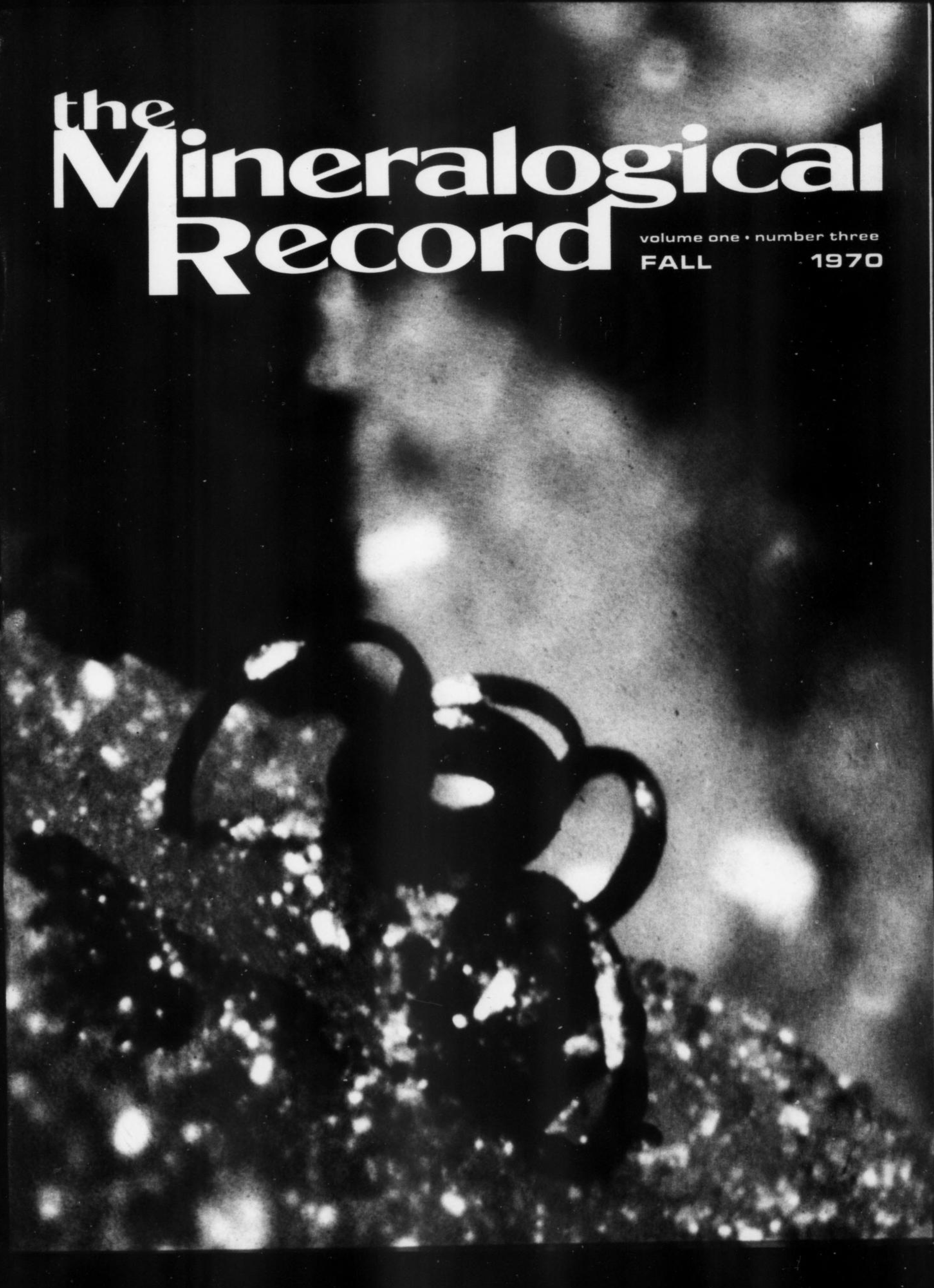

the Mineralogical Record

volume one • number three
FALL 1970

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editor & publisher
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Division of Mineralogy
The Smithsonian Institution

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address
the Mineralogical Record
Post Office Box 783
Bowie, Maryland 20715

editorial matter

Contributed manuscripts and news items are welcomed, but acceptance is subject to the approval of the editorial board. They should be mailed to the editor at the aforementioned address, and should be accompanied by a stamped, self-addressed envelope. No responsibility can be assumed for unsolicited material.

publishing information

The Mineralogical Record is published bimonthly by the Mineralogical Record, Inc., P.O. Box 783, Bowie, Maryland. Printing is by Kaufmann Graphics Inc., 1110 Okie St. N.E., Washington, D.C.

subscriptions

The Mineralogical Record costs $6.00 per year in the United States, Canada and Mexico. All other countries, $7.00 per year.

Second class postage paid at Bowie, Md.

feature articles

departments

Cover

Rings of pyrite found in a geode from Hall's Gap, Lincoln County, Kentucky. Photomicrograph by Ben Kinkead. The specimen belongs to Lee Wood, Kingsport, Tenn.

friends of mineralogy

Swarthmore-Leidy Collection Part II

Arthur Montgomery

In this conclusion to the report on the Leidy mineral collection, which came to us at Lafayette College from Swarthmore College in 1959 on permanent loan, it will be of interest to single out some of the finest of the 500 specimens added to our systematic collection. Mention will be made also of a number of especially well-represented North American localities. The Leidy minerals described in the last issue of the *Mineralogical Record,* of notable quality or important for their well-documented Pennsylvania occurrences, will not be treated again.

The 500 specimens now considered are mostly of small to medium size (2 × 3" to 3 × 4") and ninety percent of them are characterized by excellent, sharply-formed crystals. Only about 200 of the commonest species are represented, rare minerals being almost totally absent. In the following listing of selected specimens, locality and other names as well as descriptive terms will be shortened (as xls for crystals) wherever possible.

Extra-fine crystallized specimens:

copper, dendritic xl cluster (Fowey Consols, John's Lodge, Cornwall, England)
tetradymite (gruenlingite), splendant plates (Carrock Fell, Cumberland, England)
galena, modified xls with siderite xls (Neudorf, Harz, Germany)
bismuthinite, acicular xls with chalcopyrite xls (Cornwall, England)
corundum, 2 large incomplete ruby xls (Franklin, North Carolina)
brucite, large platy xl cluster (Texas, Penna.)
martite, sharp dodecahedral xls (Digby Neck, Nova Scotia, Canada)
manganite, group of brilliant inch-long xls (Ilfeld, Harz, Germany)
calcite, 3 × 5" group of sharp tabular xls (Andreasberg, Harz, Germany)
calcite, 2 loose twin xls and large group of twins (Rossie, New York)
alstonite, small group of sharp xls (Alston, Cumberland, England)
scorodite, small group of clear green-blue xls (Schwarzenberg, Saxony, Germany)
apatite, small cluster of large white opaque xls (Norway)
childrenite, perfect brown glassy 1/4" xls (Tavistock, Devonshire, England)

(Continued on page 86)

AFMS Elects New Officers

The following officers were elected at the Forth Worth convention of the American Federation of Mineralogical Societies to serve beginning November 1, 1970 through October 31, 1971.

President: Paul Seel of the Eastern Federation.

Vice President: Ed Immel of the Texas Federation.

Treasurer: Mrs. Walter Steinbrenner of the Midwest Federation.

Secretary: Dorothy Lee of the Northwest Federation.

Senior Regional Vice President: Mary Anderson of the Rocky Mountain Federation.

Junior Regional Vice President: Gus Meister of the California Federation. □

NOTICE

If your copy of the *Mineralogical Record* is slow in arriving, please be patient— The class of mailing we must use is erratic at best.

Ed

IN THE NEXT ISSUE . . .

"Ancylite from Pennsylvania—New Data"
by F. A. Keidel, A. Montgomery, C. W. Wolfe and R. P. Christian

"Descriptive Mineralogy of Langban-type Ore Deposits, Central Sweden"
by Paul B. Moore

"The History of Colombian Emerald Mining"
by Tomas Feininger

"Second Occurrence of Benstonite"
by John S. White, Jr.

editorial page

We are receiving many requests for information concerning the policies and plans for this magazine and questions about its content so this is perhaps a good time to discuss some of them.

In an early advertising flyer, we stated that the *Mineralogical Record* would appear as a quarterly this year and become a bimonthly in 1971. The decision to begin publication as a quarterly was based on two factors. First, we didn't get under way early enough to reasonably permit the printing of six issues in 1970. Second, the quarterly publication timetable allows us a bit more flexibility in these first crucial months while we are developing a format that will best serve you.

The initial acceptance of the *Mineralogical Record* among avid collectors has been very gratifying in view of the limited amount of promotion undertaken thus far. This circulation growth can be largely attributed to many of our readers voluntarily advertising the magazine to their fellow collectors. We wish to express our appreciation for this promotion. It plays a very important part in the future growth and development of the *Mineralogical Record* into a viable, comprehensive aid for the serious mineral collector.

Since the *Record* must ultimately rely on circulation and advertising revenue for its support and growth, we hope that you will continue to encourage others to subscribe and also that you will inform our advertisers that you saw their ad in this magazine. It is this kind of active support that will allow us to bring you more new and informative articles about minerals than any other magazine devoted to the subject.

In addition to the major articles, we are attempting to include columns which delve into what you, your club, and other mineral enthusiasts are doing. To do this we need your assistance. News notes that can be worked into the various columns are welcome at any time. Reports on museums in your area—their personnel and collections; mineral specimen discoveries; mineral locality information; club activities and mineral shows will all be appreciated and will help to make this your magazine. If you have questions, or wish to express an opinion, don't forget the "Q/A Column" and the space provided for letters in "To the Editor". Another feature which relies heavily on you is the "Personality" column. There is no shortage of collectors who deserve this special recognition but we need your help in learning about them. Simply write telling us about collectors you know of whose mineral collecting activities have been impressive.

A word about book reviews is in order. Much of the modern literature which we feel is worthy of a place in the libraries of our readers will be reviewed. We plan to go back at least ten years to select books for review. Books that tend to be too technical for novices and casual collectors will be so identified in the review. Those easily understood by readers without formal training in mineralogy will also be described as such. Of course, good books of the most technical sort will also be reviewed if they are useful for collectors and students. Books with few redeeming qualities, those which could only be negatively reviewed, will not be treated. Unfortunately, for the new collectors who do not have access to the counsel of advanced collectors, there are many worthless books on the market which siphon off their library dollars needlessly. We hope our book reviews will aid readers to better select between the worthy and the worthless.

The *Record* is introducing another new service in this issue which we believe is unique and may pave the way to unprecedented cooperation between collectors and professional mineralogists. At the suggestion of one of our contributing authors, Dr. William A. Henderson, Jr., the *Mineralogical Record* will provide space for legitimate research specimen requests. One of the most exasperating problems in mineralogical research is the difficulty involved in locating and obtaining suitable specimens for a particular investigation. Very few universities have extensive enough collections to serve these needs. As a result, the researcher is often forced to seek samples from one of the few major mineral museums around the world. If he cannot find what he needs, his study may come to a premature end. Hopefully, this "Mineral Specimen Requests" column will provide the researcher with another alternative, and also allow collectors to actively participate in furthering our knowledge of mineralogy.

The first issue of the *Mineralogical Record* contained 32 pages. The second was expanded to 48 pages. As our circulation continues to grow we will be able to improve our coverage of the field of minerals and, we hope, the *Record* will become THE magazine for mineral enthusiasts.

John S. White, Jr.

To The Editor . . .

Dear Sir:

The arrival of the Volume 1, Number 2 of the *Mineralogical Record* on my desk provided great pleasure. The first issue was 'no flash in the pan'. You have established a pattern of impressive quality in producing a much needed publication for the mineralogical community.

With best wishes for your continued success.

Yours sincerely,
D. Vincent Manson
Chairman and Assistant Curator
Department of Mineralogy
The American Museum of Natural History
New York, New York

Dear Sir:

It is a pleasure to tell you of the stimulation I am deriving from the *Mineralogical Record*. The focus of many of your articles is such that they treat specific areas in which I have been parched for information, and now welcome its availability.

In Volume 1, No. 2, p. 73, in an article decrying the use of the catch-all designation "Minas Gerais", there is a reference to spodumene crystals (kunzite) poorly attributed to Governador Valadares though actually found at the Urupuca quarry. May I ask if you can provide full locality labelling information for kunzite from the Urupuca quarry?

On p. 74 of the same issue, in the excellent department "What's New in Minerals", the Portuguese locality appears as "Panesquiera". Is that spelling correct, or is it "Panasqueira"?

When the mineralogical record is tallied, you will have scored high in elevating the standards of specimen collecting. As a beneficiary, I am deeply appreciative.

Very truly yours,
Jack Halpern
San Francisco, California

All that we can add about the Urupuca quarry is that it is in the pegmatite belt extending from the vicinity of Governador Valadares to that of Teófile Otoni. Perhaps one of our readers can supply additional information. You are right, we goofed on the spelling of Panasqueira. Ed.

Dear Sir:

Please enter my subscription to the *Mineralogical Record* with the enclosed $6.00 money order. I browsed through your first issue (Si Frazier's) and was immediately enthusiastic. It fills a definite gap between the amateur publications . . . and the professional journals like *American Mineralogist* to which I subscribe and enjoy reading but I always felt that just the magazine you have produced has been badly needed for a long time. I will do all I can to tout this important development in mineralogy.

Malcom K. Smith

Dear Sir:

Congratulations! The first issue of the *Mineralogical Record* is splendid.

David R. Williams, Jr.
Chairman, Geology Department
Santa Barbara City College

Dear Sir:

I am elated by the *Mineralogical Record* which arrived today. I have long been disappointed in *Rocks and Minerals* for its lack of sophistication on the one hand and by the *American Mineralogist* for its totally technical approach on the other hand. The present journal is a pleasing compromise. Its quality speaks well for the editorial staff and contributing authors, both professional and amateur.

Carl A. Francis
Springfield, Mass.

Dear Sir:

It was a pleasant surprise to receive your Volume 1, Number 1 of the *Mineralogical Record*. I think your publication will indeed fill a

(Continued on page 97)

Collection

(continued from page 84)

euchroite, small group of 1/2 inch xls (Hungary)
wolframite, pseudomorph after large sharp scheelite xl (Trumbull, Connecticut)
scheelite, complete yellow 1 inch xl in quartz (Carrock Fell, Cumberland, England)
quartz, large sparkling cluster of clear xls (Ellenville, New York)
quartz (amethyst), group of pale-color prismatic xls (Hungary)
quartz (amethyst), large xl cluster (Lake Superior, Michigan)
adularia, 2 large sharp snow-white xls clusters (Switzerland)
nepheline, small sharp glassy xls in lava (Vesuvius, Italy)
meionite, small perfect glassy xls in lava (Vesuvius, Italy)
harmotome, small group of sharp xls (Andreasberg, Harz, Germany)
hemimorphite, 2 large sparkling glassy xl groups (Sterling Hill, New Jersey)
beryl (emerald), small pale clear xls in matrix (Colombia)
willemite, 2 small clusters of large prisms (Sterling Hill, New Jersey)
pyrosmalite, sharp stubby 1/2 inch xls on matrix (Sweden)
zircon, brown 1 inch xl in matrix (Urals, USSR)

Well-represented North American localities (specimens of good to first class quality)

Amelia, Virginia (amazonite, cleavelandite, columbite, microlite)
Antwerp, New York (hematite, millerite, siderite, stilpnomelane)
Bob's Lake, Ontario, Canada (scapolite)
Diana (and Natural Bridge), New York (diopside, microcline, nepheline (altered xls), scapolite, wollastonite)
Ducktown, Tennessee (diopside, zoisite)
Ellenville, New York (chalcopyrite, quartz)
Franklin, North Carolina (cleavable corundum, including ruby and sapphire)

(Continued on page 91)

Participants of the A-3 excursion examine a 'Kuroko' (black ore) mine in the Shakanai district, northern Honshu, Japan.

IMA SEVENTH GENERAL MEETING

George Switzer
Smithsonian Institution

At the invitation of the Science Council of Japan, the Seventh General Meeting of the International Mineralogical Association (I.M.A.) was held in late summer 1970 in Japan. Meeting concurrently with the International Association on the Genesis of Ore Deposits (I.A.G.O.D.), the sessions were held in Tokyo August 28 and 29, and in Kyoto August 31 to September 2. Some 320 scientists from 42 countries (other than Japan) attended the meetings. Japanese scientists in attendance, plus wives and families of delegates, swelled the total attendance to 600.

Thirteen scientific sessions were held at which 293 papers were presented. Of particular interest were symposia on cosmic mineralogy, mechanism of growth and phase transition in minerals, and geochemistry and crystallography of sulfide minerals in hydrothermal deposits.

Much of the work of the I.M.A. is carried out through its commissions, of which there are seven: Abstracts, Cosmic Mineralogy, Mineral Data, Museums, New Minerals and Mineral Names, Ore Microscopy, and Teaching. Because the work of the Museums and New Minerals and Mineral Names Commissions is of particular interest to readers of the *Mineralogical Record,* I shall report on the Tokyo meetings of these two.

Presiding at the meeting of the Commission on Museums was Dr. Claude Guillemin of France. Representatives from 10 countries were present. Dr. Guillemin reviewed the status of the World Directory of Mineral Collections, a project undertaken by the Commission 10 years ago, but unfortunately never completed. It was voted to complete compilation of the data and to publish the directory at the earliest possible date.

At its 1966 meeting in Cambridge, England the Commission voted to initiate a biannual bulletin giving information on the museological activities of different country members in the fields of mineralogy, petrology, and mineral deposits. In Tokyo the Commission members reaffirmed their interest in such a bulletin and expressed

(Continued on page 120)

RUTIL

From Watertown, Co

William A. Hen

Several years ago, while collecting from a roadcut in Watertown, Connecticut, I found a single piece of schist containing a cleft or cavity. The interior of the cavity was nearly filled with iron oxides, but a few crystals seemed to be present just below the surface. I soaked the specimen for days in oxalic acid until all traces of the iron oxides were removed.

The cleaned specimen showed about a dozen extremely brilliant, ruby-red crystals which I took to be highly distorted garnets. In addition, there were well developed muscovite crystals comparable in quality to those from Brooks Farm in North Carolina. A few poorly formed ilmenite plates plus quartz and feldspar crystals were also present. All of these were less than 5 mm in size.

For quite a while, I was satisfied with the sight identification of the ruby-red crystals as garnet. The faces on the best one of them (see photograph and Fig. 1a) could all be assigned as faces occurring in the hexoctahedral class of the isometric system. The top and bottom faces labelled *c* in Fig. 1a plus the four faces labelled *a* would all be cube faces. The top four *s* faces plus the same four on the bottom would fill out the octahedron, and the eight *e* faces plus the four *m* faces would be the dodecahedron. The small modifying faces would be some more complex form or forms. An isometric crystal showing the assigned forms is shown in Fig. 1b.

A short time ago, I measured the angles between the faces on these crystals in order to identify the smaller faces, using the one-circle goniometer described in a previous article (*Mineralogical Record,* 1970, Volume 1, Number 2, 56-57). The angles found are listed in the first column of Table 1. The rest of Table 1 lists known values for various minerals taken chiefly from Dana's ***Textbook of Mineralogy***.

To my surprise, as can be seen from the Table, the angles found clearly did not match those of garnet. This is a good example of the value of a one-circle goniometer in checking the identity of minerals. From inspection of the angles in the Table plus the fact that the angle *am* (not listed in the Table) is 45 degrees, it can be concluded that the crystals are tetragonal. Two possibilities among tetragonal minerals which could be ruby-red are anatase and cassiterite. However, the crystals are neither of these since the angles *ss′* and *ee′′* for cassiterite and the angle *ee′* for anatase do not agree with those found.

The angles listed for rutile, though, all agree with the observed angles to within less than one degree. Moreover, the angle for the minor faces *tt′*, the ditetragonal dipyramid, agrees as well. The remaining minor faces on the crystal (drawn in Fig. 1) were too small to give good measurements with the goniometer and remain unidentified. The mineral is thus rutile, and the faces may be assigned corresponding to the idealized crystals drawn in Fig. 1c and 1d.

It is quite possible to find some less common faces on a crystal that are not listed in Dana. Therefore, it is also possible that the angles measured for the various faces will not all match values listed in the literature. These angles may actually represent a new form for the mineral but measurement with a more precise goniometer would be required to definitely establish a new form.

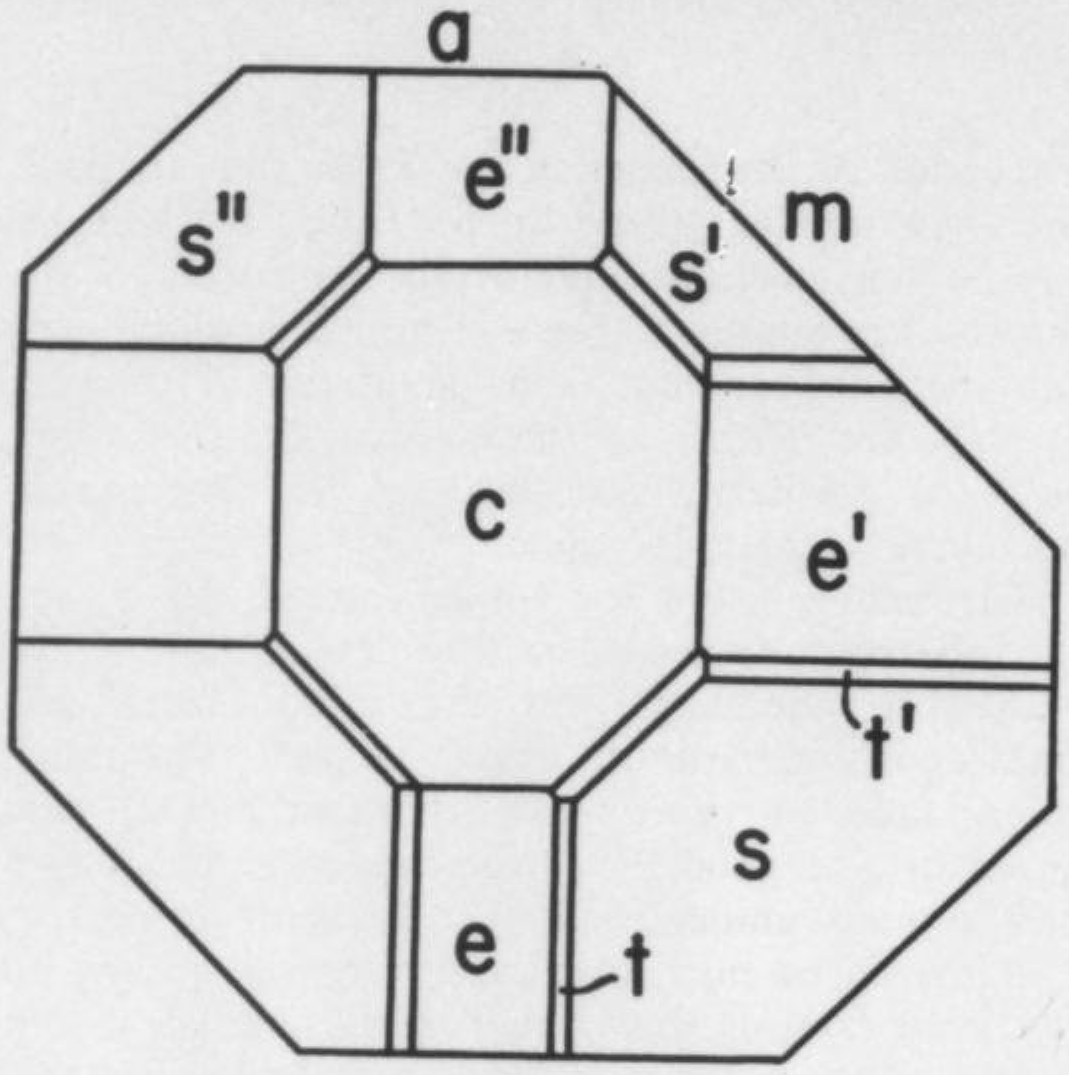
It is also possible that some less common form of anatase or cassiterite, for example, might display angular values that closely match those measured on this rutile. In such a case, however, these faces would have high Miller indices, e.g., (708) or (695). It is a rule of crystallography that faces with high Miller indices are much less common that those with low Miller indices such as those listed in the Table. Therefore, only when a crystal is found whose angles closely match those of low index faces for a known mineral, are the two probably the same.

Clearly, the angle between cube faces of isometric minerals will always be 90 degrees, and measurement of such an angle will not distinguish between two isometric species. The most valuable angular measure-

Table 1.

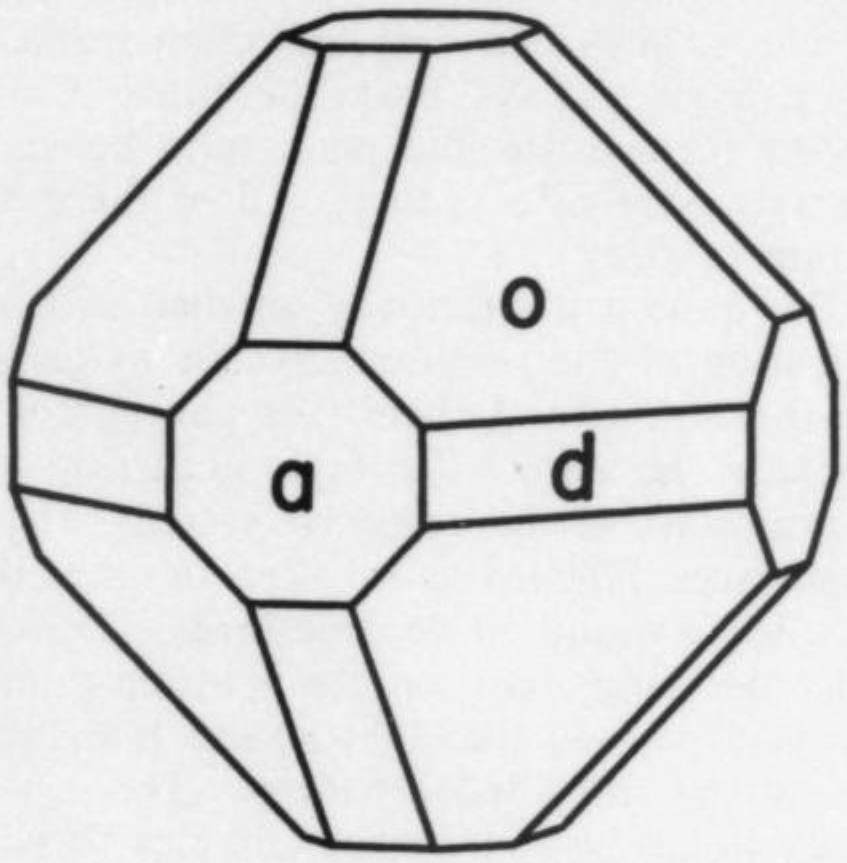
Comparison of interfacial angles of Watertown, Conn. rutile with those of garnet, rutile, anatase and cassiterite.

Watertown rutile **Observed**				**Garnet**		**Rutile**		**Anatase**		**Cassiterite**	
Deg	**Min**	**Face**	**Indices**	**Deg**	**Min**	**Deg**	**Min**	**Deg**	**Min**	**Deg**	**Min**
45	40	*ee′*	(101) (011)	60	00	45	02	76	05	46	28
65	30	*ee′′*	(101) $(\bar{1}01)$	90	00	65	35	121	16	67	50
57	10	*ss′*	(111) $(\bar{1}11)$	70	31	56	52	82	09	58	19
84	30	*ss′′*	(111) $(\bar{1}\bar{1}\bar{1})$	109	28	84	40	136	36	87	07
29	50	*tt′*	(313) (133)			29	06				
32	40	*ce*	(001) (101)	45	00	32	62				
40	10	*cs*	(001) (111)	54	44	42	20				

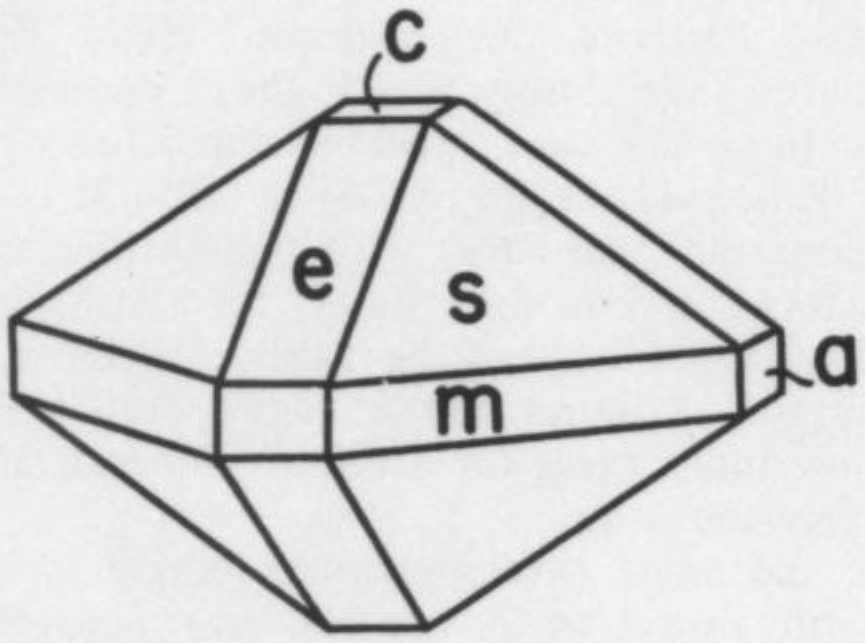


(a)

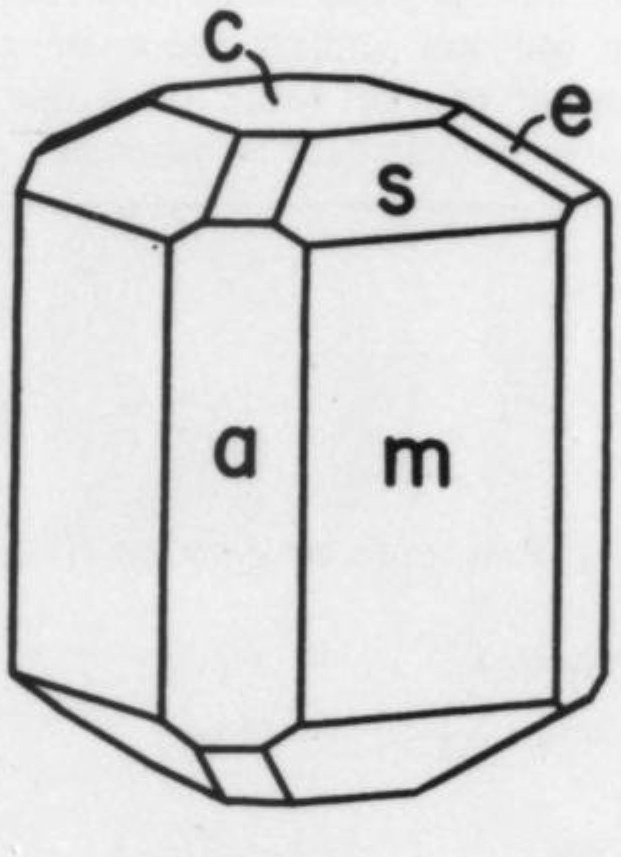
Fig. 1. a—Top view of distorted rutile crystal from Watertown, Conn. b—Isometric crystal showing cube, octahedron and dodecahedron. c,d—Idealized views of major faces of Watertown rutile.



(b)



(c)



(d)

ments for nonisometric minerals are those involving pyramid or dome faces. These angles are different for different tetragonal minerals, for instance, and are of high diagnostic value.

The value of a goniometer as a descriptive and diagnostic tool was certainly underlined in this case, since it provided me with the finest micro rutile crystals I have ever seen from Connecticut—crystals much more desirable than the distorted garnets I first took them to be.

Dr. Henderson is a Senior Research Chemist for American Cyanamid Company in Stamford, Connecticut. Born in Winthrop, Mass., he holds a B.A. degree from Harvard (1954), and the Master's and Ph.D. degrees from Yale (1956, 1958); all in chemistry. While at Harvard Dr. Henderson took geology courses under Prof. Mather and studied mineralogy under Prof. Hurlbut. His interest in earth science has led to teaching geology at Fairfield University, Fairfield, Conn. □

Collection

(Continued from page 86)

Gouverneur, New York (dravite, tremolite)
Monroe, New York (allanite, magnetite, spinel)
Nova Scotia, Canada (analcime, apophyllite, chabazite, gemlinite, heulandite, martite, mesolite, Natrolite, thomsonite)
Renfrew County, Ontario, Canada (apatite)
Rossie, New York (calcite scapolite)
Russell, New York (danburite)
Silver District, Yuma County, Arizona (vanadinite)
Trumbull, Connecticut (fluorite, topaz, wolframite)

Some items that should be present in a collection like this are conspicuous by their absence. Only three very small stony meteorites (Germany, Iowa, Poland) are included. There are no good cassiterites, epidotes, pyrites, Japanese stibnites, or Franklin rhodonite and franklinites. Western U.S. and gem-quality specimens are very sparse. Some of these absences may be a reflection of the interests of the man who made the collection as well as of the early period of his collecting; thus Paterson zeolites are wholly missing (too early), while Bergen Hill is richly represented.

A very few source and other labels accompanying certain minerals give us additional historical clues. A flat colorless clear cleavage of topaz from Brazil is labelled: "originally yellow, passed through the fire of Swarthmore College in 1881." Source labels include those of Bryce M. Wright (London), G. L. English and A. E. Foote (Philadelphia), and of Krantz (Germany). Such clues and especially the specimens tell us that the Leidy collection, as originally given to Swarthmore, was a truly fine small one consisting of perhaps 1,500 to 2,000 specimens, chiefly of small, but beautiful, display quality, concentrated in the commoner species, and generally lacking in very costly "pure-show" items. Most of the specimens were purchased from well-known dealers of the latter eighteen hundreds who supplied the great

(Continued on page 126)

Yedlin on micromounting

Classic localities go on forever when you collect micromounts. When Plumbago Mt., Newry, Maine was in its heyday it produced some rare and startling things, among which were "watermelon" tourmalines; lepidolite crystal clusters; 12" amblygonites, sharp and lustrous; fine apatites; rose quartz crystals (the first available in the U.S.); eosphorite; fairfieldite; goyazite (first called hamlinite, in honor of the family of the discoverer of the Mt. Mica gem tourmaline); herderite; triphylite; purpurite; vivianite; cesium beryl; beryllonite; columbite; cassiterite; scorzalite; microlite; spodumene; some radioactives; and a host of others.

As with every locality (even with those requiring a 30 degree, one mile uphill hike (at least it is downhill with a loaded pack) the fine hand specimens disappeared. As a result of the fluctuation in the prices of feldspar, mica and lithium, the area of Newry, comprising some 5 zones of operation, was only sporadically operated by hopeful gleaners of commercial material.

With each such venture collectors had a field day, hopefully pulverizing to pea size all promising boulders and masses. Inasmuch as the area is a lithium rich pegmatite, and cleavelandite is one of the main constituents, a host of rare accessory minerals came to light—some at triphylite-albite contacts, some in the interstices of the albite, some frozen in the groundmass, and some lining vugs in the prevailing rock.

Vandall King, now at the University of Maine, Orono, Maine 04473, has undertaken to compile a list of the minerals at the Newry complex. His data have been derived from prior lists, publications, the cataloging of private and public collections and other available sources. This list now includes some 104 species and 3 or 4 as yet undescribed new ones. His tabulation includes the mine or mines in which the mineral appeared, and is a good index of what the m/m collector may yet obtain.

Recently a package was received from Joseph Pollack, a fine dealer at The Brick House, Harrison, Maine 04040. In it were some choice fragments (we say choice because they contained desired minerals) collected by him in 1965 from the Bell pit, Newry, and for any m/m collector they were manna from, well, Maine. He has a barnful yet available.

(Continued on page 114)

EAKERITE—a new t

PETER B. LEAVENS **JOHN S. WHITE, JR.**

Abstract

Eakerite, $Ca_2SnAl_2Si_6O_{16}(OH)_6$, is found at the Foote Mineral Company spodumene mine, Kings Mountain, Cleveland County, North Carolina. It occurs in colorless, prismatic crystals up to 5mm long in seams with quartz, albite, bavenite, and apatite in spodumene-rich pegmatite. It is monoclinic, $P2_1/a$, a = 15.83, b = 7.72, c = 7.44 Å, β = 101°19′, Z = 2. The strongest x-ray lines are 7.31 (80) (001), 6.91 (50) (110), 5.93 (50) $(\bar{2}01)$, 5.25 (90) $(\bar{1}11)$, 4.81 (100) (111), 4.00 (50) $(\bar{3}11)$, 3.88 (50) (400) and 3.02 (80) (221). The mineral is prismatic [001] and shows, in order of abundance, the forms {111}, {210}, {410}, {201}, $\{\bar{2}01\}$, {001}, and {100}. The crystals somewhat resemble those of laumontite in habit. Eakerite is colorless; hardness about 5 1/2; gravity 2.93 ± 0.01 (meas.) 2.931 (calc. from x-ray data); optically biaxial, positive, $n\alpha = 1.584$, $n\beta = 1.586$, $n\gamma = 1.600$ (Na light) with $2V \sim 35°$. Analysis gave $SiO_2 = 46.75$, $Al_2O_3 = 14.07$, $SnO_2 = 18.59$, $CaO = 14.2$ and $H_2O = 6.7$ percent. Thermogravimetric analysis indicates that the water is held as hydroxyl.

Introduction

In August 1966, Mr. Jack Eaker, of Kings Mountain, North Carolina, sent the authors a specimen of a transparent, prismatic mineral from the Foote Mineral Company spodumene mine near Kings Mountain, Cleveland County, North Carolina. He thought the mineral might be a new species. X-ray examination confirmed his estimate, and wet chemical analysis established the formula $Ca_2SnAl_2Si_6O_{16}(OH)_6$. The mineral has been given the name eakerite (pronounced ĒKERAIT) in Mr. Eaker's honor. The description and name were approved in advance of publication by the Commission on New Minerals and Mineral Names, IMA. Type specimens will be preserved at the National Museum of Natural History and the British Museum (Natural History).

The Foote mine has been described by Kessler (1961). It is an open pit developed in a complex swarm of pegmatites. The region is part of the Carolina tin-spodumene belt of tin- and lithium-enriched pegmatites.

The pegmatites of the Foote mine are tabular dikes which trend roughly NNE and dip steeply both east and west; the largest is more than 300 meters long and 75 meters thick at its widest point. Mineralogically the pegmatites are nearly homogeneous; they contain roughly 32% quartz, 41% feldspars (sodic plagioclase and microcline), 20% spodumene, 6% muscovite, and 1% other minerals. The quartz has an unusual, fine granular texture, and many of the other major minerals are broken and veined by quartz.

Several sets of fractures cut the pegmatites; the most prominent are vertical and strike E-W. The fractures contain a number of interesting secondary minerals including the new species switzerite (Leavens and White, 1967), eucryptite and bikitaite (Leavens, Hurlbut, and Nelen, 1968), and lithiophosphate (White, 1969). Besides eakerite, tin minerals found in the seams include stannian sphene, a new polymorph of wickmanite, and another new tin silicate now under investigation which is apparently a structural analogue of osumilite. Cassiterite is found as a primary mineral in black crystals in massive pegmatite.

Eakerite is found in open seams at about section 10N of Kessler's map (Kessler, 1961, fig. 2). All of the specimens have come from a very restricted area, perhaps a single vein. Specimens typically contain numerous crystals, standing or lying on the walls of the seam. Eakerite crystals are implanted on those of quartz and albite; they are commonly intergrown with needles and blades of bavenite, and are coated in some specimens with crystals of pink apatite. A few crystals of the polymorph of wickmanite have been found on eakerite crystals. The setting and mineralogy of the veins suggests a hydrothermal origin for eakerite.

Physical Properties

Eakerite has been found only in crystals, up to 5 mm in length. Smaller crystals and the terminations of the larger ones are colorless; the lower parts of many of the larger crystals are highly flawed and milky white. The mineral has a conchoidal fracture and no recognizable cleavage or parting. The hardness is about 5 1/2. The specific gravity, measured on flawless crystals by immersion in Clerici solution, is 2.93 ± 0.01; gravity calculated from the formula and x-ray data is 2.931.

The indices of refraction, measured in Na light, are $\alpha = 1.584$, $\beta = 1.586$, $\gamma = 1.600$, 2V is about 35°, r > v (marked), X = b, $Y \wedge c = +23\ 1/2°$.

Eakerite is not soluble in acids or bases.

tin silicate

MAX H. HEY

Crystallography

X-ray precession photographs of the 0, 1st and 2nd levels about the *a* and *b* axes of eakerite showed the mineral to be monoclinic, $P2_1/a$. X-ray diffraction data (Table 1), obtained with Cu/Ni radiation using a 114.59 mm Debye-Scherrer camera and corrected for film adjustment, were indexed and the cell dimensions refined using a least-squares computer program written by Evans et al (1963). Initial parameters were taken from the precession photographs. The refined cell dimensions are $a = 15.829 \pm 0.007$ Å, $b = 7.721 \pm 0.003$ Å, $c = 7.438 \pm 0.003$ A, $\beta = 101° 19' \pm 2'$ (errors are one standard deviation). The cell volume is 891 A^3 and $a_o:b_o:c_o = 2.051:1:0.964$.

The observed forms are listed in Table 2 with calculated angles, and Fig. 1 illustrates the typical habit, front and back. The prism zone is striated parallel to [001], and many crystals show trains of reflections corresponding to faces of the forms {h10}. All other faces tend to be undulose and give poor reflections. In order of abundance the forms are {111}, {210}, {410}, {201}, {$\bar{2}$01}, {001}, and {100}. All of the crystals observed by the authors tend to exhibit the same habit. Interestingly, the prominence of several forms does not conform to the law of Bravais as extended by Donnay and Harker (1937); {210} and {410} should be less important and {100} and {110} more prominent. Structural analysis, presently underway, may help to explain this anomaly.

Chemistry and Formula

The analysis (M.H.H.) was carried out on 11.50 mg of eakerite. Details of the analysis are reported in the appendix. The results of the analysis are given in Table 3; on the basis of 22 oxygens the formula is

$$Ca_{1.96}Sn_{0.95}Al_{2.12}Si_{6.03}H_{5.77}O_{22} \text{ or } Ca_2SnAl_2Si_6O_{16}(OH)_6$$

Typical crystal of eakerite with acicular bavenite, Foote Mineral Company spodumene mine, Kings Mountain, North Carolina (50X).

Table 1

X-ray powder diffraction data for eskerite (Cu/Ni radiation, camera diameter 114.59 mm, intensities visually estimated)

hkl	d(obs)	d(calc)	I
200	7.76	7.76	20
001	7.31	7.29	80
110	6.905	6.913	50
$\bar{2}01$	5.944	5.927	50
$\bar{1}11$	5.257	5.252	90
111	4.812	4.812	100
211	4.116	4.113	10
$\bar{3}11$	3.999	3.999	50
400	3.882	3.880	50
$\bar{4}01$	3.738	3.744	5
410	3.466	3.467	5
$\bar{1}21$	3.396	3.399	40
$\bar{1}12$	3.353	3.349	60
012	3.291	3.298	5
$\bar{2}21$	3.229	3.235	50
112	3.116	3.115	30
221	3.021	3.023	80
$\bar{4}12$	2.767	2.767	20
$\bar{2}22$	2.623	2.626	30
600	2.584	2.587	5
511	2.527	2.526	15
$\bar{5}12$	2.491	2.492	5
$\bar{4}22$	2.351	2.351	30
601	2.300	2.300	10
$\bar{4}03$	2.271	2.270	5
$\bar{3}31$	2.249	2.255	5
$\bar{1}32$	2.112	2.116	20
$\bar{2}23$	2.079	2.076	30
132	2.052	2.053	5
$\bar{3}32$	2.028	2.030	5
$\bar{8}01$	1.973	1.974	5
223	1.908	1.912	5
332	1.876	1.875	5
$\bar{1}33$	1.785	1.785	5
$\bar{3}33$	1.748	1.751	5
133	1.729	1.729	10
423	1.704	1.704	5
$\bar{8}03$	1.688	1.680	5
$\bar{2}24$	1.675	1.674	10
$\bar{9}12$	1.653	1.653	5
$\bar{7}32$	1.619	1.620	5
333	1.603	1.604	10
250	1.515	1.515	5
623	1.493	1.494	10
$\bar{3}51$	1.467	1.466	5
$\bar{4}51$	1.428	1.428	10
$\bar{6}44$	1.254	1.255	5

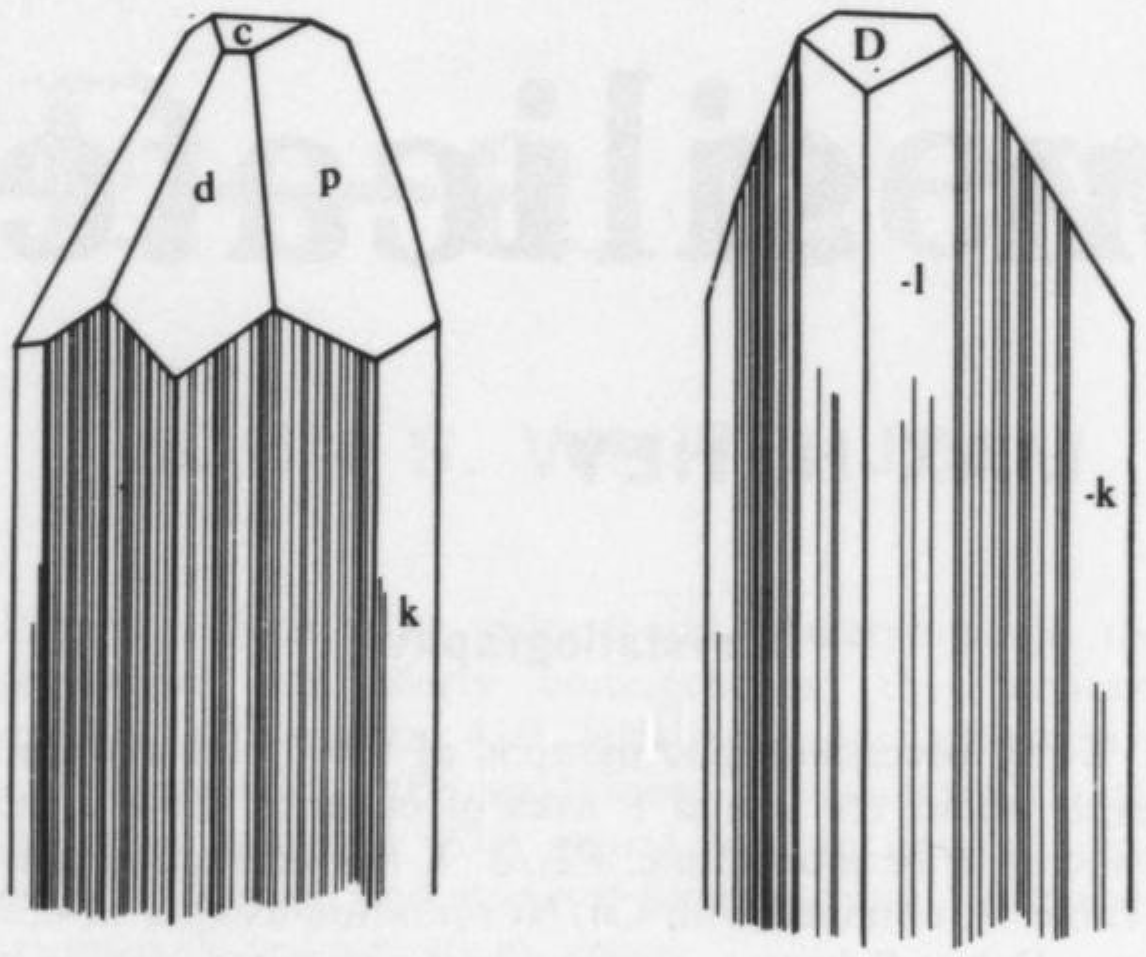


Fig. 1. Eakerite crystal in two orientations.

Semiquantitative microspectrochemical analysis by the U.S. Geological Survey showed, in addition to the major components, the following trace elements: Li 0.3, Be 0.3, Fe 0.1, Mn 0.03, Na 0.03, K 0.03, Ti 0.03 and Mg 0.03 weight percent. The significance of these numbers is discussed by Waring and Worthing (1961) and Waring (1962).

Thermal Study

A thermogravimetric analysis was made on 10.25 mg of eakerite, using a heating rate of 10°C per minute. Eakerite does not lose weight below about 350°C; it then loses weight slowly to about 725°C, having lost nearly 3% weight at that temperature. Between 725°C and 775°C, weight loss increases smoothly but steeply to about 6 1/2%, then slows. The run was discontinued at 1175°C, with a total weight loss of about 10 1/2%. Independent tests show that eakerite fuses at about 1075°C.

The abrupt weight loss between 725° and 775° is surely water; the high temperature and narrow range of dehydration support the proposed formula for eakerite with water held as hydroxyl. The earlier 3% weight loss is about equivalent to one H_2O in the formula; however, the presence of a water molecule would necessitate the unusual formula $Ca_2SnAl_2Si_6O_{17}(OH)_4 \cdot H_2O$. A structural analysis by one of us (Leavens, in progress) should elucidate the true nature of the water in eakerite.

Appendix

Details of the chemical analysis. The mineral was ignited at 800°C in a muffle; ignition at 900° gave no further loss in weight (<0.002 mg), and the mineral had not fused. The ignited mineral was fused with 120 mg Na_2CO_3, and the melt dissolved in a small

Table 2.
Crystallographic Data for Eakerite

$a : b : c = 2.050 : 1 : 0.9633$ β 101°19′ $p_o : q_o : r_o = 0.474 : 1.018 : 1$ $r_2 : p_2 : q_2 = 0.982 : 0.483 : 1$ μ 78°41′ p'_o 0.483, q'_o 1.038, x'_o 0.200

Forms:

		ϕ	ρ	ϕ_2	ρ_2 = B	C	A
c	001	90°00′	11°19′	78°41′	90°00′	--------	78°41′
d	201	90 00	49 38	40 22	90 00	38 19	40 22
D	$\bar{2}01$	-90 00	37 01	127 01	90 00	48 40	127 01
k	210	44 51	90 00	0 00	44 51	82 02	45 09
l	410	63 19	90 00	0 00	63 19	79 54	26 41
p	111	34 08	48 53	57 16	51 25	43 18	65 00

excess of H_2SO_4 and evaporated to fumes, then 100 mg $Na_2S_2O_7$ added and the whole fused just below a red heat.

The melt was dissolved in dilute (1:9) H_2SO_4 and filtered with a King microfilter; the crude silica was washed with 1:9 H_2SO_4, ignited, and weighed. After expulsion of the silica with HF + H_2SO_4 and weighing, the minute residue was fused with a speck of $Na_2S_2O_7$, dissolved and added to the main solution, which was made up to 20 ml with dilute (1:9)H_2SO_4; 1 ml 6% cupferron was added, and the stannic cupferrate extracted with 10 ml carbon tetrachloride; after separation, two more drops of 6% cupferron were added, and further extractions with 5, 2, and 2 ml carbon tetrachloride were made. The combined carbon tetrachloride extracts were collected in a weighed porcelain crucible and allowed to evaporate in a warm place, then ignited and weighed as SnO_2.

The aqueous layer was evaporated in a silica dish and the H_2SO_4 fumed off thoroughly, the residue being dissolved in a little water and 2 drops concentrated HCl. To the clear solution were added 30 mg sodium citrate, and the solution transferred to a 15 ml microbeaker with filterstick, 12 ml 2% 8-hydroxyquinoline in acetic acid added, then ammonia in slight excess; after a 30 minute digestion on the water-bath, the aluminum 8-hydroxyquinolate was filtered off, washed with hot water, dried at 130°C, and weighed.

The filtrate and washings were evaporated in a silica dish and the citrate destroyed with nitric and perchloric acids; after expulsion of nearly all the perchloric acid the residue was transferred with water to a 10 ml microbeaker with filterstick, diluted to 4 ml, 100 mg ammonium oxalate in 2 ml water added, and then a slight excess of ammonia. After digestion for 30 minutes on the water-bath and standing overnight the precipitate of $CaC_2O \cdot H_2O$ was filtered off, washed with cold water, dried at 105°C, and weighed, then dissolved in perchloric acid and titrated with N/20 $KMNO_4$ as a check. CaO is certainly the least

Table 3.
Chemical Analysis of Eakerite

	%	Atomic ratios		Atoms per 22 oxygen
SiO_2	46.75	Si	0.778	6.03
Al_2O_3	14.07	Al	0.274	2.12
SnO_2	18.59	Sn	0.123	0.95
CaO	14.2	Ca	0.253	1.96
H_2O	6.70	H	0.774	5.77
TOTAL	100.3	O	2.84	22

reliable determination, and could be in error by as much as 0.5%.

Acknowledgements

Mr. Louis Shrum, of Lincolnton, North Carolina, supplied several samples of the new mineral. The x-ray data refinement was done by Miss Judy Konnert of the U.S. Geological Survey. The thermogravimetric analysis was run by the Thermal Analysis Applications Laboratory of the Du Pont Instruments Company. The spectrographic analysis was performed by Claude L. Waring of the U.S. Geological Survey.

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obituary

J. Frank Schairer, 66, died suddenly on September 26, 1970 while swimming in the Chesapeake Bay, Maryland. With his passing mineralogy lost a truly wonderful man and a prodigious contributor to science. Dr. Schairer was a member of the National Academy of Sciences and for 43 years a physical chemist at the Carnegie Institution's Geophysical Laboratory.

Two of the numerous awards Dr. Schairer received in recognition of his scientific achievements include the Arthur L. Day Medal of the Geological Society of America and the Roebling Medal of the Mineralogical Society of America. He was president of the Mineralogical Society of America in 1943 and of the Geochemical Society in 1960. Last year a special volume of the American Journal of Science was published to mark his 65th birthday.

During his student days at Yale University Dr. Schairer was an avid mineral collector and author of Bulletin No. 51 of the Connecticut State Geological and Natural History Survey ***The Minerals of Connecticut.*** He spoke frequently to mineral clubs on this subject, and those who had the privilege of hearing him will recall it as a memorable experience.

Nor did Dr. Schairer's interests and boundless energy end with science. He was a founding member of the Potomac Appalachian Trail Club and the National Capital Orchid Society, and enthusiastic fisherman and square dancer.

Dr. Schairer was one of those rare individuals who enriched the life of everyone he met. He will be sorely missed by his hosts of friends all over the world, for as H. S.Yoder, Jr.[1] said: "The man is indeed a legend in his own time", and "Mr. Frank, as he was known to the mountain people of Virginia, is one of the richest men in the world when friends are counted."

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[1] H. S. Yoder, Jr. Presentation of the Roebling Medal to J. Frank Schairer. *American Mineralogist, 49,* 453-456, 1964.

To The Editor

(Continued from page 86)

long-recognized gap in the type of journals related to mineralogy and mineral collecting. My congratulations!

Victor J. Hoffmann
Golden, Colorado

Dear Sir:

Some time ago I received the first number of the *Mineralogical Record*. I want to congratulate you for this really fine magazine which was much wanted by many collectors. The excellent balance is just right between the highly scientific level of a paper for scientists and the level of the collectors' magazines, especially for agate collectors. All of the articles of the first number are of great interest. However, the column "What's New in Minerals" is especially important and welcome. I wish you a great success and I shall be proud to provide you with an article before long.

Dr. Werner Lieber
Heidelberg, Germany

Dear Sir:

When I first read the announcement of your new magazine in one of the mineral magazines I thought "Six dollars for one year's subscription! Too much!"

However, at the International Gem Show held at our Civic Center I purchased Volume I—#1. I must say I thoroughly enjoyed the copy (except for 1 item—the article on Paul Seel. I enjoyed the item but I disliked having to turn back in the magazine and then forward to complete the article. I always find this shuffling back and forth rather irritating.)

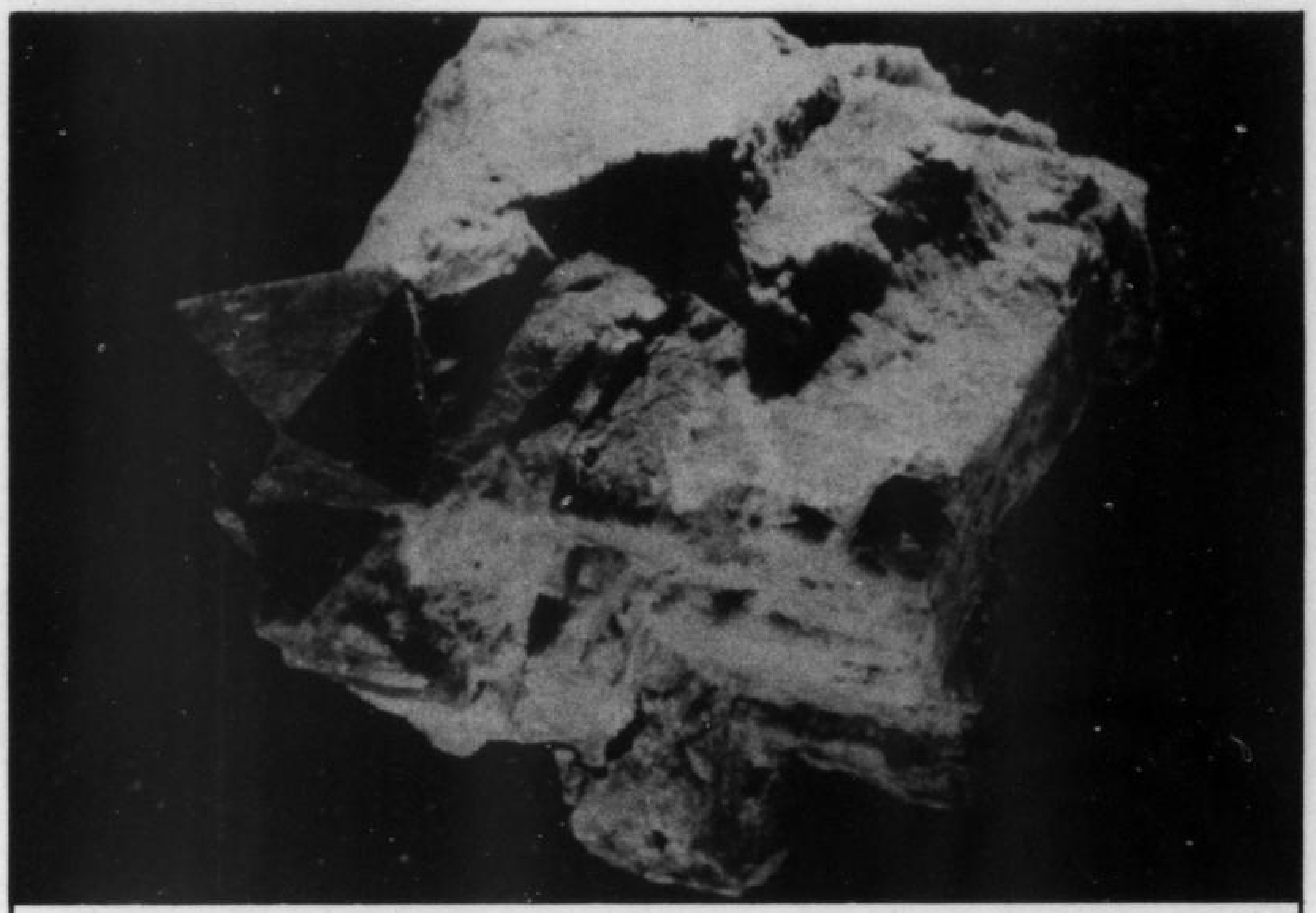
I like the quality of paper, the type of print, and the very nice photographs.

All in all, I was sold on your publication, so enclosed is my check for six dollars for one year's subscription—beginning with the next issue.

Good luck, and success in your next venture.

Very truly yours,
(Miss) Grace M. Kearney
Baltimore, Md.

☐



Lee Boltin **Zircon-Tigerville, South Carolina**

What's New In Minerals

A recent note in the "Canadian Micronews", vol. IV, nos. 8 and 9, 1970 mentioned the "unique" paulingite locality along the Columbia River, at Rock Island Dam, in the state of Washington. Actually a second locality has been known for several years but no description of it has yet appeared in the popular literature of the hobby. The occurrence is quite exciting in that individual specimens contain hundreds of crystals. The matrix is very similar to the Washington material, a vesicular basalt, but the rock is oxidized to a reddish-brown color. The vesicles are numerous, averaging about 1/2 cm in diameter but may reach 1 cm or more. They frequently contain several crystals and many are completely lined with paulingite! The crystals are simple dodecahedra. The only associated mineral is phillipsite in fine micro-size crystals.

So much for the good news. The bad news is that the locality cannot be found. The specimens turned up in study material at one of the universities in the Northwest and was being used to illustrate a vesicular basalt for geology students. It had been collected by a graduate student in his thesis area which was reported as the junction of Squaw and Pappoose Creeks, about 2 miles west of Riggins, Idaho. This sounds sufficiently detailed that it could be easily located but at least one experienced collector has combed the area rather well without finding any trace of paulingite.

Fortunately the U.S. National Museum of Natural History was able to acquire about 2 dozen specimens from the remains of the study material. Perhaps this description will stimulate some activity in that area and lead to the discovery of the source of the specimens.

(Continued on page 101)

CENOSITE from Switzerland

by Max Weibel

Cenosite (kainosite[1]) is a very rare mineral. Its formula is $Ca_2Y_2[CO_3|Si_4O_{12}]\cdot H_2O$, and crystallography is orthorhombic, dipyramidal. The species name comes from a Greek word for *unusual*, a denomination which matches the rarity of the mineral and its exotic composition.

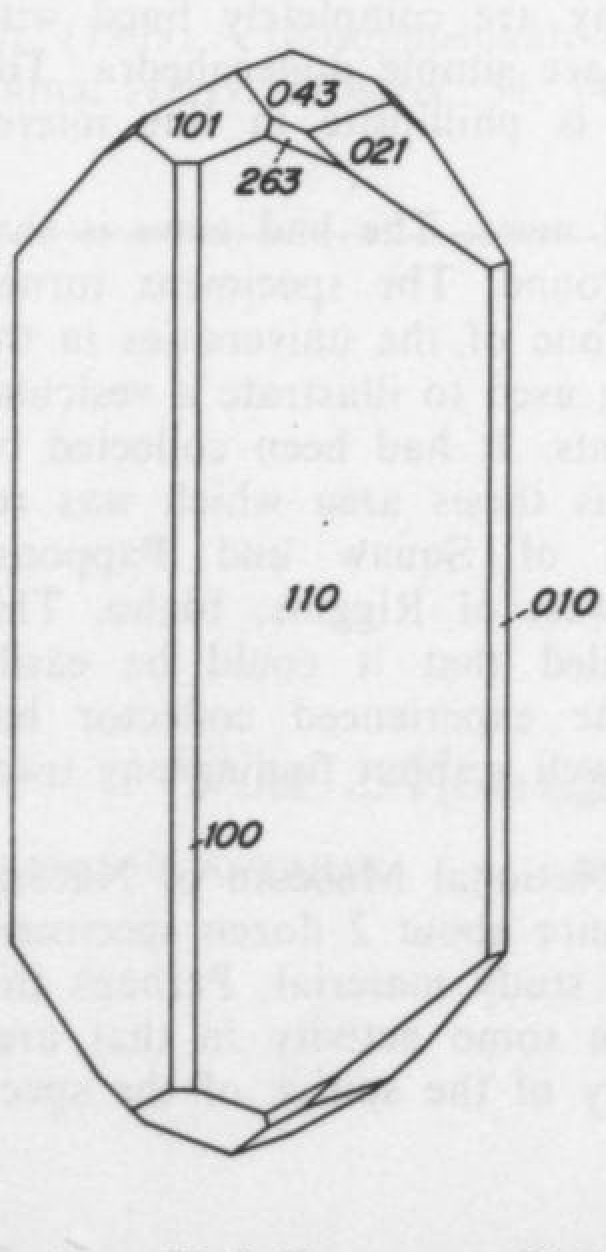


Fig. 1. Cenosite, Val Curnera. Orientation of Graham and Ellsworth. a : b : c = .9 : 1 : .45.

Crystals are not abundant at any of the dozen or so known occurrences. The literature lists as localities: Hitterö, Norway; Nordmark, Sweden; North Burgess and Bancroft, in Ontario, Canada; and Cotopaxi, Colorado, in the U.S.A. In addition, a few sparse finds have been reported in Swiss Alpine clefts at Guttannen, Trübtensee, Oberaar, Piz Ganneretsch and Val Curnera.

The last named locality has yielded the best crystals thus far from any Swiss occurrence. The cleft was opened in 1966 during mining and diversion-dam construction in connection with the Vorderrhein Hydroelectric Project in the Curnera Valley. The site of the cleft is now under water, but fortunately the entire pocket contents were collected before inundation. Many additional specimens were found in the waste material as the discoverers of the deposit had earlier ignored the inconspicuous crystals which were covered by or impregnated with chlorite. How often does similar negligence keeps collectors from paying enough attention to rare minerals that look worthless because of their small crystals and inconspicuous appearance? Several instances of this kind are known in Switzerland. Very likely many more rare minerals remain unnoticed and constitute an irreparable loss to science.

The unusually good crystals of cenosite found in the Curnera Valley provided an incentive for writing this article and for including some speculation on the behavior of the contained rare earths as well as on their occurrence in other rare-earth minerals discovered in Alpine cleft associations. No attempts are made to compile and compare occurrences other than Alpine as these others constitute completely different types of deposition-partly associated with ore veins, partly with pegmatites. Cenosite seldom forms good crystals, these being either acicular or

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[1] *Kainosite* has priority over cenosite and is now the preferred name but cenosite is retained in this article because of familiar usage.

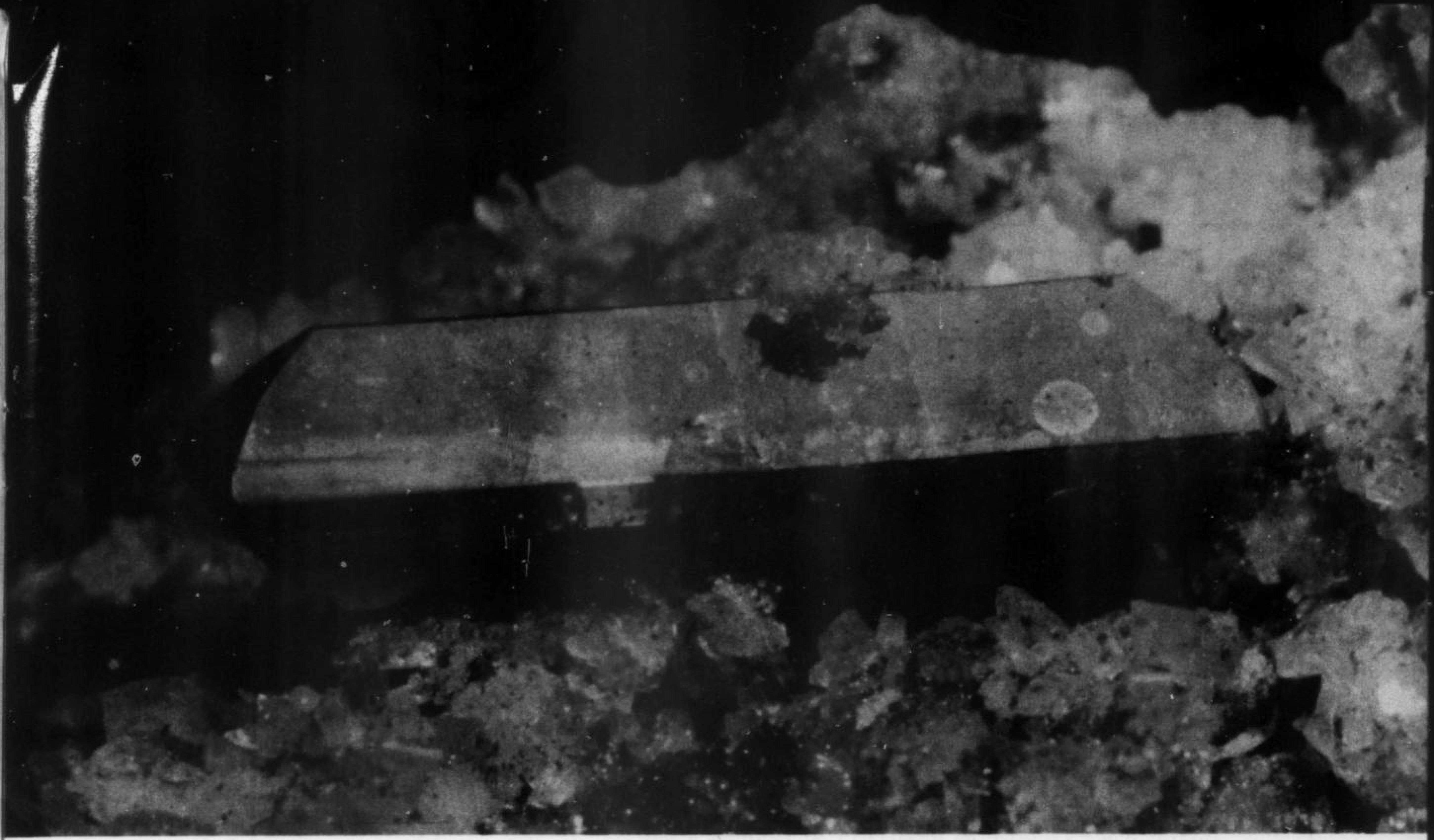

Fig. 2. Cenosite and adularia, Val Curnera. Length of single crystal 12 mm.

otherwise lacking in clean-cut faces. It is a well-known characteristic of certain other Alpine cleft minerals, such as quartz, hematite and apatite, to show complex crystal habits in crystals nothing short of perfection. Let us consider, for example, apatite from Val Casatscha where crystals of more than 1 cm in size occurred displaying up to two-score faces, many belonging to third-order forms matching the theoretical angles to within a few minutes of arc.

Cenosite is liable to weather rather easily compared with other Alpine minerals. Therefore, it has never been found fresh in superficial clefts. Even the crystals brought up from underground mining are, in the majority of cases, dull and etched. The tendency for a number of cleft minerals to turn up during tunnelling operations induced Parker (1954) to create a specific "tunnel association" for these, a misleading term since the minerals are not confined to tunnels. Minerals typically found in this category include ferroan dolomite, siderite, gypsum and anhydrite.

Cenosite Occurrence Of Val Curnera

The find from Val Curnera is the second of cenosite in the Gotthard Massif, where A. Arnold (private communication) first discovered the mineral in a loose boulder near Piz Gannaretsch. The eastern Gotthard Massif is one of the richest cleft areas in Switzerland. Other rare-earth minerals occurring there in minute amounts include xenotime, monazite, synchisite and gadolinite. In the Val Curnera the cenosite cleft is associated with mica schist of the greenschist facies. The cleft paragenesis is quartz, adularia, calcite, cenosite, apatite and fluorite. Except for the first two, all are calcium minerals.

Cenosite was seen in crystals up to nearly two cm in length, an enormous size compared with other Alpine cenosite. The habit of the crystals is prismatic and the color yellow. Many crystals were found loose and so impregnated with chlorite as to give them a dark green appearance. The faces of some are etched or distorted by numerous vicinals and not well suited for goniometric measurements. The idealized drawing (Fig. 1) shows a Val Curnera crystal in the orientation according to Graham and Ellsworth (1930). Parker and De Quervain (1940) reported on two single crystals from a tunnel near Guttannen (Aar Massif). Their crystal drawing, showing a somewhat similar-appearing prismatic habit, displays the same orientation as that of Fig. 1 purely by accident. The two authors failed to determine the optical orientation of their crystals and confounded their crystallographic orientation with the older one of Sjögren.

Only a few specimens showed the mineral attached to its parent rock. After the discovery, the locality was thoughtlessly over-promoted and within a short time the rare material was no longer available. The best specimens are dispersed among private collections.

Other Rare-earth Minerals of Alpine Clefts

The following rare-earth bearing species are ar-

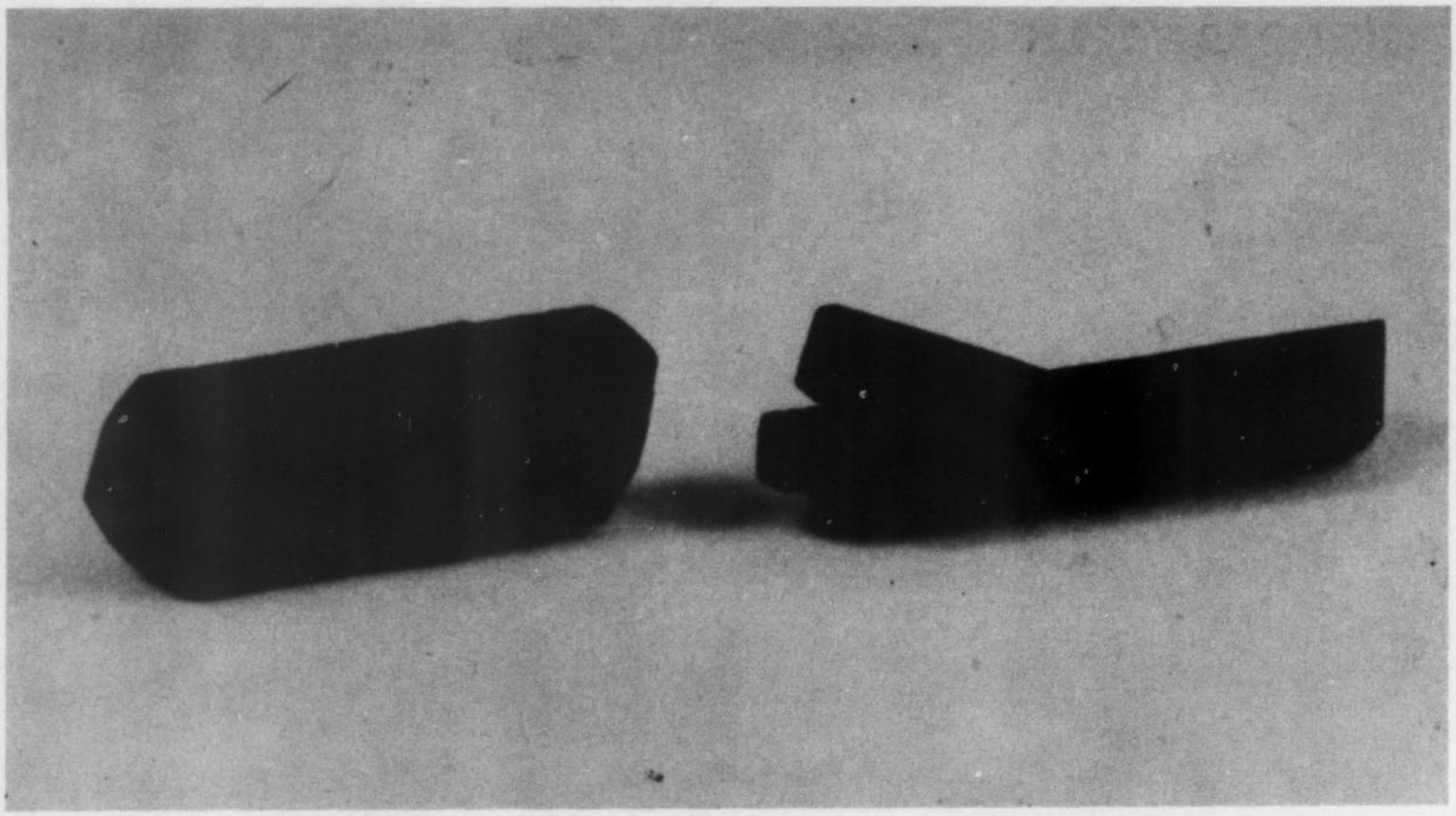

Fig. 3. Cenosite crystals, impregnated with chlorite, Val Curnera. Length of single crystal 17 mm.

ranged in accordance with the decreasing abundance in which they have been found: monazite, xenotime, synchisite, cenosite, gadolinite, allanite and parisite. Rare-earth minerals are strikingly scarce in Alpine clefts. The relatively large number of local occurrences contrasts with the minuteness of the crystals, commonly of micromount size, and the presence of just a few isolated individuals among the more abundant minerals. Various rock types, including mica schists and gneisses, occur as hosts of the clefts.

Two factors govern the formation of a cleft mineral: availability of the chemical elements and possibility of crystallization. Cerium and yttrium are abundant trace elements. We may assume that some rare earths were always present in the thermal solutions giving rise to the Alpine cleft associations during late stages of Alpine folding. These rare earths were derived from the wall rock. The degree of leaching was small but the amount of rock affected may have been large since the solutions percolated a considerable distance. Slight differences in concentration of the solutions were critical for rare-earth minerals to crystallize at all. We have little data on rare-earth distribution in crystal structures of commoner cleft minerals. Some of the latter have high chemical purity and fit theoretical formulas to within analytical errors. Low temperatures of formation and rates of growth may be responsible here for the insignificant atomic substitution. When I investigated two Alpine sphene occurrences (Weibel, 1957), I failed to find any rare earths by normal emission spectrography, suggesting a total content considerably lower than 0.1%. One of the two localities was Muotta Naira in the same tract of the Gotthard Massif where rare-earth minerals are found.

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Dr. Max Weibel is professor of geochemistry at the Swiss Federal Institute of Technology in Zürich, Switzerland. He is probably best-known to mineral collectors for his book A Guide to the Minerals of Switzerland, published by Interscience-John Wiley & Sons, 1966 (in German, Die Mineralien der Schweiz. Birkhaüser Verlag, Basel and Stuttgart, 1966). This book will be reviewed in a later issue of MR. □

What's new

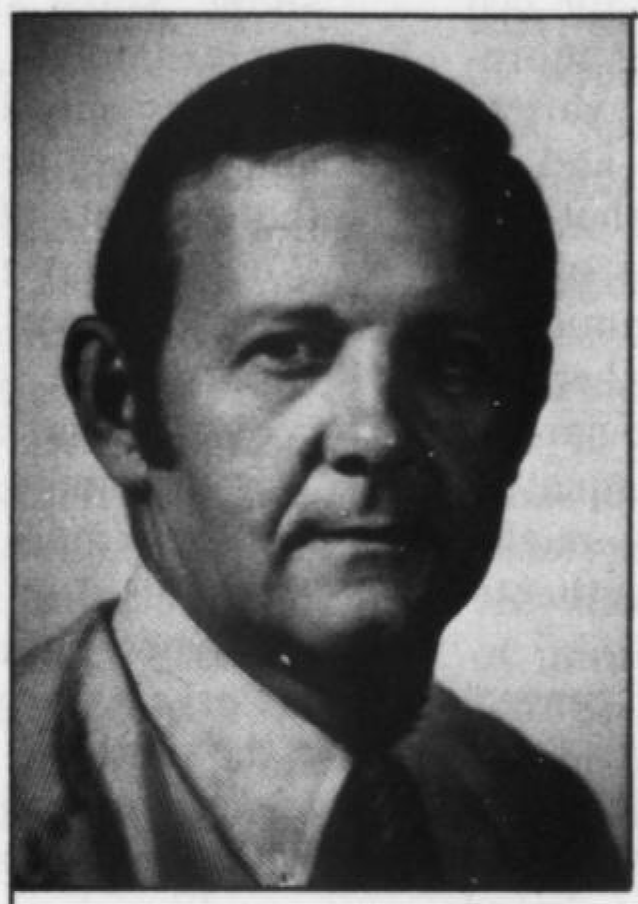
(Continued from page 97)

Another relatively rare mineral, alabandite (manganese sulfide), has recently been collected and transferred to the National Museum by T. Botinelly and G. Neuerbert of the U.S. Geological Survey. The locality is the dump of the Manhattan mine, about 1/4 mile southeast of the Whale Mine, Hall Valley, Park County, Colorado. This may be a new locality for alabandite. The specimens consist of black cleavages with a rhombohedral carbonate and quartz in vein rock. They are rich in alabandite but unspectacular.

The iron- and magnesium-rich varieties of tourmaline, schorl and dravite respectively, from Yinnietharra, Western Australia certainly rate as among the best specimens of these minerals ever found. Most are doubly terminated and very well formed. Individual crystals of both, up to 6"×4", are found. The dravite crystals tend to have mica imbedded in their faces; the schorls tend to be smaller, mica-free and more lustrous. It may seem odd that both varieties are reported from the same locality but a similar association is known in Maryland in at least two localities where pegmatite intrudes the Cockeysville marble. Dravite is found in marble seemingly unrelated to the pegmatite. The pegmatite contains small but good schorl crystals usually imbedded in massive plagioclase. Here too dravite is associated with a mica and schorl is not. Unfortunately no details of the occurrence at Yinnietharra have been supplied.

Exceptional mineral localities can come and go before many collectors know of them. Two such finds have apparently expired recently after about one year's notable production. The first of these has been a *known* locality for years but only in the last year or so did it really come into its own. This is the pegmatite mined for vermiculite near Tigerville, Greenville County, South Carolina which provided a small number of local diggers with some of the best zircon crystals ever found. The crystals are simple, flat dipyra-

(continued on page 119)



the museum record

by Paul E. Desautels
the Smithsonian Institution

It is not possible to visit every country in the world. Even if it could be arranged, the task of visiting every mineral museum would be one of staggering proportions. Fortunately, I can often rely on first hand reports from friends and colleagues who are knowledgeable about mineral collections and have the good fortune to travel to distant parts.

Recently, Richard Thomssen, a personal friend and a member of Friends of Mineralogy spent several months in New Zealand. His first hand report follows:

"The Auckland War Memorial Museum contains collections of minerals, ores, rocks, and fossils from New Zealand which are well displayed in the Hall of Geology and Paleontology. The Museum is situated on a promontory in Auckland Domain (Park) about one mile from the downtown section of the city and overlooking the campus of Auckland University.

In the Hall the General Collection—Minerals of New Zealand—is the first display which greets the visitor. Two outstanding specimens were among the 200-odd items of average quality. The collection is arranged by Dana's system and in the first case is a very fine piece of native arsenic from the Kapanga mine, Coromandel measuring 3×4×2 inches. The arsenic occurs in dark grey, microcrystalline, botryoidal, banded crusts over one inch thick covering the large flat surface.

A specimen of stibnite from Thames is also in the first case. This piece is the finest specimen in the collection. It measures 7×9×4 inches and is composed of a roughly stellate cluster of sharply terminated, prismatic crystals up to 3/4 inch square and six inches long. The quality of this material ranks it among the finest stibnites in the world behind the classics from Japan and Roumania.

Among several collections of ore and rock specimens, one exhibiting the Vein Minerals (The Hauraki Goldfields) contains a display of some 50 mineral specimens with four worthy of specific note. The first is a fine gold from the Una mine, Thames, measuring 1/2× 2 1/2 inches. Platy crystals up to one inch square

(continued on page 113)

“type” specimens in m

by Peter G. Embrey & Max H. Hey Britis

One of our more enjoyable activities for the last few years has been a daily session over morning coffee in the lab, discussing a wide variety of problems—mainly mineralogical—and in particular the descriptions of new minerals that are circulated by Dr. Michael Fleischer on behalf of the International Mineralogical Association Commission on New Minerals and Mineral Names. On rather too many occasions we have had cause to regret the narrow approach of some authors, who have not adequately considered the full range of species that they ought, and the failure of others to secure properly authenticated material for their studies.

There is a tendency for our petrology and general geology colleagues, (who encounter, at most, some two or three hundred mineral species) to complain about the large number of species on display in the Mineral Gallery and the fact they have not heard of most of them. “Who cares about cahnite—or fluellite—and why waste display space on it?”. This is not the appropriate occasion to answer their question, tempting though it may be, but it gives an opportunity to remind these same colleagues that they do not realize how lucky they are. While entomologists have a quarter of a million or so species to consider, we have only a couple of thousand mineral species—two whole orders of magnitude less!

It is obvious that we have our problems as mineralogists—there is no noticeable tendency for the *American Mineralogist* to get slimmer each year—but, at the same time, we have a much easier job to perform in putting our house in order. Working in the Natural History Museum, we are surrounded by colleagues in the biological sciences who have for many years accepted the need for strict rules of nomenclature, and for careful distinction between different degrees of authenticity of the specimens used to define a species or variety. These reference specimens are known as “types”, and provide a fundamental area for us to start a “tidying-up” operation. The designation of type specimens in mineralogy is not a new idea, but arising from our coffee deliberations Max Hey submitted a discussion paper, “ ‘Type’ specimens and the discrediting or redefinition of species,” to the Commission in 1964. Since then, the idea of adopting some of the different categories of ‘types’ has been taken up by French cataloguers,[1] and it seems desirable to examine the problem rather more closely.

At least two dozen varieties of ‘type’ specimen have been suggested in the biological field, but there has been a tendency for this complexity to be reduced. Moreover, not all the distinctions are applicable equally to all the biological sciences, and since there is no established precedent in mineralogy we are free to select which of the kinds of ‘type’ we may care to adopt. Some are obviously unsuitable for our science. For example: since it has been generally accepted in post-alchemical times that minerals have neither sex nor gender, we are on fairly safe ground in rejecting the concepts of ‘androtype’, ‘gynetype’, and ‘allotype’. We feel that there is a case for distinguishing seven kinds of type:[2]

Holotype—A single specimen selected by the author of a species as its type, or the only specimen known at the time of description.

Cotypes (more than one)—Specimens other than the type used in making the original description. Ideally, cotypes should be from the same locality.

Metatype(s)—specimen(s) compared with the type by the author, and ***determined*** as co-specific with it.

Ideotypes—metatypes from a different locality.

Plesiotype(s)—specimen(s) upon which subsequent or additonal description is based. This may, in some instances, be a neotype.

Neotype—a plesiotype selected to represent the holotype when the holotype is lost or detroyed.

Topotype—a specimen from the original locality, and corresponding to the original description.

Having introduced these terms, it may be useful if we digress a little into a general discussion of descriptive mineralogy before giving some examples to illustrate their use. With very few exceptions, writers on mineralogy before 1800—certainly before 1750—were qualitative in their outlook and tended to describe minerals solely in terms of their appearance to the naked eye. In saying this, we do not underestimate the work of the early mineralogists, but Lavoisier's discovery of the role of oxygen in chemistry was around the year 1775; the contact goniometer was devised by Carangeot in 1780; and Wollaston's reflecting goniometer, Mohs' scale of hardness, and Brewster's work on optical crystallography all had to wait for the early 19th Century, together with the chemical classifications of minerals that are linked with the names of Berzelius, Mohs, and Rose.

In addition to this qualitative approach of the early authors, early collectors and curators (even at the British Museum!) tended to be far from complete in their labelling and cataloguing of specimens, including those that had served for the description of a species. To establish one of these early specimens as a type often calls for a great deal of painstaking historical research, and even greater good fortune in finding adequate labels and records still extant. Right up to the present day there are authors who name new species with grossly inadequate supporting descriptions. In general, the standards have tended to

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[1] C. Guillemin and J. A. Sarcia, 1968, Bull. B.R.G.M., 2me serie, sect. IV. no. 3, p. 35

[2] We have based our definitions on those of N. Banks and A. N. Caudell, The Entomological Code, Washington D.C. (1912). Guillemin and Sarcia have introduced the term 'Necrotype' for the type of a discredited species, but since species do not always remain discredited and in any case the name tends to linger on regardless, we cannot feel that this serves a useful purpose.

n mineralogy

Hey

British Museum (Natural History)

improve over the years, in large part, because of the steady increase in the number and accuracy of the techniques that are readily available. In parenthesis, we may note that there are already signs of a decline; chemical analysts with any degree of familiarity with the tested techniques of wet analysis are becoming very scarce. It is well to recall, before ending this digression, that although the methods of x-ray diffraction (to name but one technique) are recognised as modern, the determination of refractive indices by immersion was barely practised at all before it was popularized by E. S. Larsen as recently as 1921.

We now have a situation in which descriptions of mineral species and varieties in the literature cover a wide spectrum of completeness and accuracy while on the other hand, we have the specimens of the species, which may or may not be the ones used for the original description. Certainly we have many species for which the correlation between specimen(s) and description is far from satisfactory. It cannot be too strongly emphasized that, since few (if any) mineral specimens consist of only one species, any reexamination of a species (even from the original specimen) must be done in light of the original description. This is doubly necessary if it seems possible that redefinition or discrediting of a species may be the outcome of the work. The zeolite offretite was at one time identified with phillipsite, simply because it was not noted that the original description stated clearly that the crystals were minute hexagonal prisms. Confusion arose among the copper silicates planchéite, shattuckite, and bisbeeite because refractive indices in the original descriptions were ignored. Mountainite was recognised as distinct from the very similar species rhodesite because of a serious discrepancy between x-ray diffraction results on one part of the original specimen and electron diffraction results on another part.

The *holotype* of a species is at the same time the simplest case to consider and the hardest (until recent times) to realise in practice. If we grant that a chemical analysis is an essential part of a mineral description, we must start by preparing a homogeneous (powdered) sample, but through this analysis we destroy the holotype! The electron microprobe can get us out of this difficulty in two ways: it can be used for the definitive analysis, in which case we still have the original crystal, or it can (together with optics and x-rays) establish that each of several crystals or fragments are genuinely the same substance. One of the nicest examples of a true holotype is the stokesite crystal at Cambridge University. Since only the one single crystal was known, Professor Hutchinson carefully removed a small portion from the back for the chemical analysis. Sometimes a holotype may be of little or no use to us, and this is almost certainly the case with torbernite (if it still exists). It is also true of wyartite, of which we have a fragment from the type specimen in the B.M.(N.H.)—irreversible dehydration occurs very easily.

The term *cotype* has been largely dropped by the biologists because its exact meaning became muddied by confusion between the cases where a holotype was designated (paratype) and where it was not (syntype). We have decided that mineralogical needs are somewhat different, and that for us the designation of a holotype is a little unreal (see above), so we are recommending the use of 'cotype' with its slight degree of imprecision. We similarly feel that there is no need for the term 'lectotype', a cotype (or syntype) selected as the holotype. The use of this term is exemplified in the case of ludlockite, a new lead iron arsenate from Tsumeb. We started with two specimens, both originally from a larger block. The description will be based on material from both specimens—and since neither has precedence the specimens are true cotypes.

We have stated that cotypes, ideally, should all be from the same locality. Generally speaking this will tend to be the case, since, even when material is known from several localities at the time of description, one locality will furnish better specimens than the rest. Specimens from the other localities are better termed *ideotypes*. In the recent description of agardite, the cotype specimens are from Bou-Skour, Morocco, and specimens from other localities in Spain, Germany, France, the U.K., and the U.S.A. are ideotypes (even though some of them have varietal status). In the case of strunzite, although the mineral was first discovered at Palermo, New Hampshire, and later at several other localities in the U.S.A., a definitive description was not possible until material from Hagendorf, Bavaria, was shown to be the same and provided enough for a chemical analysis. Clearly, in this case, the specimens from the U.S.A. are ideotypes despite their being found earlier.

The distinction between cotypes and *metatypes* may be a little difficult, but an attempt must be made to delineate it. For example, if one of the authors of agardite presents one of the *original* specimens, that is a cotype. If he presents a specimen from a later collecting expedition at Bou-Skour, that is a *metatype;* but if someone else collects at Bou-Skour, and on comparison with the description decides he has agardite, that is a *topotype*. The point of distinction is when the determination was made, and by whom. We place some emphasis on the need for the term *metatype* because there are many specimens, particularly in the older collections of the world, which are known to have come directly or indirectly from the original author but which have a status clearly less than holotype and probably less than cotype. Many old private collections are incorporated in the mineral collection at the British Museum (Natural History), and special mention may be made of a collection by Thomas Allan, augmented by R. H. and R. P. Greg, which was accompanied by an excellent manuscript catalogue. Taking an entry at random, we read (under Amblygonic Felspar of Haidinger [= Oligoclase]): "*no. 6. Cristalline and massive, of a dark colour, the soda spodumene of Berzelius, but probably belonging to this* *species [i.e. oligoclase], accompanied with red Felspar. Presented to Mr Haidinger by Berzelius, from Danvickgate [= Danviken, Sweden]"*. Another entry (under Hemipyramidal Felspar [= Edingtonite] reads: *"no. 1. Small detached crystal white and translucent. This is one of the new species discovered by Mr Haidinger, it occurs along with thomsonite. From the collection of Mr. Edington from Kilpatrick, Dumbarton."* It is evident from these examples that the Allan-Greg collection contains specimens of sound pedigree, many of them metatypes at the very least.

The *plesiotype* deserves special mention on at least two counts, either because the original description was made before suitable methods were available to complete it or because the originally-found material was too impure, poorly crystallized, or small in quantity. There is no real need to give examples of plesiotypes because they are so numerous, but we must point out that they are not the same as described specimens. There is a difference between the completion of an inadequate description, and the provision of additional data to illustrate the variability of chemical composition, optical properties, and the like. Thus, the crystals of eucryptite from Kings Mountain, North Carolina,[3] add so much to the morphological data for the mineral that they are properly plesiotypes.

When well-authenticated specimens of a species are not available, the specimen on which definitive work is done becomes a *neotype* rather than a plesiotype. This was the case in the recent redescription of the two nickel arsenates aerugite and xanthiosite, since the types from Johanngeorgenstadt, Saxony, could not be located. Topotype material in the B.M. collection thus became the neotype, and other specimens (from South Terras mine, Cornwall) described at the same time became ideotypes.

It was quite incorrect, in this or any other context, for ureyite to be named as a new species; Laspeyres' original description of cosmochlore may have left something to be desired, but he was a shining example to us all in that he distributed fragments of his mineral to several museums. Perhaps only sperrylite, in sealed and labelled tubes, has achieved a wider circulation!

The lowest rank of all in the hierachy of types is held by *topotypes*. The name simply implies specimen(s) from the original locality, and which conform to the original description. This second condition, often overlooked, is essential. But, the question of topotypes is far from being as simple as it sounds! First, the original locality is not easy either to define or to locate; this is even more true of rocks than of minerals, since in some cases a few inches may make all the difference between one rock and another. We have recently encountered this difficulty with montebrasite from Montebras—the same specimen may have both montebrasite and amblygonite on it—and the example of rhodesite and mountainite is referred to above. A great deal also depends on the original collector: Richard Talling was quite content with a Cornish locality defined to the nearest twenty miles or so, and some specimens labelled 'Minas Gerais' are even worse, but F. N. Ashcroft regarded alpine cavities a few feet apart as separate localities and put photographs in his catalogues to illustrate his point.

The second consideration is the original description, and we have illustrated this with the example of offretite above. It would be invidious to labour this point, but the unfortunate fact remains that the literature is strewn thickly with examples of redefinition and discrediting that would never have been perpetrated if the original description had been carefully studied.

One final point concerns figured specimens, and we have given careful thought to whether they should be given any kind of type designation. We think not, although the temptation is strong in view of the many figured specimens in the B.M. Collection. Among the first to come to mind are the two bournonites from Wheal (Huel) Boys, Cornwall, figured by Philip Rashleigh in *'Specimens of British Minerals'*, 1797. The point is that Rashleigh referred to the mineral as 'ore of antimony', and the name bournonite with description was not given until 1805 (by Jameson); description and naming must go hand in hand, with very few exceptions.[4] An illustration or figure serves little more purpose than to give a general idea of the appearance of the specimen. A biologist can usually get more out of an illustration than a mineralogist, who is limited to a rough idea of colour and association and (one hopes) a rather better idea of crystal habit and morphology. Of course, a figure may serve to identify a particular specimen when the number has been lost or (as commonly occurred in the past) not recorded as part of the description. Curators know to their cost that there is another side to the coin—if enough investigators, especially careless ones, get their hands on a type it can readily become a disfigured specimen!

We hope that we have said enough to encourage some interest in the identification, tracking-down, and classification of type specimens. Some eminent colleagues have suggested that the preparation of a master-list of type specimens and their whereabouts would be a worthwhile joint project for the Museums and New Minerals Commissions of the I.M.A., but we disagree. We see the acquiring of expertise in tracking down type material for a particular investigation as part—an essential part—of the apprenticeship of the descriptive mineralogist. The identification of a specimen as a *'type'* is not something that can be done, in general, without a curatorial training of some sort. Also, the ready availability of mineralogical yellow pages to all comers would be the last straw for that over-worked and under-appreciated species, the curator.

Mineralogical nomenclature and the cataloguing of collections are two subjects that cannot easily be separated from a consideration of types. We hope that the indulgent and kindly editor will consider letting us have space in a future issue for suitably provocative articles on these subjects. ☐

P. B. Leavens, C. S. Hurlbut, and J. A. Nelen, Amer. Min. 1968, 53, p. 1202.

The only exceptions that come to mind are the cases where an author feels that his description is inadequate for a name to be given, usually because of the nature or small amount of material at his disposal. Much good and little harm can come from a description without a name, but a name without a good description clutters the literature and calls for censure. Fortunately for the science the activities of the New Minerals Commission have been having an increasingly salutory effect over the few years it has been in existence.

mineral rings & cylinders

by **Richard A. Bideaux**

Microscopic mineral crystals, when examined under adequate magnification, exhibit a variety of crystal morphologies virtually unknown from macrocrystals. Some of the most interesting of these are perfectly regular rings and cylinders found for a number of different species. These habits are such an extreme departure from the more usual multi-faceted forms as to almost defy explanation. This must presumably be sought, in part, in an adequate understanding of the crystal structure and crystal chemistry involved. The results of crystal structure analysis, the most powerful microscope of all have been infrequently turned to these problems, but some information is available.

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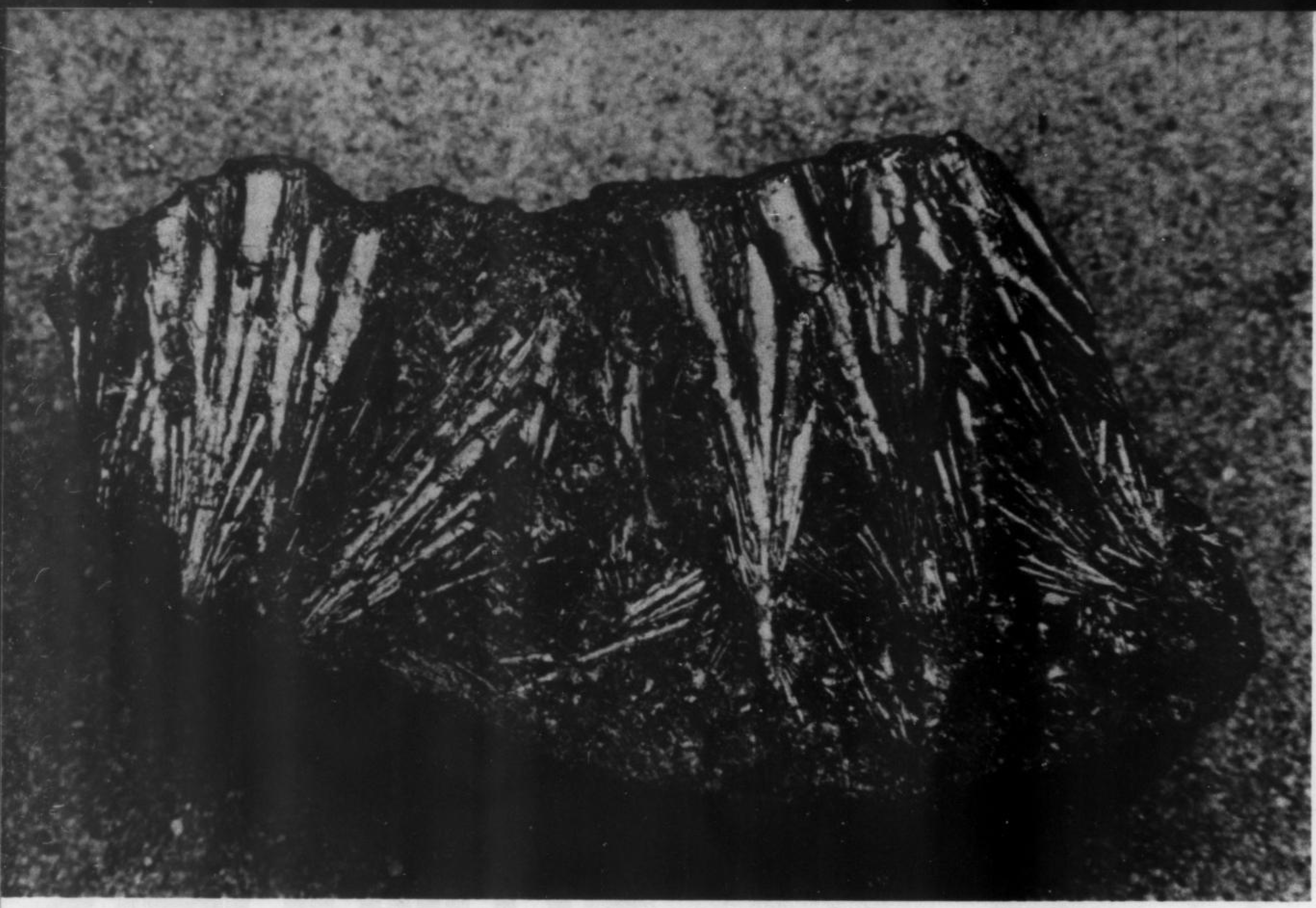


Fig. 1 (above) Cylindrite, Poopó, Bolivia. 2X. Specimen NMNH, Photograph, Lee Boltin.

Fig. 2 (left) Jamesonite, Felsobanya, Rumania 60x. Specimen photographed by Lou Perloff.

The cylindrical crystals of some important silicate species have received the most attention. Hollow tubular crystals of the clay mineral halloysite, $Al_2(Si_2O_5)(OH)_4 \cdot 2H_2O$, were first directly observed on transmission electron micrographs reproduced and discussed by Bates, et al. (1950). Sometimes tubes within tubes were noted. Particle sizes ranged from 0.01 to 15 microns.

The halloysite crystal structure is essentially that of kaolin, $Al_2(Si_2O_5)(OH)_4$, with additional interlayer water molecules. The kaolin structure (Bragg, et al., 1965, 277-280) is that of a layer composed of sheets of two different kinds. A strongly bonded sheet of Si-O atoms is in contact with a second sheet of Al-OH groups. This Al-OH sheet is a close modification of that found in gibbsite, $Al(OH)_3$. In gibbsite, the unit cell has dimensions of 5.06 Å and 8.62 Å measured in the sheet. The corresponding dimensions for the Si-O sheet are 5.14 Å and 8.93 Å, a close enough fit to allow bonding between them into a single layer in kaolin.

The explanation for the tubular morphology of halloysite proposed by Bates, et al. depends on this slight

Fig. 3 (right) Jamesonite, Felsobanya, Roumania. 700X. (SEM). Specimen, William Pinch. Photograph, Eastman Kodak.

mismatch between the two kinds of sheets. In kaolin, the layers are repeated immediately on top of one another, but are held together by relatively feeble forces. This closely spaced stacking reinforces the hold of the more rigid Si-O sheet on the Al-OH sheet, stretching the latter to conform. Some slight bending of the layers to accommodate the mismatch, however, is probably evidenced by the tendency of kaolin crystals to remain small and imperfect.

In halloysite, the kaolin structural layers present are more widely spaced by the interlayer water. Thus the layers can bend more freely, and calculation of the curvature to be expected agrees fairly well with the observed diameters of the most tightly rolled tubes seen.

The chemical formula of chrysotile, $Mg_3(Si_2O_5)(OH)_4$, is seen to be similar to that of kaolin, and, indeed, their crystal structures are similar (Bragg, et al., 1965, 282-285). In chrysotile the layers are made up of the same Si-O sheet, but combined with an Mg-OH sheet. This pair has an even larger mismatch in dimensions than does kaolin. Even without water of hydration between layers, the sheets must bend strongly to bond at all. This has been found actually to be the case by direct observation at magnification of about 100,000 X provided by the electron microscope. Multiple tubes within tubes are sometimes seen, in an extensible telescope-like arrangement (Bragg, et al., 1965, Pl. V). Asbestiform chrysotile is explained by this tubular habit.

Turning to a rare example of tubular structure visible in hand specimen (Fig. 1), cylindrite, originally obtained from the Santa Cruz mine, Poopó, Bolivia, was named for its occurrence in cylindrical forms separating under pressure into distinct shells or folia (Dana, 1899, app. I, 21). This complex sulfosalt, approximately $Pb_6Sb_2Sn_6S_{21}$, presented an extremely challenging problem for crystal structure analysis. This has been met by Makovicky (1970) who found that "the cylindrite structure is composed of alternating layers of two kinds. . . . Cylindrical growth is caused by the flexibility of bond adjustments on interlayer boundaries. . . ."

Crystals of other species showing these types of development, seen by visible light microscopes, have been known to collectors of microminerals for some time. Perhaps the most widespread of these are the "heteromorphite" rings from Felsobanya, Roumania. Recent x-ray diffraction determination of these specimens confirms the identity of "heteromorphite" with jamesonite, $Pb_4FeSb_6S_{14}$, as established by chemical analysis in the last century (Dana, 1892, 122). Jamesonite from numerous localities usually shows an acicular habit, either as felted masses of individuals, or as massive fibrous aggregations. These jamesonite specimens from Felsobanya thus occur principably as needles, growing from a quartz crystal matrix. Examination under even as little as 30X magnification will often disclose a few remarkable rings, tubes, and related forms (Fig. 2).

A relatively new development, the scanning electron microscope (SEM), has made possible preparation of some fine micrographs of specimens requiring intermediate magnifications (100-10,000X). Fig. 3, taken with this instrument, shows a fine Felsobanya jamesonite ring. This example is suspended on needles of the same mineral. Note that the ring is flattened in a plane perpendicular to the axis of rotation, and seems to show steps. These could visually be interpreted as several thinner rings stacked together, or concentric rings of varying thicknesses and diameters. Fig. 4, of the same material, shows a squat cylinder of approximately the same diameter as the ring of Fig. 3. The direction of flattening is here parallel to the axis of rotation. The resolution of this micrograph is such that even tinier

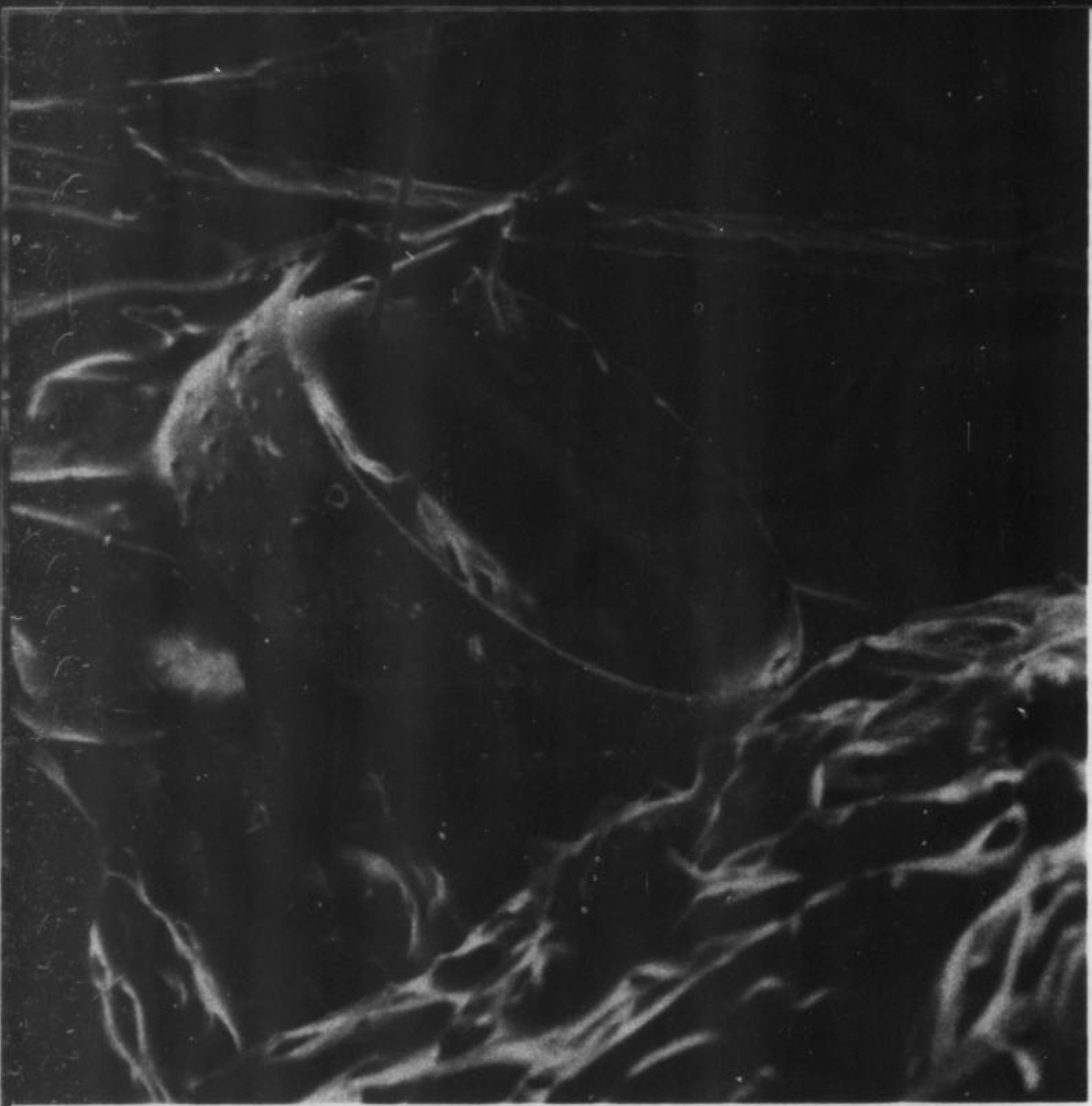
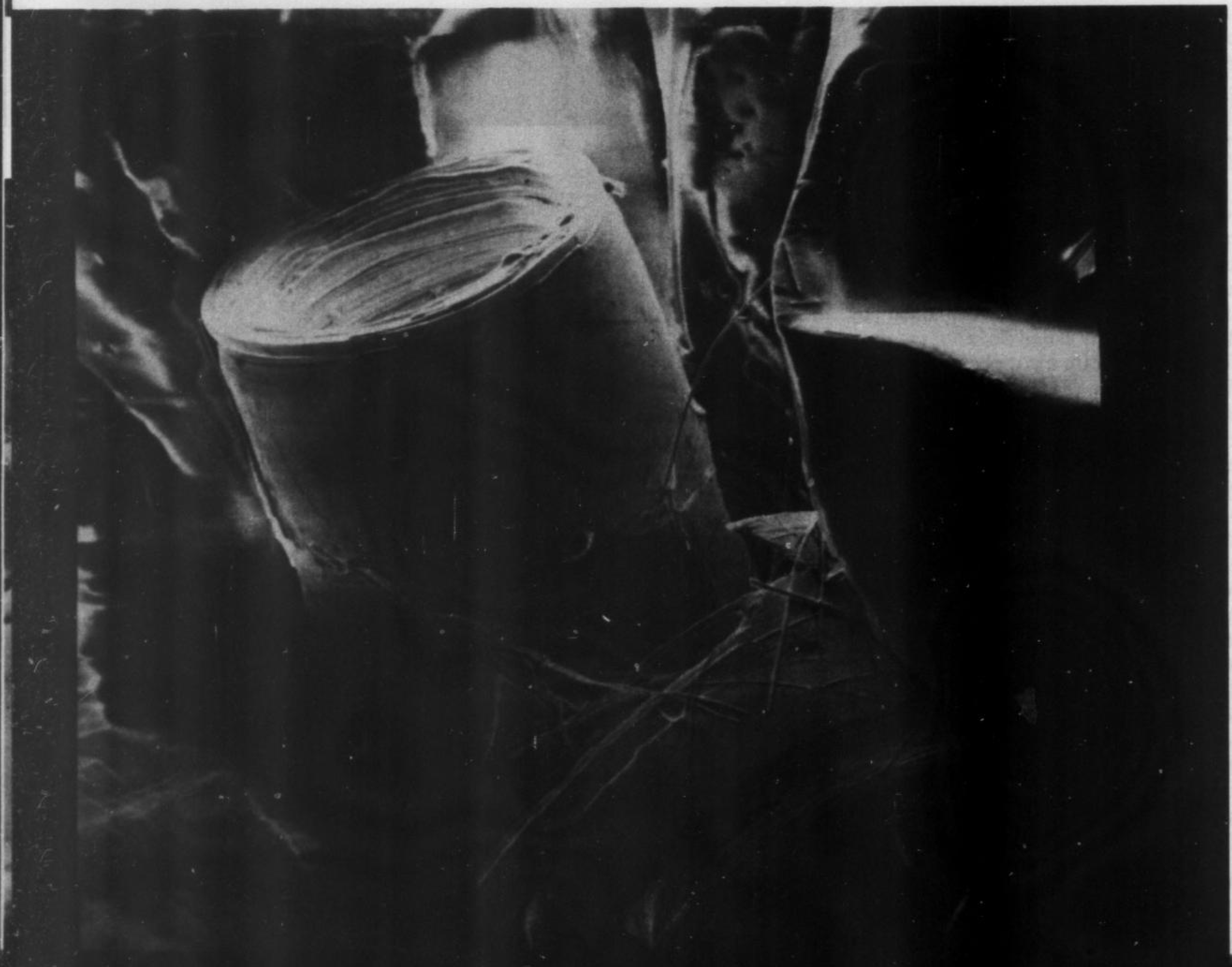
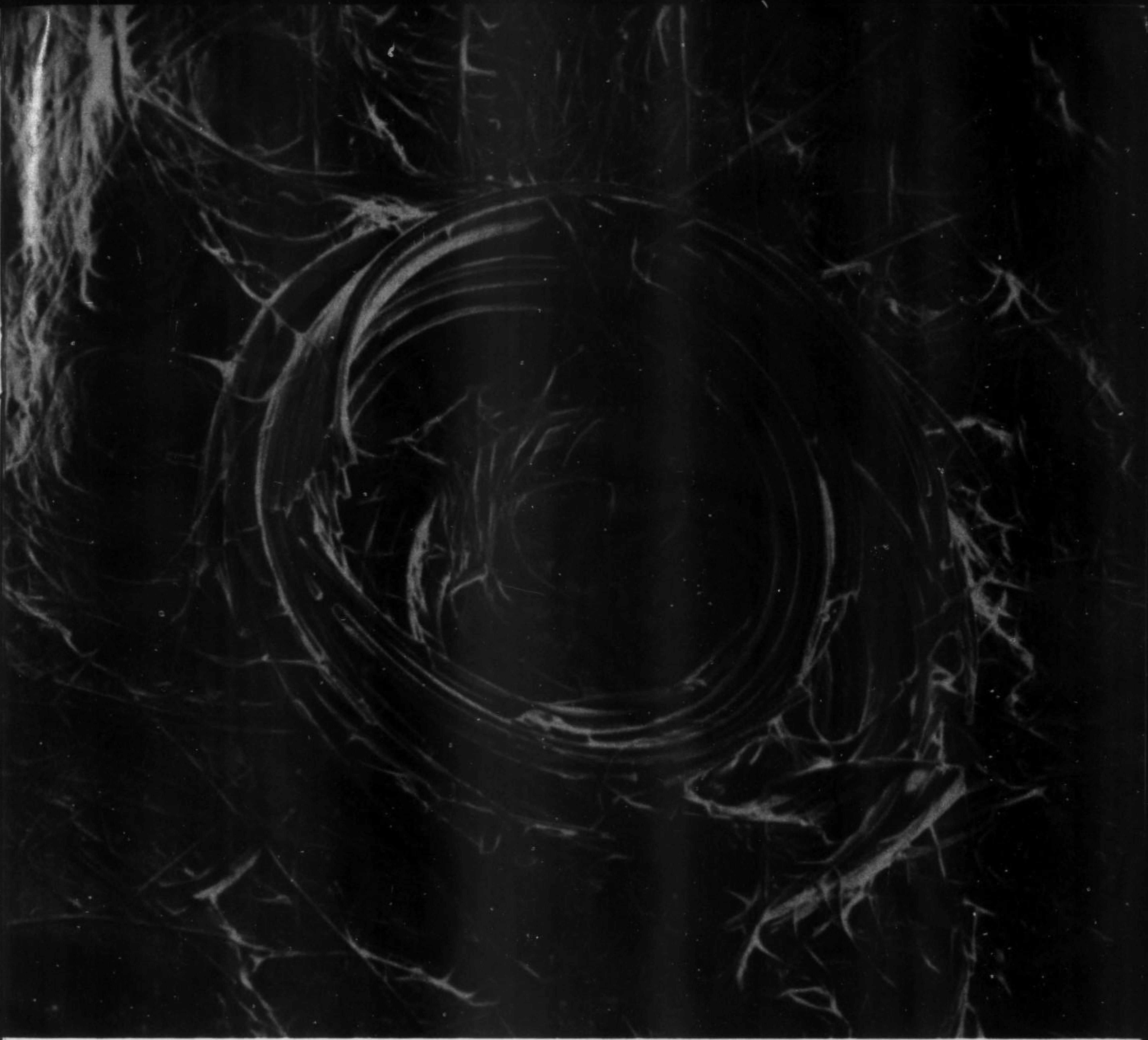


Fig. 4 (left) Jamesonite, Felsobanya, Roumania. 700X (SEM). Specimen, William Pinch. Photograph, Eastman Kodak.

Fig. 6 (right) Boulangerite, Madoc, Canada. 500X (SEM). Specimen, William Pinch. Photograph, Eastman Kodak.

Fig. 5 (below) Boulangerite, Madoc, Canada. 300X (SEM). Specimen, William Pinch, Photograph, Eastman Kodak.





circular excrescences on the surface of the cylinder are visible.

Roger's Fluorspar mine, near Madoc, Ontario, Canada, has provided Canadian collectors a number of rings, etc. of another of the "feather-ore" sulfosalts, boulangerite, $Pb_5Sb_4S_{11}$, confirmed by x-ray powder methods. Some of these have been pictured in Caesar (1966). Most are enclosed in calcite or fluorite, but some occur on the faces of these crystals or suspended on needles of boulangerite. Fig. 5 shows some Madoc boulangerite cylinders. While their exteriors are fairly smooth, the interiors appear made up of a multitude of individual coils. A degenerate coil-like group is seen in Fig. 6, where some individuals are only semi-circular. The fact that the coiled individuals are thicker than those of the tangled straighter background material may be significant from a genetic standpoint.

Dadsonite, $Pb_{11}Sb_{12}S_{29}$, a newly described sulfosalt from Wolfsberg, Germany, is reported (W. Pinch, pers. comm.) to show ring structures similar to those of jamesonite and boulangerite.

Considerable similarity can be seen between Figs. 6 and 7. The mineral in Fig. 7 is pyrite from Hall's Gap, Lincoln County, Kentucky. The blocky material forming the matrix for this coil is pyrite of more usual habit. The occurrence is in quartz geodes, containing calcite, chalcedony, and millerite (Berndt, 1969).

Hall's Gap has provided a number of other enigmatic pyrite rings. Fig. 8 shows one such, of striking "feathery" form. The individual "feathers" do have the same sense of direction around the ring, but there is no suggestion of the smoothness of surface structure shown by most of the previous examples. These "feathery" rings give a pyrite x-ray pattern usually interpreted as from a polycrystalline mass, almost amorphous in crystallite size. Fig. 9 shows several such "feathery" rings intertwined, on a matrix of pyrite crystals. The cover photograph displays three rings of this type.

Rutile, TiO_2, is another common mineral which rarely shows ring structures. Fig. 10 shows a rutile ring enclosed in a cleavage fragment of topaz, from San Luis Potosi, Mexico. The occurrence of topaz enclosing rutile from this locality was noted (Dana, 1892, 495) but without mention of the rings.

The crystal structures of jamesonite, boulangerite, and dadsonite are not known in sufficient detail to possibly support the misfit theory of bending. While the crystal structures of pyrite and rutile were among the earliest worked out, there are no obviously mismatching features. Geniculated twins of rutile, such as those from Magnet Cove, Arkansas, etc., might suggest a relationship with ring formation. These twins however show well-formed re-entrant angles, while the rings are apparently absolutely circular, without trace of breaks in continuity.

Cylindrite's composition is somewhat variable, and the formation of cylinders is restricted to a certain compositional range (Makovicky, 1970). This may be true of others of these minerals. Even a small number of contaminating atoms might possibly give rise to two phases interlayered in such a way as to promote bending. An explanation of this nature is difficult to support where rings, etc. are distributed randomly among apparently contemporaneous normal crystals.

Other unusual crystal habits are perhaps related to ring formation, since they seem to occur with more than chance frequency on some of these specimens. Twisted acicular crystals, with pitches varying but on the order of their diameters, are often seen among the Felsobanya jamesonites. Millerite, NiS, also shows twisted

Fig. 7 (above) Pyrite, Hall's Gap, Kentucky. 800X (SEM). Specimen, Douglas Berndt, Eastman Kodak.

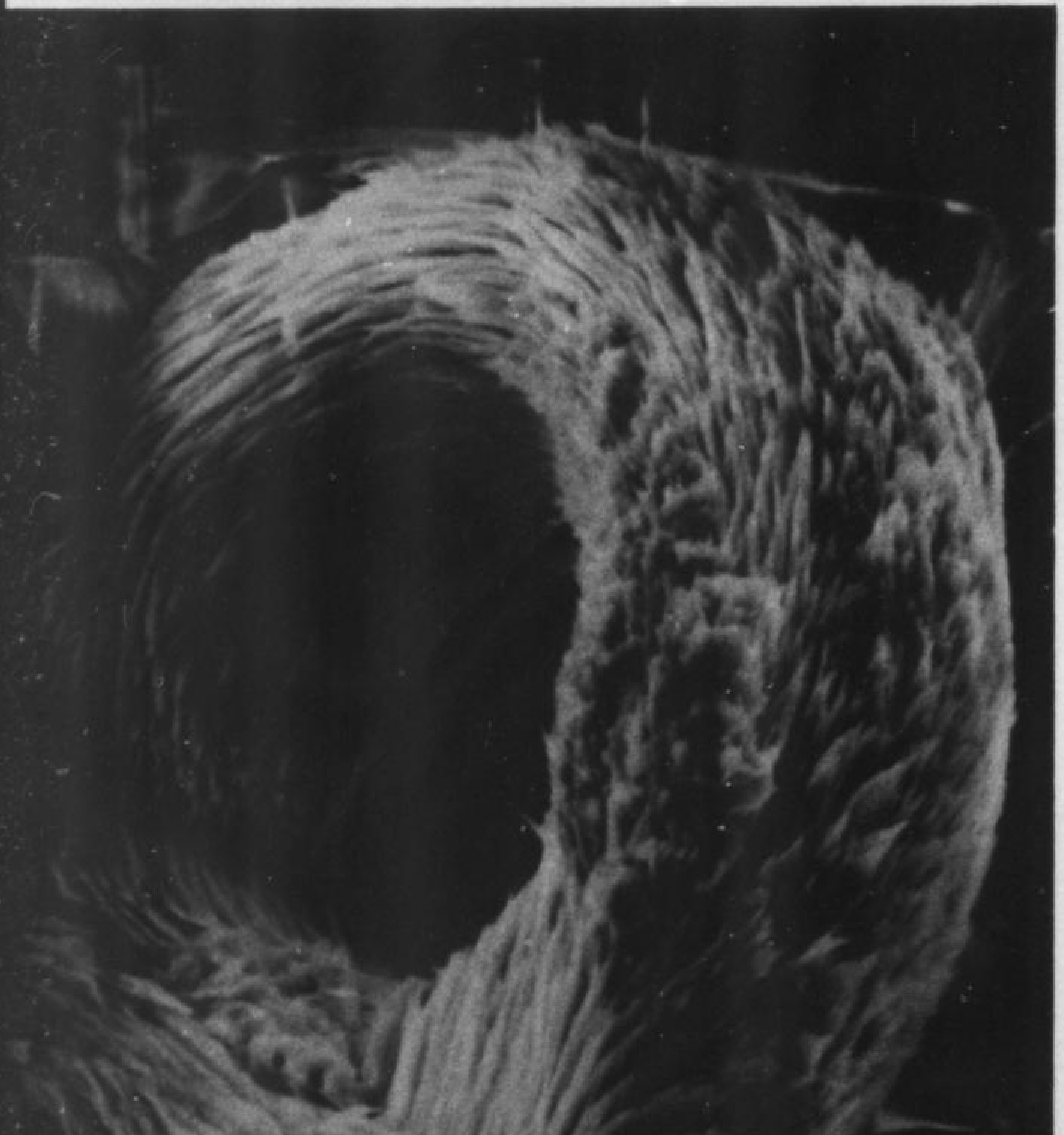


Fig. 8 (left) Pyrite, Hall's Gap, Kentucky. 700X (SEM). Specimen, Douglas Berndt. Photograph, Eastman Kodak.

Fig. 9 (right) Pyrite, Hall's Gap, Kentucky. 650X (SEM). Specimen, Douglas Berndt. Photograph, Eastman Kodak.

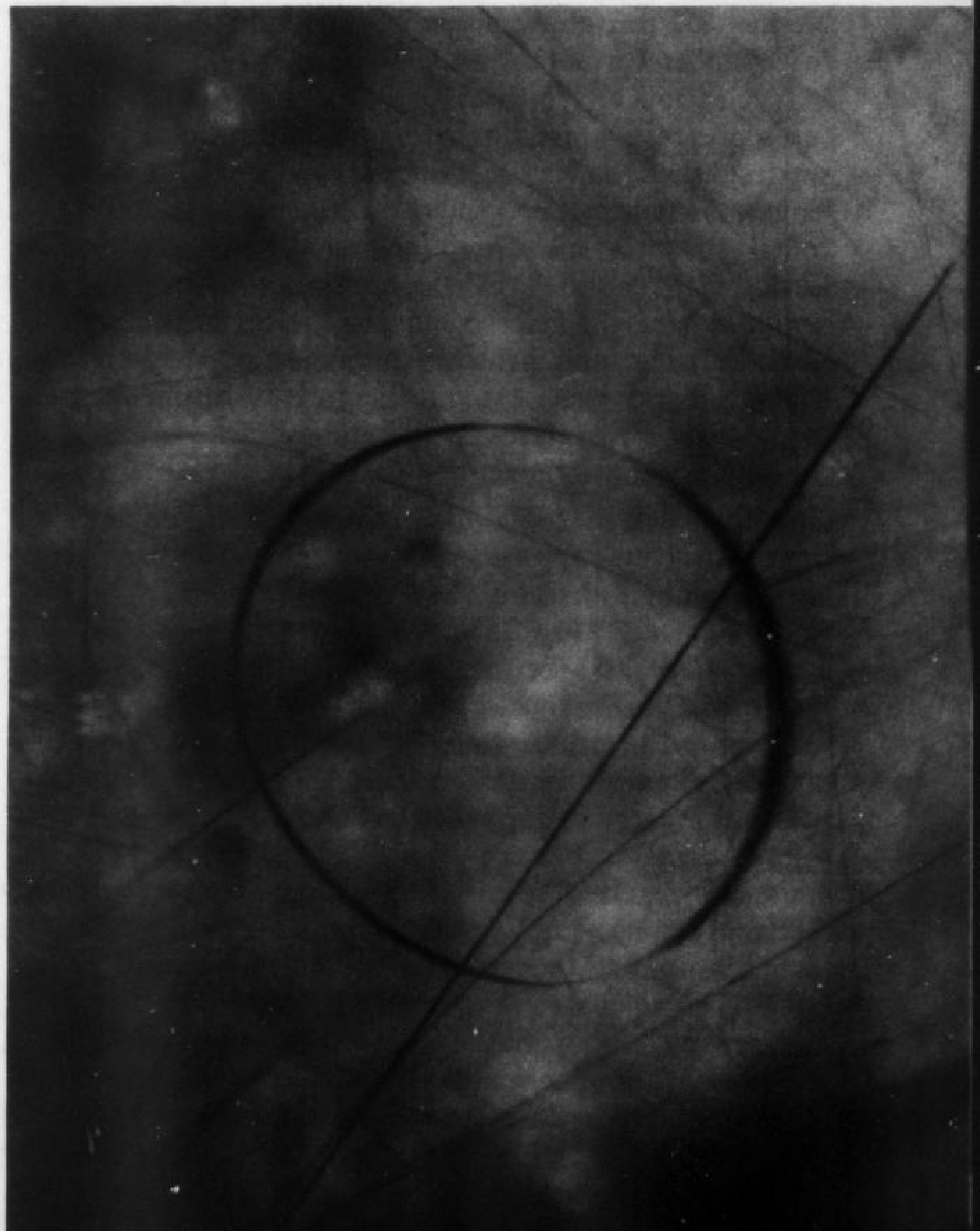


Fig. 10 (below) Rutile in topaz, San Luis Potosi, Mexico. 250X. Specimen, Neal Yedlin. Photograph, Julius Weber.

crystals, but rings have not been observed for this species so far as this author knows. Optical diffraction effects from iris agate are caused by parallel, closely spaced chalcedony fibers. Microscopic study of this material using polarized light leads to the conclusion that the individual fibers are tightly twisted (Frondel, 1962, p. 203).

Open helical forms, such as Fig. 11 (enclosed in fluorite), may be a part of the puzzle. The interior of this pictured helix may well be void, but perhaps encloses or enclosed boulangerite. Black tourmaline needles included in quartz crystals from Jefferson County, Montana, are reported (J. Puckett, pers. comm.) to sometimes form a helix of one turn. This material exhibits needles with frayed ends, indicating that what appears to be a single crystal may be a fiber bundle. Caesar (1966) reports needles with frayed ends on Madoc boulangerite. Felsobanya jamesonite also shows this phenomenon. What are believed to be incipient rings are sometimes developed along this type of needle. Following along a straight portion of the needle its character suddenly changes. From a dull, fibrous appearance it takes on a brilliant metallic luster and all indication of fibrosity vanishes. While in this lusterous state, the needle curves through circular arcs observed from about 90 degrees to nearly 360 degrees on various examples. Equally abruptly, the luster resumes its former duller appearance, the needle straightens out, and may finally terminate in a frayed end.

Two other potential mechanisms for ring formation may be mentioned. Epitaxial overgrowth of one mineral species on another is known in some cases to modify the habit normally taken by the overgrown species. A crystal growing on a substrate which had almost equal atomic dimensions could be subjected to forces bending it into a closed circular form. There is however no clearcut evidence for this mode of formation in any of the foregoing examples. While some of the rings do seem to grow flattened on the crystal faces of other species, these are often adjacent to others which are on edge or suspended away from such interference.

Many kinds of interactions can occur between a growing crystal and the medium from which it is grown. A two-component nutrient solution could be hypothesized in which one component formed immiscible spherical droplets within the second. A crystal growing in such an environment could encounter one of

Fig. 11 Boulangerite (?) in Fluorite, Madoc, Canada. 50X. Specimen, NMNH. Photograph, Louis Perloff.

these spherical droplets and be warped into circular form about it by surface tension (J. Arem, pers. com.). Neither of the above hypotheses would fully account for cylinder formation.

Nucleation and growth to larger size of these structures presents interesting questions. Bates, et al. (1950) suggest that halloysite tubes grow most rapidly in length. Whether they grow at all in diameter after the rolled sheet cylinder is joined is problematical. Makovicky (1970) states that "cylindrite growth starts from a minute straight-layered nucleus." Do rings in general start as rings and grow in diameter as they become larger, or do they extend themselves during growth along their circumference and finally close off, sealing the join without trace?

A scanning electron microscope (SEM) consists of three basic systems; an electron-optical column, vacuum specimen chamber, and detection and display devices (Thornton, P., 1968). An intense beam of electrons is generated and spot focused to as little as 250 A at the specimen. Two magnetic coils, driven by a scan generator, sweep the primary electron beam across the specimen. The same scan generator synchronously drives the beam of a cathode ray tube (CRT) display. Both beams follow a raster pattern like a television set. Various emissions, excited from the specimen by the primary electron beam, at any point in the scan pattern are detected, amplified, and control the beam intensity of the CRT. This is coated with a phosphor which glows with an intensity proportional to the beam intensity, creating a picture of the scanned specimen. The CRT picture size is constant, while the specimen area scanned is variable, effecting magnifications typically from 100 to 10,000X.

Surface specimen material is ionized in the primary electron beam, stimulating secondary electron emission. Some of these may recombine with the ions, giving visible photons in the process, called cathodoluminescence. (The recombination may also give invisible x-rays, characteristic of the specimen material's composition. Detection of these latter form the basis for the x-ray microanalyzer, or electron microprobe.)

SEM micrographs accompanying this article were taken in the emissive mode. These non-conductive specimens were coated with gold, which serves to conduct away excess electrons. This avoids a charge buildup and loss of resolution.

ACKNOWLEDGMENTS

Especial credit is due to Kent Brannock, Kingsport, Tennessee, for obtaining the scanning electron micrographs, through Tennessee Eastman Kodak, which made this article possible.

Specimens for photography were lent by William Pinch, Rochester, New York; Douglas Berndt, Kingsport, Tennessee; Neal Yedlin, New Haven, Connecticut; Lou Perloff, Winston-Salem, North Carolina; and the U.S. National Museum of Natural History through John White. Ben Kinkead, Kingsport, Tennessee took the cover photograph.

James Puckett, Tucson, Arizona contributed his observations on tourmaline. Discussions of these problems with Joel Arem, U.S. National Museum, were informative. John Anthony, Tucson, Arizona, helpfully reviewed the manuscript. Finally, John White brought overall coordination to this effort by assembling the accompanying photographs for the author's inspection.

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Richard A. Bideaux earned the B.S. in geological engineering at the University of Arizona and the M.A. in geology at Harvard University. He worked at the California Institute of Technology, Jet Propulsion Laboratory for four years processing lunar probe data. He is presently with Computech Research, Ltd., Tucson, Arizona, where he is engaged in computer applications to geology and mining. A well-known private collector, he has a keen interest in scientific mineralogy and crystallography. □

Museum Record

(continued from page 101)

are cemented together with fine drusy quartz. Another fine stibnite from the 100-foot level, Golden Age lode, Moanatairi mine, Thames measuring 3×3×2 inches with crystals to 1 1/2 inches thick is included in this group. The last specimen of note is a gold on native arsenic from the Royal Oak mine, Coromandel. This specimen, 1×2×2 inches, consists of leafy gold crystals up to 1/4 inch lying on and between botryoidal crusts of arsenic. A remarkable combination!

The Coromandel School of Mines Museum is a remnant of the once thriving technical school. The ore, mineral, and rock collections, as well as a library (35 volumes), two microscopes and laboratory together with a variety of memorabilia comprise the present museum. The mineral collection, distinct from the ore and rock accumulations including an old Krantz collection of mediocre quality, consists of approximately 200 pieces. Only one outstanding specimen was found, a single botryoidal crust of native arsenic, 3×3×2 inches, from Tokatea Hill in the Coromandel area.

The Thames Mineralogical Museum contains the mineral, rock, and ore collections of the Thames School of Mines which closed its doors in 1954. The Museum is owned and maintained by the borough of Thames, a thriving community at the foot of the Hauraki Gulf and some 20 miles south of Coromandel.

In a collection of approximately 500 ore and mineral specimens, seven are worthy of description. Three stibnites out of a total of twenty are of particularly fine quality although none compare with the large piece in the Auckland Museum.

The first stibnite is an open jackstraw aggregate of crystals, 3×5×2 1/2 inches, with individual crystals up to 3 inches long and 1/4 inch through. Unfortunately, most of the crystals have a thin coating of yellowish oxide. A single, sharp, brilliant, terminated crystal measuring 3/16×1/4×5 inches resembles some of the less striated Japanese crystals. The third stibnite is the best piece in the Museum and the best miniature of stibnite I have seen. It measures 2×2×1 1/2 inches and is composed of well separated 1 × 4 × 2 inches long, sharp, terminated, brilliant crystals in a stellate grouping.

A very good native arsenic from Coromandel, measuring 1×2×3/4 inches thick, has a glossy, dark grey, botryoidal surface. Another gold on native arsenic from Meavesville, measures 1 1/2×1×3/4 inches thick. The specimen is displayed with the botryoidal crust downward on the shelf, so the view is of the base where fine, light colored, spongy gold fills in cracks, and selvages between crusts of arsenic.

Two specimens from Australia were of notable quality. A jackstraw, white cerussite from Tasmania (Dundas?), 3×3×2 inches, stood out among a dozen badly bruised Broken Hill cerussites, measuring 3×3×1 1/2 inches, is of note with two undamaged 1 1/2 to 2 inch by 1/2 to 3/4 inch crystals on one corner. Unfortunately, several badly bruised patches of azurite are next to the two crystals and detract from the overall appearance."

Such reports are very illuminating and I'm always fascinated by new ones as they come in. This time the arsenic and stibnite specimens were new to me in spite of having already seen hundreds of stibnites from many occurrences. □

NOTICE

Mineralogical Research Company announces they have moved. New address is 14770 Whipple Court, San Jose, Calif. 95127. With larger facilities for displaying their stock of thumbnail, miniature and cabinet size specimens, they will now be able to accommodate visitors more readily, though still by appointment only.

YEDLIN

(continued from page 91)

For the most part the material was albite, with perhaps 20 percent of the masses a tan siderite, and when vugs occurred in the latter material they were lined with translucent to transparent (what are we saying is that translucency is but a degree of transparency) tan, very steep dogtooth crystals of the iron carbonate. Where the siderite had been exposed to weathering it had become a dark earthy brown, and the clear quartz crystals disseminated throughout, in the "quartzoid" habit, (Fig. 1) made striking specimens.

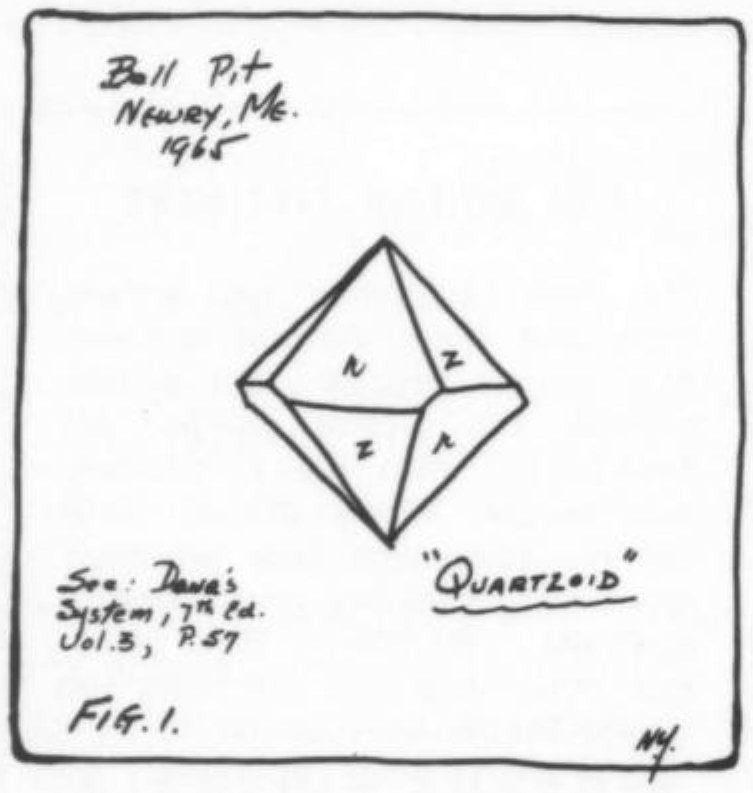


FIG. 1.

We began to take the material apart (as distinguished from smashing it to fragments), and one by one we uncovered the following, in addition to those described above:

1. Amblygonite. This was indeed a surprise. Clear triclinic crystals, nestled among siderite crystals, and exhibiting a form similar to the figure on page 824 of Dana's System, 7th Ed., vol. 2. In addition there were a number of flat tabular amblygonites, represented by Fig. 2 herewith.

2. Apatite. Deep aqua blue. Showing long prism and base, frozen in albite matrix, and luckily released unbroken.

3. Cassiterite. Black tetragonal. Thin edges show dark brown. High adamantine lustre. Frozen in albite mass. (see Fig. 3 for types)

4. Cyrtolite. The rare-earth-bearing zircon. Several brown-black crystals frozen in massive material. Evidence of radioactivity exhibited by the discolored "halo" and slight fracturing around the crystal.

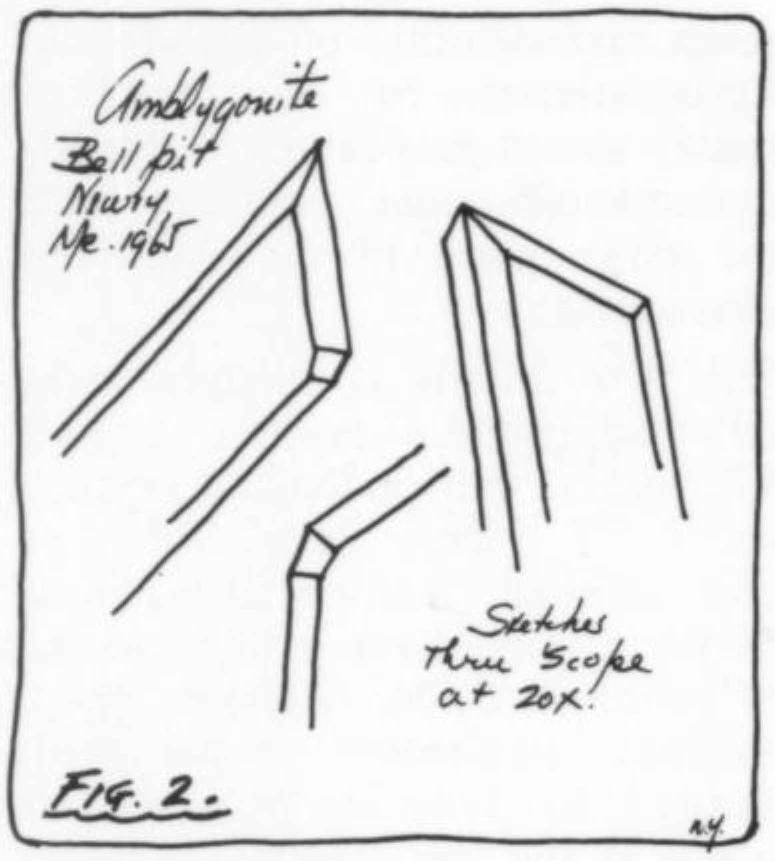


FIG. 2.

5. Eosphorite. Single, clear tan, orthorhombic. Light colored and therefore probably low in iron. Ergo, not childrenite. Some small radiating clustered masses, the terminations alone showing crystallization.

6. Herderite. Minute bunches of rounded nodules, light brown, almost transparent. Where such nodule is broken it shows a compact radiating structure.

7. Pyrite. Combinations of cube and pyritohedron. Some altering to goethite on exposed areas.

8. Triphylite. Blue, irregular crystalline masses, disseminated throughout albite. An occasional sharp crystal face indicates an attempt by the material to crystallize, but the compact albite retarded this trend. Some of the surfaces of the triphylite have altered to a dark blue vivianite.

9. Vivianite. Long prismatic monoclinic in habit, grouped in minute clusters of crystals, coating surface of triphylite.

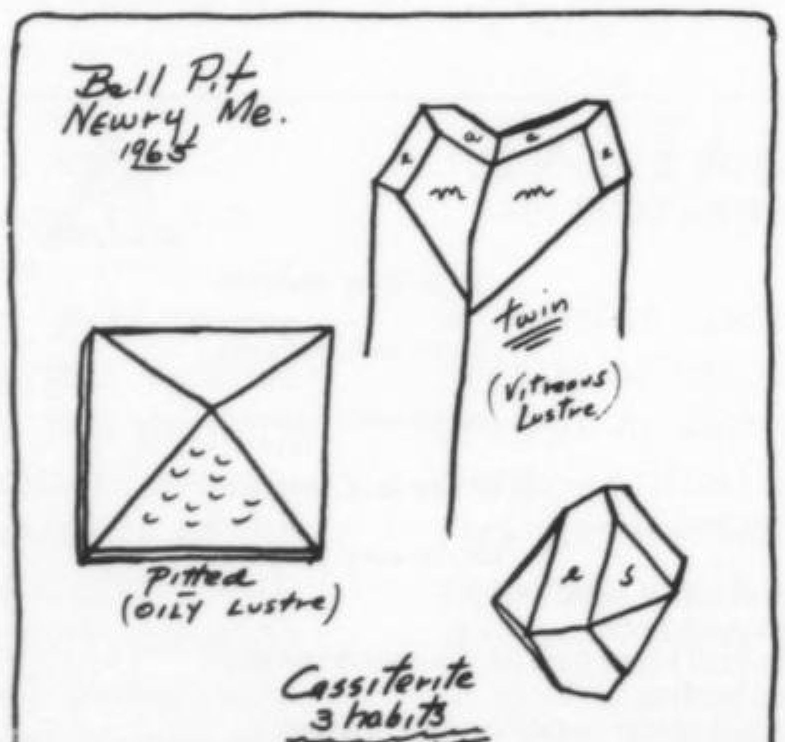


FIG. 3.

10. Arsenopyrite. No visual evidence of this sulfarsenide of iron. However, when a large fragment of the Newry rock was being sawed with a diamond blade to free a fragile crystal, the typical arsenic odor prevailed.

11. Unknown (to us, at all events). Clear, colorless rhombohedra, in an open seam, with minute pale lavender apatite. Not a carbonate. No discernable cleavage. Hackly fracture. Hardness about that of a knife blade, 5-5 1/2. Looks like whitlockite, which is reported on King's list mentioned above. Goyazite, too, comes to mind, as there seem to be striations on the rhomb face, parallel to (0001), the basal pinacoid. But goyazite is a bit softer, and has a good cleavage. This material differs. We'll find out and advise later.

Wait, wait. We've seen this stuff before. Yes, old files show that the Cliff Grays of Old Town, Maine, sent us some from the Bell mine at Newry, in 1968. We then thought it to be whitlockite, but did nothing about it. The Grays had sent some to California, to the Bureau of Mines, thinking the material might be woodhouseite, quite similar in appearance and occurrence. It was determined to be a hydrated phosphate and sulfate of aluminum and calcium, but no name was forthcoming.

Going through some 1970 acquisitions we came upon a couple of rare ones, acquired in February, 1970. Our label says "col. pers. 2/70," which means we were there, in person, using a hammer and chisel. The minerals were ferrierite and clinoptilolite, from Agoura, California, no mean species to pick up on a casual visit.

At the end of the Pacific Micromount conclave Mike and Aileen Kokonos suggested we come along and visit with them at Santa Barbara. Query by Mike—"How'd you like to collect a couple of fine ones, not more than 50 yards from the Highway?" And from Aileen—"You don't need more than a light hammer, and you can get a sackful!"

We acquiesced, and drove northerly, along Cornell Road, and stopped at the quarry, some 6 miles southwest of Agoura, in west Los Angeles County, where, in addition to a large quantity of loose rock lying about, several large boulders invited examination. (See *Amer. Mineral.*, **54,** p. 887, 1969 for a report on this locality. Mike Kokinos is one of the authors.) The boulders were a brecciated porphyritic andesite, lined with seams and cavities, in which occurred clusters of clear clinoptilolite crystals, intergrown with white tufts of needles of ferrierite.

The clinoptilolite very easily can be mistaken for heulandite. Save for the fact that we noted a complete vitreous lustre on the Agoura material, and that most heulandite has a pearly lustre on the (010) face, visual identification is one we'd rather not do. The chemistry and structure of the minerals are discussed in full in the article cited above. Fig. 4 herewith shows a rough line drawing of the ideal crystal, taken from the article. Through the 'scope at 32X we sketched a compound crystal on one of our mounts (Fig. 4).

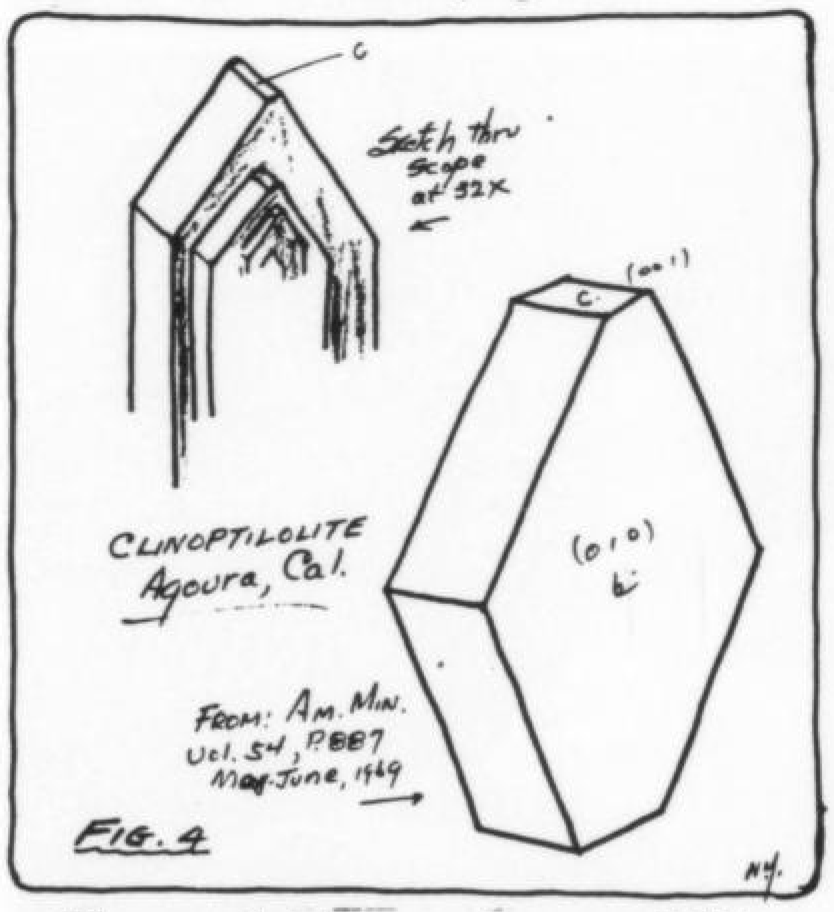
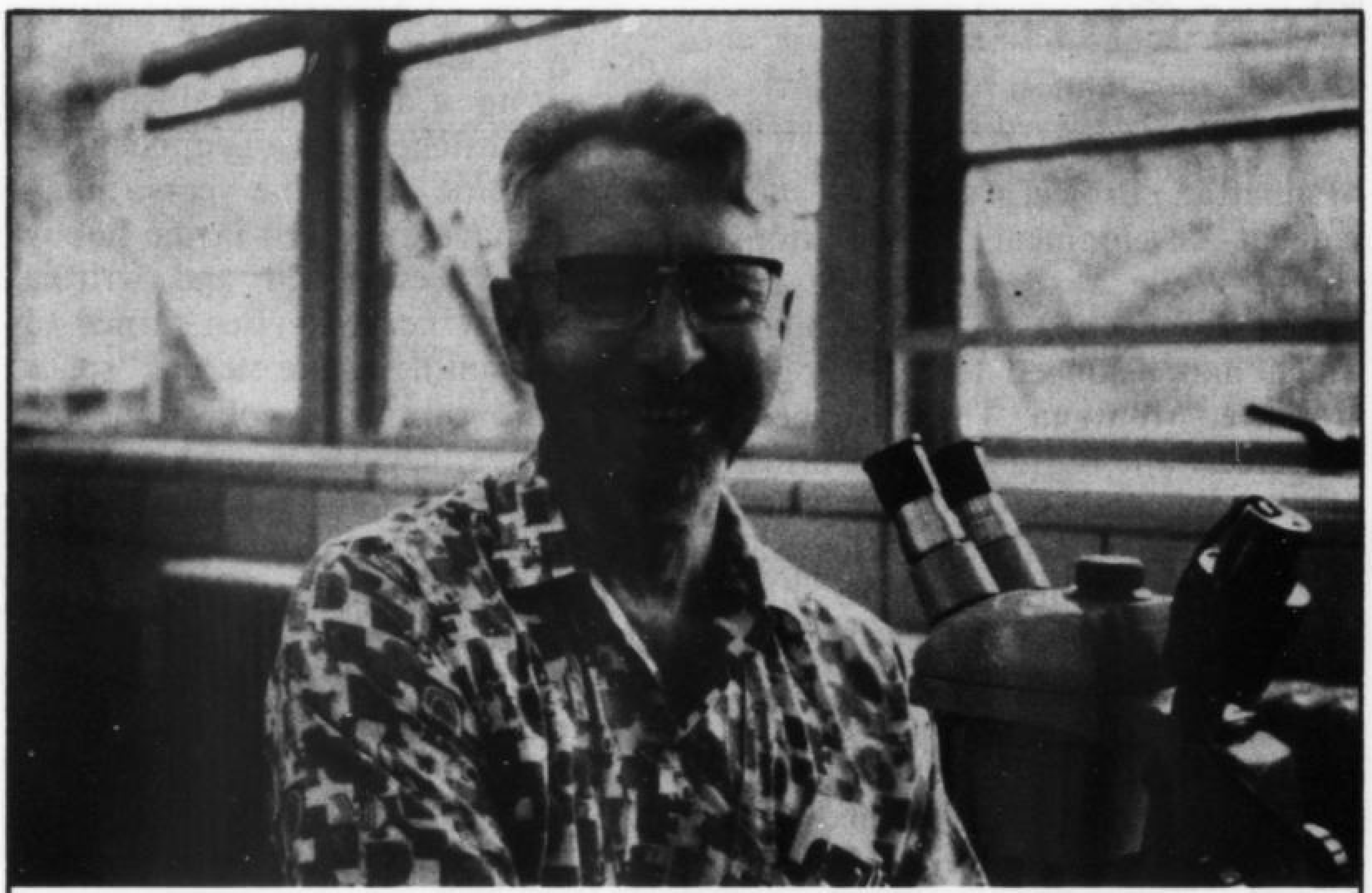


FIG. 4

The availability and accessibility of this material, and the ease with which the boulders can be picked apart, as well as the plethora of loose rock already broken to workable size make this a priority spot for any m/m collector in the area. For those who cannot "col. pers.," why not write Mike and Aileen Kokinos, 3791 Pescadero Drive, Santa Barbara, California 93105, who are advanced collectors advertising "Have 2 rare zeolites. Will trade."

Buy and use a good mineral book.

Neal Yedlin, The Micromounter □



Ben Chromy

by Dona Lee Leicht

As interesting and varied as the mineral world is, so it is with mineral collectors. In an oversimplification, we might suggest that the introduction of the quartz crystal for frequency control in ham radios steered a young high school student toward a life with mineralogical interests.

Ben Chromy, now a sprite 66 years, had the usual brief childhood exposure to minerals we all experienced, understandably in his case, since he lived near the glacial moraines in Minnesota as a young boy. His high school years were spent in Hopkins, Minnesota and his keen interest in chemistry at that time formulated a natural background for an interest in minerals. Ben was an enthusiastic and capable ham radio operator—hence the reference to the quartz crystal oscillator. He vividly recalls the thrill of "being there" at the beginnings of this early use of natural crystals for electronic purposes.

After high school, Ben went on to study electrical engineering in Milwaukee. A job with the U.S. Patent Office led him to Washington, D.C. in 1927. A doctorate in law was earned at night school and very soon Ben joined a Washington law firm. Eventually he established his own practice.

It would seem that such a busy schedule would hardly leave time for anything else, but that same magnetism of the Smithsonian's mineral collection which draws us today also drew Ben Chromy for frequent visits in those days. His interest in crystallography was further expanded when his firm began work on patents for quartz crystals. Naturally, he became an active participant in the Mineralogical Society of the District of Columbia in 1942.

The war years found him at the University of California in Berkeley working on the now-historical

(continued on page 116)

Ben Chromy

(continued from page 115)

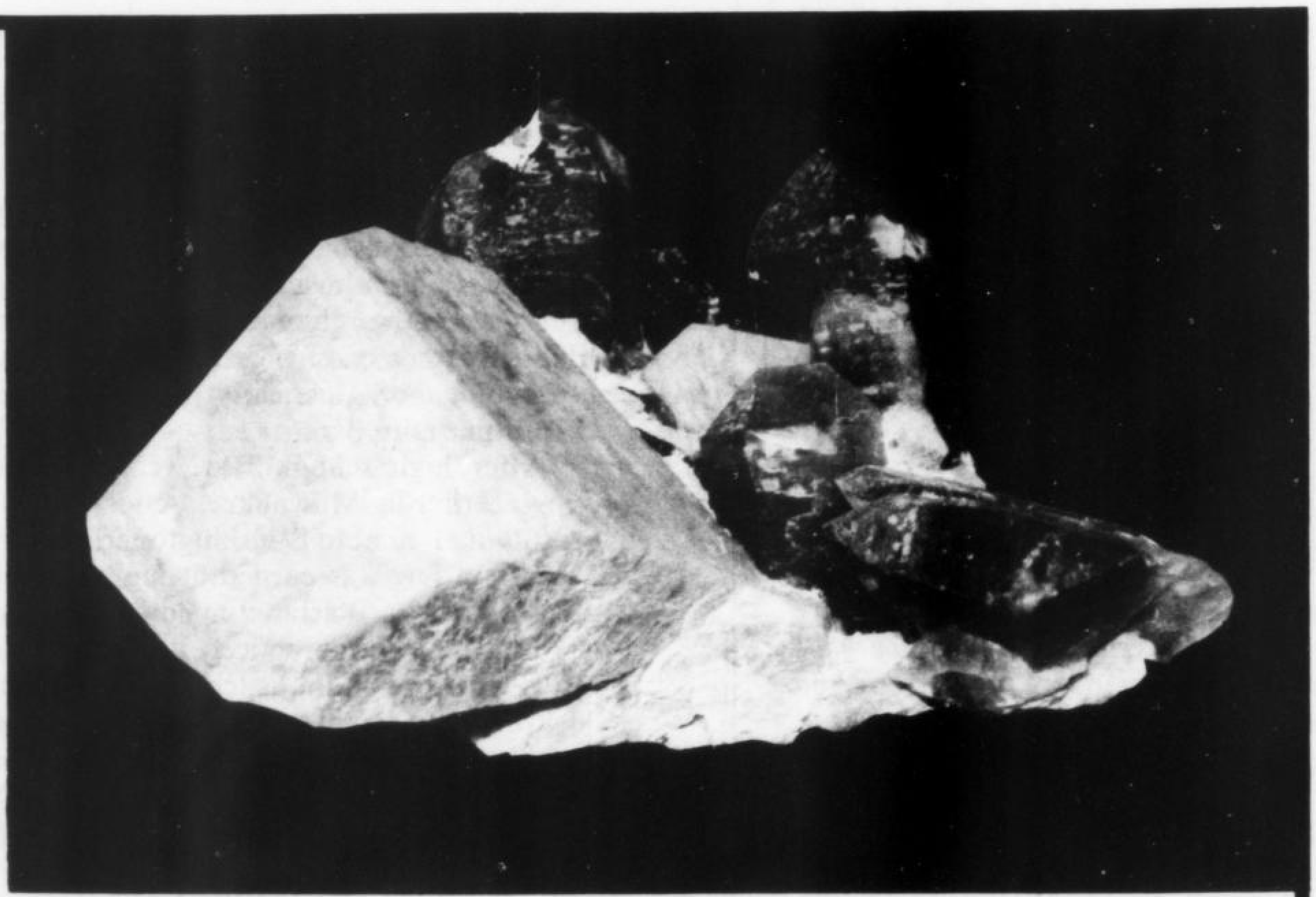
Manhattan Project, and the subsequent development of the atom bomb. While at Berkeley Ben acquired a collection of micromounts which had belonged to a geologist at Butte, Montana. They had been collected while Butte was in its prime as a gold and silver camp, and Montana still a territory. This was the initial exposure to micro mineralogy which geared Ben for the future.

After the war, it was back to Washington and to a resumption of his former activities. With his close friend, Harry Woodruff, plans were formulated for the organization of the Eastern Federation of Mineralogical Societies, of which Ben was the first secretary. He also served as its president in 1954. A position with a large textile firm soon found him traveling through textile country in the southern states. It was an ideal area for adding to his mineral collection.

On one of his collecting trips to nearby Centreville, Virginia Ben turned up a new mineral for the quarry-wittichenite, a copper bismuth sulfide. Over the years, many articles have appeared in the hobby magazines researched and written by Ben. By necessity Ben turned to micromounting as the eternal "space problem" of macro collections became pressing. He now has more than 3,000 exquisite micromounts in his collection. Now residing in Saratoga, California, Ben has been an active member of the Santa Clara Valley Mineral Society since coming West in 1956. Currently he writes a micromounting column for *Earth Science Magazine,* and has been a judge for the California Federation for many years.

One of the delights of the Christmas season for Ben's friends is to find one of his superb micromount photographs in the mail as a special holiday greeting. This interest in photography is a lingering one. His first camera was a homemade plywood box 5 feet in length with a mounted lens on a folding camera on the front end, and film holder at the back end. Some of his prize photos were taken with this apparatus and, in fact, gained him a silver medal for photography from The National Speleological Society. He has also won many awards with his micromount collection and is eagerly sought as a special exhibitor. He usually incorporates many of his excellent photographs in his display. Ben joined with Charles and Juanita Curtis, of Long Beach, California, in placing an educational micromount exhibit in the Los Angeles County Museum. It has been on display there for two years.

In talking with those who have known Ben for many years, the one most mentioned fact is that he is unselfishly eager and willing to spend time with any novice interested in minerals. He gladly dispenses mineral knowledge without thought of personal gain. Enthusiasm, generosity and a great respect for natural beauty would be the main ingredients to use in producing another Ben Chromy. □



CORNETITE

From Saginaw Hill, Arizona

BaSaw Khin

The mineral cornetite, $Cu_3(PO_4)(OH)_3$, was recognized for the first time at Saginaw Hill by S. A. Williams in June, 1968. Saginaw Hill lies about seven miles southwest of Tucson, Arizona, and can be readily located on the San Xavier Mission fifteen minute quadrangle sheet. The cornetite occurs on the southern side of the hill in a copper prospect which follows a fracture zone that trends approximately northeast.

Occurrence

The few known occurrences of cornetite are: the L'Etoile du Congo mine in Katanga which is the type locality; Bwana M'kubwa in northern Rhodesia; and the Empire-Nevada and Blue Jay mines of Yerington, Nevada (Palache, et al.). It has also been reported from the Kalabi mine, Katanga (R. A. Bideaux, personal communication). At Saginaw Hill, cornetite occurs in association with other oxide zone minerals including brochantite, pseudomalachite, malachite, atacamite and chrysocolla. The cornetite, in well-crystallized but fine-grained soft clusters, plasters the fracture walls of quartz or chert gangue. There are two distinct modes of occurrence: as clear, light peacock-blue, well developed, soft crystal aggregates, and as darker, deep blue or deep greenish blue, harder, crystalline clots which frequently alter to pseudomalachite.

Libethenite and pseudomalachite are the minerals most closely associated with cornetite. Libethenite may occur as pale green, greasy masses surrounding cornetite crystals and sometimes giving the impression of forming from the partially corroded, fairly large cornetite crystalline masses. In very few cases, the libethenite may be found as clusters of yellowish green prismatic crystals.

The fracture zone along which the copper minerals are noted contains fragments of Cretaceous arkosic sediments, granodiorite porphyry, and vein quartz. There has been mild, low-temperature, hydrothermal alteration which is seen in the fracture zone mainly as silicification.

Supergene chalcocite and covellite are common and, very rarely, unreplaced chalcopyrite may be noted as minute specks. In the oxide zone, brochantite forms first, followed by cornetite and contemporaneous libethenite. Pseudomalachite replaces both cornetite and libethenite. Malachite precedes atacamite and chrysocolla, the last minerals to form in the association.

Morphology

The cornetite crystals are usually between .05 and .20 mm in size. Most of the larger crystals are anhedral or subhedral and occur as partially corroded masses. Measurable crystals are usually smaller, about .10 mm across. They are invariably short prismatic or equant in habit.

The forms obtained by measuring two crystals on a Stoe two-circle goniometer are: *M* {021}, *r* {221}, *v* {121}, *n* {102} and *b* {010}. None of these are new. The form {210} reported by Berry (1946) was not seen in the crystals measured. A cornetite crystal is shown in Fig. 1.

The orientation of Berry (1946) is retained here because $c < a < b$. There have been three other orientations and their transformations to Berry's setting are as follows: Hutchinson and MacGregor (1913) to Berry, 200/010/00 1/2; Cesaro (*in* Hutchinson and MacGregor, 1921) to Berry, 002/200/010; and Ungemach (1928-29) to Berry, 001/200/010.

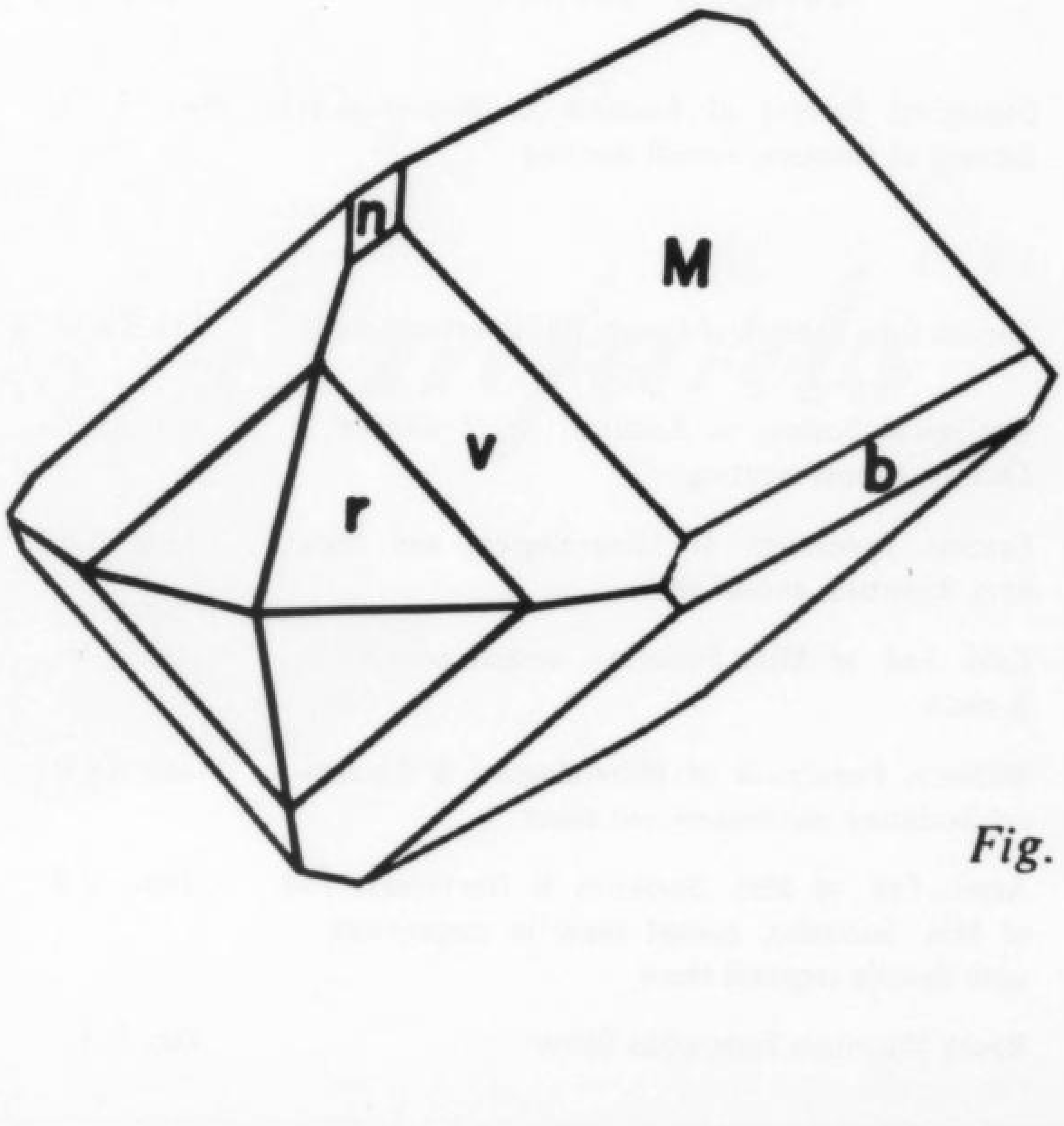


Fig. 1

X-Ray Studies

X-ray studies consist of rotation patterns taken on two axes, *O*-level Weissenberg photographs on a^* and b^*, and upper level Weissenberg photographs obtained on a^*. The point group of the mineral is mmm and the space group, *Pbca*. Cell data from various methods are shown below.

Cell Constants for Cornetite

	Morphological	*Rotation*	*Weissenberg*
a:*b*:*c*	.752:1:.508	.774:1:n.d.†	.775:1:.504
a (Å)		10.898 ± .004	10.931 ± .009
b (Å)		14.089 ± .039	14.101 ± .005
c (Å)			7.107 ± .002

†Rotation pattern on c^* was not taken

Optical Properties

The mineral is light blue to dark blue in transmitted light and is nonpleochroic. The optic orientation of $X = c$, $Y = a$, and $Z = b$ differs from Berry's $X = b$, $Y = a$, and $Z = c$. All the crystals examined are biaxial (-) with a slight variation in isogyre spacings. Dispersion is noticeable, $\nu < \rho$. The refractive indices are as follows:

Refractive Indices of Cornetite for Various Wavelengths

	F	*E*	*D*	*C*
α	1.781	1.767	1.744	1.721
β	1.800	1.787	1.767	1.743
γ	1.871	1.858	1.836	1.814
$\gamma - \alpha$	.090	.091	.092	.093
$2V$ (calc)	56°27′	57°43′	61°55′	60°09′

Values of the refringence have been corrected for dn/dt and with the exception of the β-index, which may vary as much as ± .010, the rest are within ± .0005.

Acknowledgements

Grateful acknowledgements are due to Sidney A. Williams for his initiation, guidance and encouragement of this work, and finally reviewing the manuscript.

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BaSaw Khin earned the B.S. in geology at Rangoon University, Burma and the M.S. in geology at the University of Minnesota. For ten years he worked for the Burmese government as exploration geologist and petrographer. He is now with Phelps-Dodge Western Exploration, since 1968, as a petrographer. □

meetings & shows

WHO & WHAT	WHEN	WHERE	CONTACT
Geological Society of America & Mineralogical Society of America, annual meeting	**Nov. 11-13**	Milwaukee, Wisc.	**GSA Headquarters,** Box 1719, Boulder, Colo. 80302
1971			
Tucson Gem & Mineral Society, 17th annual show	**Feb. 12-14**	Fairgrounds, Tucson, Arizona	**Show Chairman,** P.O. Box 6363, Tucson, Arizona 85716
Geological Society of America, *North Central Section,* annual meeting	**Apr. 29-May 1**	Lincoln, Nebraska	**W. J. Wayne,** Dept. of Geology, Univ. of Nebraska, Lincoln, 65808
Eastern Federation of Mineralogical and Lapidary Societies, annual show	**June 11-13**	Olympic Arena, Lake Placid, N.Y.	**M. F. Witherell,** Bristol, Vermont 05443
Calif. Fed. of Min. Societies, annual convention & show	**July 2-4**	Ventura Fairgrounds, Ventura, Calif.	**Bruno Benson,** 207 S. Pueblo, Ojai, Calif. 93023
Midwest Federation of Mineralogical & Geological Societies, convention and show	**July 22-25**	Richland Co. Fairgrounds, Mansfield, Ohio	**B. F. Parr,** 1488 Marion Ave. Rd., Mansfield, Ohio 44906
Amer. Fed. of Min. Societies & Northwest Fed. of Min. Societies, annual show in conjunction with Seattle regional show	**Sept. 3-6**	Seattle Coliseum, Seattle, Wash.	**Ed Messerly,** 3017 N.E. 97th., Seattle, Wash. 98115
Rocky Mountain Federation Show	**Oct. 1-3**	Topeka, Kansas	**R. C. Roderick,** 2106 East 6th., Topeka, Kansas 66607

What's new

(continued from page 101)

mids modified by a very minor prism and a steeper pyramid. They are sharp and lustrous, their color a pale greyish-mauve. Loose complete crystals and crystals in matrix were found up to more than 3 cm on an edge, averaging about 1-1/2 to 2 cm. The matrix in which they occur is interesting, consisting of partially altered, massive, white microcline, green riebeckite in jackstraw bundles of lustrous crystals and mustard-yellow pseudomorphs of anatase (xanthitane) after titanite (?). The latter are unusual in that the original crystals, if titanite, were of an atypical habit. They were very long and narrow bladed crystals arranged in parallel or slightly divergent clusters. Those from the more famous locality for titanite pseudomorphs, in Henderson County, North Carolina, are single, wedge-shaped crystals which closely resemble most titanite in habit. The feldspar is so crumbly that keeping matrix specimens together is a problem. The zircons tend to separate readily from the matrix with very clean faces. These are truly superb specimens but the supply at the source reportedly is depleted.

The second find is not far away in North Carolina. The locality is given as about 3 miles east of Boiling Springs, Cleveland County. It is only one of many remarkable rutile localities in North Carolina. Here rutile is found in two distinctly different habits. That which is nestled among dark-green tabular muscovite crystals occurs in randomly divergent bundles of acicular crystals which are deep red where thick but yellow-orange at the tips. The others are classically reticulated and are found on limonite pseudomorphs after siderite. In both types individual crystals, or crystal clusters, more than 3 cm are found. Large specimens containing abundant rutile have been mined in quantity. Many of the limonite pseudomorphs are good specimens in themselves as the rhombohedral form of the siderite is sharply defined and the original crystals were rather large. The muscovite too is good in its own right being well crystallized and attractively colored. Although this occurrence is also supposed to be mined out, many specimens were recovered and should be available from mineral dealers for quite a long time.

The following note was received from Gary Hansen describing pseudomorphs of arsenopyrite after pyrrhotite: "The minerals were discovered by a group of professional mineralogists three days before the mine was shut down due to lack of production by the Homestake Mine Corporation and the mine was subsequently flooded. The Double Rainbow mine was discovered in 1876 and worked into the 1890's. The mine is in the Lower Deadwood formation, Cambrian age. Most of the early mining was in the oxidized ore body, in the upper contact of the Deadwood. Principally a lead deposit, pyromorphite was found in abundance.

At a depth of 200 ft. the lower contact vein was worked in 1966.

(continued on page 124)

IMA MEETING

(Continued from page 87)

the hope that the first issue would soon appear.

An interesting discussion was held about type specimens of mineral species, including possible rules for the preservation of type specimens, how to make them available for investigation by other scientists, and the feasibility of preparing a catalog of type specimens presently preserved in major collections throughout the world. It was voted to ask the Commission on New Minerals and Mineral Names to cooperate in persuading authors describing new minerals to give information on where the type is preserved and the exact nature of their samples. This request was later considered and approved by the New Minerals and Mineral Names Commission.

The Tokyo meeting of the Commission on New Minerals and Mineral Names was chaired by Dr. Michael Fleischer of the United States. Representatives from 13 of the 27 member countries were present. This Commission, by vote of its members, passes on proposed new mineral species before publication. In discussion it developed that many members felt that the Commission had been too lenient about passing new minerals, and it was voted that if a new mineral is approved by more than 50% but less than two-thirds of those voting, the chairman will summarize the objections, ask the author to reply, and a new vote will be held. If more than 50% vote yes on the second vote the mineral is approved. This new voting procedure will replace the simple majority vote previously used.

The Commission has undertaken the very difficult task of trying to clarify and systematize the nomenclature in some major mineral groups. Some time ago subcommittees were appointed on nomenclature of the pyrochlore and amphibole groups, and these reports are expected soon. It was voted to establish new subcommittees to deal with the problems of nomenclature in the pyroxene and mica groups.

A wide choice in field excursions was offered, both before and after the meeting. With typical thoroughness the local committee had planned the excursions to the last detail, and the two that I attended were extremely interesting and enjoyable.

Before the meeting I went on the excursion to the northern end of the main island of Honshu. The northernmost part of Honshu is characterized by an extraordinary combination of Quaternary volcanoes and Miocene mineral deposits, especially the Kuroko (black ore) deposits, valuable high grade deposits of copper, lead, and zinc. The three day trip took us to the Kosaka, Shakanai and Hanaoka mines, and to beautiful Towada National Park. In the park we examined Hakkoda Volcano and Lake Towada, a magnificent crater lake.

The excursion following the meeting took me to the southern end of the southern island of Kyushu. Here we visited the Kushikino and Kasuga gold mines, and had a detailed look at Sakura-jima Volcano. This volcano, rising spectacularly out of Kagoshima Bay to an elevation of 1,118 meters, is one of the most active in Japan, and is presently emitting ash and smoke. On the south flank of the volcano we collected at the type locality of the rare mineral osumilite.

Needless to say not all of our time in Japan was spent in scientific sessions and commission meetings. Our hosts provided a full round of social events, including receptions by the Science Council of Japan and the Governor of Tokyo, and a sumptuous banquet in Kyoto to close the meeting. Several free days allowed most of us to see EXPO '70 and at least a few of Japan's many historic and natural wonders.

The meeting was judged an unqualified success, thanks to the truly outstanding planning and execution by the local committee, chaired by Professor T. Watanabe. ☐

Some possible new MINERALS not yet found

by Michael Fleisher **U.S. Geological Survey**

This note was prompted by the suggestion of Griffitts (1967) that a mineral of composition $BaBeF_4$ might be found in certain geological environments. I have for a long time kept a list of possible new minerals (which had not included $BaBeF_4$), and it may be of interest to outline the basis on which the list has been drawn and to give a few examples of the dozens of possible minerals.

Such lists may be prepared in several ways. For example, one can list compounds that have been prepared in the laboratory that might be reasonably expected to be found in Nature, but have not yet been reported. Alternatively, one can simply go through lists of minerals (Dana's System, Hey, Strunz) and write simple substitutions of one element by another of similar ionic radius. Typical examples are listed in Table 1, along with some recently described minerals that show the same substitution; obviously the list could easily be expanded to hundreds of compounds. Furthermore, only a single example (the last entry in Table 1) has been given of double replacements, so commonly found in complex silicates and oxides, as for example the replacement of $2Fe^{+3}$ by $(Mg, Fe)^{+2} + Ti^{+4}$, recently reported in the oxide armalcolite (pseudobrookite) and the borate azoproite (ludwigite group).

It is evident that the degree of probability in finding such compounds differs greatly, even for the few examples listed, and that it is influenced by several major factors. It is necessary to consider, as was done by Griffitts, the effects in different geological environments of availability of the elements (especially for such rare elements as Ge or Tl), competition for these elements by other possible compounds, the relative solubilities of these compounds, and crystal structure. The last will not be discussed further, but is doubtless important in explaining, for example, the small number of silicates with Fe^{+3} replacing Si in tetrahedral coordination (but note cronstedtite), and probably in explaining the absence of a magnesium analogue of staurolite.

As an illustration, a look at the well-known groups aragonite-strontianite-witherite-cerussite, and anhydrite-celestite-barite-anglesite immediately suggests that one might reasonably expect to find the series:

fluorite - SrF_2 - BaF_2 - perhaps PbF_2 and
perovskite - $SrTiO_3$ - $BaTiO_3$.*

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*Publication authorized by the Director, U.S. Geological Survey

*$PbTiO_3$ has recently been found as a mineral (unpublished data by two laboratories submitted to the International Mineralogical Association Commission.)

Table 1

Examples of Possible Minerals Analogous to Some Known Ones

Substitution Involved	Examples of possible minerals (in parentheses the known analogue)		Recently described minerals involving the same substitution	
Al-Fe	$BaAlSi_4O_{10}$	(gillespite)		
	$NiAl_2O_4$	(trevorite)		
B-Al	Many		reedmergnerite	(albite)
Cr-Al (Fe)	many, for example-		eskolaite	(corundum)
	Cr_2SiO_5 (kyanite, sillimanite, andalusite) or the Cr-analogue of tourmaline.		ureyite	(jadeite)
			knorringite	(pyrope)
Cu - Zn	$PbCuSiO_4$	(larsenite)		
Cu-Ag	CuBr	(bromargyrite)		
Fe-Al	$FeBO_3$	(jeremejevite)	julgoldite	(pumpellyite)
	$LiFeSi_2O_6$	(spodumene)		
Fe-Mg	Fe analogues of humite group		amakinite	(brucite)
	$FeAlBO_4$	(sinhalite)	ferrohexahydrite	(hexahydrite)
Fe-Mn	many		pyroxferroite	(pyroxmangite)
Ge-Si	GeO_2	(quartz)		
Ge-Sn	GeO_2	(cassiterite)		
Mg-Fe	many; Mg-analogue of staurolite			
Mn-Fe	many		manganbabingtonite	(babingtonite)
			kupletskite	(astrophyllite)
NH_4-K	$(NH_4) BF_4$	(avogadrite)	buddingtonite	(sanidine)
Ni-Mg	many, especially silicates		gaspeite	(magnesite)
			nimite	(chlorite)
			pecoraite	(clinochrysotile)
			willemseite	(talc)
Sb-Bi	SbOC1	(bismoclite)	tintinaite	(kobellite)
	SbOF	(zavaritskite)		
Se-S	many, for example-			
	$CuFeSe_2$	(chalcopyrite)	kullerudite	(marcasite)
	Cu_5FeSe_4	(bornite)	trüstedtite	(polydymite)
	Sb_2Se_3	(stibnite)		
	$MoSe_2$	(molybdenite)		
Sn-Ti	SnO_2	(anatase)	malayaite	(sphene)
	SnO_2	(brookite)	pabstite	(benitoite)
Sr-Ca	$Sr_2B_6O_{11} \cdot 5H_2O$	(colemanite)		
	$NaSrB_5O_9 \cdot 8H_2O$	(ulexite)		
Sr-Ba	$Sr(NO_3)_2$	(nitrobarite)	barytolamprophyllite	
Ti-Sn	$CaTiSi_3O_9 \cdot 2H_2O$	(stokesite)		
	$CaTiB_2O_6$	(nordenskioldine)		
Ti-Zr	$K_2TiSi_6O_{15}$	(dalyite)		
Tl-Ag	TlCl	(chlorargyrite)		
	TlBr	(bromargyrite)		
	TlI	(iodargyrite)		
V-Al(Fe)	many,	(V-analogues of tourmaline, jadeite, etc.)	karelianite	(corundum)
			goldmanite	(grossular)
			mukhinite	(clinozoisite)
Zn-Cu	$ZnSiO_2(OH)_2$	(dioptase)		
	$Zn_5(SiO_3)_4(OH)_2$	(shattuckite)		
Zn-Fe	Zn-analogue of staurolite			
$(A.O_4)$-(PO_4)	many		chernovite	(xenotime)
$VO_4)$-(PO_4)	many		wakefieldite	(xenotime)
NaNb-CaTi	$NaNbSiO_5$	(sphene)		

An examination of the data on the fluorides (Table 2) gives indications as to why the fluorides of strontium and barium have not yet been reported.

Comparison of the solubilities of the fluorides and sulfates shows that except for CaF_2 the corresponding sulfates are so much less soluble that one can say the fluorides are unlikely to be found in an environment where sulfate is present. Very likely the presence of phosphate and carbonate would also decrease the likelihood of the formation of the fluorides. Furthermore, there seems to be a strong tendency towards the formation of fluoaluminates of strontium and barium (for example, jarlite, stenonite, tikhonenkovite, usovite), further decreasing the likelihood of finding SrF_2 or BaF_2, and the low solubility of $PbFC1$ (matlockite) decreases the likelihood of the formation of PbF_2 in the presence of chloride.

Nevertheless, it would seem quite possible that SrF_2 exists as a mineral, but has been overlooked because its index of refraction is so close to that of fluorite. The industrious person who makes heavy concentrates of a few thousand fluorite samples just might be rewarded by finding SrF_2!

Solubility is, of course, only one of many determinative factors. The very insoluble compounds titanium phosphate and zirconium phosphate have not yet been found, whereas the extremely soluble $CaCl_2 \cdot 6H_2O$ (antarcticite) occurs in two unusual environments (the Antarctic and a desert), and the soluble compound NaF (villiaumite) is not uncommon in certain alkalic rocks.

The diversity of possible natural environments and the remarkable natural concentrations of many elements, the latter well exemplified by the discovery of five indium minerals during the past ten years, make the prediction of new minerals a hazardous hobby for anyone who doesn't like to be wrong. Who would have predicted the rare earth borate braitschite, found in marine evaporites, in the face of the evidence of very low concentrations of the rare-earths in sea water? Nevertheless, such predictions are instructive and fun to try!

References

Griffitts, W. R. (1967) $BaBeF_4$, a possible undiscovered mineral: *Amer. Mineralogist*, **52,** 1542-1544.

Winchell, A. N. and Winchell, Horace (1964), The microscopical characters of artificial inorganic solid substances: Optical properties of artificial minerals: Academic Press, New York and London, 439 pp.

Michael Fleischer has had a distinguished career in mineralogy. After receiving his doctorate at Yale University he was assistant to W. E. Ford in revising Dana's System. He was a physical chemist at the Geophysical Laboratory from 1936-1938 and has been a chemist with the U.S. Geological Survey since 1939. He has served as president of the Mineralogical Society of America (1952), the Geochemical Society (1964) and the Geological Society of Washington (1967). He has also been chairman of the Commission on New Minerals and Mineral Names, I.M.A. since 1959. □

Table 2.

Some Properties of CaF_2, SrF_2, BaF_2, PbF_2 and Some Possible Competing Compounds

	Symmetry	*n* (1)	G (1)	Solubility in water at 25° g/l
Fluorite (CaF_2)	Cubic	1.434	3.18	0.018
SrF_2	Cubic	1.438-1.442	4.24	0.39
BaF_2	Cubic	1.471-1.475	4.89	1.614
PbF_2 (>200°)	Cubic	—	7.66-8.24	—
PbF_2 (<200°)	Orth.	—	8.37	0.66
$PbFC1$	Tetrag.	—	—	0.37
$CaSO_4$	Orth.	—	—	2.080
$SrSO_4$	Orth.	—	—	0.13
$BaSO_4$	Orth.	—	—	0.003
$PbSO_4$	Orth.	—	—	0.045

(1) Winchell and Winchell (1964)

Q/A column

I recently purchased a small collection of minerals in which were two amethyst geode sections—one labelled merely Uruguay and the other Brazil. These casual localities disturbed me and when I inquired of a dealer how he determined the differences he said that the material from the Brazil area was in smaller crystals, and has a red-purple cast, and has a much thinner agate matrix. He was not able to give exact localities. Can you help to clear this up?

Martha (Mrs. George) Gordon, New York

The amethyst with agate from Uruguay-Brazil occurs in volcanic rocks which cover a broad area in Uruguay and Rio Grande do Sul, Brazil. As far as we know there is no way to distinguish between the amethyst from either side of the border and the problem is compounded because of much indiscriminate use of these names.

In your column "What's New In Minerals" (vol. 1, no. 2) you mentioned the pyrite crystals from Spain available at the National Show. I happened to buy several, but there is a discrepancy between your spelling of the location and the dealer's, which is Ambas Aguas Province Logrono. Which is correct, his or yours? I don't want to be caught in a competitive show with a wrong label as every point counts. I would appreciate your advice.

Trudy Houser, Cincinnati, Ohio

According to the Spanish Embassy, Ambassaguas, as it appears in the *Record* is correct.

In the Q/A Column of the last issue (vol. 1, no. 2, summer) we answered a *posed* question about the locality for the transparent quartz crystals with deep to pale amethyst tips. As a consequence, additional information has been supplied enabling us to refine the details of the locality. Originally given as Vera Cruz, Vera Cruz, Mexico, the locality should instead be *near* Las Vigas, Veracruz, Mexico. In order to minimize confusion it should be pointed out that much amethyst from another Mexican locality, Amatitlan, near Mexcala, Guerrero, has been sold by mineral dealers in recent years. This is quite different from Las Vigas amethyst. It consists of cloudy crystals with amethyst cores, the outer zones and tips of which are either colorless or white. The crystals tend to be large, up to more than a foot in length, and are usually grouped in divergent clusters.

What's New

(Continued from page 119)

During 1967-68, the first pseudomorphs were discovered. At that time no quantity was found and it wasn't until this year that a major crystallized vein was discovered. The hexagonal pseudomorphs were 1/8 to 1-1/2 in. across and up to 3/8 in. thick. Most of the specimens were under 3x3 in. but several fine museum specimens were collected.

Superb micromount-size polybasite (to 5 mm), argentite and wire silver were found along with fine, bright pseudocubic galena with marmatite and siderite crystals up to 1-1/2 in. across. Also abundant in the ore is argentian tetrahedrite."

MINERAL NOTES
NEW MINERALS

WELOGANITE
Ann P. Sabina, J. L. Jambor and A. G. Plant
Can. Mineral., 9, 468-477, 1968

Weloganite, named in honor of Sir W. W. Logan (first director of the Geological Survey of Canada, 1842-1869), occurs in an alkalic sill at St. Michel, Montreal Island, Quebec. Crystals are roughly hexagonal in outline, and oscillatory growth {001} produces striations and grooves, parallel to the base, on prism faces. Terminations are pyramidal (either pointed or ending in a pedial face) and weloganite crystals range in size from 3 cm down to 2 mm parallel to the elongation. Their color is lemon-yellow to amber, and basal sections are often zoned (white to yellow). The mineral exhibits perfect basal cleavage, vitreous luster, white streak, conchoidal fracture with a hardness of 3-1/2. Weloganite twins on {001} forming prominent reentrants.

Chemical analysis yields the empirical formula $Sr_5Zr_2C_{9.3}H_{9.3}O_{32.2}$ or, ideally, $Sr_2Zr_2C_9H_8O_{31}$. Infrared spectroscopy and thermogravimetry suggest that Co_2 and water are complexly bound to zirconium.

Associated with weloganite are euhedral calcite, quartz and dawsonite, and also hydrous barium-aluminum-carbonate. Additional species found with weloganite include plagioclase, siderite, dolomite, strontianite, barite, celestite, fluorite (both black and colorless), cryolite, zircon, anatase, a new barium analog of dundasite, marcasite, pyrite, galena and sphalerite.

Trigonal—space group $P3_1$ or $P3_2$

a = 8.96, c = 18.06 A
G = 3.22; 3.260 (calc.) Z = 2
nα = 1.558 Biaxial (-)
nβ = 1.646 2V about 15°
nγ = 1.648

Strongest x-ray lines; 2.81(10), 4.35(9), 2.59(7), 2.227(7), 2.009(7)

JOESMITHITE
Paul B. Moore
Arkiv. Min. Geol. Stockholm, 4, 487-492, 1968

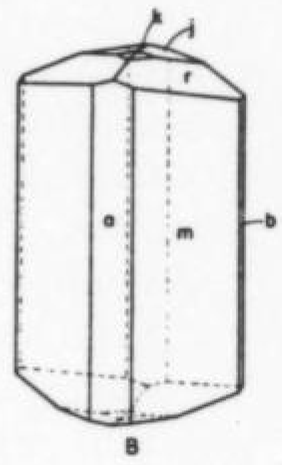
Joesmithite, formerly known as "Flink unknown No. 101" or "a mineral resembling pinakiolite" in the Swedish Natural History Museum's Langban collection, is similar to the amphiboles, and structure analysis suggests the formula $(Pb,Ca,Ba)_2Ca_4Fe_2(Mg,Fe)_8(Si_2O_6)_4[Si(O,OH)_4]_4(OH)_8$.

The mineral is the last to crystallize in a magnetite-hematite-schefferite skarn assemblage, lining cavities and entirely enclosed in younger calcite. It was collected in the Ramsorten drift, Langban, Sweden by C. Morton in 1922. The crystals attain lengths of 1 cm, are monoclinic prismatic (somewhat flattened), some fully terminated, and exhibit perfect {110} cleavage. They are lustrous black, resembling hornblende; the streak is pale brown and the hardness is 5-1/2.

The mineral is named in honor of Professor Joseph (Joe) V. Smith of the University of Chicago.

Monoclinic—space group *P*2/*a*

a = 9.88,
b = 17.87,
c = 5.227 A;
β = 105°40′
G = 3.83 Z = 2
nα = 1.747 Biaxial (+)
nβ = 1.765 2V large
nγ = 1.78



Strongest x-ray lines: 3.33(10), 2.564(6), 2.530(6), 2.740(5-1/2), 3.70(5)

Fig. 1. Joesmithite. Långban, Sweden. (A) Plan; (B) clinographic projection showing the forms *b* {010}, *a* {100}, *m* {110}, *r* {011}, *j* {$\bar{1}$12}, and *k* {$\bar{1}$13}.

KINOITE
John W. Anthony and Robert B. Langhon
Amer. Mineral., 55, 709-715, 1970

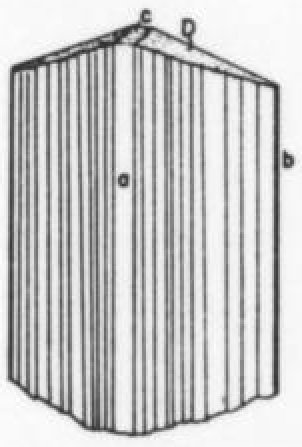
Kinoite, $Cu_2Ca_2Si_3O_{10} \cdot 2H_2O$, was found in core from surface drilling in the Santa Rita Mountains, Pima County, Arizona. It occurs in well-formed crystals and in veinlets about 1 mm thick in a diopside-garnet skarn. It is associated with abundant apophyllite while djurleite, bornite, chalcopyrite and copper are present in the skarn in lesser amounts. Kinoite and copper are contemporaneous with apophyllite and are interpreted as being of a later generation than the skarn but not formed under oxidizing conditions related to a supergene process.

The crystals are deep azure blue, transparent to translucent. Individuals up to 1 mm in length were reported but the average is less than 0.5 mm. Their morphology is dominated by {*hk*O} and they are tabular in the *b-c* plane. Terminal forms are poorly developed. It exhibits excellent {010} cleavage and distinct {100} and {001} cleavages. The hardness is about 5.

The mineral is named for Fr. Eusebio Francisco Kino (1645-1711), celebrated Jesuit pioneer of the southwestern United States.

Monoclinic—space group $P2_1/m$

a = 6.990,
b = 12.890,
c = 5.654;
β = 96°05′
G = 3.16; 3.193(calc.) Z = 2
nα = 1.638 Biaxial (-)
nβ = 1.665 2V = 68°
nγ = 1.676 $r < v$ distinct



Strongest x-ray lines: 4.72(10), 3.052(8), 6.441(7), 2.116(4), 3.138(3)

Fig. 1. Appearance of typical kinoite crystal.

SPECIMEN REQUESTS

The idea of providing assistance to professional mineralogists in their search for study specimens was that of Dr. William A. Henderson, Jr. We know first hand of the difficulty researchers have had, and are having, in obtaining suitable mineral specimens for their investigations. Many of these researchers are located at isolated institutions and they do not have extensive mineral collections at their disposal. Even the largest collections, however, frequently do not have the precise sort of material required.

Dr. Henderson suggested, and we find the idea exciting, that the *Mineralogical Record* publish legitimate research specimen requests. Any collector having such material may, if he cares to, send it directly to the requester. The exact nature of the material needed must be clearly specified, ***e.g.*** "100 mg of clean crystal fragments" or "any visible single crystal at least 1x1x1 mm showing some crystal faces". In order to avoid making this a cumbersome procedure, donors should not expect payment or specimens in return or send along lengthy letters requiring answers. If the researcher is able to obtain what he needs through this service, and he publishes a paper in which he refers to the sample, he will credit the donor with having supplied it. That should be reward enough. When we are informed of any successful bringing together of a researcher and suitable samples resulting from this column we will happily acknowledge the event. If the specimen supplied is one which the collector was obliged to buy, he should, of course, feel entirely justified in asking that he be reimbursed by the researcher if it is used. There are many non-destructive studies, however, where samples can be returned without having been consumed or damaged. If this is the kind of study envisioned, such information should be included in the request.

Dr. Henderson points out that he has plenty of material he would like to share but has no way of knowing who can use it. Just to start things off Dr. Stephen Spooner, at the Nuclear Research Center, Georgia Institute of Technology, Atlanta, 30332, is in need of large (at least 1x1x1 inch) single cleavages of siderite from Roxbury, Litchfield County, Connecticut. He wants this particular siderite because it has a very low manganese content. Do any of you New England collectors have specimens to send to him? As other requests come in we will list them regularly in this column. □

Collection

(continued from page 91)

collections of Bement and others. What above all marks this collection, and has made it so useful to us at Lafayette College, are the several hundred first-class specimens from well-documented Pennsylvania localities. A good many of these were possibly collected at the source by Joseph Leidy himself. Although primarily a paleontologist, he seems to have been sufficiently interested in securing fine minerals for his collection to have roamed the fields and quarries of Pennsylvania, also of adjacent states, in search of well-crystallized specimens. The resultant collection, despite some losses and considerable travelling, and thanks to the IMA-sponsored survey of American mineral collections, has now found an appreciative home at last. □

An Occurrence of Basaluminite In Maryland

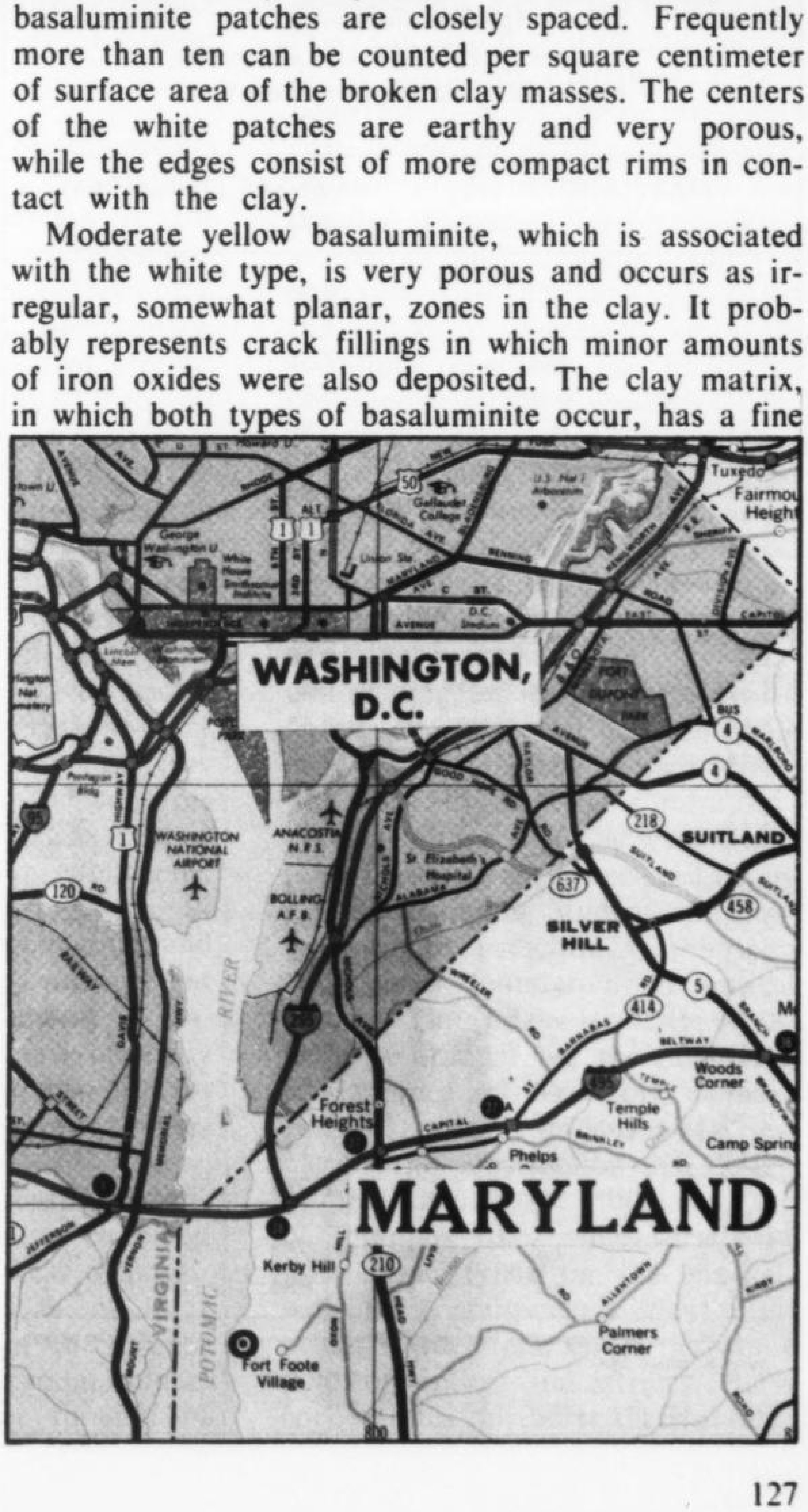
Richard S. Mitchell
University of Virginia

The relatively rare mineral basaluminite, $Al_4(OH)_{10}SO_4 \cdot 5H_2O$, has been identified in clay specimens from a gypsum crystal locality near Fort Foote, Maryland, just south of the District of Columbia boundary. The mineral came to my attention in 1962 while investigating the occurrence of jarosite in various gypsum localities of the Coastal Plain. Swift (1961), who described the occurrence of large gypsum crystals near Fort Foote, sent the representative materials. A study of these specimens failed to show jarosite, but did reveal the presence of basaluminite in light gray kaolinite masses associated with the gypsum. Although the locality has been covered as a result of building at the site, the rarity of the mineral warrants a note on its existence in the area.

From the standpoint of appearance basaluminite is not a spectacular mineral. It usually occurs as white to yellowish chalky masses. So far crystals of the mineral have only been observed in electron photomicrographs (Tien, 1968). They are thin rhomboid plates, about 2 microns across the long diagonal and about 0.05 micron thick. Measurements of angles by Tien (1968) suggest a symmetry other than hexagonal as originally postulated by Hollingworth and Bannister (1950). Since the original discovery of the mineral over twenty years ago, in specimens from England and France (Hollingworth and Bannister, 1948, 1950), basaluminite has been found in several places, especially in the United States. Occurrences have been reported in Russia (Fominykh, 1965; Srebrodolskiy, 1969), Tennessee (Milton *et al.*, 1955), Indiana (Sunderman and Beck, 1969), Utah (Frondel, 1968), Kansas (Tien, 1968), and Virginia (Dietrich, 1965, 1967).

The Maryland material occurs as small white subhedral patches (like phenocrysts) in brownish-gray clay masses, and as yellowish porous zones in the same rock. The subhedral earthy patches, which average about 3 mm across, resemble pseudomorphs after some former mineral (possibly hydrobasaluminite which easily dehydrates to basaluminite). The basaluminite patches are closely spaced. Frequently more than ten can be counted per square centimeter of surface area of the broken clay masses. The centers of the white patches are earthy and very porous, while the edges consist of more compact rims in contact with the clay.

Moderate yellow basaluminite, which is associated with the white type, is very porous and occurs as irregular, somewhat planar, zones in the clay. It probably represents crack fillings in which minor amounts of iron oxides were also deposited. The clay matrix, in which both types of basaluminite occur, has a fine



even texture and is light to medium brownish-gray. X-ray diffraction analyses of the clay show it is a mixture of well-crystallized kaolinite with minor quartz. Sand grains adhere to planar surfaces of some of the clay masses.

The basaluminite from Maryland was first identified by X-ray diffraction analysis. The x-ray data for all the material are essentially identical. Data for the white patchy material are compared with published data for specimens from Kansas in Table 1. A visual comparison of x-ray films with those of films made of a specimen from Newhaven, Sussex, England, further verified the identification. A semiquantitative spectrographic analysis showed aluminum to be the chief cation. Clay or quartz impurities were indicated by the presence of some silicon. Quartz impurity was also verified by x-ray diffraction studies.

Table 1.
X-ray Powder Diffraction Data for Basaluminite.
Cameras of 11.46 cm diameter, nickel-filtered copper radiation.

MARYLAND		KANSAS (Tien, 1968)	
d(Å)	I[a]	d(Å)	I
9.33	vs	9.30	vvsB
7.76	vvw	7.81	vw
7.35	mw	7.30	ms
6.82	mw	6.80	ms
5.91	m	5.90	s
5.31	mwB	5.30	ms
5.01	w	4.99	w
4.71	s	4.67	vs
4.56	w	—	—
4.44	w	—	—
—	—	4.13	vvw
3.89	w+	3.88	ms
3.69	m	—	—
3.64	mw	3.65	s
3.44	m-	3.43	s
3.23	vw	3.22	w
3.13	vvw	3.14	vvw
3.03	vvw	—	—
2.94	wB	2.94	m
2.83	w	2.83	m
2.73	mw	2.72	ms
2.67	vw	—	—
2.55	vvwB	2.55	vvw
2.46	wB	2.46	m
2.39	vvw	2.39	vvw
2.28	wB	2.28	ms
2.19	w+	2.177	s
2.07	vw	2.072	vw
2.04	vw+	2.036	w
1.96	vw	1.963	w
1.89	ms	1.886	s

[a] Scale of decreasing intensities from visual estimation: vvs, vs, s, ms, m, mw, w, vw, vvw; B (broad line).

Basaluminite heated in air at 185° C for one hour gave x-ray diffraction data identical to that of metabasaluminite, $Al_4(OH)_{10}SO_4$, a further verification of its identification. Similar results for heated basaluminite have been obtained by Hollingworth and Bannister (1950), Tien (1968), and Sunderman and Beck (1969).

The area from which the specimens were collected has been described by Swift (1961). It is along the Potomac River in Prince Georges County, Maryland, about a mile south of the District of Columbia line, and near the site of Fort Foote. The material was discovered where a road was being built for access to a housing development. The original collecting site was practically obliterated by the time Swift's (1961) paper appeared. Hundreds of gypsum crystals were collected at the site. Single crystals over 6 inches long and rosettes 4 inches in diameter were found. The gypsum was limited to a relatively small zone in variegated clays of the Patapsco formation (Lower Cretaceous).

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The Record Bookshelf

Origins of the Science of Crystals, by John G. Burke, Berkeley: Univ. of California Press, 1966, 198 pp. ($6.50)

Origins of the Science of Crystals is primarily a scholarly work. The attention Burke has paid to detail has not, however, been at the sacrifice of readability and entertaining style.

The book traces the history of theories of the solid state, from the Greeks to the advent of x-ray analysis at the beginning of this century. Special emphasis is given to the early ideas regarding description and classification of crystals, especially minerals. The writings of Werner, Haüy, de l'Isle, and others are exhaustively summarized. Of interest to the technically-oriented reader is the interplay of published theory and refutation which characterized 18th and 19th century science. Many early observations by such savants as Brewster, Hooke, Biot, Mitscherlich and Wollaston are surprising in their keen insight and accuracy, and Burke has quoted numerous examples.

For the mineralogist or crystallographer, this book is especially interesting and enjoyable, for it offers detailed accounts of the development of many well-known mineralogical "laws". The arduous task of formulating and perfecting these principles is seldom emphasized, but the reader is here made aware of the painful process of hypothesis testing and generalization. The personalities of many famous scientists emerge in the narration.

Burke's treatise is rigorous enough to satisfy any serious student of the history of crystallography, and yet so well written that even the casual reader will not lose interest. A single reading of the book will undoubtedly add much to the historical perspective of any mineralogist, and also provide numerous anecdotes and facts about the founders of the science of crystals.

The Nature of Solids, by Alan Holden, Columbia University Press, 1965, 241 pp. ($6.95)

Books on science and technology, written for the non-scientist, are currently enjoying wide popularity. Although such books exist for virtually all aspects of the physical sciences, their usefulness is severely limited because the reader too often does not have the background necessary for a conceptual (rather than superficial) understanding of the subjects presented. For the reader interested in expanding the base of his capability for intelligent science reading, Holden's book is almost a necessity.

The Nature of Solids presents material crucial to a true understanding of developments in the technological and theoretical aspects of solid state physics, electronics, mineralogy and inorganic chemistry. This material is presented clearly, succinctly and logically. More important, perhaps, is the fact that the subjects covered are all nuclei of advanced college courses, making the book useful for the science student as well. The text is entirely nonmathematical, and difficult concepts are explained through illustrations and analogies. The discussion of heat capacity at the very start is a seldom used but very powerful approach to the concepts of symmetry and structure, atomic theory and molecular vibrations. These concepts lead, in turn, directly to electrical conduction and semiconductor theory and current ideas about magnetism. It is unusual to find so many critically important and potentially difficult subjects presented together coherently and lucidly.

It is becoming increasingly difficult to classify the research being carried out in many areas of physical science, since much of it is "materials science" in the broadest sense. The professional mineralogist today must be thought of as a chemist, thermodynamicist and solid state physicist as well. Holden's book is choice reading material for anyone seeking a better understanding of current progress in these fields.

An Introduction to the Methods of Optical Crystallography, by F. Donald Bloss, Holt, Rinehardt and Winston, New York, 1961, 294 pp. ($7.00)

Few amateur mineralogists (and, in today's funding crisis, many professionals are in the same situation) can afford to own and operate X-ray diffraction equipment. A very powerful tool of more moderate cost is the polarizing microscope. Optical properties of crystals are, in many respects, more sensitive to structural and compositional inhomogeneities than are X-rays; in the hands of a trained and conscientious observer the polarizing microscope yields a wealth of mineralogical information.

To use such a tool to its fullest capacity requires a sound knowledge of how it works. Many books are available to the student of optical crystallography, yet most that treat theory in any detail are difficult reading, unclear on some critical points and more or less unusable as a practical step by step guide. The book by Bloss is a refreshing exception to the above generalization. The text was written specifically for the beginning student and concentrates on presenting a thorough and sound foundation of optical theory. The book is designed to help the student use the polarizing microscope, and therefore includes chapters not only on lens properties, but on the construction and design of the microscope. Included are photographs of a wide variety of microscope types on the market, with their components clearly labeled. Rather than cover the whole field of optical indicatrices, Bloss concentrates on the refractive index

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surface, probably the most generally useful one for practical work.

Few aspects of the large field of optical crystallography are entirely omitted, as seen in the comprehensive index. Perhaps the most valuable asset of the book is the vast number of superb drawings. These alone are worth the (very low) cost of the book. No professional should be without a copy of Bloss' text, and it is probably the best available for classroom use. The amatuer mineralogist has little excuse for not reading the book, and attempting to develop his skills at optical techniques. With such a lucid guide available, optical crystallography should become a standard tool for any collector, and purchase of a microscope the goal of any individual or club.

Crystal Growth, by H. E. Buckley, John Wiley and Sons, New York, 571 pp. ($14.00)

Few branches of science are as important to chemists, physicists, geologists and materials scientists, as obscure to the general public and as infused with practical "cookbook" data as the science of crystal growth. The history of concern about how crystals form stretches back to ancient Greece, yet much of today's knowledge is tentative, under constant debate and scrutiny, and more soundly based in practical experience than in theory. A good impression of the diversity of opinion and current state of the field (as of 1951) is obtained from this classic work by Buckley.

Crystal growth is involved in a tremendous number of basic industrial processes, and control of crystal habit is a major concern in many areas. Entire industries (such as those of semiconductors and lasers) depend for their existence on the successful controlled production of high purity crystals. The field itself has been called an "art" as well as a science, an observation unchallenged by anyone who has tried to produce large crystals. Buckley's work treats not only the many theories that have been proposed to explain and predict aspects of nucleation and growth, but also industrial and laboratory procedures and numerous examples of the effects of growth conditions on the growing crystal. The book has become known as the authoritative work on the effects of impurities, especially dyes, on crystal habit.

Many theoretical discussions presented in the text involve some mathematical notation, but these constitute a very small percentage of the book, and all the rest is eminently readable. Buckley's work is one of the only books available containing a comprehensive introduction to the theories of crystal growth, as well as a discussion of early techniques and modern improvements. Rigorous detail is left to the vast (and rapidly expanding) literature, by means of a large reference list at the end of each chapter. There is a name index as well as a subject index. The current literature is so highly theoretical and mathematical that it defies attempts by most non-professionals to peruse it. The review by Buckley provides a welcome entrance into a truly fascinating and important field of science.

X-Ray Crystallography, by R. W. James, Methuen and Co., London (John Wiley and Sons, New York), 1953, 101 pp. ($2.00)

This delightful little book by James is an excellent summary of the geometry of X-ray diffraction and the origin of structure-determination principles. Although the average reader can easily work through the first chapter and parts of the second and third, the remaining material is somewhat advanced. The book was written primarily as a review for physics students or others with technical training.

The first chapter deals exclusively with lattices, and concisely and lucidly summarizes their properties. The Law of Rational Indices is derived in a way that would greatly assist the understanding of the advanced amateur mineralogist. In the second chapter, James derives the Laue conditions for diffraction and shows how the Bragg Law conceptually simplified the phenomenon. The rigorous aspects, however, are needed for the following discussions, in which structure amplitude and intensity calculations are outlined and structure determination techniques are described. This treatment parallels that of most current textbooks on the subject.

X-ray Crystallography is well within the budget of anyone seriously interested in diffraction theory. The book is to be highly recommended as a review for those with technical backgrounds. Only scattered pages can be considered potentially useful to the nonprofessional, but these are well worth the effort required to obtain and peruse them. ☐

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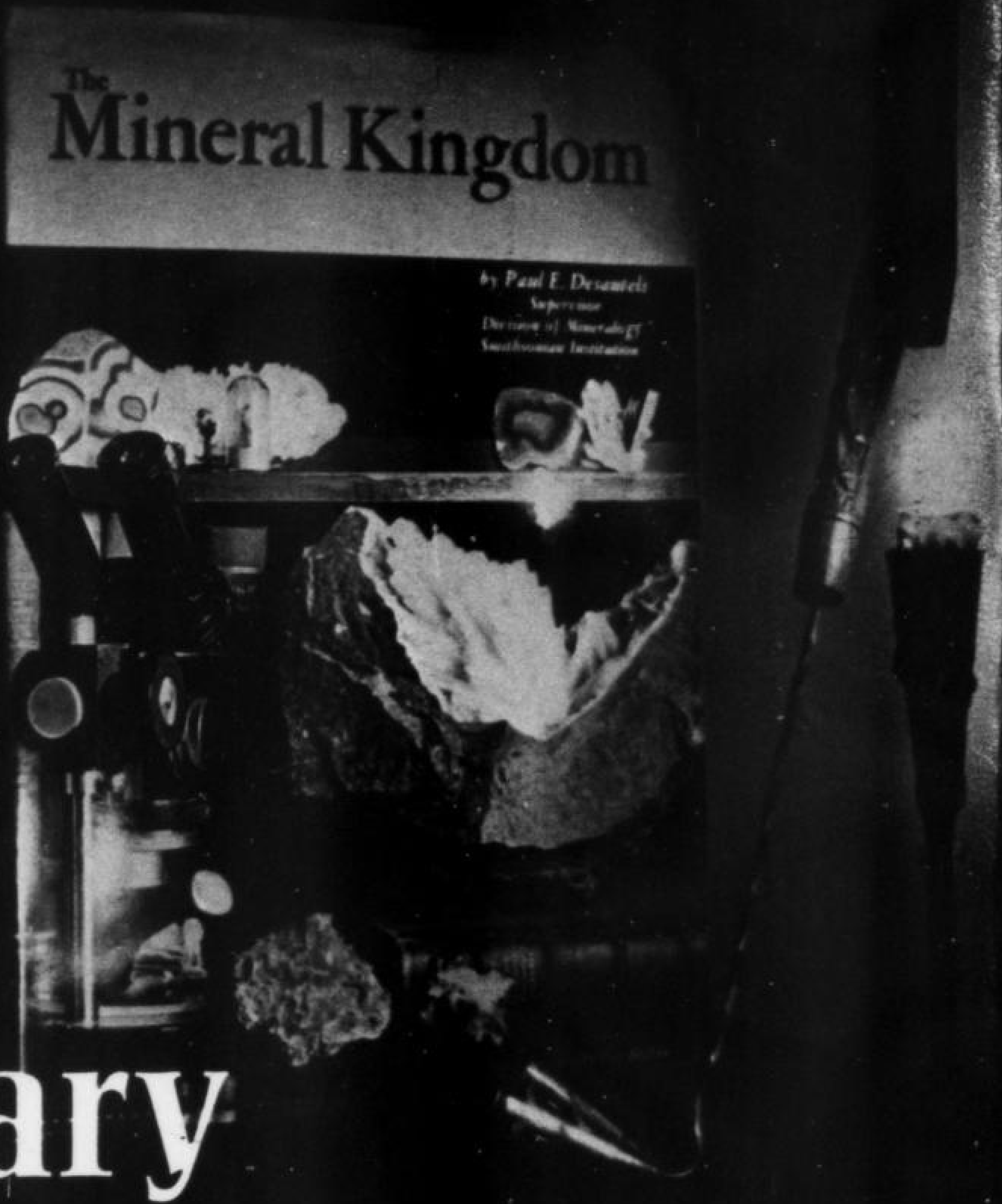
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