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editorial matter

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feature articles

departments

ADAMITE from the Ojuela mine, Mapimi, Durango, Mexico. The specimen is a micromount in the collections of the Smithsonian Institution. The photograph was taken by Lee Boltin.

Editorial SPECIES COLLECTORS

A term which will appear with regularity in the *Mineralogical Record* is *species* collector. Most advanced mineral collectors know what is meant by the term but it is probable that many relatively new collectors do not understand it, so a brief discussion is in order.

Species collectors are, in a sense, fanatical systematic collectors. The goal of most is acquiring a specimen of every known mineral — owning every mineral no matter how minute or unattractive it may be.

On the surface this may seem a worthy and reasonable endeavor. Certainly its educational value is potentially great. However there is at least one reason why this "specialty" is not such a good idea and is disparaged by many museum cuators. Certain species are exceedingly rare and exist in no more than micro quantities in the collections of one or two museums. Under no circumstances, then, should a museum be persuaded to part with a small sample of such a mineral just so the species collector can eliminate another name from his "want list." The temptation to do this is often strong as the exchange bait may be very alluring.

It must be remembered, however, that some museums, especially *national* museums, are entrusted with preserving mineral specimens as potential study material for possible future investigations. The rarer a mineral the more important it is that samples not be distributed frivolously. It is wrong for such a museum to allow its precious supply, perhaps all that has ever been found, to be doled out to species collectors. The chance is excellent that specimens so dispersed may never find their way back to important museum collections and one can consider them lost to science.

The bait may be an equally rare species, but what is the point of seriously depleting the reserves of mineral A in order to add a tiny amount of mineral B to the collection?

It is easy to understand how a collector may become intrigued with the prospect of building a *nearly* complete species collection. I say nearly because there are certain species that are absolutely unobtainable. The goal, therefore, of a complete species collection is defeated at the outset. What is not so easy to understand is what motivates the species collector to continue once he has discovered how difficult or impossible certain species are to obtain. Further, a large percent of rare species are in no way interesting to look upon. In fact, many cannot even be seen except in thin section through a petrographic microscope. An unethical curator or mineral dealer could send him a piece of rock not containing the desired mineral and the collector would not be able to test for the presence of the desired mineral.

In recent years more and more descriptions of new minerals have been based upon electron microprobe analyses of solitary micro-sized grains in small pieces of rock. The species collector cannot reasonably hope to acquire even a small number of these, so why bother at all? The species collector is not the only one pursuing this practice. Some collectors who have adopted "specialties" have done the same thing. A Franklin collector, for example, believing that it is important to own specimens of every Franklin mineral may make life miserable for curators of large Franklin collections. If the trade bait does't work, he may simply wear down the poor fellow until the latter is ready to part with a precious sample just to get the pest "off his back."

My distaste for species collectors does not extend to those who set reasonable limits upon their collecting objectives. Building a "limited" species collection can be very educational, and the practice should be encouraged. Species collectors of this sort have, in fact, been of great value to major museums. The famed Roebling, Canfield, and Bosch Collections, now integrated into the Smithsonian Collections, were built by reasonable species collectors. These collections became important additions of valuable research and reference specimens. There are numerous modern collections of a similar nature that may end up in museums where the probability of preservation is much greater. These collectors are not competing with the museums but are utilizing their energy and resources to gather specimens that will ultimately supplement those of the museums.

John S. White, Jr.

HANSEN'S MINERALS

1223 PORT ROYAL, ST. LOUIS, MISSOURI 63141

PRESENTS NEW MINERAL LIST M-1

In lieu of quarterly lists we are planning full page specimen listings in future issues of the Mineralogical Record. Please contact us for specific requirements in minerals, reference material or cut gemstones. Please include a check with your order and postage consideration. Any specimen may be returned for cash or credit if you are not satisfied. Refer to list M-1. See us at the following 1972 shows: Cincinnati, Phoenix, Anaheim, Detroit. Hansen's Minerals, Inc. Dr. Gary R. and Maurine Hansen. Ph. (314) 432-2882. (Showroom: 149 N. Meramec, Clayton, Missouri).

HUEBNERITE. Adams Co., Colorado. 4x2 in. Excellent group of free standing crystals to 1.5 in. length. **$100.00**

METASTRENGITE. Bull Moose Mine, Custer, South Dakota (SDSM&T Museum Specimen). Several specimens 1x0.5 to 2x2 in. with crystals from 1/32 to 1/16 in. on Barbosalite. **$9.50 - $25.00**

PYROMORPHITE. Hercules Mine, Burke, Idaho. (Single pocket, found 1966). Green single, TN-crystals 8-18mm. x2-4 mm., clean and bright. **$7.50-$12.50 ea.**

WULFENITE. Old Yuma Mine, Arizona. Bright orange TN to sml. miniatures. Mostly twinned crystals 0.5x1 and 0.75x 1.75 in. **$20.00-$40.00 ea.**

COBALITE Cobalt, Ontario, Canada. TN-size. Bright, silver metallic crystal on matrix, rare. Eight specimens at **$10.00 ea.**

ERYTHRITE w. Belovite. Bou Azzer, Morocco. 2.75x2. Bladed deep, rose red crystals up to 3/8 in. grouped on matrix with small pink balls of Belovite. **$115.00**

MANGANITE w. Barite. Ilfeld, Harz, Germany. 2.5x2, White barite matrix with bright terminated manganite crystals to 1/8x3/8 in. displays well. **$110.00**

CROCOITE. Dundas, Tasmania. Several well crystallized groups. 1x1 to 1.75x2. Good color, six specimens available. **$25.00 to $40.00 ea.**

MARCASITE. Frederick der Grosse Mine, Herne, Westphalia, Germany. 2.3x1.8x1.5. A single pocket occurance of stacked, bright octahedral crystals to 3/8x1/2 in. **$60.00**

BOURNONITE on Sphalerite w. Quartz. Felsobanya, Romania. 3x2. Attractive arrangement of 1/4x3/16 in. xls. of bright Bournonite with drusy Quartz. **$65.00**

GRATONITE (Rare), Cerro de Paso, Peru. (Single pocket occurrence, found by G. Rust 1936) Small TN to sml. miniature specimens of crystal groups. Clean, silvery 1/16 to 1/8 in. xls. Very limited supply. **$6.50-$30.00 ea.**

TETRAHEDRITE w. Barite on Pyrite. Cavnic, Romania. 4x2.5. A group of 3/8x 1/2 in. xls. with white blades of Barite. Very clean for this sulfosalt. **$125.00**

AZURITE on Malachite. Dixie Mine, Washington Co., Utah. (Found 1892, with original labels). 3.5x2. A malachite matrix covered with 1/8 to 1/4 in. Azurite balls on reverse side a solid blue botroydial azurite coating. **$65.00**

HESSONITE GARNET. Jeffrey Mine, Ontario, Quebec, Canada. An extremely choice lot collected from the original pocket in 1964. Excellent apricot-orange color. TN-single xls. to sml. groups **$4.50-$30.00**, 2x2 at **$9.50-$95.00.** Cabinet Specimens. **$25.00-$300.00.** Small groups available for jewelry. **$7.50-$20.00**

PYRRHOTITE. Santa Eulalia, Mexico. Perfectly formed crystals up to 2 in. long. Available in TN to 2x2 size. Excellent specimens. **$8.50 to $30.00**

WITHERITE. Gaskin Mine, Pope Co., Ill. A very nice selection of clean, white 1x1; 2x2 and several cabinet specimens. Elongated barrel-shaped crystals, many dld. terminated at **$4.00-$6.00; $7.50-$15.00** and **$15.00-$60.00**

STRONTIANITE. Homestake Gold Mine, Lead, South Dakota. 5x3.5, A very fine cabinet 'floater', type specimen. Two sides, each displaying balls of crystallized strontianite, approximately 3/8-1/2 in. diameter, a tertiary deposition. **$40.00**

Native **BISMUTH** in Quartz. Monroe, Connecticut. 2.5x2.3. A very rare specimen with a 0.8x0.8 in. crude crystal of Bismuth on Quartz. **$85.00**

LIBETHENITE. Castle Dome Mine, Gila Co., Arizona (Dana) 1.5x1.3x1. A group of approx. 10-1/8 in. deep green rosettes of micro-crystals on matrix. **$40.00**

DOLOMITE. Eugi, Navarra, Spain. Two large intersecting rhombohedrons. Very clean, translucent to transparent, gray to clear. 3x2.5 in. **$115.00.** Four other specimens at **$65.00, $70.00, $75.00** and **$120.00**

ARAGONITE. Minglanilla, Cuenca, Spain. Lot A. 9-specimens. Pseudo-hexagonal twinned crystals, with penetration twinning at terminations; pale to deep violet color, approx. 1.5x1.5 in. **$15.00 ea.** Lot B. Similar to above, without twinning at terminations. Extremely clean, violet hexagonal prisms up to 1.5 in. long x 0.75 to 1.0 in. diameter. **$7.50 ea.**

ARSENOPYRITE. Santa Eulalia, Mexico. Brilliant, silver, diamond shaped crystals. (Cf. Mineralogical Record 2 (6), 248), TN. 6. **$35.00.** Miniature **$30.00-$50.00.** 2x3. **$40.00-$50.00.** (Limited supply).
Several TN and miniatures exhibiting an epitaxial pyrite overgrowth. **$20.00-$40.00**

REALGAR. Nagyag, Romania. 6x2. 7x 1.5 in. A very old specimen with short, prismatic deep red realgar crystals and horizontal sections on a matrix of deep black sphalerite-tetrahedrite. Very fine for this old European Locality. **$135.00**

VIVIANITE. Blackbird Mine, Cobalt, Idaho. 6x3x2.5. A fine cabinet specimen with 70% of the face encrusted with blue-violet crystals up to 0.8x0.8 in., displays well on natural base. **$125.00**

GALENA. St. Joseph Lead District, Missouri. This is the most brilliant cubic galena we have seen from any location, a true patent finish. Individual crystals from 0.5x0.5 to 4x3 in., matrix and crystal group specimens. All are superb show specimens. Priced at **$10.00** to **$200.00** dependent on crystal size (A fine cabinet size crystal at approximately **$45.00**).

SIEGINITE. St. Joseph Lead District, Missouri. A rare cobalt nickel sulfide with brilliant crystals up to 1/8 in., the finest quality material reported. TN, miniature, cabinet and museum specimens available. **$15.00-$40.00; $50.00-$165.00; $175.00-$300.00** and **$600.00-$800.00** (X-Ray fluorescence and powder data availabe, very limited supply as it was a one pocket occurrence).

ADAMITE. Mina Ojuela, Mapimi, Mexico. From the superb pocket mined during 1970. A very choice selection of bright yellow to yellow-green material available in TN to cabinet specimens, many of the specimens carry National Museum (Smithsonian) labels. Material of this quality is very scarce. **$5.00** to **$75.00** Please give us size and price requirement.

TSUMEB, S.W. Africa. We have just purchased a superb collection of approximately 500 specimens from this classic locality. The collection is very heavy in TN's and miniatures.

SMITHSONITE. (Rare green), botryoidal and crystallized. TN 8. **$30.00;** 2x2. **$25.00-$50.00;** cabinet specimens. **$60.00-$165.00.** Other colors available Clear, cream, pink at comparable prices.

CERUSSITE. These are very clean specimens. Thick, single and sixling. Crystals in miniature **$45.00-$100.00** to small cabinet specimens. **$65.00-$400.00**

DIOPTASE. Excellent green color and crystal form, some with calcite TN **$8.00-$20.00;** 2x2 **$20.00-$45.00;** cabinet specimens **$60.00-$450.00.** One choice museum specimen. **$1,100.00**

AZURITE. Deep blue blocky crystals on limonite. TN to cabinet specimens. **$15.00-$135.00**

TARNOWITZITE. Plumbian aragonite. Clean white single crystals and small groups with tan colored terminations. TN. **$4.00-$6.00.** Miniature. **$7.50-$15.00.**

WILLEMITE. Vitreous, blue-green botyroidal crystals. Exceptional for this rare mineral. Miniature. **$30.00-$45.00.** Two cabinet specimens. **$85.00** and **$135.00**

FRIENDS OF MINERALOGY

Activity Proposals For Mineral and Locality Preservation

D. M. Lapham, Chairman
Minerals Preservation Committee
Pennsylvania Geol. Survey, Harrisburg, Pa. 17120

During the first eight months of its operation, the Minerals Preservation committee has been involved in five simultaneous activities: 1) structuring the organization with the hope of involving everyone interested in participation, 2) defining our goals, 3) polling the membership for their ideas on programs of action, 4) obtaining case histories of the *modus operandi* of successful locality preservation, and 5) initiating or supporting action at specific localities. Needless to say, this shotgun approach has been somewhat hectic, but a firm structure and enthusiastic support are slowly emerging. This report will focus on the committee goals and the results of the questionnaire concerning activity proposals, two inter-related aspects of the same problem; namely, where should we concentrate our efforts.

The goals of the committee as originally formulated comprise four general points as follows:

1. To preserve specimens from, and augment our mineralogical knowledge of, mineralogically important localities that are currently active or otherwise accessible. Particular emphasis is to be placed on sites that may become closed or severely restricted.
2. For inaccessible but important localities, to maintain an up-to-date location description, to encourage owners to maintain or restore accessibility to collectors, and to exemplify with case histories the loss of collecting localities with the aim of providing future solutions.
3. To promote an integrated balance among industrial-economic, historical, environmental, scientific, and recreational interests with the aim of realizing the best possible future utilization of mineral localities.
4. By education and example, to promote ethically responsible behavior in the belief that a good relationship among professional scientists, amateur collectors, and industry is a primary concern in the useful preservation of minerals and mineral localities.

Although these four statements cover most aspects of mineral and locality preservation, they are incomplete. Primarily, there is no indication of relative importance, of methods that might produce results, nor even of the feasibility or practicality of attempting some of them. Thus, to complement these aims, a questionnaire was sent out to the entire FM membership. The questionnaire comprised ten proposals for which FM members were asked to state their approval or disapproval, to give an indication of priority, and to make comments. Only 36 questionnaires were returned, representing about 25% of the membership. Except for two, all contained comments, some of them quite extensive, all of them interesting, a few surprising in the extreme, and one or two questionably decipherable (penmanship obviously is not a mineralogist's virtue). I would like to take this opportunity to thank all who participated, particularly those who were willing to crawl out on a ledge and state their frank opinions. Now to the results.

The first question, publication of the goals of the MP committee, was approved by 97% and given a high priority by all but three respondents (not everyone indicated a priority for this and succeeding programs). Several, with perhaps a slight note of pessimism, noted that goals, unless implemented, are worthless. As succeeding columns from MP appear, we hope that both the goals and their implementation become evident. Two related questions dealing with the publication of case histories and the ways that preservation problems have been, or can be, solved were approved by 97% of the respondents. Rather curiously for a society deeply interested in preservation, the dissemination of information about solutions to current problems not only rated a lower priority and a lower favorable response (85%) than the other two, but also a lower priority than the preparation of a locality data sheet.

Approximately 92% of the respondents favored the preparation by FM of locality data sheets on a world-wide basis (less on a state-wide basis) and all except three gave it a high priority. On the other hand, only 57% favored their publication. This data sheet, to be comprised of location and mineralogical information for significant localities, especially those endangered by megalopolis, elicited some interesting comments. Several cautioned that such data should not become available (i.e., published) until the locality became sufficiently protected, specifically noting that advertising of the locality would serve to stimulate the greed of dealers and even of individual collectors, Federation clubs, professionals and land profiteers out to 'make a buck'. It is clear that, as a heterogeneous group, we nevertheless agree in our distrust of each other. Surely, this is regrettable. Hopefully, we can change the attitude by advancing ethical responsibility. Several also commented that local FM members and clubs can best gather these data and suggest implementation. This procedure already is underway in Pennsylvania. Once these data are gathered, some restriction in dissemination (e.g. to schools, researchers, compilers, responsible club officials) was favored by most who commented. In this connection, a proposal to circulate a list of endangered localities was favored by only 75%; many of these (as well as those who disapproved) fear that such a circulation, while perhaps putting pressure on owners and corporations, would merely spur collectors on to "grab while the grabbing is good". Here again, keeping the information at a local level was favored.

Another important question, favored (with restrictions) by 97% of the respondents, concerned the pursuit of controls on collecting at endangered sites and the encouragement of a better relationship between owners and collectors. In spite of the general approval and the committee goals, this item was given a lower priority than the programs discussed above. In most cases, this rather low priority derives from the difficulties involved in finding a workable method ofcontrol; indeed, some said "Forget it. There always will be vandalism, discourtesy, and greed." While regrettaby true, should this stop us from trying? Most added that collecting should not be totally stopped just "for the sake of preservation", noting that continued collecting commonly reveals new minerals and new knowledge. Again, many preferred that the investigations and solutions be carried out locally, several cautioning that local mineral clubs may not be sufficiently knowledgable, responsible, or interested to do a good job (that same suspicious nature again, but apparently not without some foundation). Suggested solutions ranged from (armed ?) guards to outright purchase of property by FM. More realistic were controls under a state of local park ownership, entrance fees to prevent an occasional profit from trucking for landfill or local trash dumping, promoting owner supervision, and acquisition by clubs, universities, or other cultural and/or scientific groups. Several commented that as FM's prestige grows so will its ability to effect controls. Consequently, an active membership is essential. A comment by Louis Moyd reveals another pertinent aspect: "Mineral localities must be considered ephemeral. They cannot withstand forever the requirements for research, training, exhibition and just personal pleasure." He also notes that the demands of our society for natural resources may outweight their importance as mineralogical localities. Where such economic consideration applies, it seems obvious that both specimens and complete information are now essential.

The most controversial program was the preparation and publication of a guide to collecting, stressing in detail ethical, responsible behavior as well as safety measures and general collecting restrictions (91% in favor). The controversy becomes evident by its priority ranking: last among all suggested activities. Many felt the subject was already covered in the Federation code and in books, is below the level of FM concern, or would be ignored by those whom it was intended to reach (are we really so ineducable?). Others felt existing codes were insufficient or not properly stressed. Several thought that MR should publish a code; others that a code should be compiled and submitted to the Federation through member clubs. Thus, the only areas of agreement seem to be that there is an ethical problem and that codes are, at best, guidelines. Perhaps this is an area where FM members can best work directly with clubs and, through the clubs, with the parent

continued on page 16

ROCK AND MINERAL EXCHANGE SERVICE

Elementary, secondary, and college earth science teachers interested in swapping rocks, minerals, fossils and/or earth science curriculum materials are hereby notified that a clearinghouse for the exchange of earth science materials has been established in Athens, Georgia.

To take advantage of this *free,* voluntary service, send a list (with size and quantity) of the rocks, minerals, fossils, and/or earth science curriculum materials you NEED, along with a list of the materials YOU CAN SWAP, to: Charles A. Wall, RMES, Department of Science Education, University of Georgia, Athens, Georgia 30601.

You will be supplied with the names, addresses, and "swap sheets" of those teachers who can meet your earth science materials needs on a SWAP basis. To receive additional RMES "swap sheets," send a *stamped, self-addressed envelope* (business size), to the RMES. Due to the *free,* voluntary nature of the RMES, *only* those inquiries accompanied by *stamped, self-addressed envelopes* will be processed.

MINERAL NOTES

NEW MINERALS

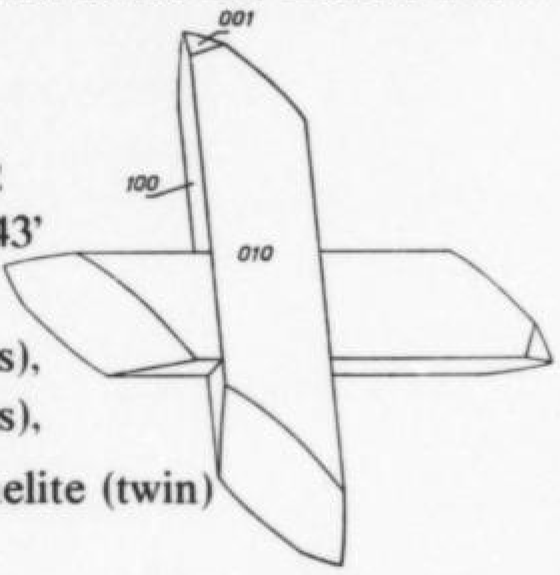
SCHUBNELITE

La schubnelite, nouveau vanadate de fer hydrate
Fabien Cesbron
Bull. Soc. fr. Mineral. Crystallogr., 93, 470-475, 1970

Schubnelite, a new hydrated iron vanadate of composition $Fe_2V_2O_8 \cdot 2H_2O$, occurs at the base of the oxidation zone of the uranium deposit of Mounana, Gabon. It is associated with fervanite ($Fe_4V_4O_{16} \cdot 5H_2O$) and goethite. Schubnelite is distinguishable from fervanite by its powder pattern.

Crystals of schubnelite are black with brilliant luster; thin splinters are transparent and weakly pleochroic from yellowish brown to greenish brown. The crystals, less than 0.5 mm in length, are prismatic and elongated *c*, showing well-developed (010) and (100), and very small (001); they are twinned on (212).

The mineral is named for H. J. Schubnel, French mineralogist and gemmologist.



Schubnelite (twin)

Triclinic - space group *P* 1
$a = 6.59$ Å $b = 5.43$ $c = 6.62$
$\alpha = 125°$ $\beta = 104°$ $\gamma = 84°43'$
Z = 1 S.G. = 3.28 (meas.)

Strongest x-ray lines: 4.47 (vvs), 3.21 (vvs), 5.15 (vs), 3.19 (vs), 3.07 (s)

BRÜGGENITE

Brüggenite, $Ca(IO_3)_2 \cdot H_2O$, a new saline mineral from the Chilean nitrate deposits (abstr.)

Mary E. Mrose, George E. Ericksen, and John Marinenko
20th Clay Minerals Conference, Rapid City, S.D., Ann. Mtg., *Program and Abstracts,* p. 13, 1971

Brüggenite, a new hydrous calcium iodate of composition $Ca(IO_3)_2 \cdot H_2O$ is found intimately associated with lautarite, $Ca(IO_3)_2$, in veins of high-purity fibrous soda-niter at Pampa Pique III, Oficina Lautare, Chile - the type locality for lautarite and for dietzeite, $Ca(IO_3)_2 (CrO_4)$.

The new mineral occurs as long columnar anhedral crystals intergrown with fibrous soda-niter, and as encrusting crystalline masses and short columnar crystals at vein borders. Brüggenite is colorless to bright yellow, translucent to transparent, with vitreous luster. Hardness is about 3 1/2. The mineral is brittle and shows conchoidal fracture. Brüggenite is slightly soluble in water, but insoluble in acetone, xylene, and alcohol.

The mineral is named for Juan Brüggen M. (1887-1953), whose broad investigations in Chilean geology, including the nitrate deposits, are fundamental to modern geological studies in Chile.

Monoclinic - space group $P2_1/c$
$a = 8.505$ Å $b = 10.000$ $c = 7.498$ $\beta = 95°15'$
Z = 4 S.G. = 4.24(meas.), 4.267(calc.)

Biaxial (-) with $2V = 88°$, $\alpha = 1.773$, $\beta = 1.797$, $\gamma = 1.814$ (Na, at 25°C) $Z = b$, $X\alpha = +9°$; elongation negative; $r > v$, moderate to strong

Strongest x-ray lines: 3.048 (100), 3.232 (71), 4.235 (50), 2.992 (50), 2.517 (50), 1.746 (50). (Data on ASTM Card 1-0386 are for synthetic brüggenite, not lautarite.)

STENHUGGARITE

Stenhuggarite, a new mineral from Långban and new data on magnussonite

Paul B. Moore

Arkiv Min. Geol., 5, 55-62, 1970

Stenhuggarite, $Ca_2 Fe_2 Sb_2 O_3 (As O_3)_4$, occurs as very rare, minute, deep reddish-orange, nearly equant tetragonal crystals in pockets in granular hematite ore at Langban, Sweden; only four specimens could be located. The mineral has a bright yellow streak; hardness is 4-; There is no diagnostic cleavage.

Crystals of stenhuggarite are transparent to translucent and show the forms *a*{100}, *k*{211}, and *s*{301}, giving a pseudo-octaedral appearance.

The name is derived from the Swedish *stenhuggar* [=(stone mason]; the mineral is named for Dr. Brian Mason, U. S. National Museum, in recognition of his contributions to Långban mineralogy.

Tetragonal - space group $I4_1/amd$
$a = 16.12$Å $c = 10.70$ Z = 8
S.G. = 4.63±0.05 (by Berman balance on 6.021 mg of material)

Strongest x-ray lines: 2.985 (10), 1.845 (4), 2.548 (3 1/2), 1.544 (3 1/2), 5.92 (3)

ERRATA

From "Classic Locality: The Apache Mine" Vol. 2 #6

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Mineralogy of the Miarolitic Cavities[1] in the Plutonic Rocks of the Oslo Region, Norway

by Gunnar Raade

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Editor's note: we are printing the author's photographs as stereo pairs to see how this practice is received by our readers. Of course, special glasses are required to achieve a three-dimensional image. These glasses, for viewing stereo pairs, are available at low cost from Ward's Natural Science Establishment, 3000 East Ridge Road, Rochester, N.Y. 14603, and T. N. Hubbard Scientific Co., P.O. Box 105, Northbrook, IL 60062.

INTRODUCTION

The Permian igneous rock complex of the Oslo Region is world famous among mineralogists and petrologists. This is mainly on account of the comprehensive descriptions published by W. C. Brøgger from about 1880 to 1930, dealing with the mineralogy of the nepheline syenite pegmatites of the Langesundsfjord district, and the petrology of the interesting suites of intrusive and extrusive rocks of mildly alkaline character. The classic treatise on contact metamorphism by V. M. Goldschmidt was also based on observations from the Oslo region.

It is well known that some of the plutonic Oslo rocks are very rich in miarolitic cavities, pointing to a high content of volatiles in the magmas, but rather little attention has been given to the mineralogy of these cavities. Although the cavity minerals have been studied sporadically for about a century by several Norwegian mineralogists, surprisingly little has been published.

The purpose of the present paper is to make a worldwide mass of readers acquainted with the interesting suite of minerals found in these cavities, and to point out some peculiar features concerning the distribution of the minerals and the geochemistry of the magmatic volatiles. A complete list of the minerals identified so far is given in Table 1. The possibilities of making new discoveries are good - micromounters visiting Norway should pay attention to this.

ROCK DESCRIPTIONS

Miarolitic cavities are found in three principal rock types:

1) *Syenites*, of which there are two kinds - *Grefsen syenite* being an ordinary syenite carrying biotite, and *nordmarkite* being an alkali syenite with aegirine and/or sodic amphiboles. Most of the minerals listed under syenite in Table 1 refer to the Grefsen syenite, which is thus the most important from our point of view.

2) *Alkali granite*, called *ekerite*, is a soda granite with aegirine and/or sodic amphiboles. There are often transitions between nordmarkite and ekerite in the field.

3) Ordinary *biotite granite*, or *Drammen granite*. This rock seems to occupy a more independent position in the Oslo region series.

FORMATION OF THE CAVITIES

It is evident that the magmas forming the Grefsen syenite, nordmarkite, ekerite, and Drammen granite were very rich in volatiles. The most important localities for miarolitic cavities in the Drammen granite are mostly situated near the contact to marine Cambro-Silurian sediments (Raade 1971), and at least for this rock both the concentration of volatiles in the outer parts of the magma and the assimilation of sediments may have played an important role in the development of the cavities. The Drammen granite is also the only rock carrying tourmaline within the cavities, which could be interpreted as a result of boron contamination by assimilation of sediments.

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[1] miarolitic cavities are cavities in plutonic rocks, especially granites, into which small crystals of the rock-forming mineral project.

TABLE 1. MINERALS FROM MIAROLITIC CAVITIES, OSLO REGION, NORWAY

	Syenites[1]	Alkali granite[2]	Biotite granite[3]
Sulphides			
Sphalerite	3*	+**	
Chalcopyrite	1-3		
Pyrrhotite	1		+
Galena	3-7-8		
Pyrite	1-3-7	2	11
Molybdenite	3	2	11
Halides			
Sellaite		13	
Fluorite	1-3-7-8	2	1-10-11
Gagarinite		13	
Gearksutite		2-13	
Thomsenolite		13	
Oxides, Hydroxides			
Magnetite	3-7-14		10-11
Hematite	3-8		11
Pyrochlore	8	+	
Quartz	1-3-5-7-8-14	2	1-6-10-11
Opal	+	+	11
Rutile			+
Anatase	14	+	11
Brookite		13	11
Goethite			11
Carbonates			
Calcite	1-3		11
Malachite	+		
Bastnäsite	7		
Synchysite			11
Ancylite	8		
Sulphates, Molybdates			
Barite			+
Gypsum	+		
Wulfenite	7-8		
Phosphates			
Monazite		+	
Apatite	3	+	11
Silicates			
Neso-			
Phenacite	8		
Zircon	1-8	2	11
Titanite	1-3-7-8-14	2	3-6-10-11
Soro-			
Bavenite			10
Astrophyllite		2	
Epidote	3		10
Allanite	1-3-7-8		11
Cyclo-			
Catapleiite		2	
Elpidite		2-13	
Beryl			+
Tourmaline			3-6-11
Milarite	7-8		
Ino-			
Diopside	3		11
Aegirine	1-14	2	
Ramsayite		13	
Bertrandite	7-8		
Actinolite	+		11
Hornblende	1-3-7-8-14		11
Arfvedsonite		2	
Narsarsukite		2-13	
Phyllo-			
Epididymite		13	
Muscovite	+	+	6-9-11
Biotite	1-3-7-14		1-11
Stilpnomelane	+		
Chlorite	7	+	10-11
Kaolinite			+
Dickite			11
Pyrosmalite	8		
Zeophyllite		2	
Tekto-			
K-feldspar	1-3-7-8-14	2	1-6-9-10-11
Albite	1-3-5-7-8-14	2	1-10-11
Helvine	5-7-8		
Laumontite			10
Heulandite	3		11
Stilbite	1		3-6-10-11
Harmotome	1-3-8		11
Chabazite	+		6-10-11

[1] Grefsen syenite, Nordmarkite

[2] Ekerite

[3] Drammen granite

*Numbers refer to the literature list.

**+means unpublished observations.

The same magmatic volatiles which were responsible for the formation of the cavities are also commonly believed to have given rise to the contact-metasomatic deposits in the Oslo region. Zinc, lead, and iron mineralizations are typical for both syenites and granites - bismuth, copper, and molybdenum for the Drammen granite. However, minerals of these elements (like sphalerite, galena, pyrite, hematite, chalcopyrite, molybdenite, etc.) are only found in small amounts in the syenites and are still more rare in the granites. Quite simply, the reason may be that the elements in the magmatic volatiles are very unevenly distributed, some being largely concentrated in certain parts of the magmas. This point is thought to be of some importance, and is typically shown by elements like beryllium and molybdenum, minerals which seem to have a tendency of being restricted to small areas within a pluton. It is, however, also possible that the volatiles forming the contact-metasomatic deposits were of a different chemical composition from those forming the cavities, and this difference might be explained by a process of endomagmatic hydrothermal differentiation (Neumann 1948).

It is also interesting to compare the mineralogy and chemistry of miarolitic cavities and pegmatite dikes, which are related in many ways (e.g. in the rocks treated here there are all transitions between miarolitic cavities and pegmatitic veins). Thus, the mineralogy of the syenite and Drammen granite cavities can be compared with granite pegmatites, and the mineralogy of ekerite cavities with nepheline syenite pegmatites.

Further, comparison with the hydrothermal Alpine veins (Weibel 1969) also reveals certain similarities in mineralogy and chemistry, although this could be just a superficial assessment.

SOME MINERALOGICAL AND GEOCHEMICAL ASPECTS

As is apparent from Table 1, the syenite and Drammen granite cavities are not very different in their mineralogy. It is worth mentioning that the titanite from one particular Drammen granite locality (Raade 1969), is largely decomposed by late, siliceous solutions, to form a mixture of anatase, brookite, synchysite, and the 1M polymorph of muscovite.

Beryllium is present in all three rock types, and it is interesting to note that quite specific beryllium minerals are found in each rock, namely phenacite, milarite, bertrandite, and helvine in the Grefsen syenite, bavenite and beryl in the Drammen granite, and epididymite in the ekerite.

The cavity minerals of the ekerite are very different from the other rocks. Titanium and zirconium are characteristic elements, forming rare minerals like elpidite, ramsayite, astrophyllite, narsarsukite, and catapleiite.

Zeolites and carbonates, especially calcite, were among the latest minerals to crystallize in the Drammen granite and syenite cavities. None of these minerals are present in the ekerite - instead, an unusual fluoride paragenesis is formed, with gagarinite, sellaite, thomsenolite, and gearksutite. The fluoride assemblage of the ekerite is thus directly equivalent to the zeolite and carbonate assemblage of the other two rock types.

The large variety of different minerals found in each rock indicates that the crystallization within the cavities went on for a considerable temperature (and time ?) interval, commencing with minerals like diopside and aegirine and ending up with zeolites or fluorides, and still later kaolinite, dickite, and opal.

The few points discussed above clearly show that the cavity formations deserve a thorough investigation, which will hopefully be undertaken in not a too far future.

In Figs. 1-7 are shown photomicrographic stereo pairs of some well-crystallized cavity minerals. All pictures were taken by the author.

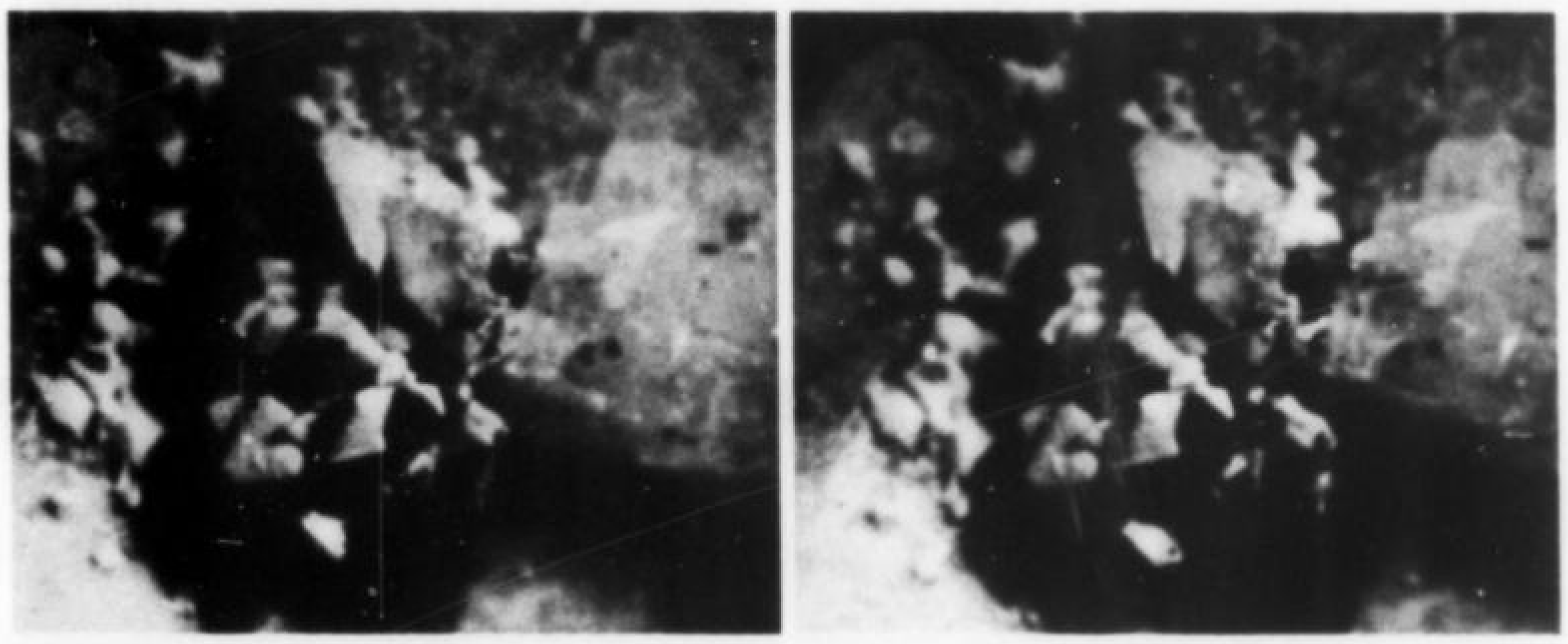

***Fig. 1.* Ancylite crystals, completely altered to bastnasite, from Grefsen syenite at Bonkall, Oslo. 15X.**

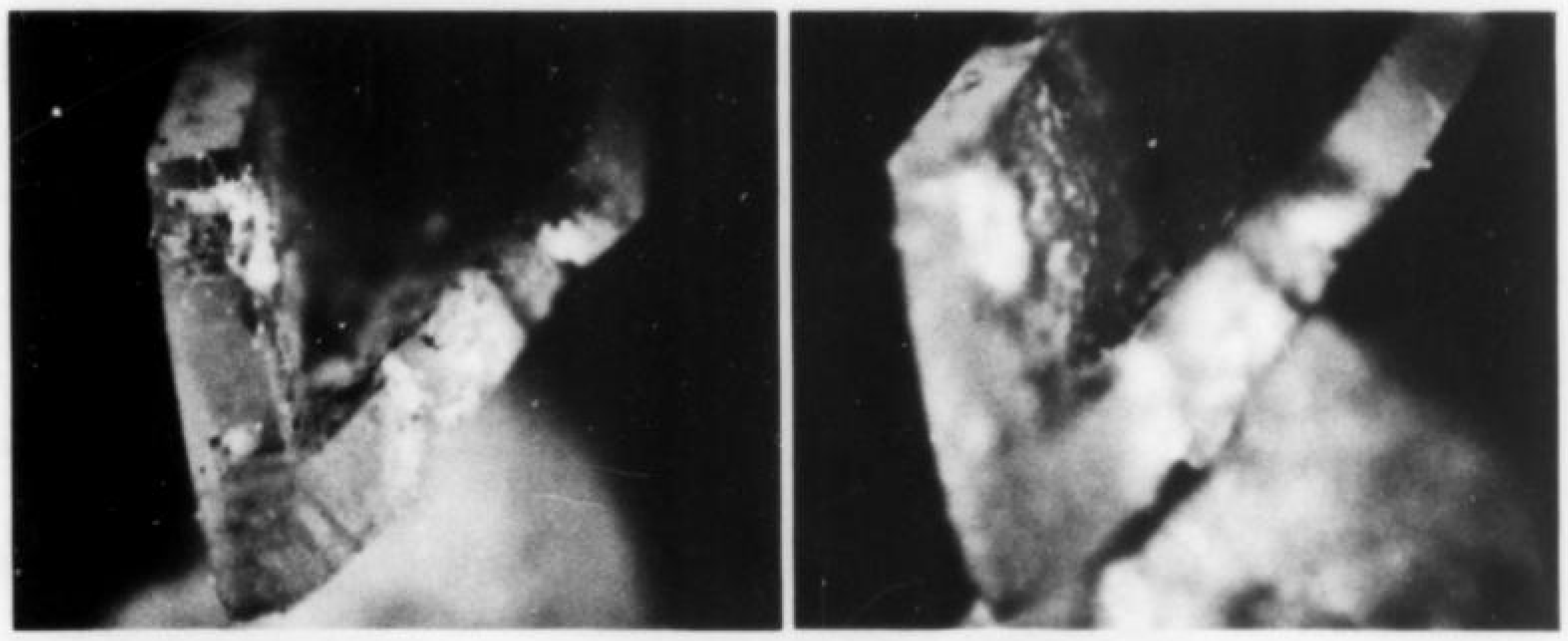

***Fig. 2.* V-shaped twin of bertrandite, from Grefson syenite at Bonkall, Oslo. 30X.**

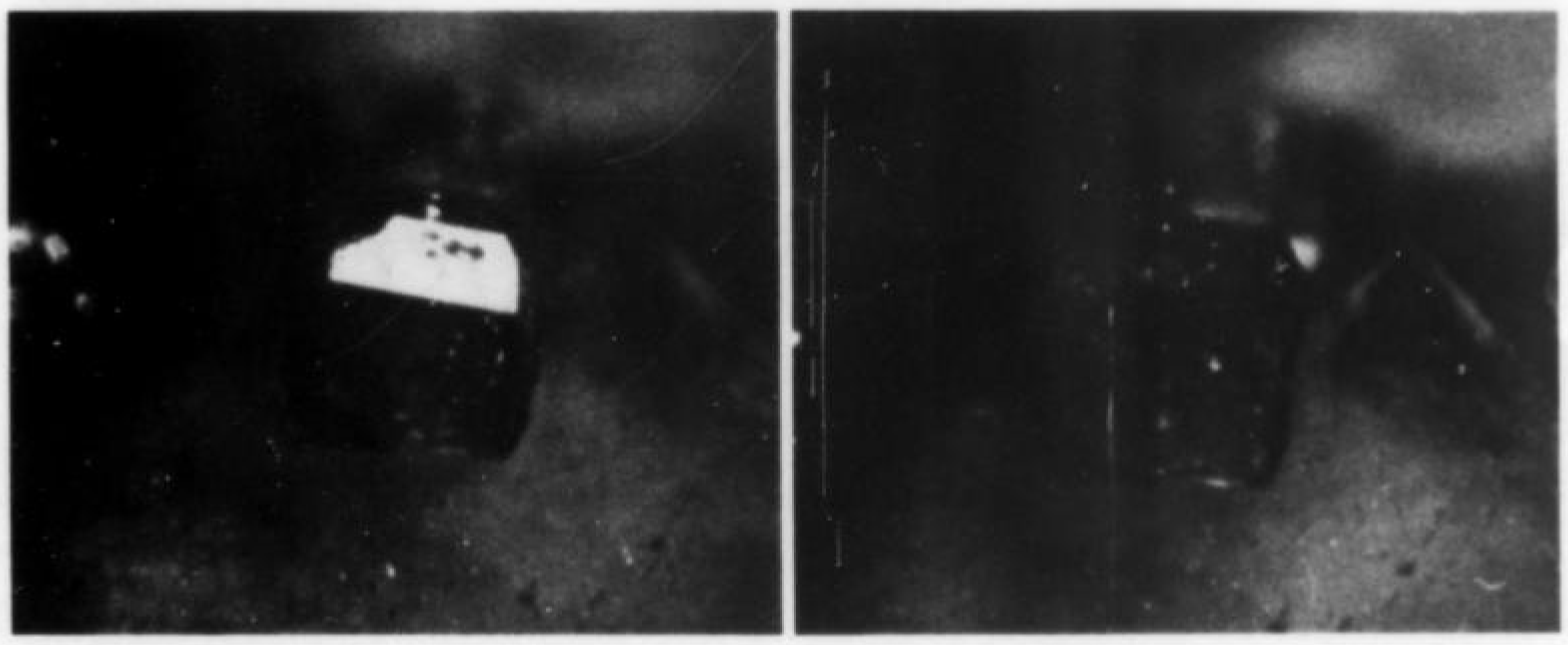

***Fig. 3.* Gagarinite crystal, hexagonal, $NaCaYF_6$, from alkali granite (ekerite) at Gjerdingen, Nordmarka. This is the only known occurrence outside the USSR. 60X.**

Fig. 4. **Fibers of ramsayite, which are dusted by small sellaite crystals, protruding from an aegirine prism. From alkali granite (ekerite) at Gjerdingen, Nordmarka. 30X.**

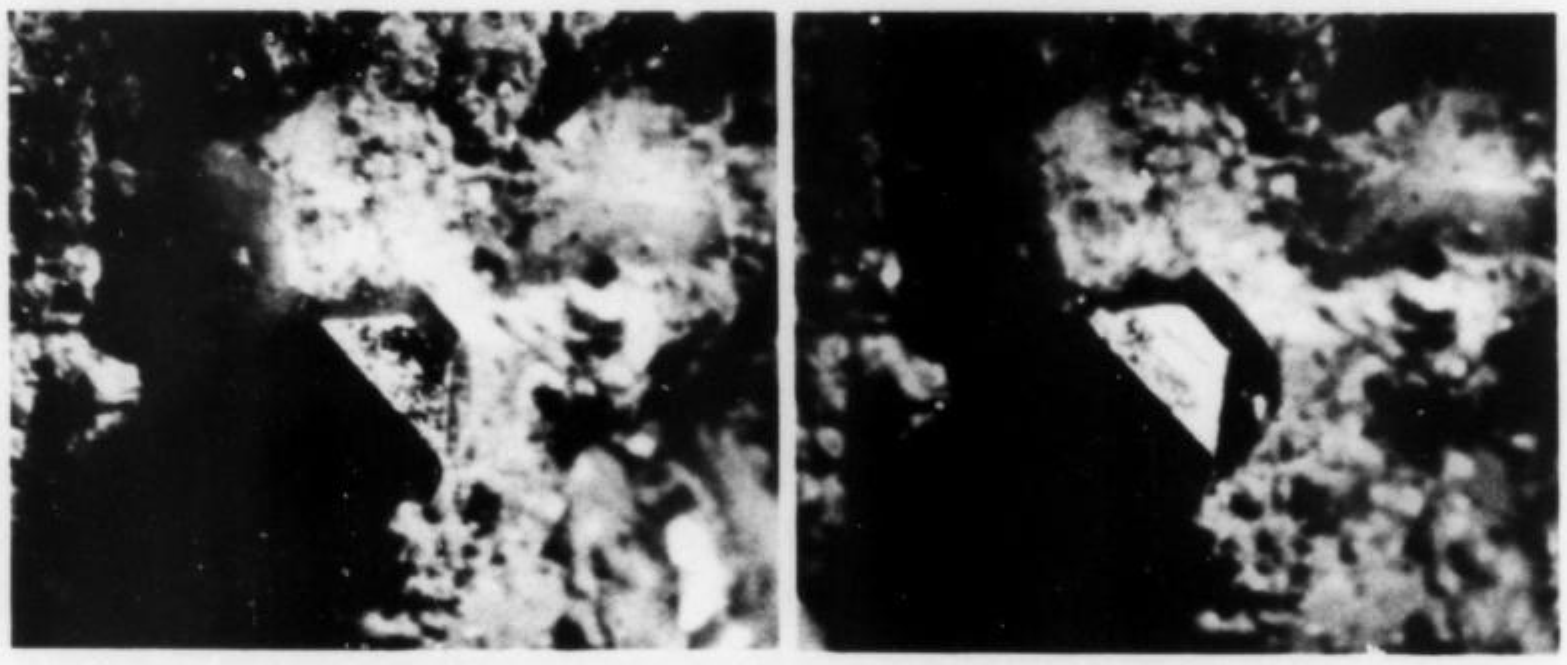

Fig. 5. **Anatase crystal, showing (111)-(113)-(001), from biotite granite at Nedre Eiker Church. 15X.**

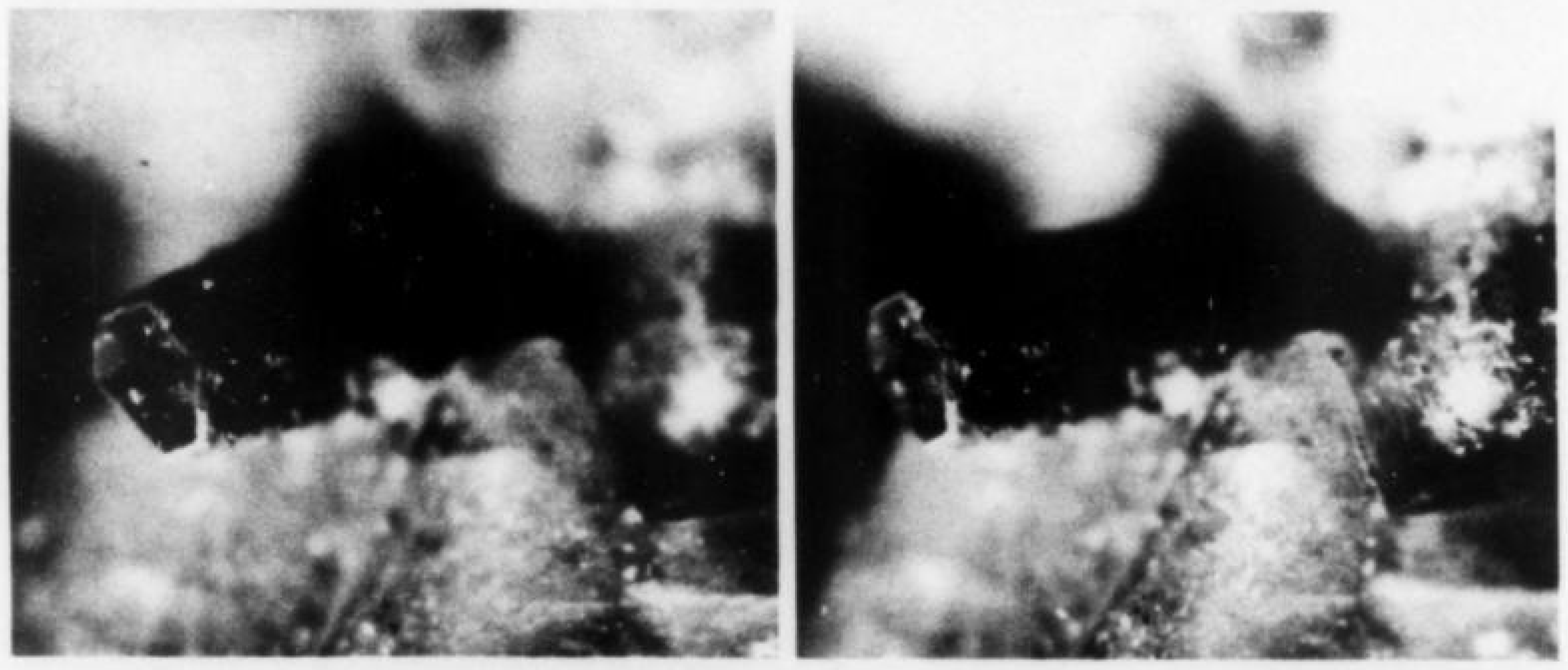

Fig. 6. **Synchysite crystal, from biotite granite at Nedre Eiker Church. Note that the prism faces are slightly altered and covered by chlorite, while the base is well developed and shining. 30X.**

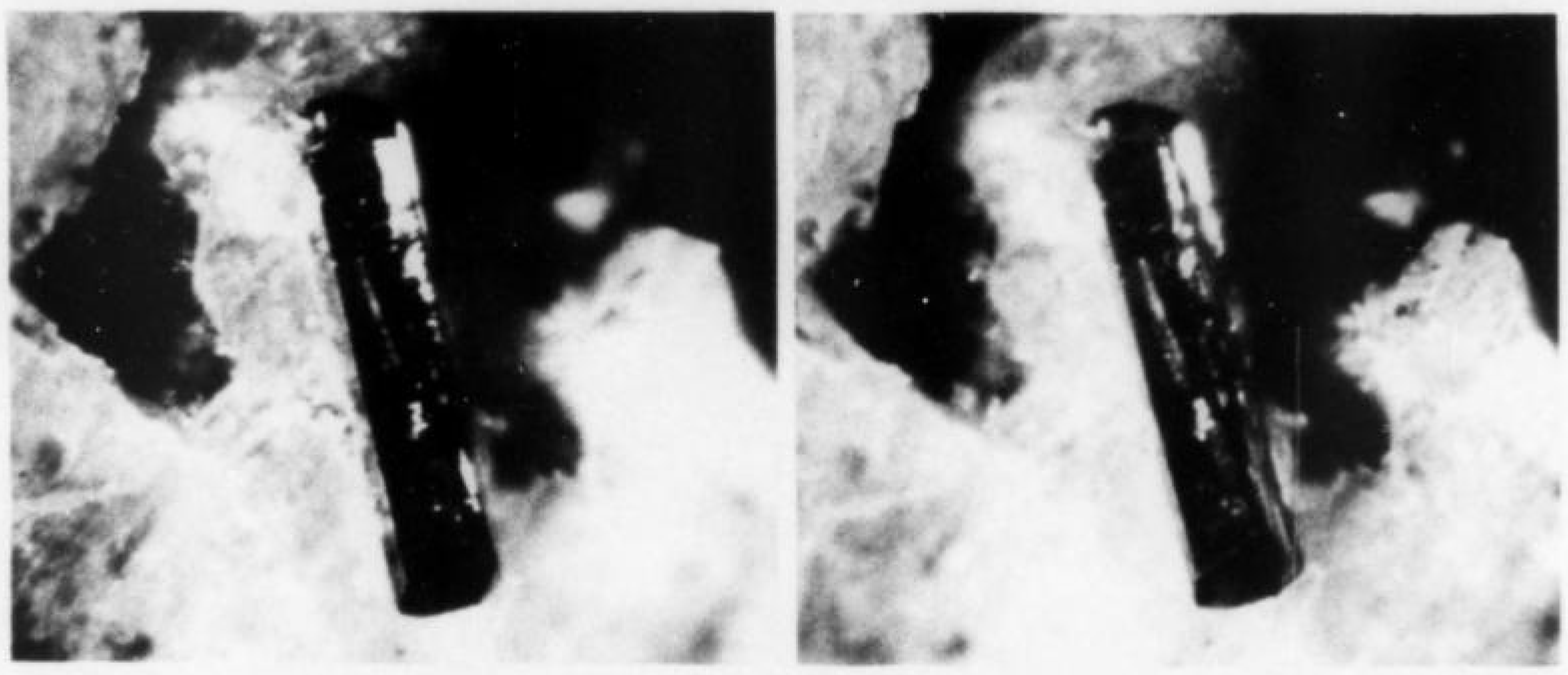

Fig. 7. **Prismatic crystal of titanite, from biotite granite at Nedre Eiker Church. 60X.**

ACKNOWLEDGEMENTS

I am indebted to Mr. Per Chr. Saebøfor permission to incorporate unpublished data in Table 1. Mr. Knut Eldjarn also gave valuable information. The titanite and gagarinite micromounts reproduced here were kindly placed at the author's disposal by Mr. Jan Haug.

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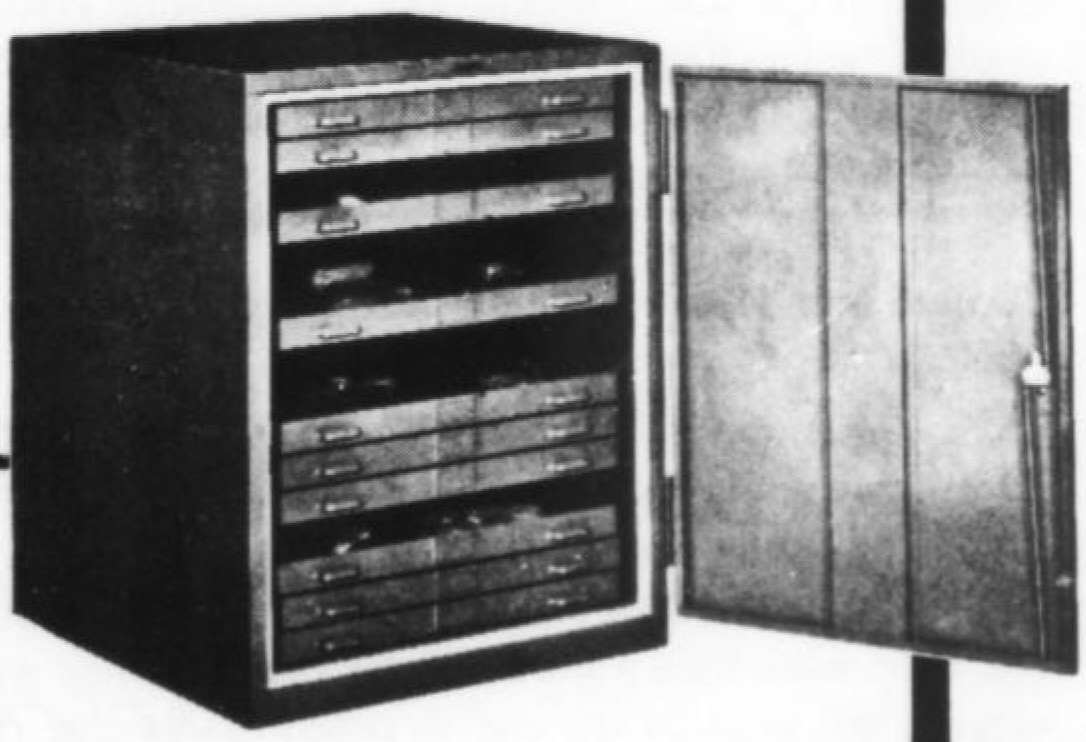

THE COLLECTOR

by Richard A. Bideaux

This column's purpose is to provide more material in the pages of the *Record* for those predominate interested in the collection of fine mineral specimens. Why are there these collectors in the first place, and of what significance are their collections?

As a child of thirteen I spent a summer in a nearby mountain canyon, walls pockmarked with prospecting pits of three-quarters of a century earlier. Mere location of these provided some necessary interesting activity. One day while exploring around these dumps, I chanced on a small quartz specimen that someone had carefully placed on a boulder. One crystal in a vug was jewel-like in clarity and perfection; surely this could not be of natural origin! Rather, its owner, by then indeterminate, must have had the misfortune of loss of this valuable object, transported onto the property from whence it was made.

By summer's end, this quartz was joined on the cabin's shelves by bright bits of bornite and chalcopyrite, colorful lumps of malachite and chrysocolla, knobby masses of chalcedony, and other indeterminate but still attractive specimens. Only the loudest pleas permitted these treasures to be transported back to Tucson, after the now classic comment from father—"What would anyone want to keep these for?"!

A few friends of similar age also became interested, and fathers were further called upon to transport this crew to potential collecting grounds, the nearby "Dana locality" of the Old Yuma mine being a favorite. This must have been more than a little dull for them, as they were generally left most of the day to reflect on parting promises that all would reappear by sundown. My father, on one such trip to the old mining camp of Helvetia, began to notice, and then sort out, tiny but perfect pyrite crystals scattered in the dirt near the car. Today he is a dealer in specimen material, and continues his interest in building our joint collection. Two of this group of youngsters have become professional geologists.

In the early stages, none of us knew the identity or significance of these specimens, but finally a patient mineralogist with the Arizona Bureau of Mines was located and inundated with "unknowns." I once almost stopped taking in more specimens, for fear they would again be chrysocolla, no matter how unlike they were from pieces previously identified as this "mineral." The mineralogist, John Anthony, now professor of geology at the University of Arizona, later taught me most of what I know about formal mineralogy. The editor of this magazine is also one of his former students. Another year of this association should see completion of an updated mineralogy of Arizona, in company with Sid Williams. A little patience can have far-reaching effects.

There are two sides to collecting, esthetic and scientific. Many mineral specimens are beautiful objects to contemplate, and are well worthy of collecting for that reason alone. The variety of crystal shapes and the seemingly endless variations in composition and occurrences of minerals initially excite a desire for understanding, which has given rise to the scientific side of collecting.

The broadest goal in collecting, fully satisfying both esthetics and science, would be to acquire the finest possible examples of all mineral species, in every type of crystal form, association, etc. Some collectors of past years, notably Col. Washington A. Roebling, whose collection is the nucleus of the National Museum's collection, seriously had this aim. At the present time few, if any, could afford the time, space or cost of acquisition such a goal would require. Specialization is the obvious answer to build a collection with limited goals but still of significance. Here I will touch on just a few of the more common ways of so limiting one's collection.

Certain species have sufficient diversity within themselves to provide an interesting collection alone. Calcite is foremost of these in popularity. The mineral is usually well crystallized, and shows a wide variety of crystal habits, as well as several twin laws, but it is not usually found in strongly colored specimens. Nearly a thousand different types of crystal faces have been measured and recorded for this species, far more than for any other.

Fluorite is another frequently collected species, also usually in good crystals, which remarkably occurs in all colors of the spectrum, as well as colorless, white, gray and black. Our collection has more than its proportionate share of these two minerals, as well as of cerussite and azurite, but the more than 300 wulfenite specimens are really our single species sub-collection.

A suite of all minerals from one geographic area can provide an attractive and scientifically valuable collection. Sir Arthur Russell's collection of British minerals, now in the British Museum, is an incredible testament to the range of species and their superior quality occurring in such a limited area. Paul Moore's recent *Record* article noted that there were no private collectors successfully specializing in minerals from the Langban, Sweden area, the world's leading locality for number of species recorded. However, there have been a number of collections made of minerals from Franklin, New Jersey and Crestmore, California, generally recognized as the world's number two and three most species-prolific localities.

To collect all species occurring at a locality with, say, thirty or more species recognized, can be quite a challenge, and in most cases will provide an irreplaceable scientific record. Our collection has the most complete suite of Mannoth mine, Tiger, Arizona species, and we collect examples from the finer Arizona occurrences in general.

To obtain good examples of all species bearing one metallic chemical element presents the same type of problems as the general goal of collecting all species. Not all will be available likely, even with the most intensive efforts, and will preclude acquisition of the last few percent of the species known. This aim requires constant scanning of new species as they are reported into the literature; the most up-to-date references, such as Michael Fleischer's *Glossary of Mineral Species - 1971*, published by the *Record*, are essential.

Calcium-bearing species are the most numerous, with over 500 known. Iron and lead are represented in a large number of species. Copper follows with around 200 species, nearly all colorful, an added attraction. Zinc and silver have about 100 species each. We know one collector still attempting to commplete a set of the approximately 25 mercury minerals. As a resident of the world's leading copper-producing area, we early became interested in the copper-bearing minerals, have perhaps 125 different ones now.

Excellent crystals of any species have long been a central interest to most collectors. We are partial to euhedrons; completely faced crystals, without visible point of attachment. Twin crystals are another specialization, as well as those exhibiting unusual crystal forms and combinations. Recognition and proper appreciation of these requires substantial study.

Rigid size restrictions are not a valid limiting of goals. Far too much irreplaceable material is sacrificed in attempts to trim already balanced specimens to fit arbitrary maximum sizes, or passed over because it is a little too big or small. In this respect current competitive rules perform a disservice to mineralogy.

Rather than attempting to build a collection of all species, almost certainly foredoomed to mediocrity, we advocate a collection made up of a number of sub-collections for those with more than one interest. With limited collecting goals, more possible of attainment, real excellence can be achieved. Further, sharply defined interests make it much easier for friends and dealers to call attention to desirable specimens.

Another time we would like to devote a column to some of the more unusual collecting specialties which have come to our attention. If you have an out of the ordinary specialty, I would like to hear about it, and how you are coming.

What's New in Minerals?

Photos by Joel E. Arem

RESPONSES

In this column two issues ago (Vol. 2, no. 5) I described identical-looking parisite specimens reported to have been obtained from two different localities in Montana—(1) Snowbird deposit, Mineral County and (2) F and S mine, Missoula County. I've had one letter explaining that this resulted from confusion over the exact location of the common boundary line of the two counties. The two localities are actually one—the F and S mine, Missoula County. The writer of the letter was embarrassed because he collected some of the parisite and it was he who attributed it to the locality (1) above.

Shortly there came another letter, this from Raymond Lasmanis, Spokane, Washington. I quote, "Both the Snowbird deposit and the F and S mine are correct localities. The Mineral and Missoula County Line separates the prospects. I might add that the Idaho State Line with Clearwater County lies just 1½ miles to the south and some specimens may actually have an Idaho label." Lasmanis also reported that parisite has been said to have been found near the old White Cloud mine in northeastern Ravalli County, Montana.

Peter Embrey (British Museum) replied to my query (Vol. 2, no. 4) about the precise location of Alp Lercheltini, as did Martin Plotkin of Massapequa Park, New York and Kay Robertson of Los Angeles, California. According to Embrey, Desbuissons' *La Valee de Binn* (1909) pinpoints the locality as about 2 miles east of Binn on the south bank of the Binna proper and on the other side of the hill from Lengenbach. Today Alp Lercheltini is known as Alp Binneltini. Mrs. Robertson informs that Cherbadung (given as a cafarsite locality in the column) is a mountain on the Italian border and may be called Pizzo Cervadone on specimen labels.

WARDITE

Wardite is one of the secondary phosphate minerals of pegmatites that seems not to attract much attention. It is a sodium aluminum phosphate hydroxide hydrate and is known in small crystals (about 2 mm) from Wolfsberg, near Spittal, Carinthia, Austria, Frondel (*Dana's System)* reports "large crystals" from a pegmatite at Beryl Mountain near West Andover, New Hampshire, but dimensions are not given. It is also relatively abundant as blue-green crusts with other supergene phosphates, particularly variscite, at Fairfield, Utah. It is now demanding more attention in a conventional manner - it has turned up in what are, for wardite, exceptionally large crystals. Figures 1 and 2 show a specimen from the famed rose quartz, eosphorite, roscherite locality described by Alvaro Lucio (Vol. 2, no. 1) as "a 'garimpo' located on an island at the Jequitinhonha River. The island is located approximately 3 km north of Taquaral (locality), Itinga (county)." Most labels are shortened to Taquaral, Minas Gerais, Brazil. The figured specimen consists of a 7 cm very pale rose quartz crystal over the surface of which are scattered 7 to 8-mm wardite crystals and 3-mm radial clusters of dark olive green roscherite crystals. The wardite crystals are white-colored, simple tetragonal dipyramids. The pyramid faces are striated by fine horizontal rulings and the pinacoid is represented by a small face which reflects brightly even though the pyramid faces appear dull due to the striations.

Rich Kosnar (Mineral Classics, Aurora, Colorado) may have cornered the market, at least until the river level drops and more specimens are dug from the currently flooded prospect on the island. Kosnar acquired some 50 specimens out of which the figured specimen was pried loose for the collections of the Smithsonian Institution.

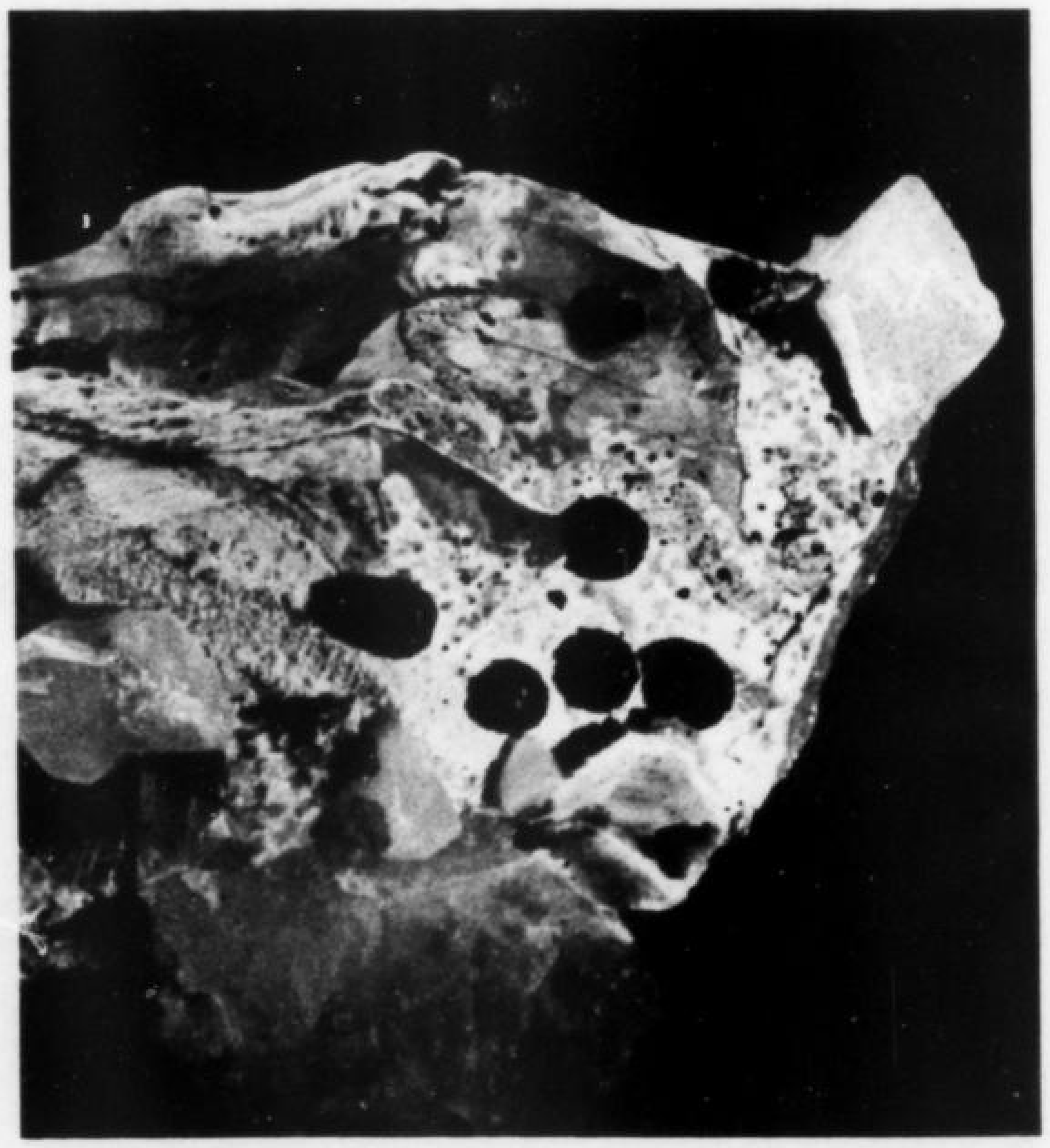

Fig. 1, **Wardite with roscherite on rose quartz - Taquaral, Minas Gerais, Brazil. Smithsonian Institution Specimen.**

INSTABILITY OF CHALCOCITE

The following note was submitted by William R. Cook, Jr., Gould Laboratories, 540 East 105th Street, Cleveland, Ohio 44108. It represents a portion of his PhD thesis studies and should be of interest to the mineral collector. . .

A number of minerals are known to be unstable in normal ambient atmospheres. Most are hydrates, but a few are sulfides or sulfosalts, of which realgar is perhaps the best known example. Chalcocite can now be added to the list. I have examined a number of synthetic and natural crystals of chalcocite with the following conclusions.

Chalcocite is not stable in air (i.e., oxygen). The copper will slowly oxidize on the surface of the mineral, frequently giving an iridescent sheen, and lowering the average copper content of the interior until the crystal changes to another phase. Copper migrates sufficiently rapidly that a crystal will remain relatively (not absoultely) uniform in composition. Depending on the size, a crystal in the range 0.1 to 2.0 mm will take a few months to a few years to transform completely from chalcocite (Cu_2S) *to djurleite* ($Cu_{1.93}S$). *Crystals attached to massive chalcocite may not show this transformation unless the specimen has been in a collection for a long time, since it will take a very long time for a massive piece to oxidize sufficiently to change phase.*

With further oxidation (sitting in a collection) the crystal may change again to a new phase with the composition of digenite (approximately $Cu_{1.8}S$ *or* Cu_9S_5*). Crystals from Cornwall, England with the external morphology of chalcocite, but which had been collected prior to 1899 (Case Institute of Technology sample 29) were found to be pure digenite. Synthetic crystals transformed from djurleite to a metastable new phase which proved to have the composition of digenite (1) but which was hexagonal or pseudohexagonal (2) after three months to two years at ambient atmosphere and temperature. This phase has not yet been found in naturally occurring crystals, but can be expected to exist temporarily in crystals which have reached the correct stage of oxidation. Since the phase is only metastable, it can be expected to transform eventually to digenite, as in Case Institute#29.*

***Fig. 2,* Close-up of Fig. 1 Wardite crystal at top is 8 mm. across.**

Crystals from about half a dozen samples in excess of 43 years old from two collections were examined, courtesy of the Cleveland Natural History Museum, and only one was found to contain any chalcocite at all. All the others were either djurleite or digenite. Only one of these specimens, that from Bristol, Conn. (Case Institue #4187) showed a morphology that was not consistent with the expected pseudohexagonal symmetry, but was like the Dana(3) drawing from Bristol. Since chalcocite transforms from hexagonal to pseudohexagonal at 103°C and djurleite is unstable above 90°C, the Bristol crystals, which appeared orthorhombic and were embedded in calcite, most probably formed below 103° and may have been djurleite from the beginning. The long axis of the crystal was the a axis of djurleite.

One massive specimen of chalcocite was examined (Natural Science No. 363 from Bisbee, Ariz.), and was found to be mainly djurleite, with no significant difference between the surface of the piece and an internal slice. Small crystals from a specimen from the "Lavender Pit" of Phelps Dodge, Bisbee, Ariz. collected in the summer of 1970 and supplied by David Mouat proved to be mixed, with varying amounts of chalcocite and djurleite. Undoubtedly the reason that they were not completely djurleite was that they were still attached to the matrix.

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TOBERMORITE. THAUMASITE, and APOPHYLLITE

Relatively abundant but largely overlooked is tobermorite from Concepcion del Oro district, Zacatecas, Mexico. It occurs as hemispheres and oblong round shapes dispersed over pyrite specimens (see photo). The rounded masses reach several millimeters in greatest dimension. Although observed for 3 or 4 years now it has never created much of a stir. This occurrence is rather unusual as tobermorite has been more or less confined to calc-silicate rocks, not sulfide deposits. Specimens of arsenopyrite from the same locality also have tobermorite on them. The locality for the latter is more detailed — the Cabre-Estantes mine, Concepcion del Oro district.

continued on page 42

QA column

Q. **Refering to your editorial in the *Mineralogical Record* (Vol. II, no. 4), I note that you give elbaite, schorl and dravite the status of species. Then tourmaline is, as garnet is, a group name and should not appear on labels. Is this correct? Elbaite is a new name to me. I do not find it in the textbooks.**

F. A. Cajori
Denver, Colorado

A. You will not find complete agreement on this point among leading references. It appears that the use of tourmaline for the group, and elbaite, schorl and dravite for the species, is gaining general acceptance. If one is willing to accept this practice for the garnets, then how can one not recognize an analogous situation in the tourmalines? Elbaite is the *lithium-aluminum* member, schorl the *sodium-iron*, and dravite the *sodium-magnesium*. There is still another, uvite, the *calcium-magnesium* member, but it is only known as a synthetic. Varietal names like achroite, indicolite, and rubellite refer only to color variants.

Q. **Sometimes the magnetite formula is written as Fe_3O_4 and sometimes as $FeFe_2O_4$. Which is preferred and why are there two usages?**

Rock Currier
Ardsley, New York

A. Magnetite is a member of the spinel group, all of which have the general formula AB_2O_4. All of the members of this group contain *A* elements that are divalent (charge of 2+) and *B* elements that are trivalent (charge of 3+) in the ratio of 1A:2B:40xygen. When magnetite is written properly, $FeFe_2O_4$, one knows immediately that the first iron is divalent (the *A* position in the formula) and the other two irons are trivalent (the *B* positions in the formula).

Q. **What do you do when you buy a specimen labeled argentite? I have read about it in references that say most argentite is altered to acanthite. So how should these specimens be labeled?**

Elmer Craft, Jr.
Eldorado, Oklahoma

A. It is probably safe to say that there isn't a single specimen of argentite in a mineral collection in the world, that is, unless the collection is kept at a temperature above 179°C. Below this temperature argentite (isometric) is unstable and alters to monoclinic acanthite. The alteration is in the form of subtle shifts in the internal atomic arrangement and is not apparant from observing the external form which remains that of argentite. Such alteration products are known as *paramorphs*. Therefore, specimens may be labeled simply "acanthite" or "acanthite after argentite". The latter is probably better for the paramorphs because it is also possible to have specimens of acanthite that crystallized as acanthite from the beginning.

FRIENDS OF MINERALOGY, continued from page 5

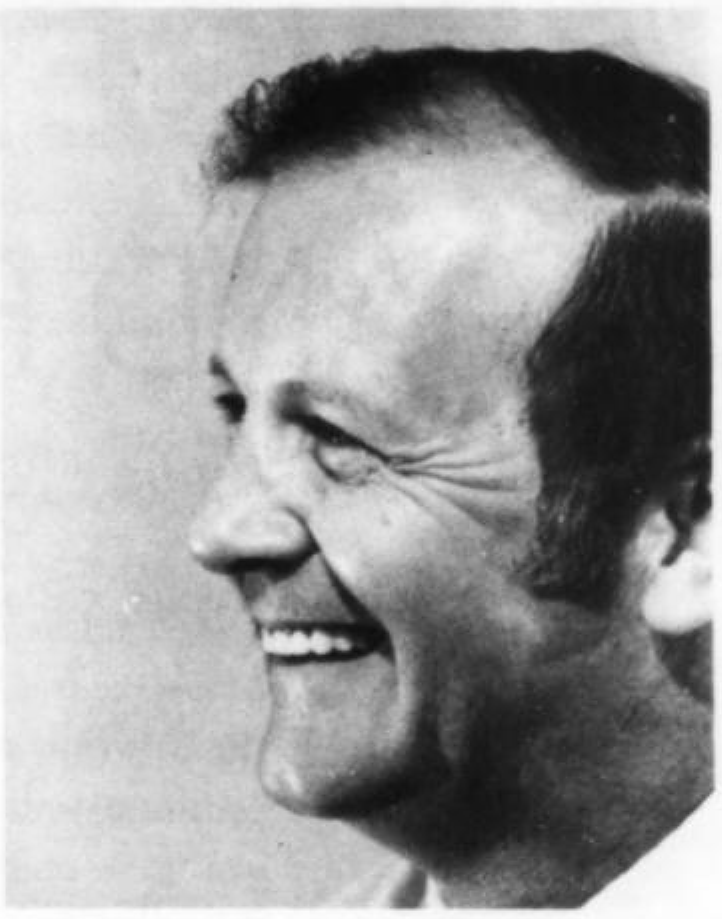
Federation. Personal contact and persuasion undoubtedly are more effective than any published 'Principles of Propriety' can ever become. We would like to hear comments from MR readers on this subject.

A final question dealt with the suggestion of posting a notice board at significant and endangered localities requesting compliance with collecting restrictions and giving a local (if possible) address where more information and/or entry permission could be obtained. Somewhat more than 60% of the respondents favored FM as a data and sponsoring source, but only 34% felt that financing should be through FM, most favoring local clubs, social organizations, or academic institutions. Generally, the suggestion has a low priority in part because signs tend to be quickly destroyed and in part because those who wish to collect indiscriminantly will not heed any restrictions. Then too, as Robert Smith pointed out, we do not want to drive a wedge between the scientist and the collector, nor to set up a privileged class of collectors. Here again local assessment and local action would seem to be the only reasonable course. As Allen Heyl pointed out, however, this does provide an opportunity to impress upon the owners the importance of their property to mineralogy.

In summary, the Minerals Preservation Committee should be engaged in 1) reporting case histories and solutions to problems involving mineral and locality preservation, 2) publishing results of activities whenever publication will not endanger the mineralogical status of a locality or any negotiations in progress, 3) collecting data on significant localities that can be made available upon request, subject to any distribution restrictions deemed necessary by local societies and FM members, 4) actively engaging in locality controls, sample preservation, and restoration or continuation of collecting at specific localities, primarily through local efforts and with the support both of professional and amateur mineralogists, and 5) through personal contact and through the federation of mineral clubs to persuasively promote ethical, responsible behavior on the part of all collectors.

Some progress already has been made toward achieving these goals and will be reported upon subsequently. Until then, we urge your ideas and active support in these projects whether or not you are a member of FM. Locality data or problems can be sent to me until local committees are established. Summary articles of famous localities, especially those now past their prime, lost, or inaccessible, along with their current status, will be welcomed for review and publication by the Editor of the *Mineralogical Record*. Any readers who have recommendations for the solution of a particular locality problem hopefully can be referred by FM to individuals who can give assistance. In short, we all can participate; in fact, we all must for this venture to be the success we think it deserves.

The Museum Record



by Paul E. Desautels

Yielding to an impulse, I recently accepted an invitation to stop in at Kingsport, Tennessee to speak to the local mineral society. The entire experience was quite a pleasure and it was good to see such an aggregation of active mineral collectors. Casey (K. C.) Brannock, a most knowledgeable collector friend of long standing, and his friends saw to it that my time was profitably spent.

One of the places I was taken to was the new Bays Mountain Park. This is a 1300 acre semiwilderness area on a mountaintop about six miles from downtown Kingsport. The city has developed and maintains the property as a nature preserve. It is a marvelously conceived and enlightened plan they are following in its development. Much of the activity at the Park centers around a beautiful new nature interpretive building. I hate to think what the building must have cost but feel that every penny was well spent. Among other things, in the central part of the building, there is a circular exhibit gallery following around the walls of an excellent and large planetarium. At the moment this gallery is practically empty since the building has been opened only a couple of months and most exhibits have yet to be prepared. It is intended that these exhibits will change with some frequency.

Seizing an opportunity, some of the members of the local mineral society had a beautiful wall case built measuring about seven feet high and ten feet across. In it, on glass shelves, they have arranged a neat and very attractive, but simple, display of minerals selected from their collections. The whole effect is very good and the individual specimens are of remarkably high quality. Some of them are just about as good as a collector can hope for.

While standing there admiring the exhibit and discussing mineral exhibits, and museums in general, an interesting point came up. It was suggested that perhaps the next project might be to set up an exhibit of minerals related to their economic uses. Of course, I am not opposed to such exhibits at all and would like to see lots more done in this direction. However, I thought I detected the suggestion that a showy display of minerals—such as the one we stood admiring—wasn't good enough and that something had to be done to make things more respectable by converting to "instructional" or "educational" type exhibits. At this point I mounted my soap box and gave my lecture for the day.

Since when does an exhibit of good mineral specimens need justification? There isn't a single art museum that I know of which would bat an eyelash at hanging a painting by Rembrandt or Picasso or Vermeer or Renoir with only a small name tag, and education be damned. Yet, almost all natural history museums of any account seem obsessed with the idea that explanation and instruction are perhaps more important than the objects themselves. If such feelings are based on the knowledge that natural history objects are extremely interesting, lend themselves handily to demonstrating ideas, and stimulate curiosity to the point where everyone wants to know what it's all about—then well and good. However to mount interdisciplinary integrated educational exhibits only because it gives us academic respectability and academic justification for our existence—to say nothing of new and different sources of funds—is almost hypocritical. I've seen too many such exhibits degenerate into spreads of labels, photographs, models, graphics—a designer's delight—with a couple of specimens stuck in as a reminder that this is a museum.

What I was doing again was mounting a defense for the idea that the primary purpose of a museum exhibit is to show specimens to the public—as many specimens as space and esthetics will permit. True, they can be grouped, explained, used—hopefully not abused—in any groupings or for any purpose, for education or for fun, as long as we remember that they are the reason for the exhibit being there at all.

The second part of my dissertation had to do with suggesting that if the specimens had to be used to instruct the public then they should be used to tell about themselves. Mineral specimens don't need to be related to environment, ecology, air pollution, race problems, or even the annual production of steel in the United States. They can be used to explain what they are, how they form, how they differ from each other, their physical and chemical nature, their crystallography, and so on. Their behavior toward light, heat and other forms of energy, their stability, their peculiarities, and a multitude of other topics are suitable fare. I have yet to see a bird exhibit which emphasizes the kinds of pebbles birds prefer to pick up for gizzard stones. I have yet to see a botany exhibit which emphasizes the sources of soils which certain plants prefer for their roots. And yet, mineral specimens are often expected to lend themselves to exhibits telling all about many things not closely related to their own entities.

continued on page 42

INTERFERENCE COLORS
IN OIL SLICKS AND FELDSPARS

by P. H. Ribbe

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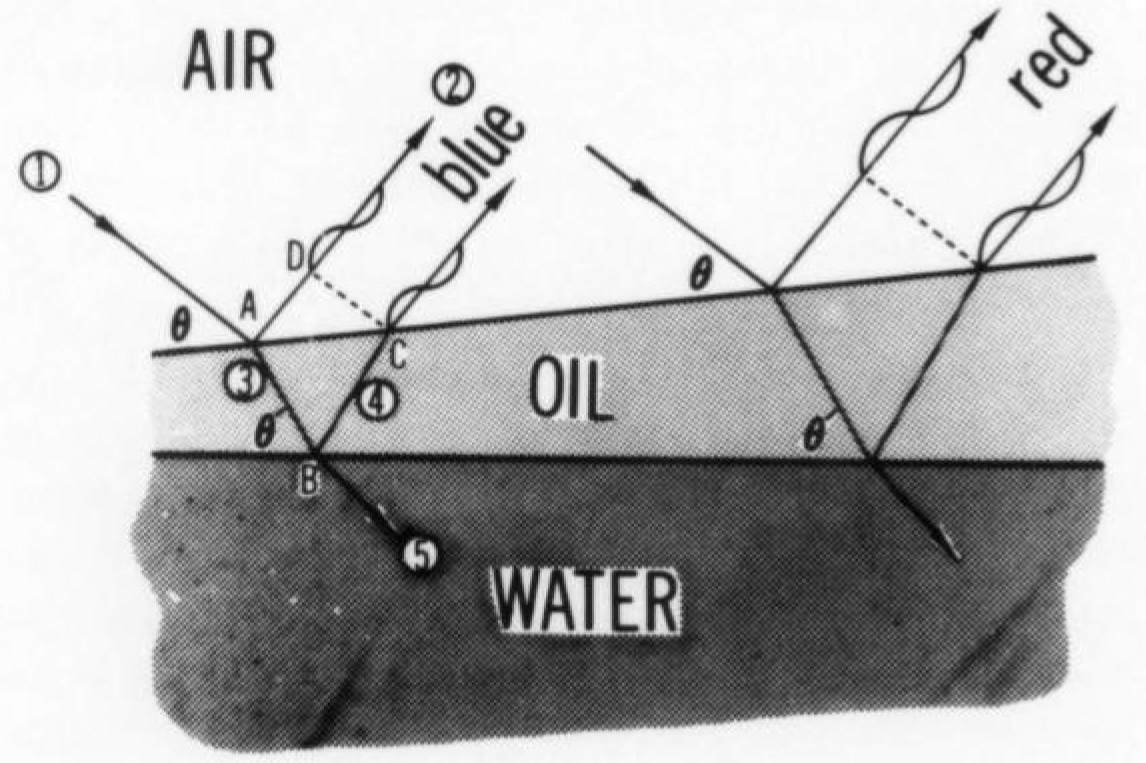
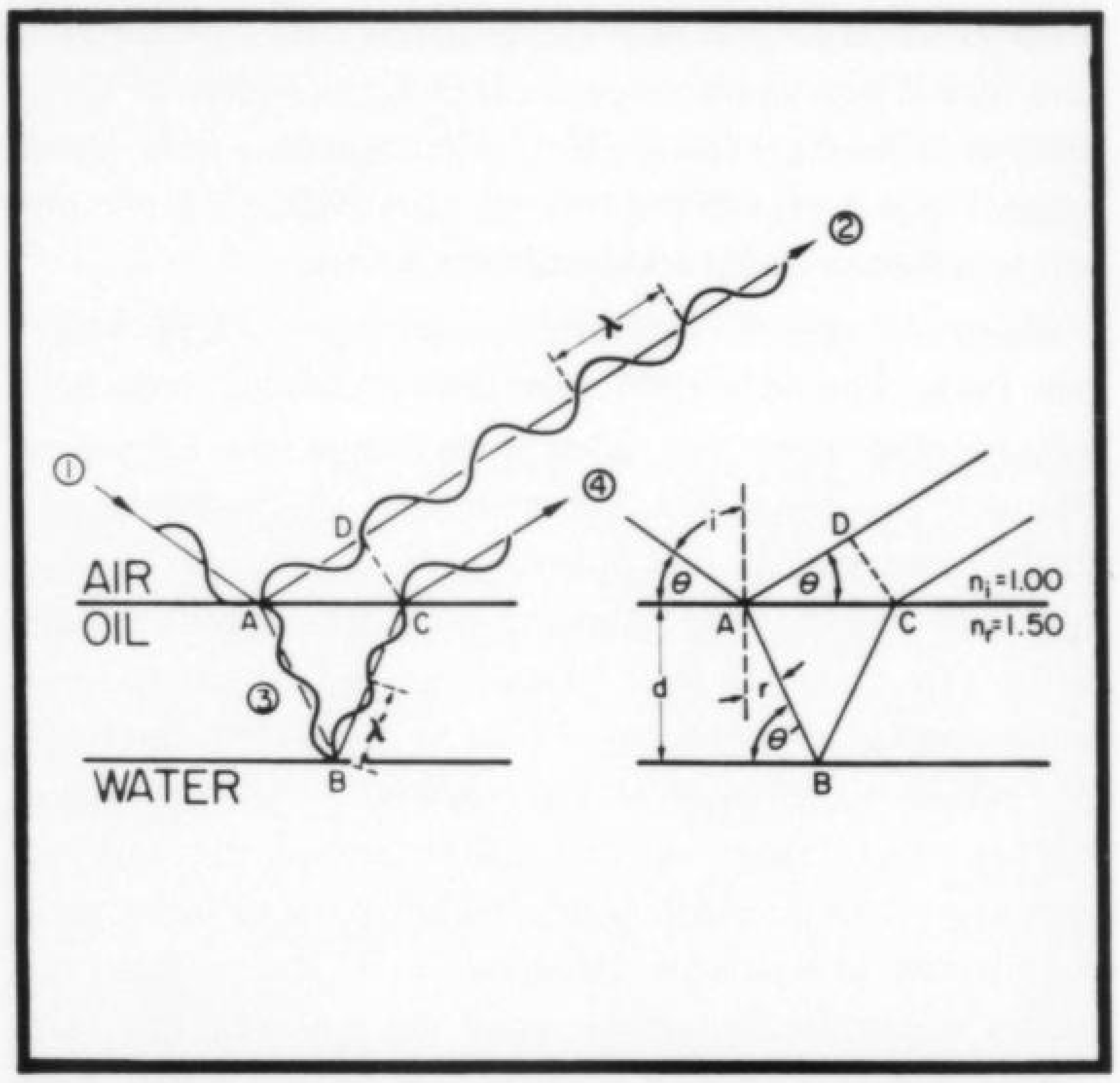
What do oil slicks, oyster shells, peacock feathers, fish scales, and feldspars have in common? The brilliant iridescent colors often seen on the surfaces of all these are natural manifestations of the same phenomenon: interference of light reflected from one or more thin layers in an optically inhomogeneous medium.* Some of us, particularly those from Santa Barbara, San Francisco, or the Gulf Coast, are all too familiar with the interference colors produced by an oil slick on water. To understand the source of interference colors, let's look at Figure 1. When white light, containing rays of all wavelengths in the visible spectrum, and thus representing the entire rainbow of colors, strikes the surface of an oil slick, several things happen. At the air-oil boundary the incoming beam (1) is partly reflected (2) and partly transmitted (3). That part which is transmitted changes its direction somewhat because light travels more slowly in oil than it does in air. At B, the boundary between the oil and the water, beam (3) will be partially reflected (4) and partially transmitted (5). Ray (4) changes direction again at the oil-air boundary by exactly the amount necessary to emerge into the air in the same direction as reflected ray (2). Notice that at the wave front $\overline{DC}$, ray (4) has followed a path which is longer than that for ray (2) by a distance equal to $\overline{AB}+\overline{BC}-\overline{AD}$.



1. **Illustration of the interference phenomenon producing colors in an oil slick on water. See text for discussion.**



2. **The diagram above shows that the wavelength of the beam in oil ($n_r = 1.50$) is two-thirds that in air ($n_i = 1.00$). The period of vibration of the light waves in air is the same as that in oil. For the case illustrated, it takes four times as long for the refracted beam to traverse the path (AB+BC = 4λ' as it does for the reflected beam (2) to traverse the path AD = λ. Starting from point A, beam (2) will travel 3λ beyond the wavefront DC by the time beam (4) reaches point C. Thus**

$$n_r\ (\overline{AB}+\overline{BC})\ -\ \overline{AD} = 3\lambda$$

The rays in beams (2) and (4) reinforce each other because their difference is an integral number of wavelengths. (See Figure 3).

The diagram on the right gives the symbols used in the equation which exactly expresses the condition for constructive interference in thin films:

$$2d \sin\theta \sqrt{1 + \frac{n_r^2 - 1}{\sin^2\theta}} = N\lambda$$

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*See the cover story on "Optical Interference Coatings" by P. Baumeester and G. Pincus in the December 1970 issue *Scientific American* and the fascinating article on "Reflectors in Fishes" by E. Denton in the January 1971 issue of the same journal. A new book, "The Splendor of Iridescence: Structural Colors in the Animal World," by H. Simon (Dodd, Mead & Co.: N.Y., 1971) is a pure delight.

Because light travels more slowly in oil than in air, we must take the relative velocities into account when evaluating this path-length difference. The refractive index of the oil can be determined by conventional methods (see Bloss, 1961): it is equal to the velocity of light in air divided by the velocity of light in the oil. Thus if the refractive index of the oil is 1.5, we know that the velocity of light in the oil is two-thirds that in air. So ray (3) in the oil travels the path $\overline{AB} + \overline{BC}$ at 124,000 miles per second, while ray (4) travels in air at 186,000 miles per second.

The wave front $\overline{CD}$ is a line drawn perpendicular to the direction of travel of rays (2) and (4). If these rays are to be *in phase* and reinforce one another at this wave front, the path difference $\overline{AB} + \overline{BC} - \overline{AD}$ must be a whole number multiple of the wavelength λ (Greek "lambda") of ray (4). Two simple equations can be written to express this truth:

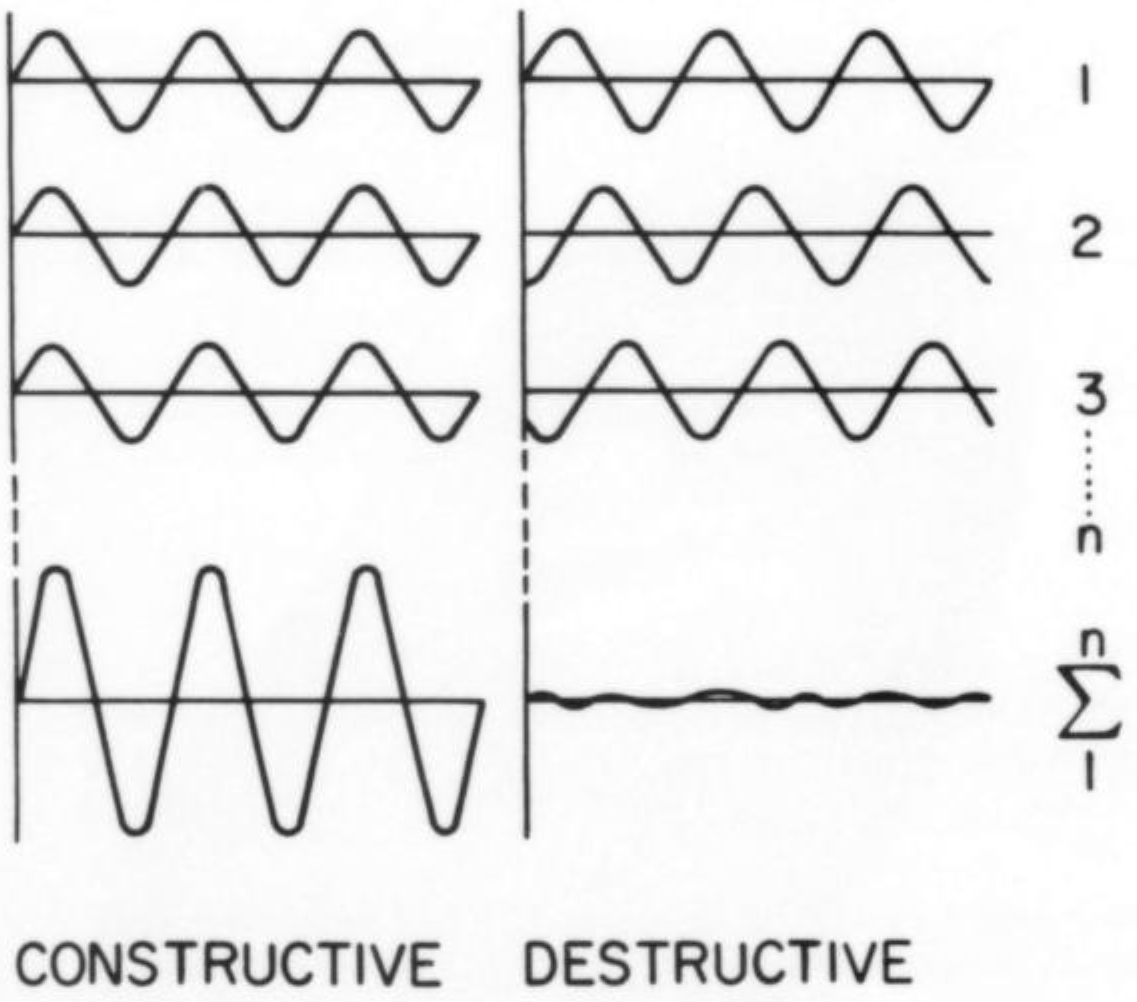
$$\frac{\text{distance } \overline{AB}+\overline{BC} \text{ in oil}}{\text{velocity in oil}} \quad \text{minus} \quad \frac{\text{distance } \overline{AD} \text{ in air}}{\text{velocity in air}}$$

$$N \text{ times } \frac{\text{wavelength in air, } \lambda}{\text{velocity in air}} \quad \text{where N is a whole number.}$$

Knowing the relation between refractive index and velocity and that the refractive index of air is 1.0 (by definition), this equation becomes simply:

refractive index of oil times ($\overline{AB} + \overline{BC}$) minus ($\overline{AD}$) equals $N\lambda$

As shown in Figure 3, light rays with identical wavelengths, λ, add their amplitudes to become very intense.



3. Schematic diagrams showing interference of waves 1, 2, 3 . . . n (their amplitudes are additive). When the waves are *in-phase* as on the left, the effect is constructive interference producing an intense light beam of one color (i.e., one wavelength). When the waves are *out-of-phase* as on the right amplitudes are cancelled by algebraic addition. After Azaroff (1968).

This is called constructive interference. Rays of other wavelengths in the beam do not reach the eye because they are *out-of-phase,* interfering destructively and cancelling out one another. As shown in the right-hand portion of Figure 1, a thicker oil slick produces in-phase reflected rays of longer wavelength than blue (λ = 4500 Ångstroms)**, which give rise in our eye to the sensation we call red (λ =6500 Ångstroms). Intermediate thicknesses produce colors (green, yellow, orange) of intermediate wavelengths.

The equation given above which states the conditions for constructive interference in an oil slick is similar to the Bragg equation derived by Joel Arem in *Min Record* (V. 2, p. 115) for x-rays. It must be somewhat modified when applied to feldspars exhibiting interference colors or "schiller", but we shall consider this after a discussion of peristerites and labradorites.

The Peristerite Plagioclases

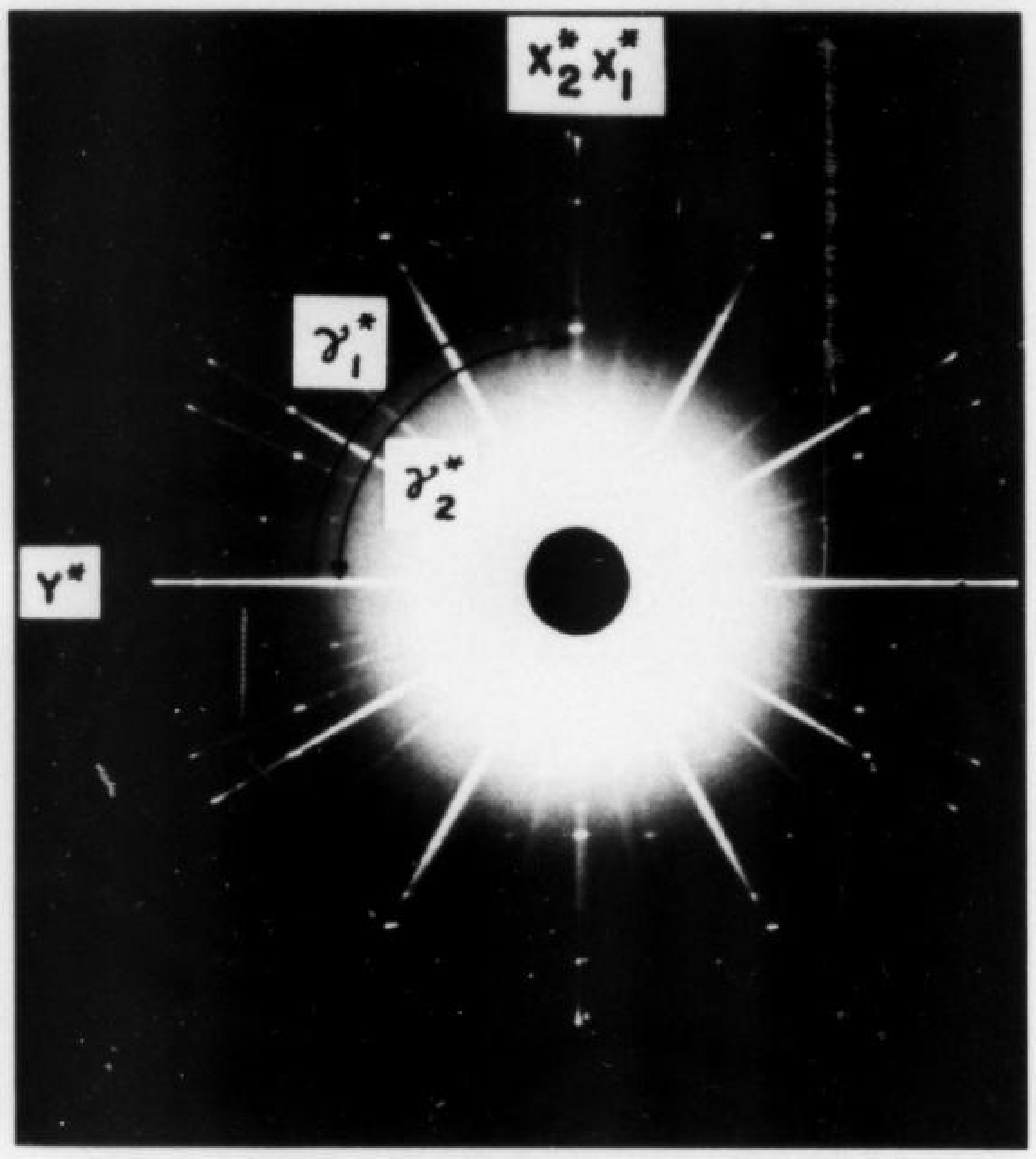
The albite-rich feldspars commonly found in pegmatites, with compositions ranging between approximately 2-3 and 15-16 mol % anorthite, often exhibit pale to intense interference colors on the (010) cleavage. These feldspars were called *peristerites* by Thompson (1843) because the colors resembled those in the neck feathers of a pigeon (Greek: *peristera*).

As early as 1924 Bøggild examined the iridescent reflections from peristerites and concluded that some sort of lamellar structure nearly parallel to the (08$\bar{1}$) plane, must be responsible for the color. Thirty years later Laves (1954) undertook a single-crystal x-ray study of these iridescent feldspars that showed two phases coexisting on a submicroscopic scale; one was geometrically (and compositionally) equivalent to low albite (Ab), the other was equivalent to an oligoclase containing approximately 30 mol % anorthite ($\text{An}_{\sim 30}$). These intergrowths of Ab and $\text{An}_{\sim 30}$ were explained as the products of exsolution similar to that observed in moonstones and perthites, which are intergrowths of albite and orthoclase (Or). Using x-ray precession photographs*** like the one shown in Figure 4, it was found that the unit-cell geometries, in particular the reciprocal lattice angles γ^* of the two phases, can be used to determine the compositions of the intergrown plagioclases. One phase is invariably low albite, An_{0-2}; the other phase ranges in composition between $\text{An}_{\sim 18}$ and $\text{An}_{\sim 35}$ from specimen to specimen, averaging near $\text{An}_{\sim 25}$.

Although chemical and structural data on peristerites abounded, the lamellae hypohesized by Boggild remained unobserved until the electron microscope was used to photograph and identify the exsolved Ab or Or lamellae in moonstone and Ab and $\text{An}_{\sim 25}$ lamellae in peristerite.

**An Ångstrom is one ten-billionth of a meter.

***The precession method was discussed by Joel Arem in *Min. Record* **2,** p. 118.

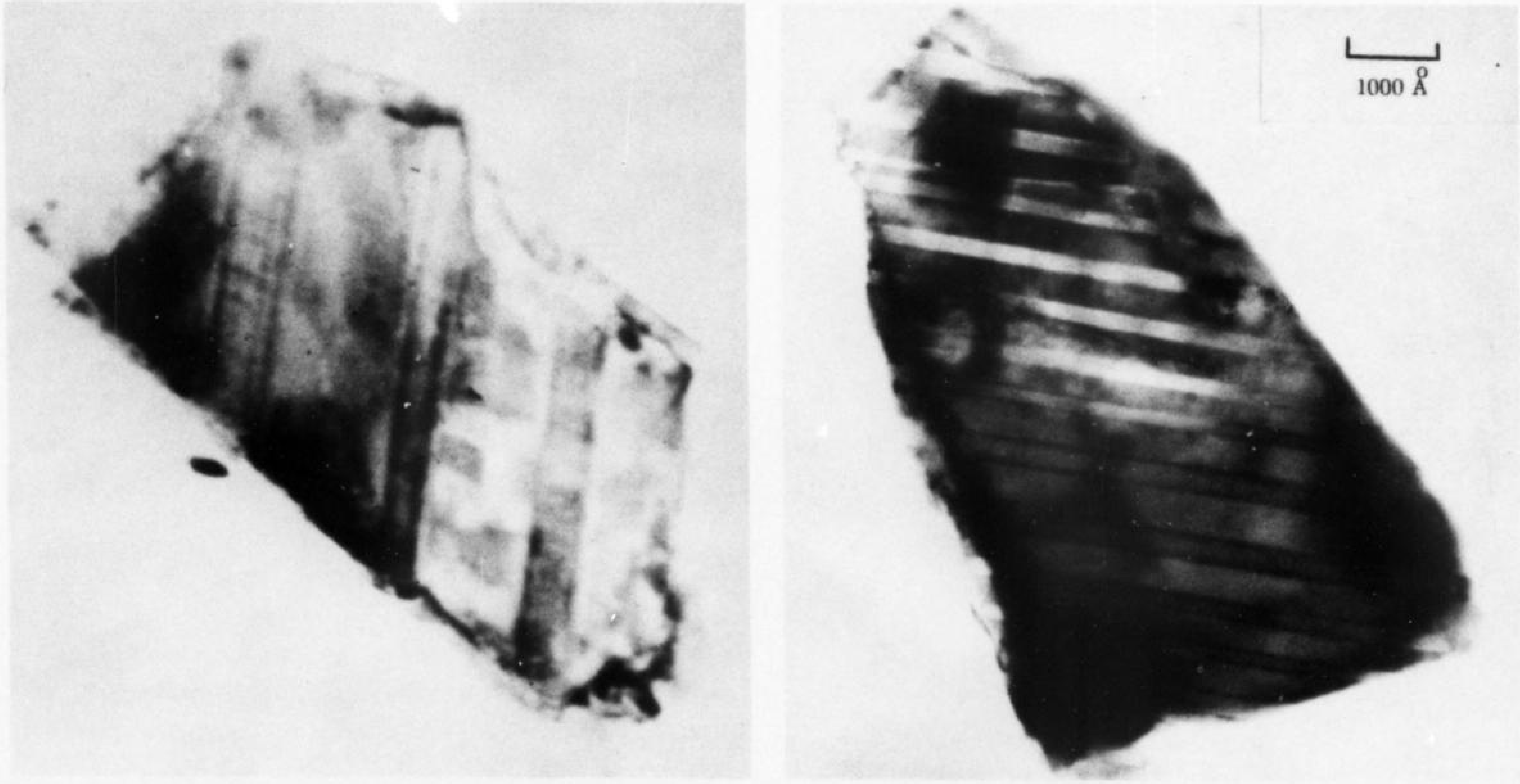


4. A zero-level precession photograph of the x* y* plane of a peristerite from Villeneuve, Quebec (bulk composition: An$_7$). Notice the two x* reciprocal axes and the two angles γ_1^* and γ_2^* representing the lattices of low albite (An$_2$) and An$_{\sim 23}$, respectively.

Figure 5 shows two peristerite grains: the one with alternating thick (Ab) and thin (An$_{\sim 25}$) lamellae exhibits yellow to orange interference colors in hand specimen, the other is a brilliant blue. Electron diffraction patterns confirmed that the exsolved lamellae were indeed oriented parallel to $(08\bar{1})$.

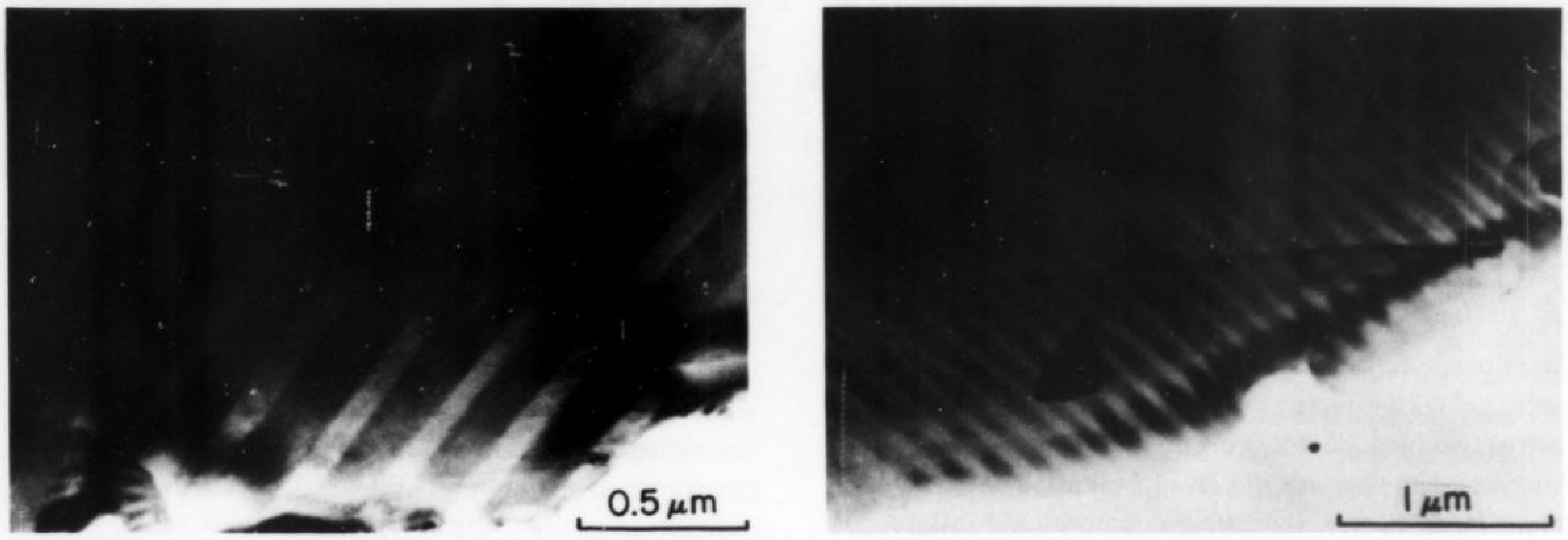
The Iridescent Labradorites

The well-known iridescence of plagioclases with compositions near An$_{50}$ came to be called *schiller* (from the German for iridescence) and *labradorescence* (referring to the classic occurence of these feldspars in the anorthosites on the Isle of Paul, Labrador). Single-crystal x-ray studies failed to show the presence of more than one phase in iridescent labradorites, yet the interference colors are evidence of optical inhomogeneities (as in the oil-water case), and the reflections are characteristic of lamellar intergrowths like those in peristerite. Fine-scale twinning was incorrectly hypothesized to explain the interference colors. Then in 1965 Laves, Nissen, and Bollmann published transmission electron photo-micrographs of red- and blue-schillered labradorites that look remarkably like the peristerites pictured in Figure 5. They claimed that if d_a and d_b are the average thicknesses of the sets *a* and *b* of alternate light and dark lamellae (as in Figures 5 and 6), then the Bragg equation predicts the observed interference colors when the refractive index of the feldspar is taken into account (see the second equation above and the legend of Figure 7). As part of a detailed study of labradorite iridescence Bolton and co-authors (1966) found in the specimens pictured in Figure 6 that the average thickness of *a* and *b* lamellae is the blue labradorite were 725Å and 651Å respectively, and in the red labradorite 1766Å and 874Å, respectively. These are sketched in Figure 7. Notice that the path differences, and thus the wavelength and color of the reflected light, differ mainly because d_a and d_b are different. (We assume $n_a = n_b$ and $\theta_a = \theta_b$.) For the blue specimen the wavelength of the constructively interfering in-phase rays is calculated to be



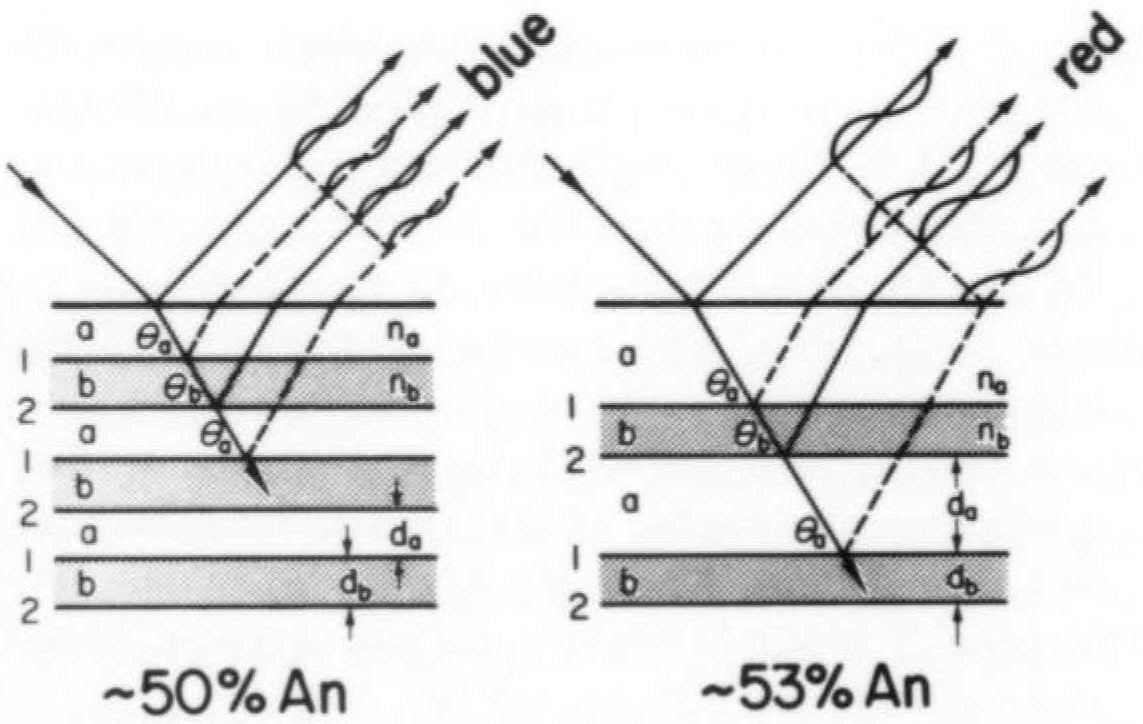
5. Transmission electron photomicrographs of peristerite grains. On the left a specimen from Monteagle Township, Ontario (An$_{7.5}$) showing yellow-orange interference colors; thick lamellae are Ab, thin lamellae An$_{25}$. On the right a specimen from Froland, Norway (An$_{10.5}$) showing blue iridescence; the thicker set of alternate lamellae are An$_{\sim 1}$, the thinner An$_{\sim 20}$. After Fleet and Ribbe (1965).

4230Å at $\theta = 80°$ (with $n_a n_b = 1.56$); for the red it is 8250Å at $\theta = 80°$ and 6580Å at $\theta = 53°$. These are in good agreement with the observed interference colors of these feldspars.



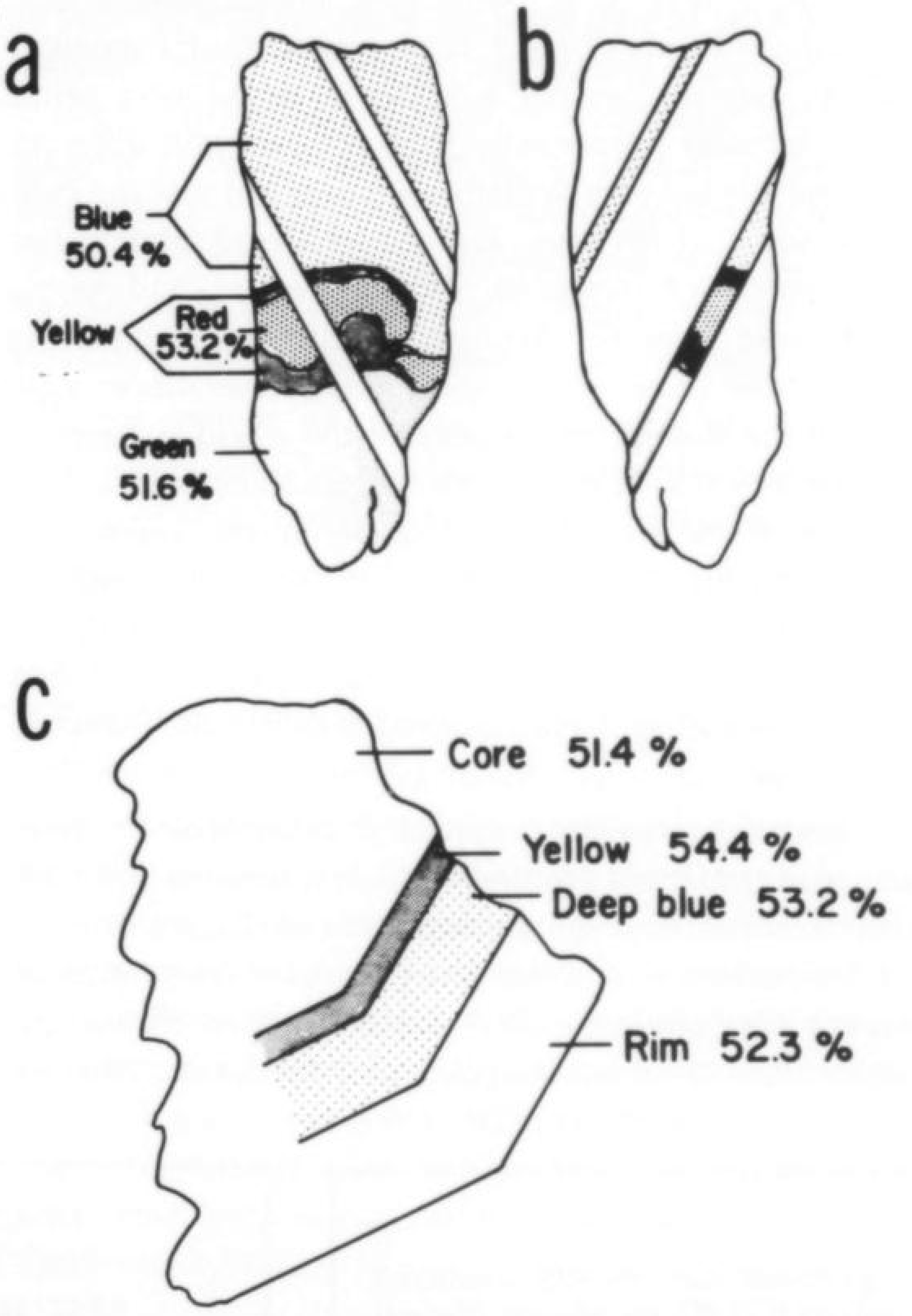
6. **Transmission electron photomicrographs of labradorite grains: to the left a red- and to the right a blue-schillered specimen. Courtesy of Bolton, Bursill, McLaren, and Turner. (1966)**

Electron probe microanalysis confirmed the observations of Boggild (1924) that the longer wavelength colors in a multi-colored labradorite come from regions of the crystal with somewhat higher anorthite contents. For example, in one multi-colored specimen (Figure 8) the red regions are $\mathrm{An}_{53.2}$, whereas the blue are $\mathrm{An}_{50.4}$. Regions of intermediate wavelength colors would have intermediate compositions. If the specimen is albite-twinned, the colors of alternate twin lamellae can only be seen by turning the crystal through 180° with respect to the incident light beam. This accounts for the striped appearance of many polished labradorite specimens. Colorless regions of the



7. **Schematic drawing of interference phenomenon in blue- and red- schillered specimens (see Figure *6*). The *a* and *b* lamellar sets have mean refractive indices n_a and n_b and thicknesses d_a and d_b.**

Glancing angles of the beam at interfaces 1 and 2 are θ_a and θ_b, respectively. When d_a is not equal to d_b (as on the right), the beams from the boundary interfaces 2 are retarded relative to those from interface set 1, although the wavelengths are the same. The two sets of waves shown by solid and dashed lines then interfere to produce a coherent, monochromatic (one wavelength) beam of somewhat reduced intensity. Interference colors from both specimens are governed by the equation $2(n_a d_a \sin\theta_a + n_b d_b \sin\theta_b) + N\lambda$. Compositions are discussed in the text.



8. **(a) Sketch of the relation between interference color and composition in a thin section of labradorite from the Isle of Paul, Labrador. Notice that every other albite twin lamella (diagonal stripes) does not exhibit schiller in this orientation. (b) Maintaining the same orientation of light source and observation point, the reverse side of the thin section exhibits interference colors in the thin twin lamellae. (c) Blue and yellow schiller in a zoned labradorite crystal from Tevalainen, Finland. The core and rim of this specimen do not exhibit interference colors in the visible range.**

zoned crystal sketched in Figure 8c may have interference colors in the invisible ultra-violet range.

Unlike peristerites, there has been until now some uncertainty as to the compositions of the lamellae in labradorites. X-ray and electron diffraction studies show that the geometries of the two phases are essentially indistinguishable. As in the case of peristerites, whose colors are not normally as intense as those in labradorite, there must be refractive index differences (optical inhomogeniety) between adjacent lamellae. The fact that alternate sets of lamellae are light and dark in electron photomicrographs indicates that electrons travel in slightly different directions in adjacent lamellae; this must be due to compositional differences because orientation differences, such as twinning, do not show up in the x-ray photographs. Alternate lamellae are dissolved by certain acids at different rates, further indicating compositional differences (see replica electron micrographs in Nissen *et al.*, 1967).

An indirect proof that the lamellae have different compositions, as they do in peristerites, comes from a consideration of Figures 7 and 8. If we assume for the moment that, like peristerites, the lamellae in labradorites result from a lamellar intergrowth of two phases with different compositions but very similar geometries and that the bulk compositions of the blue- and red-schillered labradorites investigated by Bolton *et al.* (1966) are $An_{\sim 50}$ and $An_{\sim 53}$ (see Figures 7 and 8), then it is possible to calculate the compositions of lamellae *a* and *b* using some simple algebra and the average thicknesses of the *a* and *b* lamellae measured by Bolton *et al.* The compositions are close to An_{60} for *a* and An_{40} for *b*. Considering the assumption involved in guessing the composition of the blue and red labradorites, these values agree remarkably well with the extremes of the composition range. An_{42}-An_{58}, within which Nissen *et al.* have observed lamellae in iridescent labradorites.

Of course the true compositions of the lamellae for these particular specimens are not yet known because the bulk compositions of Bolton's specimens are not known exactly. But the technique outlined has been used very recently in more carefully controlled experiments to obtain the compositions of the lamellae in other labradorites. Nissen's (1971) values are near An_{38} and An_{62}, based on 10 different samples.

And so we see that interference colors in peristerites and labradorites are caused by lamellar intergrowths of two phases with different optical properties. Reflections at all the boundaries between lamellae give rise to many rays of different wavelengths, most of which interfere destructively with one another, leaving only those rays which are in-phase and satisfy the Bragg equation to reach our eyes, exciting the pleasant sensation our minds interpret as color.

Acknowledgements

I thank Dr. Alex. McLaren of Monash University for permission to use the photomicrographs in Figure 6. My colleague, Prof. F. Donald Bloss, gave freely of his time in checking calculations and criticizing the text.

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the state of the art - crystal growth

by K. Nassau

Bell Telephone Laboratories, Incorporated • Murray Hill, New Jersey

PART I

Introduction

Some purist mineral collectors may shudder at the thought of adding a man-made specimen to their collection. There is however a vast area beyond the familiar synthetic corundum or spinel boules or faceted gemstones. Synthesized minerals will be found in most museum collections and the professional mineralogist readily avails himself of the kind of data that can sometimes be obtained only from synthetic mineral crystals.

Some examples may illustrate this point. Natural minerals may not occur in crystals of sufficient size for all the necessary properties to be determined; as immediate example that comes to mind is greenockite (CdS), which can be grown in inch size pieces in the laboratory. Naturally occurring minerals often contain large quantities of impurities, and even the color of the absolutely pure mineral may not be obvious. Thus greenockite (CdS) and zincite (ZnO) occur in a variety of colors from yellow via brown to red, etc.; synthetic specimens show that CdS is inherently yellow but ZnO crystal can be quite colorless when pure.

The study of crystal growth under conditions close to those occurring in nature (the overlap occurs really only under hydrothermal conditions at present) can help to clarify the natural growth process. Thus it can be of interest to compare liquid inclusions in natural quartz with those in synthetic quartz grown under known conditions. Again it may be possible to determine the stability region for a given mineral during crystal growth experiments (that is, the range of temperature, pressure, and concentrations within which the crystal could have been formed, but outside of which a different mineral would have resulted).

Based on crystal growth experience, and some reasonable assumptions, even a time scale estimate for natural crystal growth may be possible on a rare occasion. The transition region occurring in trapiche emeralds from Chivor, Colombia originates from a diffusion process, and it has been estimated that this 1 mm thick region grew in at most a few minutes (K. Nassau and K. A. Jackson, *American Mineralogist 55,* 416, 1970).

The origin of additively caused color and fluorescence may be difficult to determine. Thus the color of amethyst has for long been known to involve Fe as well as radiation, yet only with the successful laboratory duplication have the relevant factors been understood. In the case of the fluorescence of fluorite the situation is still unresolved. Answers may come from laboratory growth of crystals with the addition of one suspected impurity after another, one at a time and then two at a time, and so on; these results are then coupled with detailed radiation, absorption, energy transfer, radiation emission studies, interactions with irradiation-produced color centers and other defects. All this may need to be done before all the phenomena in natural fluorite can be understood.

One problem is that such detailed studies are expensive and time-consuming and can frequently not be justified on a cost effective basis in mineralogy oriented laboratories. In industry such extensive work can only be performed on materials where there is the expectation of devices useful in the electronics, communications, and other fields. Fortunately a number of materials of interest in the laser, semiconductor, piezoelectric, and magnetics fields have produced detailed studies on materials of mineralogical interest such as quartz, ruby, scheelite, fluorite, powellite, greenockite, zincite, magnetite, and so on.

Often crystals of mineralogic interest are produced incidentally or even accidentally while working out the details of new growth techniques or surveying classes of compounds for specific properties. For example, quite large magnetoplumbite crystals can be a by-product of yttrium iron garnet crystal growth if the growth conditions are not quite correct.

The converse is also found, of course. It is not a coincidence that the first three laser crystals ruby, fluorite, and scheelite are minerals. In the search for laser hosts, minerals known to show fluorescence were the first substance to be investigated since laser action is in fact a modified form of fluorescence. And when searching for a specific property (e.g., piezoelectricity or nonlinear optical properties) it may be possible to focus attention onto, or eliminate from consideration, certain types of compounds by preliminary tests on available minerals, thus avoiding time-consuming synthesis.

There is clearly considerable interaction between the mineral field and the crystal growth—solid state technology areas—yet there is equally clearly room for much more. It is hoped that this series of articles will contribute to this end.

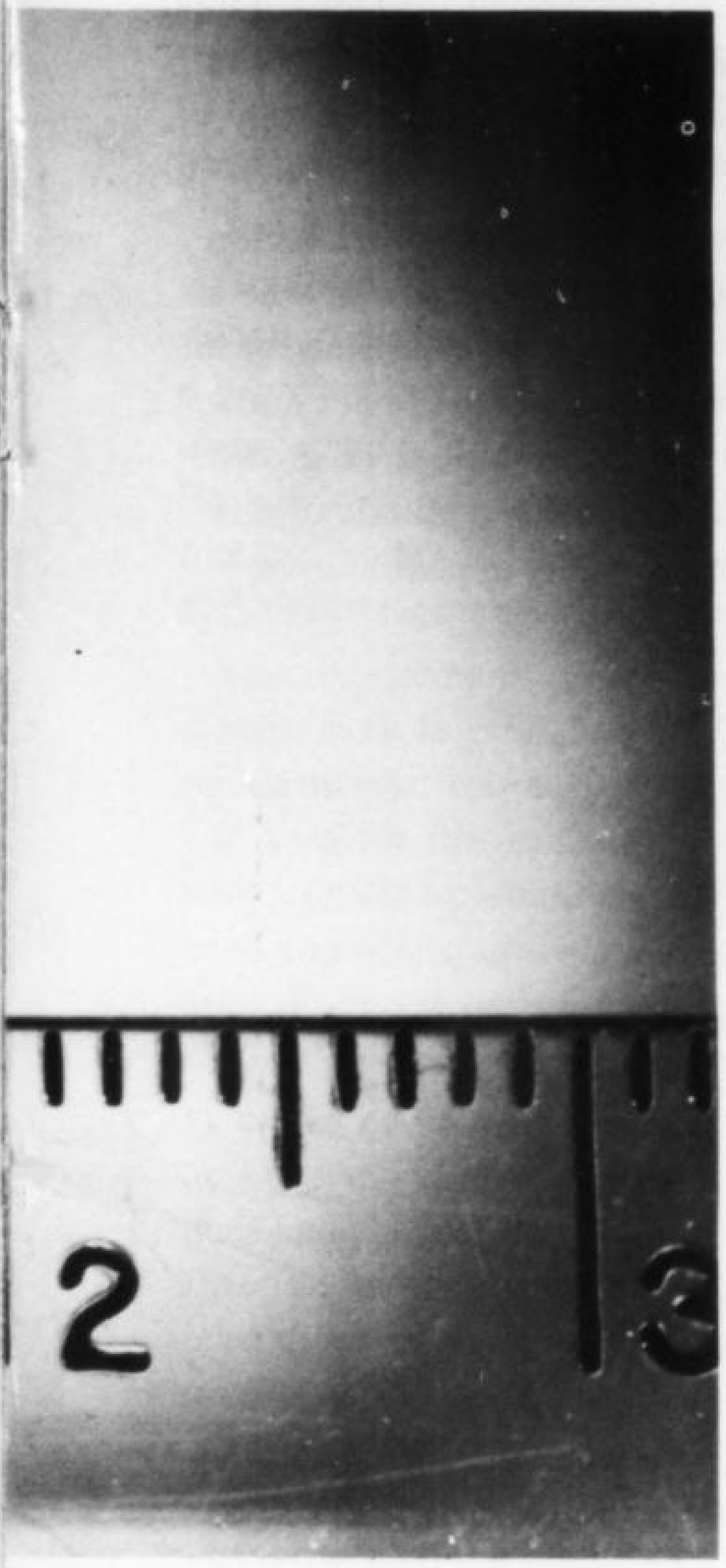
In the following sections the current state of the literature, practice, and theory of crystal growth will be outlined, including a partial listing of synthesized minerals with the techniques by which they were prepared. Figures 1 through 6 illustrate some man-made mineral crystals.

Fig. 1. **Czochralski grown scheelite crystals; largest is 6 inches long.**

Fig. 3. **Hydrothermally grown greenockite.**

some man-made mineral crystals

Fig. 2. **Flux grown emerald crystals; cluster is 2 inches across.**



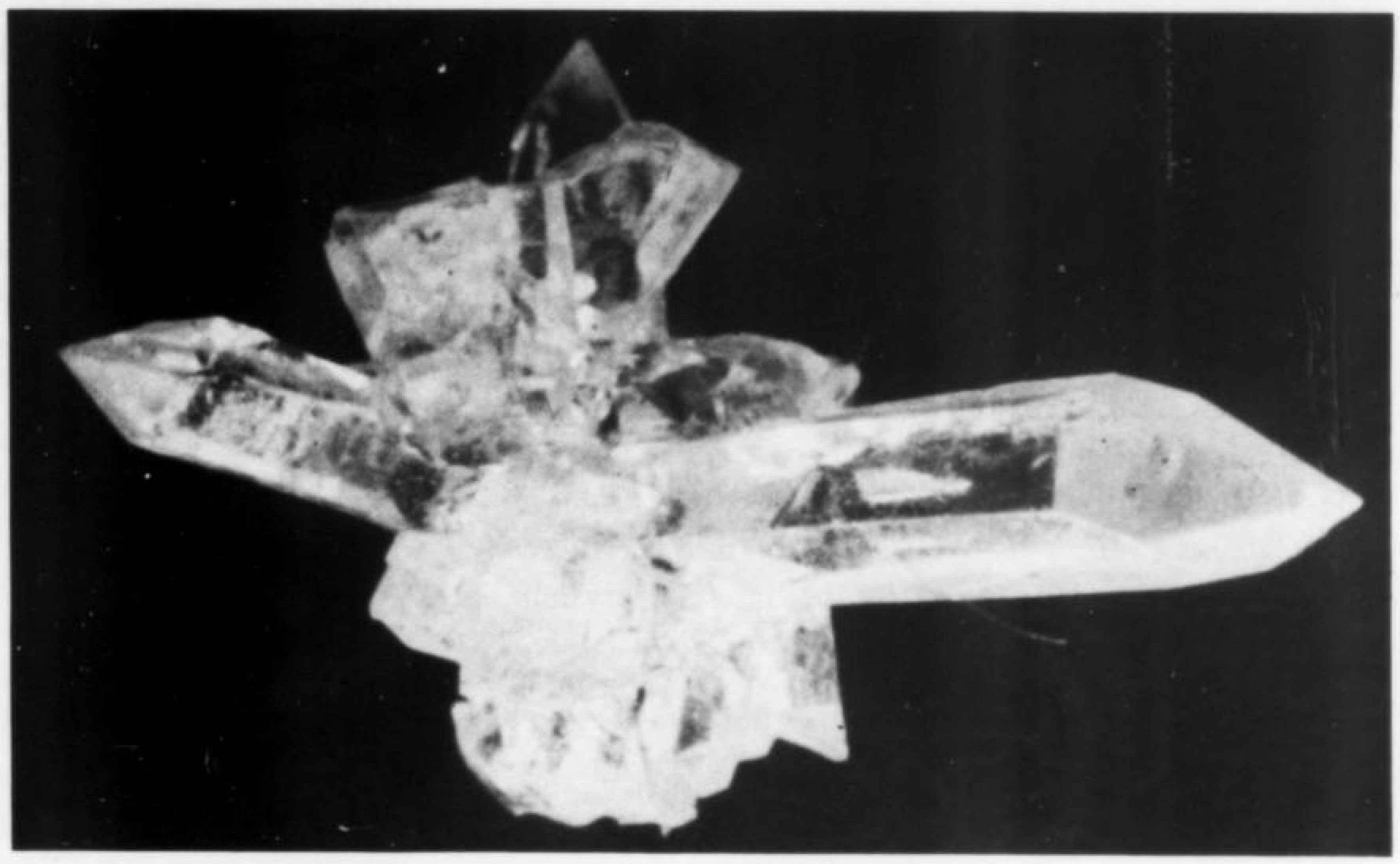


Fig. 4. **Vapor phase grown zincite; cluster is 1/2 inch a cross.**

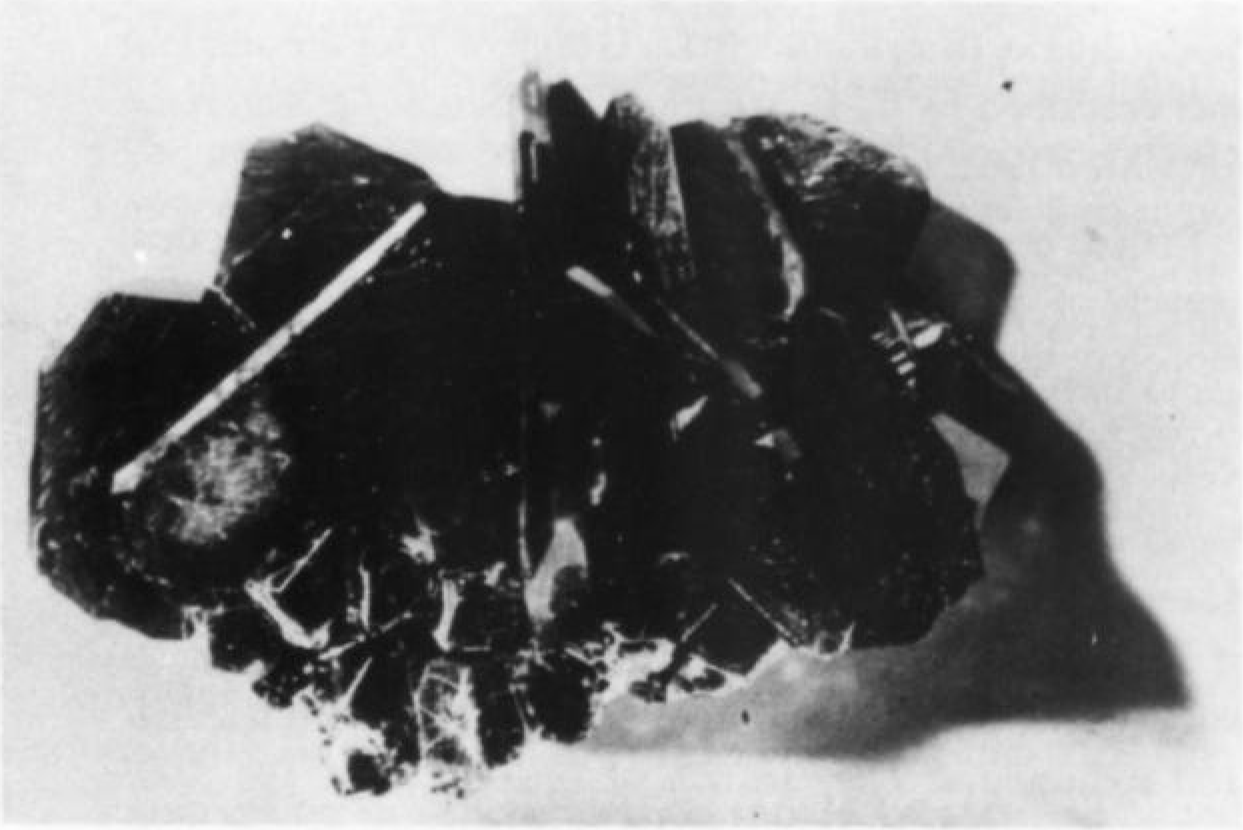


Fig. 5. **Flux grown ruby (large red hexagonal plates) and yttrium aluminum garnet (small green rhombohedral crystals); specimen is three inches across.**

Fig. 6. **Vapor grown stibnite; specimen is 1/2 inches across.**

The Literature of Crystal Growth

The last book that could claim to cover all aspects of crystal growth and list all crystals that had been grown to date was written ten years ago. This is unfortunately in German, *Einkristalle,* by A. Smakula (Springer Verlag, Berlin, 1962). Since that time the literature has grown so rapidly that completeness in one volume is probably no longer possible.

Older books, more or less out of date except for their sections on water solution growth, are *Crystal Growth,* by H. E. Buckley (Butterworths, London, 1951); *Preparation of Single Crystals* by W. D. Lawson and S. Nielsen (Wiley, New York, 1958); and the commercial crystallization oriented *Crystallization* by A. Van Hook (Reinhold, New York, 1961) and *Crystallization* by J. W. Mullins (Butterworths, London, 1961).

Excellent descriptions of water solution growth for the amateur are given in *Crystals and Crystal Growing,* by A. N. Holden and Phylis Singer (Anchor Books - Doubleday Co.) which is also available with a kit of chemicals from Edmund Scientific Co. (Barrington, N.J.). Gel growth for the amateur was described by C. L. Strong in the *Scientific American* for March 1962, p. 155.

Recent books and review articles on the more practical aspects of crystal growth but intended more for the professional include the general treatments: *The Art and Science of Growing Crystals,* J. J. Gillman, Editor (Wiley, New York, 1963); "Crystal Growth Techniques" by K. Nassau in *Technique of Inorganic Chemistry,* Vol. VII (Interscience Publishers, New York, 1968): and *The Growth of Single Crystals* by R. A. Laudise (Prentice Hall, Englewood Cliffs, N.J., 1970). There are also the more specialized treatments: *The Growth of Crystals from the Melt* by J.C. Brice (North Holland Pub. Co., Amsterdam, 1965): "Flux Growth" by E. A. D. White in *Technique of Inorganic Chemistry,* Vol. V (Interscience Publishers, New York, 1965); *Zone Melting* by W. G. Pfann (Wiley, New York, 2nd Edition, 1966); and *Crystal Growth in Gels* by H. K. Henish (Penn. State U. Press, 1958).

A less technical description "Growing Synthetic Crystals" by K. Nassau appeared in six parts in the *Lapidary Journal* starting April 1964 (Vol. 18, pp. 42-45, 313-317, 386-389, 474-477 and 483, 588-595, and 690-693).

Technical journals in which articles on crystal growth can be found include *Journal of Crystal Growth,* 1966 on; *Material Research Bulletin,* 1966 on; the Soviet series *Rost Krystallov* (Growth of Crystals); and also many other physics, chemistry, ceramics, and materials science journals which contain isolated reports.

Inquiries about techniques used for specific materials or technical details should *not* be addressed to the author, but should be taken to the nearest university or other technical library where *Chemical Abstracts* will usually lead one directly to the required information. On the question of the availability of specific crystals (for serious professional work) inquiries may be made to the Research Materials Information Center, Oak Ridge National Laboratory, Oak Ridge, Tennessee, attention Dr. T. F. Connolly.

Which Growth Technique?

A good approach to the variety of crystal growth techniques is to examine the action of the crystal grower who is faced with the problem of growing single crystals of a material, the growth characteristics of which are not know. A baker's dozen listing of some major groups of growth techniques which have been used for the synthesis of mineral crystals will indicate the multiplicity of possibilities:

Growth from the Melt
1. Czochralski
2. Bridgman
3. Zone
4. Verneuil

Growth from Solution
5. Water or other solvents
6. Gel reaction
7. Hydrothermal
8. Flux and Flux zone
9. High pressure
10. Electrolysis (aqueous and flux)

Growth from the Vapor Phase
11. Sublimation
12. Reaction
13. Chemical transport

Each one of these groups may contain a whole series of different variants, often employing radically differing apparatus. Details of these techniques will be given in Part III of this series.

Some materials may be grown by a wide variety of techniques. Thus corundum crystals have been grown by at least seven techniques, namely, numbers 1, 2, 3, 4, 7, 8, and 12 of the above listing. In the case of mica (fluorphlogopite) only the Bridgman technique, 2, has been used successfully for large crystals, and even then the process could never be successfully controlled.

When a crystal, such as corundum, can be grown by a number of different techniques, it must not be assumed that the products are identical. There can be appreciable differences in imperfections, defects, inclusions, and low level impurity distributions which can make drastic differences in the behavior, just as the same mineral obtained from different localities may show considerable differences in appearance, color, habit, etc.

A trade-off may sometimes be involved. For example the higher temperature melt growth techniques tend to produce more point and line defects, while lower temperature solution growth instead tends to introduce solvent impurities. The study of this area, usually called crystal characterization, is unfortunately often neglected.

Sometimes the crystal grower's choice may be simple: he may only have the facilities for a single technique, or he may be so mentally committed to a technique that he could consider no others; in such a case he may even choose to grow only those crystals which can be handled by his technique. If this choice is not possible, then the problem becomes more difficult and decisions must be made.

Much depends on the properties of the material to be crystallized. If the molten material is very viscous (as with silicates), decomposes (as with carbonates), or has too high a vapor pressure (as with diamond), then the melt techniques can be ruled out. Certain techniques, such as the flux (8), will work for just about any material if only the correct flux can be found — and there may be hundreds of these high temperature nonaqueous solvents that could be tried.

Size requirements present another problem. Some techniques, such as Bridgman or Czochralski growth, can be scaled up relatively easily (1 ft. diameter for the former and 2 ft. long for the latter are achieved without undue difficulty). Other techniques, such as the flux or hydrothermal ones, are scaled up only with great difficulty. The techniques discussed here are those which will lead relatively easily to crystals 1/4" or larger in size.

As can be seen, the choice ultimately depends on a fit between the characteristics of one of the growth techniques and the properties of the material to be crystallized. Often these properties are not known. The crystal grower must thus search out all the known properties and perhaps determine some additional ones himself.

Finally he must use that most important ingredient which every crystal grower must have: it is the ability to observe and study preliminary crystal growth attempts and deduce (by skill, expertise, insight, or intuition) just what the exact conditions are that the crystal really requires for satisfactory growth.

Crystal Growth Theory

A single crystal is defined by the existence of regular atomic ordering without significant* internal boundaries; the presence of boundaries can best be established by specialized X-ray diffraction techniques. The ordering can also show its presence in the existence of crystal faces, but the absence of faces does not negate the crystalline nature. Single crystals prepared by techniques which do not produce large, well-formed faces such as the Bridgman, Verneuil, and Czochralski techniques are often called "single crystal boules," or simply "boules". A close examination however will often reveal small faces or flash reflections on rough surfaces deriving from vicinal or stepped faces.

There are five major areas of theory which apply to the growth of crystals. First there is the question of phase diagrams, stability regions, formation or solution energies, structural transitions, etc. Secondly, there is the large area of impurity and defect concentrations, involving distribution coefficients, energies of substitutions, coupled substitutions, and interactions among these parameters. These items are too complex for disussion here: the last three areas of theory will however be briefly described: nucleation, growth, and morphology.

Consider first homogeneous nucleation — nucleation within the bulk of a liquid. Above the melting point in the case of a pure substance (or in a less than fully saturated solution) there will always be small clusters of atoms or molecules forming and then dispersing again at random. As the melt is cooled below the melting point, i.e., supercooled (or the concentration of a solution is increased to become supersaturated) these clusters, termed "embryos", become larger, last longer before dispersing, and finally some will continue to grow. The probability for either growth or dispersal of such a cluster becomes equal, and when such an embryo grows well beyond the point at which it might disperse again we have a "nucleus".

It may take from a few degrees to as many as 80° C of supercooling in an extremely pure melt for the rapid production of nuclei, but too much supercooling has a disadvantage: as the temperature falls, the atoms or molecules slow down in their motion and nucleation slows down again.

In practical crystal growth homogeneous nucleation rarely occurs; it is almost always heterogeneous. This may be nucleation initiated on the walls of the container, on dust particles, at the melt-air interface, etc. Very little theory has been developed for this process. If a thin film of crystal is grown on a substrate of its own or of another composition in such a way that the crystal lattices match, then the process is termed epitaxy. Nucleation is of course unnecessary if a seed is used.

Once a nucleus or a seed is present, there are several mechanisms by which growth can occur. At this stage the supercooling or supersaturation should be small so as to avoid further nucleation which could then lead to the formation of additional crystals and polycrystalline growth. Consider a flat crystal face with one or a few units of the next layer in position as shown in Fig. 7. It will take little

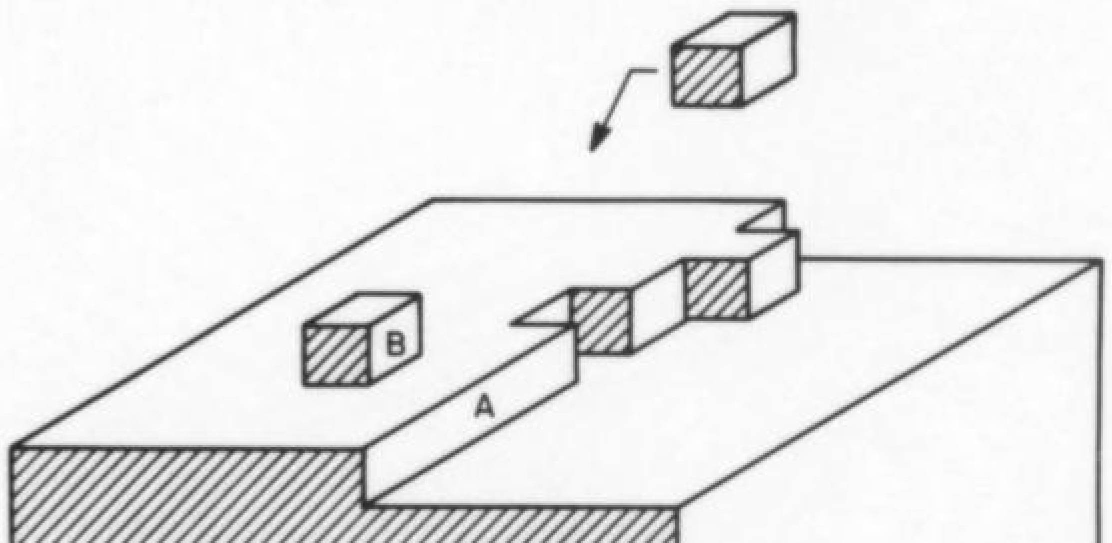


***Fig. 7.* Schematic diagram of a growing crystal face showing attachment of units.**

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*Whole volumes deal with the "significant" aspect, i.e. low angle grain boundaries, lineage, dislocations, etc.

energy dissipation (absorbed by the supercooling or the supersaturation) to complete the layer A, but much more to start another layer as at B. In most crystal growth it has been shown that the supercooling or supersaturation needed for actual growth is so small that this mechanism cannot be operating.

The mechanism which does seen to be the most common one is that involving a "screw dislocation". This is a defect which can be visualized by imagining a partial cut into a crystal followed by a slight twist as shown in Fig. 8. There is now a step or ledge where attachment of new units is easy, and this step continues to reform itself. The result is a growth spiral as seen in Fig. 9 for a solution grown crystal. Such spirals are seen on many crystal faces under favorable examination conditions.

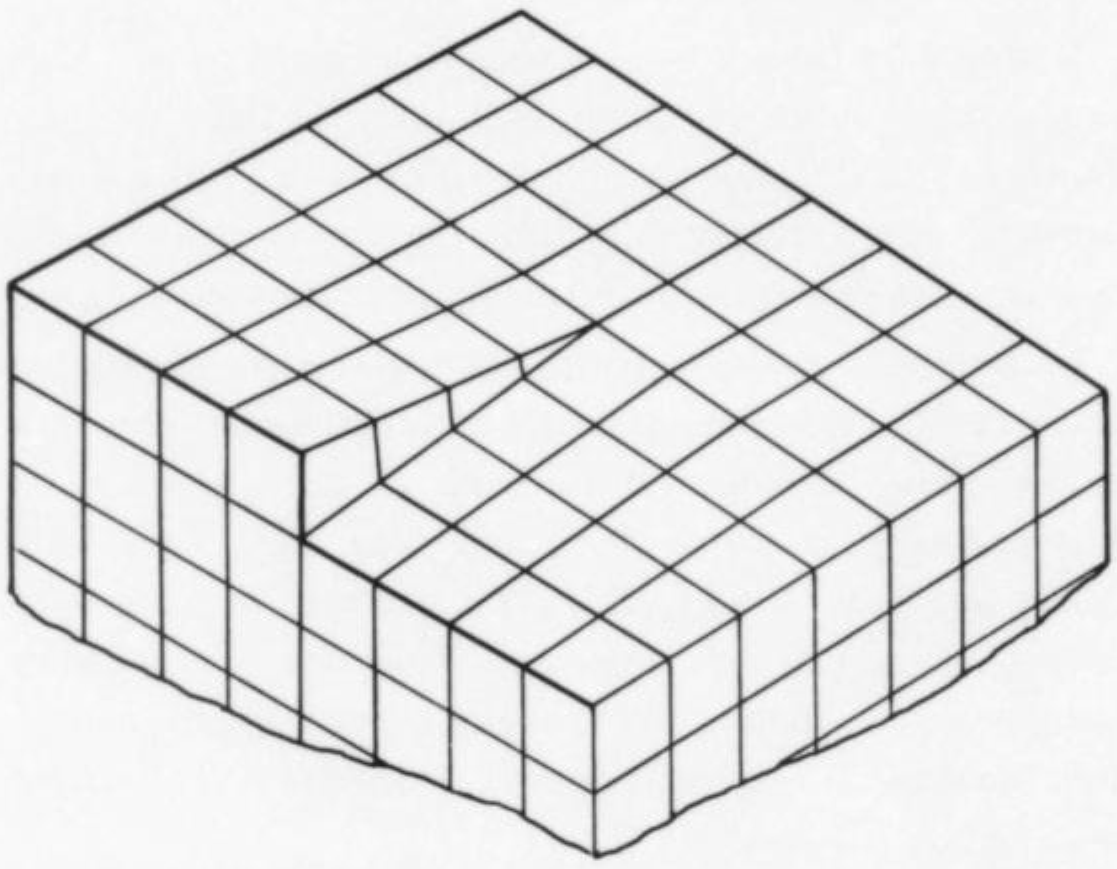


***Fig. 8.* Schematic representation of a screw dislocation.**

***Fig. 9.* Growth spirals on a solution grown crystal.**

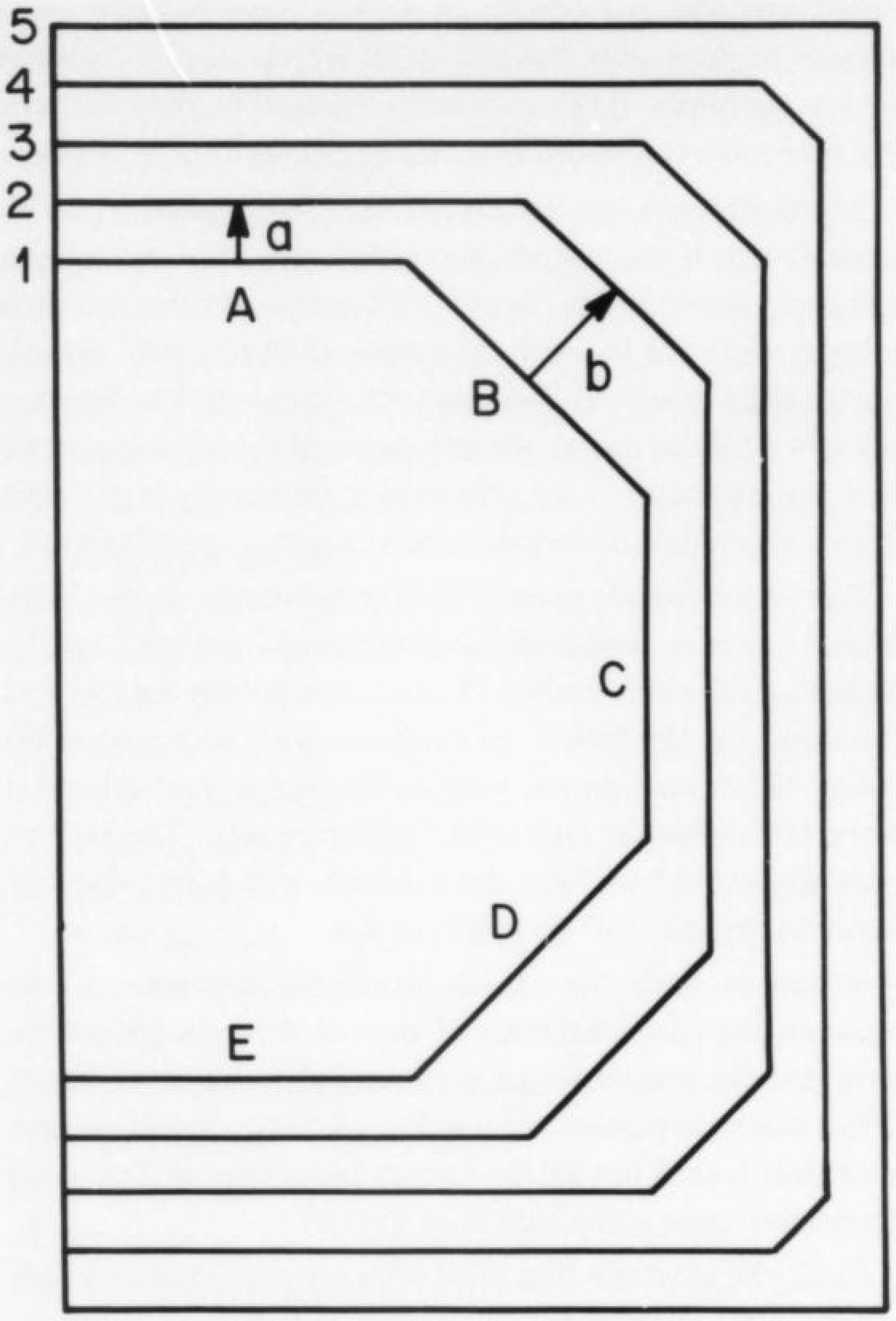


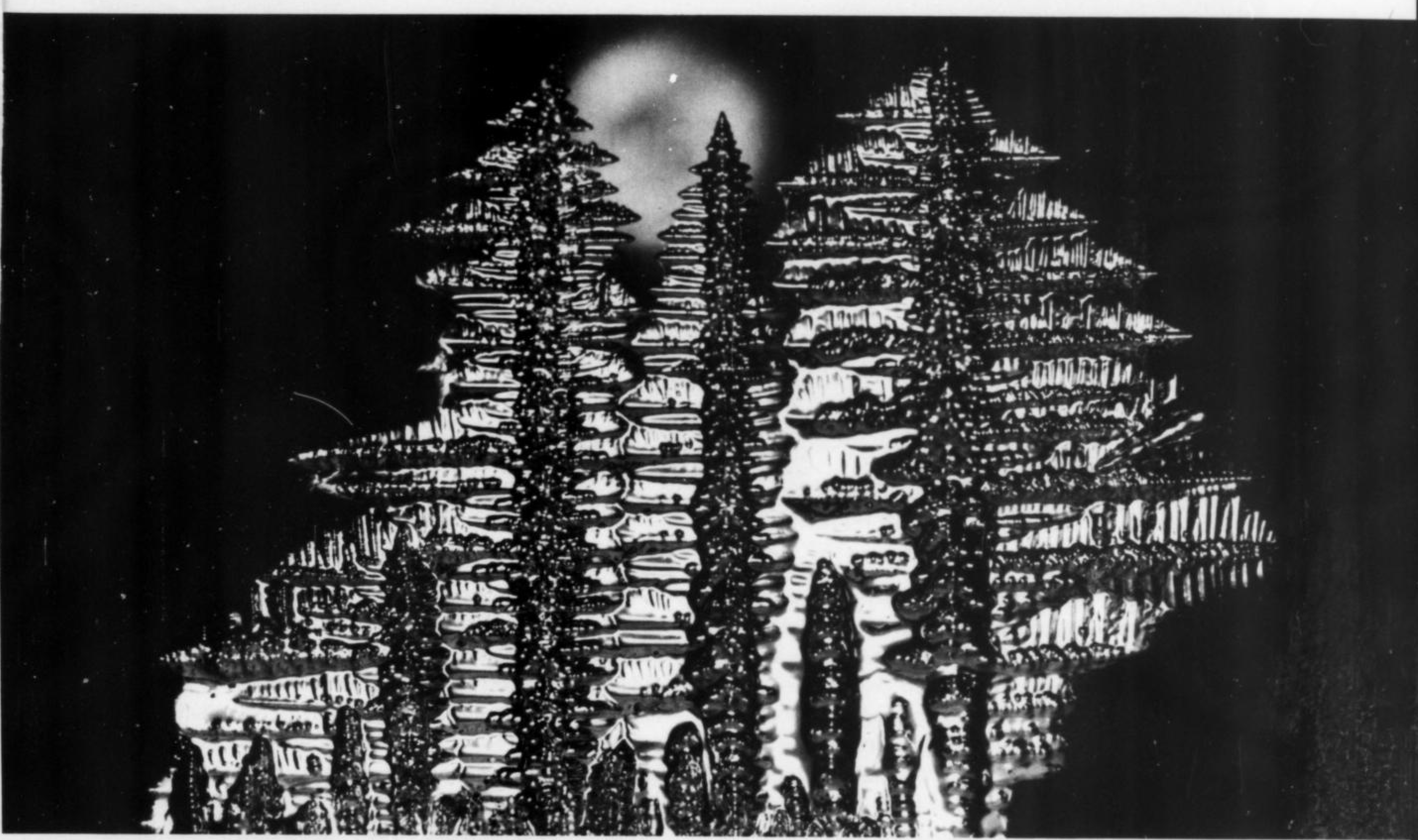
***Fig. 10.* Slow growing crystal faces A, C, E, survive; rapidly growing faces B, D disappear.**

Surprisingly enough it is the rapidly growing crystal face that disappears and the slowly growing one that survives and controls the crystal morphology. This can be seen in Fig. 10 which shows a seed crystal A, B, C, D, E, with successive equal time growth portions 1, 2, 3, etc. As can be seen, the rapidly growing faces B and D disappear and the slowly growing faces A, C, and E remain. The relative growth rate of different faces depends on the amount of supercooling, on the presence of impurities which are absorbed on the surface, and so on. In this way different crystal habits occur. Crystal faces do not have the opportunity to form when growth is very rapid with large supercooling, a condition which leads to dendrites as shown in Fig. 11. Intermediate between dendritic and faceted growth is hopper growth as shown in Fig. 12.

Part II to be continued in the next issue.

***Fig. 11.* Melt grown dendritic crystals of tin; specimen is 3 inches across.**

***Fig. 12.* Melt grown hopper crystals of bismuth; specimen is 3 inches across.**



ZEOLITES FROM SKOOKUMCHUCK DAM, WASHINGTON

by Rudy W. Tschernich

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In the spring of 1969 construction started on an earth filled dam located on the upper Skookumchuck River near the towns of Bucoda and Tenino, Thurston County, in southwestern Washington. During two years of construction, extensive blasting in the basaltic rock revealed pockets of well-crystallized zeolites that rival those found anywhere else in the world. Collecting was essentially limited to those persons directly involved in the dam's construction. Fortunately they were able to save a large amount of the minerals from destruction. Now that the dam is completed and collecting at this site has ended, only the spectacular specimens and the memories remain.

GEOLOGY

Southwestern Washington consists chiefly of Tertiary basalt flows, flow breccia, and subordinate sandstone and conglomerate units (Huntting, et. al., 1961). At the dam site, extensive, nearly horizontal Eocene basalt flows and flow breccias of the Northcraft formation predominate (Snavely, 1958).

Zeolites are found in small vesicles of localized extent and in large pockets, some of which occur at the contact between flows. While the small vesicles, ranging from 2 to 6 inches in diameter, produced many fine stilbite and pink heulandite crystals, most of the spectacular stilbite, mesolite, and analcime specimens were found in the larger pockets. Some of these pockets reached dimensions of 3x4x8 feet.

MINERALOGY

Early in the dam's construction, the tremendous collecting potential was realized when three or four large pockets as large as 3x4x6 feet lined with extremely large mesolite crystals were found by Charles Trantham, project geologist. These large pockets were found at two locations in the dam area. The finest mesolite came from the initial construction of the northern bedrock wall of the dam and from a small outcrop along an access road leading to the dam. Mesolite usually forms extremely thin needles in other world occurrences. At the Skookumchuck Dam site, mesolite crystals commonly reached 3 to 4 inches in length and 1/8 to 1/4 inch in diameter. Most of the specimens consist of 2x3 and 3x3 inch groups of radiating crystals as seen in Figure 1, but several groups reached 6x10 inches. One superb specimen composed of 3- to 4-inch

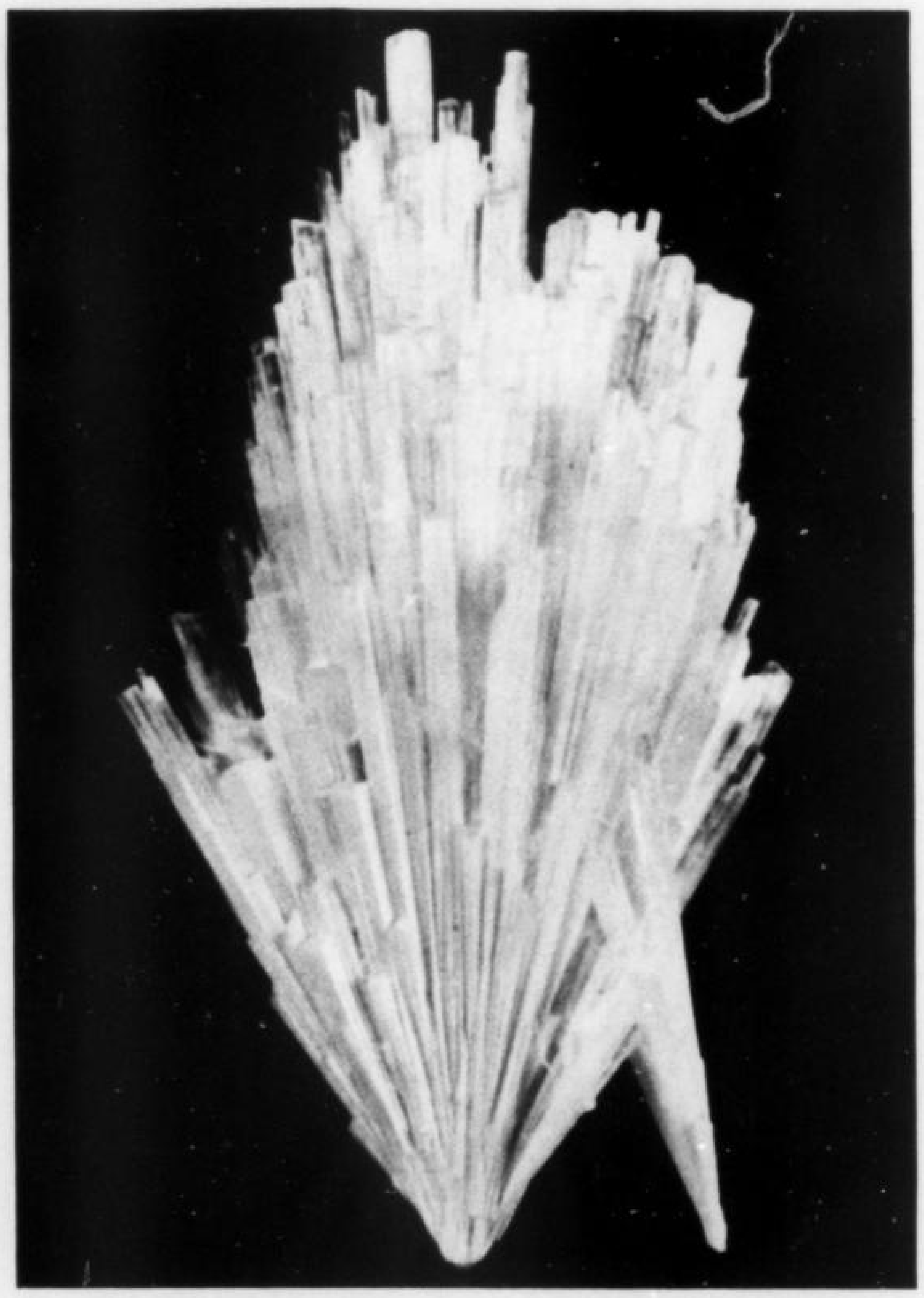


***Fig. 1* MESOLITE from Skookumchuck Dam, Tenino, Washington. Group is composed of 3-inch terminated crystals.**

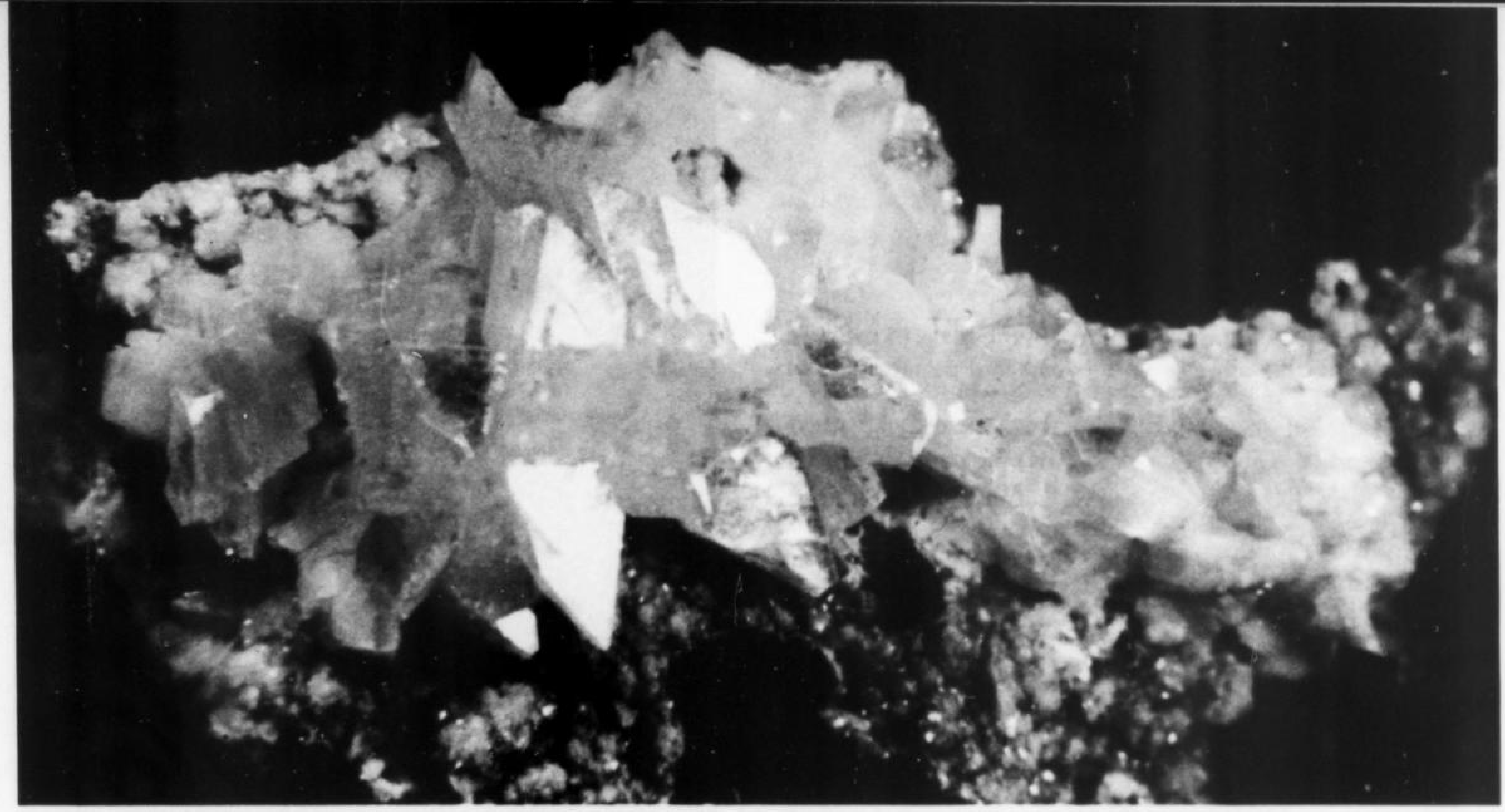


***Fig. 2* Pink secondary generation heulandite, 5/8 inches long, on drusy first generation heulandite.**

long crystals on 2 to 3 inches of massive mesolite matrix reached dimensions of 19x12 inches. This specimen is now at the Smithsonian Institution. These mesolite specimens were soon recognized as some of the finest known and quickly found their way into collections all over the country.

With these great finds of mesolite being made so early in the dam's construction, much more of the same material was anticipated. As construction proceeded, work was concentrated in building a side channel spillway in the bedrock along the left abutment of the dam. Large pockets of stilbite, mordenite, apophyllite and unusual forms of quartz were encountered but no mesolite was found. Vesicle pockets containing many small crystals of heulandite, stilbite, and mordenite were also found in the spillway construction. Near the end of the dam's construction, work resumed upstream from where the original mesolite crystals had been found. Visions of finding more large mesolite crystals were renewed. This time pockets containing fine large analcime and thomsonite crystals were found but the only mesolite present was in the form of hair-like needles. With completion of the dam, the spectacular discoveries of mesolite made at the beginning of construction are never to be repeated.

Many very find zeolites and associated minerals were found at the dam site. A more complete description of the minerals found follows in the order in which they crystallized in the basaltic cavities.

CALCITE: $CaCO_3$. Rhombohedral. Occurs as yellow to colorless scalenohedrons and rhombohedrons commonly about ½ inch. A few crystals reached three inches in length. Two distinct generations of calcite crystallization exist. The early generation forms dark yellow rhobohedrons covered by drusy heulandite and stilbite. A second generation is present as colorless scalenohedrons and rhombohedrons, and was the last mineral to crystallize. Early calcite is very scarce and localized while the second generation is abundant and widespread.

HEULANDITE: $(Ca,Na_2)\ [Al_2Si_7O_{18}]\cdot 6H_2O$. Monoclinic. Occurs in various shades of white, cream, tan, salmon, and pink, both massive in amygdules and in sharply terminated crystals. Two generations of heulandite are present. The first generation initiates the crystallization of the zeolite minerals and forms a drusy lining in most of the pockets. The second generation of heulandite (seen in Figure 2) is distinguished by much larger crystals, up to one inch, and by its separation from the first generation of heulandite by intervening mordenite. Needles of mordenite completely surround and are included within some crystals of second generation heulandite.

MORDENITE: $(Na_2,K_2,Ca)\ [Al_2Si_{10}O_{24}]\cdot 7H_2O$. Orthorhombic. Occurs as very thin 3/8- to 1/2-inch long white needles which possess the appearance of matted wet hair. Mordenite is found by itself, associated with stilbite, covering drusy heulandite, and included in secondary heulandite; but most commonly, mordenite is intergrown with quartz.

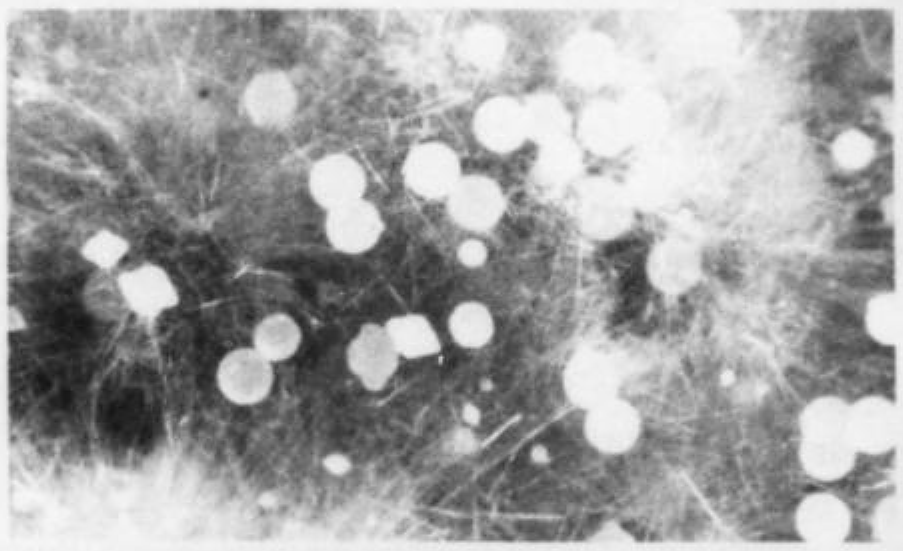
QUARTZ: SiO_2. Trigonal. Occurs as colorless transparent crystals to 1½ inches in diameter and frequently as milky-colored aggregates. Quartz crystals covered with ½ -inch colorless stilbite crystals and micro-sized stilbite crystals were found lining several large pockets. The quartz crystals generally show only their terminations and exhibit three predominant rhombohedral faces. Other pockets in the spillway area were lined with a massive mixture of mordenite and quartz, on which needles of mordenite and many unusual micro-sized quartz aggregates had developed (Fig. 3). In some pockets, quartz formed micro-sized spheres which resemble layers of "fish eggs" (Fig. 4). Other pockets were filled with complex aggregates possessing the appearance of "rice grains". Still other pockets contained combinations of the two forms. Extremely small crystals with the appearance of "beta quartz" are scattered among the other forms. Due to the unusual habits, X-ray diffraction was required for positive identification. Apophyllite,

Fig. 3 Mordenite needles with quartz in the form of spheres, small "beta quartz" appearing crystals, and penetration of the two forms.

Fig. 4 Pyramidal apophyllite on quartz aggregates which resemble "fish eggs".

Fig 5 Stilbite on massive snow-white mordenite-quartz. Largest crystal is 2 1/2 inches long. Photograph by Dean Hubbard.

Fig. 6 Transparent mesolite needles radiating from 3/8-inch white thomsonite hemispheres and associated with analcime.



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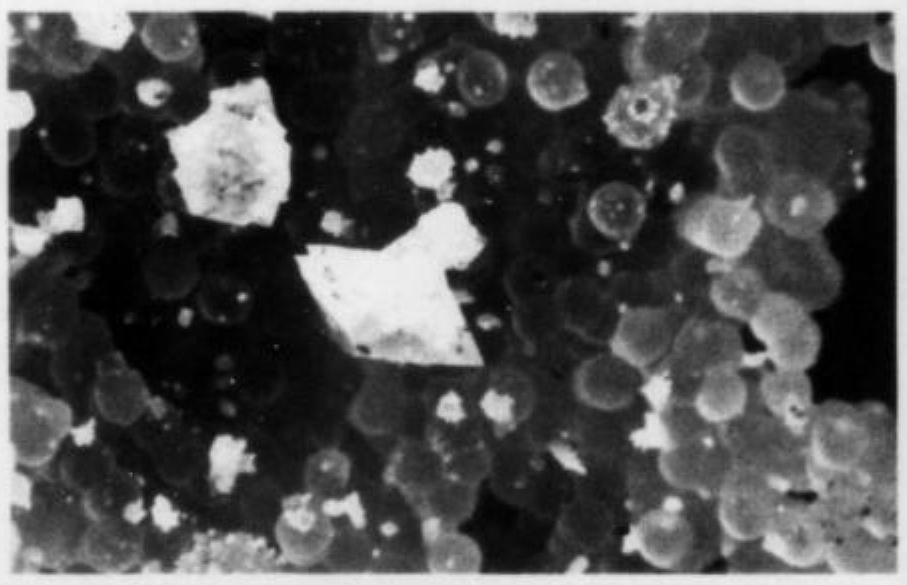

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6

calcite, stilbite, mordenite, and okenite are commonly found with either massive or terminated quartz.

A massive snow-white material, seen in Figure 5 covered with large white stilbite crystals, often lined many of the large pockets. This material was first thought to be a new mineral but was determined by X-ray diffraction to be a mixture of mordenite and quartz (W.S. Wise, priv. comm.).

A period of disturbance occurred after the crystallization of quartz and mordenite, probably during crystallization of stilbite. Many quartz-mordenite layers were fractured or broken loose from the walls of the cavities. Stilbite filled the fractures in the quartz-mordenite and cemented fragments onto stilbite crystals.

OKENITE: $Ca[Si_2O_4](OH)_2 \cdot H_2O$. Monoclinic. Occurs as chalky white hemispheres ranging up to 5/8 inch in diameter with a fibrous radiating structure. This material was tentatively identified as okenite by X-ray comparison (W.S. Wise, priv. comm.). It was found in one pocket where okenite formed hemispheres on massive quartz and was then completely covered with apophyllite crystals.

APOPHYLLITE: $KFCa_4[Si_8O_{20}] \cdot 8H_2O$. Tetragonal. Occurs as transparent, colorless to opaque prismatic crystals with pyramidal and basal pinacoid terminations. Commonly it occurs as small (1/4 inch) crystals on quartz (Fig. 4) but has been found in crystals upto 1½ inches long. Stilbite, mordenite, calcite, quartz, and, in one pocket, okenite have been found associated with apophyllite.

STILBITE: $(Ca,Na_2,K_2)[Al_2Si_7O_{18}] \cdot 7H_2O$. Monoclinic. Occurs as small, colorless doubly-terminated individuals and as large, lustrous, cream colored aggregates. Stilbite, variety epidesmine, possessing only three pinacoids, is common in crystals up to 1/8 inch. Slightly larger crystals (up to ½ inch) show distinct isolated "textbook" crystal form with sharp pointed extremities. Stilbite crystals larger than ½ inch are complex aggregates which possess a predominant flat termination with numerous off-set prism faces (fig. 5). Large aggregate crystals show the typical pinching at the middle and swelling at both extremities but the typical sheaf structure so commonly displayed on Eastern U.S. stilbite was scarce. Stilbite is a common mineral at the dam site, forming crystals up to 4 inches in length, and is found associated with most other minerals.

MESOLITE: $Na_2Ca_2[Al_2Si_3O_{10}]_3 \cdot 8H_2O$. Monoclinic (pseudo-tetragonal). Occurs as colorless or pink, transparent to translucent, prismatic crystals, elongated along the *b* axis and terminated by pyramidal (111) faces with perfect (101) and $(10\bar{1})$ cleavage. Crystals are always twinned parallel to (100), yielding striations parallel to the crystal elongation and across the terminal pyramidal faces. Inclined extinction has been found from 5° to 8°. The mean refractive index of $\beta = 1.503$. Commonly mesolite crystals are 1/8 inch in diameter with a few reaching 1/4 inch and form needles three to four inches in length. Specimens were found as individual sprays of crystals and as intersecting sprays of crystals (Fig. 2). These mesolite crystals were the most abundant mineral in the large "mesolite pockets" but a minor amount of stilbite, calcite, and micros of chabazite and laumontite have been found in association. A few pockets of very thin, exceptionally transparent hair-like needles were found associated with analcime and thomsonite. The thin mesolite needles commonly radiate from balls of thomsonite as seen in Figure 6.

ANALCIME: $Na[AlSi_2O_6] \cdot H_2O$. Isometric. Occurs as colorless translucent and opaque white trapezohedral crystals commonly reaching 3/8 to 3/4 inch in diameter with a few reaching 1½ inches. Some analcime crystals are etched, leaving skeletal cavities in the crystal. Mesolite needles penetrate through some analcime crystals and form on the surface of others. Common associates of analcime are thomsonite, chabazite, laumontite, and mesolite. Analcime was found only in an outcrop upstream from the right abutment of the dam.

THOMSONITE: $Ca_2Na[Al_5Si_5O_{20}] \cdot 6H_2O$. Orthorhombic. Occurs as colorless translucent blades with only three pinacoids present. Thomsonite is found as small isolated individual crystals and in crystal groups forming 5/8-inch balls which cover analcime. Thomsonite balls often have thin mesolite needles radiating from their surface. Thomsonite was found primarily upstream from the right abutment of the dam and has the same mineral associates as analcime.

LAUMONTITE: $Ca[Al_2Si_4O_{12}] \cdot 4H_2O$. Monoclinic. Occurs as small opaque white prismatic crystals generally under 1/16 inch in size. Laumontite is most noticeably found enclosed in and perched upon the tips of many of the mesolite crystals. As one of the last minerals to crystallize, laumontite would be expected to be found on many of the minerals at the dam site; it is, however, found only on mesolite, analcime, apophyllite, and thomsonite. Chabazite coats laumontite crystals.

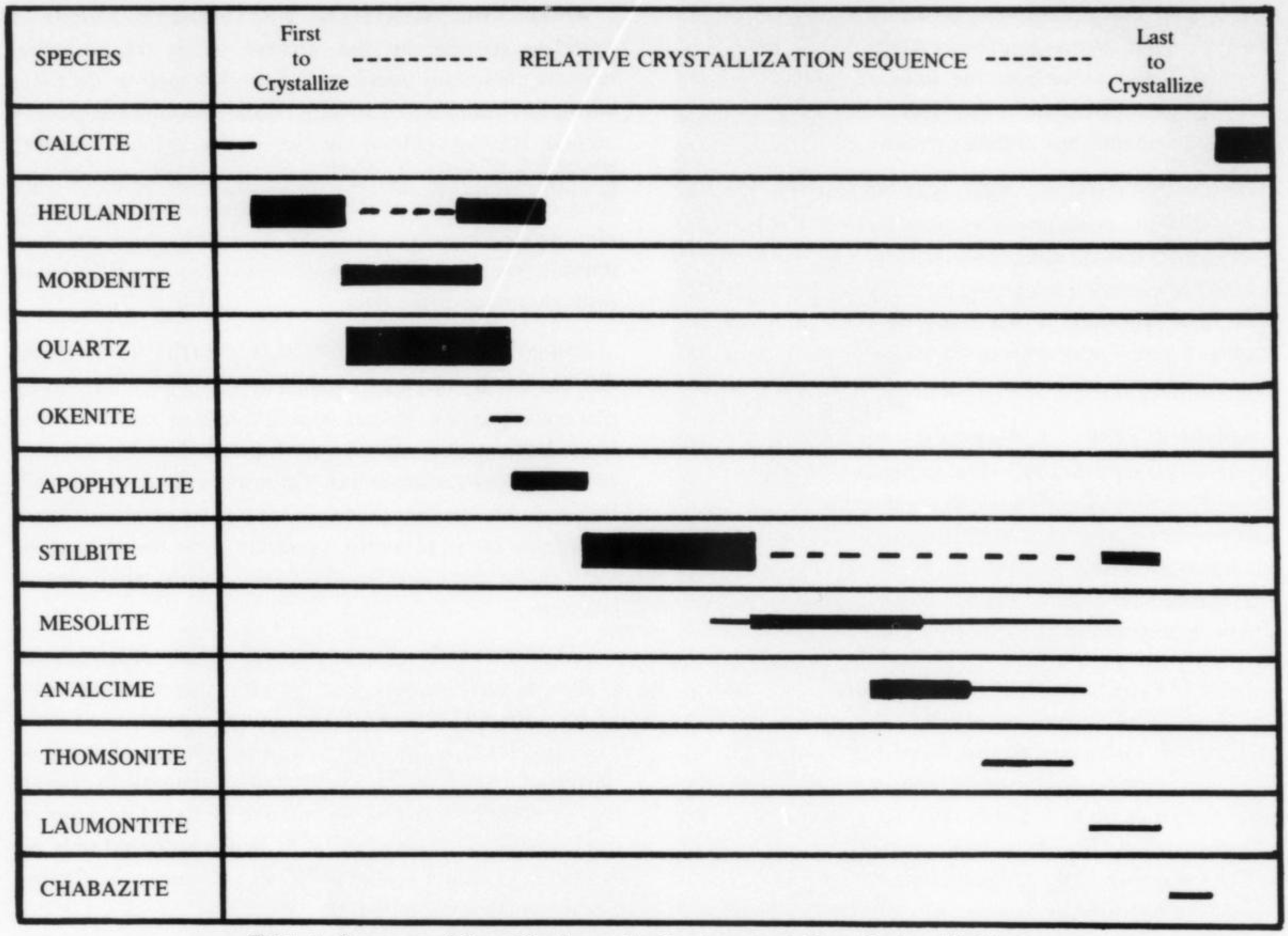

Table 1. Sequence of Crystallization at the Skookumchuck Dam, Tenino, Washington
a) Thickness of the bar indicates relative abundance of the mineral.
b) Relative time of crystallization runs from left to right.

CHABAZITE: $Ca[Al_2Si_4O_{12}]\cdot 6H_2O$. Rhombohedral. Occurs as very small colorless transparent rhombohedrons, under 1/8 inch in size. Although chabazite is not abundant it is found on all other minerals with the exception of the final generation of calcite.

SEQUENCE OF CRYSTALLIZATION

The order in which the minerals at the dam site crystallized is illustrated in Table 1. Ca-rich minerals predominate throughout most of the period of crystallization, with the exception of a Na-rich period that occurred towards the end of the sequence when mesolite, analcime, and thomsonite formed.

The following generalizations seem to be consistent at the Skookumchuck Dam site as well as at most of the other zeolite locations in Washington and Oregon.

1) Calcite commonly is the first and/or last mineral to crystallize.
2) Heulandite, if present, is the first zeolite to form.
3) Stilbite generally follows heulandite crystallization.
4) Mordenite and quartz often crystallize together.
5) Analcime is commonly followed by thomsonite and chabazite.
6) Laumontite and chabazite followed by calcite, if present, are the last minerals to crystallize.

ACKNOWLEDGMENTS

I would like to thank Charles Trantham and Richard Bideaux for their many helpful suggestions in reviewing the manuscript. I am also grateful to the Bechtel Corporation for the opportunity of collecting material for study. Special thanks is given to Dr. William Wise for X-ray determination of several of the minerals.

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Specimen Requests

We would like to examine small hollow geodes from the Keokuk area. We are primarily interested in geodes containing opaque minerals. Microscopic amounts of material would be removed for analysis but the geodes will not be otherwise damaged. The material would be returned upon completion of the analysis. Arrangements can be made for shipping.

Robert B. Finkelman
U. S. Geological Survey - Bldg. 14
4200 Connecticut Avenue, N.W.
Washington, D.C. 20242

The Division of Mineralogy at the Smithsonian Institution has begun a project whose success depends on your assistance.

One of the most important jobs of a museum is preservation of materials for future generations; at the Smithsonian, this aim is supplemented by the documentation of historically significant events, discoveries and inventions. The study of materials synthesis and crystal growth has mushroomed in recent years into a major worldwide industry. Yet nowhere is a systematic record or collection being maintained that comprises a cross section of the research and development efforts in the materials industry. Such a collection would have immeasurable value to future research scientists, engineers, science historians and students of crystal growth processes. Many of the crystals grown in laboratories today are analogs of natural minerals, thus offering unique study material for the mineralogist.

Our goal is to acquire for the Smithsonian representative samples of all inorganic synthetic materials, produced both in laboratories and in industrial plants, by accident or by design. Included in this collection would be:

- crystals grown commercially for materials applications
- crystals formed accidentally in laboratory experiments
- crystals formed accidentally in commercial production runs
- experimental materials produced in laboratory studies

All growth techniques (solution, flux, vapor, gel, melt, VLS, zone, etc.) and all types of inorganic materials (metals, ceramics, chemical compounds such as used as reagents, minerals) should be represented. Even the "accidents" of crystal growth, normally unwanted by research and production people, offer opportunities to study morphologies of rapidly-grown crystals. The processes by which these form resemble in many ways those of natural environments, and are of great interest to earth scientists.

It is hoped that materials scientists will recongnize the value of the proposed National Synthetics Collection, and will put aside all crystalline materials that are no longer needed. A brief description of available material should be sent to:

Dr. Joel E. Arem, Crystallographer
Dept. of Mineral Sciences,
Smithsonian Institution
Washington, D.C. 20560

All donations to the collection will be formally acknowledged.

We are engaged in an attempt to correlate the rare-mineral content of pegmatites with the trace-elements in muscovite and feldspar of the wall zone of such pegmatites. To accomplish this we are in need of samples of muscovite and feldspar from the wall zones of many different pegmatites, both rare-mineral bearing and common types, along with observations and notes on the mineralogy of the entire pegmatite.

The samples we require need not be large (1 or 2″ pieces) or of specimen quality. It is more important to have representative material, accurate locality information, and detailed mineralogical data on the pegmatite if it is available. If any readers plan to visit pegmatites and would like to collect for us, they should write for data cards, sample bags, and a more detailed description of the project and the sample requirements.

The project should be of great interest to collectors since it may lead to a means of predicting rare-minerals in pegmatites and perhaps to the discovery of new localities. All assistance will be gratefully acknowledged. For more information, write to:

Harold W. Krueger
Geochemistry Laboratories Division
Krueger Enterprises, Inc.
24 Blackstone Street
Cambridge, Mass. 02139

I am working on a master thesis (M.S. Geology - San Jose State) and am in need of platinum specimens to complete my laboratory work. The project involves trace element analysis by microprobe technique of lode and placer platinum from worldwide localities. I am particularly interested in placer platinum grains or platiniferous black sand concentrates. Even small samples of a few grains will be helpful. Since my graduate funding is very limited, I would prefer to recieve specimens on a loan basis, or in exchange for specimens of mineralogical interest from my private collection.

Thomas D. Palmer
Building N-245-5
Ames Research Center
Moffett Field, Calif., 94035

Yedlin on Micromounting

We have a pretty unfailing rule we go by, namely, that minerals are where they're supposed to be. Scanning through Dana, the mineral atelestite caught our eye. Its description—monoclinic, resinous to adamantine lustre, wax yellow, formula $Bi_8(AsO_4)_3O_5(OH)_5$ was interesting, mainly because there are not many bismuth minerals, but also because of its occurrence and associations. Still with Dana's *System,* there was noted "Found with bismutite, eulytite, etc. . . . .at Schneeberg, Saxony."

So we went to our eulytite mounts and found, on several of them, pale yellow, tabular, monoclinic crystals, with waxy lustre—atelestite! We'll never know why we missed 'em the first time. Perhaps we were so taken with the acquisition of a 2 inch piece of material showing eulytite in 3 crystal habits that we were blind to all else. We suggest that *every time* you process an uncommon mineral you read about it before you put it away. This will develop your familiarity with the species and all its properties, advise as to its major sources, and usually list its associated minerals.

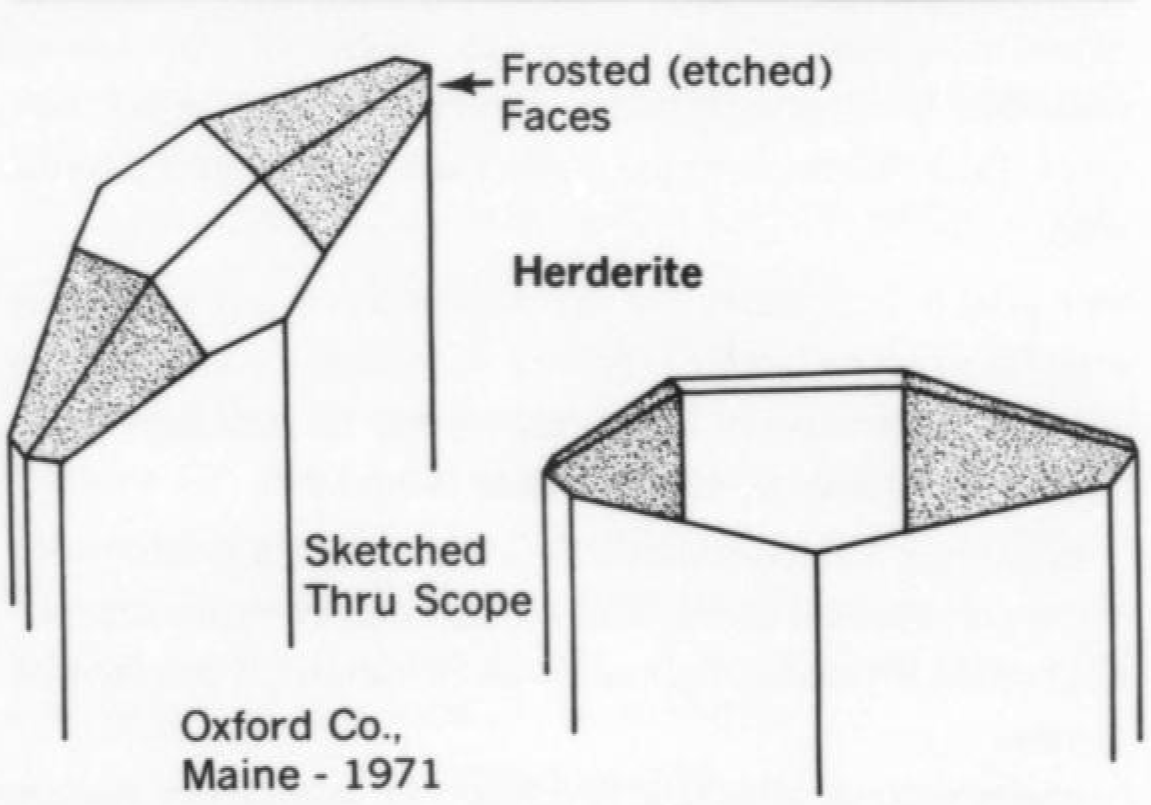
Douglas J. Berndt, 1102 Watuga St., Kingsport, Tennessee, 37660, has just sent a list of 65 m/m items. For those of you who are interested in m/ms of some eastern localities this is an opportunity to obtain things from the Foote mine at Kings Mountain, North Carolina, Mullica Hill, New Jersey, Hall's Gap, Kentucky, Chalk Mountain, Hiddenite, Cleveland County (all North Carolina), and others. Such things as bertrandite, eucryptite, apatite, fairfieldite, strengite, beraunite, switzerite, strunzite, rutile, millerite, honessite, bavenite, anatase, wavellite and others are listed. Prices from fifty cents. Send a stamp for a list. Some of these things are a one locality item. Honessite is found in but 2 or 3 places. And crystallized eucryptite! Most eucryptite is but an alteration coating spodumene. At the Foote mine it occurs in beautiful crystals.

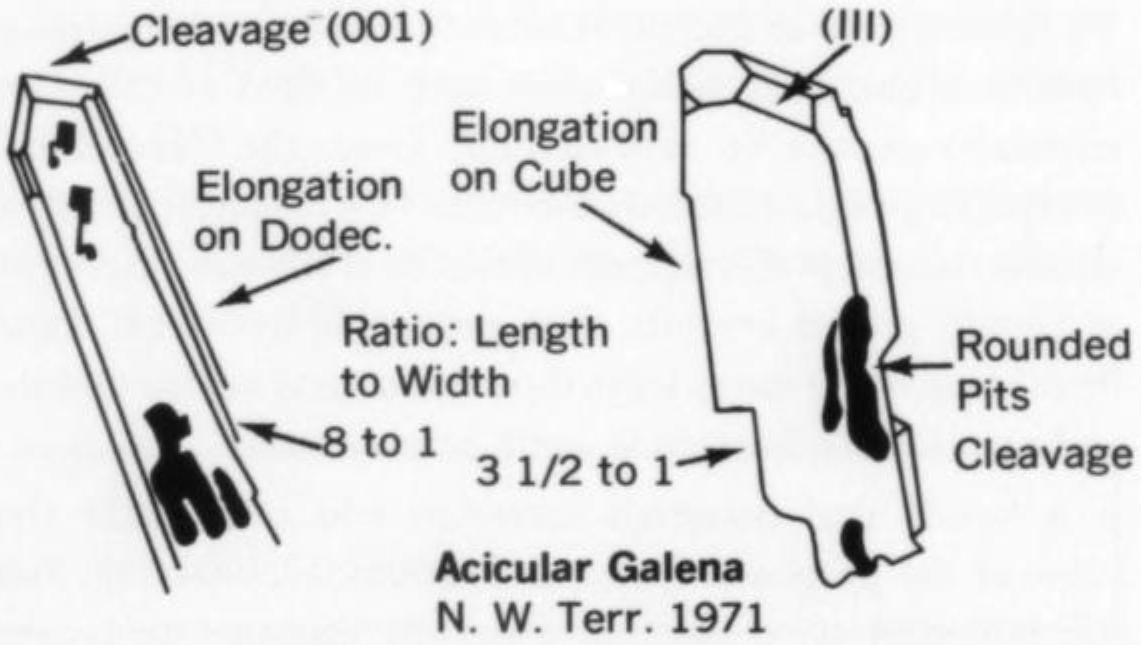
Ray Lasmanis, 618 E. Central Ave., Spokane, Washington, 99207, tells of some unusual galena. His missive: "I've sent you some micro galena from the North West Territories. I worked there as an economic geologist during 1968. In the pit one day I saw some hairlike galena filling a small vug. Impossible to get out, but I'm sending to you some crystals that are thicker. Looking at the curved surfaces of some of them they appear to have formed in a gel of some sort. A good discussion of this deposit is found in *Economic Geology,* Vol. 63, 1968, pages 451 to 471."

The crystals we received were distorted, elongated, pitted and rounded, but with a sufficient number of crystal faces and cleavages to orient them. Their ratio of length to width ranged from 10-1 to 4-1. Rough sketches show the typical specimens.

We continue to get things from Joe Pollack, The Brick House, Harrison, Maine 04040. For this we are thankful, for we've been supplied with some great things. The latest, from the pegmatites at Oxford, Connecticut, included some masses of albite, with surfaces of compact cookeite, in which were superb prismatic crystals of herderite, some clear etched material looking like rock candy, and some black, metallic, crackerbox-shaped things that showed red reflections on the surfaces when the material was popped from matrix. Turned out to be manganotantalite.

The etched clear material was easy. It scratched quartz and, when one of the fragments was crushed, some of the pieces showed perfect cleavage. The mineral is topaz and, since topaz has an easy and perfect cleavage at right





angles to the "c" axis, it was easy to orientate the other crystals.

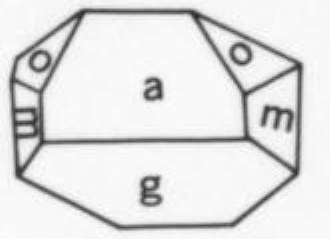
The herderite was in rather flat prismatic, orthorhombic crystals, and somewhat like those shown in Dana's *System*, 7th ed., vol 2, page 821. We've sketched a couple through the scope. The Sketches we do for this column are not set up in the ideal textbook manner. They're not meant to be. We mount specimens to "put their best foot forward" and the results do not necessarily comply with crystallographic purism. Our rough drawings follow our mounting technique. We call 'em as we see 'em.

We have herderite from a number of localities. From Maine, Topsham produced rather equant prismatic crystals. Newry material occurred as globular masses, internally fibrous-radiating, as well as in somewhat equant crystals. Greenwood herderite seems identical to that of Newry, both as to globules and crystals. A pocket at the Palermo mine, N. Groton, New Hampshire produced clusters of clear, flattened, striated crystals, and a find at Riverside, California turned up forms similar to those at Topsham.

A new discovery in Brazil has produced cabinet specimens. We've not yet seen micromount-sized euhedra, but we're hoping, and we'll keep you alerted.

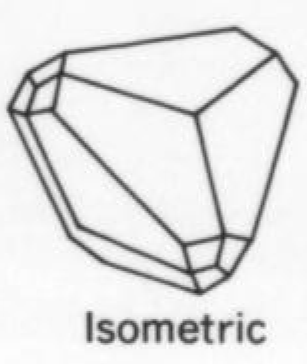
BRIEF NOTES AND QUOTES: Bill Hunt, 10350 Andover, Sun City, Arizona 85351: "Sending some carminite on scorodite, and pharmacosiderite from Central Eureka mine, Eureka, Utah. They're some of the last to come out. You've heard the sad story. (No. Tell us.) We arrived the day after it happened. Place is now closed." What we received was beautiful red carminite crystal clusters and singles, growing in vugs of grey-blue scorodite. These vugs were crystal lined, and in many cases isolated pseudocubes of honey golden pharmacosiderite were evident. Bill's a trader.

Forrest Cureton II, Stockton, California "Collected some nice plattnerite at Eureka, Nevada (Note the State.) and when the article on this mineral appeared in the *Record* I thought I'd send some. (Our thanks. A new locality for us.) My son David was collecting in British Columbia this past summer and found what appear to be crystals of collinsite from Francois Lake, though I'd never heard of them before. He collected nice ferrierite too. I'm enclosing samples. For those interested this material is obtainable from Mineralogical Research Co., 1490 Mt. Shasta Drive, San Jose, California 95127, and from Mathiasen Minerals, 41149 St. Anthony Drive, Fremont, California 94538."



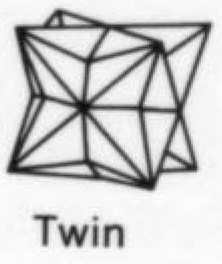
Atelestite
Monoclinic
Schneeberg
Saxony

Sketches from Goldschmidt's Atlas der Krystallformen 1916.



Isometric

Eulytite ③
Schneeberg
Saxony



Twin

The collinsite is most interesting. The Dana description of the mineral, $Ca_2(Mg,Fe)(PO_4)_2 \bullet 2H_2O$,in layers composed of radial blades or lathlike fibres enongated (100). Found with a dark brown fibrous fluorapatite, the minerals occurring as concentric alternate crusts with a radial fibrous structure.

We'd had a polished slab of this stuff from Wards many years ago. No crystallization was evident. The recent material showed some light tan crystals on the surfaces of shrinkage cracks in compact fibrous collinsite. We sent a specimen on for study and determination. We'll keep you posted.

Anent our query of the identification of micromount boxes marked "E. S. New York", and our surmise that they may have been those of Ernest Schernikow, an erstwhile member of the New York Mineralogical Club, we've just received some information. A letter today (Jan. 4, 1972) from Hatfield Goudey, 1145 W. 31 Ave., San Mateo, California 94403, supplements our guess. He says: "I can confirm that Ernest Schernikow was a micromount collector. About 1930 I had the privilege of viewing his collection in his apartment on Russian Hill in San Francisco. It was the first micromount collection I had seen and I was greatly impressed. He spent his years of retirement in San Francisco. I don't know what became of his collection (Ed. Note. It is now in the possession of Pete J. Dunn of Boston U.). One of his cabinet specimens was a beautiful crystallized gold with a fine tetrahedrite suspended in it. It was on display in the State Division of Mines exhibit in the Ferry building, San Francisco, and after Schernikow's death Walter Bradley, then state mineralogist, purchased it and donated it to the museum."

By way of note, we've just received a new m/m price list from Goudey. Some very interesting things. A stamp brings it.

Glossary of Mineral Species: Dr. Michael Fleischer's fine and complete (To June 1, 1971.) listing of all recognized minerals is out of press, and is being distributed by the *Record*. (See announcement in this issue.) One dollar to subscribers; two dollars to all others. You can no more afford to miss this publication than you can afford to miss *Mineralogical Record* itself. Get a flock of 'em to distribute as gifts to your collector friends. Clubs lay in a supply and distribute to new members, together with copies of your club's constitution, membership list, and membership card. The glossary is an index of all minerals, together with the chemical formula of each, and is a definitive means of knowing what"is and isn't". It will be of great aid to exhibitors and judges at shows.

We amend our usual closing plea: "Buy, use and distribute Fleischer's *Glossary of Mineral Species.*

Neal Yedlin

HÅKANSBODA copper and cobalt deposit, SWEDEN

by ***Stig G. Adolfsson*** Nobelvägen 1G • 710 30 Gyttorp, Sweden

LOCATION

The mines are situated close to the road between the villages Sto̊ra and Stråssa, Ramsberg parish, about 40 km north of Örebro and some 200 km west of Stockholm. The deposit is within the mining district "Bergsslagen", in central Sweden.

HISTORY

Like several mines in Sweden, Håkansboda has a very old history. It was worked in the 15th century by King Karl Knutsson. Most likely, however, the mines were in operation even around 1350 but very little is known about this early period. Around 1540, King Gustav Vasa mined some copper which was smelted at a nearby furnace. The continuation is unknown until 1627 when Louis de Geer made some exploration work, which however was not very successful. The real mining period began in 1702 when Detlof Heijke put what was then called the Norrgruvan mine in operation. For the following 100 years the annual output of copper metal was about 3 metric tons. Due to its high cobalt content, the ore from Håkansboda was not popular among the smelters. Later cobalt was recovered as a byproduct. During the years 1836-1841, 7100 kilos of cobalt ore were hand-picked from the rocks and brought to the surface from the underground operations. In 1861 the mines were abandoned due to the low copper content of the remaining ores. Then, in the early 1900's, the price of copper went up and in 1915 production started again, continuing until 1924. During this period, about 20,000 tons of ore with a copper content of about 2.2 percent were produced.

In the beginning of 1950, the Märrgruvan mine was pumped dry again and a little headframe was raised. Exploration work underground lasted three months and about 3 tons of ore were brought to surface. It proved to be very low grade with regard to copper and cobalt and, as the work proved no high grade reserves, once again the mine was abandoned. Since then nothing has been done about this deposit. It is believed that even with today's modern methods and machinery no profitable mining can be carried out here.

GEOLOGY

All of the mines in the Hakansboda deposit are in a body of dolomite which is surrounded by a dark leptite. The ores occur as impregnations in the coarse dolomite, with serpentinized olivine and a spinel. In the southern part of the deposit the ore was found mainly with a diopside skarn. The ores were steeply dipping (about 60-85 degrees) and were oriented generally north-south. The deepest part of the mine was about 300 meters. At this depth the ore was narrow and it is believed that it pinched out at further depth.

MINERALOGY

The ore minerals of Håkansboda are listed below in order of abundance:

Pyrrhotite ($Fe_{1-\chi}S$) is the main mineral of the orebody. It was found as fine-grained to large crystalline masses.

Chalcopyrite ($CuFeS_2$), a copper ore, was found intergrown in the pyrrhotite, often with some quartz and cobaltite. It also formed large masses.

Pyrite (FeS_2) occurs fine-grained and massive. Spread throughout the deposit, it was often found in crystals between the ore and dolomite.

Arsenopyrite ($FeAsS$), occurred with pyrrhotite and quartz in fine-grained shiny masses. Glaucodot was common in this assemblage.

Cobaltite ($CoAsS$) was recovered in beautiful metallic shiny cubes and dodecahedrons, with pyrrhotite and chalcopyrite, in sizes 1-15 mm. Several larger crystals were found over the years, especially in the southern part of the deposit.

Glaucodot ($(Co,Fe)AsS$) was first thought to be a cobaltian variety of arsenopyrite, but close examination proved it to be a distinct species. Very unusual, orthorhombic, greyish with metallic luster. Found mainly in the middle part of the ore, intergrown with pyrrhotite and arsenopyrite.

As very minor constituents of the ores, magnetite ($FeFe_2O_4$), galena (PbS), and sphalerite (ZnS) were also present. None of these three minerals had any economic importance. The gold content of the ore was about 1-2 grams per metric ton and silver ran about 20 grams per ton.

COLLECTIONS

In the late 1800's and early 1900's several mineral dealers, from different parts of Europe, encouraged young boys to collect the shiny cobaltite and glaucodot crystals. These specimens were priced according to size and perfection of shape but all were inexpensive. Several of the collected crystals found their way to different museums and can now be seen at many places throughout the world. One of the largest cobaltite crystals ever found, the size of a large fist, is now at the Swedish Museum of Natural History, where many nice glaucodots are also to be seen. The Swedish Universities' collections also have many beautiful specimens as well as the Bergsskolan (School of Mines) in Filipstad. If someone should be interested in crystals, the author has some available for trading. As the ore was handsorted, nothing is to be found on the dumps today.

REFERENCES

Sveriges ädlare malmer och bergverk (Nonferrous ores and mines of Sweden), by F. R. Tegengren, *Sveriges Geologiska Undersökning,* serie Ca no. 17, pp. 233-234, 1924.

Dana's System of Mineralogy, Vol. I, 7th ed., pp. 296-298 and 322-325, John Wiley & Sons, New York, 1966.

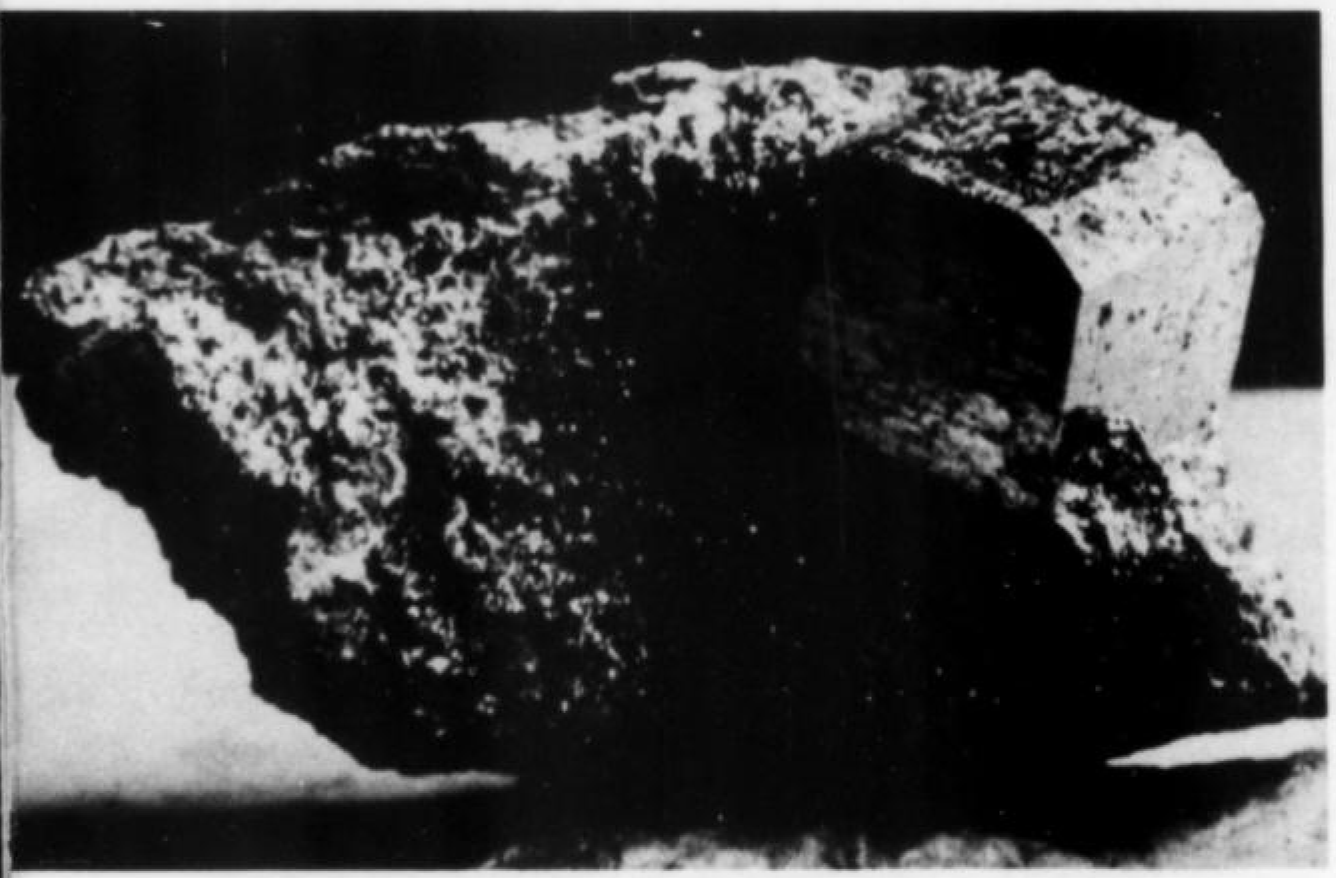


Fig. 1 **Close up of a Cobaltite cube, 15 mm on the edge.**

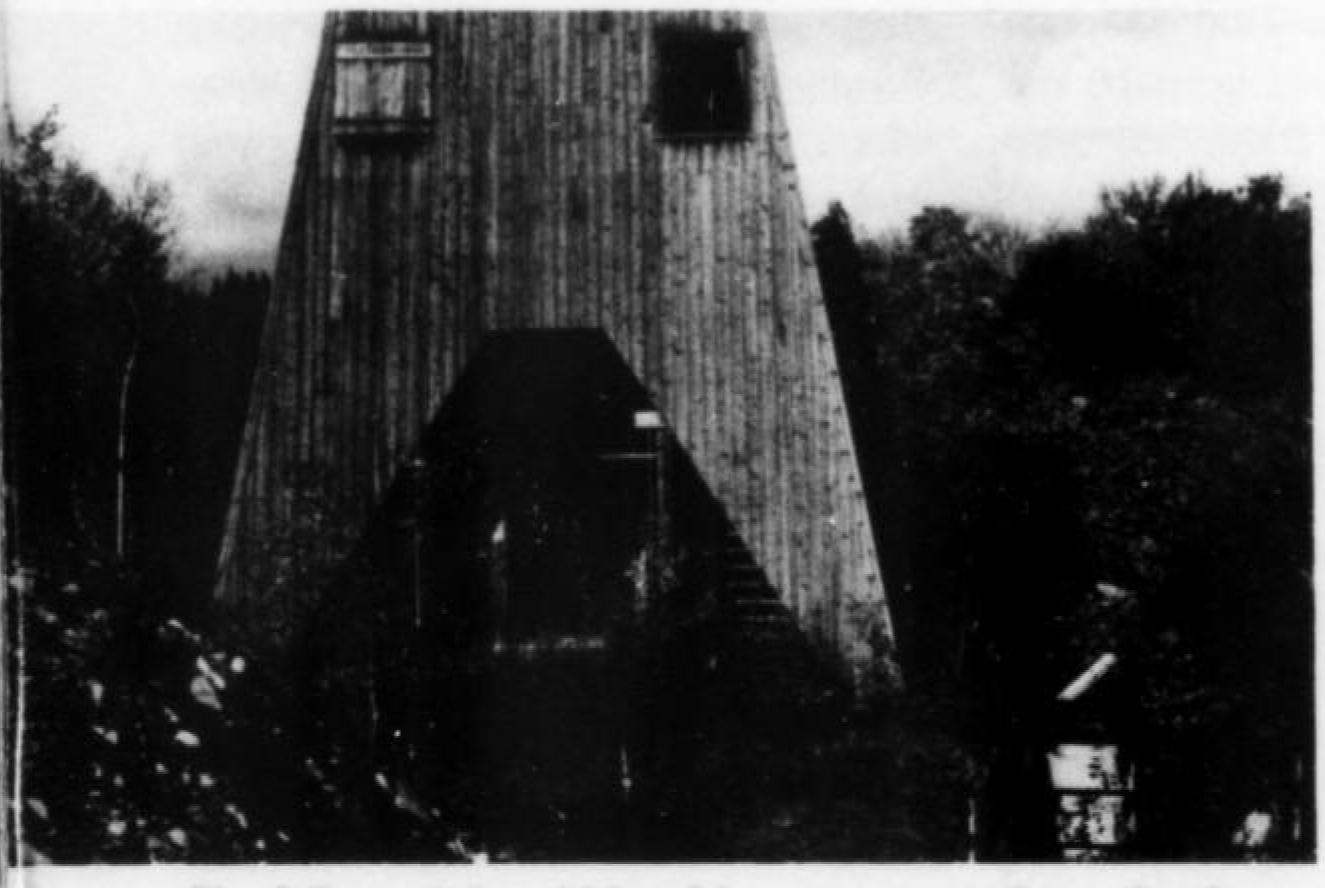


Fig. 2 **Part of the old head-frame, as seen from the dump.**

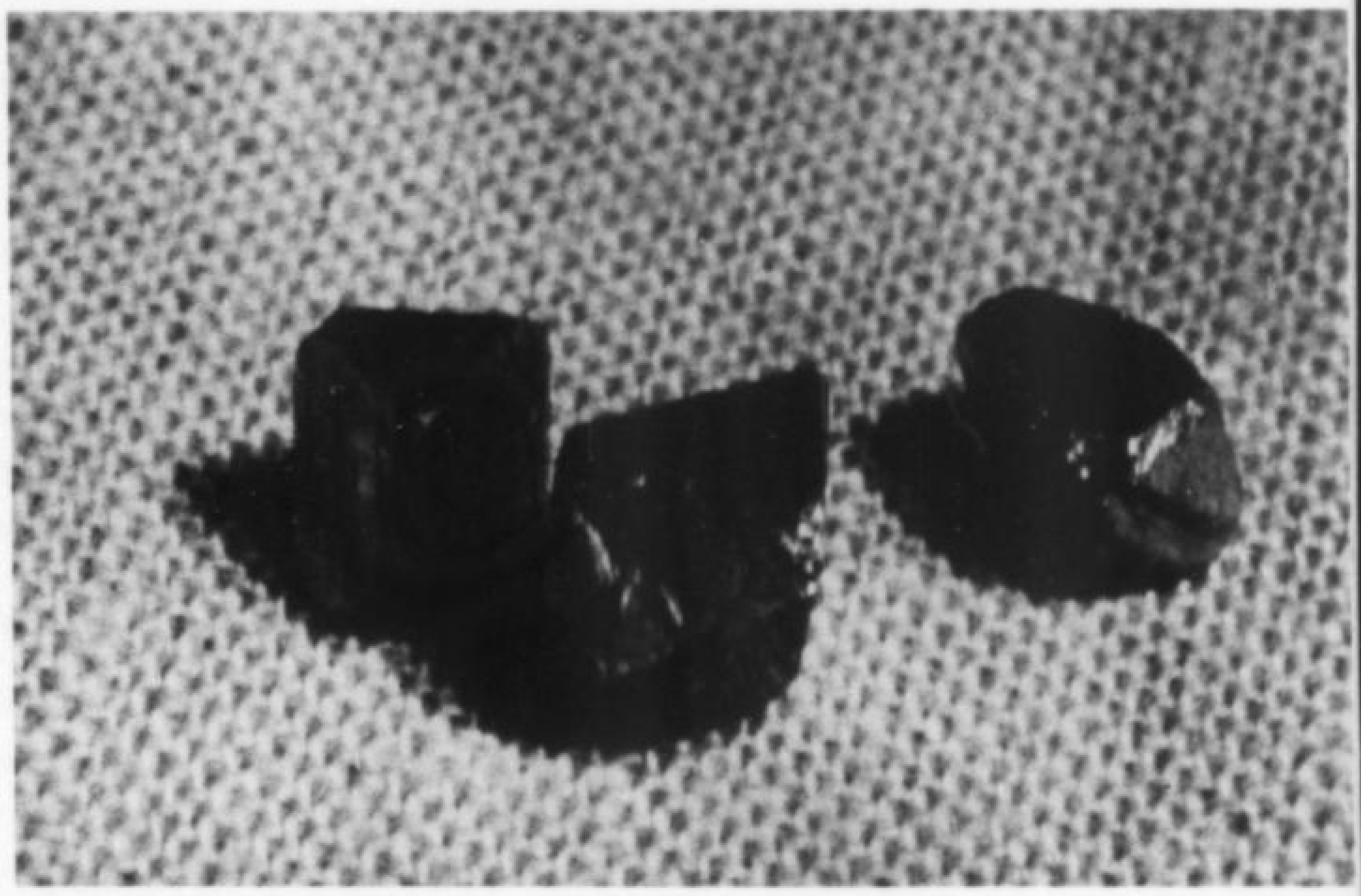


Fig. 3 **Glaucodot crystals, about 6 mm in size.**

Fig. 4 **The author looking for the great find.**

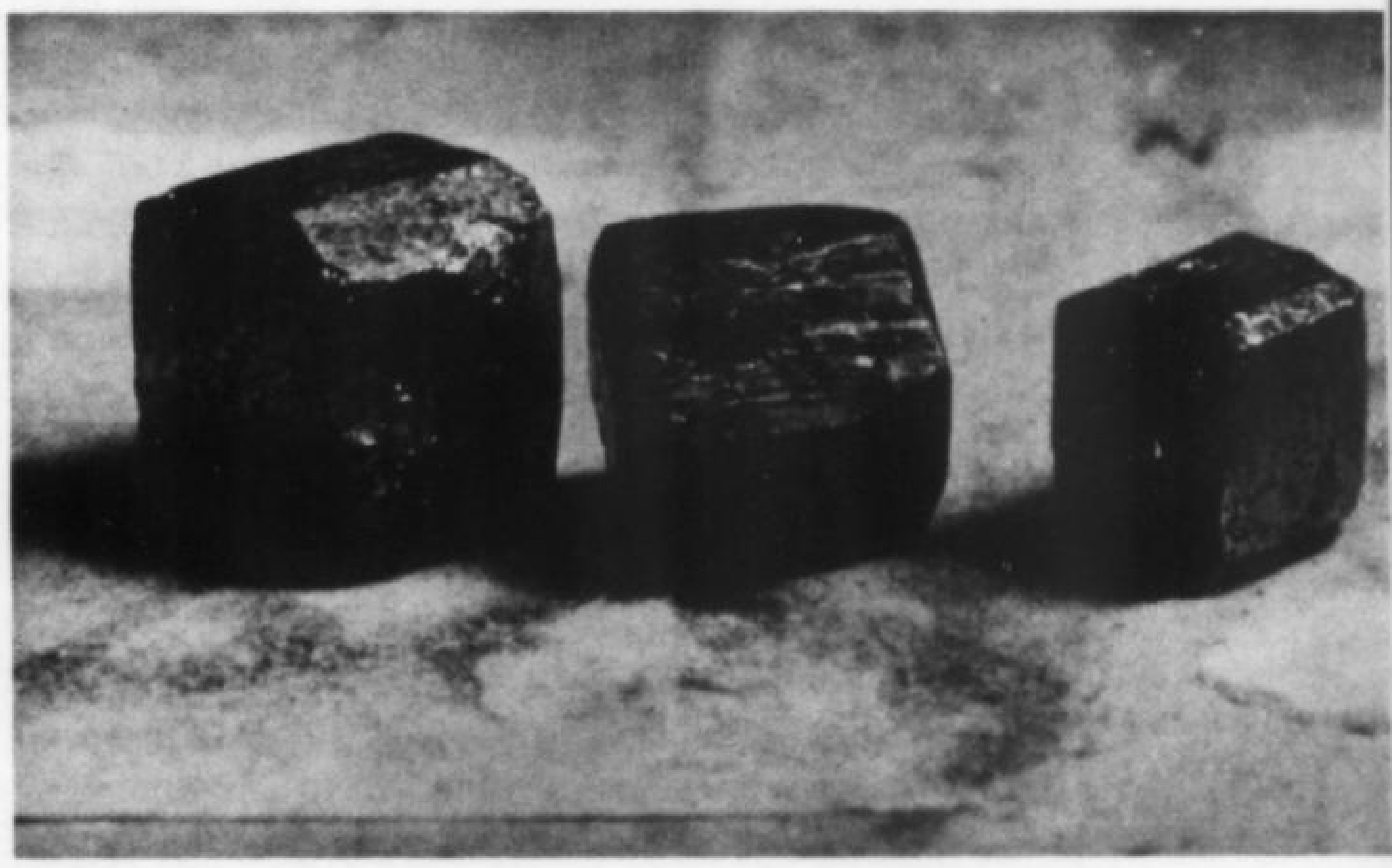


Fig. 5 **Three single cobaltite crystals, the biggest 14 mm on the edge.**

The Record Bookshelf

by Joel E. Arem

***Exploring Crystals*, by James Berry, Collier Macmillan Ltd., London, 1969, 104 pp. ($4.50)**

Exploring Crystals is one of the most entertaining, stimulating and up-to-date of all currently available science books for young people. Written for the teenage market and the secondary school science curriculum, the book combines narrative style and factual accuracy in a way rarely seen in books for the young reader.

The first few chapters open with stories recounting the discoveries of crystalline structure and unit building blocks of crystals (Håuy), the structure of the atom (Rutherford) and Brownian motion (Brown). The drama of these discoveries is revealed in mystery-novel fashion, thus immediately capturing the interest of the reader. Chapters are kept short (5 to 8 pages) and each develops an aspect of crystallography important in modern science. The range of subject material treated surpasses that seen (by this reviewer) in any other book not written for the senior high school or college market. The subjects covered are far from elementary (including dislocations, transistors and lasers) but are explained clearly and succinctly. A major asset of the book is the inclusion of examples of uses of crystals (radios, ballpoint pens, phonographs) that are relevant and identifiable by the young reader. *Exploring Crystals* succeeds chiefly through its sophistication and language—complex subject material is well explained in words the teenager is likely to know or can easily find in a dictionary.

As with nearly all books on science written by laymen, there are errors in word usage. Berry equates habit with polymorphism; habit relates only to the overall, characteristic shape of a crystal, while polymorphism refers to different internal structures exhibited by the same chemical compound. Thus, (on page 36) Berry's statement: "The element carbon has two habits." is incorrect, since it refers to diamond and graphite which are polymorphs of carbon. Berry also uses the term allotropy in reference to minerals such as water, whereas this term is used almost exclusively to describe characteristics of a chemical element rather than a compound. On page 40 we find: "Most jewels crystallize in the hexagonal system." Jewels are gems that have been set in (metal) mountings; minerals crystallize, jewels do not. In the final chapters of the book (on growing crystals) the various chemical salts commonly used in experiments (alum, Rochelle salt) are all termed minerals. Minerals are *naturally*-occurring chemical elements and compounds, and so this usage is incorrect except for alum (which occurs near volcanic fumaroles) and copper sulfate (the mineral chalcanthite). On page 38 Berry states: "Some crystals have no planes of symmetry, while others may have many more than the cube." Examination of the simplest text on crystallography shows that the cube has the maximum symmetry possible to any crystal. Many crystals have many more faces than a cube and thus might appear to have additional planes of symmetry. But close scrutiny reveals that many of the apparent plans in such crystals are redundant and the cube does indeed display the maximum number (nine).

In spite of these errors, *Exploring Crystals* is interesting, lively and very timely. Books on crystals tend to be overly pedantic or so oversimplified as to be incoherent. This one strikes a pleasing balance, and the result is somewhat unique on today's bookstore shelves. It is difinitely one to have, to read, and to give to young people who want to know what crystals are, how they grow, and how they are used by modern man.

***Answers About Rocks and Minerals* by Frederick Smithline, Grosset and Dunlap, New York, 1971, 60 pp. ($2.50).**

This book is somewhat of a novelty, in that the presentation format is not found in any book that might compete with it in the marketplace. The subject material presented is up-to-date, and includes earthquake belts and shock waves, as well as a modern picture of the structure of the earth. The book might have been a valuable contribution to the literature for very young readers, were not the concentration of factual errors and self-contradicting statements so high.

On page 8, the science of geology is stated to have two divisions: mineralogy and petrology. This reviewer wonders what discipline would then adopt geomorphologists, structural geologists, geophysicists, paleontologists and many other geoscientists who might have considered themselves "geologists". On page 14, Smithline writes: "If you live in the West, you can still see where volcanoes were active. Today they are extinct." Mount Lassen was active in 1914, and smoke can still be seen emanating from Mount Hood, so these volcanoes can hardly be considered extinct. Stalactites and stalagmites are stated (page 29) to be made of "...a mineral called calcium bicarbonate." This reviewer fails to find such a mineral in any standard text: this may be due in part to the fact that calcium bicarbonate is not a mineral, but it would not be of much geological importance anyway — stalactites are made of calcite, calcium carbonate. On page 36: "So a crystal is really another form of rocks and minerals, except that the word "crystal" tells us that the rock or mineral is of a certain shape", I have never seen a crystal of rock (and never hope to); does this mean that there are three categories of geologic materials: minerals, rocks and crystals? Breaking a calcite crystal with a hammer is stated to produce many tiny fragments, each of which"...will have a perfect six-sided shape" (p. 39). Calcite seldom breaks into "perfect" 6-sided (rhombohedral) shapes, and the text gives no indication whatever of which of nature's myriad 6-sided shapes is involved in the case of calcite.

The hardness scale is listed, and then the text goes into great detail about all the "hardness minerals". One question asks about rock-forming minerals, and answers it by stating (p. 41) "Quartz, number seven, is..." How did quartz get to number seven? Does that mean it tries even harder than Avis? Such statements taken out of context would be totally meaningless and thus have no place in a book for children.

The figures (colored drawings) are hopelessly poor and some are actually a detriment rather than an asset to the book. Figure captions are occasionally mislabeled ("microline" feldspar: "rock crystal in quartz") One question is answered in the text in a complete self-contradiction. The text asks "Is a petrified tree wood?" The first sentence of the answer is "Contrary to what most people think, petrified wood is not a piece of wood that has truned to stone"; the last sentence is "The wood actually turned into mineral matter". What child would not be hopelessly confused by such "explanations"? As to "Which mineral is a natural magnet?", we have "Magnetite, commonly called lodestone, is an iron oxide mineral". Only *one* form of magnetite is naturally magnetic and called lodestone. The text makes it seem as if the situation were the reverse of what it is. In a discussion of uranium ores, we find "Some ores...are uranite, pitchblende (a form of uranite)...". The misspelling of uraninite is not a typographical error, since the error is repeated.

The bright spots in this book are few, but present in the form of questions and answers about coal and oil, earthquakes and how the earth formed. There are 60 pages and 60 questions, and far too many errors in spelling and content for this size book. Another book on minerals rocks and gems that uses a question-answer format contains 1,001 questions and is not completely comprehensive. One can only guess how an author could hope to say something meaningful in 60 questions. It is sad that in this attempt even the 60 chosen are so poorly treated.

Wonders of Stones, by Christie Mcfall, Dodd, Mead & Co., New York, 1970, 64 pp. ($3.25)

As with most books, *Wonders of Stones* has both good and bad points. The good points far outweight the bad, however, and the book is an excellent introduction to the uses of rocks throughout history and in modern times.

The first chapter deals with the various types of rocks - igneous, sedimentary and metamorphic. There is even a diagram giving the scientific terminology for various particle sizes in referring to sediments (sand-granule-pebble-cobble-boulder). A serious fault in the text appears on page 9, with the statement: "Stones are broken away from rock and so are of the same composition. The terms, rock and stone, are often used interchangeably. They differ only in size and shape in their natural form. Very large masses of stone are called rocks; small or quarried masses are called stone." This is a mixture of dictionary definition ("rock is a large mass of stone"), popular usage, and some utter nonsense as well. While it is true that rock and stone are often used interchangeably, this equality exists only in the mind of the layman. Rock is a scientific term with very rigorously-defined attributes. Stone is actually defined correctly in the same dictionary that butchers the definition of rock: stone is a rock that has specified function. Later in the text McFall actually uses the word stone in the correct sense, and it is a pity that the opening definition of rock and stone is so poor.

Most of *Wonders of Stones* is extremely well written and contains a wealth of lively and interesting information. The chapters include: How stones are formed; Gravel and crushed rock; Minerals and gem stones; Life on stones; Historic uses of stones; Stones for building and carving. The chapter about life on stones is delightful, and goes into great detail about lichens and various marine animals that live their lives attached to rocky masses. Lichens secrete chemicals that decompose rock and are thus major contributors to erosional processes, a fact known by few mineral enthusiasts. Drawings in the book are adequate, and the photographs are all excellent and well-chosen. Only a few serious technical errors appear throughout the body of the text (p. 28: "Another form of quartz, coesite, a silica formed at extremely high pressure. . ."; p. 30, discussing halite cubes of atomic size: "When enough of these cubes are combined to be visible to the naked eye they are called crystals.") McFall apparently does not consider coesite as a distinct species, and the term "microscopic crystal" must be self contradictory by the above explanation! On page 36 we find "Even silicate, the hardest crystal found in granite can be dissolved in time, by lichen acids." The oversight with coesite is thus corrected by adding a new species to the literature: silicate.

In spite of technical faults the book reads very well. The language used is appealing to youngsters, but is not so simplified as to be boring to the adult reader—this is indeed a hard feat to accomplish. The chapter on historical uses of stone is fascinating, and discusses such landmarks as the pyramids of Egypt and Central America, Stonehenge, Roman roads, the Great Wall of China, Inca stonework, Easter Island statues, Angkor Wat, Mount Rushmore and others.

Although errors in usage and definition may appear, they pale into insignificance compared to the blatant misstatements in some of the other books for children currently available. There is little doubt that *Wonders of Stones* is by far one of the better introductory books on the current market. ꟿ

THE MUSEUM RECORD, continued from page 17

Of course, I didn't say all this to the group at Kingsport. I only thought it to myself. They didn't need the lecture because, after all, they had already set up a superb display of mineral specimens without any real hesitation about whether it was the right thing to do, or not. ꟿ

WHAT'S NEW IN MINERALS, continued from page 15

One specimen of tobermorite also carries perfectly colorless, stubby, striated crystals of thaumasite terminated by a simple pinacoid. These are the most perfect thaumasite crystals I have ever seen. Maximum size is about 3 mm in length.

More abundant are transparent, grey, equant apophyllite crystals with tobermorite. These look very much like cuboctahedra, averaging 1 cm in diameter. Apophyllite formed after tobermorite. Tobermorite, thaumasite, and apophyllite are all hydrated calcium silicate minerals and may be expected to occur together.

Calcite is the only other mineral identified in the suite.

J. S. W., Jr.

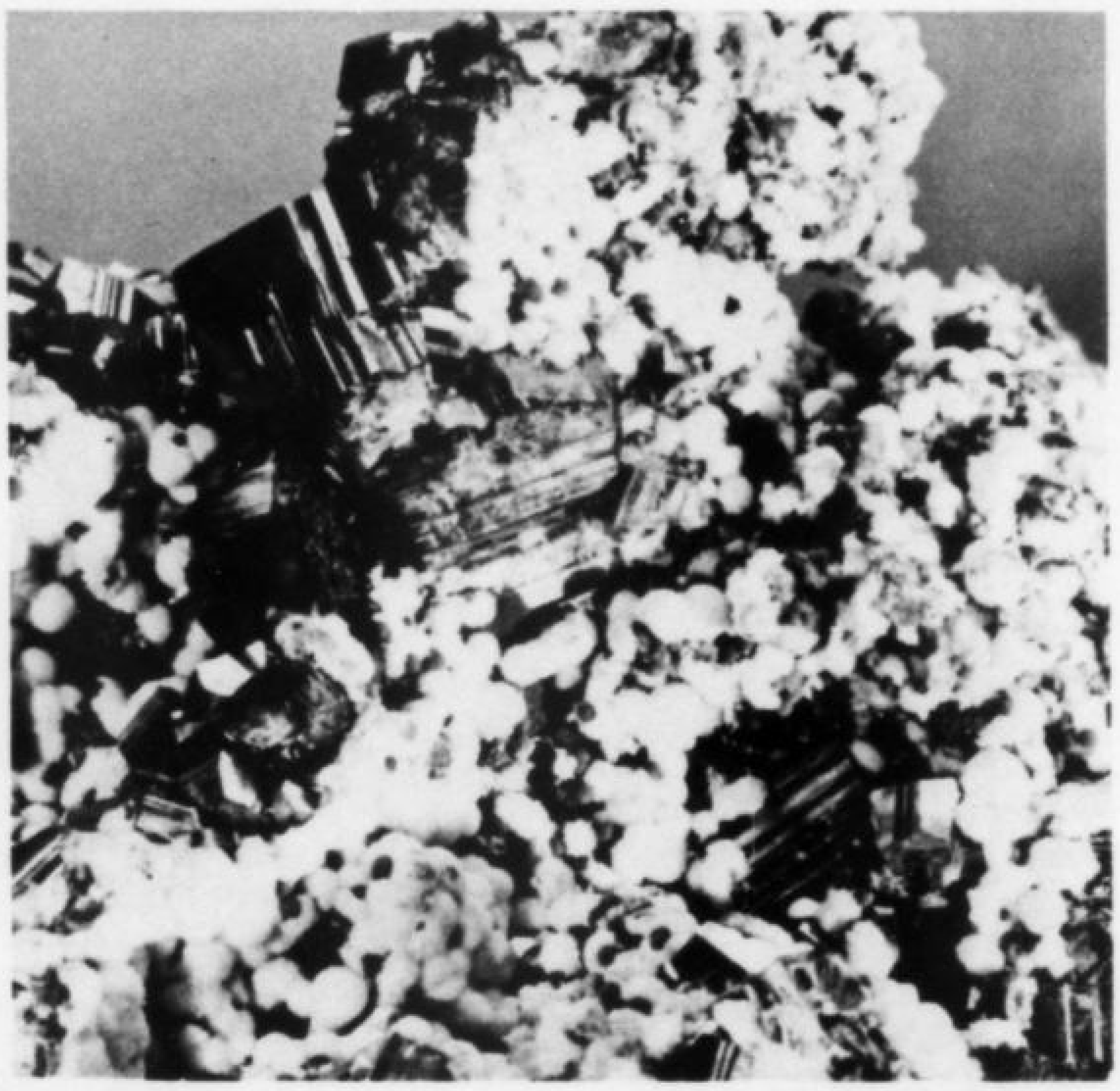


Fig. 3, **Tobernite on pyrite. Concepcion del Oro, Zacatecas, Mexico. Smithsonian Institution Specimen.**

DIRECTORY OF MICROMOUNTERS

The International *Directory of Micromounters* is published biennially by the Baltimore Mineral Society, a section of the Maryland Academy of Sciences at the time of its annual Micromount Symposium in September. The fifth edition of this *Directory* was published in September of 1970; thus, the sixth edition will be due in September of this year. In order for the sixth edition to be as correct and up-to-date as possible, those interested are asked to furnish the following information.

1. The new address and/or name of anyone listed in the fifth edition who has moved and/or changed his or her name since it was published.
2. A request by anyone listed in the fifth edition who is no longer a Micromounter that his or her name and address be deleted.
3. Full name, address and zip code of anyone who is a Micromounter and wishes to be listed in the sixth edition and who knows that he or she was not listed in the fifth edition or has no knowledge on this score (we will do the checking).
4. The full name and address of each dealer who sells Micromounts and/or material from which Micromounts can be made and who, having knowledge of what is Micromount material, would like to be listed, without charge, in the *Directory of Dealers* which forms a part of the *Directory of Micromounters.*

The price of each copy of the sixth edition will be 50 cents; by mail, 70 cents. Anyone who wishes to have a copy mailed to him or her after the conclusion of the Micromount Symposium which will be held on September 23 and 24, 1972 is invited to send us a check or money order for one or more than one copy. All communications in connection with this matter should be addressed to Randolph S. Rothschild, 20 S. Charles Street, Baltimore, Maryland 21201.

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To the Editor

Dear Sir:

Should it ever be necessary to raise your price to cover expenses, I am sure I could come up with the extra money somewhere. I think I would rather see this than a decrease back to only four issues a year.

I enjoy all of your articles but especially those on well known localities. This gives me a check on my minerals from these locations. I think your covers are fantastic. Don't ever make them black and white. It is a great magazine.

Kevin Williams
Belvidere, Illinois

Dear Sir:

I like the *Mineralogical Record* very much and, in case needed, I will pay two or three times as much for it yearly if this might help you over a difficult start. I feel sure that quite a lot of us would if needed.

Jan Haug
Norway

Dear Sir:

Thank you for a wonderful magazine which is eagerly awaited and is constantly referred to as a source of information. Best wishes for continued success.

Mildred B. Watson
Stratford, Connecticut

Dear Sir:

You have the finest publication of its kind! I will do my best to sell the *Mineralogical Record* to interested friends.

Wayne W. Holt
Rochester, New York

Dear Sir:

As I am quite new to the mineral collecting hobby I find some of the articles too advanced for me. However, I am keeping all copies of the *Record* from the beginning, and as I become more knowledgeable I will be able to re-read the articles and understand them. This is as it should be. It doesn't make sense to buy magazines or books filled with information that you already know.

So keep up the good work. I appreciate being able to read good informative articles without page after page of ads, trying to sell me something. Also the ads that you do print leave me with the impression that they are genuine and not just out to grab my money and say goodbye.

The wonderful covers of the *Record*, by themselves, are well worth the subscription.

E. F. Brawley
Toronto, Canada

Dear Sir:

I have finally had time to read your editorial (Vol. II, Number 5). Hope you wrote it in time and especially hope that it does some good. You've told us your troubles, now let me tell you mine.

I've been seriously collecting minerals since 1955, when Mr. A. L. Flagg got me started in Phoenix. Basically I'm a species (Dana) collector. I now live in Macon, Georgia. Other than one other person here in Macon who is developing a love for species collecting and one micromounter I can't find anyone who will even take time to seriously discuss the depths of the mineral hobby in this area. You guys with friends in the academic community with an interest in mineralogy and who are surrounded by serious collectors don't know how lucky you are!

To make a long story short—I *must* have your magazine if I am going to keep informed and current. It is specific and to the point for us serious collectors and has helped me tremendously with new developments as well as labeling and species descriptions. This locality work you are doing is great and badly needed. Your magazine is exactly what I need to keep informed. Digging what I wanted out of the lapidary and "rockhound" magazines on one hand and the *American Mineralogist* on the other was trouble and, as you know, you have perfectly and successfully bridged the gap.

I will continue to try to get subscribers but, of course, my contacts are limited. Meanwhile—you decide how much it will cost to continue your present format and simply bill us accordingly. If you need to charge $15.00 per year to keep going with your present plans, just bill us $15.00 per year. I assume you aren't stealing the money so just charge us what it costs. This will still be cheap enough considering what I get in return. Let us all know how we can help. We'll do all we can.

John S. Whatley, Jr.
Macon, Georgia

Dear Sir:

Like many of the other subscribers to the *Mineralogical Record* I had assumed that the *Record* had ample financial support. Your editorial in Vol. II, Number 5 certainly changed the picture.

I would like to see the *Record* continue in its present form for it is unquestionably the best magazine ever published for the mineral collector, be he professional or amateur. Every subscriber should be willing to help make this possible. Having exhausted my current possibilities for helping by obtaining new subscribers my only recourse to help immediately is through a cash contribution. Enclosed herewith is my check for $20 which represents 25 percent of the amount I can afford to spend on mineral collecting in 1972. This I am glad to do in order to help the *Record*. It is my sincere hope that every other subscriber will be willing to contribute on this basis.

George D. Jordan
Harlem, Georgia

Dear Sir:

The dearth of subscribers to the *Mineralogical Record* raises serious questions about the assumption that there are, in fact, sufficient persons interested in the purely mineralogical aspects of the whole Rock/Mineral collecting hobby. Had I been involved, as you were, in the development of a *Mineralogical Record* - type publication, I too would probably have felt that there were enough hobbyists to support a magazine devoid of lapidary, bad poetry and camping-out recipes.

Now that your specialized journal, a labor of love by well-known and knowledgeable men in the field, has proved to be its own market research barometer by turning up only two thousand subscribers from this supposedly "fastest-growing" hobby, it must be that the assumption was incorrect.

Have you, perhaps, been catering to too high a level of knowledge of the subject? Although you say that only 25% of your articles contain technical details, beyond the ken of most laymen-collectors, it may be that 25% is enough to give the *Record* an aura of "technical" journalism that will tend to keep away the not-so-well-informed or not-too-mineralogically-well-educated.

Or, are you perhaps devoting too much space to describing collecting localities in the U.S. and abroad that will never be visited by most of your current and potential readers because

continued on page 48

MEETINGS & SHOWS

WHO & WHAT	WHEN	WHERE	CONTACT
1972			
Geological Soc. of America, *South Central Section,* ann. mtg.	**Apr. 6-8**	Manhattan, Kansas	**Fred Handy,** GSA, Box 1719 Boulder, Co. 80302
York Rock & Mineral Club, 3rd Annual Rock-O-Rama	**Apr. 8-9**	Manchester Township Bldg., Emigsville, Pa.	**Doris K. Morse,** RD #1, Box 92A, Dillsburg, Penna. 17019
Cincinnati Mineral Society, 8th Annual Show	**Apr. 22-23**	Colerain High School Cincinnati, Ohio	**Terry E. Huizing,** 5341 Thrasher Dr. Cincinnati, Ohio 45239
The Gregory Museum, Gem & Mineral Show	**Apr. 29-30**	Hicksville H.S., Hicksville, NY	**Anne Gregory,** 207 Cottage Blvd., Hicksville, NY 11801
South Central Fed. of Mineral Societies Convention and Show	**May 5-7**	New Convention Center Waco, Texas	**Otto Schlemeyer** 1913 Mountainview Drive Waco, Texas 76710
The Rochester Gem & Mineral Show	**May 6-7**	Nazareth College Rochester, N.Y.	**Miss Dorothy Lind,** 190 Weldon Street, Rochester, New York 14611
Geological Soc. of America, North Central Section, ann, mtg.	**May 10-12**	Dekalb, Illinois	**L.D. McGinnis,** Dept. of Geology, Northern Illinois University DeKalb, Illinois 60115
Geological Soc. of America, *Rocky Mountain Section,* ann. mtg.	**May 11-13**	Laramie, Wyoming	**Fred Handy,** GSA, Box 1719 Boulder, Co. 80302
International Gem and Mineral Show	**Jun. 16-18**	Sheraton Park Hotel Washington, D.C.	**Sylvan M. Marshall,** 1825 K St., NW, Washington, D.C. 20006
Mineralogical Society of Arizona (&Rocky Mountain Federation), 1st Annual Show "Gems of the Desert"	**Jun. 23-25**	Veterans Memorial Coliseum, Arizona State Fairgrounds Phoenix, Arizona	**Perry Stufflebeam** 3139 W. Holly Phoenix, Arizona 85009
Amer. Fed. of Min. Societies & Calif. Fed. of Min. Societies, Annual Show "Fantasy of Gems"	**Jun.29-Jul. 2**	Anaheim Convention Center Anaheim, California	**Don J. Blood,** P.O. Box 3055 Orange, California 92665
Jefferson County Rock & Mineral Club, 8th Ann. Int'l Gem & Mineral Show	**July 15-16**	Fairgrounds, Watertown, New York	**Roger Wendell,** Henderson Harber, New York, 13651
Midwest Fed. of Mineralogical & Geological Societies, 32nd Annual Field Trip Convention & 5th Annual Upper Peninsula Gem & Mineral Show	**Jul. 19-24**	Ishpeming, Michigan	**Bob Markert,** Route #1, Box 620 Ishpeming, Michigan 49849
Greater Detroit Int'l Gem & Mineral Show	**Oct. 13-15**	Light Guard Armory, Detroit, Michigan	**Abel J. Selburn,** 24700 Northwestern Hwy, Suite 410, Southfield, Michigan 48075
Central Michigan Lapidary & Mineral Society, 7th Annual Gem & Mineral Show	**Oct. 20-22**	Michigan National Guard Armory, Lansing, Mich.	**William B. Rogers,** R #3, St. Johns, Mich., 48879
Middlesex Mineral Club, Annual Show	**Oct. 21-22**	Holiday Inn, Meriden, Connecticut	**Charles Malloy,** 87 Swain St., Meriden, Connecticut, 06450
Waterford Gem & Mineral Club, Annual Show	**Nov. 4-5**	C.A.I. Building, Waterford, Michigan	**J. J. Root,** 6861 Desmond, Waterford, Michigan, 48095
Geological Soc. of America and Mineralogical Soc. of America, ann. mtg.	**Nov. 13-15**	Minneapolis, Minn.	**GSA Headquarters,** Box 1719 Boulder, Colorado 80302
1973			
Geological Soc. of America, *Cordilleran Section,* ann. mtg.	**Mar. 22-24**	Portland, Oregon	**Dept. of Earth Sciences** Portland State University, Box 751 Portland, Oregon 97207
Amer. Fed. Of Min. Societies & Eastern Fed. of Min. Societies Show	**Jun. 28-Jul.1**	Charlotte Merchandise Mart, Charlotte, N.C.	**Al Lewis,** P.O. Box 712 Charlotte, North Carolina 28201
Midwest Fed. of Mineralogical & Geological Societies, Convention & Show	**Jul. 26-29**	Cincinnati Convention-Exposition Center, Cincinnati, Ohio	**Terry E. Huizing,** 5341 Thrasher Dr. Cincinnati, Ohio 45239
Geological Soc. of America & Mineralogical Soc. of America, ann. mtg.	**Nov. 12-14**	Dallas, Texas	**Geological Soc. of America,** Box 1719 Boulder, Colorado 80302

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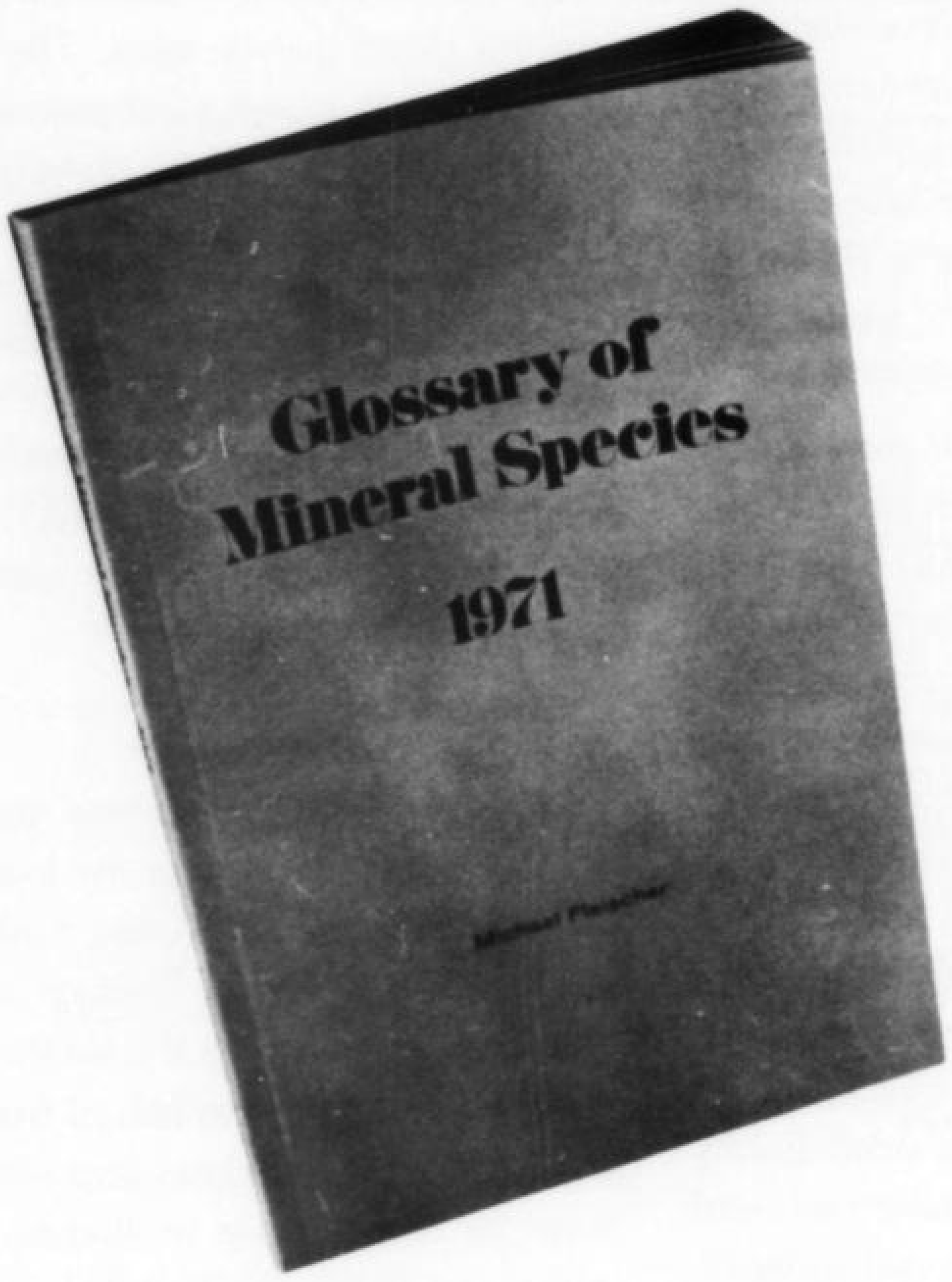

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TO THE EDIROR, continued from page 45

of inaccessibility or special-permission-to-collect requirements? It's nice to visit these places vicariously through the interesting descriptions of your writers, but I have the feeling that many readers would like to know more about places they can actually get to.

In short, are you placing yourself in a position of writing for your own inbred group of professional and advanced amateurs (museum, university and mining company personnel—who happen also to be mineral collectors) in order to have a forum for your special technical and semi-technical views?

If you are, the *Record* may indeed flounder and sink, because as nice as the idea may be, it may ultimately be impossible to confine yourselves to that upper stratum of the collector fraternity that finds enjoyment mostly in the rarities, the technical specifics and the information about meetings which only the "chosen" group attend and, at the same time, produce a financially sound (even non-profit) magazine. If, with the publicity to the mineral clubs and through other hobby magazines you say you have had, and you *still* cannot attract subscribers, you may do well to consider some of the ideas I have presented.

My son Gary and I, who are neither advanced amateurs nor professionals in the field, would like to see the *Record* succeed, because we enjoy the columns, the photos and the information we are capable of understanding. But are there enough like us to keep it going? Maybe that basic assumption of sufficient numbers amongst the many is just pie-in-the-sky?

Stanley Roberts
Jamaica, New York

In reply to your basic question I can only say "I hope not!" At this time I am not at all discouraged. The circulation growth rate has increased to an all-time high. I never thought that acceptance of the Record *would come easy. It will take time to convince many in the hobby that they are capable of reading these pages with understanding because other journals have all but convinced these people that they can understand only second grade level articles.*

Ed.

Dear Sir:

We were all very pleased to have the Personality Sketch of my husband, Colonel Clarence M. Jenni, published and think that David Burgess did an excellent job of telling the story.

Colonel Jenni was released from the hospital for the holiday season and we hope he can remain at home. He is improving slowly but it will be a long term recovery. The article brightened his Christmas considerably, at a time when it was needed. Thank you.

Mrs. Clarence M. Jenni
Columbia, Missouri

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This giant pyrrhotite crystal from Santa Eulalia, Chihuahua, Mexico is one of the most extraordinary specimens added to the mineral collections of the National Museum of Natural History (Smithsonian Institution) this year. It is in excellent condition - unusually sharp and brilliant - and measures 8 inches across by 7 inches high by 3 inches deep. Black sphalerite is concentrated at the base of the specimen and a few isolated galena crystals are scattered over the surface. The specimen weighs nearly 27 pounds.
Photograph by Joel E. Arem.