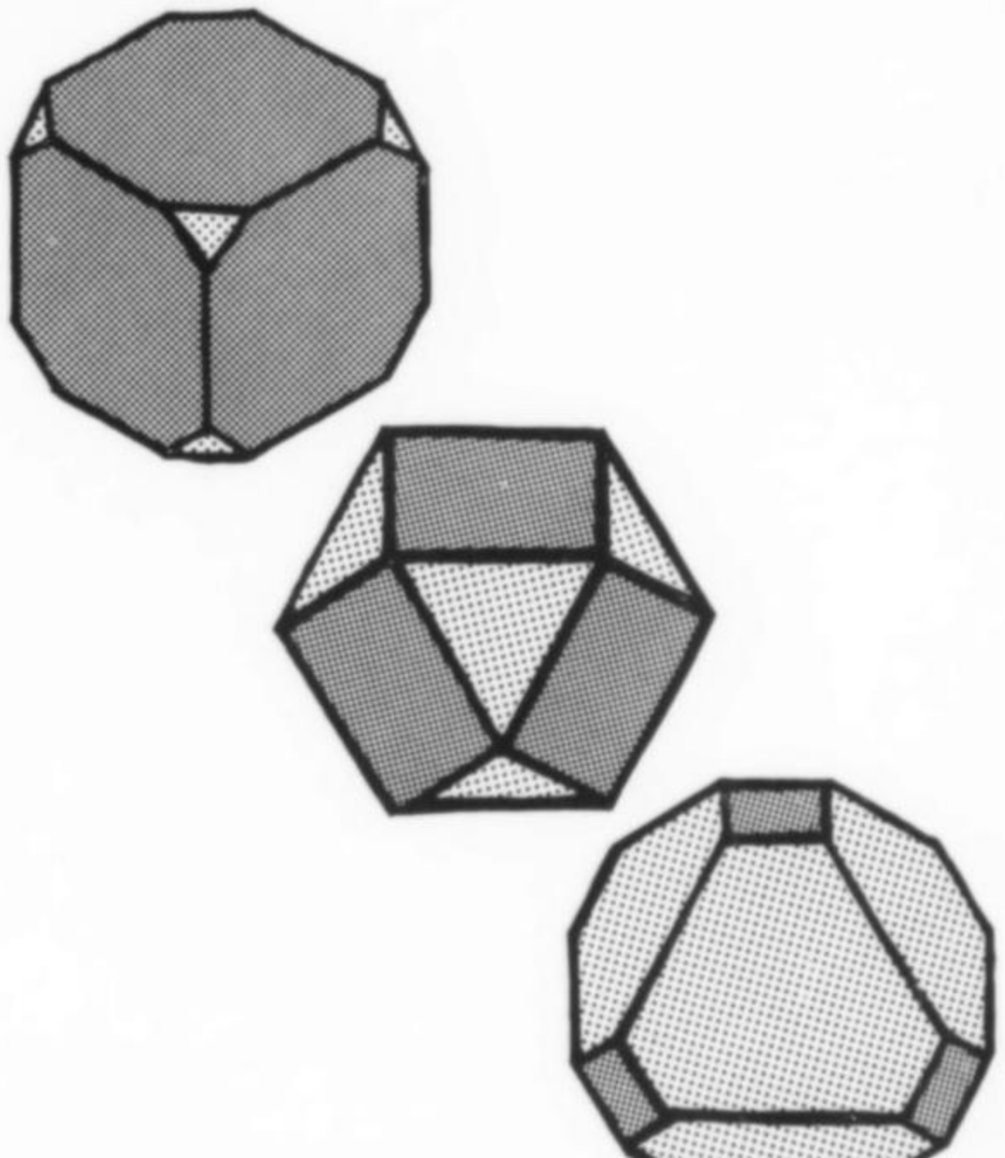
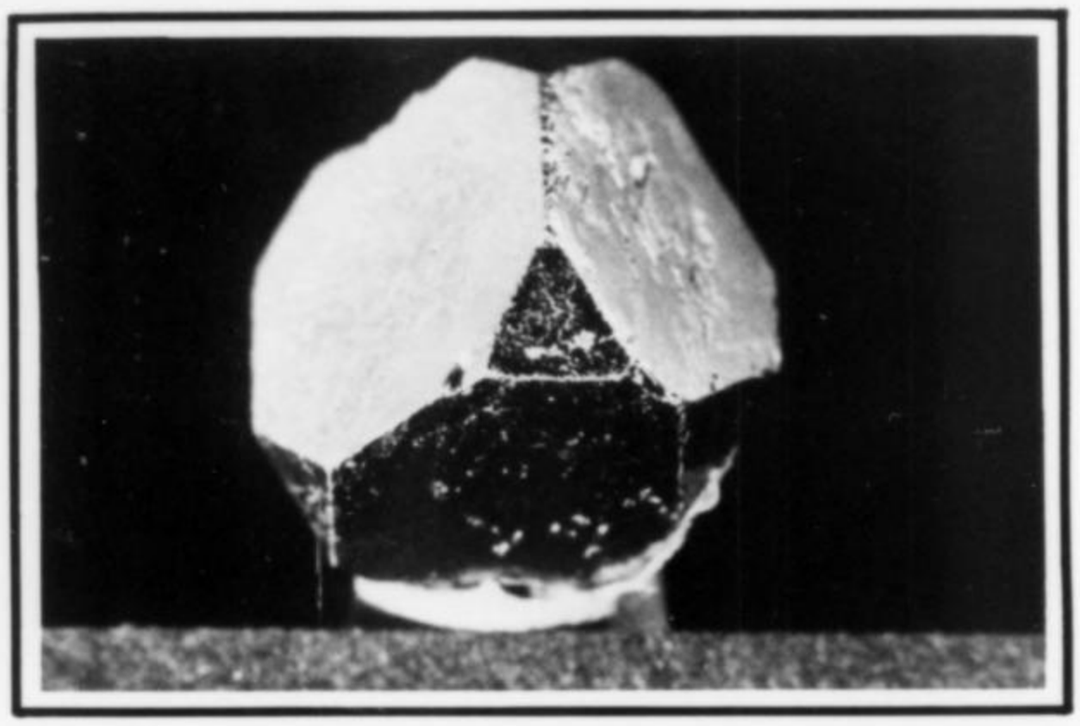


Figure 15. **Combinations of the cube and octahedron: cube > octahedron (top), cube and octahedron equally well developed (middle), octahedron > cube (bottom).**



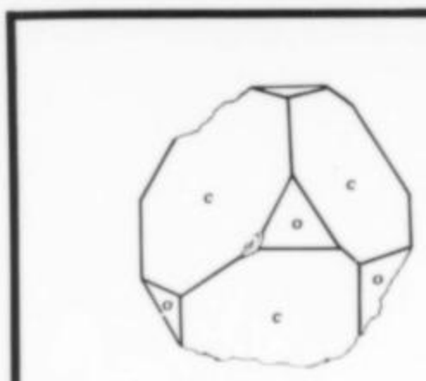


Figure 16. **Cube and octahedron from the Paymaster mine, South Porcupine, Ontario, Canada. Size: 0.9 x 0.9 x 0.7 cm (M19777).**

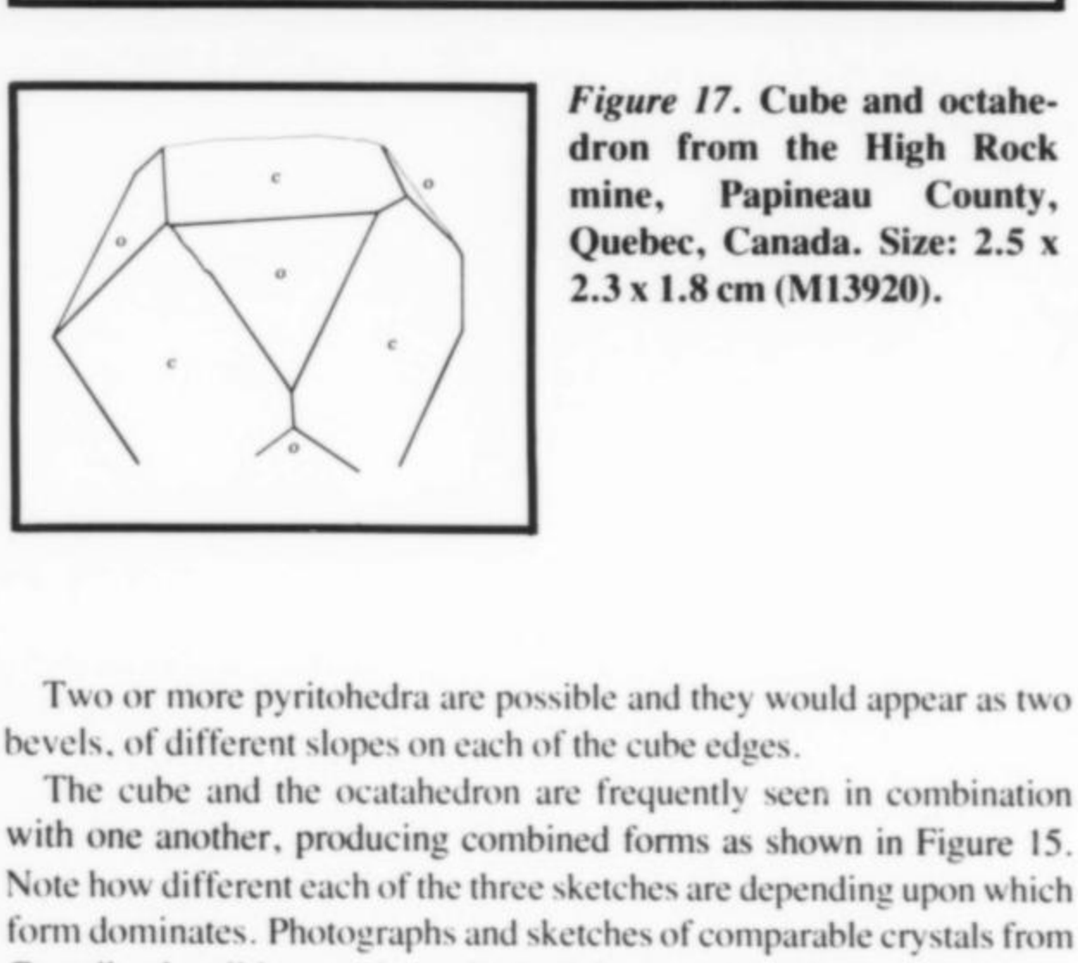


Figure 17. **Cube and octahedron from the High Rock mine, Papineau County, Quebec, Canada. Size: 2.5 x 2.3 x 1.8 cm (M13920).**

Figure 18. **Octahedron and cube from the High Rock mine, Papineau County, Quebec, Canada. Size: 1.5 x 1.5 x 1.8 cm (M13920).**

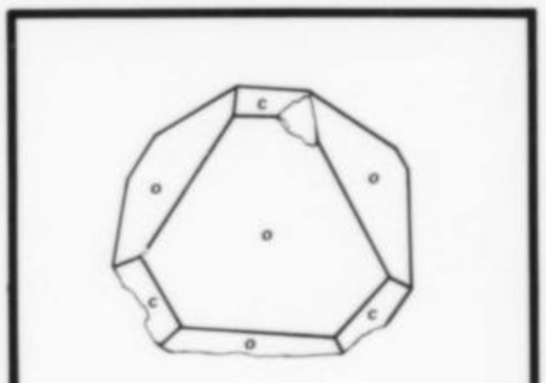
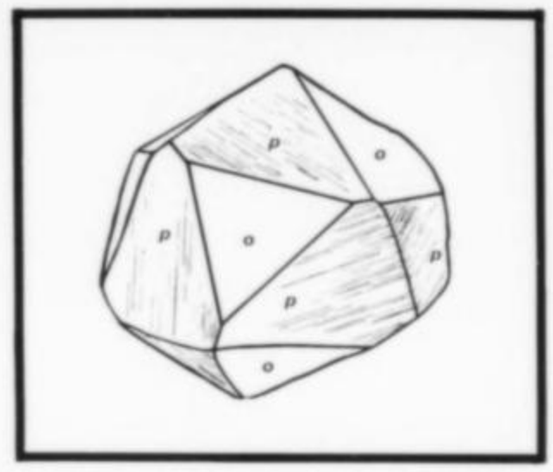


Figure 19. **Octahedron and pyritohedron from Rio Marina, Isle of Elba, Italy. Size: 1.5 x 1.5 x 1.5 cm (M15562).**



Two or more pyritohedra are possible and they would appear as two bevels, of different slopes on each of the cube edges.

The cube and the ocatahedron are frequently seen in combination with one another, producing combined forms as shown in Figure 15. Note how different each of the three sketches are depending upon which form dominates. Photographs and sketches of comparable crystals from Canadian localities are shown in the following three figures: Figure 16, from the Paymaster mine, South Porcupine, Ontario, with the cube dominating the octahedron; Figure 17 from High Rock mine, Papineau County, Quebec, with almost equal development of the cube and the octahedron; and Figure 18 from the same Quebec locality with the octahedron dominating the cube.

Another fairly common combination is the octahedron and the pyritohedron. The combined forms may have either the octahedron or the pyritohedron dominant. Figure 19 shows a crystal from Elba, Italy, where the two forms are almost equally developed. This combined form resembles the *icosahedron*, one of the Platonic solids with 20 faces, each an identical equilateral triangle. However, in the combined form in

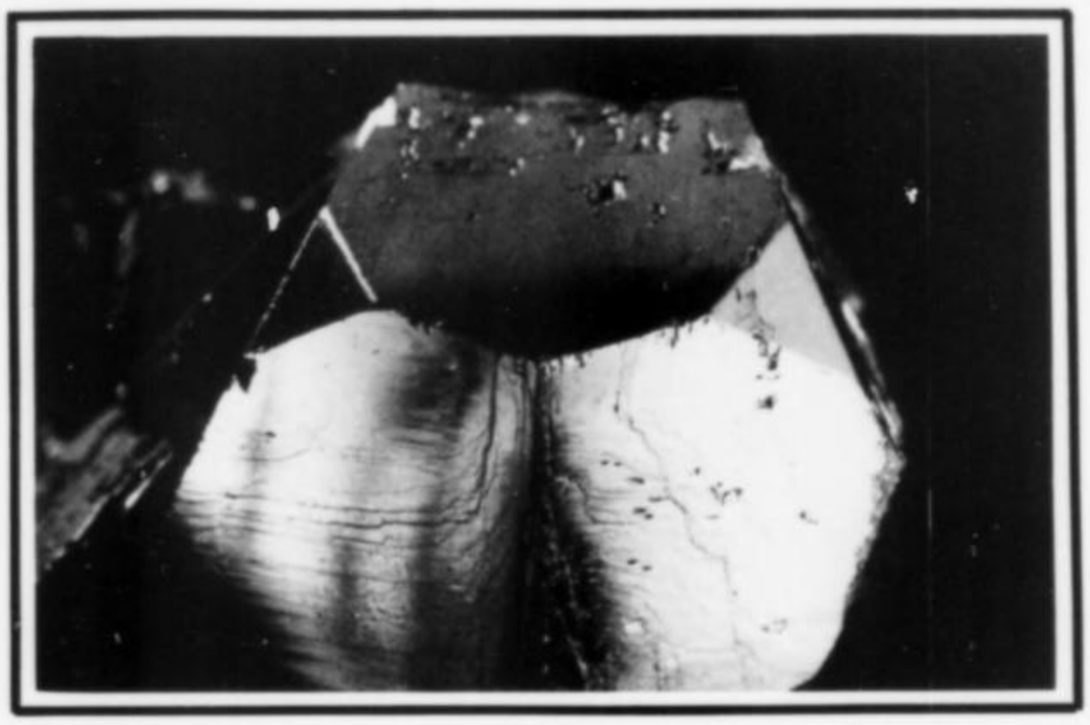


Figure 20. **Pyritohedron, octahedron and trisoctahedron (viewed along a 2-fold axis) from Rio Marina, Isle of Elba, Italy. Size: 2.5 x 2.5 x 2.5 cm. Same crystal as shown in Figure 21 (M34578).**

Figure 21. **Pyritohedron, octahedron and trisoctahedron (viewed along a 3-fold axis) from Rio Marina, Isle of Elba, Italy. Size: 2.5 x 2.5 x 2.5 cm. Same crystal as shown in Figure 20 (M34578).**

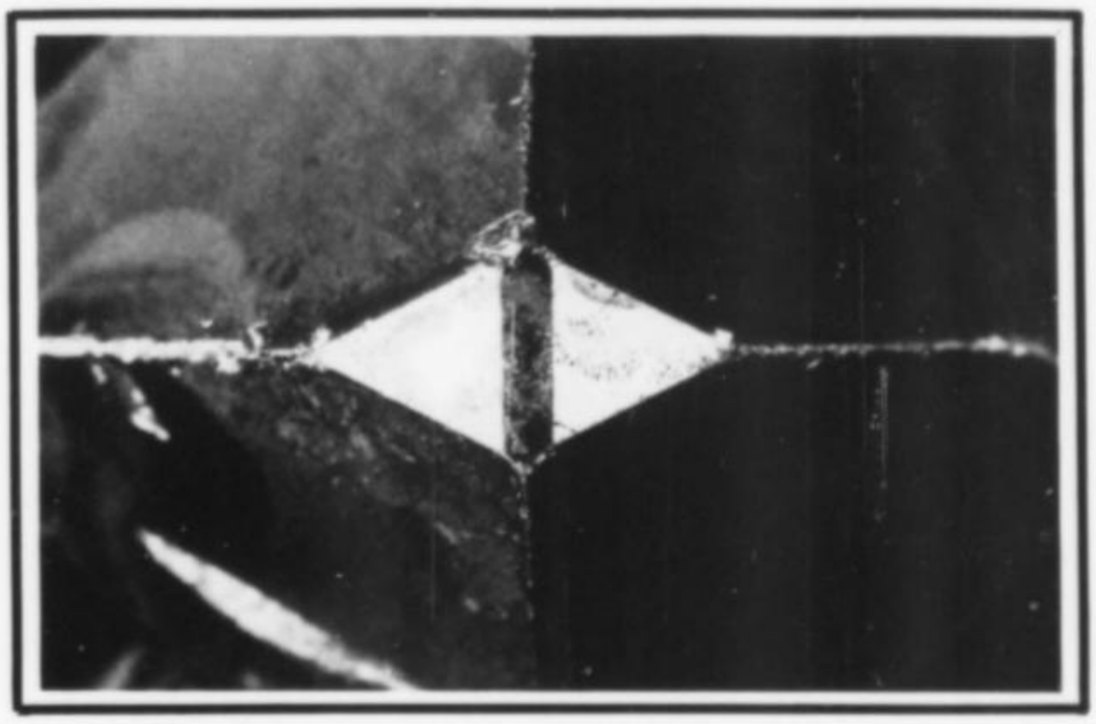
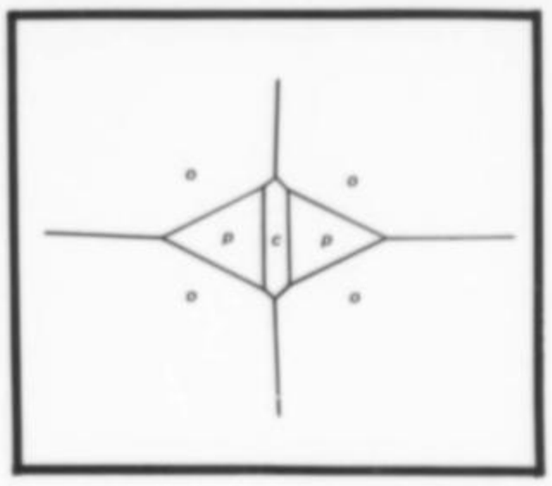


Figure 22. **Octahedron, pyritohedron and cube from Zacatecas, Mexico. The octahedron is about 2 cm on an edge (M34675).**



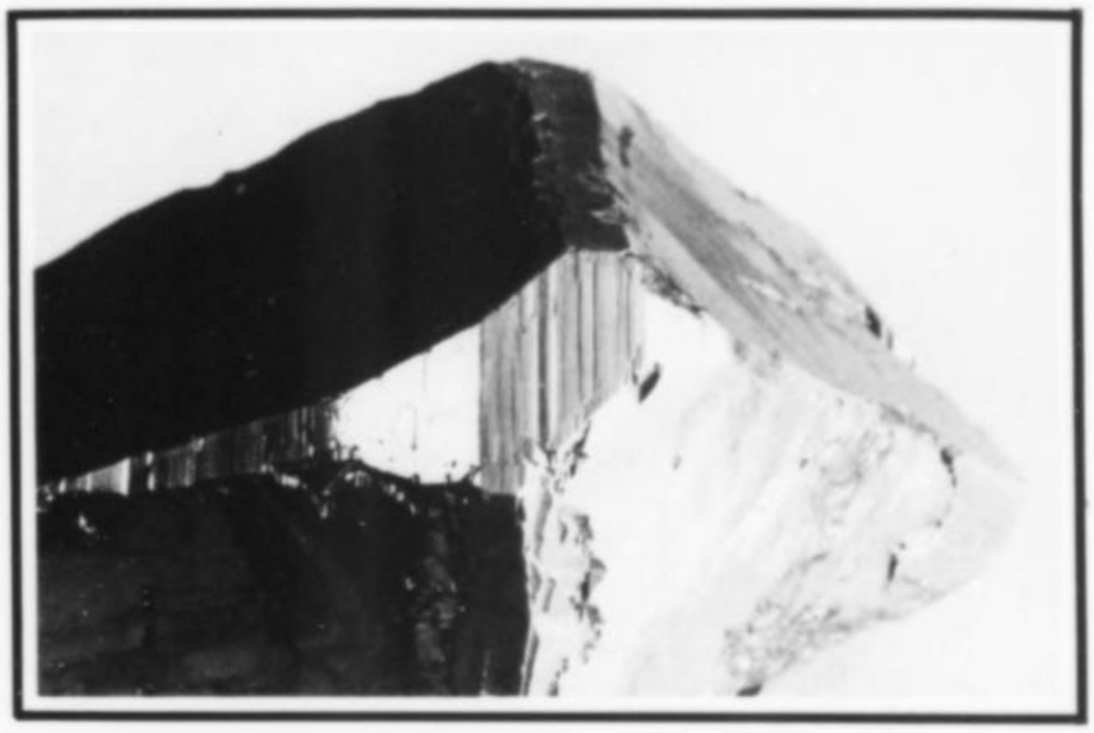


Figure 23. **Octahedron, pyritohedron, cube and dodecahedron from Peru. Size: 10 x 6 x 5 cm (M34597).**

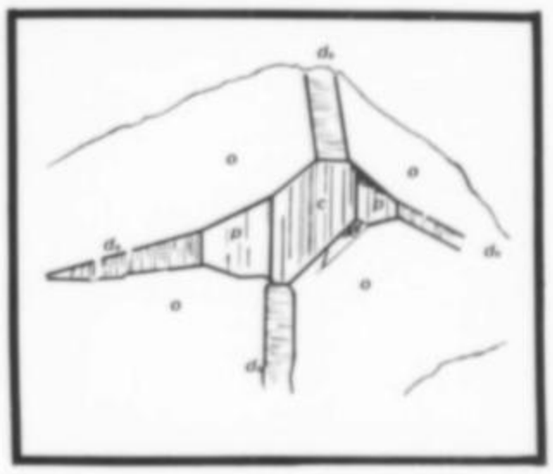


Figure 19, eight of the faces are equilateral triangles (the octahedral faces) and 12 are isosceles triangles (the pyritohedral faces).

Figure 20 shows a crystal, also from Elba, Italy, which is dominantly a pyritohedron with triangular modifications due to the octahedron. This crystal is viewed almost along the 2-fold axis. Figure 21 is of the same crystal seen along one of the 3-fold axes. In both figures the three narrow bevels at each edge of the triangular octahedral face are due to the presence of the ***trisoctahedron*** labeled "t" on the drawings). A superb example of the combination between the octahedron, pyritohedron and cube is shown in Figure 22. The crystal is from Zacatecas, Mexico, and is dominantly an octahedron, viewed along one of the 2-fold axes. The positions and shapes of the pyritohedron and cube modifications are clearly seen. A similar combination is shown in Figure 23 on a crystal from Peru. It involves the octahedron (dominant) with cube and pyritohedron faces modifying it, but in addition the bevels along the octahedral edges are ascribed to the dodecahedron (marked "do" on the drawing). It is also viewed along a 2-fold axis.

Figure 24 illustrates the shapes of the faces in the combination of the

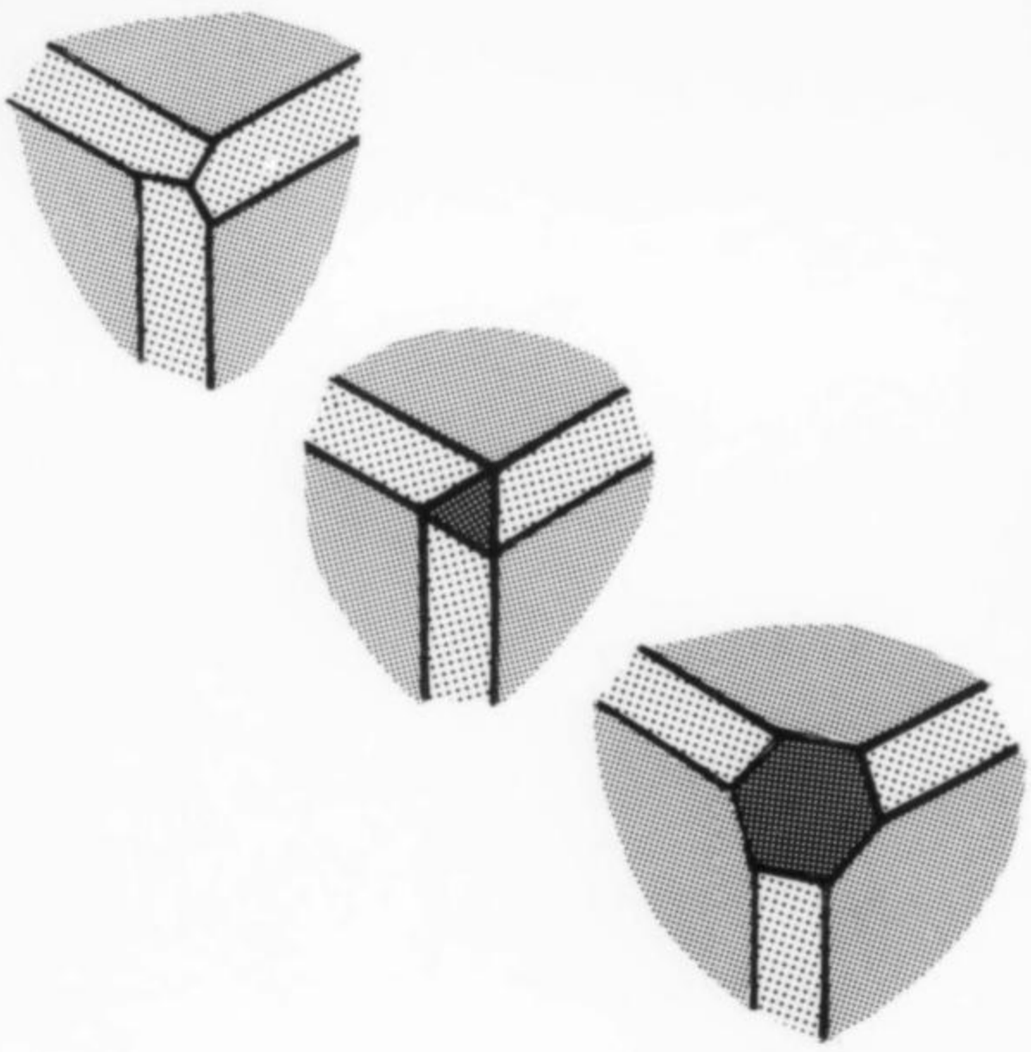


Figure 24. **Combinations of the cube with the pyritohedron (top), cube, pyritohedron and octahedron (middle and bottom).**

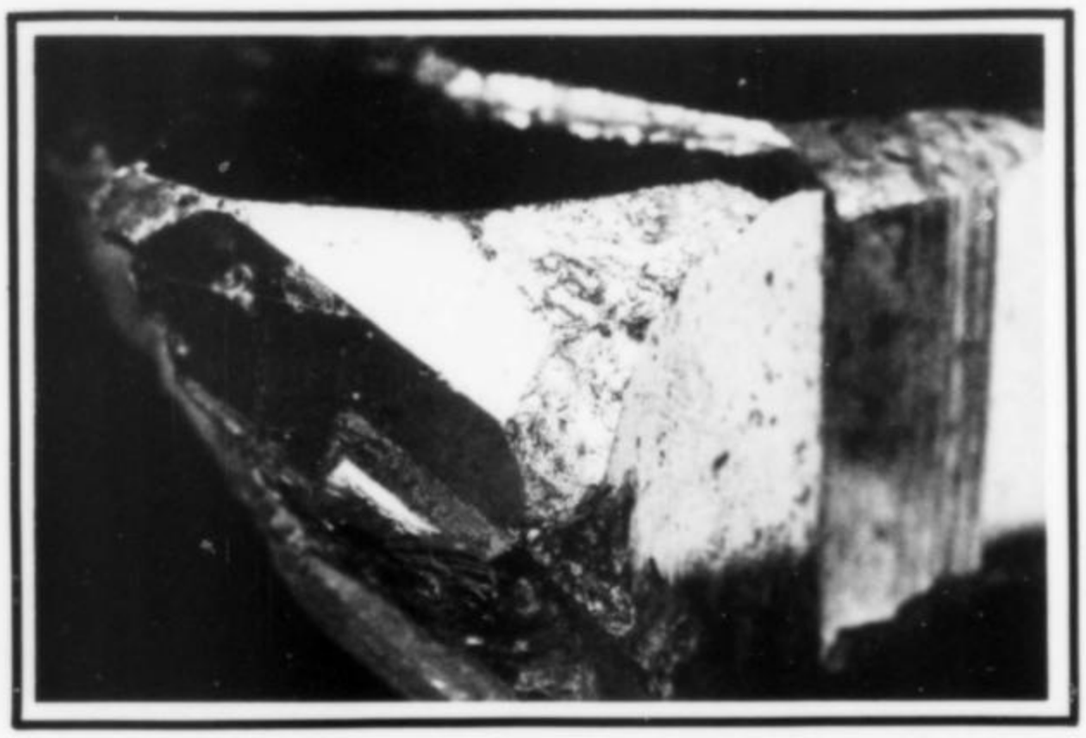
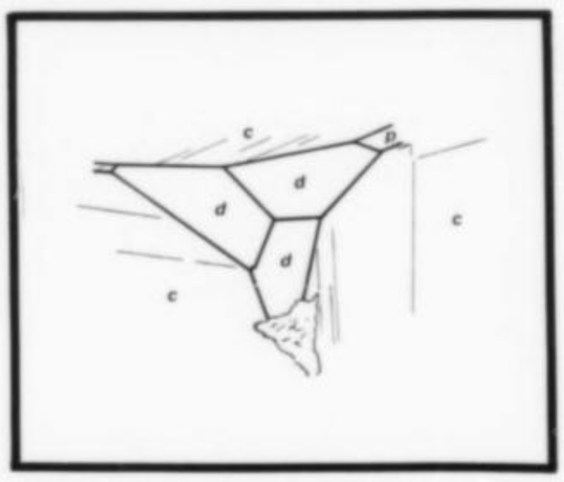


Figure 26. **Cube and diploid from Gavorrano, Grosseto, Tuscany, Italy. Size: 6.5 x 5 x 2 cm, overall (M16170).**



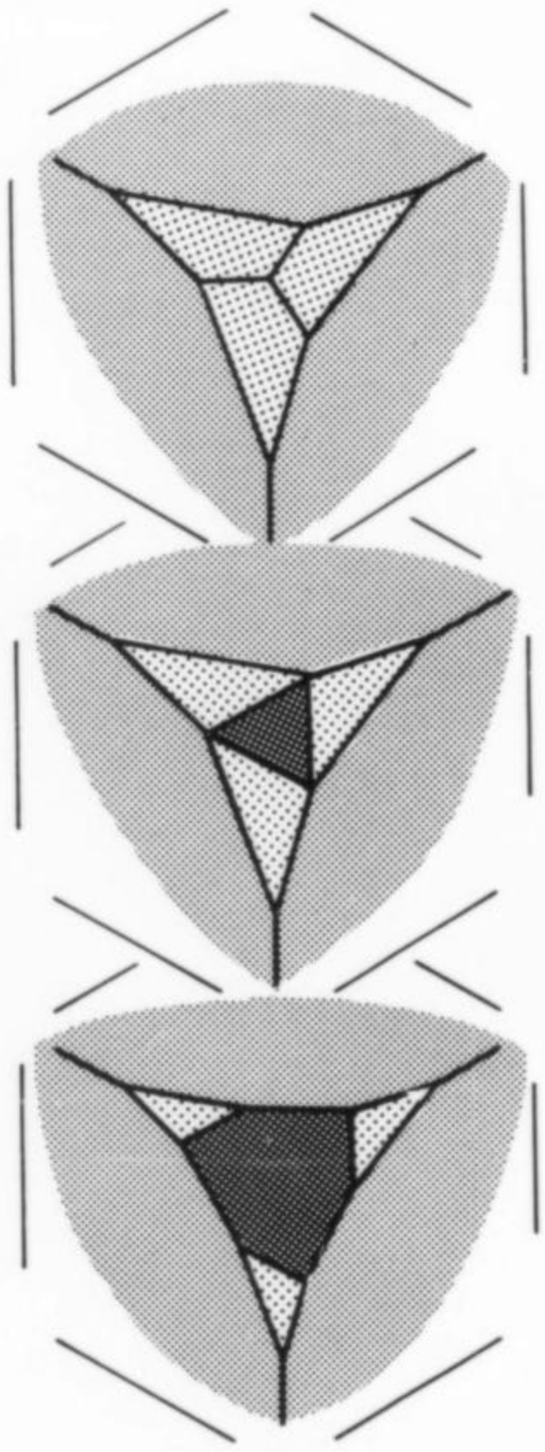


Figure 25. **Combinations of the cube and diploid (top), and the cube, diploid and octahedron (middle, bottom).**

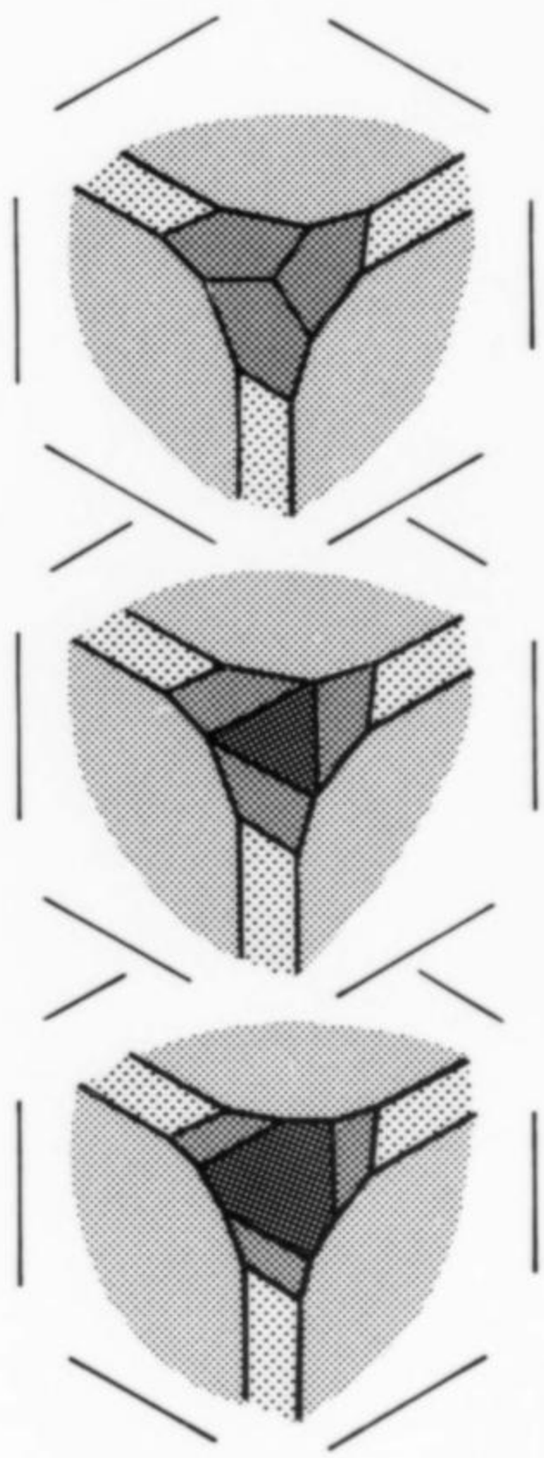
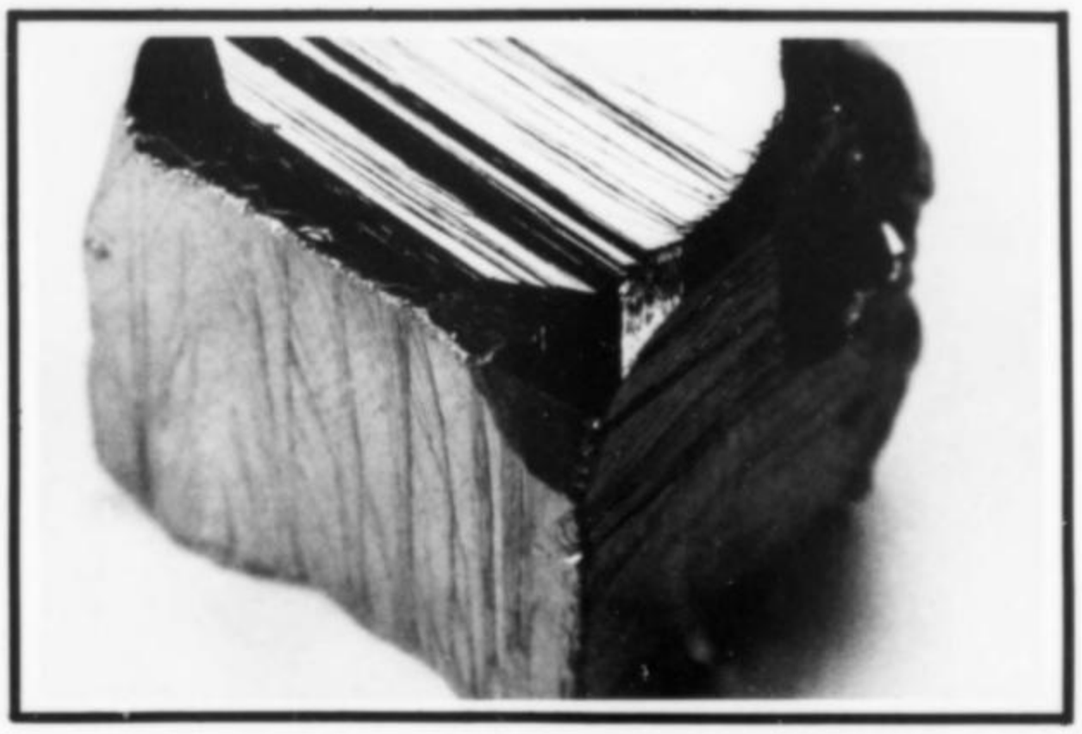


Figure 27. **Combinations of the cube with the pyritohedron and diploid (top) and also with the octahedron (middle and bottom).**



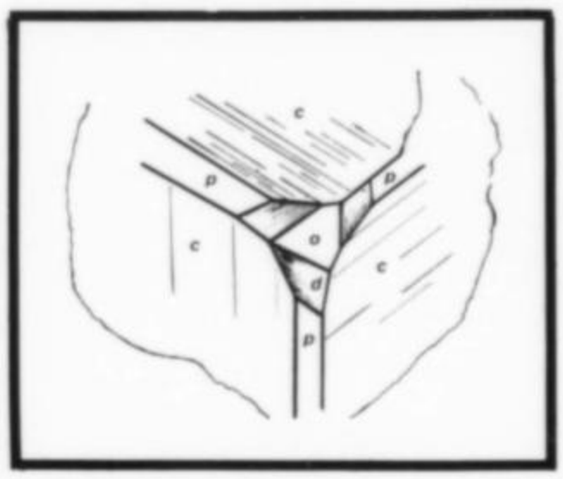


Figure 28. **Cube, diploid, pyritohedron and octahedron from the Tribag mine, Batchawana Bay, Ontario, Canada. Size: 2.5 x 1.5 x 1.5 cm (M29806).**

cube (dominant), the pyritohedron and the octahedron viewed along a 3-fold axis.

In this final section of this article, combinations involving the diploid will be discussed and described. Figure 25 shows idealized views of the cube and the diploid (top), viewed along a 3-fold axis, and the other two show the effect of introducing an octahedral modification to this combination. A crystal from Tuscany, Italy, is illustrated in Figure 26 and is comparable to the ideal sketch in Figure 25 (top). Again this crystal is viewed along a 3-fold axis; it differs from Figure 25 in that is has pyritohedral faces. Figure 27 is similar to Figure 25, but pyritohedral modifications have been added. A crystal from Ontario, Canada, is shown in Figure 28 and is very similar to the middle sketch in Figure 27. The shapes of the faces in these combinations are distinctive.

Figure 29 shows a crystal from Elba, Italy, a fine example of the combination involving the octahedron, the cube and the diploid. In this triad axis view of the crystal, the octahedron dominates with large triangular faces. Each of these is surrounded by three wedge-shaped diploid faces and the octahedral corners are cut by diamond-shaped cube faces. Figure 29, showing the octahedron dominant,contrasts with Figure 28 where the cube is dominant.

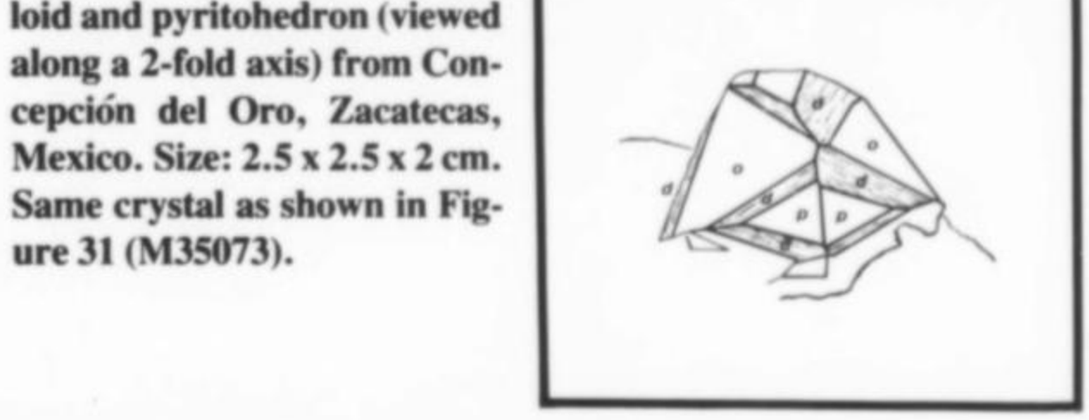
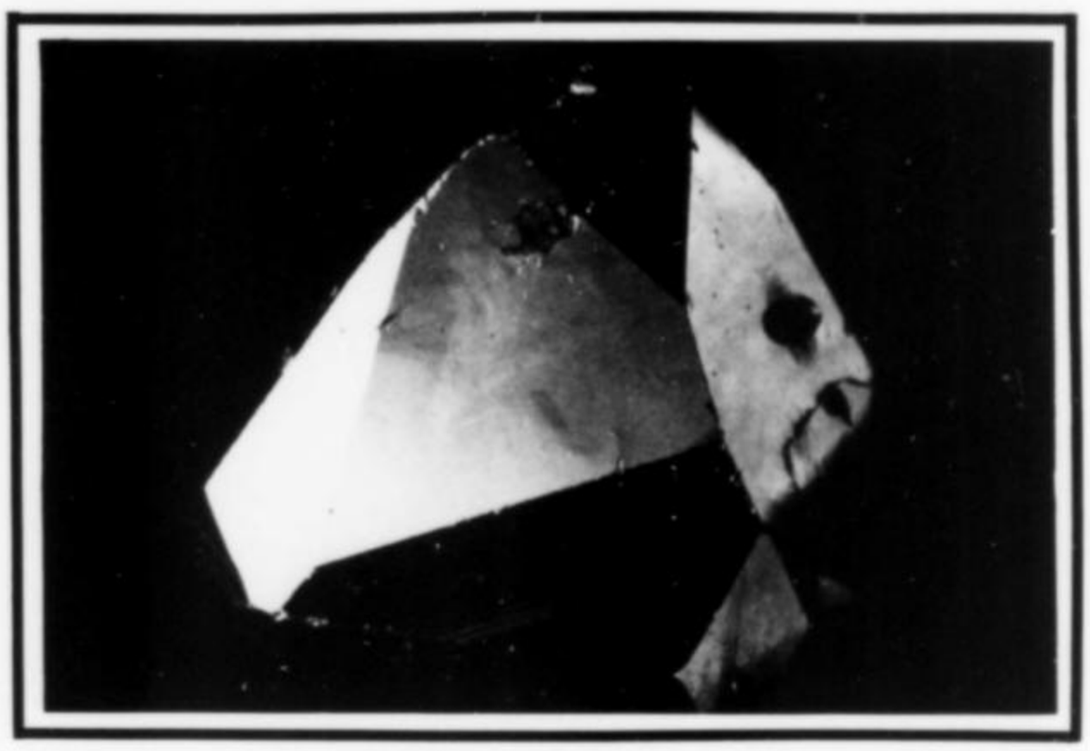


Figure 30. **Octahedron, diploid and pyritohedron (viewed along a 2-fold axis) from Concepción del Oro, Zacatecas, Mexico. Size: 2.5 x 2.5 x 2 cm. Same crystal as shown in Figure 31 (M35073).**



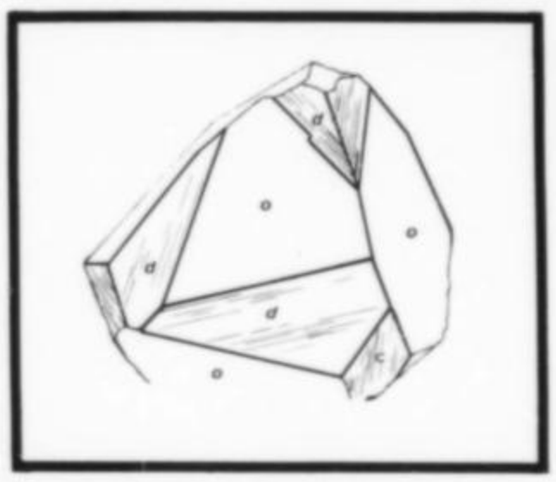
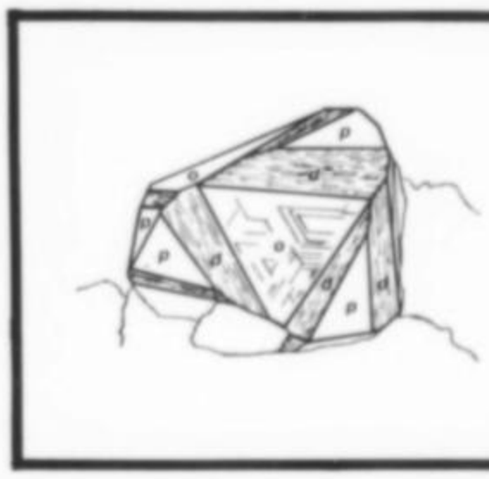
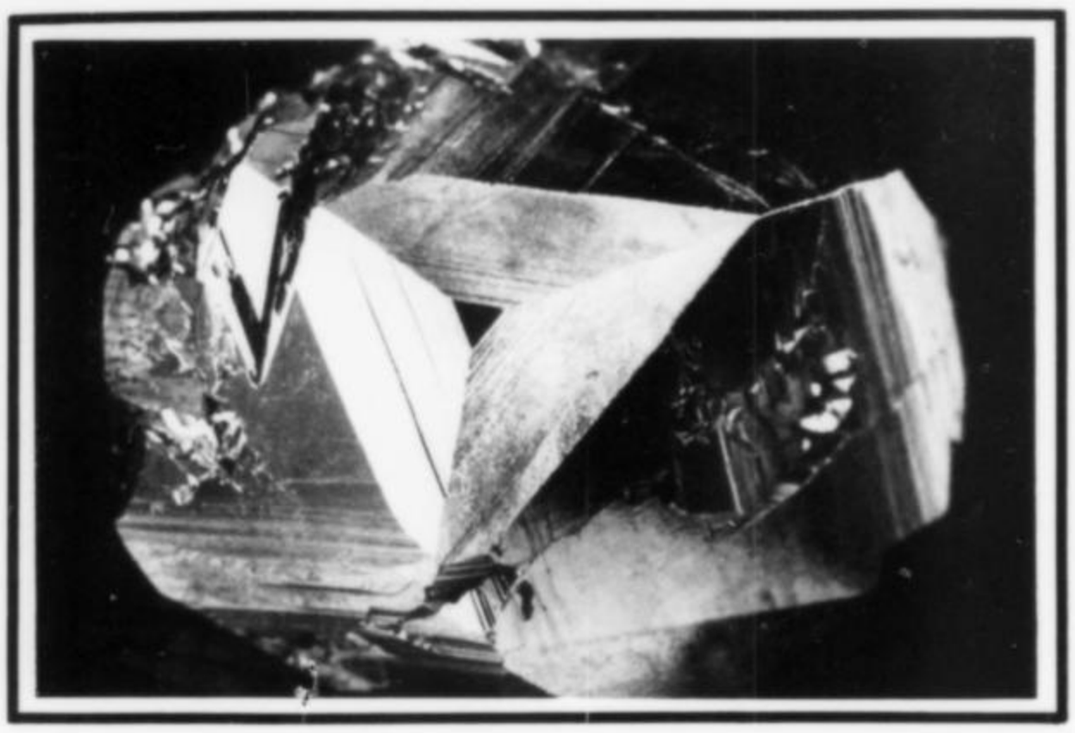


Figure 29. **Octahedron, diploid and cube from Rio Marina, Isle of Elba, Italy. Size: 2 x 2 x 2.5 cm (M31165).**

Figure 31. **Octahedron, diploid and pyritohedron (viewed along a 3-fold axis) from Concepción del Oro, Zacatecas, Mexico. Size: 2.5 x 2.5 x 2 cm. Same crystal as shown in Figure 30 (M35073).**





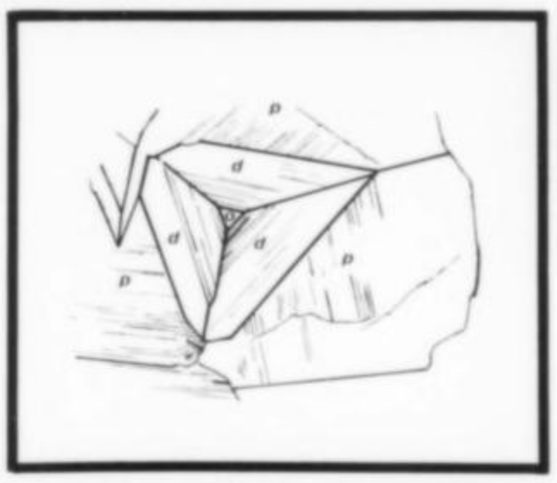


Figure 32. **Pyritohedron, diploid and octahedron from Rio Marina, Isle of Elba, Italy. Size: 3 x 2.5 x 2.5 cm (M20913).**

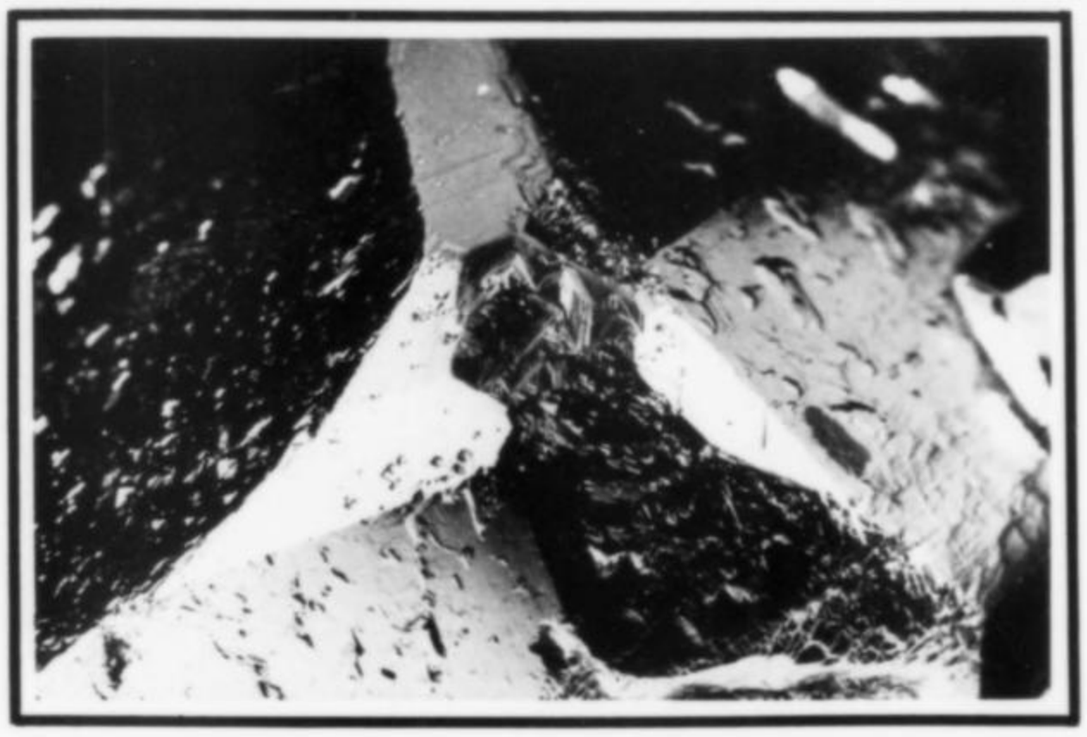


Figure 34. **Two pyritohedra, diploid, trisoctahedron and octahedron from Quiruvilca, Peru. Size: 7 x 5 x 3 cm (M35075).**

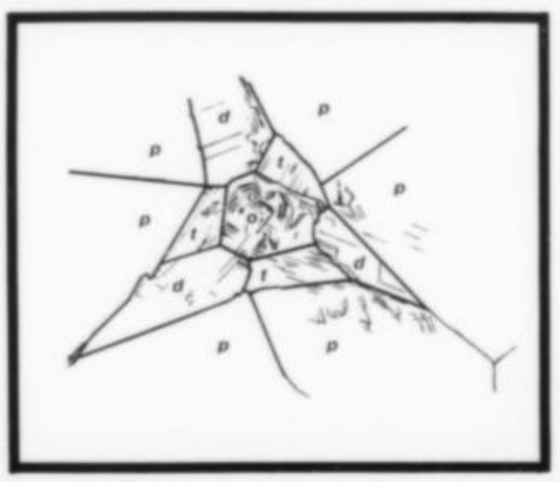
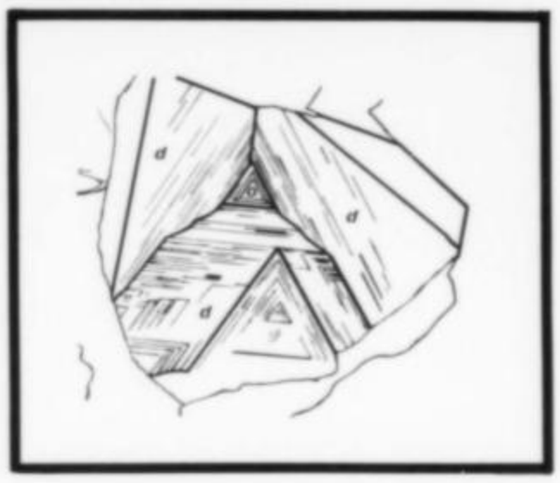


Figure 33. **Two pyritohedra, diploid and cube from Huanzala, Peru. Size: 5 x 5 x 4 cm (M35081).**

Figure 35. **Diploid and octahedron (viewed along a 3-fold axis) from Concepción del Oro, Zacatecas, Mexico. Size: 2.5 x 2.5 x 2 cm. Same crystal as shown in Figure 36 (M35072).**



A similar and superb example is shown in Figures 30 and 31, both of the same crystal from Zacatecas, Mexico. Figure 30 shows the crystal viewed along a 2-fold axis and Figure 31 is a view along a 3-fold axis.

Figure 32, a crystal from Elba, Italy, shows how the diploid faces appear when modifying a dominant pyritohedron. The three diploid faces are themselves modified by a tiny equilateral triangle which is an octahedral face. The crystal is viewed along a 3-fold axis.

Figure 33 is a very complex crystal and all its faces have not been identified. The crystal is from Huanzala, Peru, and is predominantly a cube modified by two different pyritohedra (p_1 and p_2). It is further modified by an octahedral face which is surrounded by three faces belonging to the diploid form. The six tiny, indistinct faces between the octahedron and the diploid have not been positively identified.

The brilliant, multifaced crystal shown in Figure 34 is from Quiruvilca, Peru, and has complex modifications surrounding the 3-fold axis of two combined pyritohedra. At the center is an octahedral face which is flanked by two sets of three faces—the set of three larger faces are assigned to the diploid and the three smaller faces between them (labelled "t") belong to the trisoctahedron.

Figures 35 and 36 are two views of the same crystal from Zacatecas, Mexico, showing a prominent diploid. Figure 35 is the view of the crystal along a 3-fold axis, the largest faces are diploids and they are

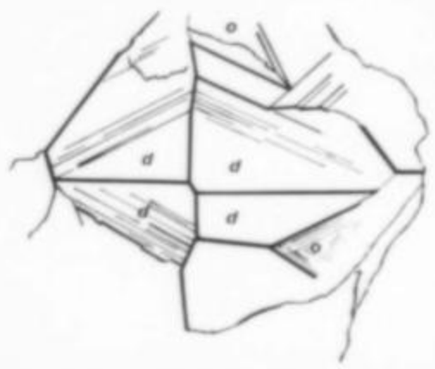


Figure 36. **Diploid and octahedron (viewed along a 2-fold axis) from Concepción del Oro, Zacatecas, Mexico. Size: 2.5 x 2.5 x 2 cm. Same crystal as shown in Figure 35 (M35072).**

modified by a tiny equilateral triangle which is an octahedral face. The striations on the diploid faces are due to oscillatory growth between the octahedron and the diploid. Figure 36 is the view of the crystal along a 2-fold axis and the four big faces belong to the diploid. Compare these sketches to the ideal diploid in Figure 4.

The crystal forms of pyrite are extremely varied and difficult to identify especially on multifaced complex combinations.Nevertheless it is hoped that this article, especially the photographs and drawings, will give some inspiration to crystal collectors to indulge in some morphological speculation about the forms present on pyrite crystals in their collections. For those who have not become involved, now is a good time to start. Fortunately, good pyrite crystals are still quite readily available; small ones are just as fascinating as big ones, and so even a beginning collector can acquire at least some of the common forms and combinations to use as a basis for a crystal form collection.

ACKNOWLEDGEMENTS

I should like to express my sincere thanks to Jack Satterly who has assisted and encouraged me throughout the development of both the exhibit and this article. Bill Robertson of the Photography Department of the Royal Ontario Museum deserves my gratitude for his efforts in taking the photographs, and the staff of that Department was of great help in preparing the graphics for publication. The staff of the Department of Mineralogy and Geology have been kind enough to put up with numerous disruptions and to them all, my thanks. Joseph Mandarino kindly read the manuscript and I thank him for his valuable comments.

NOTES for Collectors

PRESERVING PYRITE

The deterioration of pyrite and marcasite specimens has long been a problem for collectors and curators. Some of the specimens, over a period ranging from a few days to several decades, tend to disintegrate with the formation of a white powdery efflorescence and sulfuric acid. Not only are the specimens lost in such cases, but the sulfuric acid attacks the labels and wooden mineral cases, and possibly other mineral species stored nearby.

Francis Howie, of the British Museum's Paleontology Department, has recently published a study of the problem in the *Newsletter of the Geological Curators Group* (numbers 9 and 10, 1977). Considering that *NGCG* is a journal of very limited distribution not liable to fall into the hands of collectors, and also in view of the article on pyrite morphology in this issue of the *Record*, it seems appropriate to present here a summary of Howie's work. Readers wishing further details (such as references and technical information) should write to Howie at the British Museum for a reprint. However, the information presented here in this summary should suffice for most readers of the *Record*. It makes an interesting story.

Pyrite and marcasite (both FeS_2) undergo oxidation under certain conditions, producing chiefly sulfuric acid and various hydrated sulfates, mainly of iron. These sulfates, usually visible as efflorescences on the specimens, can cause total disintegration by rapid growth within the interstices of the specimens. The extent of deterioration appears to depend upon several factors, mainly the type of pyrite and the storage environment. Well crystallized specimens suffer less, sometimes yielding only a surface tarnish.

The problem has attracted the attention of curators, collectors and conservators for at least the past 200 years. Many ideas as to the cause or causes of the decomposition have been proposed and several types of treatment attempted. Probably without exception, all have failed and large numbers of valuable mineral and fossil specimens have been irretrievably damaged.

Considerable efforts by museum workers to find a relatively simple and effective "cure" or preventative have been hindered by a lack of agreement on the actual cause of the problem. The first and older theory maintains that purely chemical mechanisms are responsible. The second, more recent, theory is that certain bacteria, either wholly or in part, are responsible and that bactericides may serve as a preventative.

Early efforts to explain the phenomenon were many and varied. It had been realized from ancient times that pyrite and other sulfide ores were natural sources of *vitriols* and *vitriolic acid* (i.e. metallic sulfates and sulfuric acid). The earliest mention of the oxidation of iron disulfides in air appears to have been made by Mayow in 1674. He noted that marcasite formed vitriol through combination with "nitro-aerial spirit" (oxygen). In that same year, Boyle observed that some aerial substance was incorporated into marcasite as it "vitriolized" in air, causing it to gain in weight.

In 1725, Henckel deduced that dampness is a necessary factor in vitriolization. He and various other researchers proposed a variety of possible impurities as the cause, including copper, arsenic and manganese. Nevertheless, Borlase noted in 1758 that even though well crystallized pyrites were more stable than other varieties, "the latter will divide and fall to pieces in any moist place, and shoot forth vitriolic salts into white, wool-like threads."

Other possible causes continued to be proposed: sulfur deficiency, a "looser combination" of iron and sulfur, electrochemical imbalances, crystal structure peculiarities, pyrite-marcasite mixtures, and others. Julien noted in 1887 that large, well-formed crystals of marcasite were as stable as similarly formed crystals of pyrite and that, when these crystals were crushed to powder, oxidation in the presence of air rapidly ensued. He further suggested that the amount of moisture in the air was a critical factor.

Subsequent advances in chemistry and physics have failed to uphold many of the early proposals, but the basic observations of Henckel, subsequently extended by Julien (i.e. that a link between grain size or texture, air and water exists) have been confirmed.

Because pyrite oxidation in mines (especially coal mines) had been strongly suspected as the major cause of fires and explosions, several investigations were carried out at the beginning of this century. Winmill showed in 1916 that pyrite could absorb 40 to 60 times its own volume in oxygen at temperatures around 20° C within about 100 hours, and also calculated the heat produced thereby. He found that increases in temperature, oxygen pressure, and surface area of the pyrite increased the oxidation rate. He calculated that for every rise in temperature of 10° C, the oxidation rate doubled. Li showed in 1926 that water was necessary for the rapid oxidation of crushed pyrite, suggesting that moisture absorption rather than simple wetting might be a critical factor. The result of these investigations was to rule out pyrite oxidation as a cause of fires in coal mines (the oxidation of coal itself was the major cause), although it might be capable of causing fires in other types of mines.

A new theory was originated in 1949 when Leathen and others isolated a microorganism from acid streams that could oxidize ferrous iron to ferric. Laboratory studies demonstrated that the bacillus could accelerate the oxidation of crushed pyrite in water; particle size of the pyrite was again found to be a critical factor. The bacillus was named *Thiobacillus ferro-oxidans*.

Intensive research into the microbiological aspects of sulfide oxidation have been undertaken during the last 20 years but have failed to reveal the fundamental bacterial mechanism. Two hypotheses are under consideration: (1) thiobacteria catalyze the slow chemical oxidation of pyrite, and (2) thiobacteria can directly attack pyrite. It is known, at least, that pyrite in water can be rapidly oxidized in the presence of *Thiobaccillus ferro-oxidans* at temperatures between 10° and 40°C, and at pH's between 2 and 6 (i.e. acidic).

Stenhouse and Armstrong showed in 1952 that pyrite could be oxidized in alkaline solutions at temperatures between 100° and 200° C, yielding hydrated iron oxides. Although this doesn't help explain pyrite oxidation in air, it does suggest a possible mechanism for the natural formation of the well-known goethite-limonite pseudomorphs after pyrite.

Recent suggestions as to the cause of pyrite oxidation susceptibility range from the presence of carbonaceous material to the presence of silver or a larger pyrite unit cell.

There is little recorded information on the museum conservation of pyritic specimens before the end of the 1800's. Bowerbank and other early collectors recognized the need to protect pyritized fossils from the air, and achieved this by boiling and storage under linseed oil or water. Later, paraffin oil was probably used and, by the mid 1800's, some collectors were coating specimens with shellac. Other materials undoubtedly used include fish and animal glues and various waxes. By the turn of the century it was realized that these treatments had failed, and it was thought that perhaps the acidic decay products needed removal before the specimens were further treated. Neutralizing solutions of sodium carbonate or hydroxide were then tried before a water rinse, drying, and impregnation with thin solutions of dope (nitro-cellulose) or shellac.

A study by Radley in 1929 showed that, of the many coating materials in use, dope was probably the most effective. In 1934, Bannister improved upon neutralization techniques by using ammonia vapor or solution, followed by drying and impregnation with vinyl acetate dissolved in toluene. Later developments in plastics technology led to the

replacement of vinyl acetate with Bakelite, polyvinyl acetate and polybutyl methacrylate (Bedacryl). The use of Bedacryl, either by vacuum impregnation or by the immersion of heated specimens in a Bedacryl-toluene solution, led to considerably greater success in the treatment of both mineral and fossil specimens containing pyrite.

For storage under liquid, glycerine was first tried but was later shown to be detrimental; glycerine is hygroscopic, an oxygen solvent, and probably also combines directly with pyritic iron. The experimental use of silicone fluids was first employed at the British Museum in the early 1960's and has proven very successful. Silicone fluids are inert and almost totally impermeable to air and water vapor.

The majority of other methods used in conservation of fossils and minerals are based upon the bacterial oxidation theory, and date mostly from the mid-1950's. A wide variety of bactericidal chemicals and application methods have been tested since then. Apparent short-term success was achieved with some difficult specimens but others were not stabilized at all. In the Mineralogy Department of the British Museum (Natural History) the current method of choice consists of washing or swabbing specimens in a very dilute methanol solution of Cetrimide. As mentioned, this method is not completely effective and, although bacteria can clearly play a part in the oxidation of pyrite in moist environments, it has also been established that pyrite can be chemically oxidized in moist environments without bacteria. Their complicity in the oxidation of pyrite in air (as in museums) is no more than a possibility at the present time.

Curators and researchers working with both mineral and fossil specimens are concerned with finding an effective treatment, because none of the methods used at present are entirely satisfactory. This is (according to Howie) because insufficient notice has been paid to the environmental factors in the problem. Pyrite oxidation clearly falls into two categories: (1) oxidation under water, and (2) oxidation in air. In the first case, oxidation is controlled by the amount of oxygen in the water; remove the oxygen and the reaction ceases. In the second case, since the oxidation products are essentially hydrated, it appears that the reaction is strongly dependent upon water vapor in the air or, more precisely, the relative humidity.

Howie devised an experiment to test the effect of relative humidity on the oxidation of pyrite. Several samples of pyrite of varying stability were exposed to controlled atmospheres, each of a specific relative humidity ranging from 50% to 95%. A standardized washing and drying procedure was used to ensure, as far as possible, that all of the samples started out clean and dry. The samples were weighed at two or three day intervals over a period of 30 days. The total percentage of weight gain of each specimen after 30 days was plotted against the relative humidity in each case.

The results were interesting. For the most stable sample there was a very small, consistent weight gain of less than 1% which appeared to be essentially identical regardless of the relative humidity. For the less stable samples, however, the behavior was different except at the low relative humidity of 50%. At 60% relative humidity the unstable samples showed a weight gain of about 3%. At higher humidities the weight gain was dramatic, reaching a maximum of 40% in gained weight at 95% humidity. Subsequent drying of the samples showed that up to 80% of the total weight gain was due to water absorption while the remainder was presumably due to chemical reactions between pyrite, oxygen and water. Estimation of the total iron leached from the pyrite (using a colorimetric method) confirmed that, for the stable sample, no pyrite oxidation occurred at any humidity; for the less stable samples little or no oxidation occurred when the samples were stored at 50% relative humidity. Measurements of the acidity of extracts from the less stable samples under conditions above 60% relative humidity indicated that sulfuric acid concentrations exceeded 10% during deterioration. Further tests on a variety of other pyrite specimens from other localities gave very similar results, i.e. commencement of water vapor absorption at about 60% relative humidity, accompanied by visible deterioration or development of surface acidity. As will be seen, these results closely parallel the behavior of material in museum storage.

At the beginning of oxidation, the rate seems dependent upon the sample's ability to absorb water into minute cracks and grain boundaries. Significant absorption does not occur in well formed, compact crystals. Studies under the microscope demonstrated that oxidation begins at the boundaries between microcrystals. Hexagonal platelets of szomolnokite ($FeSO_4 \bullet H_2O$) and other hydrated ferrous sulfates formed in the grain boundaries, eventually resulting in the destruction of the more porous or fine-grained samples. The compact, stable samples showed no visible deterioration except for a slight irridescent tarnish. Scanning electron microscope photographs revealed that the tarnish probably resulted from limited surface oxidation, accentuated where the surface of the pyrite was disrupted by scratches.

These observations suggest that pyrite, irrespective of texture, is amenable to oxidation in damp air. The surface areas of grains available to aeration in porous pyrite are obviously many thousands of times greater than the surface areas of large, lustrous, well-formed crystals. The capacity for moisture absorption in porous pyrite reflects this fact. In addition, as the oxidation reactions produce hygroscopic sulfuric acid which will draw additional water out of the air in order to dilute itself, the process is accentuated. Water will also be used in the formation of hydrous sulfates. Under humid conditions these reactions reach catastrophic proportions, but if available water vapor is removed the reactions slow down and eventually cease. In the case of relatively large, well-formed crystals in humid conditions, water can condense on the outer surface only and the resulting production of sulfates and sulfuric acid is minute. Increases in surface area, as caused by scratching, increase the possibility for oxidation.

The surface chemistry of pyrite in air is still, as yet, poorly understood. It is known, however, that pyrite can remain unaffected during exposure to air. Protection is thought to be supplied by a strongly adsorbed layer of oxygen atoms on the surface. If this layer is disturbed and prevented from reforming, pyrite shows corrosion characteristics very similar to metals such as iron.

The available evidence from experimental work and observations of stored material strongly suggest that bacterial attack is not a factor in the deterioration of pyrite in collections. The samples studied were first sterilized and still showed characteristic deterioration. Furthermore, the high concentrations of sulfuric acid and sulfates in actively oxidizing pyrite would inhibit the activity of bacteria such as *Thiobacillus*. Finally, a study attempted to culture *Thiobacillus* from actively oxidizing pyrite specimens; the results indicated that *Thiobacillus ferro-oxidans* was not present in any sample.

Howie believes that the continuing failure of various conservation treatments for pyrite undoubtedly results from storing the material under conditions of high relative humidity. An example is provided by recent events within the British Museum. The temperature and relative humidity has been monitored in certain storage areas since 1976. Areas in the main building were found to be fairly dry, with a relative humidity between 30% and 55%. Pyritic specimens had been stored reasonably satisfactorily in old, well-seasoned cabinets for several decades. (The relative humidity within cabinet drawers was between 40% and 45%.) At the beginning of 1976, large numbers of pyritic fossils were moved to new wooden storage units in the East Wing Extension and, a few months after the transfer, a routine check revealed that extensive pyrite deterioration was on the point of breaking out. The relative humidity in the East Wing Extension had been monitored, mainly because of problems in adjusting the air-conditioning system, and was found to exceed 60% almost continuously. Measurements in the interior of the new storage cabinets revealed relative humidity near 65%. Material was transferred back to the old, dryer storage area until the relative humidity in the East Wing Extension could be better controlled.

Several important observations were made as a result of this incident. (1) Deterioration commenced simultaneously in widely separated parts of the collection. (2) It soon became apparent that both treated and untreated specimens were similarly affected. Several specimens treated

with various resins, plastics and bactericides were found to have suffered. (3) Transfer back to dry storage caused the deterioration to cease. (4) It was found that when the relative humidity in the new storage area was brought down to less than 50%, it took several months for the relative humidity inside the cases there to reach similar levels.

Most of the resins used for specimen conservation are permeable to air over fairly short periods of time. Very thick coatings of resin might resist penetration of damp air until such time as unavoidable flaws in the coating (cracks, scratches, bubbles, etc.) allow access. Once pyrite oxidation is started, probably within a period of days rather than weeks in moist surroundings, the acid produced begins to disintegrate the resin film.

When pyrite deterioration is discovered, it is therefore recommended that the specimen(s) be removed to a dry area *immediately*. Neutralization of the already-formed acid should then be attempted, possibly by exposing affected material to ammonia fumes in a closed box or bag. Neutralization should generally be followed by mechanical removal of badly decayed areas, but this is not always necessary because the oxidation products, after neutralization, are not corrosive. Careful drying of neutralized specimens by washing in dried acetone or ethanol where possible, and oven drying at about 90° C, should be immediately followed by storage in a very dry area. Storage cabinets should be wood, preferably thoroughly seasoned (well-dried wood can absorb and hold water vapor, shielding specimens inside). It may be feasible to protect specimens in well-sealed, glass-topped wood (not cardboard!) boxes. The most important safeguard is regular checking of both specimens and environment.

At this stage it appears that the only satisfactory method of controlling pyrite (and presumably marcasite) oxidation is control of the relative humidity in the storage environment. Methods employing synthetic coating resins or bactericides do not offer any real protection in uncontrolled environments. Nevertheless, research into the mechanism of oxidation reactions is continuing, according to Howie, and we may yet hope for a treatment that will chemically prevent deterioration.

W.E.W.

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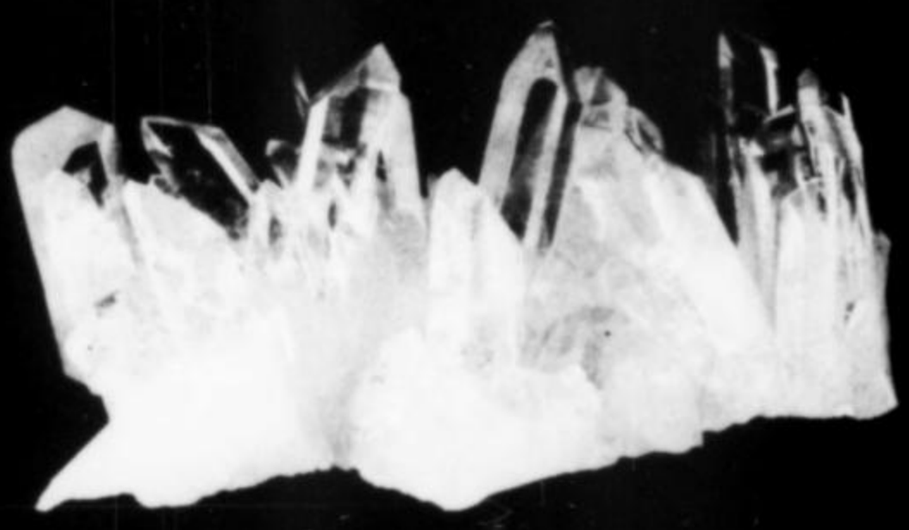

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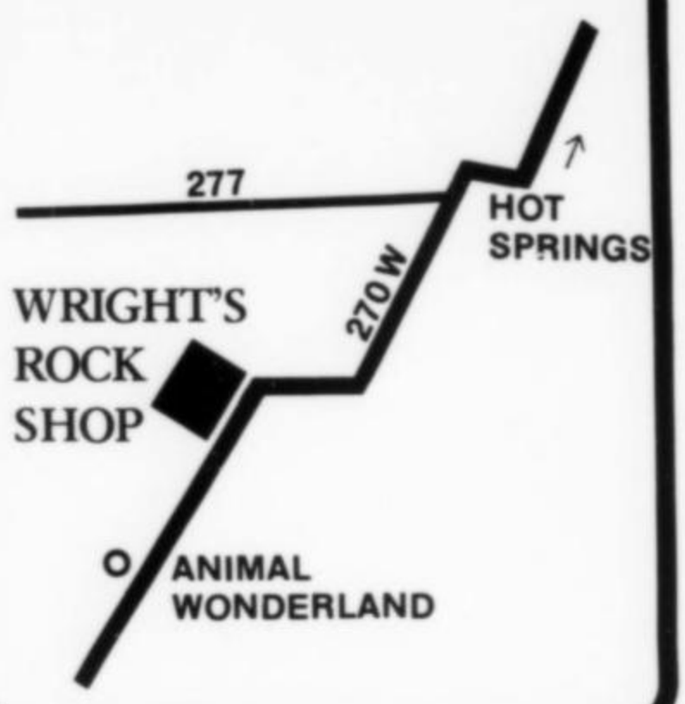

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THE CHESTER EMERY MINES

by **G. Fred Lincks**
867 West Street
Pittsfield, Massachusetts 01201

The Chester emery mines have produced fine specimens of margarite crystals, diaspore crystals, and others, for more than 140 years. These and perhaps 26 other species can still be collected there today.

INTRODUCTION

Both emery and magnetite were mined at Chester, Hampton County, Massachusetts, from the middle 1800's until after World War II. However, for simplicity and following tradition, we will here refer to the locality as the Chester emery mines. Emery is an intimate mixture of corundum and magnetite and/or hematite, as well as zircon in some cases. Emerson (1898) reported an analysis of the Chester emery by Charles T. Jackson, a geologist and State assayer, which showed 40% magnetite and 60% corundum. Recent work on polished samples by Carl Francis of the Harvard Mineralogical Museum have demonstrated the presence of ilmenite up to 50% in both the Chester magnetite and emery. This probably gives the rust resistance noted as an advantage of the emery by earlier writers. Francis states that the presence of magnetite is indicative of a rather complex history (1976, personal correspondence).

In addition to corundum and magnetite, 29 other minerals have been found at the mines. The author has found 28 of these on the dumps in recent years. Except for very short periods, collecting on the dumps has been unrestricted. Assurance has been given the author by the District Manager of the Wild Life Area that this will be continued. This decision was reached after we looked over the extensive dumps and estimated that, at the current rate of collection, good specimens should be available for many years to come.

HISTORY OF THE MINES

The first emery discovered in America was found at the Chester mines. The presence of iron ore deposits at Chester was known as early as 1835-1841. Mining of the magnetite was started in 1856 (1200 tons) but it was not until 1863 that a blast furnace was erected and extensive mining begun. The dulling of drills led to a study by Charles T. Jackson (Emerson 1898). The presence of margarite (a calcium brittle mica) was the key to his discovery of emery at Chester in 1864. However, the miners were reportedly calling it emery before Jackson's discovery.

This discovery came at an opportune time for the grinding and polishing of armaments for the Civil War, especially at the nearby Springfield Armory. The British and French had a monopoly on the mining of emery in Turkey and Greece, the major source of the ore. Emerson (1898) quoted an English statesman as saying "A good mine of emery is worth more to a manufacturing nation than many gold mines." Mining continued at Chester until after World War II with the Hampton Emery Company and the Chester Emery Company the principal operators, as described by Emerson (1898, 1917). The ownership of the main vein changed hands and at one time was involved in a law suit. The Hamilton Emery and Corundum Company, a subsidiary of the Bendix Corporation, still makes emery powders at Chester but uses ore brought over as ballast from the Island of Naxes off the coast of Greece. Emery derived its name from Cape Emeri on this island. Turkish ore is a very fine-grained mixture of corundum, magnetite and hematite with white margarite and diaspore. The Cortland Abrasive Company, another subsidiary of the Bendix Corporation, makes grinding wheels at Chester but uses synthetic abrasives such as carborundum and alundum.

THE EMERY MINES AT CHESTER

The emery and magnetite vein extends in a series of disconnected and irregular lenses for 4 miles from the top of Round Top Hill 2 miles south of Route 20, which follows Walker Brook, to the top of Gobble Mountain 2 miles north of Route 20 (Fig. 1). Over a period of years, six different mines were operated, as follows: (Norton, 1962)

1. Snow mine was the most northern mine located 1100 feet southeast of the top of Gobble Mountain. It was an open pit operation in a vein about 10 feet wide. The minerals associated with the emery and magnetite were paragonite, amesite and margarite.

2. Sackett mine was located 2600 feet north of the intersection of the Walker and Austin Brooks on the side of the mountain north of Route 20. Magnetite was the principal ore with no corundum in it to form emery. From 1876 to 1886 it was operated as an open pit. The mine was reopened in 1889 and an adit was driven through Savoy schist 114 feet to the vein. This adit is flooded now. The associated minerals were chlorite, talc, biotite, and bronze-colored corundum in crystals up to ½ inch in diameter and in masses up to 1 pound.

3. Marcia mine was dug in 1893. Starting from Austin Brook, 440 feet north of Route 20, an adit was driven 90 feet east to intersect the emery vein (Fig. 2). Then a 440 foot drift was driven north and another south. The south drift has caved in, but it is still possible to enter the mine. The minerals were similar to those of the Sackett mine except for the presence of more talc and beautiful rosettes of schorl in the fringe rock in the Marcia mine. Very little emery was recovered.

4. Old mine was the principal source of the emery and magnetite (Fig. 3). Three adits were driven south into the mountain south of Route 20. The lowest one started at the level of the bank above Walter Brook under the present power line. As of 1899 it extended 1689 feet almost straight into the mountain. The second adit was 220 feet above the first one starting further up the mountain. It was 1359 feet long in 1899 extending beyond the lower adit. The third adit was 85 feet above the second one, starting farther back on the mountain and extending farther in than the others. For much of its length it was 55 feet or more below ground level. The entrances to adits 1 and 2 have been sealed, however, the ore of the second adit came close to the ground level so a cave-in

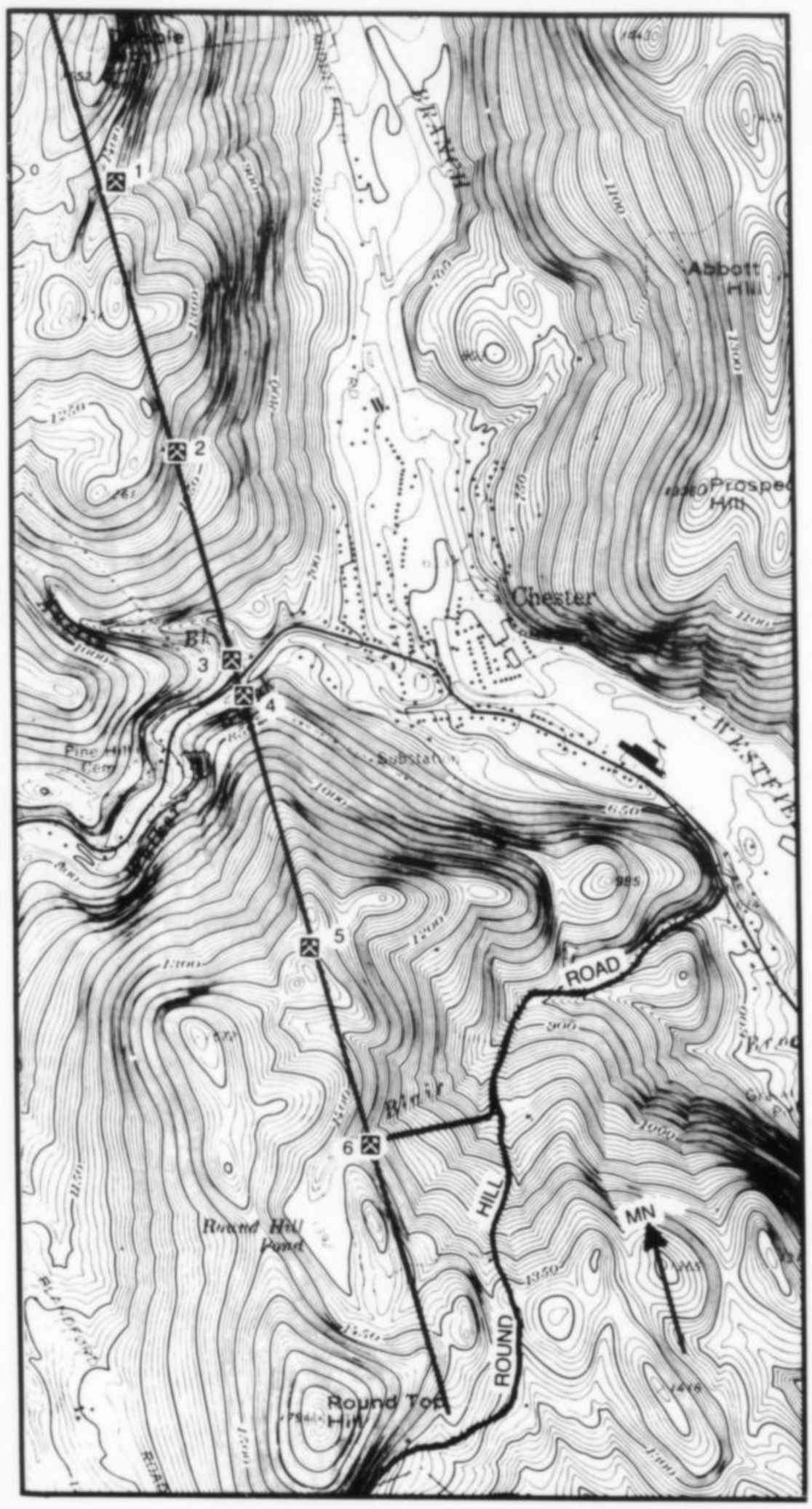


Figure 1. **Location map showing the trend of the Chester vein and the various mines located on it. The vein consists of irregular, disconnected lenses striking roughly parallel to magnetic north. The mines shown are (1) the Snow mine, (2) the Sackett mine, (3) the Marcia mine, (4) the Old mine, (5) the Melvin mine, and (6) the Wright mine.**

now provides an opening well back from the sealed entrance. Entering here or by the open entrance to adit 3 (now to be closed by the State) has caused some collectors to become trapped, necessitating rescue by the town's people. This has caused periodic posting of the area to stop collecting on the prolific dumps. The greatest number of mineral species are found on these dumps.

5. Melvin mine was located 3000 feet south of Walker Brook. It was an open cut 130 feet long following a 6½ to 16 feet wide vein for a depth of 35 to 40 feet. Corundophilite-magnetite was the principal ore with few accessory minerals except some tourmaline and margarite, the latter of exceptional beauty, being rose-pink rather than grey-pink as at the Old and Wright mines. Very little collecting has been done at these dumps.

6. Wright mine was the southernmost mine located 5500 feet south of Walker Brook. Initially it was an open pit worked in the early 1900's to a depth of 30 feet for a quarter of a mile. Later an 87-foot shaft was sunk but little ore was removed. The shaft is now flooded. Emery and magnetite were the ores mined. Associated minerals are margarite, corundophilite and some diaspore. The dumps provide good collecting, and some are hardly touched.

THE EMERY AND MAGNETITE VEIN AND PARENT ROCKS

The emery and magnetite vein at Chester (Fig. 4) lies within, and close to, the junction of the Chester amphibolite with the Savoy schist. The amphibolite crosses Massachusetts from north to south and extends into Vermont and Connecticut. It varies in width, being about 3200 feet wide at Chester. It is a dark green to black, foliated, epidote-quartz-hornblende schist containing prochlorite, ilmenite, rutile and calcite. It is relatively free of quartz near the emery vein. Corundophilite is present from alteration of the prochlorite. The amphibolite is of Ordovician age (425 to 500 million years old).

A short disance east of the vein lies the junction with the Savoy schist, also Ordovician. It is a rather coarse muscovite schist generally greenish in color due to the presence of chlorite. Both chlorite and almandine are found quite extensively therein. Kyanite is present also but south of the vein. Near the eastern border of the amphibolite are great peridotite-serpentine lenses which were intruded into the amphibolite, as were lenses of anorthite. It is of interest that near the junction of the railroad with the road north of Chester great olivine crystals have altered to yellow serpentine pseudomorphs (Palache, 1907). The emery and magnetite vein is overlain with magnesium-rich rocks. The paragenesis of the vein discussed in Emerson (1898, 1917) probably should be re-studied in the light of modern concepts. Shepard (1865) wrote:

> *"...but a parent rock or menstruum for the formation of corundum and emery is supplied in talcose slate series equally deficient in free silica, this being a compound which, if coexistant with alumina and protoxide of iron, would seem incompatable with the formation of either corundum or emery, inasmuch as under the play of the ordinary chemical affinities, several different species would be more likely to result."*

Emerson (1917) (page 161) wrote:

> *"The emery at Chester and at Peekskill (N.Y.) is very similar because the olivine was in contact with similar rocks in both places. The bed at Chester has passed through a much more complex and continued series of metamorphic changes than the others and as a result furnished a more varied and beautiful series of secondary minerals."*

(See Figs. 5 and 6.)

MINERALS FOUND AT CHESTER EMERY MINES

Shepard (1865) compiled the initial list of minerals found at these mines and Emerson (1898) added others to the list (Table I). The minerals in bold on the following list have been found by the author and are in his collection. The color designations of the National Bureau of Standard (1955) are used in the following descriptions. Table 2 gives these colors and also the corresponding names in the National Research Council (1948) standard for minerals.

MINERALS FOUND IN THE VEINS

AMESITE $(Mg_2Al)(AlSi)O_5(OH)_4$

Amesite is abundant in association with corundophilite of which it is an alteration product (Emerson, 1917). It is also associated with calcite. It is one of the latest minerals to form in the vein. It is a strong yellowish-green in color and talc-like in appearance. Originally it was classed as a septa-chlorite but is now considered to be a serpentine.

ARAGONITE $CaCO_3$

Aragonite is a late and not abundant mineral which formed in fissures in diaspore and margarite. It is white, light gray or light pink and forms long, thick blades in microscopic tufts, as well as thick, granular, sugary crusts.

BROOKITE TiO_2

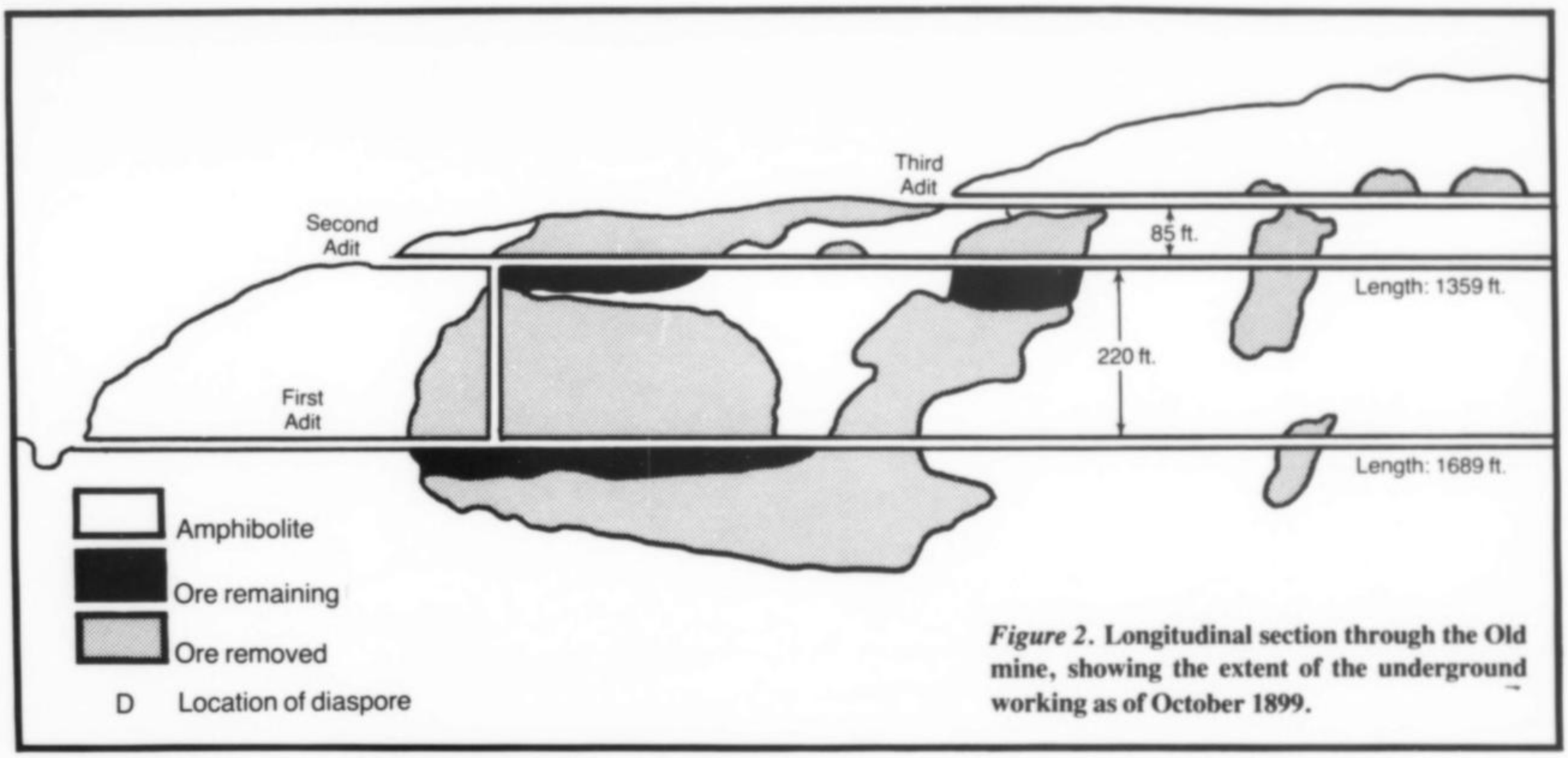


Figure 2. **Longitudinal section through the Old mine, showing the extent of the underground working as of October 1899.**

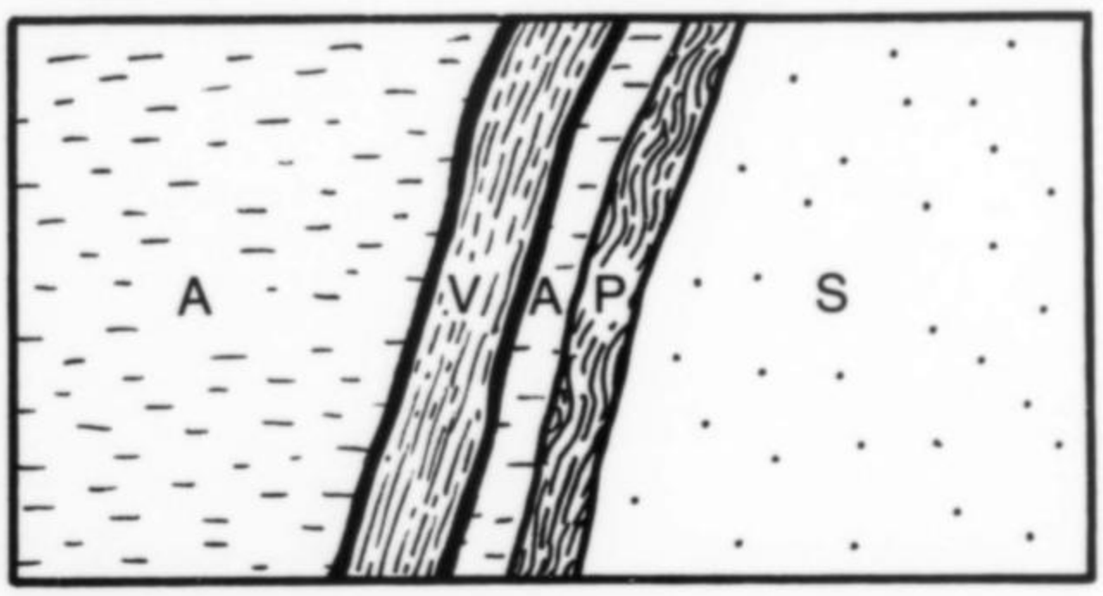
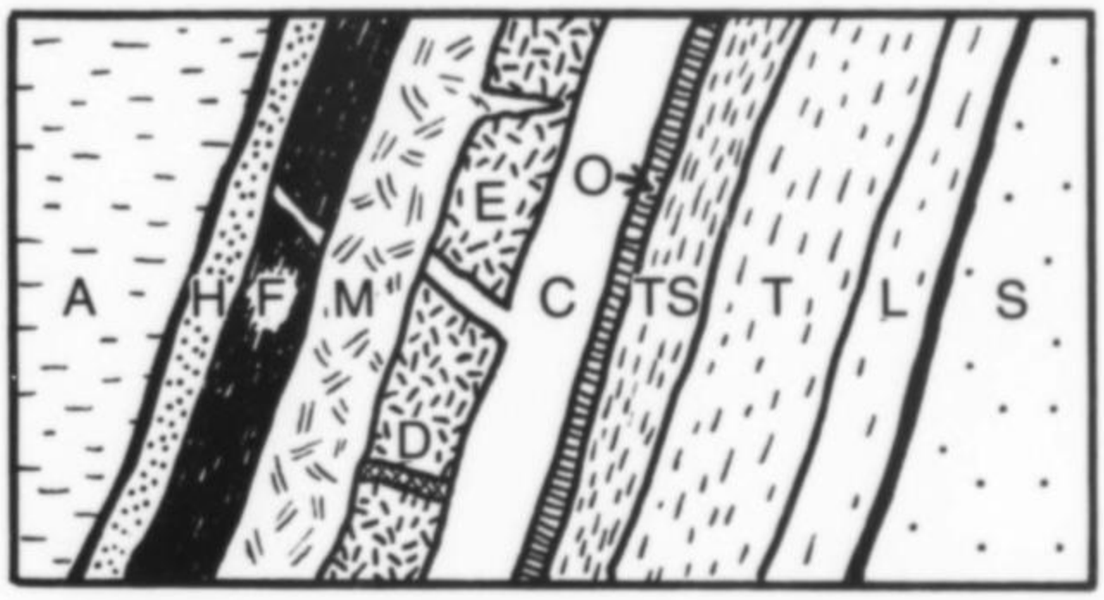


Figure 3. **General structure of the vein relative to surrounding rocks.**

A = Chester amphibolite
V = Vein
P = Peridotite/serpentine lenses
S = Savoy schist

Figure 4. **General structure of the vein at the Old mine.**

A = Chester amphibolite
S = Savoy schist
H = Hornblende (coarsely crystalline)
F = Magnetite
M = Margarite/chloritoid
E = Emery vein (4 feet wide)
D = Diaspore-filled fissures
C = Corundophilite rock
O = Oligoclase transition layer (1 foot wide)
TS = Talcose slate (2 feet wide)
T = Crystallized talc (15 feet wide)
L = Soapstone (talcose shale)



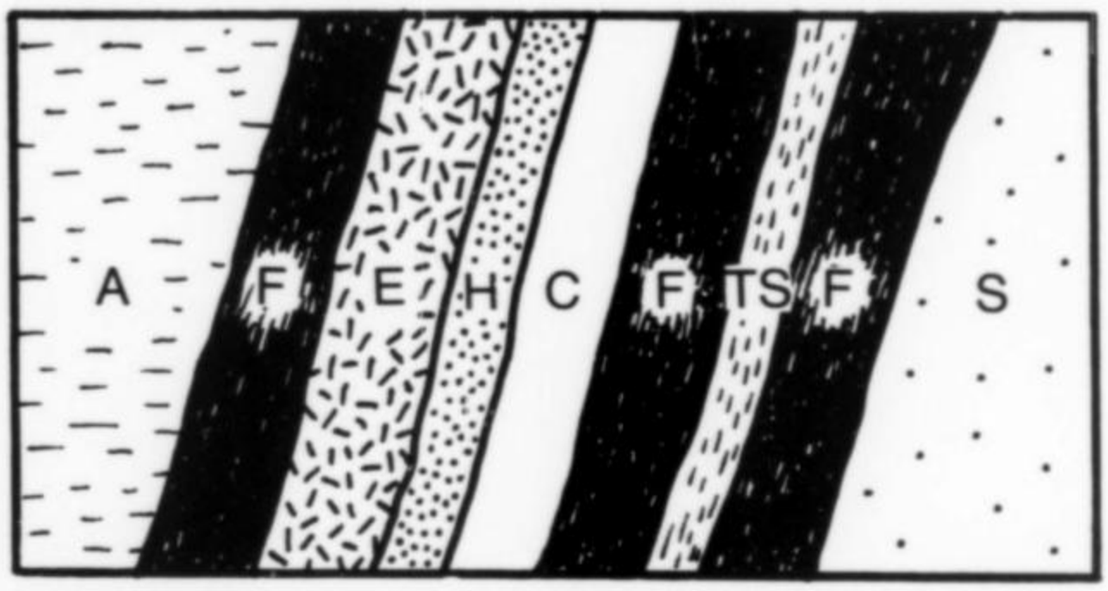


Figure 5. **General structure of the vein at the Melvin mine.**

A = Chester amphibolite
S = Savoy schist
F = Magnetite vein (6 to 6½ feet wide)
E = Emery, chloritoid, margarite vein (7 feet wide)
H = Coarsely crystalline hornblende
C = Corundophilite rock
TS = Talcose slate

Brookite is a rare vein mineral at Chester, light to dark brown in color or yellowish, reddish brown or black. It is found only in microscopic, prismatic or tabular crystals of varied habit having striated faces. It is associated with diaspore and corundophilite.

CALCITE $CaCO_3$

Calcite is a late and not abundant mineral which has formed over diaspore, rutile, corundophilite, corundum and sometimes brookite. When etched away, delicate parallel threads of corundum or a lacework of rutile needles sometimes appear, generally associated with diaspore. It is white, deep pink or medium red and is massive in form.

CHLORITOID $(Fe,Mn)_2Al_4Si_2O_{10}(OH)_4$

From old reports this was an abundant vein mineral mixed or associated with margarite and emery, and blackish green in color. It can be confused with corundophilite but its greater hardness (6.5 as compared with 2 to 2.5) makes identification easy. It should be available on the

Figure 6. **White aragonite crystals about 5 mm long, on pale lavender diaspore crystals. Smithsonian specimen #R2120-2; photo by WEW.**

dumps of both the Old and the Melvin mines.

CLINOZOISITE $Ca_2Al_3Si_3O_{12}(OH)$

Clinozoisite is found on the dumps of the Old mine, recently identified by the Harvard Museum and the American Museum of Natural History. It forms a series with epidote which Michael Fleischer (1976, personal correspondence) states: "*...is among the most illogical examples of nomenclature in mineralogy. Logical nomenclature would put the transition point in naming at the point where the Al=Fe (atomic ratios). But it is actually far over toward the Al side; it is traditionally taken at the point of transition from optically biaxial negative, roughly at Fe_2O_3 content about 5-6%, i.e., with Al/Fe ratio about 6:1.*" Tests made by Carl Francis (1976, personal correspondence) on specimens from the Old mine show an iron content on the border line or slightly over this transition point on the epidote side. Chemical tests were necessary to distinguish between the series members; X-ray diffraction is unreliable.

The Chester clinozoisite is light brown, in cleavable masses and small crystals in compact corundophilite, associated with margarite and tourmaline. Small crystals have also formed in the massive matrix.

CORUNDOPHILITE Ferroan clinochlore (Michael Fleischer, 1976, and personal correspondence) $(Mg,Fe^{+2})_5Al(Si,Al)_4O_{10}(OH)_8$

Corundophilite, diaspore and margarite commonly accompany emery and massive corundum at Chester. Corundophilite was the most abundant gangue mineral (Figs. 5 and 6). Its color varies from dusky blue-green, dark yellow-green to greenish black. Generally it is massive with loosely associated lamina having a micaceous character, or it may occur in compact masses. The rare crystals are monoclinic with hexa-

Figure 7. **Dark green corundophilite (ferroan clinochlore) crystals up to 1 cm in size. Smithsonian specimen #18180; photo by WEW.**

gonal form. Microscopic books have been noted. The lamellae are brittle, slightly more so than clinochlore. It formed in separate veins paralleling emery and magnetite (Figs. 5 and 6) and also fills fissures generally forming a border around the outside of margarite. Some of it is coated with a strong yellowish green (sometimes called apple-green) talc-like amesite.

CORUNDUM Al_2O_3

Corundum at Chester is rare as a separate mineral except as reported at the Sackett mine, where only magnetite was found. Here crystals up to one-half inch were found along with massive material; otherwise crystals are generally microscopic. A specimen found with corundophilite on the Old mine dumps is white with spots of dark or dusky red. Other colors reported include blue, pale pink, sapphire-blue and bronze, the latter two having been found with diaspore and corundophilite (Emerson, 1898, and Norton, 1962).

Figure 8. **Pale lavender diaspore crystals to 1 cm in size. Smithsonian specimen #R2120-2; photo by WEW.**

DIASPORE AlO(OH)

Diaspore, one of the most sought-after minerals, is relatively rare. The colors are brownish gray and yellowish brown, sometimes tinged pale violet. Generally diaspore at Chester is found as foliated or scaly opaque aggregates. Crystals are rare although Sinkankas (1964) reports them up to 2 inches in length. Diaspore formed in fissures crossing the emery veins, with corundophilite bordering each side at the junction with emery. Where it did not completely fill the fissures, free crystals are found lining the remaining open spaces. Microscopic crystals have been found on the surface, bordered by corundophilite. Naturally the best specimens came from the active mine. However, specimens of varied habit are now found principally on the dumps of the Old mine, with a few coming from the Wright mine. Emerson (1898, page 141) wrote:

> *"In a limited portion of the workings in the lowest shaft the rock carries diaspore in large quantity and of the finest color, especially the isolated crystals resting in open fissures upon and partly enclosed in crystals of corundophilite and shot through and overgrown with delicate needles of rutile; and radiated crystals of epidote and rarely of brookite were of exceptional beauty, both of form and color. The diaspore presented square prisms 25-30 mm in length, finely terminated, of rich violet-tinted hair-brown color. It occurs also in compressed rounded masses quite within the substance of the emery."*

Specimens of diaspore somewhat resembling those described by Emerson have been found with microscopic crystals of brookite and of rutile in pockets in diaspore as well as crystals of corundum and radiating crystals of epidote.

Figure 9. **Pale pink-violet, pseudohexagonal crystals of margarite to about 8 mm in size. Associated is a black, tabular crystal of ilmenite at center-bottom in the photo. Smithsonian specimen #B16979; photo by WEW.**

EMERY Not a mineral. At Chester it is an intimate mixture of magnetite, corundum and ilmenite.

Emery is the most abundant ore in the vein (Figs. 5 and 6). Emery is easily distinguished by its strong magnetism and from magnetite by being more granular. Five different textures of emery are found at Chester (Shepard, 1865):

1. granular emery: Consists of flat grains from the size of a kernel of corn down to the size of a peppercorn disseminated through corundophilite. The grains rarely touch each other and lie flat with the corundophilite. It is both cleavable and easily broken. The emery comprises from one-half to three-fourths of the aggregate.

2. veined emery: Similar to granular emery except the grains often touch at the edges, or partially unite. Granular and veined emery sometimes grade into each other.

3. compact emery: A very compact, fine-grained, vein emery which is darker than the preceding textures and having a faint violet-blue tarnish. It fractures with extreme difficulty in many directions. It is more granular than magnetite.

4. emery magnetite: A massive magnetite containing an intermixture of emery. It closely resembles magnetite but is harder, has a purplish tarnish and is more difficult to break. Shepard (1865) found it "not abundant."

5. stony emery: Shepard (1865) reported this as a chloritoid rock which is slaty, greenish gray, rather heavy and containing from 10% to 20% fine-grained emery. Other minerals present are tourmaline and margarite scattered through the aggregate.

EPIDOTE $Ca_2(Al,Fe)_3Si_3O_{12}(OH)$

Epidote is not an abundant vein mineral but is abundant in the amphibolite. It is grayish olive in color. Massive epidote in amphibolite often is associated with other minerals. In the vein, monoclinic, prismatic, sometimes acicular crystals have formed in pockets in massive epidote in sizes to nearly ⅛ inch in diameter and ½ inch in length. Lengths up to 2 inches were reported in the early days and, as noted earlier, crystals associated with diaspore have been found. Epidote occurs both north and south of Walker Brook (and Route 20) associated with grayish margarite, chloritoid and emery.

HEMATITE Fe_2O_3

Hematite is another late, very rare vein mineral. The color is metallic black. It is reported in small rosettes of bright scales in aragonite.

ILMENITE $FeTiO_3$

Ilmenite is rare as a separate mineral, in both the vein and the amphibolite. It is medium gray to dark gray in color with a metallic luster, forming foliated masses with curved lamina. In the vein it is associated with margarite, corundophilite and emery. It is much more limited in the vein than in the adjoining talcose slate or the amphibolite.

MAGNETITE Fe_3O_4

The most abundant vein mineral at Chester (Figs. 5 and 6) is magnetite. It is black but with a purplish tinge on the fractured surfaces, which are smooth or less granular than emery. It is rust resistant, possibly because of the presence of ilmenite or absence of hematite. Jackson (1865), having found titanium in emery, believed it might be in the magnetite. Shepard (1865) reported finding magnetite similar to stony emery.

MARGARITE $CaAl_2(Al_2Si_2)O_{10}(OH)_2$

Margarite is another much sought-after, relatively abundant mineral which formed in fissures cutting across the emery veins as well as in corundophilite (Figs. 5 and 6). The color varies from light pink, sometimes called rose, at the Melvin mine to pale yellowish pink or grayish yellowish pink at the Old and Wright mines. Margarite is a calcium-bearing brittle mica which is sometimes bleached so it looks like muscovite. There is no muscovite in the emery veins. Shepard (1965) wrote:

> *"The margarite presents itself frequently with a richness of crystallization and color nowhere else known."*

Like diaspore, margarite did not always fill the fissures in the emery, and some crystals formed in the open spaces along with corundopholite crystals. Also, as with diaspore, corundopholite borders the margarite at the junction with emery. Beautiful specimens of margarite up to 1½ inches in thickness are found bordered with greenish corundophilite. On some specimens margarite and corundophilite intermingle across the whole face. It is also associated with chloritoid. Sometimes margarite is mistaken for diaspore but the lesser hardness (3.5 to 4.5 compared

Figure 10. **Lavender-pink margarite vein section 4 cm wide. Smithsonian specimen #82009; photo by WEW.**

with 6.5 to 7) and the micaceous character permit easy differentiation. Margarite also forms as a white to pink schistose rock.

PYRITE FeS_2

Pyrite is a rare mineral at Chester, appearing in corundophilite as pale, brassy-colored cubes.

RUTILE TiO_2

Rutile is a rare, generally microscopic, vein mineral at Chester which is a deep reddish brown or dark reddish orange in color. It is found as microscopic, single, vertically striated, prismatic crystals with geniculated twinning. Delicate needles, some of which are striated, bent and twisted, are found in or on corundophilite or in calcite in association with diaspore and clinozoisite.

TITANITE (Sphene) $CaTiSiO_5$

Titanite is a very rare mineral in the vein and possibly a little less rare in the amphibolite. Crystals up to ½ inch long and ¼ inch wide in vugs in the amphibolite have been found on the Old mine dumps. They are tabular with wedge-shaped terminations, sometimes doubly terminated, and with a grayish greenish yellow color.

BORDER ZONE MINERALS WITH THE CHESTER AMPHIBOLITE

ACTINOLITE $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$

Actinolite is not an abundant mineral. On the dumps it is generally found in greenish gray masses unassociated with any matrix.

BIOTITE $K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2$

Biotite is a somewhat rare mineral at Chester. It is black and generally massive.

CARBONATE-CYANOTRICHITE $Cu_4Al_2(CO_3,SO_4)$-$(OH)_{12}\bullet 2H_2O$

An extremely rare mineral not included on previous lists, carbonate-cyanotrichite was found by the author and identified by X-ray diffraction. It is brilliant greenish blue, occuring as a coating of rosettes of acicular crystals associated with malachite in granular corundophilite.

CHALCOPYRITE $CuFeS_2$

Shepard (1865) reported that only a few grains of chalcopyrite had been found on gneiss near the emery vain.

CHLORITE (Prochlorite, ripidolite) General formula $M_{5-6}(Al,Si)_4O_{10}(OH)_8$

This is a second-stage mineral which formed in both the Chester amphibolite and Savoy schist before the emery and magnetite veins formed. It is rare at Chester, grayish green to grayish blue in color and massive with loosely associated lamina having a micaceous character. Corundophilite formed as an alteration product of chlorite in some cases.

CORDIERITE $Mg_2Al_4Si_5O_{18}$

Cordierite is a very rare mineral not included on previous lists. It is dark grayish blue (dusty blue) in color and massive. Cordierite, being relatively unstable, is generally coated by a dark, yellowish brown, pearly, platy alteration mineral which has been given a number of different names such as *chlorophyllite, hydrous iolite, fahlunite*, etc., none of which are valid today. Dana (1909) describes this alteration as follows:

> *"The alteration of iolite (cordierite) takes place so readily by ordinary exposure, that the mineral is most commonly found in altered state, or enclosed in altered iolite. The change may be a simple hydration; or a removal of part of the protoxide of iron; or of alkalies, forming pinite and mica. The first step in the change consists in division of the prisms of iolite into plates parallel to the base, and a pearly foliation of the surface of the plates; with a change in color to grayish green, greenish gray and sometimes brownish gray. As the alteration proceeds, the foliation becomes complete; afterwards it may be lost."*

The author has found altered cordierite partially enclosing fresh cordierite on the dumps.

CUMMINGTONITE $Mg_7Si_8O_{22}(OH)_2$

Cummingtonite is a rare mineral bordering the amphibolite. It is light gray in color and found with talc.

HORNBLENDE $(Ca,Na)_{2-3}(Mg,Fe^{+2},Fe^{+3},Al)_5(Al,Si)_8O_{22}(OH)_2$

Hornblende is not an abundant mineral on the dumps but was reported as abounding in thick seams in amphibolite along the vein. It is dark greenish gray in color, lustrous with a coarse-grained structure. Generally it is found without any matrix.

MALACHITE $Cu_2(CO_3)(OH)_2$

Malachite is a very rare mineral occurring with epidote in the amphibolite. It is light yellowish green and is found as crusts or as crystals in pockets.

SCHORL $NaFe_3^{+2}Al_6(BO_3)_3Si_6O_{18}(OH)_4$

Schorl, the black species of tourmaline, is an abundant mineral along the border of the vein over its whole length. It forms hexagonal crystals having smooth faces but lacking terminations. Occasionally beautiful, radiating groups are found as well as crystals up to several inches in length and ½ inch or more in diameter. It can be mistaken for hornblende but hornblende is not in crystals at Chester and schorl has a hardness of 5 to 6 compared to 7 to 7.5 for hornblende. It is associated with the vein minerals but most commonly with compact corundophilite, with which it is intergrown, so that unbroken crystals are impossible to remove.

OLIGOCLASE $(Na,Ca)Al(Al,Si)Si_2O_8$

Oligoclase is not abundant at Chester. It is fine-grained, in small triclinic crystals and is white to reddish in color. It is found associated

with corundophilite and sometimes emery.

TALC $Mg_3Si_4O_{10}(OH)_2$

Talc is a relatively abundant mineral formed from serpentine bordering the ore body, and with remnants of serpentine in it. It is very pure otherwise, and grayish green to light gray in color. Much of the talc carries disseminated ankerite which has been dissolved away in some cases leaving rusty brown holes. There is also dark leak-green, compact talc. The light gray talc has white crystals in it resembling tremolite making it harder than the normal 1 to 1.5.

MINERALS IN THE SAVOY SCHIST

ALMANDINE $Fe_3Al_2(SiO_4)_3$

Almandine has been reported as plentiful in the Savoy schist but not on the dumps. The color is dark reddish brown and it is opaque. Specimens were found under the power line near the Old mine dumps.

KYANITE Al_2SiO_5

Kyanite is a rare mineral at Chester not now found on the dumps although Dana (1911) lists good specimens from the Emery mines. Emerson (1898) states that it occurs in the Savoy schist south of the vein. It is blue with long, bladed crystals.

Table 1. Minerals observed at the Chester emery mines

	A	*B*	*C*	*D*	*E*
Ores mined at Chester:					
Emery	X	X	X		X
Magnetite	X	X	X		X
Minerals associated with ore:					
Amesite	X	X			X
Aragonite		X			X
Brookite	X	X			X
Calcite		X			X
Chloritoid	X	X	X		
Clinozoisite				X[2]	X
Corundophilite	X	X	X		X
Corundum	X	X	X		X
Diaspore	X	X	X		X
Epidote	X	X	X		X
Hematite		X			
Ilmenite	X	X	X		X
Margarite	X	X	X		X
Pyrite		X			X
Rutile		X	X		X
Titanite		X			X
Minerals bordering Chester amphibolite:					
Actinolite	X				X
Biotite		X	X		X
Carbonate-Cyanotrichite				X[1]	X
Chalcopyrite	X				
Chlorite		X			X
Cordierite				X	X
Cummingtonite				X	X
Hornblende		X			X
Malachite	X	X			X
Schorl	X	X	X		X
Minerals in Savoy schist bordering ore vein:					
Oligoclase		X			X
Talc		X			X
Minerals in Savoy schist:					
Almandine		X			X
Kyanite			X		

A = Minerals reported by Shepard (1865)
B = Minerals reported by Emerson (1898)
C = Minerals reported by Dana (1909)
D = Minerals first reported in this study
E = Minerals in the author's collection from Chester
1 = X-ray identification
2 = Identification by chemical analysis

COLLECTING ON THE DUMPS OF THE OLD, MELVIN, AND WRIGHT MINES

The Bendix Corporation was the owner of an L-shaped portion of the mountain on which the Old, Melvin and Wright mines are located. The town's people had them post the whole area periodically because collectors and children sometimes became trapped or injured and had to be rescued from the third adit of the Old mine. In 1973 the Kelley Hardwod Company bought a part of this L-shaped area and, in 1974, gave it to Massachusetts principally to protect the rare Indiana bat, now on the endangered list. The bat hybernates in the third adit. The John J. Kelley Wildlife Area will be administered by the Massachusetts Division of Fisheries and Wildlife of the Department of Natural Resources and the adits will be closed to all but the bats (and people who obtain permission to enter). We have assurance that collecting minerals will be encouraged in the Wildlife Area and efforts will be made to keep open the area on which the Old mine dumps are located, as in the past. An exhibit of minerals found on the dumps during the course of this study has been given to the State for the office of the District Manager, Hubbard Street, Pittsfield, Massachusetts.

Figure 11. **Red rutile crystal about 3 mm long imbedded in the side of a dark green corundophilite crystal. Smithsonian specimen #18180; photo by WEW.**

Old mine dumps

These dumps are where the greatest number of different minerals are found. They are reached by an old wood road starting from a cement bridge crossing Walker Brook from Route 20 about ¼ mile west of Chester. The wood road crosses under a power line about 150 feet above Walker Brook and enters the woods. The dumps start on the right, downhill side about 30 feet into the woods, but fine schorl specimens can be found on the uphill side. The dumps stretch for 100 feet or more along the road.

Melvin mine dumps

These dumps have beautiful, light pink margarite which is bordered by green corundophilite and emery. Some magnetite is also found there, but they are not as productive as the Old mine dumps. They are reached by an old mine road which starts from the power line a little above the road to the Old mine dumps. It passes the entrance to the third adit and continues steeply up the mountain for about ¾ mile. The dumps and the flooded mine trench are close to the road on the left side. Very little

collecting has been done at this mine.

Wright mine dumps

Fine margarite specimens (some intergrown with corundophilite) and some diaspore are found here. The dumps and the mine are reached by driving south for about a mile up Round Hill Road, starting from Route 20 east of Chester. Park by a driveway leading to a house far back on a hill to the east. Then, starting about 30 feet uphill from the parking spot, walk west up the old mine road for about ½ mile. The dumps are on both sides of the road with the mine starting as a shallow cut on the left side and extending across a brook to a deep cut in the mountain. Another dump which shows few signs of collecting is on the mountain side to the right of the deep cut.

Other mine dumps

The dumps of the Marcia, Sackett and Snow mines north of Route 20 are reported to be unproductive of good specimens. The Marcia mine can be entered but the productive south drift has caved in and is flooded.

THE ILMENITE PROSPECT

Fine ilmenite, almandine and hornblende specimens are found here. The prospect is located east of Round Hill Road accessible from a wood road starting about a mile beyond the parking area for the Wright mine. Having a guide or explicit directions is advisable since the turnoff from the wood road is unmarked and the prospect is located from 100 to 200 feet up a steep wooded hill with no paths.

OTHER MINES AT CHESTER

For minerals found at Chester other than at the Emery mine, Dana (1911, page 1056) lists scapolite, zoisite, spodumene and indicolite (elbaite) as good specimens and amphibole, garnet, apatite, magnetite, chromite, stilbite, heulandite, analcime and chabazite as of lesser quality. Emerson (1898) mentions unsuccessful chromite diggings east of the Emery mine near the village. A booklet available at the new museum located above the library (a bicentennial project with a mineral room worth visiting) describes a mica mine and several quartz quarries where minerals may be collected. References Emmons (1814, 1826) and Palache (1946, 1947) give information on these mines.

ACKNOWLEDGEMENTS

I would like to particularly thank Carl Francis who gave me great help and encouragement in the preparation of this article. Also my thanks go to Michael Fleischer who so kindly answered many questions and reinstated corundophilite in the *1975 Glossary of Mineral Species*, to Pete J. Dunn for his X-ray identification of carbonate-cyanothrichite, to Clifford Frondel for his comments on an early draft and especially his suggestion that a professional restudy be made of the paragenesis by a qualified geochemist, to Wendell E. Wilson for photography and to John S. White for his criticisms of early drafts which challenged me to make this a better article.

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THE HISTORICAL RECORD

by Ron Bentley
P.O. Box 366
Windsor, Connecticut 06095

In the last column (vol.9, no.2) I related the story of the Schortmann brothers and how I was indebted to them for my interest in minerals. As it happened, my interest in the historical record also began with them. Though Raymond unfortunately died before we could become closer friends, I did come to know his wife Mitzi better in later years. It was an evening in 1972, while I was selecting specimens to buy from Raymond's collection, that Mitzi brought a pile of magazines out of the attic and gave them to me. Upon later examination I found they were copies of a monthly publication called *The Mineral Collector*. Edited by Arthur Chamberlain from 1894 to 1909, these 80 issues were the spark for my growing interest in mineral memorabilia.

I have yet to discover exactly how many complete sets of *The Mineral Collector* remain in existence today, but I would guesstimate that less than 50 have survived. My set was helped toward completion when (the late) Neal Yedlin learned that I possessed one of the two issues he was missing to complete his own set. He generously swapped me over 60 of his duplicates for that one issue! Though I cannot do the magazine justice in this limited space, readers might find a synopsis interesting.

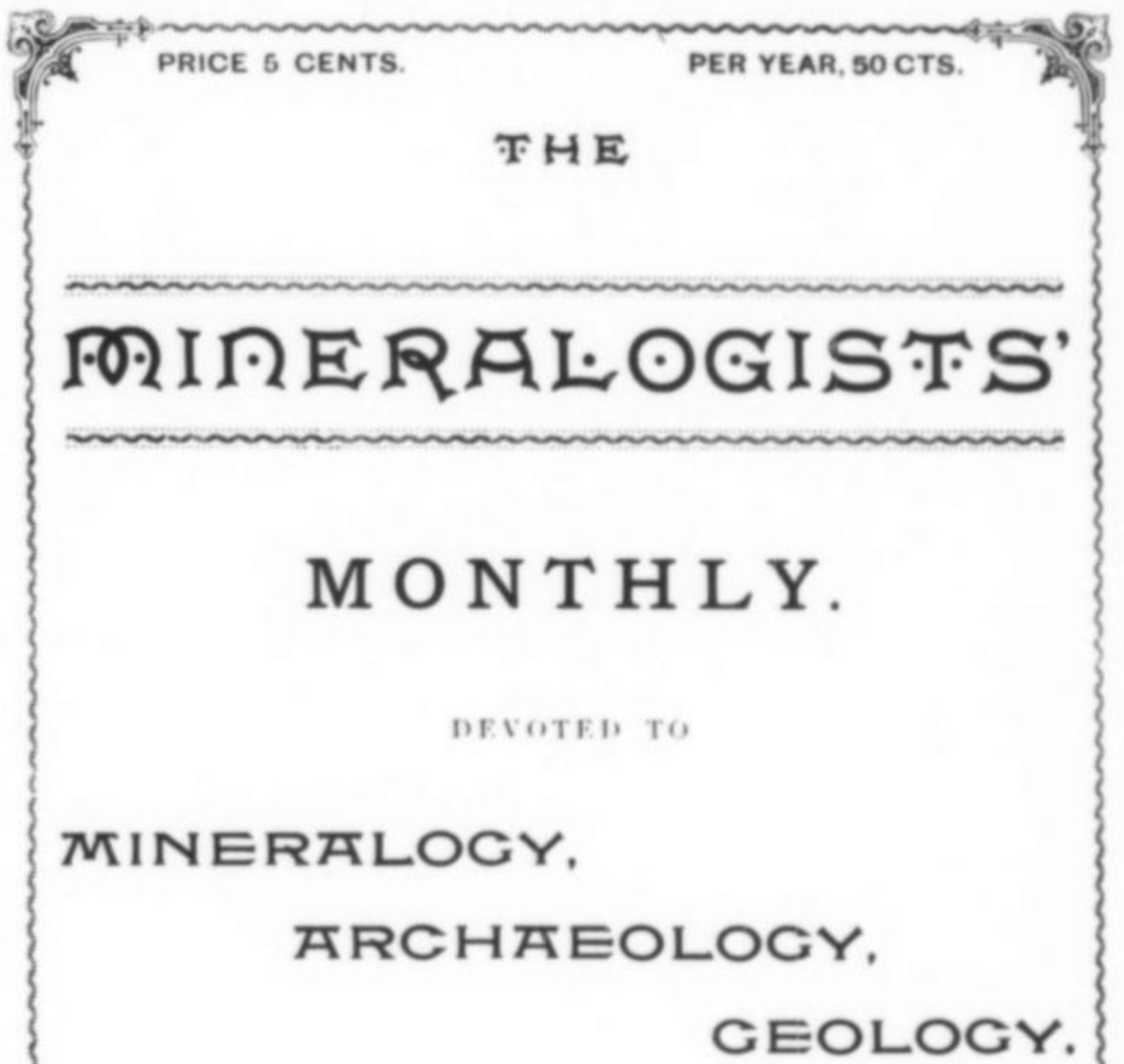
I have taken it from the introduction and greeting to volume 1, number 1 of the *Mineral Collector*.

> "In November, 1885, Mr. Chamberlain published the first number of the *Exchanger's Monthly*. It was a modest little publication, neat and trim, which moved along happily up to its fifth birthday, and then was given a new and more imposing name — *The Mineralogists' Monthly*.
>
> "Collectors eagerly awaited its monthly appearance so as to be early informed of new things offered for sale by the dealers, and to read reports of the current events in the specimen world."

In January of 1892, Mr. Goldthwaite began the publication of another journal for the same audience. It was doubtful, however, that enough subscribers could be found to support both the new journal (entitled *Minerals*) and *The Mineralogists' Monthly*. Consequently it was agreed to merge the two publications, with Mr. Goldthwaite as proprietor and publisher, and Mr. Chamberlain as editor of the new *Minerals*. The last number of *The Mineralogists' Monthly* was published in March of 1893.

> Quoting again from the introduction: "*Minerals* improved with each succeeding number. Biographical sketches of eminent mineralogists were printed, together with fine photo-engravings of the subjects of the sketches. Collectors were pleased with the general make-up of the magazine.
>
> "In the Summer and Fall of '93, *Minerals* appeared in double numbers (i.e. on alternate months instead of every month), closing with the November and December double number. Mr. Goldthwaite informed Mr. Chamberlain, in an interview held the latter part of January, '94, that *Minerals* would not again be published.
>
> "Several gentlemen actively engaged in collecting minerals had, for some time previous to the first of the year, considered the advisability of starting a new magazine to be published regularly, and which would appeal to (mineral) collectors throughout the country. Their chief aim being a subscription list sufficiently large to support a magazine strictly on its merits.
>
> "Mr. Chamberlain reported the facts of his interview with Mr. Goldthwaite, and we concluded immediately to set about getting out a new monthly magazine, deciding to issue the initial number March 1, 1894.
>
> "There is much that is new in minerals, especially as to what the country affords in specimens. It is news relating to new localities, what may be had, and how to obtain it, that we mean to lay before our readers. The West is wonderfully rich in beautiful, new, rare and interesting minerals. We have arranged with collectors to furnish descriptions of several of these fields, which cannot fail to please the sober as well as the enthusiastic collector.
>
> "We may, therefore, conscienciously request your early subscription — THE EDITORS"

The editors, Arthur C. Chamberlain and Albert C. Bates, charged $1 for a 12-month subscription, with a 25% discount to clubs. Each issue was about 6½ by 10 inches and 22 to 26 pages in length with black and white photos and specimen engravings only rarely included. Accounting for inflation, $1 in those days was worth $10 or $15 today. Still, a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THE

MINERALOGISTS'

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DEVOTED TO

MINERALOGY,
ARCHÆOLOGY,
GEOLOGY.

ARTHUR CHAMBERLAIN, EDITOR.

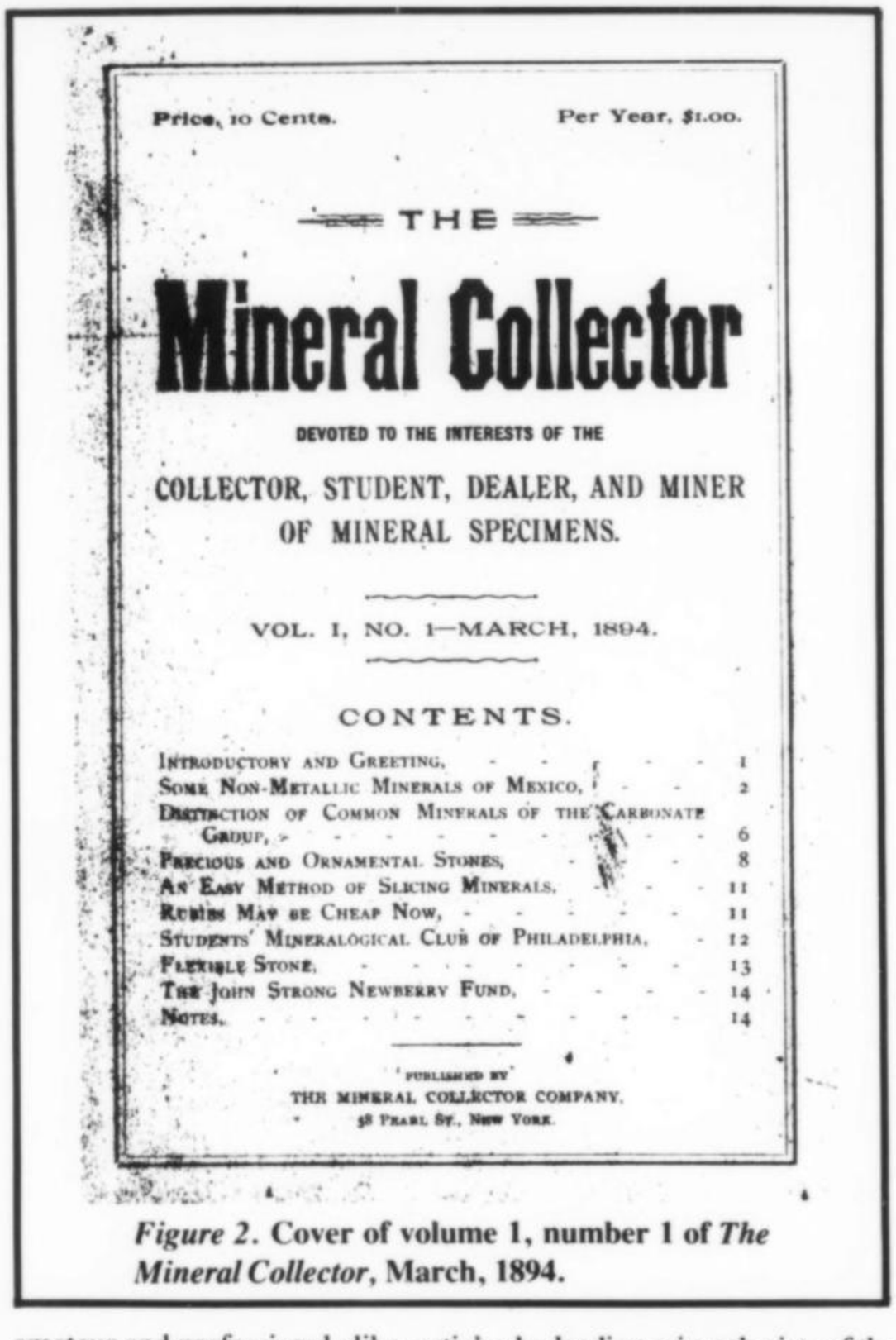
Vol. VI, No. 10—AUGUST, 1891.

PUBLISHED BY
THE CHAMBERLAIN PRINTING CO.,
JERSEY CITY, N. J.

Figure 1. **Cover of *The Mineralogists' Monthly*, 1891.**

full-page back-cover advertisement cost only $6! And the ads were interesting: the sixth edition (1892) of *Dana's System of Mineralogy* offered for $12.50, for instance, and Cumberland, England, fluorites from 25¢ and up.

For 15 years *The Mineral Collector* offered to the mineralogist,



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THE

Mineral Collector

DEVOTED TO THE INTERESTS OF THE

COLLECTOR, STUDENT, DEALER, AND MINER OF MINERAL SPECIMENS.

VOL. I, NO. 1—MARCH, 1894.

CONTENTS.

PUBLISHED BY
THE MINERAL COLLECTOR COMPANY,
58 PEARL ST., NEW YORK.

Figure 2. **Cover of volume 1, number 1 of *The Mineral Collector*, March, 1894.**

amateur and professional alike, articles by leading mineralogists of the day, information on new minerals and localities, advice on collecting, swapping and buying, and the ads of the largest mineral dealers. That the magazine was well received can be seen from some of the letters to the editors, such as the following:

"I wish you well in your undertaking, and hope you have the support you deserve from the mineral collectors in the country.

Edward S. Dana

"I am exceedingly sorry to learn from the January number of *The Mineral Collector* that there can be any doubt as to its continuance. I feel sure that if the large number of persons, young and old, who are interested in the study of mineralogy would give the magazine the support which its merit deserves, they would find, as I have done, that it is well worth what it costs them, and more too. I sincerely hope that you will not find it necessary to discontinue the publication which I always read with interest. If mineralogists generally would join in helping you, I believe there is a great future for the "*Collector*." Assuring you that I shall do what I can to help along the project, I am very truly yours,

George Vaux, Jr.

"I have read *The Mineral Collector* since the first number issued, and it affords me great pleasure to state that in my opinion it is the most newsy of all periodicals devoted to mineral collecting. It is printed on good paper, with clear type, and the price being so low there ought to be no reason why any mineral collector should be without it.

Wishing you even greater success in the future,

George F. Kunz"

The Mineral Collector was amusing as well as "newsy" and informative. Each issue carried an anecdote or two relating to the mineral field. For example:

The Scotchman and the mineralogist: "Yon man gave me his bag to carry by a short cut across the hills to his inn, while he took the other road. Eh! It was dreadful heavy, and when I got out of his sight I determined to see what was in it, for I wondered at the uncommon weight of the thing. And man, it's no use for you to guess what was in that bag, for you ne'er find out. It was stones!" "And did you carry it?" "Carry it! Man, do you think I was as mad as himself?

Figure 3. **The New York Mineralogical Club on a collecting trip at Kingsbridge, New York, in 1893 (pictured in the first issue of *The Mineral Collector*).**

Nae! Nae! I emptied them all out. But I filled the bag again from the pile by the house, and I gave him good measure too!''

And then there's the chicken story:

''*Orange, Texas; March 23, 1895*. Col. W. D. Bettis has a valuable opal about the size of a grain of peaberry coffee, that he wears in a scarfpin. Yesterday he called up a pet chicken and took it in one hand while he allowed it to pick some grains of corn from his other hand. The chicken soon swallowed the half-dozen grains that were held out to it and, looking about for more, spied the opal and struck it but did not quite dislodge it from the setting. As quick as a flash, the bird made another more successful grab at the stone, tearing it out and swallowing it. The chicken was a great pet in the family, but opals cost more than chickens. A council of war was called, and it was decided that the opal must be found, even at the cost of a life, so about two hours later the chicken was executed and the opal discovered lodged in its gizzard.''

Clearly this was a case of life immitating art, since Sir Arthur Conan Doyle had published a Sherlock Holmes story in *The Strand* magazine only three years earlier, entitled *The Adventure of the Blue Carbuncle* (actually a blue diamond), about a valuable stone swallowed by a goose.

Figure 4. **George L. English ad in the September, 1894, issue of *The Mineral Collector*.**

Figure 5. **A page of ads from the December, 1895, issue of *The Mineral Collector*.**

But one of the most interesting parallels I found in reading about the mineralogy of yesteryear was in the kind of admonition and advice given which is still appropriate today. For example:

''*June, 1894*. In a recent discussion of prices of mineral specimens, it was contended by one side that a collector could seldom realize half the original price of a specimen when offered for sale by himself. Another collector, of wider experience, claimed that if purchases were made judiciously, and only really fine specimens bought, even though prices seemed high, that about the original price could be obtained at forced sale. His own experience had been that when he found it necessary to sell off specimens to make room for better ones, he could get within a small percentage of the original price paid. In several instances he had sold specimens at considerably more than cost. It seems advisable, therefore, to buy as fine specimens as one can afford. This appears an obvious conclusion, but the fact is that long experience is required in collecting for one to fully comprehend it. Youthful eagerness to possess is followed by dissatisfaction and the usual gamut of experiences. Still, experience must be the teacher.

''*February, 1895*. Mending specimens is legitimate, of course, but not with intention to deceive. It is, therefore, admissible to write on the label that the specimen is a mended one, even though one means to keep it for himself, because it will sometime come under

the notice of careful observers.

"*February, 1909*. Even the wealthiest of collectors complain of the high prices asked by dealers for specimen minerals. But in the case of some minerals the high prices are in a measure justified. The great demand by jewelers for all kinds of semi-precious stones — clear, flawed or matrix — has made a ready market for many crystals, and especially for tourmalines. Otherwise the large, multi-colored crystals from California would doubtless have been cheap enough. The mines produced heavily all sizes and colors of crystals. At first they came on the market at very reasonable prices. But for years past, large, fine crystals have been priced up in the hundreds of dollars. They will be cheaper sometime, perhaps.

"Recently a small lot of chinese cinnabar crystals came on the market, and these were priced so high that only the wealthiest collectors and curators of museums could afford to buy specimens.

"Singular as it may seem, the opinion is held that the only hope for low prices lies in the coming of a large number of people newly interested in collecting."

The amount of material that was contained in *The Mineral Collector* is extraordinary, and it is difficult for us today to understand why such a periodical had to be terminated in 1909. But the retrospective of Mr. Bates is a reminder that the problems of yesterday still plague us, to a certain extent, today:

"This number completes volume XV of *The Mineral Collector*. A brief look backward may prove interesting. In March, 1894, the first number was issued and in an introductory greeting, the purposes and hopes of the editors were presented. The purpose has been loyally carried out. The magazine has appeared regularly and with the best reading matter, advertisements, and general make-up that it was possible for its conscientious editor and publisher to obtain.

"The hope, as originally expressed, was that the fraternity would help by furnishing original copy and notes of interest. That the dealers would offer liberal patronage for the advertising pages, and that a majority of American collectors would become subscribers. This hope has been only partially filled.

"Mr. Benge and his fellow members of the Philadelphia Mineralogical Club have contributed many excellent articles. Mr. W. S. Valient was always helpful, and his enthusiasm was remarkable, and there were others who helped in like manner. But those collectors who were subscribers and who often criticised the magazine for not printing more original and scientific articles did not, when they had articles they wished published, send them to this magazine.

"The quantity of advertising has varied greatly. At times it has been large, interesting and compelling. Again it has slacked off to a few pages. At no time has it paid the publisher more than the cost of composition and paper.

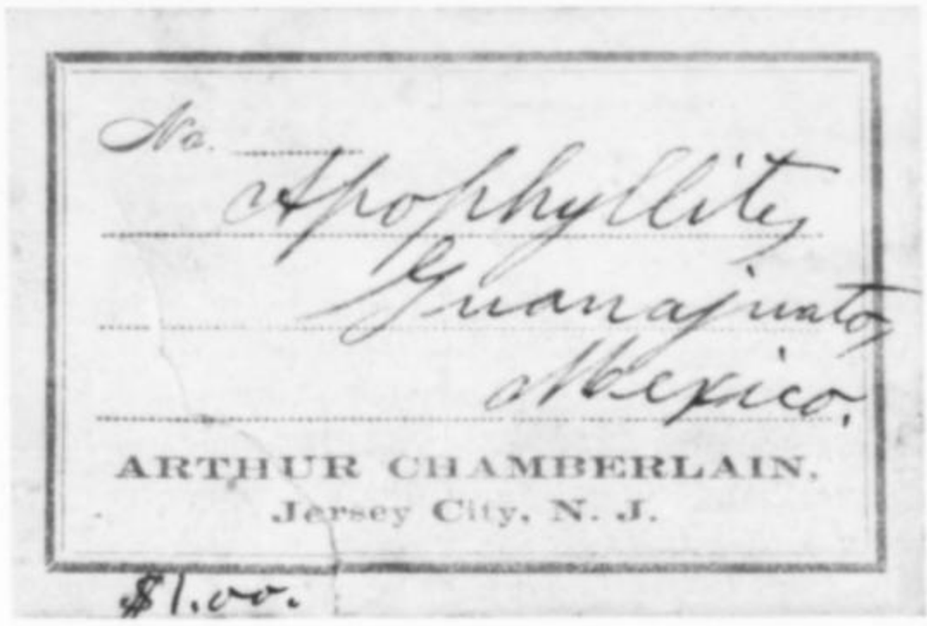

Figure 6. **A label from the personal collection of Arthur Chamberlain, editor of *The Mineral Collector*.**

"The great hope was reposed in the subscription list, and that never materialized sufficiently to make the magazine pay its way. And this was a result, not of too small an army of collectors, nor of a fault in the magazine, but of that indifference peculiar to and so often evidenced by collectors of any or everything.

"And now it may be asked, how has the magazine been carried on under such conditions all these years — the answer is easy to give — by what Drummond calls the greatest thing in the world — love. Hence is introduced to you the editor: a five-foot-one bundle of American energy. By trade a printer. A collector of minerals from boyhood — quiet, loyal and conscientious. He loves his profession and minerals and many other good things. He has kept *The Mineral Collector* going for sheer love of what it meant to him. He has not uttered a word of complaint from any cause at any time; he thinks he has none to make. And so on this, the fifteenth anniversary of *The Mineral Collector*, let us stand and drink a silent toast to Mr. Arthur Chamberlain."

Thus we have seen the birth of a mineral magazine out of one man's enthusiasm and love of his hobby, and its death not through lack of that love but of interest on the part of his fellow hobbyists. Since then there have been many parallels. But if it is true that we can learn from history, let's take a lesson from the historical record and work together to make sure that our own magazine, the *Mineralogical Record*, celebrates many more than 15 anniversaries.

Microminerals

by Violet Anderson

At one time, say about the first of February, I thought that the Tucson Show might make a proper beginning of the column to be written for this issue of the magazine. By now I believe that no one but a very elaborate octopus with ten lives in every arm could manage Tucson. This year there must have been five hundred independent dealers spread over ten or twelve Tucson motels (more or less) besides the dealers who had their booths in the main showroom. Days went by in a constant running from room to room, with little time to remember at any particular moment why one had started out or where one was going. Among the amusing sidelights of all this was the label some wag had written for a magnificent forgery of a specimen anonymously donated to the Saturday night auction in support of the *Mineralogical Record:*

------*ITE* * **

Paragenesis: Rock Currier's worst nightmare. Locality: Scraped off the bottom of a New York garbage scow.

* *Note rare dendritic boleite with red beryl on shattered and useless tourmaline with minor scheelite on a superb partially pseudomorphosed gold and bland colored Pectin matrix — only slightly used and hardly repaired.*

***This specimen is wanted by the Smithsonian — they've offered a reward to have it destroyed before it is donated to them.*

Tucson is like that. But, of course, Tucson is many things. It is a rich source of many of the most beautiful minerals in the world, and even a micromounter may find treasures.

My gratitude goes out to the many people there who directed me to where microminerals could be found, and to those others who asked "Have you got a piece of ...? Here, take this."

One could write a whole column on Tucson events, including purchases made (such as the oddly attractive wulfenite covered with drusy quartz, perhaps half replaced by quartz, from the Barking Spider mine, Gila County, Arizona, which Jim and Joyce Vacek were selling with such zest), and end up with a description of Tucson highjinks at the Saturday night auction when the light-headed side of being a mineral collector (or dealer) had a chance to express itself. But I regret I do not have the skills of the elaborate octopus and must leave Tucson at this point. Readers are referred back to Wendell Wilson's *What's New in Minerals?* column in the previous issue of the *Record*.

My "Correction of Error" department must be used here. I described vuagnatite in the California issue as greenish and botyroidal. The vuagnatite crystals on the small specimen I had at that time were very poor and I bypassed them as mere matrix (unstudied) for the greenish mineral on the top which, of course, had not been labeled.

One piece of information I want to hand on to you, before delving into the core of this column, is that Sharon Cisneros (Mineralogical Research Co.), a one-time micromount dealer, continues to sell the plastic boxes which are part and parcel of being a micromounter. Plastic boxes are not always easy to buy in small quantities, which is what Sharon can make possible for you. Note her advertisement in the *Record*.

And now, about that core.

Recently I have had occasion to become entangled with the minerals of the Jeffrey mine, Asbestos, Quebec, arising from a letter sent me by Joe Rothstein of the New York Mineralogical Club. One sentence particularly caught my attention: "Golly, that was the year we got the purple vesuvianite!"

How's that? Purple vesuvianite? I was reminded of that Ogden Nash verse beginning "I never saw a purple cow" etc. (One would have to think up a different ending.) At any rate, I began searching for my purple cow, in some danger of becoming one, sad-eyed with failures, tantalized by bits and pieces of broken purple mineral, no terminations, no clear forms, until Cynthia Peat produced a pretty pair of specimens from her own collection. Her vesuvianite (idocrase) is more nearly pink than purple, but it's the same mineral without a doubt — and I had my chance to photograph it. I decided then that Asbestos, Quebec, might well be worth writing about (it is not unnewsworthy today in many ways).

But from there it was something of a leap into the geology of the Asbestos area, for if the purple vesuvianite was difficult to find, the Asbestos geology was almost too complex to grasp. With the help of Fred Wicks of the Royal Ontario Museum, and of papers by Peter Riordon, Roger Laurent, and Robert Lamarche, the mountain of my confusion has managed to bring forth a small mouse as introduction to the Jeffrey mine minerals which, of course, are the primary concern here.

The Jeffrey deposit is near the southwest end of a belt of somewhat similar formation running for about 55 miles from southwest to northeast, paralleling the St. Lawrence River on the southeastern side. This places the belt in the Notre Dame range of the Appalachians, in Richmond County, Quebec. The valleys cutting northwest across the belt probably indicate the location of faults which are the very important precursors of the mineralization.

Peridotite rock (largely olivine, with pyroxene, and a small amount of chromite), and its close relatives, dunite and harzburgite, are ultramafic rocks which were brought up from the mantle into the crust of the earth by gradual movement along the faults. The consequence was the cheek-by-jowl arrangement of peridotite with the gabbro, volcanic rocks, and the topmost sedimentary layers existing in the footwall of the fault. Herein lay many opportunities for the development of a variety of mineral species.

The peridotite arrived near the surface, riddled with many small fractures which were already allowing the serpentinization of the olivine. This propensity to fracture is of considerable importance. Meantime, also noteworthy were the larger fractures which contained irregular bodies of granite, quartz monzonite, and diorite. These rock bodies provided elements important to the formation of later minerals.

Other happenings produced other results. The peridotite sent forth relatively small intrusive bodies into the sedimentary rocks near the surface and, in the areas of contact, metamorphism occurred.

What was probably the most important aspect in all the movements going on was the inflow of abundant water, permitted by the faults. The serpentinization of olivine and pyroxene in peridotite requires considerable water; the pyroxene, under such attack, releases its calcium. Rodingite is formed, a calcium-rich rock made up chiefly of grossular and diopside. The opportunity for alteration that could result in the Jeffrey mine suite of minerals would now seem complete, with silicon, sodium, calcium, aluminum, magnesium, iron, and chromium all present.

But it was the serpentine mineral, chrysotile, forming within the fractured environment, developing veins in the tension cracks produced by faulting, which was the chief actor on the stage. In an environment most suitable to its fibrous habit of growth, it very nearly took over. The chrysotile asbestos proved to be economically valuable. Without it, no mining development would have taken place. Without a mine, no amateur mineral collectors on the scene, bypassing the asbestos, looking for the associated minerals. Behind commercial undertakings come straggling into an area the mineral collectors with bags, baskets, and

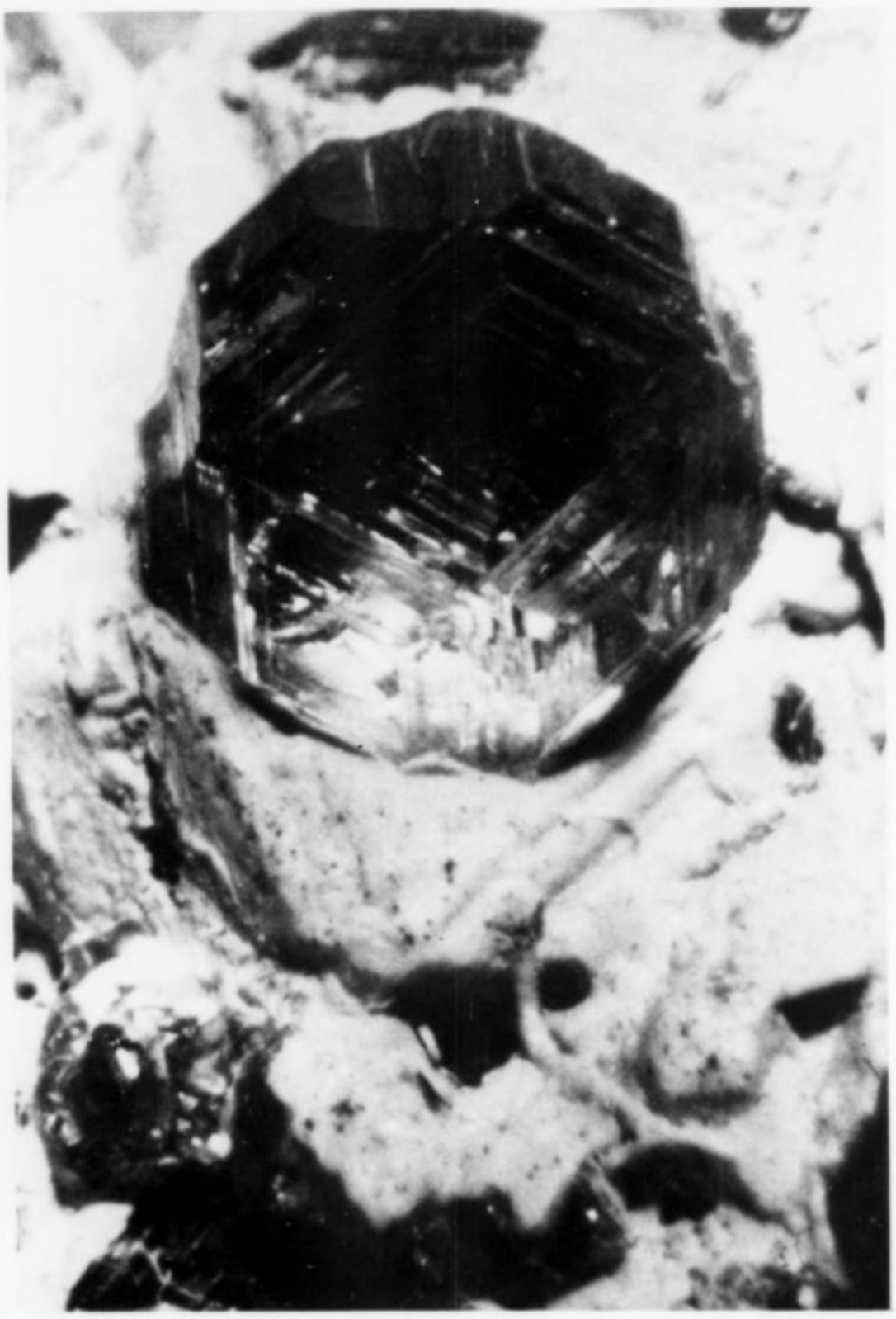

Figure 1. **Grossular of a rich amber color, on matrix, from the Jeffrey mine, Asbestos, Quebec. The crystal is about 5.3 mm across. Note the striations, which are the result of oscillatory dodecahedron and trapezohedron faces intersecting.**

hammers. We are like seagulls in a ploughed field, but I believe a good deal more useful.

Unfortunately, for the moment, no seagulls are welcome. The Jeffrey mine minerals must be obtained from past collectors who, as dealers, may be found in the small busy motel rooms at mineral shows. They may not restrict themselves to microminerals, but certainly Frank and Wendy Melanson of Hawthorneden (see their ad) have provided me with some little beauties. Also Bernard Borduas (2241 Trepanier, Vimont, Laval, Quebec, H7K 2A6), and the Horvaths (47 Bois Franc, Ste. Julie, Quebec, JOL 2C0); also Mike and Carol Ridding away off there with gems in Banff, but who I hope will never stop collecting minerals, since few have a better eye for a pretty specimen than Mike. I'm sure there are many others carrying Asbestos minerals, but who do not readily come to mind at the moment.

The **grossular** garnets of the Jeffrey mine are famous. The micromounter can look for them in colors of dark, rich green, pale green, clear as glass, clear with green chromite or black chlorite inclusions, pale pink, honey-colored and cinnamon. Gemmy green ones come pocketed in or perched on bright yellowish green diopside; clear ones come balanced on absolutely clear diopside; amber ones trail along white zoisite crystals. You find blond ones mingling with sparkling prismatic crystals of thomsonite, or almost hidden among plates of allanite. And the pink will mingle with great chunky diopside and look heavenly.

Figure 2. **White prehnite crystals 8.7 mm long from the Jeffrey mine, Asbestos, Quebec.**

Figure 3. **White pectolite crystal 8 mm long from the Jeffrey mine, Asbestos, Quebec. The specimen is in the collection of the Royal Ontario Museum, Toronto.**

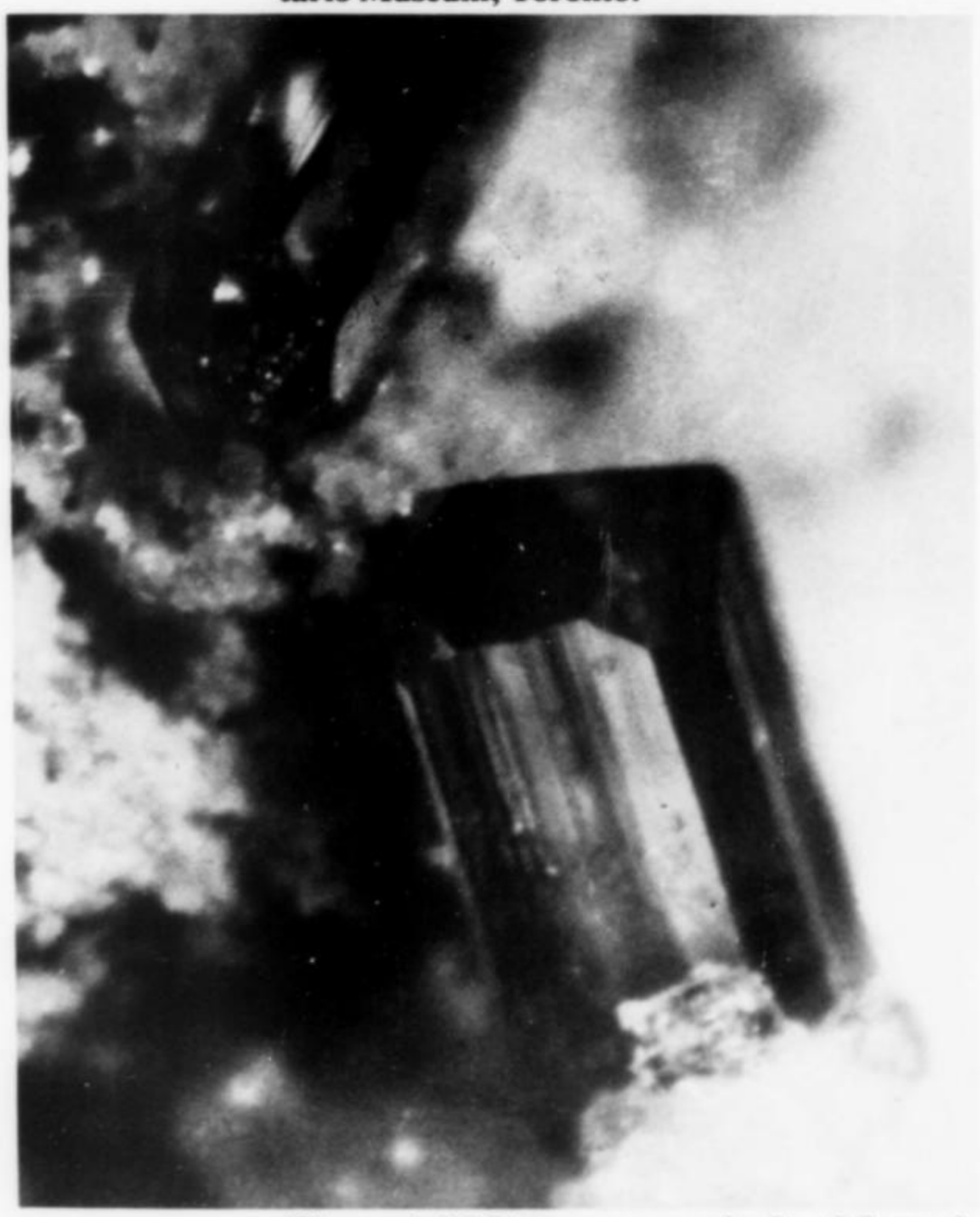

Figure 4. **Light brown vesuvianite, 3.7 mm in size, from the Jeffrey mine, Asbestos, Quebec. The specimen is from the collection of Cliff Vickery.**

The habit of the garnets is dodecahedral to trapezohedral. The amber to cinnamon *hessonite* variety is particularly prone to display beautiful striations, the signs of past battles for dominance between dodecahedral and trapezohedral forms.

The **allanite** mentioned above is notable for containing cerium or yttrium; the monoclinic crystals are tabular and almost black, very sharp as an environment for the rather rounded green garnets. **Zoisite** may make nice enough background for a scattering of lovely amber garnets, for it is strikingly white and striated along its length but, as a group, zoisite crystals jog off in every direction, their heads and tails absent. **Clinozoisite** is much more elegant, at least my crystals (via the Melansons) are. They too are long and white, but terminate sharply in an obviously monoclinic way. Clinozoisite forms a series with epidote, the latter having some iron in it which probably accounts for its dark green color. I have one specimen marked "clinozoisite" which is as dark as epidote. One never can tell.

But after the garnets it is a toss-up whether prehnite, pectolite, or vesuvianite make the most desirable specimens. Some of the **prehnite** crystals (orthorhombic) are stocky prismatic, with bipyramidal faces resembling the lower part of a mansard roof, or even a mere bevel, modifying pinacoid faces with some corners cut off by another pyramid face. But the really astounding crystals have very elongated bipyramids, no prisms obvious, and just the smallest of pinacoid faces if any. They are the cleanest cut prehnite crystals you could find.

The **pectolite** has several habits at Asbestos, but at its best is a classic triclinic shape, neat, large, and white. The crystals could be confused with albite of the same habit. However, the pectolite also appears in bunches of more acicular crystals, the most interesting being the so-called "bow-ties," since the crystals spring out in two opposite directions from a common center where some sort of intergrowth takes place.

Vesuvianite can be so pale a yellow as to be almost clear, or it is pale green. The Jeffrey mine also produces some large gemmy brown crystals, with much simpler tetragonal terminations than the paler varieties which often have many faces belonging to many different pyramids. The purple vesuvianite is something not as likely to come your way, as you may have gathered.

Diopside (monoclinic) can occur as mere needles to fine blades, behaving at times like a handful of jackstraws. In color, they are pure white, weakly gray or cream, yellowish or green, but the most noteworthy diopside of the Jeffrey mine (perhaps my prejudice) is the brilliant yellowish green, its crystals massed in something of a tangle, but still displaying some complete, monoclinic little shapes.

A distinctive opportunity for the micromounter lies in the **apophyllite** from the Jeffrey mine, which so rarely comes elsewhere in crystals small enough to be called micros. **Thomsonite** occurs in sparkling and well-defined prismatic crystals with blunt ends (it is an orthorhombic mineral). It can also occur looking stalactitic, each crystal tipped with a fine point. **Aragonite** (orthorhombic) again shows the long prismatic habit which appears spiky in some cases, but in others, under magnification, will show beautiful little domed terminations.

At least two more minerals should be mentioned: the green **clinochlore,** a mineral with foliated crystals, pseudohexagonal, and almost clear when it peels off into little scales, but quite dark olive-green when compacted. One finds it along with grossular garnets. **Ripidolite** is a close relative seen layered in dark green when the end of the somewhat elongated crystal is broken off. On the specimen I studied it was associated with the rich, dark brown vesuvianite.

Well, they're not exactly rare minerals, but they're worth collecting for the beauty of their habits and colors. And the one sulfide I have seen from there *is* rare: the nickel sulfide, **heazelwoodite,** which the *Encylopedia of Minerals* places only in the Canadian Yukon and Tasmania (Australia). It is found at Jeffrey mine, rich bronze in color, shaped something like a fan, not in any way revealing its trigonal nature to the eye any more than does the fan-shaped rhodochrosite from Silverton, Colorado, or the similarly shaped siderite from Nova Lima, Minas Gerais, Brazil.

So much for the Jeffrey mine, Asbestos, Quebec. Don't turn down anything from Black Lake or the collecting areas of Thetford mines to the northeast of Jeffrey. They have minerals similar to those of Asbestos.

I have not said anything about Helen Yedlin, and somehow I cannot let this column go without doing so. It seems so sad — first that big smiling man, and then the vivacious little lady — both gone. I can only add now that I think her going was something she wished not delayed. To be sick, and without Neal, was just too much.

It will take us a long time to stop looking for "the Yedlins" at the mineral shows.

Violet Anderson
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Mineralogical Notes

TEXASITE FROM COLORADO

by Wilson W. Crook, III
Mobil Oil Corporation
P.O. Box 5444
Denver, Colorado 80217

Texasite, $Pr_2O_2(SO_4)$, the only known rare-earth sulfate, was described as a new species by Crook in 1977 (see abstract in the *Record*, vol. 9, no. 1, p. 39). The type localities are two granitic pegmatites in the Barringer Hill rare-earth district, Llano and Burnet Counties, Texas. Associated minerals include gadolinite, allanite, yttrofluorite, rowlandite, bastnaesite, tengerite, behoite, and chlorine-bearing jarosite.

In January of 1978, the author began exploring in detail the mineralogy of the rare-earth mineral pegmatites of Jefferson County, Colorado. Known as the South Platte district, the region consists of over 75 complexly zoned rare-earth pegmatites. Many of these are well known for their superb crystals of the rare minerals gadolinite, allanite, bastnaesite, cyrtolite, thorite, samarskite, fergusonite, yttrofluorite, fluocerite, monazite, xenotime, and doverite (Haynes, 1965; Simmons, 1973). In addition, as a result of present research, the secondary minerals rowlandite, tengerite, and behoite have been identified from three of the district's pegmatites. More than forty species have been identified thus far in a continuing study by the author and others.

An examination of the Luster pegmatite, a granitic pegmatite in the South Platte group, revealed that sulfate-rich waters were precipitating jarosite in association with the weathering of primary rare-earth minerals. This is the same type of environment that produced texasite from the type localities. Specimens of the altering rare-earth minerals in direct association with jarosite were collected for microscopic investigation. This study revealed the presence of five crystal groups of texasite.

Colorado texasite is found as part of alteration crusts on primary cyrtolite and thorite. Associated minerals include biotite, perthitic microcline, and jarosite. Texasite is clearly secondary, and in close proximity to jarosite. The color of texasite is apple-green. The mineral occurs as minute (0.1-0.5 mm) prismatic crystals in radial stellate groups, and is easily distinguished by its euhedral form (Fig. 1), color, and association with jarosite. A summary of the mineral's physical characteristics is given in Table 1.

An electron microprobe analysis of Colorado texasite shows the mineral to be almost identical with type material from Texas (Table 2). As with type texasite, the Colorado specimens show a pronounced differentiation of the rare-earth elements, a phenomenon that is virtually unknown amongst the rare-earth minerals. The formation of texasite is believed to be due to a combination of the unique crystal chemical characteristics of the praseodymium ion and the abundance of sulfate-rich waters in the rare-earth weathering environment.

Table 1. Physical Properties of Texasite from Colorado

Crystal system: orthorhombic, $^2/m^2/m^2/m$
Hardness: 2½
Density: 5.769
Cleavage: {010}, perfect
Fracture: brittle
Color: apple-green
Luster: vitreous, translucent
Streak: pale green
Optics: biaxial (−), $\alpha = 1.826$, $\beta = 1.917$, $\gamma = 1.921$, 2V = 26-31°

The new occurrence of texasite establishes the fact that given the situation of weathering rare-earth minerals in contact with sulfate-rich ground waters (precipitating jarosite), there is a good chance that texasite will form. Rare-earth localities should be reinvestigated for the occurrence of jarosite and thus the possible presence of texasite. Thus far very little texasite has been found by the author at the Luster pegmatite. All that remains of the described specimens are three crystal groups about 1 by 0.5 by 0.5 mm and the mount that was prepared for microprobe analysis. The crystal groups have been deposited in the collections of the Denver Museum of Natural History.

Figure 1. **Apple-green texasite crystals to 0.13 mm in length, from the Luster pegmatite, Jefferson County, Colorado.**

Table 2. Microprobe analyses of texasite.

	Colorado[1]	*Texas*[2]	*Texas*[3]	*Ideal*
Pr_2O_3	80.06	80.87	80.36	80.47
La_2O_3	0.14	0.08	0.11	– – –
Ce_2O_3	0.27	0.03	0.03	– – –
Nd_2O_3	0.06	0.01	0.02	– – –
SO_3	19.61	19.16	19.89	19.53
TOTAL	100.14	100.15	100.41	100.00

[1]Luster pegmatite, Jefferson County, Colorado.
[2]Clear Creek pegmatite, Burnet County, Texas.
3Rode Ranch pegmatite, Llano County, Texas.

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CHALCANTHITE FROM THE HELVETIA DISTRICT, ARIZONA

by George Robinson
387 Division Street, Apt. 310
Kingston, Ontario,Canada K7K 4A6

Chalcanthite in fine specimens has recently been found in the Santa Rita Mountains of Arizona. The discovery was made by two Tucson mineral collectors, Roland Moore and Charles Van Meter, while collecting in one of the many abandoned mines in the Helvetia district, about 40 miles south of Tucson. The name of the specific mine has not been determined.

Chalcanthite has long been a subject of debate as to its status as a naturally-occurring mineral in many mines. Chalcanthite is commonly formed from mine water, precipitating on mine walls and water-filled pits (or, worse yet, deliberately manufactured in someone's basement). Some have argued that any substance which crystallizes as a result of mining activity is not "naturally formed" and therefore not a mineral.

The Helvetia chalcanthite specimens appear to be truly naturally formed. The mineral occurs in vuggy portions of a small vein of chalky turquoise, where it forms ram's-horn growths to 10 cm in length and of a deep blue color. The chalcanthite is typically found on a matrix of limonite and jarosite. Other associated minerals include very minor antlerite and gypsum. The entire mine drift and the rocks in the immediate vicinity appear to be far above the water table and were completely dry at the time of examination. No secondary mineralization of any kind had formed on surfaces produced by mining. Thus these chalcanthite specimens appear to have formed independent of, and apparently prior to, mining activity.

Figure 1. **Chalcanthite from the Helvetia mining district, Santa Rita Mountains, Arizona. The specimen is bright blue and measures 5 by 7 cm. George Robinson specimen; E. Fernando photo.**

The extent of the vein was relatively limited, yielding about four flats of specimens. Nevertheless, the specimens are very well-formed and attractive, and represent some of the best naturally-occurring chalcanthite known. The chalcanthite was found in a very dry environment,

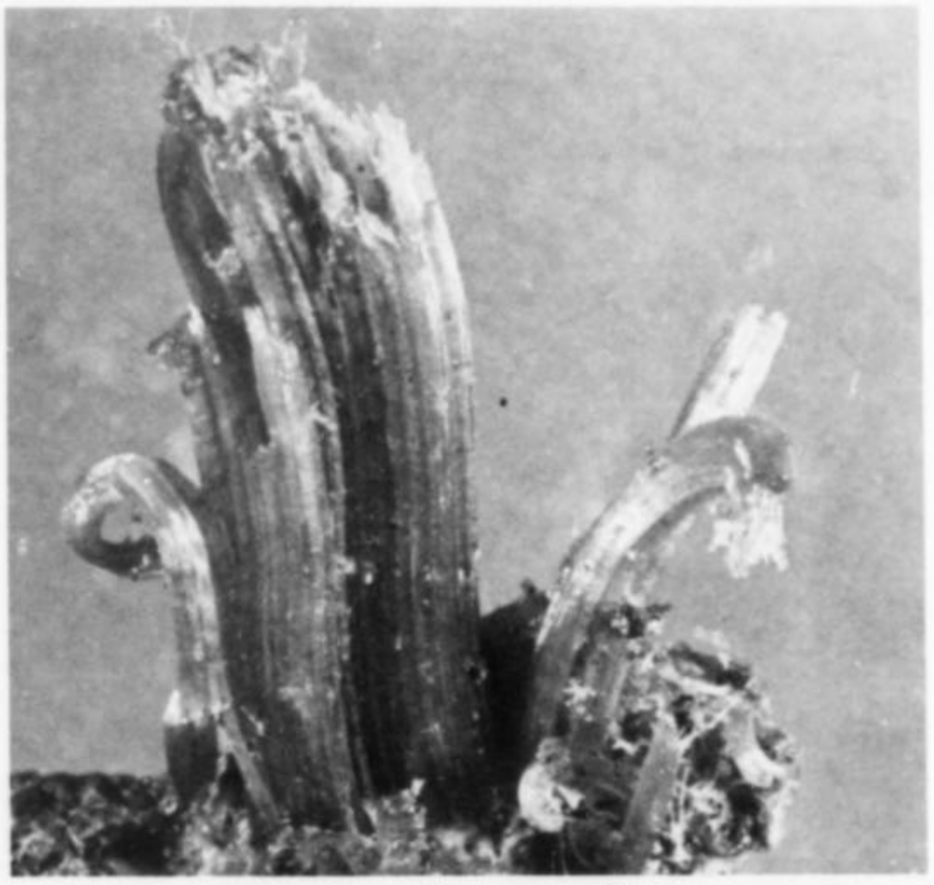

Figure 2. **Chalcanthite from the Helvetia mining district, Santa Rita mountains, Arizona. The specimen is bright blue and measures 4 by 4 cm. George Robinson specimen; E. Fernando photo.**

and appears to be stable outside of the mine, unlike chalcanthite from some other localities which has been known to begin disintegrating (probably because of loss of water) within a period of days or weeks.

ILVAITE—A NEW COLORADO OCCURRENCE

by Henry A. Truebe
Department of Geosciences
University of Arizona
Tucson, Arizona 85721

North Pole basin is a large cirque on the northeast side of Treasury Mountain, in the Snowmass Mountain Quadrangle, Colorado. In the summer of 1976, several specimens showing lustrous, black, prismatic crystals were found in talus entering the extreme western part of the basin.

The crystals were tentatively identified as augite or schorl. The specimens were then sent to the Denver Museum of Natural History for verification and addition to their reference collection. The mineral was identified there by Jack Adams, and found to be ilvaite, Colorado's only verified occurrence. Eckel (1961) notes an occurrence of ilvaite in Gilpin County which was first reported, but not described in detail, by a nineteenth century author. In this note we will document the new occurrence at North Pole basin.

LOCATION

All ilvaite found to date has been float, in talus spilling into a small gulch at the head of North Pole basin. In the fall of 1977, this float was traced up the gully to an elevation of 12,950 feet. At this point the verglas (ice coating) and fresh snow prevented further upward progress. The gully extends to a peak at 13,407 feet, so the in-place occurrence must be within 457 feet of the peak. This location can be precisely described as within 100 m of a point 2.70 km northwest of 39°N, 107° 5'W, and 2.86 km northeast of 39°N, 107° 7.5'W.

GEOLOGY AND MINERALOGY

The geology of the locality is best shown by Mutschler (1970). The ilvaite occurrence is in metamorphic rocks of the Belden formation: limestone, chert limestone and dolomite, interbedded with carbonaceous shale. A section on Mutschler's map shows that the locality is within 490 m of the approximate contact between the Paleozoic sediments and the granite of the Treasure Mountain laccolithic dome (K-Ar dated at 12.4±0.6 million years, Obradovich, et al., 1969). In this vicinity the Belden formation has been converted to Ca-silicate hornfels and marble, but retains its gross sedimentary layering.

Most of the ilvaite is in fine-grained (less than 1 mm) aggregates containing small amounts of interstitial quartz. In the field the rocks

develop a dull coating of manganese oxides and must be fractured to reveal the coal-black, sub-metallic luster of the ilvaite. The ilvaite shows euhedral crystals only where it is in contact with quartz; also, the size of the ilvaite crystals (to about 5 mm) is related to the abundance of quartz. Other associations include yellow garnet and a pale green, fibrous amphibole.

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OBRADOVICH, J. D., MUTSCHLER, F. E., and BRYANT, B. (1969) Potassium-argon ages bearing on the igneous and tectonic history of the Elk Mountains and vicinity, Colorado: a preliminary report. *Geological Survey of America Bulletin*, **80**, 1755-1762.

ABSTRACTS

NEW MINERALS

We continue here to present abstracts of the descriptions of new species recently published, which have not been previously included in Fleischer's *1975 Glossary of Mineral Species* or subsequent updates thereto *(Mineralogical Record*, **7**, 91-95, and **8**, 398-399).

Zektzerite

$LiNa(Zr,Ti,Hf)Si_6O_{15}$ Orthorhombic

From the Golden Horn batholith near Washington Pass, in southwestern Okanogan County, Washington; colorless to pink, sometimes color-zoned; luster pearly on the {100} face; hardness (Mohs) about 6; cleavage parallel to {100} and {010}, both perfect, with a vitreous luster on cleavage and fracture surfaces; translucent to fully transparent; white streak; density 2.79 g/cm^3 (measured), 2.80 g/cm^3 (calculated); typical crystals are from 4 to 15 mm in size, but the largest known crystal measures 15 by 35 by 37 mm; the dominant forms are {100}, {010} and {011}, and most crystals are tabular on {100} while maintaining a somewhat blocky appearance; fluoresces light yellow in shortwave ultraviolet radiation; no twinning noted; found in less than 50 miarolitic cavities (of thousands searched) in a riebeckite granite, the cavities generally measuring 2 to 10 cm but as large as 9 by 42 cm; associated with microcline, smoky quartz, well-formed riebeckite crystals to 3 cm, zircon, quartz, chlorite, sericite, calcite, fluorite, allanite, stilbite, bastnaesite and loellingite; possibly structurally related to tuhualite and sogdianite; named in honor of Jack Zektzer of Seattle, Washington, who first submitted the mineral for analysis; pronunciation: zeḱ-ter-ite. *(W.E.W.)*

DUNN, P. J., ROUSE, R. C., CANNON, B., and NELEN, J. A. (1977) Zektzerite: a new lithium sodium zirconium silicate related to tuhualite and the osumilite group. *American Mineralogist*, **62**, 416-420.

Christite

$TlHgAsS_3$ Monoclinic

From the Carlin gold deposit, 50 km northwest of Elko in north-central Nevada; color grayish white in reflected light, but in transmitted light it appears crimson or deep red, varying to bright orange in thinner plates and crystals; luster adamantine; hardness (Leitz indentation) 31.5 kg/mm^2; cleavage perfect on {010}, excellent on {110} and {001}, good on {$\bar{1}$01}; translucent; streak bright orange; density 6.2(2) g/cm^3 (measured), 6.37 g/cm^3 (calculated); as imbedded grains to 0.25 mm; usually lacks well-developed forms although the habit of some grains is somewhat bladed or flattened; synthetic crystals are tabular on {010} with {010} and {$\bar{1}$01} pinacoids dominant; in small, mineralized veinlets and seams along bedding planes in silty carbonaceous dolomite — the Carlin gold deposit is the largest disseminated replacement-type gold deposit in North America; associated with pyrite, gold, lorandite, realgar, orpiment, barite and getchellite; chemically related to routhierite [(Tl,Cu,Ag)(Hg,Zn)(As,Sb)S_3]; named in honor of Charles L. Christ of the U.S. Geological Survey; pronunciation: krĭst-ite. *(W.E.W.)*

RADTKE, A. S., DICKSON, F. W., SLACK, J. F., and BROWN, K. L. (1977) Christite, a new thallium mineral from the Carlin gold deposit, Nevada. *American Mineralogist*, **62**, 421-425.

Schoonerite

$ZnMn^{+2}Fe_2^{+2}Fe^{+3}(OH)_2(H_20)_7(PO_4)_3 \bullet 2H_20$ Orthorhombic

From the Palermo #1 pegmatite near North Groton, New Hampshire; pale tan to brown to reddish brown, passing into coppery tones in oxidized material; hardness about 4; cleavage perfect on {010}, good on {001}; transparent to translucent and turbid; streak pale brown; density 2.87(4) (measured), 2.79 g/cm^3 (calculated); occurs in minute quantities, scales rarely exceeding 50μ, and as isolated laths and bunches of flattened straw-like aggregates up to 2mm in length; forms observed are {001}, {010} and {100}; thin tabular parallel to {010} and elongated parallel to [100]; a late-stage, low temperature mineral found in phosphate pods in pegmatite; associations include siderite, mitridatite, jahnsite, whitmoreite, laueite, ludlamite, messelite, vivianite, triphylite, sphalerite, hydroxylapatite, childrenite, arrojadite, rockbridgeite and quartz; structurally related to montgomeryite; named in honor of Richard Schooner of Woodstock, Connecticut, lifelong collector and student of New England minerals and mineralogy. *(W.E.W.)*

MOORE, P. B., and KAMPF, A. R. (1977) Schoonerite, a new zinc-manganese-iron phosphate mineral. *American Mineralogist*, **62**, 246-249.

Downeyite

SeO_2 Tetragonal

From Glen Lyon, near Williamstown and near Shamokin in the anthracite region of eastern Pennsylvania; colorless, however some crystals appear red from bright red inclusions of amorphous selenium, and others from a dusting of sulfur; luster adamantine; hardness, cleavage and specific gravity not determined; transparent; density 4.146 g/cm^3 (calculated); individual crystals from 0.1 mm to 2 cm in length; long prismatic to acicular, sometimes with very steep pyramidal terminations; elongated parallel to [001]; possible contact twinning; non-fluorescent; extremely hygroscopic (i.e. draws water from the air and dissolves itself), breaking down in a few minutes in normal atmosphere; storage in dessicator required for preservation; associated with selenium, sulfur, mascagnite, and unnamed minerals; forms from gases escaping through vents in actively burning anthracite culm banks; material previously called *selenolite* has proven to be inadequately described and probably not SeO_2, therefore the authors suggest the name selenolite be reduced to synonymy with the preferred name, downeyite; named in honor of Wayne F. Downey who, as a high school student in Harrisburg, Pennsylvania, first attempted to collect downeyite, recognized its hygroscopic instability, and then successfully preserved samples in an improvised dessicator which were sufficient for subsequent characterization; pronunciation: dŏw-nē-ite. ***(W.E.W.)***

FINKELMAN, R. B., and MROSE, M. E. (1977) Downeyite, the first verified natural occurrence of SeO_2. *American Mineralogist*, **62**, 316-320.

Liottite

$(Ca,Na,K)(Si,Al)O_{72}(SO_4)_{3.91}(CO_3)_{1.72}Cl_{2.61}(OH)_{3.58}\bullet 1.83H_2O$ Hexagonal

From the Latera caldera, Pitigliano, Tuscany, Italy; colorless; hardness 5 (Mohs); luster and cleavage not determined; transparent; density 2.56 g/cm^3 (measured); crystals are well-developed, flattened hexagonal prisms up to 1.0 cm in diameter; forms observed include the prisms {110} and {100}, pinacoid {001}, pyramids {101}, {102}, {103}, {104}, {203} and {111}, also less commonly {120}, {121}, {112} and {113}; formed in vugs in ejected pumice blocks; associated with vesuvianite, grossular, andradite, pyroxene, melilite, latiumite, anorthite and brandisite; chemically and structurally related to minerals of the cancrinite-vishnevite-davyne series; named in honor of Luciano Liotti, enthusiast and well-informed collector, who provided the specimens on which liottite was first found. *(W.E.W.)*

MERLINO, S., and ORLANDI, P. (1977) Liottite, a new mineral in the cancrinite-davyne group. *American Mineralogist*, **62,** 321-326.

Buchwaldite

$NaCaPO_4$ Orthorhombic

Found as minute inclusions within troilite nodules in the Cape York iron meteorite; colorless, transparent; hardness perhaps less than 3 (Mohs); density 3.21 g/cm^3 (calculated); from less than 10 μm to 40 μm in size, as polycrystalline masses of compact, interlocking fine needles; one platy cleavage or parting; associated with troilite, chromite and other, apparently new, phosphate phases; named in honor of Vagn Buchwald, of the Department of Metallurgy at Danmarks Tekniske Højskole, Lyngby, Denmark, because of his major contributions to the understanding of iron meteorites over the past decade. *(W.E.W.)*

OLSEN, E., ERLICHMAN, J., BUNCH, T. E., and MOORE, P. B. (1977) Buchwaldite, a new meteoritic phosphate mineral. *American Mineralogist*, **62,** 362-364.

Sekaninaite

$(Na,Ca)(Fe,Mg,Mn)(Al,Fe,Si)Al_2Si_4O_{18}\bullet O.67H_2O$ Orthorhombic

From near Dolni Bory, western Moravia, Czechoslovakia; color blue to violet-blue; luster vitreous; hardness 7 to 7½; imperfect cleavage on {100}, parting on {001}; density 2.77; as poorly developed crystals to 70 cm in size; usually twinned on {110} and {310}, simulating hexagonal symmetry; sekaninaite is the iron analog of cordierite; occurs in the albite zones of pegmatites in granulites and gneisses; named in honor of Josef Sekanina, who first found the mineral in 1928.

STANEK, J., and MISKOVSKY, J. (1975) Sekaninaite, a new mineral of the cordierite series, from Dolni Bory, Czechoslovakia. *Scr. Fac. Sci. Nat. Ujep Brun., geol.*, **1,** no. 5, 21-30.

Slavyanskite

$CaAl_2O_4\bullet nH_2O$ Tetragonal

From a drill core in a zone of tectonic breccia, amidst the Adamovskii Upper Devonian salt stock of the Slavyansk salt cupola, southeastern Dneprovsk-Donets basin, Russia; colorless; hardness 4 to 5; distinct cleavages on {100} and {110}; transparent; density 2.52; crystals 1 to 2 mm in size; forms include pinacoid {001}, pyramid {101}, and prism {110}; associated with quartz, pyrite, dolomite, calcite, dawsonite, anhydrite, sphalerite and others; named for the locality.

DOLISHNII, B. V. (1977) [Slavyanskite, a new mineral]. *Zapiski Vsesoyuzni Mineralog. Obshchestva*, **106,** 331-335 (in Russian).

INTERESTING PAPERS in other journals

selected by
the *Record* Editorial Board

The surface of Mars
(ARVIDSON, R. E., BINDER, A. B., and JONES, K. L. (1978) *Scientific American*, **238,** #3, 76-89.)

Kimberlite pipes
(COX, K. G. (1978) *Scientific American*, **238,** #4, 120-132.)

Classification and nomenclature of the pyrochlore group
(HOGARTH, D. D. (1977) *American Mineralogist*, **62,** 403-410.)

In a cavern...
HUIZING, M. (1977) *Lapidary Journal*, **31,** 1340-1347.)

On the turquoise deposits of Nishabur (N.E.) Iran)
(MANUTCHEHR-DANAI, M. (1977) *Gems and Gemology*, **15,** 315-319.)

Mineralien aus dem Pegmatit von Hagendorf
(MUCKE, A., (1977) *Der Aufschluss*, **28,** 353-358.)

Copper minerals from Bali Lo copper mine, Ashburton Downs, Western Australia
(BRIDGE, P. J., and PRYCE, M. W. (1978) *Australian Mineralogist*, #14, 69-70. Published within *Australia Gems & Crafts*, #27.)

Baveno (Lago Maggiore, Italy)
(GRAMACCIOLI, C. M. (1978) *Lapis*, **3,** #2, 5-11.)

Rockhound wheels (a review of the 1978 field vehicles)
(LAWLOR, J. (1978) *Rock & Gem*, **8,** #5, 74-75.)

Surface structures of some trigonal bipyramidal faces of natural quartz crystals
(JOSHI, M. S., and PAUL, B. K. (1977) *American Mineralogist*, **62,** 122-126.)

Geologic history of Montana agate
(LONGHURST, R. A. (1977) *Lapidary Journal*, **31,** 1404-1412.)

The role of dislocations in regeneration of natural quartz crystals
(ASKHABOV, A. M., and BUKANOV, V. V. (1976) *Doklady Akad. Nauk SSSR* Earth Science Sections, **228,** 114-117.)

Minerals found in fossils: a literature survey
(SIMON, R. L. (1978) *Rocks and Minerals*, **53,** 16-24.)

Morphology of magnetite and pyrite crystals as an indicator of conditions of recrystallization of magnetite ore
(VELIKOBORETS, T. A. (1976) *Doklady Akad. Nauk SSSR* Earth Sciences Section, **227,** 128-131.) (In English)

Scandium in the wolframites of the Bohemian Massif and its genetic significance
(NĚMEC, D. (1977) *(Chemie der Erde*, **36,** 218-221.)

The official mineral collection from the Gotthard-Strassentunnel-Nord
(STALDER, H. A., and LUSSMANN, L. (1977) *Mineralienfreund*, **15,** 97-120.) *(In German)*

Mineral photography — possibilities and limitations
(MÜLLER, E. (1978) *Mineralien Magazin*, **2,** #1, 6-12.) (In German)

(A full issue devoted to zeolites and their localities)
((1978) *Lapis*, **3,** #1.) (In German)

News from the ROM

by
Robert I. Gait
Department of Mineralogy and Geology
Royal Ontario Museum
100 Queen's Park
Toronto, Canada M5S 2C6

The Department of Mineralogy and Geology has recently been involved with the R.O.M.'s Extension Services Department in the production of a traveling school case entitled *More than Meets the Eye: An Introduction to Minerals*, and a traveling exhibition of color photomicrographs called *More than Meets the Eye: Minerals through the Microscope*. The traveling exhibit, mounted on an Expo System, is composed of introductory panels which describe and illustrate some of the basic principles of mineralogy and provide an introduction to the basic component of the show — a selection of photomicrographs taken by Violet Anderson, a Research Associate in the Department of Mineralogy and Geology. She is well-known to readers of the *Mineralogical Record* for her column on microminerals, and many groups of mineral collectors have enjoyed her beautifully illustrated talks. The show is introduced by three, three-dimensional panels that include mineral specimens and are useful in helping the beginner understand basic questions such as "What is a mineral?", "What are crystals?" and "What is a photomicrograph?" The last question is answered by a panel which contains a mineral specimen, a micromount made from that specimen, several small color prints of the tiny crystals photographed at different magnifications and the final photomicrograph enlarged to optimum size and taken at optimum magnification. In total there are 22 brilliantly colored prints of Violet Anderson's work.

To capitalize on the research and work required to produce the show, two very similar ancillary exhibits have also been made, one of medium size containing 14 color prints and a small one containing 7 prints. All three will be circulated to community centers, libraries, and small museums throughout the province of Ontario. Pamphlets are provided at each showing which give the visitor background information about some of the minerals shown in the photomicrographs.

The school traveling case *More than Meets the Eye: An Introduction to Minerals*, was designed so that teachers and students could learn about mineralogy by actually handling mineral specimens. There are 48 mineral specimens in the case, as well as hand lenses, magnets, streak plates, contact goniometers and other equipment, so that students can perform simple physical tests on the minerals and learn ways to identify and classify them. Teacher's notes, student activity sheets, a set of slides, a suggested film list, and a bibliography are among the background materials included with the case. The most important teaching aids are the "student action cards," poster-sized boards that describe and illustrate the various physical tests and help students to follow the simple steps needed to do the tests correctly.

The case also includes a tray of artifacts, mounted under Plexiglass, that illustrate some of the cultural uses of minerals throughout history. Among the objects displayed are two Ch'ing dynasty jade carvings, an Islamic necklace with amethysts, an intaglio Roman seal made from chalcedony, carnelian amulets from ancient Egypt, and some prehistoric flint and jasper arrowheads. A few faceted stones are included in the main section of the case and these can be compared with natural crystals of the same materials.

The case has been tested and monitored in actual use and the results have been most satisfactory. The students enjoy the experience, the teachers are pleased to have real materials to use, and the damage or loss of specimens has been minimal. More of these cases are now being prepared and will be circulated through Ontario schools.

The Department of Extension Services at the Royal Ontario Museum will be pleased to furnish further details of these teaching cases to any institutions or schools.

The circulation of R.O.M. exhibits and school cases by the Department of Extension Services is made possible through funding by the Ontario Ministry of Culture & Recreation, and the National Museums of Canada.

The Record Bookshelf

***Salzburg Mineralogical Handbook*, by Albert Strasser. Strasser Publishing Co., Schwalbenstrasse 32, A 5023 Salzburg, Austria; 221 pages plus 8 fold-in area maps; 4 by 6 inches, hardcover. Price not given. (In German but most of the words are either mineral names or brief indication as to exact collecting area.)**

This pocket booklet would be most useful for American collectors planning to visit the Salzburg district of Austria. The author, who owns a book binding company, was most cordial and helpful when I visited him on several trips. The text indicates that a large number of the minerals tabulated can only be found as micromounts, but that surely could be anticipated in such a densely populated part of the world where mineral collecting has long been a popular hobby. There is also a fine small collection of minerals of the area in the Natural History Museum in Salzburg.

Sections D,E, and F of the booklet would probably have little value for the American collector since they do not deal with the minerals of the area but contain general mineral data and a glossary of minerals as of 1975.

Section B contains maps of 20 small regions, each as large as 10 by 20 kilometers, showing numerous localities in each region. These maps and the short explanations of the minerals to be found constitute the real usefulness of the booklet for American collectors. However, pinpointing the collecting sites appears to require additional local knowledge. Collectors who can make themselves understood in German should be able to make local inquiries in the little villages in order to reach the exact sites.

Curt G. Segeler

***Zauberwelt der Mineralien*, text by Harry Wilk, 110 color photos by Olaf Medenbach. Published by Sigloch Edition, P.O. Box 89, D-7118 Künzelsau, West Germany; 205 pages, 10½ x 12 inches; (1977); hardcover, $34 (includes postage) (5 copies, $30.50 each; 10 copies, $29.25 each; 20 copies, $28.60 each). (In German.)**

Many of the world's best mineral photographers have published their work in at least one excellent volume. Werner Lieber (*Kristalle Unter der Lupe*), Nelly Bariand (*Le Monde Merveilleux des Mineraux*), Julius Weber (*Encyclopedia of Minerals*), Lee Boltin (*The Mineral Kingdom, Color Underground*), and others have all had their opportunity. Now Olaf Medenbach, probably the youngest of the group, checks in with a veritable masterpiece. *Zauberwelt der Mineralien* contains 110 color mineral photos which represent Medenbach's finest work. His way with lighting, feel for drama and composition, and technical competence with the view camera are all evident. Most of the specimens chosen are superb, and some are reproduced as large as 10½ x 20 inches, possibly the largest and finest reproductions ever published in a mineral book. The publisher appears to have spared no expense in the quality of color separations, paper and printing. The binding is in sewn signatures (rather than cut off and glued), and so should last a long time.

The text by Harry Wilk is interesting, providing such information as one might find in a variety of other mineral books, but nevertheless well-chosen. Still, the text is more or less filler used to complement the magnificent photos.

All things considered, the price is not excessively high, and the quantity discounts are encouraging. Despite the German text, this book is highly recommended to anyone desiring a fine mineral picture book, whether for themselves or as a gift.

W.E.W.

***DIG IT! A Directory of Fee-Basis Rock Collecting Sites Open to Amateurs*, by Carol E. Kindler; published by Carol E. Kindler, P.O. Box 12328, Philadelphia, Pennsylvania 19119. Third edition (1978), 21 pages, 8½ x 11 inches (no cover), $3.95.**

This listing includes 238 sites open to collectors on a fee basis, and also lists the minerals that can be found there. Localities in Alaska (3), Arizona (5), Arkansas (7), California (20), Colorado (4), Connecticut (4), Georgia (10), Hawaii (1), Idaho (6), Illinois (1), Maine (7), Maryland (1), Massachusetts (1), Michigan (2), Minnesota (1), Missouri (3), Montana (6), Nevada (6), New Hampshire (6), New Jersey (1), New Mexico (9), New York (11), North Carolina (30), Ohio (4), Oklahoma (5), Oregon (24), Pennsylvania (3), South Dakota (4), Tennessee (3), Texas (26), Utah (2), Virginia (8), Washington (7), West Virginia (1), Wisconsin (1), and Wyoming (5) are included. Thirty sites now closed to collecting are also listed. Addresses, hours and fees are included with most of the listings. The majority of the localities produce lapidary material and fossils, although many bona fide mineral localities are included as well.

W.E.W.

***Atlas des Mineraux Metalliques*, by P. Picot and Z. Johan; Memoire B.R.G.M. no. 90. Published by the Bureau de Recherches Geologiques et Minieres (BRGM), B.P. 6009, 45018 Orleans Cedex, France. Hardcover, 8½ x 8½ inches, 403 pages; (1978), $64.00 (In French.)**

A superb reference for the identification of metallic minerals in polished section using the reflecting microscope. Several hundred excellent photomicrographs, most in full color, serve to illustrate the descriptions of 350 metallic species. Each description covers colors, anisotropy, textures, associations, localities and criteria for determination. Highly recommended for anyone working with metallic minerals in polished sections.

W.E.W.

OTHER TITLES RECEIVED

***Color Encyclopedia of Gemstones*, by Joel E. Arem. Published by Van Nostrand Reinhold, 450 West 33rd Street, New York, New York, 10001. Hardcover, 8½ x 11 inches, 147 pages text, 64 pages of color photos (1977), $35.00.**

***Mineral and Gem Localities in Arizona*, by Lee Hammons. Published by Arizona Maps and Books, P.O. Box 1133, Sedona, Arizona. Softcover, 7 x 10½ inches, 112 pages, 30 color maps, 667 localities listed (1977), $5.95 plus 30¢ postage.**

***Gems and Minerals of Washington*, by Lanny Ream. Published by Jax Products, 1550 Union Avenue NE, Renton, Washington 98055. Softcover, 5½ x 8½ inches, 202 pages, 25 maps, 69 specimen photos, 21 locality photos, 137; (1977), $5.95.**

The Young Rockhound's Handbook, by W. R. C. Shedenhelm. Published by G. P. Putnam's Sons, 200 Madison Avenue, New York, New York, 10016. Hardcover, 6 x 8 inches, 128 pages; (1978), $6.95.

The Moon Book, by Bevan M. French. Published by Penguin Books, 625 Madison Avenue, New York, New York 10022. Softcover, 5 x 8 inches, 287 pages; (1977), $4.95.

Gemstones of the World, by Walter Schumann. Published by Sterling Publishing Company, Two Park Avenue, New York, New York 10016. Hardcover, 5 x 8 inches, 256 pages, 87 full-page color plates, over 1400 specimens (natural and cut) illustrated; (1977), $12.95.

Zinc and Lead Occurrences in Pennsylvania, by Robert C. Smith II. Mineral Resources Report 72, (1977), published by the Pennsylvania Geological Survey. Order from State Book Store, P.O. Box 1365, Harrisburg, Pennsylvania 17125. Softcover, in hard box, 6 x 9½ inches, 318 pages, 5 separate maps.

Mineral Collector's Field Guide — Connecticut, by Bud Webster. Published by E. R. Webster, 286 South Elm Street, Wallingford, Connecticut 06492. Softcover, 8½ x 11 inches, 40 pages, 20 maps, 34 localities covered; (1978), $3.00 plus 50¢ postage.

Minerals of the St. Lawrence Valley, by George Robinson and Schuyler Alverson. Published by George Robinson, 387 Division Street, Apt. 310, Kingston, Ontario, Canada K7K 4A6. Softcover, 6 x 9 inches, 42 pages, 29 maps, 29 black & white mineral photos; (1977), $2.50 plus 50¢ postage.

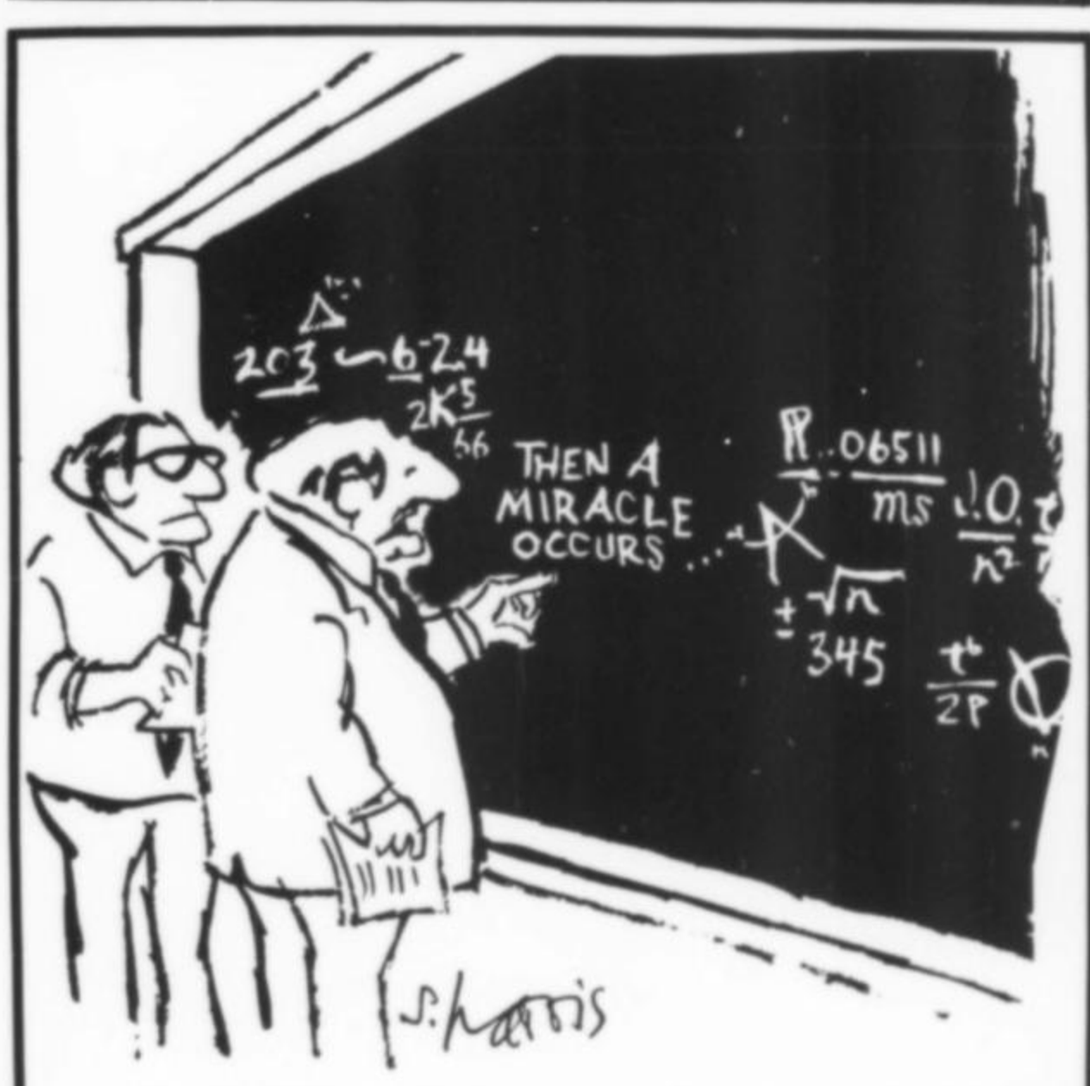
***What's so funny about science?* by Sidney Harris. Published by Kaufmann Publishers, 1 First Street, Los Altos, California (1978); hardcover $7.95 plus $1.00 postage; softcover $3.95 plus $1.00 postage.**

This book presents a collection of science-oriented cartoons that have been appearing since 1970 in *American Scientist* magazine. Harris has a pleasant, fresh sense of humor altogether too uncommon in the scientific world. The three examples reprinted here (with the artist's permission) should serve to illustrate.

W.E.W.

"We know he didn't discover that new virus — we're just naming it after Rheinblatt because it *looks like* Rheinblatt."

"... and in 1/10,000 of a second, it can compound the programmer's error 87,500 times!"



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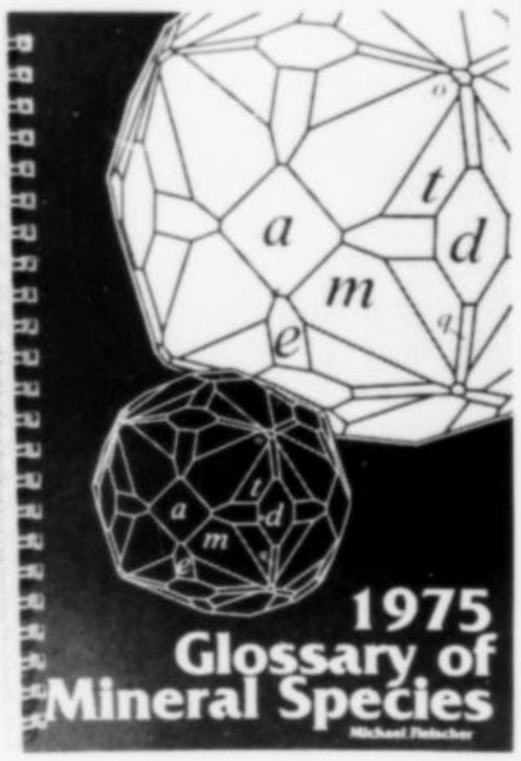

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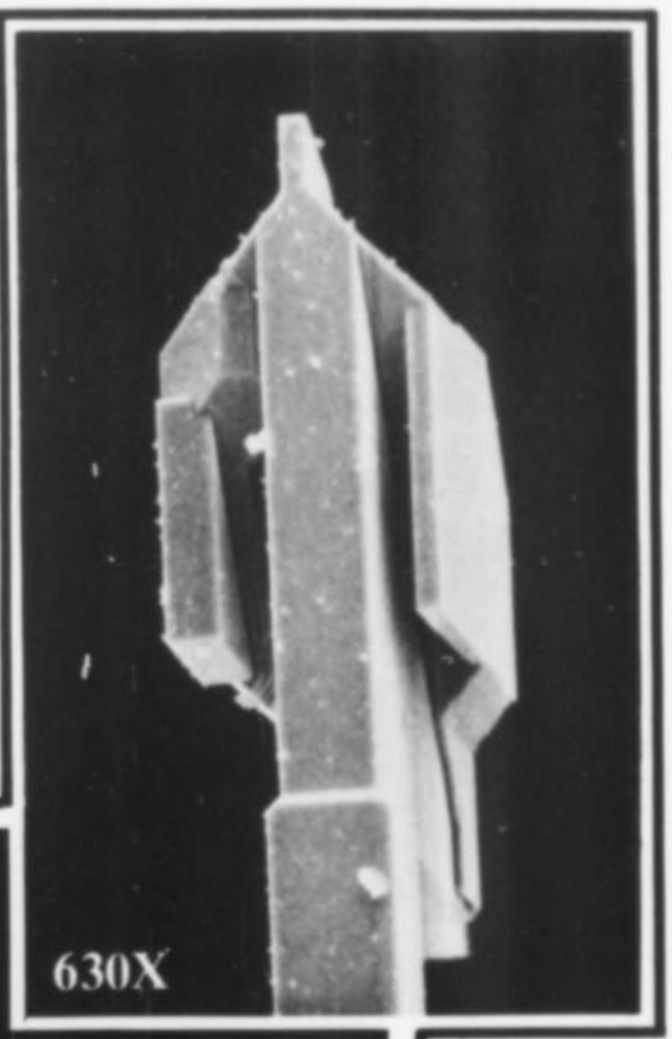
CUPRITE UP CLOSE

by
Pete J. Dunn
Dept. of Mineral Sciences
Smithsonian Institution
Washington, D.C. 20560

The Copper Queen mine at Bisbee, Arizona, has produced some very fine specimens of cuprite in the extremely acicular habit referred to as the variety *chalcotrichite*. The photomicrographs presented here were taken with a scanning electron microscope (SEM) and illustrate the beautifully symmetrical development of cuprite. The most common form by far is the cube, but other forms including the octahedron and dodecahedron are occasionally observed, as in the bottom-right and middle-right photos.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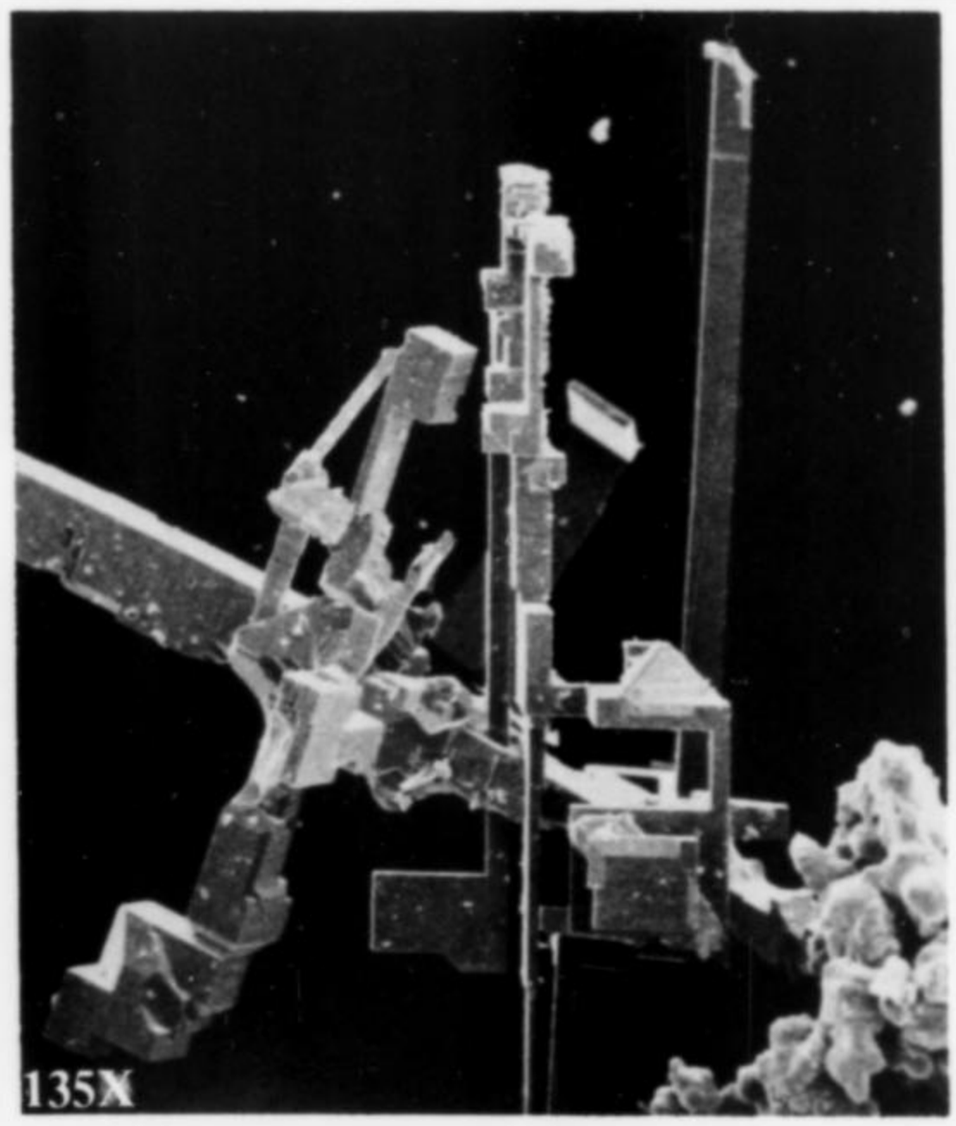
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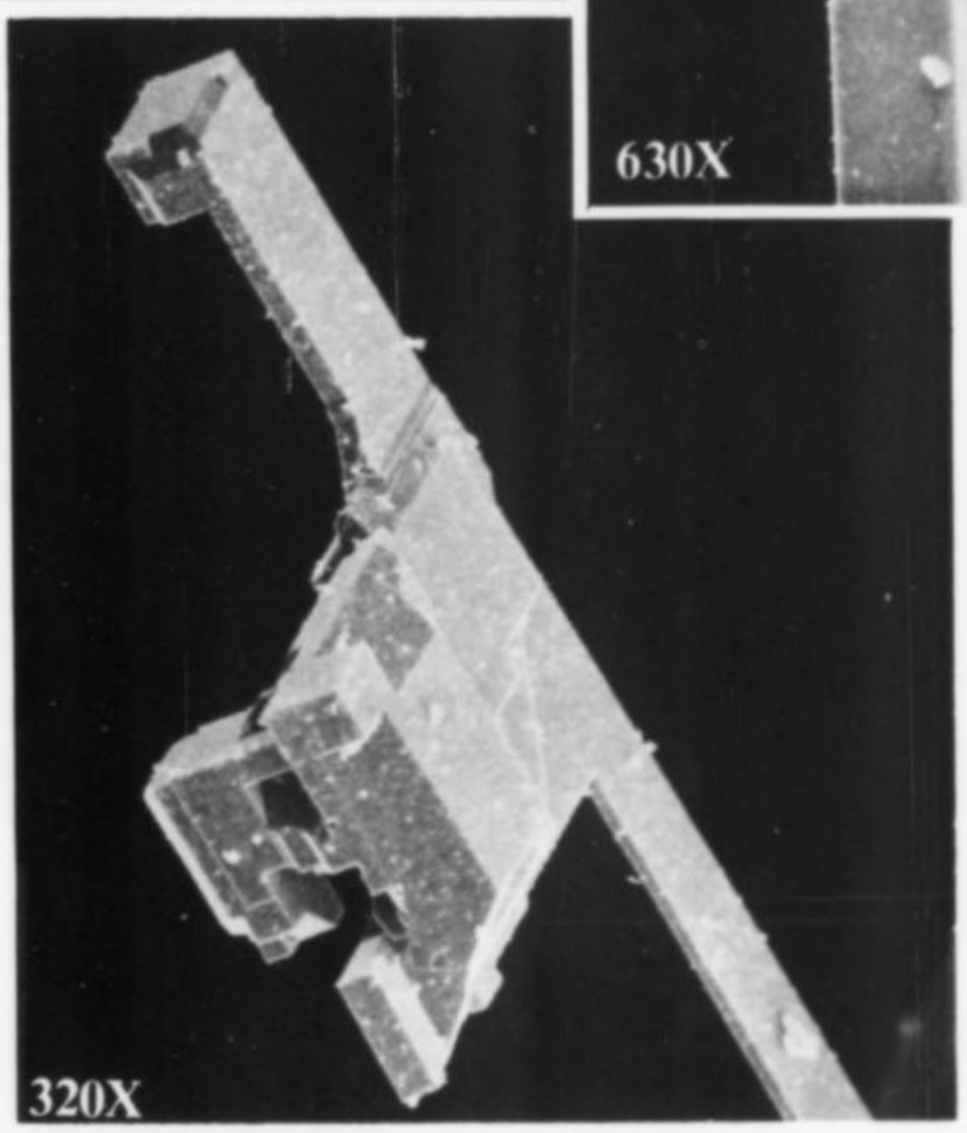
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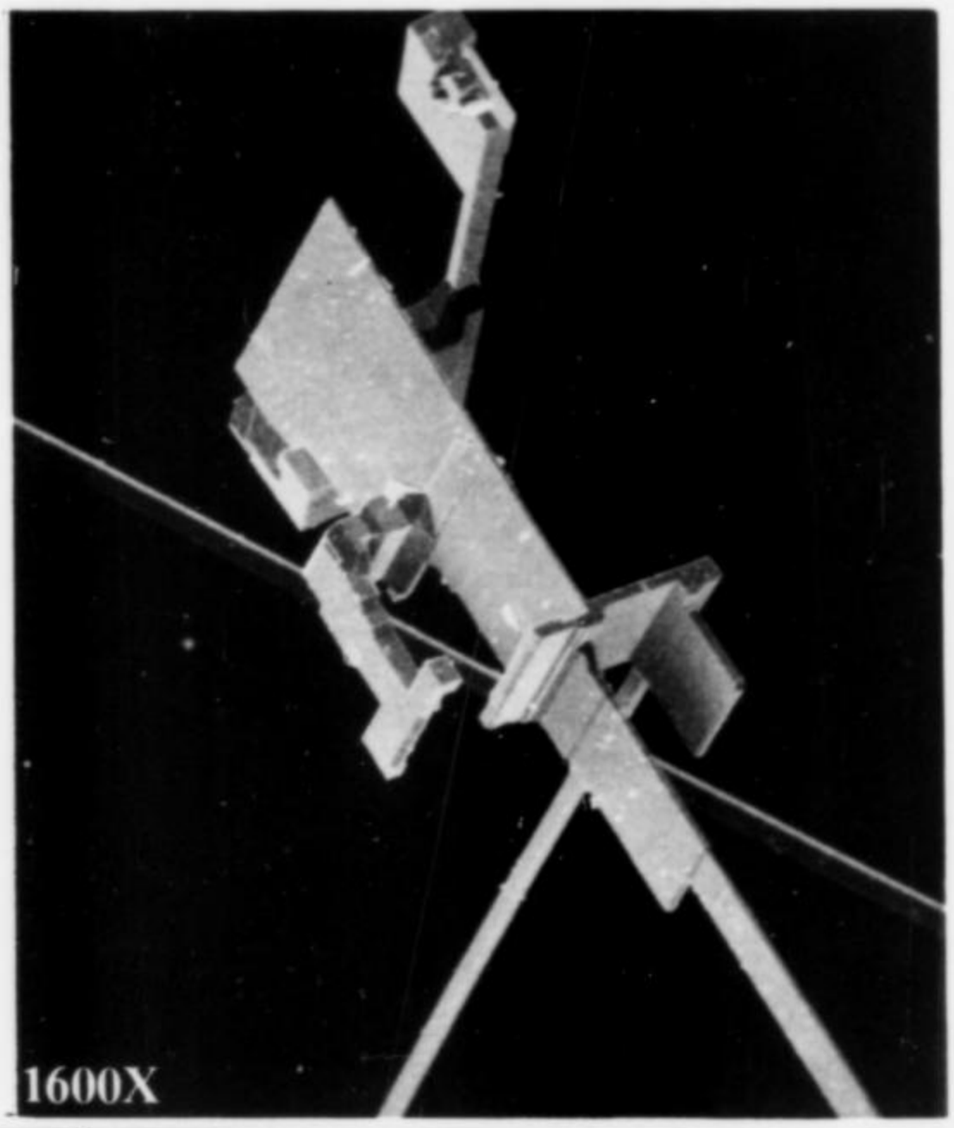
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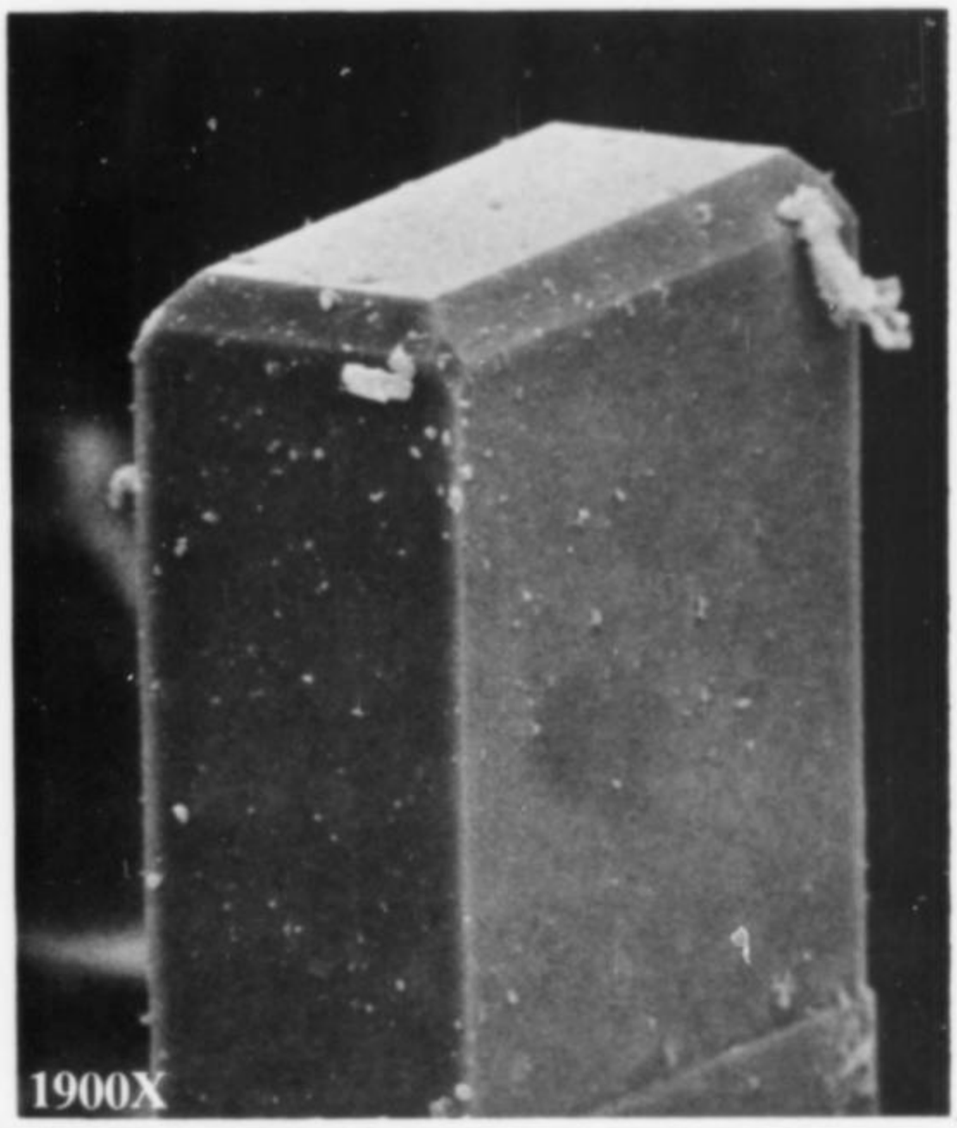
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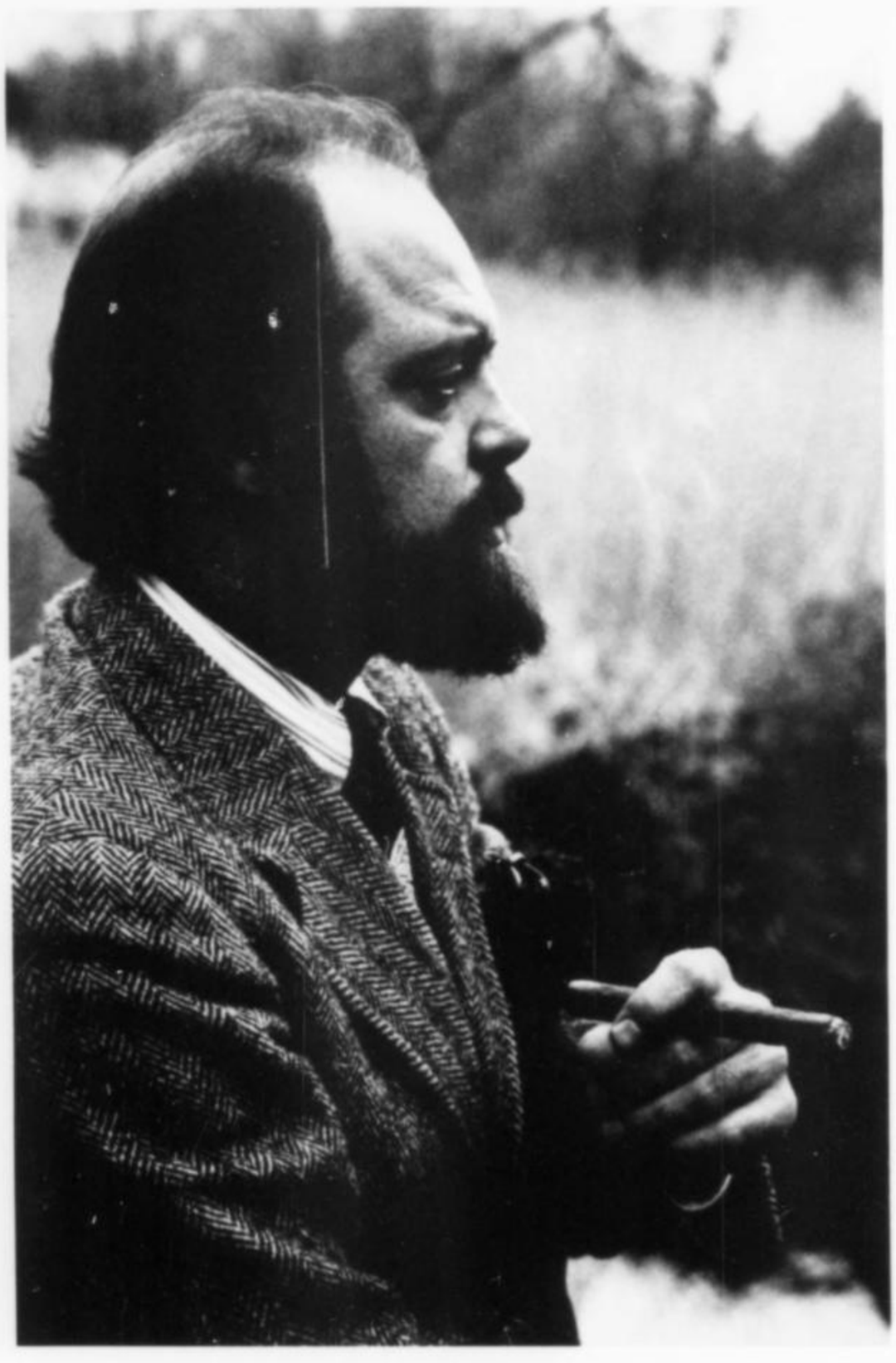

PERSONALITY SKETCH

PAUL BRIAN MOORE
by
Vandall King,
Anthony Kampf
and **Robert Whitmore**

Paul Moore is counted as a friend by many professional and amateur mineralogists; however it is by his research that he is generally well-known. He has published over 100 papers though he is only in his late thirties. More than one percent of all currently accepted mineral species have been named by him. And what is even more impressive is that he and his associates have solved the crystal structures of most of those new species as well.

Nevertheless, the essential Paul Moore can only be realized through personal contact. He is friendly, outgoing and hospitable. "Naturally, any dedicated student with a talent in pure mineralogy is always welcome in my laboratory, which includes the great outdoors as well as the solitude of the X-ray and goniometric facilities." *(American Mineralogist*, **59,** 399).

Paul is tall, handsome and somewhat formidable in appearance, but he is friendly and courteous to those who are the same to him. His personality is intense; he works hard and enjoys his research, then applies himself with equal energy to his hobbies. Often he works late into the night collecting data, interpreting crystal structures or writing scientific papers. Mineralogy is to him an active passion in which he finds no drudgery. When Paul published the results of his structural analysis of hureaulite, he remarked that the study of the electron density maps was "a pleasant way to spend two hours on a rainy afternoon." *(American Mineralogist*, **58,** 303.)

Paul was born on November 24, 1940, in Stamford, Connecticut, and received his BS degree in chemistry at Michigan Tech University in 1962. From there he went to the University of Chicago where he received his PhD in geophysical sciences in 1965. From 1965 to 1966 he pursued post-doctoral research at the Swedish Natural History Museum, and then returned to the University of Chicago where he was granted a full professorship in 1972.

Among the characteristics which set Paul Moore apart from most other researchers is his personal field collecting. While others may wait for borrowed materials to arrive in the mail, Paul is actively collecting his own research specimens. This initiative combined with his enormous ability and fresh enthusiasm for mineralogy are what most people find so impressive (even overwhelming!) about Paul. His personal field collecting has yielded new minerals from Långban, Sweden (including additional samples of species whose only previously known specimens were lost), from the Black Hills of South Dakota, and from his greatest love, the Palermo #1 quarry in North Groton, New Hampshire.

Paul's meticulous standards are carried into the field. He wields a sledgehammer with expert and rugged style; his students are hard-pressed to keep up with his pace. As interesting mineral assemblages are found, samples are carefully selected with respect to their exact locations and associations. Paul has numbered each of the phosphate pods at the Palermo quarry so that correlations based on assemblages, chemistry and exact position in the mine can be made.

Often children approach Paul in the field and ask him to identify their specimens. He explains what each one is, and how each is recognized. When asked by these young collectors, "Triphylite, huh? How much is it worth?" his reply is likely to be, "Worth? It has no monetary worth; it's *science*!"

Though his profession gives him ample opportunity to attend conventions and symposia where he can present his findings, he still feels an attachment to the amateur community. He gives as many lectures before amateur groups each year as he does to professional audiences, and was the representative of the Mineralogical Society of America to the Friends of Mineralogy.

Paul recently received recognition for his interests in people, teaching and the scientific discipline when the University of Chicago presented to him their Quantrell Award for his excellence in undergraduate teaching. He loves teaching, "bringing home ideas," and "making points." His photographic memory, remarkable personality and command of the science make his classes an exciting experience for students. Paul does not dilute his course content to make it easier on the student, and many claim he teaches "three feet over their heads at times," still it was his students who recommended him for the Quantrell Award, and he is therefore especially proud of it.

How does Paul Moore relax? He will rarely be caught watching television, which he considers a "mindless pastime." He often tells the story of the demise of his own television set; he held a party in its "honor" and then tossed it out of his apartment window. Paul is not a spectator. Americans are noted for playing as hard as they work, and Paul is no exception. He is an avid and regular tennis player. The Baroque and Romantic organ is one of his many loves, and Max Reger is one of his favorite composers. Dave Garske, a mineralogist and mineral dealer, remembers one of Paul's "recitals" at the Rockefeller Chapel of the University of Chicago, in near total darkness. The first powerful notes of the Regerian composition, combined with the eerie surroundings, made Dave feel as if he were nearly being lifted out of his seat. Paul finds much relaxation through total immersion in this kind of music. His performances on the organ are impeccable, but he is his own worst critic. When he considers all of the activities that excite him, Paul regrets not being able to pursue more than one full-time profession.

It seemed to Paul that he should find a hobby unrelated to mineralogy,

in which he could engage as a break from his occupation. Consequently Paul returned to his boyhood interest in butterflies, and threw himself into lepidoptery with characteristic verve. Though he considers himself an amateur, his name is already well-known among lepidopterists of several countries. He occasionally wisks off to the Amazon Basin, Guadalcanal Island or Southeast Asia, net in hand and specimen basket at his side, to collect his own butterflies. Wendell Wilson recalls seeing Paul suddenly spot a butterfly, identify it on the fly (down to species), and then leap off after it into the dense Brazilian jungle. Paul's personal collection of thousands of butterflies is famous and was recently on exhibit at the University of Chicago Library. It has been said that "a true naturalist delights both in the living and the natural physical world," and this description certainly fits Paul.

Paul's natural curiosity extends to an interest in Man as well, and clinical psychology fascinates him. He does not care to dissect personalities, but his knowledge of psychology adds a twinkle to his eye and brings him added enjoyment of his friends and acquaintances. He has also managed to successfully help several of his students through psychological crises.

His aim is basic research, which he feels is ultimately a better investment than short-term, goal-oriented research or review articles and books based on the research of others. He strives to make his research relate to the real world, and is concerned with the understanding of others. "Who among us can go out and teach the inquisitive man on the street of the mysteries and marvels of the natural inorganic world?" *(American Mineralogist,* **59,** 401.)

Paul has given us two glimpses into his personality and philosophy, "A mineralogist looks at his profession" *(Mineralogical Record,* **6,** 184-188), and his "Acceptance of the Mineralogical Society of America Award" (American Mineralogist, 59, 399-401. Soon he will be appropriately honored by having a new mineral species from Långban, Sweden named after him. Paulmooreite, a new lead arsenite, has been accepted by the IMA Commission on New Minerals and Mineral Names. The authors of this description (Pete J. Dunn, Donald R. Peaconr and B. Darko Sturman) have given their permission for the new name to be mentioned here.

Tragedy nearly claimed this extraordinary man last year when Paul was severly injured in an auto accident. For weeks he was near death and in a coma. When he occasionally lapsed into delirium the nurses could not understand him because, despite the fact that English is his native language, he was delirius in Swedish! Paul has now recovered, to the relief of all, and is back to work with his usual gusto.

In summary, Paul is a dedicated, aggressive, highly talented perfectionist. He is also a warm, sensitive, concerned man trying to instill his own love of mineralogy in us all.

- - -

The authors gratefully appreciate the comments and suggestions from William Welsh, Curt Segeler, David Garske and Wendell Wilson. Thanks also to Ross Giese for critically reviewing this sketch.

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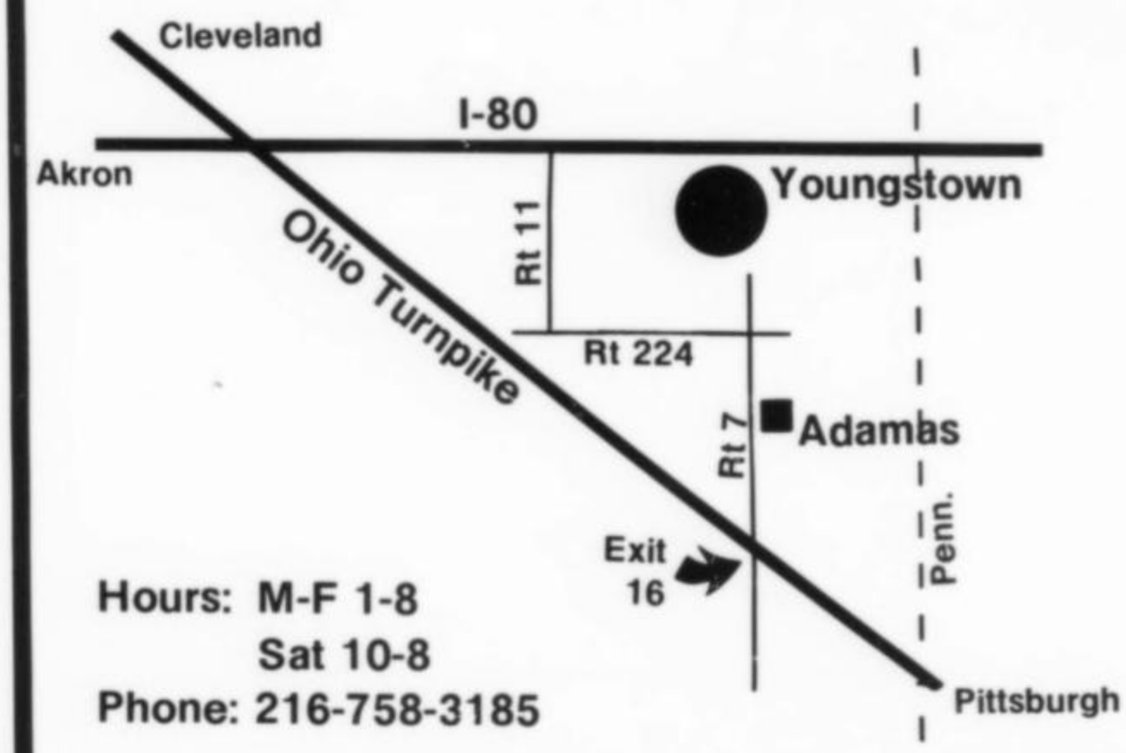

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FM friends of mineralogy

I was elected president of the Friends of Mineralogy at the February 11, 1978 Board of Directors meeting in Tucson. I accepted the presidency with some reluctance mainly because I, like many of you, have had some doubts about what FM has been doing and where it is going. Two main things, however, have convinced me to assume this responsibility. The first is that I feel the concepts of FM are still viable to the mineralogical community. We must consider that FM has evolved from one step to another, and it continues to change, we hope, in a direction of stability. It will go this way if the membership will keep their sights set on basic concepts and continue to support the organization, its chapters and projects. The second reason is due to the support of the people with whom I have been associated in FM. I have found great support and enthusiasm in the past year, establishing a regional chapter of FM in Colorado. It seems to me there are others who have the same interests and potential for forming chapters and working on regional projects. In the coming months, I hope to contribute toward promoting and accomplishing these ideas.

My experience has been that what is really happening in FM occurs at the local level. The framework of organizing local chapters is only two years old and evolved out of a larger regional complex. We need to give the local chapter structure time to grow and develop. One new incentive for local chapters is reflected in a recent vote by the Board of Directors to change the dues structure. This new method will allow some national funds to be provided to chapters for use with projects. As of 1978, three dollars will be rebated to a chapter from a member's dues if a person belongs to the chapter. Dues from members not belonging to a chapter will continue to be deposited in the FM Inc. treasury for operating expenses and project funds.

I don't believe concentration on the local level negates a national organzation which has a responsibility for coordinating certain projects and developing long-range policy direction. Forthcoming articles in the *Mineralogical Record* and a revitalized FM newsletter will go into more detail about these matters. It will also provide information about the four existing regional chapters and national projects.

I would like to say a few more words about FM concepts. They are valid and there is a continuing need to implement FM goals as they were initially conceived nine years ago. They were stated in the March-April 1971 issue of the *Mineralogical Record* as follows:

(1.) To protect and preserve mineral specimens, especially those used for teaching, study and display, and to promote conservation of designated specimen localities and mining deposits by publicizing their historic, scientific and educational usefulness.

(2.) To further a more generous spirit of cooperation and sharing of specimens and collections among mineral amateurs and professional scientists; also to encourage the collecting and acquisition of minerals for their research and educational, rather than commercial, value.

(3.) To advance mineralogical education, especially in academic programs of mineral study and research, educational activities of amateur mineral organizations, and wider appreciation of mineral specimens in terms of their esthetic, scientific and economic importance.

(4.) To support publications, such as the journal *Mineralogical Record* which communicates FM activities and is an educationally oriented affiliate, and those programs initiated by individuals or groups whose activities coincide with FM goals.

There are still national projects that are active and important. Mike Groben, Carl Frances and others continue to work on the Ad Hoc Committee for Locality Preservation. The Locality Index Project has temporarily been dormant, but is on the top of the list for action. A new committee project may attempt to preserve mineralogical archives and manuscripts. There is continued interest in many areas about reprinting mineral publications.

I feel we all have reasons to be optimistic with FM, its activities and the manner in which it brings people together. I have high hopes for this new FM year and look forward to the continued support of the membership and the formation of new chapters at local levels.

Jack Murphy
Curator
Department of Geology
Denver Museum of Natural History
Denver, Colorado 80205

Note: Membership applications and information may be obtained from FM treasurer **Art Johnstone, 996 Larkmoor Blvd., Berkeley, Michigan 48072.** Annual membership dues are $5.

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Letters

HERACLEITUS AND THE EDITOR

Dear sir,

Part of your editorial note "Hey, that looks like a..." in vol.9, no.2, prompts me to make a couple of observations. Your remark on "the obtuse logic of describing minerals in non-mineral terms" suggests that you are putting forth the old philosophical idea (of Heracleitus, I think) that we cannot predicate anything. I may be obtuse too, as I do not understand what you mean by describing minerals in mineral terms only. What are these terms? Surely we must use concepts that have meaning to us! Even John Milton, with all his brilliance and his unrivaled command of the language, was forced to use material concepts when trying to describe heaven and had to "measure things in heaven by things on earth."

Another aspect of your note deals with the naming of minerals and their habits from their fancied resemblances. But there is a much more reprehensible and increasing practice of naming minerals after persons. The ancient and laudable practice of naming minerals from some particular characteristic and using usually Greek or Latin words is of long standing and is important if only from the aspect of universality of meaning. Of course reasonable cases can be made out for commemorating great pioneers like Madam Curie or Hauy or Werner and the like. Doubtless there will always be the difficulty of drawing the line between the famous and the not-so-famous. But draw that line where you will, it must preclude this modern, vulgar practice of naming a mineral after some obscure mineral dealer. This is something at which the International Mineralogical Association ought to take a long and serious look. We may not know as much Greek, Latin or Arabic as people did in the past when education was less utilitarian and more cultural, but we can surely do better than name a mineral after some unimportant and little-known person.

Albert C. Gardner
Ashfield, N.S.W., Australia

To "measure things in Heaven by things on earth"...sometimes it does seem that nothing else on earth can compare to the extraordinary and often uniquely beautiful qualities of some minerals. Your observation is profound, and further serves to illustrate my point. If tracked to their source, virtually all descriptive terms relating to color, shape and other physical characteristics would probably be seen to originate in some mundane comparison to everyday things. So why fight it? As you point out, purely mineral terms may not exist, except perhaps the oldest mineral names themselves. My note pointed out the carrying of things to amusing extremes.

As to the "vulgar" habit of naming minerals after people, I can only say that you belong to the large fraternity of dissidents who disagree, for one reason or another, with other people's choices for mineral names. The actual utility of factual data contained within a mineral name, sometimes in code as it were, is debatable. As it stands, such matters are generally left to the conscience of the researcher, he having earned the right to name his new mineral himself. The IMA generally intrudes only for very practical reasons, which is, in my opinion, as it should be. Ed.

RECOMMENDED REFERENCE

Dear sir,

I read with great interest "The collector's library" article in vol.9, no.1. I was pleased to see what some celebrated mineralogists and mineral collectors consider "must" references, and to read their comments. I was especially glad to see some emphasis placed on several geochemistry and economic geology books. I would like to add an update to this last class if I may.

You commented on a publication: Ridge, J.D. (1958) Selected bibliography of hydrothermal and magmatic mineral desposits. An updated version is now available: Ridge, J.D. (1972) Annotated bibliographies of mineral deposits in the western hemisphere with supplemental references. *Geological Society of America Memoir* **131**, 680 pages.

This volume contains references and notes (some quite comprehensive) on each of the deposits indexed. An author index is also included. The volume was revised in March 1975, and is up-to-date through 1969. Supplemental reference were added in 1974. It should prove to be of great interest to those interested in North and South American localities.

Will Wilkinson
Tucson, Arizona

Thank you for that information. Upon checking, I find that the memoir can be purchased for $28.00 from the Geological Society of America, 3300 Penrose Place, Boulder, Colorado 80303.

MORE REFERENCES

Dear sir,

Although I was not able to accept your kind invitation to suggest books for your January-February 1978 issue, owing to previous commitments--the most enjoyable of which was the Second International Kimberlite Conference--I should like to comment now. A professor has been described as one who "thinks differently," and as one of the professors on your "hit list" I am afraid that I think somewhat differently from some.

Even though I received my first degree in mineralogy--one of only four given at the University of Colorado during its 90-some years of giving this major--I regard mineralogy as principally a geologic science, based solidly on geology and properly leading to petrology and petrography. This is where I part company with those editors of the *American Mineralogist* who regard mineralogy as a branch of physics. It may be so, but not for me.

In this respect John Sinkankas' book *Mineralogy for Amateurs* is correctly named, although it might be "for the Collector"--certainly not "Mineralogy for the Mineralogist." For there is a difference between and among mineralogy as a science and as a profession, and minerals as natural chemicals and minerals as objects to collect or to sell or to admire esthetically. There are a lot of faces (pun intended) to this fascinating subject.

If this view is right, the best book in English might well be *Introduction to Mineralogy* by Carl W. Correns. It was not mentioned. Other first-class books include the new Hurlbut-Klein *Manual of Mineralogy* in the Dana series, Kostov's *Mineralogy*, and certain other American and European books.

Apart from extensive, unoriginal copying, my chief criticism of the Roberts *Encyclopedia of Minerals* is that a large proportion of its contents pertains to matters in which most of your readers have not the slightest interest, such as lattice constants and diffraction lines. I agree more with Brian Skinner's critical review.

As for field guides, they are generally mislabeled. Butterflies and birds can be identified at sight, but minerals cannot be, for they are classified by atomic structure and chemical compositon (crystal chemistry). You cannot tell an oxide from a silicate by looking at it or licking it. The useful hints, as with some carbonates, are few. Most black minerals look alike, as gray ones and white ones do also.

In my daily work I need the following references: Dana-Dana 6th edition, Dana-Ford (1932), Dana-Palache 7th edition volumes 1 and 2, Strunz (but German), the series by Deer, Howie, and Zussman, and several of the new textbooks referred to above.

I am surprised that nobody named one of the pretty picture books, of which the very best is *Minerals* by Arthur Court and Ian Campbell. Or one of the "culture " books, of which

Hurlbut's *Minerals and Man* is much the best. Taking strongly into account both price and convenience, my favorite is the little Zim book, of which I have given away a lot of copies.

As with other things, the best book is the one most useful for the purpose. Aristotle said that intelligence is appropriateness. (I used to believe I had originated this great idea.)

Perhaps a passing thought might be given to the small books that have sold nearly, or much more than, a million copies and thus have introduced many to the subject: Zim, Pough, and Pearl. After all, most of us have started small and simple. Numerous have been the people who have told me that my *Colorado Gem Trails and Mineral Guide* has helped to change their family's life. This is worth a lot.

Most localities are of interest only to field collectors unless they signify mineral associations or paragenesis--a relationship clearly emphasized by Dr. Pough in his good book. Otherwise, they mean little more than a listing in a telephone directory. (The voracious, packrat-type of collector would not understand.) Incidentally, an extensive catalog of localities is given in Jay Ellis Ransom's *Gems and Minerals of America*.

I appreciate Peter B. Leavens' compliment on my *Cleaning and Preserving Minerals* and am sending him the 4th edition (6th printing) to replace the older one that was taken. Libraries tell me that I am one of their most stolen authors; I wish this were a credit.

As to other matters than books, may I express approval of Dr. Pough's remarks about the destruction of beautiful minerals to get a few cents' worth of metal. When the *Mineralogical Record* started, I was tempted to write something about the loss of gem turquoise to the copper smelters, but the situation seems to have improved solely through economic means.

Keep up the good work and make a fine magazine even better.

Richard M. Pearl
Colorado Springs, Colorado

Thank you for your comments. As to mineral picture books, these were specifically omitted because they are not "references" in the usual sense. They may be covered in a future article, however.

Ed.

THE DISCOVERY OF REAPHOOK HILL

Dear sir,

I was extremely interested in the article in your January-February issue on zinc phosphates at Reaphook Hill, South Australia, particularly since I spent a considerable amount of time at Reaphook Hill in its very early days. I thought I might write and clarify a few points made by Johnston and Hill and also add an important part that was left out completely.

Historically, scholzite was not discovered by the South Australian Mines Department. As I recall, the Mines Department had carried out a rock chip sampling program all through the Flinders Range (of which Reaphook Hill could be called a northeastern outlier) and reported a zinc anomaly in the general area of Reaphook Hill.

In 1963-64 and mid-1965, Kennecott Explorations (Australia) Pty. Ltd. applied for a number of large Special Mining Leases in the Flinders Range of South Australia, covering rocks of Upper Proterozoic and Lower Paleozoic age as part of a reconnaissance program for base metal deposits. One covering the Reaphook Hill area was granted in late 1965, and I participated in a detailed geochemical stream sediment sampling program that was begun shortly thereafter. This led to the recognition of a number of zinc anomalies in the streams draining the immediate Reaphook area, including one from the now famous scholzite area.

As I recall, in February or March of 1966, R. D. "Bob" McNeil (who was in charge of the project) and I attempted to get into this area. Local sheep ranchers had fenced off the whole of the Reaphook Hill area, as it was too difficult to get sheep in and out. At the time there were no roads or tracks in and the outward-dipping dip slopes with their cliff-like back sides and the boulder-choked stream beds that did penetrate the area presented real obstacles.After two attempts, we had to abandon our vehicle and walk in, which was no easy task in the late Australian summer. After walking up one of the anomalous drainages and through the steeply dipping sedimentary rocks the country opened up and became less arduous as the dip of the rocks flattened. I suspect now that we were the first ones into that area for many, many years doing any mineral exploration. We did find two shallow pits three or four feet in diameter and about a foot and a half deep in one of the more manganiferous sections of the Wilkawillina limestone. We noted the scholzite-bearing outcrop further up the valley (although at the time we did not know that scholzite was one of its constituents), and I recall commenting that while the manganese had been dug on, the more limonite-rich outcrop, which might have been a gossan, had not been touched. We sampled most of these rocks and took them back to Adelaide where they were assayed by Australian Mineral Development Laboratories and then turned over to one of their employees, Roger Townsend, for the mineral identifications. It was he who identified the scholzite and the chalcophanite in a report to Kennecott in May or June of 1966.

Kennecott continued to explore in the area, putting in numerous pits and the bulldozers' cuts for geochemical sampling. Later a number of geophysical surveys as well as a diamond-drilling program were carried out in an attempt to locate the source of the mineralization. Unfortunately, the surface mineralization did not continue at depth. Kennecott relinquished the area, and all reports and information concerning the exploration that had taken place on this special mining lease were subsequently filed with the South Australian Mines Department and became part of the public domain. The area was soon staked by people more interested in the rare minerals than in discovering another Broken Hill mine.

I might also add that a number of other similar zinc areas (although none with scholzite) which had previously gone unrecognized were also discovered at this time in South Australia by Kennecott and Anaconda. None of these proved economic for these explorers. However, their efforts have brought a good deal of beauty in the form of mineral specimens into the world.

John M. Clema
Missoula, Montana

PIERREPONT LOCALITY CLOSED

Dear sir,

This is just a note to inform you of the closing of another famous mineral locality: the uvite locality at Pierrepont, New York. Apparently last winter the owner, Mr. Bower Powers, passed away and his son and heir to the property wants nothing to do with mineral collectors. Knowing him personally, I would say the prospects don't look too good for the future. Each year many mineral collectors visit the locality. Perhaps the *Record* can convey this message to those collectors who would otherwise be making this trip in vain.

George Robinson
Kingston, Ontario

At least, for once, it was not the collectors' fault that the locality was closed.

Ed.

EXCHANGE OFFERS

Dear sir,

I am interested in exchanging some old-time European "classics" for old-time American specimens. I am most interested in good Colorado rhodochrosite and could offer in return pyromorphite (from Bad Ems), barite on hematite (from Cumberland) and realgar (from Romania).

J. Tichelman
Bremstraat 183
den Helder, Netherlands

Dear sir,

I have raspite and stolzite from Broken Hill and Cordillera, New South Wales, Australia, and small wavellite crystals on turquoise. Will trade for any top crystal specimens.

H. Bunker
Noble Parade
Dalmeny, N.S.W. 2546, Australia

CHARTER TRIP TO TUCSON

Dear sir,

We would like to arrange a charter flight from the Baltimore-Washington area to the Tucson Show in 1979. Anyone interested should get in contact with me as soon as possible.

Cynthia C. Barnes
5305 Iriquoise Road
Glen Echo Heights, Maryland 20016

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Mineral World

Amethyst – Las Vigas, state of Vera Cruz, Mexico, 2 x 3 x 2; four large xls. and several smaller ones radiating from a base of drusy quartz and chlorite. Very fine display specimen **$75.00**

Wavellite – near Pencil Bluff, Montgomery County, Arkansas. 3 x 3 x 1½ ; good showing of radiating xls. on exposed seam in brecciated novaculite **$32.00**

Dioptase – Tsumeb, near Otavi, Namibia (South West Africa). Great display material, 1½ x 1½ x ¾ pearly dolomite base covered with small bright green xls. **$47.00**

Dioptase – Tsumeb, near Otavi, Namibia (South West Africa). 2 x 1½ x 1 matrix of white calcite xls. coated with bright green xls. **$47.00**

Dioptase – Tsumeb, near Otavi, Namibia (South West Africa). 2 x 1½ x 1¼ cluster of large showy xls. **$125.00**

Adamite – Ojuela mine, Mapimi, state of Durango, Mexico. 2¾ x 1¾ x ¾; light green xls. on a base of white adamite and limonite **$34.00**

Adamite – Ojuela mine, Mapimi, state of Durango, Mexico. 3¼ x 2½ x 1 matrix of limonite covered with golden brown xls. of various sizes **$65.00**

Adamite – Ojuela mine, Mapimi, state of Durango, Mexico. 2½ x 1¾ x 1¾; blue xls. covering brown adamite xls. on limonite matrix **$100.00**

Gold – Pilgrim's Rest mine, Province of Transvaal, Republic of South Africa. ½ x ½ x ¼ ; twisted mass with no matrix **$120.00**

Gold – Farncomb Hill, near Breckenridge, Summit County, Colorado. 1⅜ x ⅝ x ⅛ thin plate with equilateral triangle markings **$67.00**

Galena – Naica, state of Chihuahua, Mexico. Extremely showy with pale blue fluorite and minor amounts of pyrite, 3 x 3 x 1½; **$92.00**

Galena – Tulsa Quapaw mine, Treece, Cherokee County, Kansas. 2¼ x 1¾ x 1½; two steel grey interlocking xls. **$12.00**

Rock crystal quartz – Idarado mine, near Ouray, Ouray County, Colorado. 4½ x 4 x 1½ cluster coated grey and dusted with pyrite **$32.00**

Rock crystal quartz – near Charcas, state of San Luis Potosi, Mexico. 5 x 4½ x 3 matrix of large cream colored danburite xls. coated with small brilliant quartz xls. **$400.00**

Smoky quartz – Hot Springs, Garland County, Arkansas. 2¼ x 1½ x 1, showing fine phantom zoning and no matrix on two sharp single attached xls. **$67.00**

Calcite – Egremont, Cumberland County, England. 4 x 2½ x 1¼ group of clear xls. on a grey and white matrix **$180.00**

Calcite – Tsumeb, Namibia (South West Africa). 5 x 4½ x 3½ mass of xls. containing red colored inclusions of hematite **$125.00**

Calcite – San Carlos, state of Chihuahua, Mexico. 2½ x 2½ x 2 bright red xl. cluster containing inclusions of hematite **$67.00**

Aragonite – Krupp Iron mine, Erzberg, near Eisenerz, state of Carinthia, Austria. 5 x 3½ x 2¾ flos-ferri type with no matrix **$40.00**

Copper & silver – Painesdale, Keweenaw Peninsula, Houghton County, Michigan. Half – breed type with no matrix 2 x 1½ 1 **$37.00**

Copper – Emke mine, near Onganja, Namibia (South West Africa). 1¾ x 1 x 1 superb little dendritic specimen with attached calcite xls. **$18.00**

Copper – New Cornelia pit, Ajo, Pima County, Arizona. 3¼ x 2¼ x 1¼ bright, clean specimen with no matrix, fine xl. definition **$32.00**

Amethyst – Denny Mountain, King County, Washington, 1⅞ x ½ x ½ single scepter xl. resting on a single milky quartz xl. **$45.00**

Rose quartz – Island of Lavra da Ilha, Jequitinhonha River, near Taquaral, state of Minas Gerais, Brazil. 1¾ x 1½ x 1⅛ excellent display specimen with no matrix, brilliant xls. **$175.00**

Enargite & pyrite – Quiruvilca mine, near Trujillo, La Libertad Department, Peru. 2¼ x 1½ x 1½ with minor amounts of quartz **$52.00**

Pyrite – region of Tuscany, Italy. 2½ x 2¼ x 1¾; very well xld. show winning type of specimen with no matrix, truly a superb piece **$100.00**

PLEASE INCLUDE A MONEY ORDER OR CHECK WITH YOUR ORDER. CALIFORNIA RESIDENTS PLEASE ADD 6% SALES TAX (SAN FRANCISCO, ALAMEDA AND CONTRA COSTA COUNTIES 6-1/2%) TO ALL ITEMS. ALL SPECIMENS ARE WELL PACKED, INSURED AND SHIPPED POSTPAID. YOUR PURCHASE MAY BE RETURNED FOR CASH OR CREDIT IF YOU ARE NOT COMPLETELY SATISFIED.