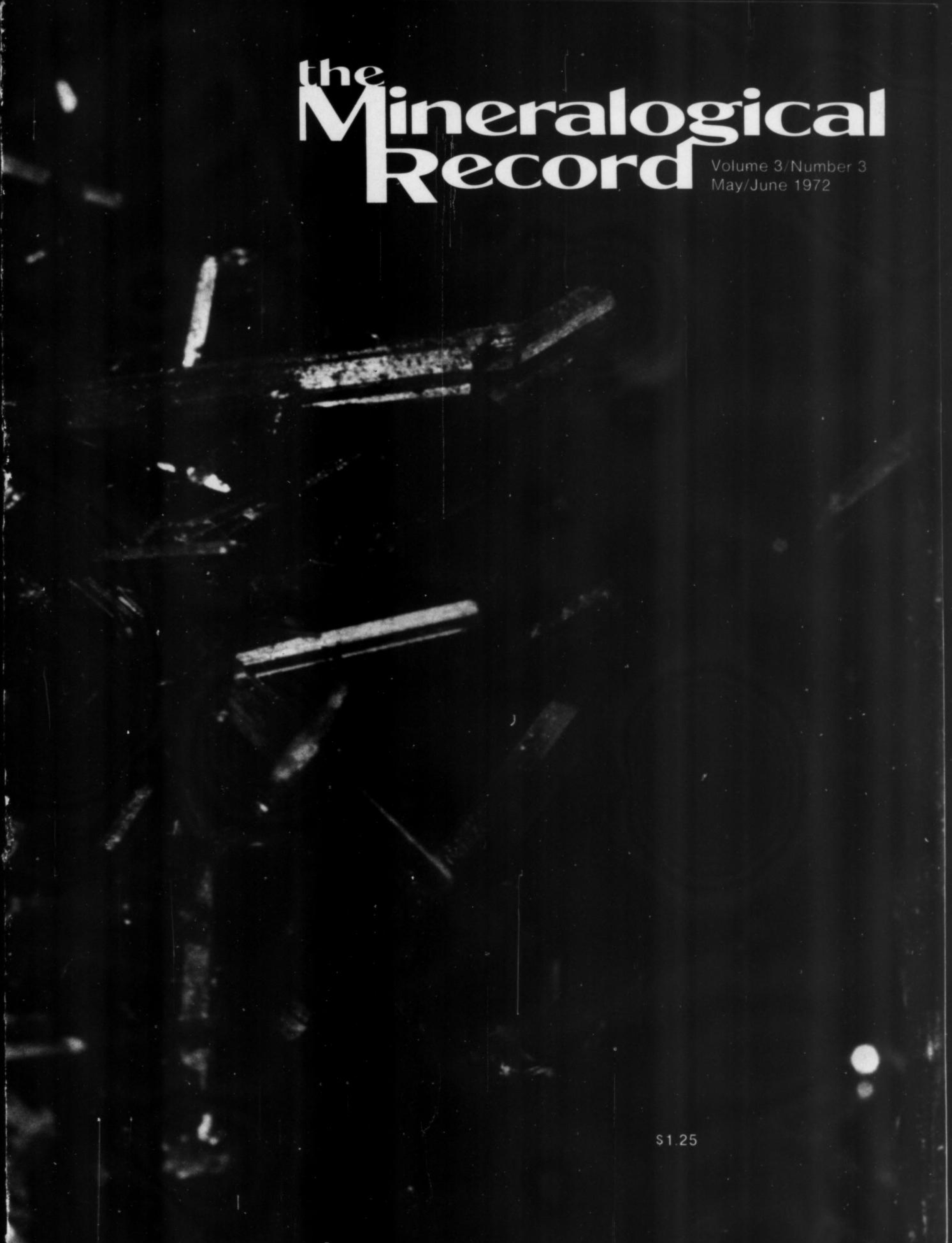
the Mineralogical Record

Volume 3/Number 3
May/June 1972



$1.25

---

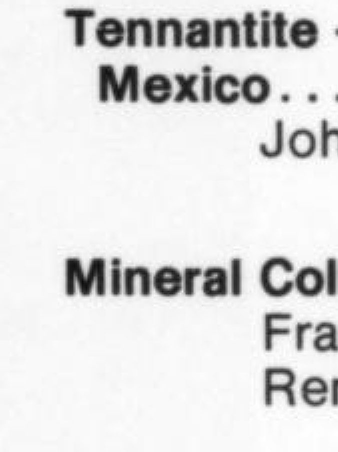
the Mineralogical Record

Volume 3/Number 3
May/June 1972

affiliated with the Friends of Mineralogy

feature articles

departments



CROCOITE - Dundas, Tasmania, Australia. Delicate needlelike crystals coupled with a deep orange-red color make this one an easy mineral to sight identify. See the article in this issue about Dundas, by Albert H. Chapman, on page 111.
Smithsonian Institution specimen. Photo by Joel E. Arem.

editor & publisher
John S. White, Jr.
Division of Mineralogy
The Smithsonian Institution

circulation manager
Mary Lynn White

design & composition
Bowie Graphic Art Services, Inc.
2502 Crain Highway North
Bowie, Maryland

address
the Mineralogical Record
Post Office Box 783
Bowie, Maryland 20715
Telephone: 262-8583

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 French/Bray Printing Co., Candler Bldg., Baltimore, Md.

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.

Editorial

A.F.M.S. 25th Anniversary

It was with considerable fanfare and ceremony that the American Federation of Mineralogical Societies celebrated its 25th birthday in Washington, D.C. and elsewhere this year. The Federation has come a long way from the personal discussion between Ben Hur Wilson and Richard Pearl at Ottumwa, Iowa, in 1946, which led to early efforts to affiliate the four regional federations then in existence. Dr. Pearl readily acknowledges that the idea of a National federation was formally proposed in a banquet speech in 1941 by H. C. Dake, the editor of the *Mineralogist Magazine.* It wasn't until 1947, at Salt Lake City, that the A.F.M.S. was actually formed — officers were elected, the name chosen, and work started on the constitution and by-laws, the finalizing of which was to take two years. The first officers, elected by two representatives of each of the four regional federations, were: Ben Hur Wilson, Richard Pearl, Chester R. Howard, and Jack G. Streeter. The first convention of the fledgling federation was in Denver the following year. The A.F.M.S. was off and running, and the influence of the organization has since become more and more pervasive within the mineral hobby.

The coming together of the regional federations was in answer to two very different needs. There was a genuine need for a central organization through which activities, rules, guidelines, show dates, etc. could be standardized and/or regulated. There is also an almost compulsive need for Americans to organize — if only for the sake of organizing — and this compulsion, no doubt, provided much of the impetus toward affiliation of all the regional federations. Those people who recognized the former need saw to it that this was served, and they did a very good job of it.

There has been criticism leveled at several of the activities of the American Federation, some of it in this journal. Very naturally shortcomings can be found and they often become magnified grossly out of proportion, while the many solid accomplishments and benefits accruing to everyone in the hobby are all but overlooked.

The A.F.M.S. can take great pride in its many successes. One need look no further than the excellence of the regional and National shows. Their continued improvement is in no small measure due to such factors as the establishment of guidelines for producing shows, enhanced publicity, improved displays, wider attendance, better judging, and the participation of more and better guest speakers. These factors have become more significant as a result of the activities of the National organization.

The Uniform Rules, in spite of obvious imperfections, have revolutionized competitive displaying. A set of standards has been adopted forcing greater attention to accuracy in labeling, more careful selection of specimens, and greater efforts in showmanship; all of which can only improve the quality of a mineral display.

One program in which the A.F.M.S. has achieved remarkable success is its Scholarship Foundation, founded in 1964. The purpose was to award cash scholarships to post-graduate students working toward a Master's or Doctor's degree in any of the earth science fields. Since its inception some 19 students have received financial support through the Foundation. The program now provides $9,000.00 annually. Six new students are selected every year and each is given $1,500.00 over two years.

So the American Federation of Mineralogical Societies may indeed celebrate its 25th anniversary with fanfare. Few National organizations have come closer to reaching their goals. If the next 25 years are as productive and fruitful, those of us with an interest in the hobby can feel confident that it will remain vital and progressive, and remain a continuing source of pleasure and reward. We congratulate the Federation on a job well done.

Perhaps this is also the time to insert a word of caution. There is a very real danger of the attitude developing that all the reasonable goals have been reached and there is nothing left to strive for or work toward. If this happens, the Federation could easily go into a decline that would cause its influence and usefulness to dissipate to an ineffectual level in much less than 25 years. Unfortunately already there is a strong feeling of defensiveness, it seems, on the part of many of the authors of A.F.M.S. rules and regulations as well as some of its other functions. Criticism, which is usually intended as constructive, sometimes is not received objectively enough and appraised on its merits. An alert Federation can overcome these difficulties and thereby remain a helpful servant of the mineral hobbyist.

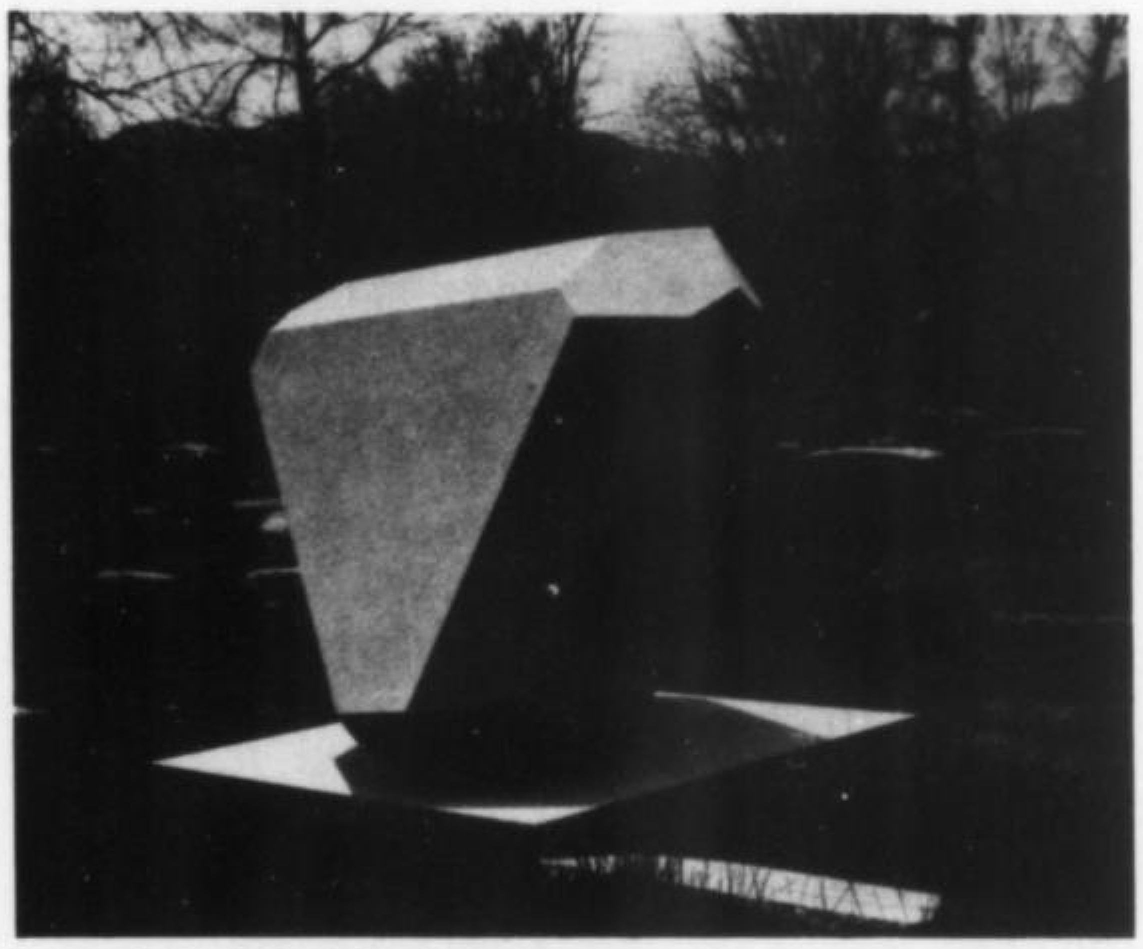
JOHN S. WHITE, JR.

AN ARTIFICAL CAHNITE

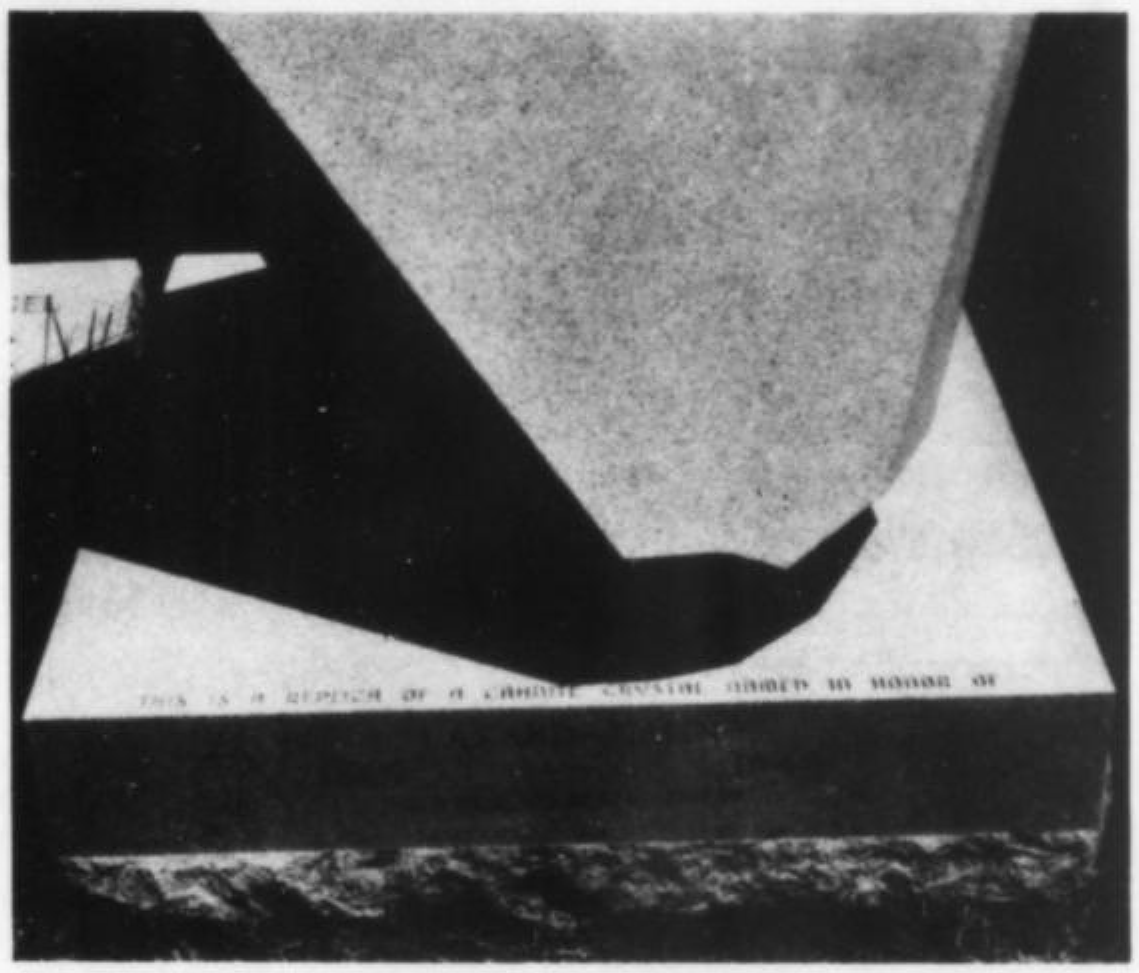
by Authur Roe

A mineralogist walking through Evergreen Cemetary in Colorado Springs might be very much surprised to see a tombstone in the form of a crystal (see cut). If he knew rare minerals he would recognize it as a cahnite twin. It marks the grave of Mr. Lazard Cahn — mineralogist, crystallographer, teacher, mineral dealer, micromounter, gentleman, and scholar - who died in 1940 in his seventy-fifth year. Professor Charles Palache named the rare Franklin mineral - a calcium borate arsenate hydroxide - after Mr. Cahn who had noticed the new mineral and sent some to Harvard for study *(Amer. Min.,* **12,** 149, 1927*)*. Professor Palache also wrote the Memorial for Mr. Cahn *(Amer. Min.,* **26,** 174, 1941).

Lazard Cahn



Lazard Cahn's Tombstone



Mr. Cahn is remembered with affection and gratitude by his students. He was most generous with his time, knowledge, and minerals, and initiated a number of people into the beauties of micromounting. In regular sessions in his office twice a week his students learned mineralogy, crystallography, and micromounting. They were helped on their way by a generous supply of excellent micromount material from Mr. Cahn's large collection, and by his ever willingness to identify material brought in from collecting trips. About a dozen excellent micromount collections, built by those whom he taught directly, are extant today, and many more, particularly in the Colorado Springs area, exist because of his influence.

The well-carved tombstone of a rare and interesting mineral is a most fitting remembrance of a remarkable man.

MARTIN L. EHRMANN NOTED MINERAL DEALER DIES

Martin L. Ehrmann, mineral dealer, died in Los Angeles after a serious illness on May 18, 1972. There are very few legendary figures associated with the activity of collecting mineral specimens, but certainly Martin was one of them. Accounts are not kept of such things, but it is possible that more high quality mineral specimens were brought by him into the United States than by any other single individual. He was either a good friend of, or was well acquainted with, every mineral museum and curator of any consequence in the world. Memories of his visits were always those of a very personable, friendly, enthusiastic lover of people and fine mineral specimens. His career was so full of fascinating and incredible experiences that friends pressed him to record them. Just before his death, knowing that the end was near, he put on paper much of his story which will hopefully be published. Martin deserves to be remembered as a unique individual, good friend, and fellow mineral enthusiast.

A lengthier sketch of Martin Ehrmann's career will appear in a future issue of the **Mineralogical Record.**

HANSEN MINERALS ANNOUNCES OPENING OF PEGMATITE COLLECTING AREA NEAR CUSTER, SOUTH DAKOTA

Gary R. Hansen, president of Hansen Minerals, Inc., announces the recent opening of a pegmatite collecting area, the Kitty No. 1 lode, about 6 miles from Custer, South Dakota. The property is managed by B & H Mining Properties. The area will be open for collecting from approximately June 20 to August 31, all material may be collected at 10¢ per pound, no minimum, no daily charge. Many camping sites are close by, but there are none at the mine site. The roads to the site are in good condition. Included in the minerals found at the Kitty No. 1 lode are rose and white quartz, tourmaline, mica, spodumene, beryl, lepidolite, columbite, tantalite, feldspar, barbosalite, and other pegmatitic phosphates. A small mineral shop will be operated at the mine for collectors. Write to either George Bland, Custer, South Dakota (Ph. 605-673-4965) or Hansen Minerals, Inc., 149 N. Meramec, Clayton, Missouri (Ph. 314-726-2236).

PROPOSED CHANGES TO RULES FOR THE 9TH ANNUAL PIKES PEAK GEM AND MINERAL SHOW

After seeing many shows throughout the country and taking a good honest look at past Colorado Springs shows, there seems to be a void — a void that should be filled here and throughout the entire country — in all shows. Our "juniors" and novices have been somewhat neglected and since they are our future "master" collectors, it is high time that we and all clubs encouraged their curious minds and gave them the support and encouragement needed in order to help them get started toward collecting and exhibiting their collections.

Consequently, after analyzing shows throughout the country, holding discussions with various show chairmen, judges, committees, workers, exhibitors and visitors to shows, the Colorado Springs Mineralogical Society announces an experiment for their coming 1972, 9th annual Pikes Peak Gem and Mineral show. We hope to achieve the following with our experiment:

1. Greater participation and interest in competitive exhibits, especially in the pebble pup, junior, novice and advanced exhibitor groups.
2. Eliminate some of the confusion over differences of formulas in different authorized references.
3. Simplify labeling and judging in all divisions where chemical formulas or basic constituents are required.

To achieve our goals we are instigating the following rule changes for our show:

1. No chemical formula or basic constituent will be required on any label in any division.
2. Judging of labels will follow the definition of rules set down by the AFMS in all other respects — rules such as duplication of minerals, spelling, mineral identification, location, neatness, legibility, with the exception of number one above.
3. The exhibitor is permitted the option of including the chemical formula or basic constituents if he so desires; however, this part of the label will not be judged.
4. The above ruling applies to all categories that require chemical formulas or basic constituents on the label, as listed in the red AFMS Rules Book.
5. A pebble pup and junior trophy will be awarded the top case in each respective group, to encourage our younger members.
6. The pebble pup exhibitor will be defined as any member under 12 years of age. It is suggested that the display case be an empty egg carton. The egg slots can be used for the 12 mineral specimens, which are required; the top of the carton can be used for labels; *only* the correct mineral name shall be required for the label. A maximum of 50 points

continued on page 102

HANSEN MINERALS

1223 PORT ROYAL, ST. LOUIS, MISSOURI 63141

PRESENTS NEW MINERAL LIST M-3

In lieu of quarterly lists we are planning full page specimen listings in future issues of the Mineralogical Record. Please contact us for specific requirements in minerals, reference material or cut gemstones. Please include a check with your order and postage consideration. Any specimen may be returned for cash or credit if you are not satisfied. Refer to list M-1. See us at the following 1972 shows: Detroit, Tucson. Hansen's Minerals, Inc. Dr. Gary R. and Maurine Hansen. Ph. (314) 432-2882. (Showroom: 149 N. Meramec, Clayton, Missouri 63105, Ph. 314-726-2236).

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

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

ARAGONITE. Minglanilla, Cuenca, Spain. Extremely clean, violet hexagonal prisms up to 1.5 in. long x 0.75 to 1.0 in. diameter. **$7.50 ea.**

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

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

FLUORITE (Yellow). Ft. Wayne, Indiana. A fine selection of pale yellow, brilliant single crystals and small matrix specimens, very similar to Cumberland, England. TN. **$5.00-$15.00;** miniature **$10.00-20.00;** cabinet **$15.00-$25.00**

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

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

NEW SPECIMEN ACQUISITIONS:

We are holding back fine specimens from our display and show stock to assure you of the best quality material which we receive in any given lot of mineral specimens.

TANZANITE. Umba Valley, Tanzania. A single gem crystal with internal flaws, perfect termination, 16x10x8 mm. **$100.00.**

TETRAHEDRITE. Casapalca, Peru. A group of large, lustrous crystals with calcite, 2x2 in. **$125.00.**

TOURMALINE CRYSTALS. Kaori, Rhodesia. Black green, lustrous, pencil crystals from 1.5 to 2.0 in. long x 0.25 in. Very attractive, some are transparent with intense light. **$8.00-$16.00.**

CUPROADAMITE. Gold Hill, Utah. A lot of five fine miniatures, light green botyroidal crystal groups on limonite, confirmed by x-ray. **$17.50-$30.00** each.

CUPROAUSTINTITE. Gold Hill, Utah. A lot of three fine miniatures, blue-green needle crystal clusters on limonite, associated with cuproadamite, confirmed by x-ray. **$25.00-$30.00** each.

Octahedral PYRITE. Quiravilca, Libertad, Peru. An excellent collection of brilliant rare crystal groups, miniature to small cabinet specimens. **$75.00-$200.00.** Several pyritohedron groups 2x3 to 3x3. **$40.00-$60.00.**

PYRITE. Ambassaguas, Spain. Very fine cubes of complex twinned brilliant pyrite, approx. 25x40 mm. Excellent display specimens. **$15.00-$20.00** each.

GARNET var. Demantoid. Campo Francia, Val Malenco, Italy. A plate of asbestos completely covered with small green garnet crystals. 2x3 in. **$45.00.**

AZURITE. Cobar, N.S.W., Australia. A specimen consisting of three intergrown crystallized balls of azurite. 1.75x1.5x1 in. Very unique. **$65.00.**

GOLD on Quartz. Waverly Mine, Halifax, Nova Scotia. Gold leaf on white-gray quartz matrix. 2x1.75 in. **$85.00.**

Blue FLUORITE. Munsterthal, Baden, Germany. A group of lustrous blue crystals with violet inclusion from this old classic locality. 4.5x3x3 in. **$110.00.**

HARMOTOME. Argyle, Scotland. A plate covered with clean, white 0.35 in. crystals. Very attractive for this mineral. 5x2 in. **$75.00.**

BERTHIERITE. Kisbanya, Romania. A lot of 3-specimens exhibiting a good luster and classic close packed fibre crystals. 2x2 at **$25.00;** 4.5x3x1.5 at **$65.00;** 6x3x2.5 at **$75.00.**

GALENA. Cavnic, Hungary. A 7.5x5 inch group of eight, exposed, octahedral, reliefed crystals up to 1.7 inch from matrix. **$95.00.**

WULFENITE. San Francisco Mine, Sonora, Mexico. A nice lot of miniature to small cabinet specimens. Yellow-orange crystals up to .75 in., some with mimetite, very similar to old Tiger Mine material. **$7.50-$40.00.**

SPHALERITE. Johnson Co., Tenn. (cf. Mineralogical Record Vol. 3, No. 2 pg. 90.) The entire lot of the material which was described consisting of 81 specimens, TN—Miniature size. **$4.00-$10.00.**

MANGANOTANTALITE. Pebane, Dist. of Zambezia, Mozambique. A lot of 5-terminated dark red crystals, approx. 0.5x0.25 in. Very fine for this rare mineral. **$40.00** each.

WULFENITE. Mies Mesica, Yugoslavia. A group of orange, bi-pyramidal crystals up to 0.3 in. covering a white rock matrix. 4.5x3 in. **$45.00.**

Blue BARITE on Calcite. Minerva Mine, Hardin Co., Illinois. An attractive group of pale blue crested crystals on light yellow calcite. 3.5x2.5 in. **$40.00.** (Several other similar specimens at **$25.00-$60.00**).

BRAZILIANITE. Conselheiro Pena, Minas Gerais, Brazil. A lot of 5-miniatures, well crystallized, yellow-green specimens. **$75.00-$175.00.** One specimen 3x2.5x2.5 in., crystals up to 1.5x1.5. Very attractive. **$400.00.**

FAIRFIELDITE. Foote Mine, Cleveland Co., North Carolina. A fine lot of 12-specimens of this very rare mineral. Crystals on matrix. 1x2 to 2x3.5 in. **$9.50-$50.00.**

Pikes Peak Mineral Show, continued from page 100

can be awarded, broken down as follows:

a. 36 points (3 per specimen) for quality of mineral

b. 12 points for labels — correct identification. Labels may be hand printed.

c. 2 points for overall cleanliness and neatness.

The case with the most points will receive the pebble pup trophy. All cases that receive 40 points or more will receive a blue ribbon; all cases that receive 39 points or less shall receive a red ribbon. For identification purposes, the pebble pup division shall be called the BPP-1 division.

7. Junior exhibitors are defined as any members between the ages of 12 and 18; juniors shall abide by all requirements as set forth by the AFMS Red Rules book, except as noted above. A trophy will be awarded to the exhibitor that receives the highest number of points.

The above changes apply only to this 1972 9th annual Pikes Peak Gem and Mineral show, sponsored by the Colorado Springs Mineralogical Society and in no way change any requirements for any other show or any Federation-sponsored show.

We would appreciate receiving comments from any person who might read of this experiment. Our main goal is to have more interesting and better shows for mineral collectors everywhere. Write to George Fisher, 511 Foothill Road, Colorado Springs, Colorado 80906.

the state of the art - crystal growth

by K. Nassau

Bell Telephone Laboratories, Incorporated • Murry Hill, New Jersey

PART III (Conclusion)

Crystal Growth Techniques

In Part I of this series the problem of the choice of a growth technique was discussed in some detail. The main criterion is that the characteristics of the material to be crystallized must match the characteristics of the growth technique to be used, and this match must be based on a detailed knowledge of phase diagrams, solubilities, phase transitions, decomposition temperature and pressures, and so on.

A surprising amount of the crystal grower's time and energy is spent on two items: temperature control and material purification. The latter point is rather obvious, and it is most helpful that many chemicals can now be purchased in high purity form, e.g., 5N grade (i.e., "five-nines" or 99.999% pure). Nevertheless such designations must be viewed with great caution because they are often obtained by subtracting the *known* impurities from 100%. If there are unexpected impurities present, the actual purity may in fact be much lower than the listed one.

Temperature control requirements vary greatly. In some instances, e.g., Bridgman growth of an easily crystallizable material, or in Verneuil growth, it may suffice to keep the electric power level or the gas flow constant. In some water solution techniques, however, control to 1/100 degree may not be adequate, while at temperatures approaching 2000°C (3600°F), control to better than one or two degrees may be impossible to achieve even with several thousand dollars worth of elaborate control equipment.

A very brief outline of the thirteen techniques listed in Part I is given below. It must be remembered, however, that many variants exist for some of these, and the list is certainly not all-inclusive. All of these techniques can yield at least 1/8 inch size crystals and all have been used to produce synthetic minerals as described in Part II of this series.

Growth from the Melt

In this group of techniques the material to be crystallized is first melted and then permitted to solidify in a carefully controlled fashion. To ensure that only one single crystal is formed and not a group of crystals two approaches are employed. In the first a seed-crystal is used and the seed controls the orientation of the growing crystal. This is the way growth is usually initiated in the Czochralski technique and it may also be used in the Bridgman, Verneuil, and zone methods. Alternatively, the apparatus is arranged in such a way that only a very small region of the melt is the first to solidify, as in the pointed tip of a Bridgman crucible. In this way the probability of only one crystal forming is favored. If growth is slow (i.e., little supercooling as was discussed in Part I under growth theory) then there will be little tendency for other crystals to form.

If the melt reacts with air, a protective atmosphere (nitrogen, hydrogen, argon, helium, etc.) must be used. For simplicity the details of atmosphere protection are omitted from the diagrams.

A. *Czochralski Growth*

The Czochralski technique is often referred to as "pulling from the melt". The melt is contained in a crucible (usually ceramic, graphite, or quartz for metals, graphite or platinum for halides, and platinum or iridium for oxides, etc.) and heated by any suitable means, e.g., electric resistance heating, radio frequency, or a gas flame. Temperature control may be via a thermocouple immersed in the melt or touching the crucible, or by an optical pyrometer. A typical arrangement is shown in Fig. 1, and a boule in Fig. 2.

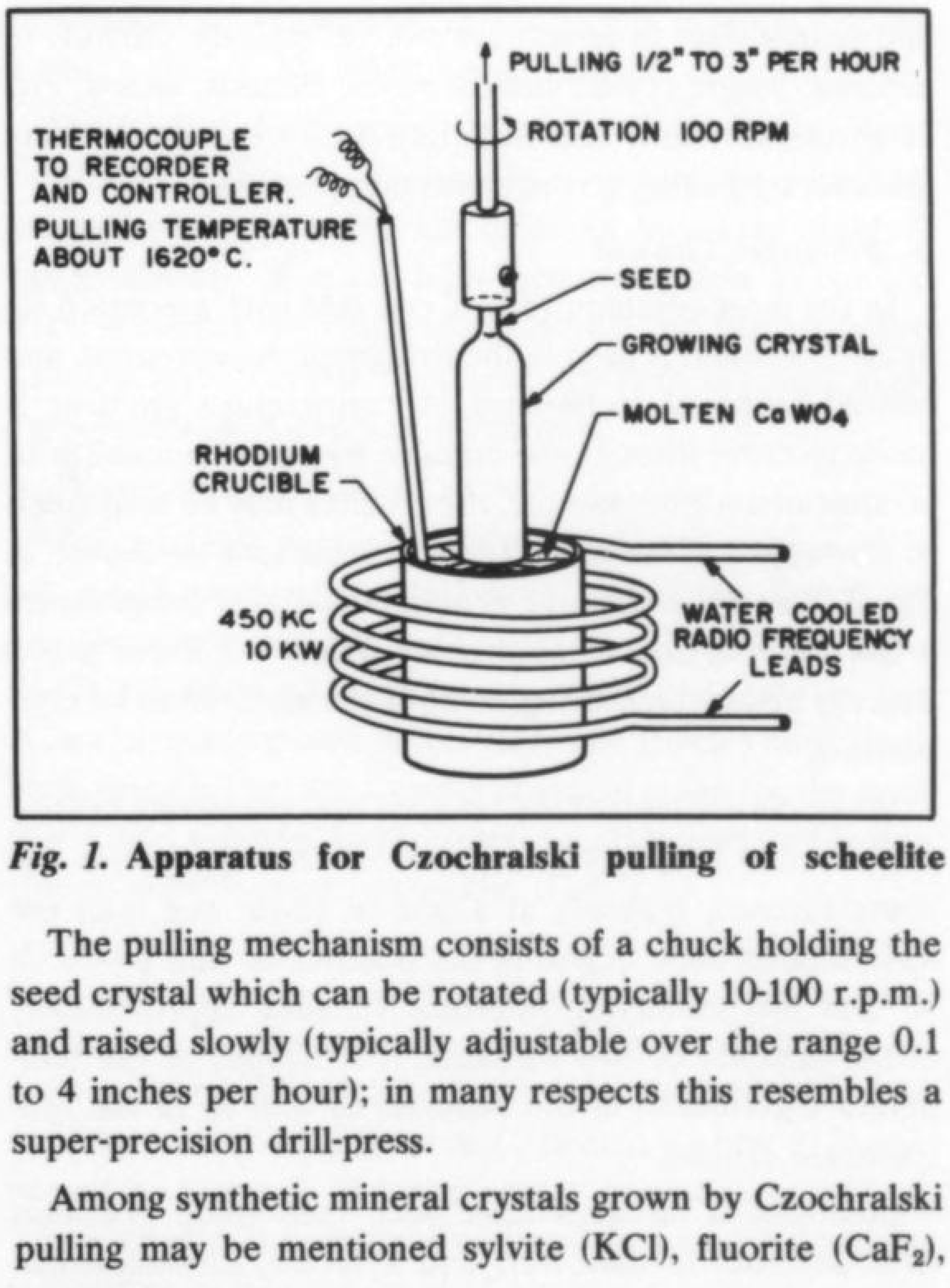


Fig. 1. **Apparatus for Czochralski pulling of scheelite**

The pulling mechanism consists of a chuck holding the seed crystal which can be rotated (typically 10-100 r.p.m.) and raised slowly (typically adjustable over the range 0.1 to 4 inches per hour); in many respects this resembles a super-precision drill-press.

Among synthetic mineral crystals grown by Czochralski pulling may be mentioned sylvite (KCl), fluorite (CaF_2),

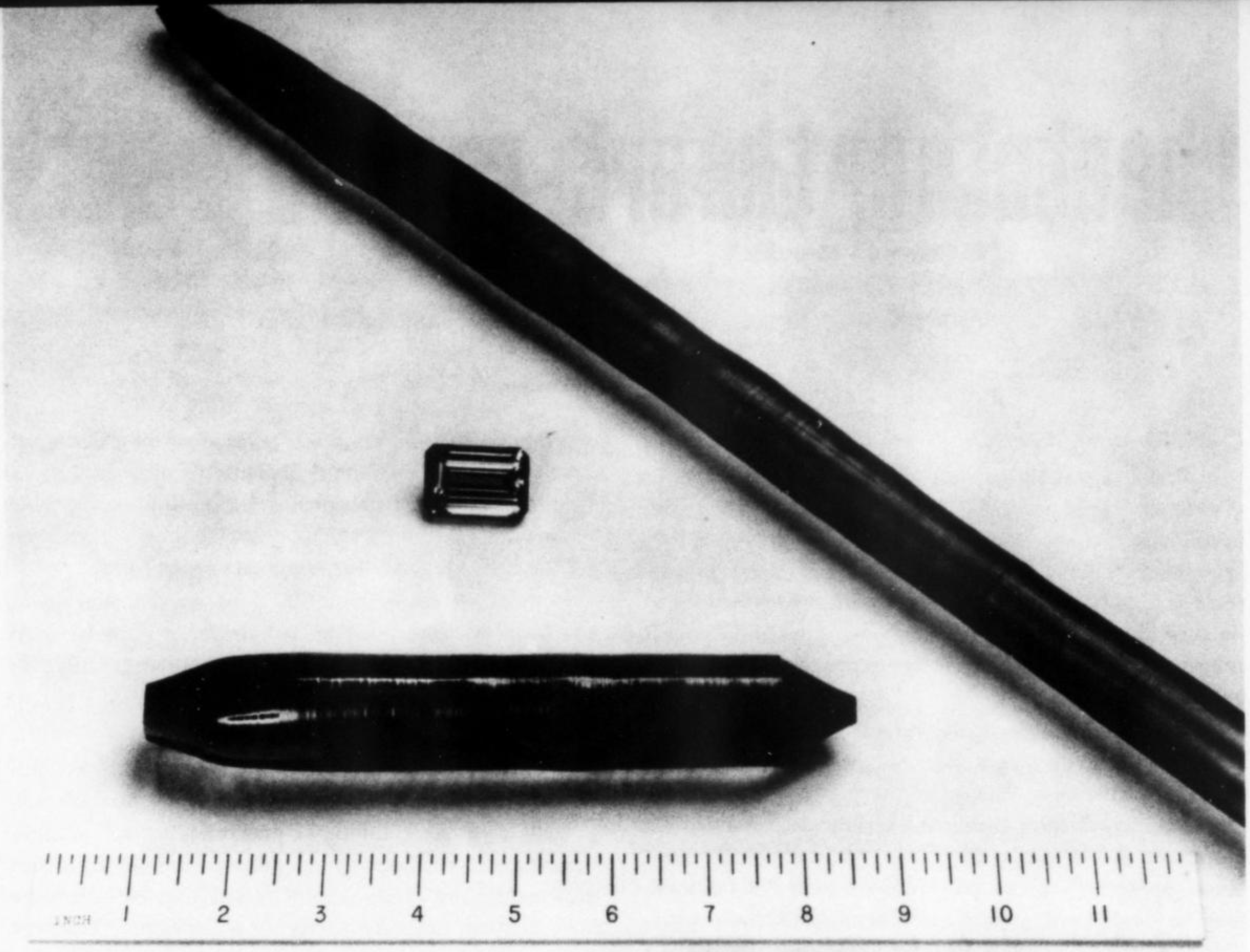


***Fig. 2.* Synthetic ruby boules: upper Verneuil grown; lower Czochralski grown**

scheelite ($CaWO_4$), corundum (Al_2O_3), and garnet ($Y_3Al_5 0_{12}$). The size is limited by the apparatus; up to 2" diameters and several feet in length are not excessively difficult to achieve. Single crystal hollow tubes, ribbons, sheets, etc. of corundum many feet in length have been grown from the melt by pulling through shaped apertures.

B. *Bridgman Growth*

In the most common form a crucible with a pointed tip at the lower end is used in the Bridgman, Stockbarger, and related group of techniques, A temperature gradient is made to move through the crucible by one of a number of arrangements. For example, the crucible may be suspended in the upper of a two-furnace arrangement as shown in Fig. 3. The upper furnace is maintained at a temperature a few degrees above the melting point, the lower a few degrees below the melting point of the material to be crystallized.

When the contents of the crucible are completely melted, the crucible is slowly lowered from the upper into the lower furnace, typically at a rate of about one inch per day. Solidification begins at the pointed tip and proceeds so that the solidifying interface remains approximately at the junction of two furnaces. The shapes of the temperature gradients, in the furnaces as well as in the crucible, are critical.

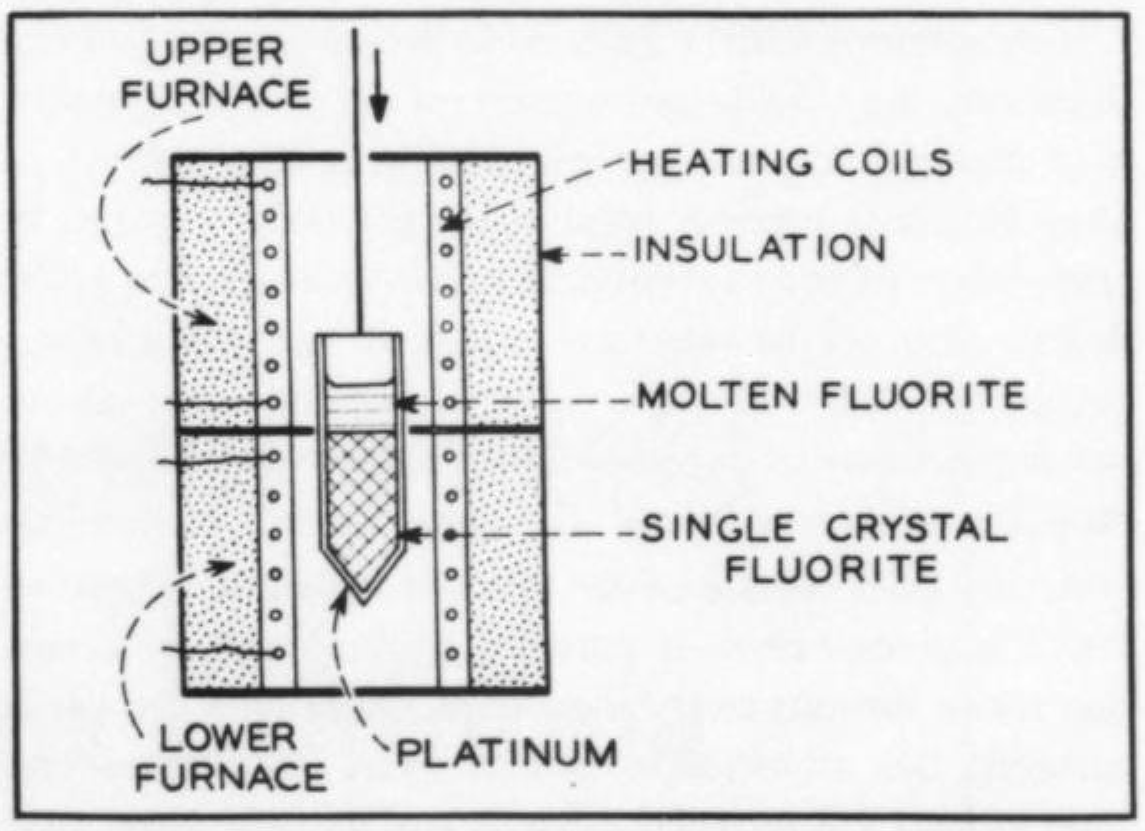


***Fig. 3.* Apparatus used in Bridgeman growth of fluorite**

Commercial furnaces have been built using crucibles over one foot in diameter, and a recent announcement speaks of a crystal 1,000 lb in weight. Synthetic mineral crystals commonly grown in this way include halite (NaCl), sylvite (KCl), and fluorite (CaF_2). In a very simple form it
vite (KCl), and fluorite (CaF_2). In a very simple form it
may be feasible to melt a puddle in the center of a pile of powder and permit the melt to solidify by reducing the heating power slowly; in this way it is possible to grow crystals of periclase (MgO) using an electric arc between graphite rods as the heating source.

C. *Zone Growth*

This group of techniques is used both for crystal growth as well as for purification: the so-called "zone refining".

A horizontal form uses a long narrow boat; in the vertical form, "float zoning", a sintered rod is held in chucks both top and bottom.

By a suitable heating mechanism a small region, the "zone", is melted near one end and made to travel along the specimen. Surface tension supports this zone in float zoning. Certain impurities will remain in the zone and thus be carried along toward the other end of the specimen. Heating is stopped, and another molten zone is started at the first end and so on. The apparatus is illustrated in Figs. 4 and 5.

A single crystal can result if conditions are suitable. Zone refining and zone crystallization have been used for metals (Cu,Ag), semiconductors (Si,Ge) halides such as fluorite (CaF_2), and even corundum (Al_2O_3).

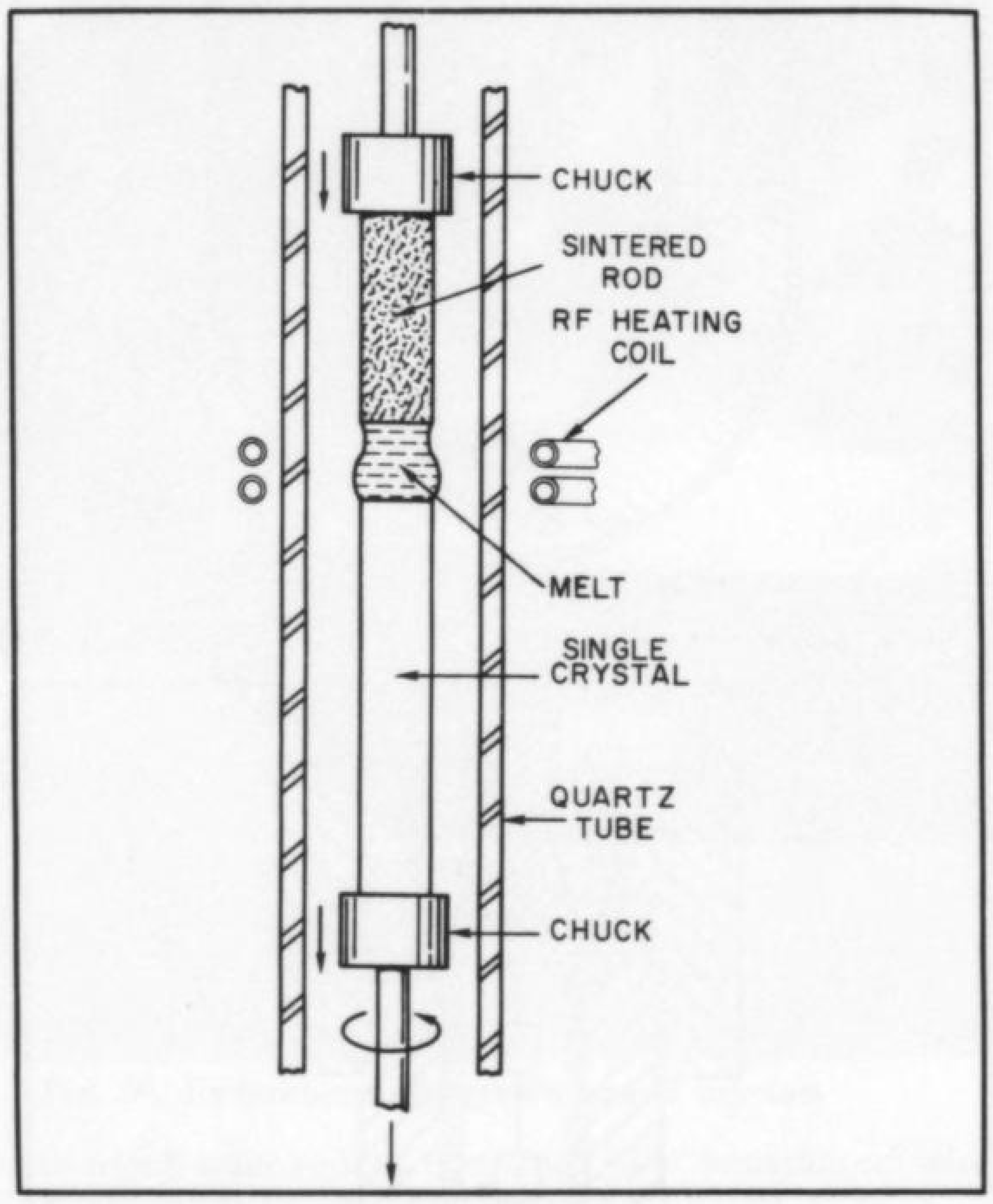


***Fig. 5.* Apparatus used for float zoning**

D. *Verneuil Growth*

The references given under corundum in Part II of this series may be consulted for the historical aspects of this growth technique. The essentials are illustrated in Fig. 6, and consist of a vertical oxygen-hydrogen blow-torch pointing downwards with an arrangement to permit powder to be sprinkled down the central tube. The powder melts as it passes thru the flame and impinges on the growing "boule" which is slowly lowered. Powder preparation is a very critical part of the process.

Rods up to several feet in length (Fig. 2) up to more than one inch in diameter, flat disks, and hollow cups or tubes, all single crystals, can be grown by suitable modifications.

Much skill is needed to produce single crystals without cracking by this technique, but it is carried on commercially on a very large scale for corundum (Al_2O_3) (ruby, sapphires), and spinel ($MgAl_2O_4$) manufacture; the largest factories contain well over 1,000 individual torches. Other materials grown, by modified units in some cases, include rutile (TiO_2), magnetite (Fe_3O_4), and scheelite ($CaWO_4$). Alternative heat sources that have been used on occasion include radio frequency plasmas, arc image furnaces, and electrical resistance heaters.

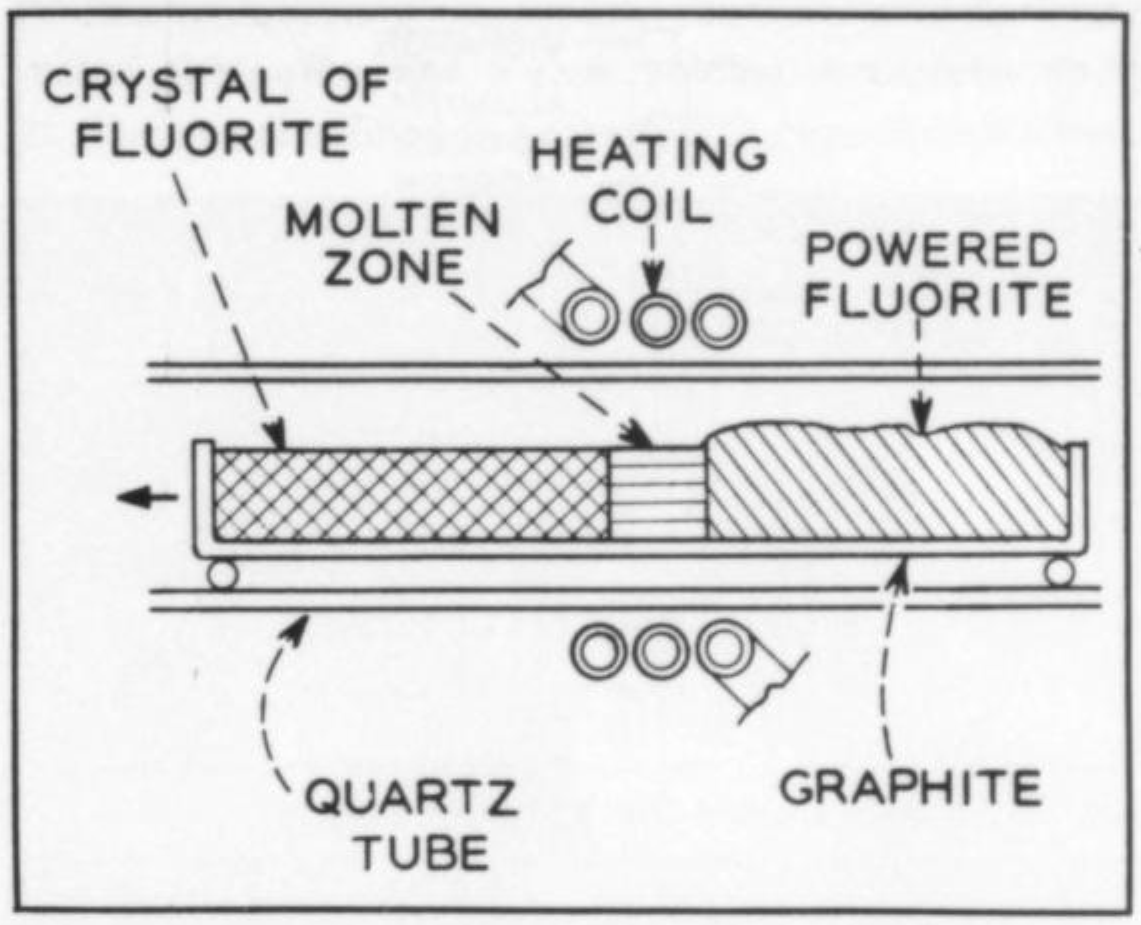


***Fig. 4.* Apparatus used for zone refining in a boat**

Growth from Solution

There are two ways in which a saturated solution is commonly made to deposit crystals: first, by evaporation, so that with less solvent present, less solute can be held in solution, and second, by changing the temperature, usually lowering it if the solubility increases with temperature. Transport can be used to obtain larger crystals and reaction, as in gel, has also been employed.

A solubility of at least a few percent is desirable. Since elevating the temperature usually increases the solubility, the hydrothermal technique achieves increased solubilities by the use of sealed high pressure vessels to contain water solutions at temperatures above the boiling point. Another way to obtain high solubility is to use high melting solvents as in the flux techniques.

A. *Water or other solvent growth*

Most students have at some time taken a water-soluble salt, made a saturated solution, and obtained crystals by permitting the solution to evaporate. Crystals of halite (NaCl - common table salt), nitre ($NaNO_3$), and so on, can in fact be easily grown in this way. The Holden and Singer book listed in Part I is a useful practical guide for the amateur. Other solvents may be used, e.g., concentrated hydrochloric acid to grow nantockite (CuCl).

To grow large flawless crystals (say 20 lbs in weight) from water solution is a difficult task and elaborate equipment, such as the transport system illustrated in Fig. 34 must be used. Here the solution is saturated with feed material in tank B, filtered at C, heated slightly in D, and passed by pump E into the cooler crystallizing tank A. There growth occurs on seed crystals supported on the rotating or oscillating "spider" shaft.

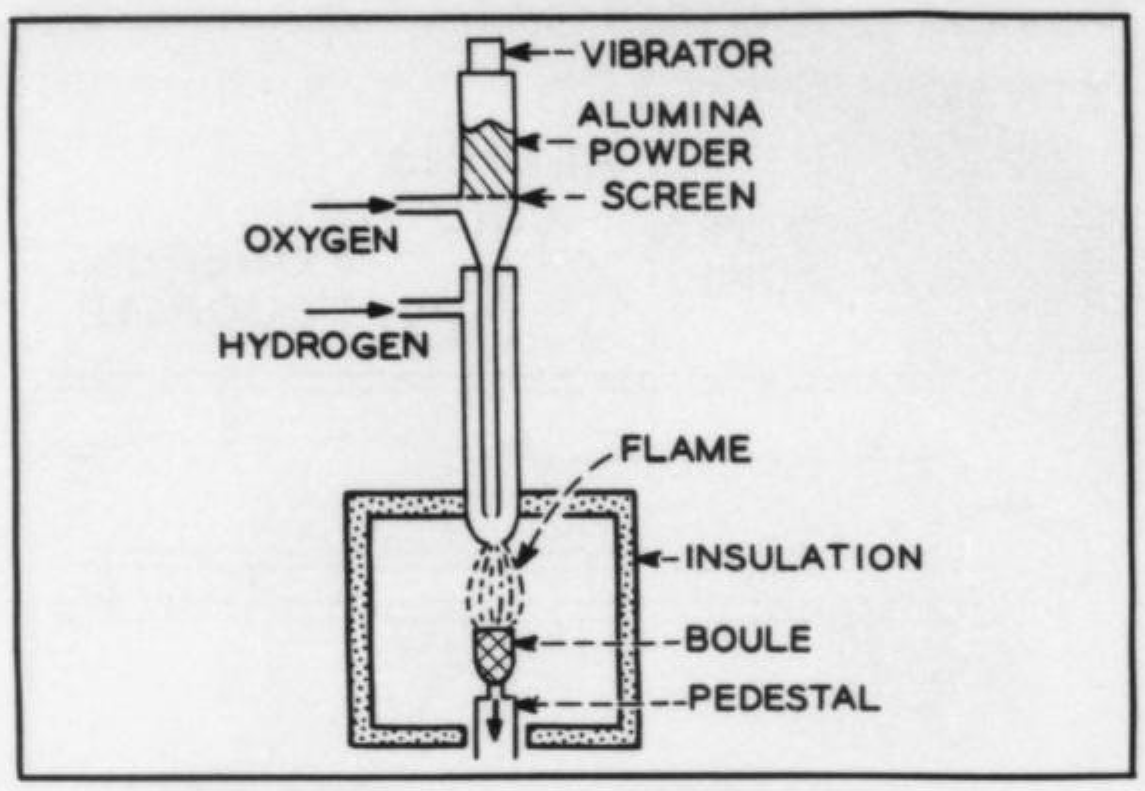


Fig. 6. **Apparatus used for Verneuil growth**

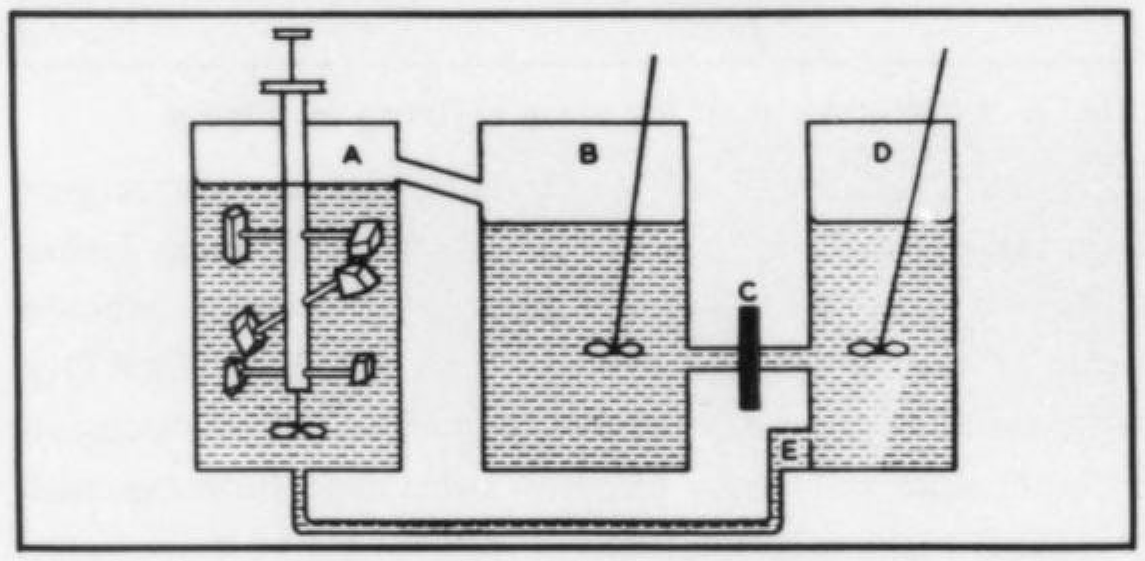


Fig. 7. **Apparatus used in solution transport**

B. *Gel Growth*

Many substances can be prepared as powders by precipitation from solution, but to prepare crystals in this way is difficult. The reagents must react very slowly so as to prevent high supersaturation and the formation of too many nuclei (see Part I). This aim can be achieved, with some difficulty, in the gel technique. Usually some silica gel (waterglass) of carefully controlled acidity (pH) is permitted to gel in the bottom of a U-shaped glass tube, Fig. 8. A solution of a calcium salt (perhaps $CaCl_2$) is poured into one arm of the U-tube, and a solution of a carbonate (perhaps $(NH_4)_2CO_3$) is poured into the other arm. The reagents diffuse towards each other thru the gel, react, and crystals of $CaCO_3$ grow: calcite, aragonite, and vaterite all may form depending on conditions. Other minerals that have been grown by this technique include nantockite ($CuCl$), copper (Cu), and scheelite ($CaWO_4$).

The book by Henish mentioned in Part I gives further details of this technique, while the article by Strong listed there gives good instructions for some beginners' experiments.

C. *Hydrothermal Crystal Growth*

This technique corresponds most closely to the growth process by which most natural minerals were formed. On a commercial scale quartz crystals are produced in quantity for use in communications devices for crystal oscillators, filters, transducers, etc. Other crystals that have been grown on an experimental basis by the hydrothermal technique include berlinite ($AlPO_4$), zincite (ZnO), sphalerite (ZnS), calcite ($CaCO_3$), emerald ($Be_3Al_2Si_6O_{18}$-Cr), and ruby (Al_2O_3-Cr).

A laboratory growth vessel as used for quartz is illustrated in Fig. 9. These are made of high strength corrosion resistant steel and may be additionally protected from the growth solution by a precious metal liner. Elaborate closures are needed to withstand the high pressures used.

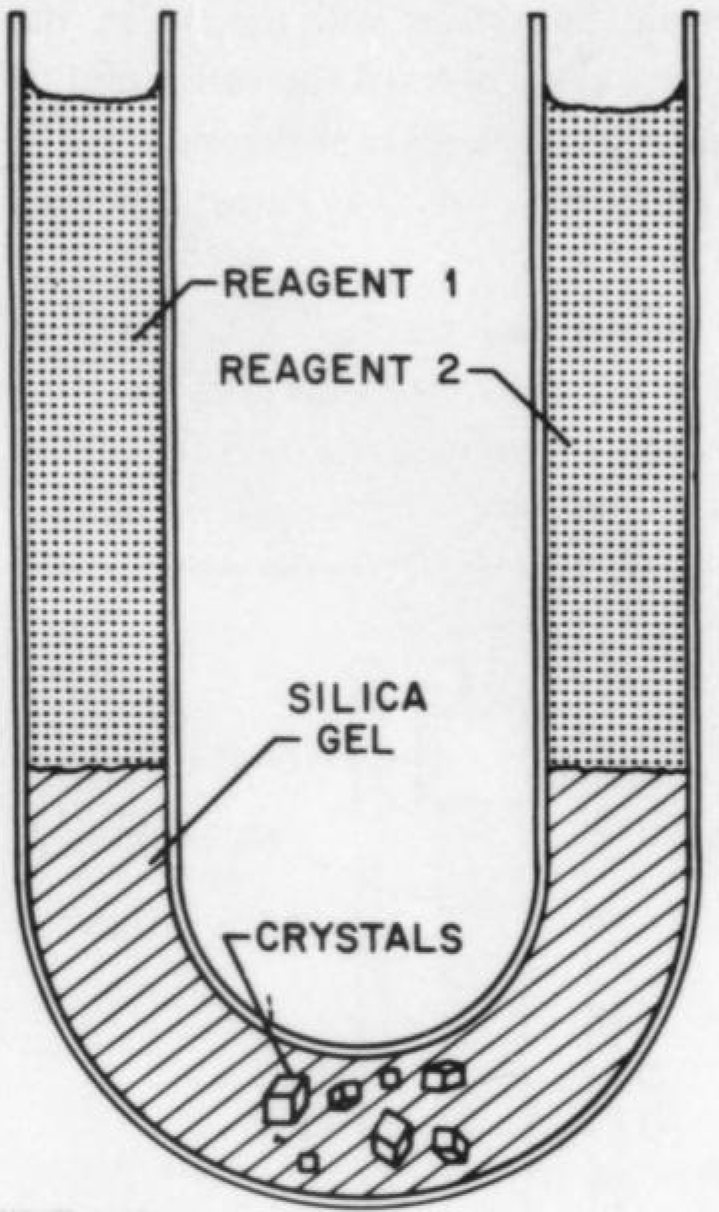


Fig. 8. **"U" tube used for gel growth**

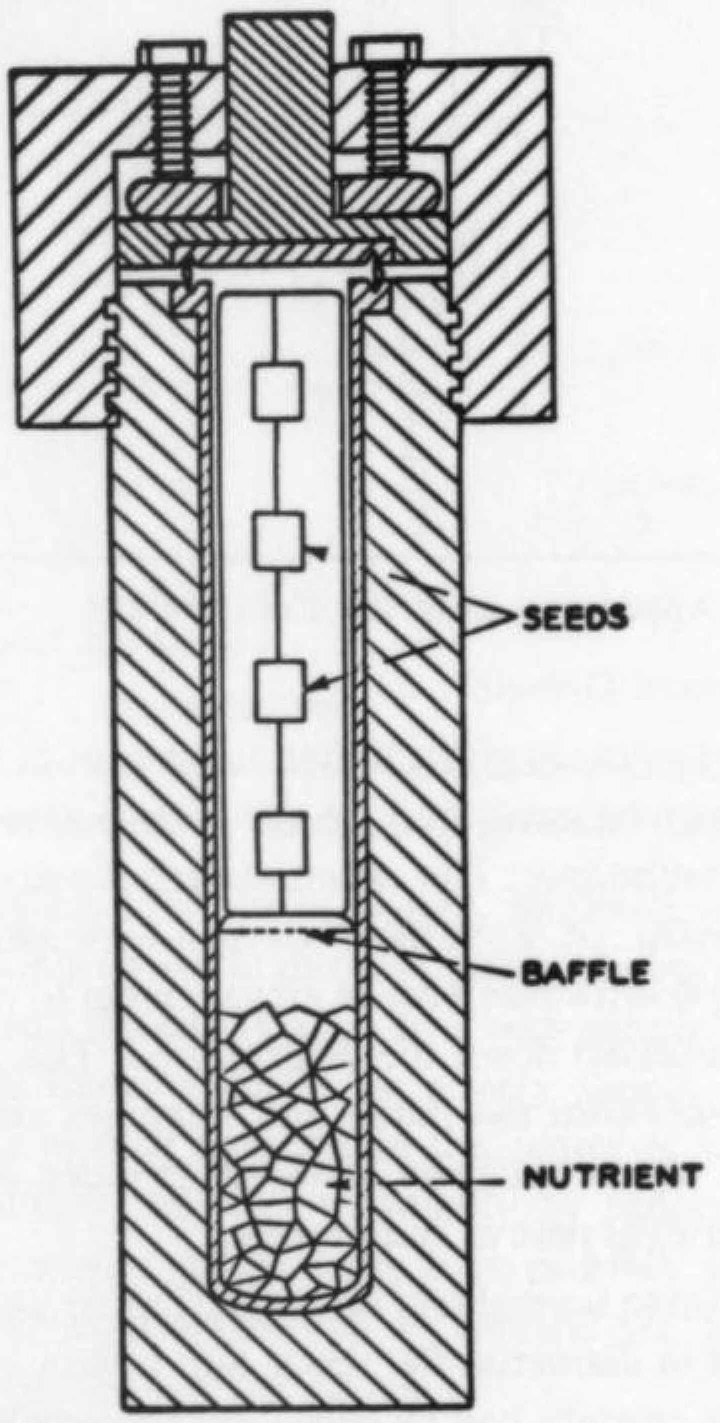


Fig. 9. **Pressure vessel ("Bomb") used for hydrothermal growth**

Accidental ruptures do occur occasionally and that is why these hydrothermal "bombs" are usually operated in a steel-lined underground enclosure.

Crushed quartz is placed into the bottom of the bomb below the baffle, and a rack holding seed-plates above it. The vessel is filled to perhaps 80% capacity with water to which some sodium hydroxide (the "mineralizer" which further increases the solubility) has been added. The bomb is closed and heated so that the base is at about 400° C with the top perhaps 50° lower. Under these conditions a pressure of about 21,000 lbs. per square inch develops and convection currents produce an upward flow from the lower region where the feed quartz dissolves to form a saturated solution. When this solution enters the upper cooler region of the bomb it cannot hold as much quartz in solution and crystallization occurs on the seeds. The cooler spent solution now flows downward by convection and is able to dissolve more quartz and repeat the cycle. In a period of two weeks the seed plate will add to its thickness 1/2 to 2 inches of new material depending on conditions. Quartz crystals grown in this manner are shown in Fig. 10.

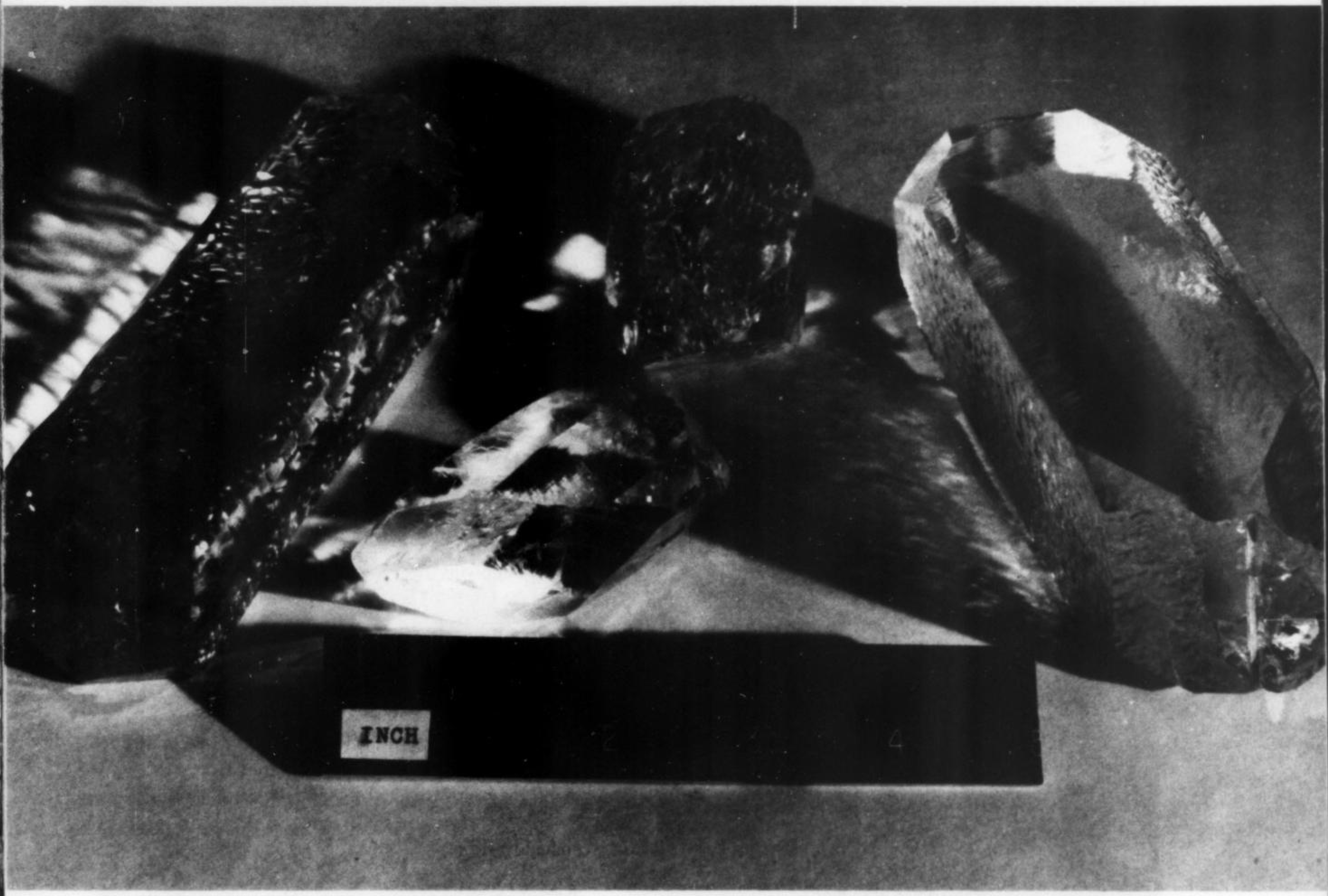


Fig. 10. **Hydrothermally grown quartz crystals**

D. *Flux Growth*

This usually involves a high melting solvent and is termed fluxed melt growth in Great Britain. The most commonly

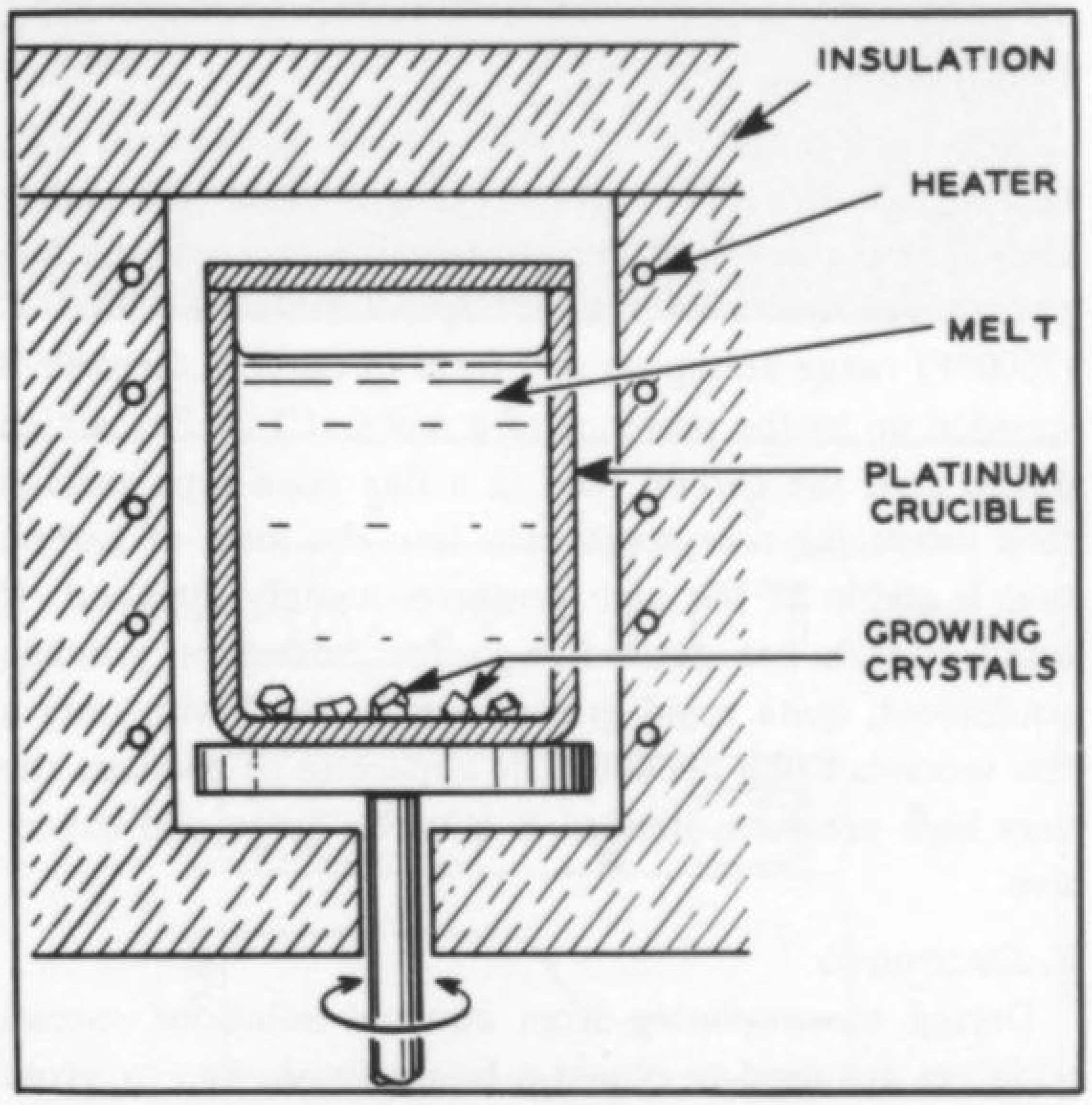


Fig. 11. **Apparatus used for flux growth**

mixed, melted at 1300° C with intermittant rotation for 6 hours; cooling 4°C per hour for 1 week, then heat is shut off; flux dissolved in 30% nitric acid.

The amounts are chosen so that the Al_2O_3+Cr_2O_3 is completely dissolved at the 1300° C temperature. As this is lowered so is the solubility and ruby begins to crystallize. used fluxes include PbF_2, PbO, B_2O_3, or mixtures of these, alkali tungstates, and halides such as KF and NaCl. One of the components of the material to be crystallized is sometimes used as the solvent, e.g., moissanite (SiC) can be grown from its solution in molten silicon (Si).

The apparatus is relatively simple, consisting of a crucible (usually of a precious metal, e.g., platinum) in a furnace with good temperature control. Interrupted crucible rotation may be used to provide mixing as shown in Fig. 11. In a typical ruby flux growth experiment the following conditions might be used in a 6 inch diameter 12 inch high platinum crucible: to be crystallized 740 gm. Al_2O_3, 0.1 gm.Cr_2O_3; flux 400 gm.B_2O_3, 5000 gm. PbO; all of this is Finding a suitable flux and the correct conditions is something of a hit and miss proposition and very time consuming. Scaling up this technique to produce crystals as large as 1 or 2 inches across is very difficult.

Many crystals have been grown by this technique, including ruby, garnets, emerald, chrysoberyl, zincite, spinels and many others, some of which were listed in Part II. The literature listed in Part I should be consulted for further details. The appearance of some garnet crystals still in the crucible is shown in Fig. 12.

In the flux zone processes (e.g., temperature gradient zone melting, travelling solvent method, thin alloy zone crystallization, etc.) a thin zone of flux is made to travel through the material, dissolving at the front and crystallizing at the back. The motion can be induced by a moving hot zone or by a temperature gradient alone. Silicon carbide has been recrystallized in this way.

E. *High Pressure Growth*

This is used primarily for the growth of diamond crystals, which have been reported over 1 carat (0.2 gm) in size. The process involves pressures above one million pounds per square inch and temperatures in the 2000° C (3600°F) range acting on any form of carbon. Growth is speeded up by the presence of a metal (Cr or Fe), which passes thru the carbon feed in a flux zone type fashion thus producing recrystallization into the form of carbon that is stable at the high pressure, namely diamond. If small crystals are desired, e.g., for cutting or grinding equipment, quite rapid growth can be used with only a few seconds being needed. The apparatus to produce the very high pressures needed is however large and expensive.

F. *Electrolysis*

During electroplating from aqueous solutions special additives are used to obtain a bright finish, i.e., to avoid crystal growth. By changing the electrolysis conditions, the growth of crystals of copper, silver (shown in Fig. 13), gold, etc. can be achieved.

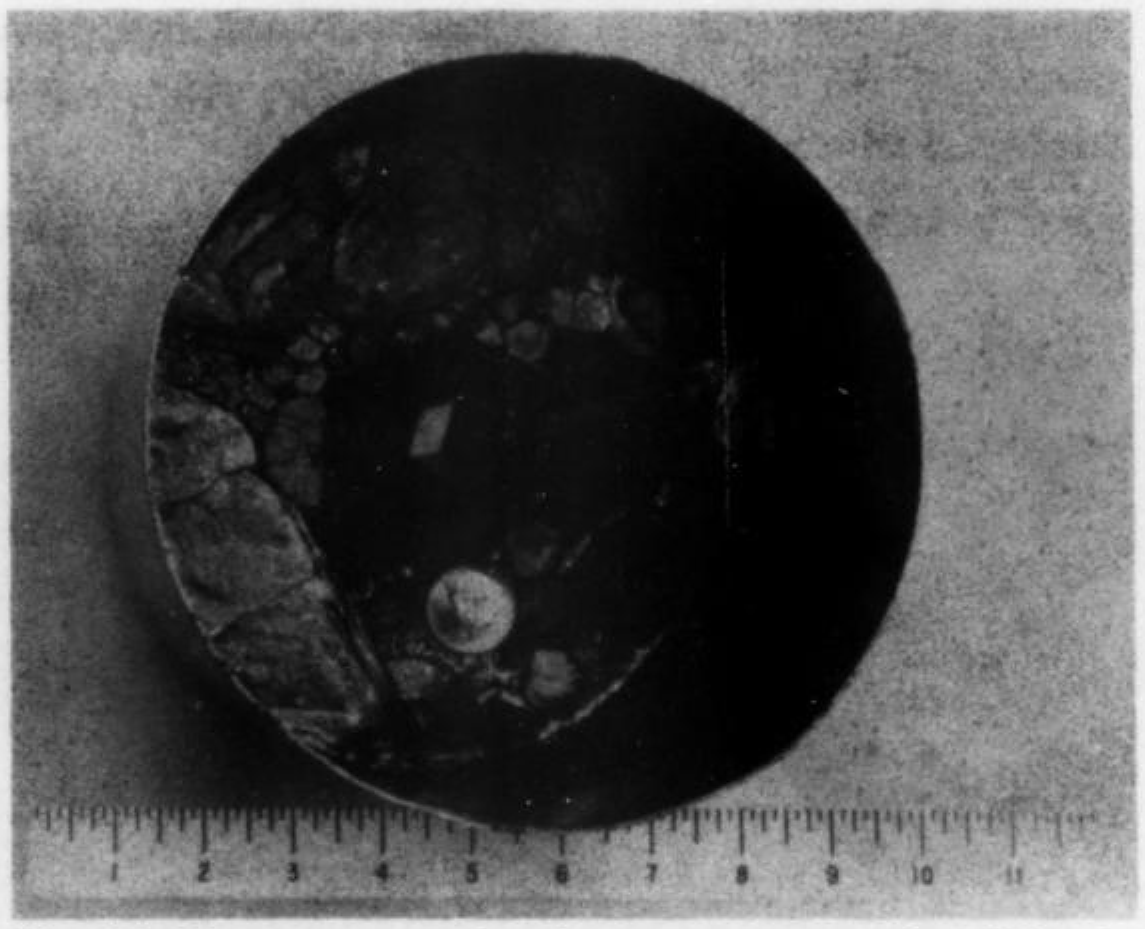


Fig. 12. **Flux grown yttrium iron garnet crystals still in the crucible; scale in inches**

Similarly elecrolytic growth can be conducted at elevated temperatures from fluxes. Thus cohenite (Fe_3C-cementite) has been grown by the electrolysis of sodium ferrate ($Na_2Fe_2O_4$-supplying the Fe) and sodium carbonate (Na_2CO_3-supplying the C) dissolved in a flux of sodium metaborate ($NaBO_2$) and lithium fluoride (LiF).

9. *Growth from the Vapor Phase*

Some materials have an appreciable vapor pressure at temperatures where they are still solid. Accordingly they can sublime without melting and, in the reverse process, crystallize by condensation from the vapor phase without formation of a melt. If this is not possible then the components may be brought together to react in the vapor phase, or another chemical may be added to produce chemical transport.

A. *Vapor phase sublimation*

This may be carried out in a closed evacuated tube or in an open tube with an inert gas flow to help the sublimation movement. The feed section is usually held at a temperature higher than the growth section as shown in Fig. 14. Nucleation and growth may occur haphazardly as small crystals on the walls of the growth tube (usually fused silica), as a thin layer on a seed crystal, or as a large single crystal at the end of the tube. Greenockite (CdS) is an example of a material that can be grown in all three ways in open or closed tubes (Part II, Fig. 2).

B. *Vapor Phase Reaction*

In this technique several gas streams may be brought together into a heated chamber where reaction occurs. Thus both Cd and S may be carried in inert gas streams to react to form greenockite crystals, a silane compound containing both Si and C such as CH_3SiCl_3 may be decomposed in a hydrogen stream to form moissanite (SiC-silicon carbide) or a gas stream containing zinc chloride ($ZnCl_2$) may be reacted with oxygen containing gas streams to give zincite (ZnO) as shown Fig. 15. Other crystals grown in

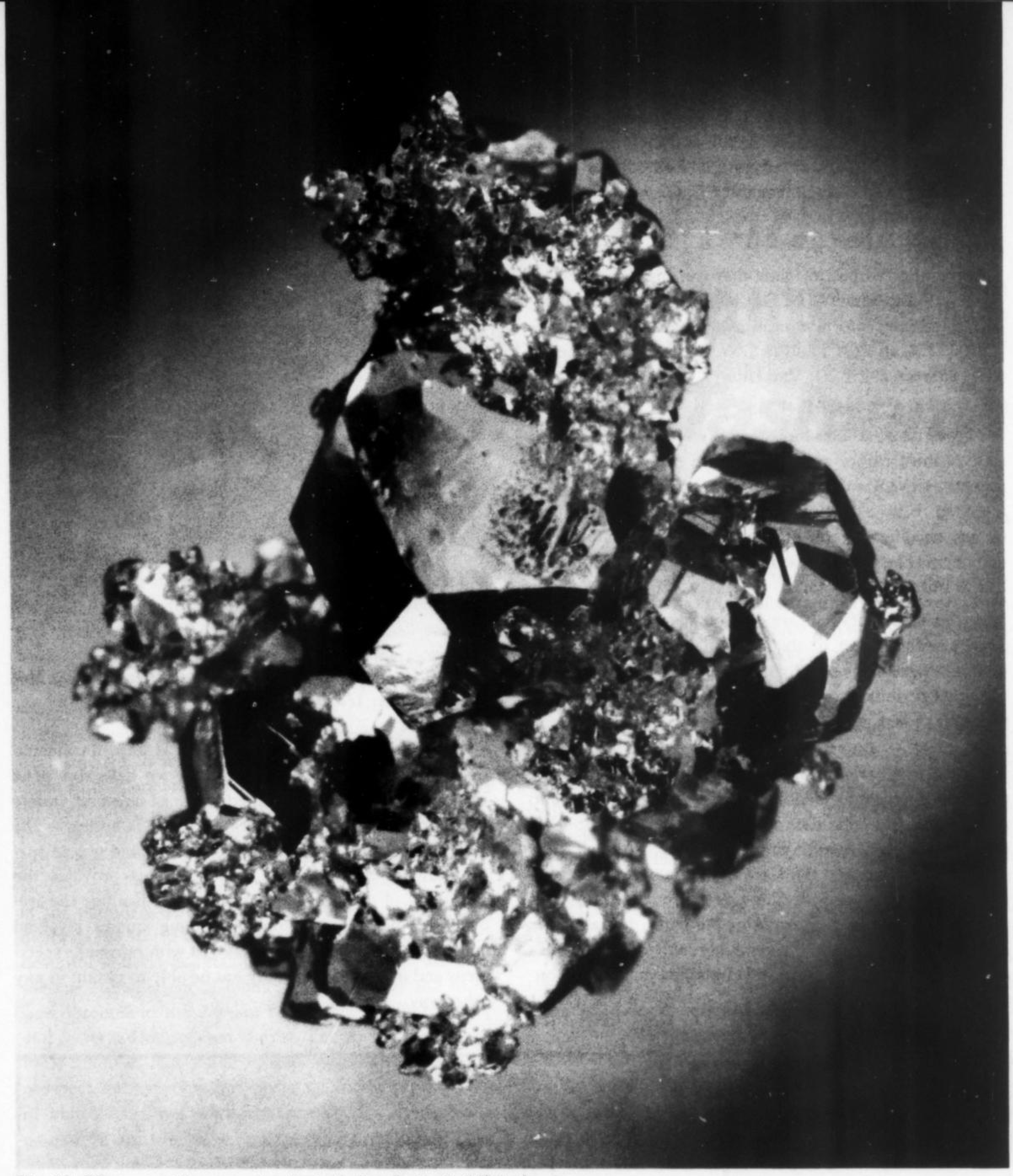


Fig. 13. **Silver crystals grown by electrolysis; cluster is 1/2 inch across**

this way include corundum (Al_2O_3), YIG ($Y_3Fe_5O_{12}$), and cassiterite (SnO_2).

C. *Vapor Phase Transport*

This is carried out in a closed tube as in Fig. 14b. As an example zinc sulfide is sealed into a tube with some iodine. In the feed section the reversible reaction

$$ZnS+I_2 \rightarrow ZnI_2+S$$

produces zinc iodide and sulfur, both of which are more volatile than the zinc sulfide. In the cold end of the tube the reaction reverses and the zinc sulfide crystallizes (as sphalerite or wurtzite depending on the temperature) and

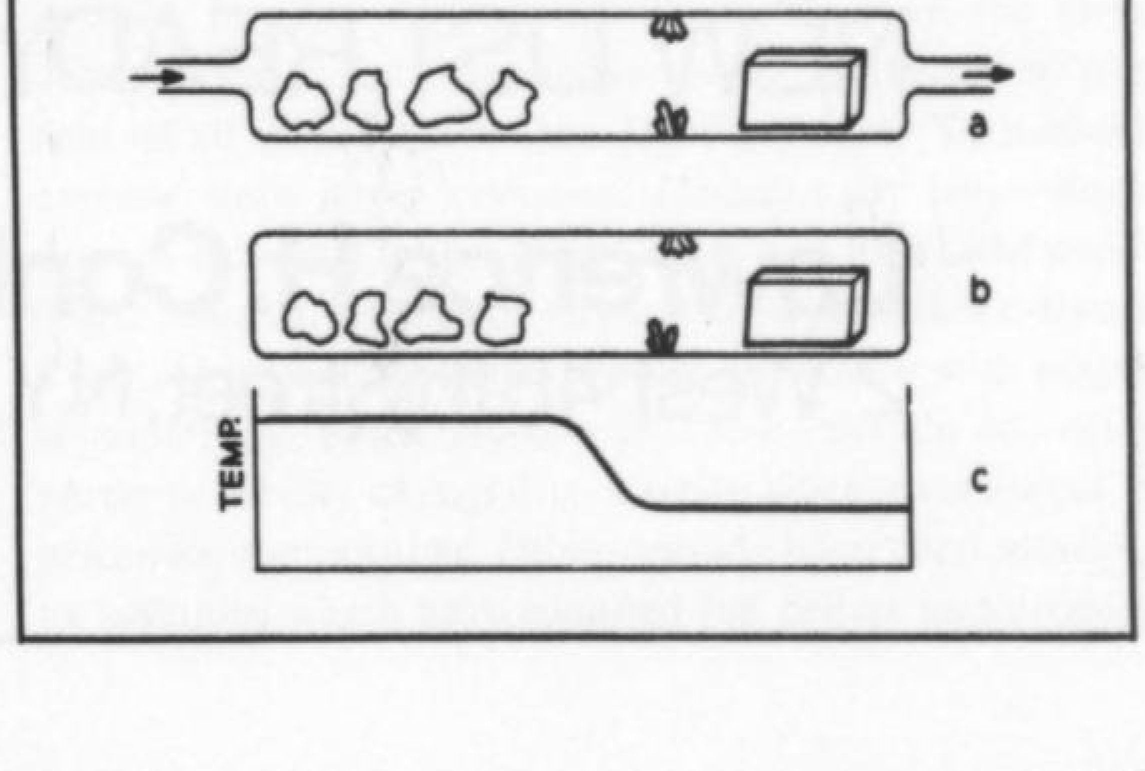


Fig. 14. **Apparatus used for vapor phase growth**

releases the iodine which can then again transport more material. The halogens (I_2, Cl_2, etc.) and their acids (HCl, etc.) are favored transport reagents, and other crystals that have been grown include magnetite (Fe_3O_4), copper (Cu), and corundum (Al_2O_3).

Acknowledgment

The author wishes to thank many of his associates for the loan of specimens, for the permission to use photographs, and for information in general. Particular thanks go to E. D. Kolb, R. A. Laudise, J. W. Nielsen, J. P. Remeika, J. W. Shiever, and L. G. Van Uitert.

Conclusion

This series of articles has been an attempt to survey the state of the art of crystal growth, with emphasis on those aspects relevant to mineralogy. The treatment was not intended to be exhaustive, and for detailed information on any specific mineral or crystal growth technique reference must be made to the literature as described in Part I (and not to the author).

In the laboratory we are limited in three important aspects with respect to the growth processes by which minerals were formed in nature. First, we do not have extended periods of time available; we become restless if a crystal growth experiment threatens to take more than a few weeks — a time miniscule on a geologic scale. Second, we do not have the analogously large volumes of magmas or pegmatites to feed our growing crystals to permit them to reach the huge sizes often found in nature, although on rare occasions, as with gem grade ruby, we seem able to surpass nature. And third, we have container problems — to contain not only the high pressures and temperatures found deep in the mantle of the earth, but also the corrosiveness of some of the crystal growth system chemicals; sometimes we can use self-containment, but not on the scale which nature employs.

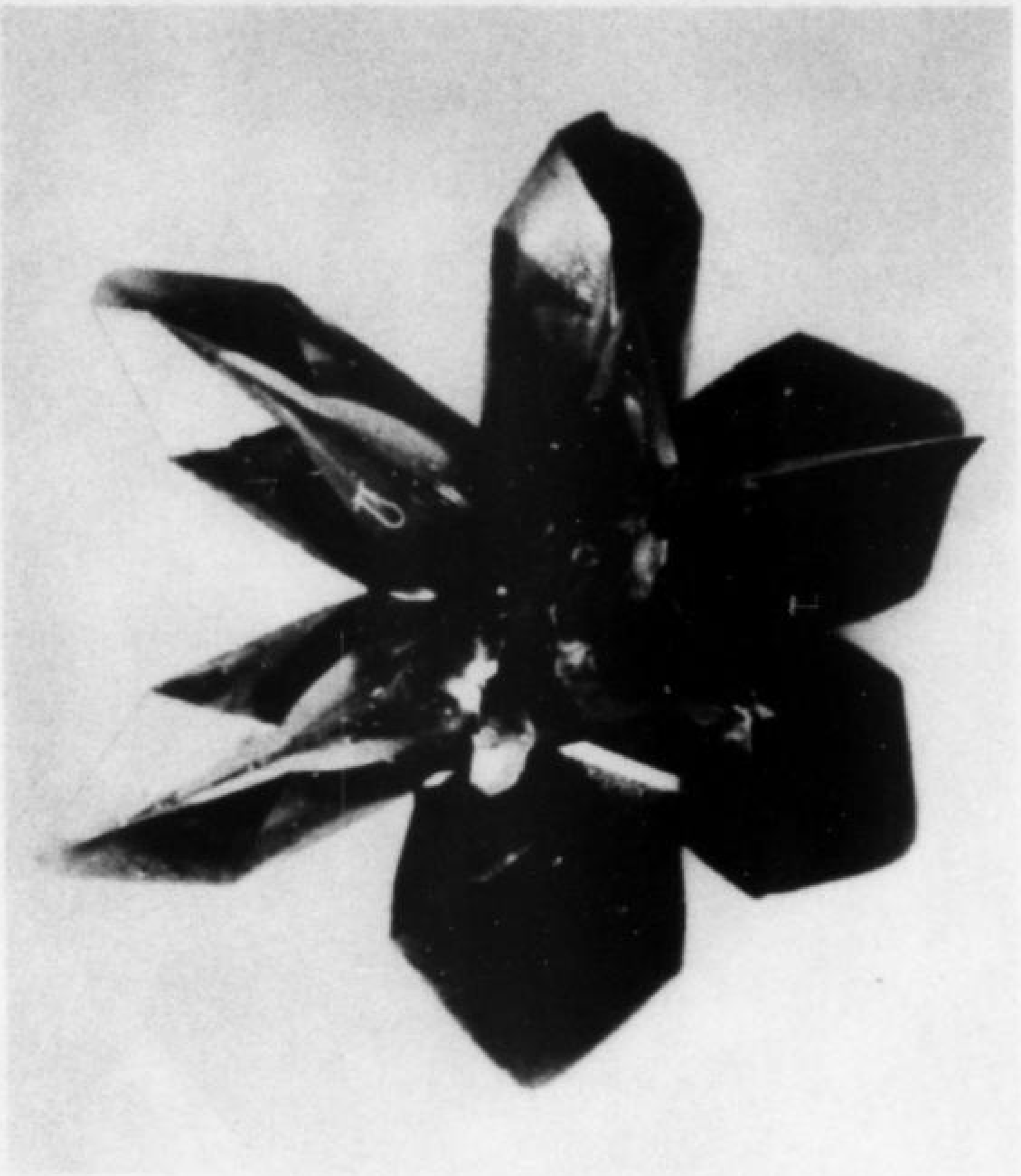


Fig. 15. **Unusually twinned zincite crystal; colored blue by impurities; 1/2 inch across**

Nevertheless, as the listing of Part II and the illustrations in these three articles indicate, we have not done too badly. To offset our limited range of size and variety we can offer one quality only rarely found in nature — the ability to provide essentially pure crystals and to add specific impurities in desired amounts. This provides the possibility of technological utility which justifies the frequently expensive and time-consuming studies involved and can also provide the mineralogist with reference specimens and information he may not be able to obtain in any other way.

On a Spectacular Find of
CROCOITE IN THE ADELAIDE MINE
Dundas, Tasmania

by Albert H. Chapman **290 Glebe Point Road • Glebe Point, • New South Wales 2037 • Australia**

The Adelaide mine, Dundas, Tasmania, is a name that must surely excite the imagination of all true lovers of the beautiful in nature, for this comparatively small mine on Tasmania's rugged west coast has afforded the most spectacular examples of the rare and beautiful mineral, crocoite, ever found.

The mines of the Zeehan-Dundas region of Tasmania were discovered in the mid 90's of the last century and came into operation shortly after, being worked mainly for their silver. Their life was short. Ten to fifteen years saw most of them abandoned, to be overgrown by the bush and forgotten by all but mineral lovers. More than fifty years were to pass before the post-war upsurge of interest in the natural sciences encouraged people to search for minerals the world over. It was only natural that such a beautiful mineral as crocoite would be one of the most sought after. Letters of inquiry from all over the world were directed to the Zeehan Post Office as the township of Dundas had long ceased to exist. The post office directed these inquiries to a miner named Smith who decided to prospect the old mine for specimens. After several years of almost constant work, he produced a considerable amount of crocoite, mostly of mediocre quality, but also some very fine specimens as well — inevitably smaller in number.

Since that time, several people have tried their luck with results approximating those of Smith. One of these men, Franz Mihajlowits, an experienced miner, decided to work full time at the Adelaide, assisted, in his spare time, by another miner Ken Bugg. Two years of work produced similar results as former workers, until one day in July, while working alone, Franze broke into a large cavity some eight feet long, six feet high, and four feet six inches wide. Enlarging the hole big enough to hold his light an arm's length into the cavity, Franz was spellbound by a scene of sparkling beauty, such as few men have ever witnessed. The roof, walls, and even the floor were completely covered with crocoite crystals of all sizes, from the dimensions of pins to a few that exceed 3 inches in length. All were terminated and of the finest colour. Not since the heyday of the mine had anything like it been seen! And the possibility that such a sight will ever be seen there again is extremely remote.

Due to the obvious need for secrecy, it is regretted that no photographic record of this remarkable find was possible. The arrival of a professional photographer, with all the necessary trappings, would undoubtedly have stirred up a veritable hornet's nest. There now remained the slow, tedious task of removing these most delicate specimens. Even though the greatest care was exercised, a care that is attested in the great perfection of many of the specimens, and for which Franz and Ken deserve the greatest praise, it has been estimated that nearly eighty percent of the specimens were lost from various causes. The principle cause of loss was the extremely earthy condition of the limonitic matrix to which the crystals were attached, as well as the awkward position of the vug high up in the back of the old stope. All in all, approximately 1,000 specimens of all sizes from thumbnail to a couple of choice specimens 18x15x8 inches were taken out unharmed. The quality of many was superb and in no small measure these help to restore crocoite to its rightful place in the forefront of the world's most beautiful minerals.

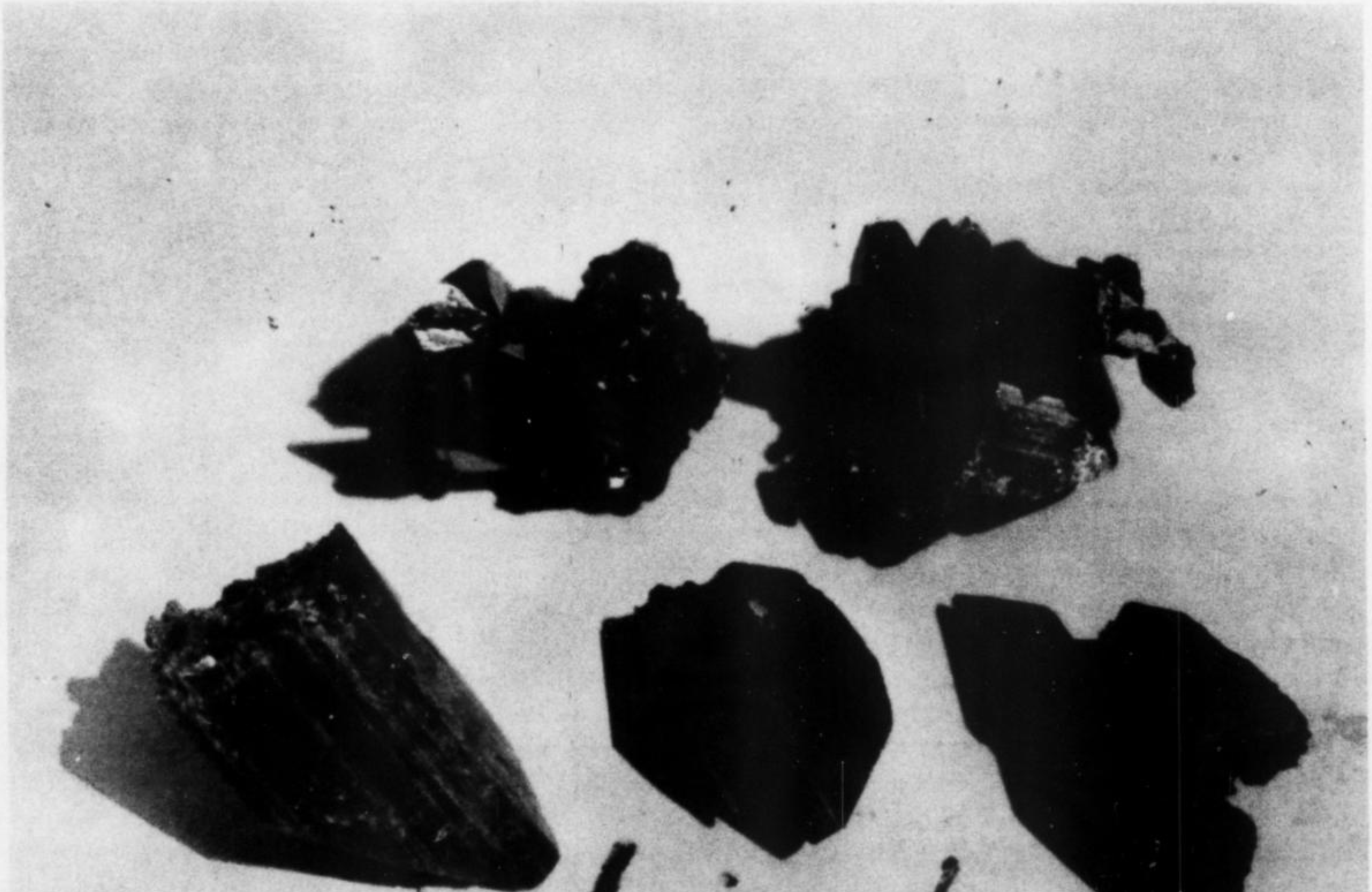
In the vicinity of the large vug a quantity of bright red crocoite occurred as veins of closely matted reticulated crystals, forming very attractive specimens of the more conventional variety that always made up at least 90 percent of all crocoite from the Dundas mines. Terminated crystals were never common. Occasionally large single crystals occurred in the West Comet and Red Lead mines (Figs. 2 and 3). Groups of terminated crystals were always a rarity. Many of the larger crystals are hollow with ragged terminations. Thick clusters of these crystals are often partly or wholly changed to a white siliceous material of unknown composition. Other crystals have been attacked by solutions which have rounded the prisms and reduced the terminations to fine points. No doubt, post-mine leaching in ground disturbed by mining operations is responsible for clusters of tiny crystals found on the walls of old adits and stopes. These crystals represent redeposition from the solutions that did the leaching. Infrequently a crystal type rare to Dundas has been met with in which the crystals are short and thick with steep terminal planes, the prism being much depressed or absent. Crystals of this type are illustrated in Fig. 1.

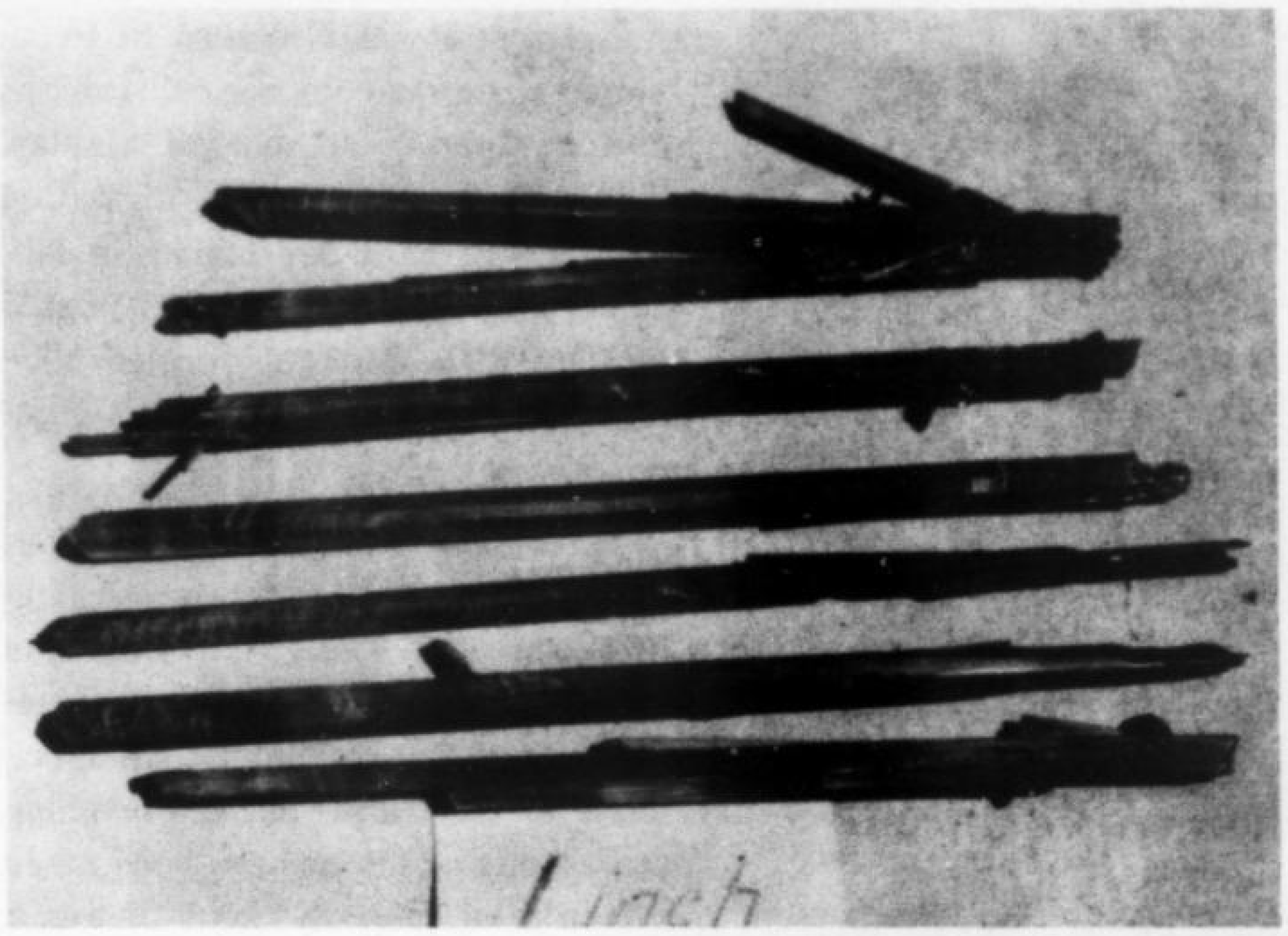
Another recent find in the Adelaide mine was a small deposit of dundasite. This rare lead aluminum carbonate hydroxide hydrate occurs as tiny, snow-white, spherical, radiating capillary aggregates on limonite. Numerous small, bright-red, doubly-terminated crocoite crystals scattered on the dundasite add considerably to the interest of these specimens. In the same area colloidal masses of another white mineral, gibbsite, were found, also on limonite. Crocoite is also present but in this case it is invested by the white mineral. The turquoise-blue coating of unknown composition investing dundasite, so characteristic of the early-day finds, was not present in this latest find.

A few notes on the mineralogy of the Zeehan-Dundas mines may not be out of place here. The primary ore consisted of coarse to fine galena with minor sphalerite and varying amounts of silver, the latter being the metal sought after in the mining; its percentage determined those mines that could be profitably worked. The principal gangue mineral was siderite. The ore bodies are enclosed in serpentine of Cambrian age. Portions of this serpentine contain numerous tiny crystals of chrome spinel (picotite). Subsequent weathering released chromic acid to react with the oxidizing galena, resulting in crocoite and chrome cerussite. Stichtite (rhombohedral magnesium chromium carbonate hydroxide hydrate) and, less frequently, barbertonite (the hexagonal dimorph of stichtite) also resulted from the weathering of serpentine in the Dundas region.

End results of the extensive weathering and oxidation of these ore bodies are siderite altered to limonite, much of which is soft, claylike material. Crocoite and other secondary minerals enclosed in this material are practically invisible until it is hosed away. Crocoite was the dominant mineral, and large quantities of it were sent to the Zeehan smelters for flux. Other mines in the Zeehan-Dundas area, as well as some mines in the Whyte River and Heazelwood districts, produced smaller amounts of crocoite often associated with other oxidized lead minerals: cerussite, chrome cerussite, pyromorphite, anglesite (in superb specimens, often with clear, colourless crystals 5x4x1 cm) associated with massicot and dundasite. Silver halides were less plentiful, and phosgenite, in remarkably perfect crystals, was rarest of all the secondary minerals in this district.

***Fig. 1.* Crocoite in short, thick crystals with steep terminal planes. Dundas.**





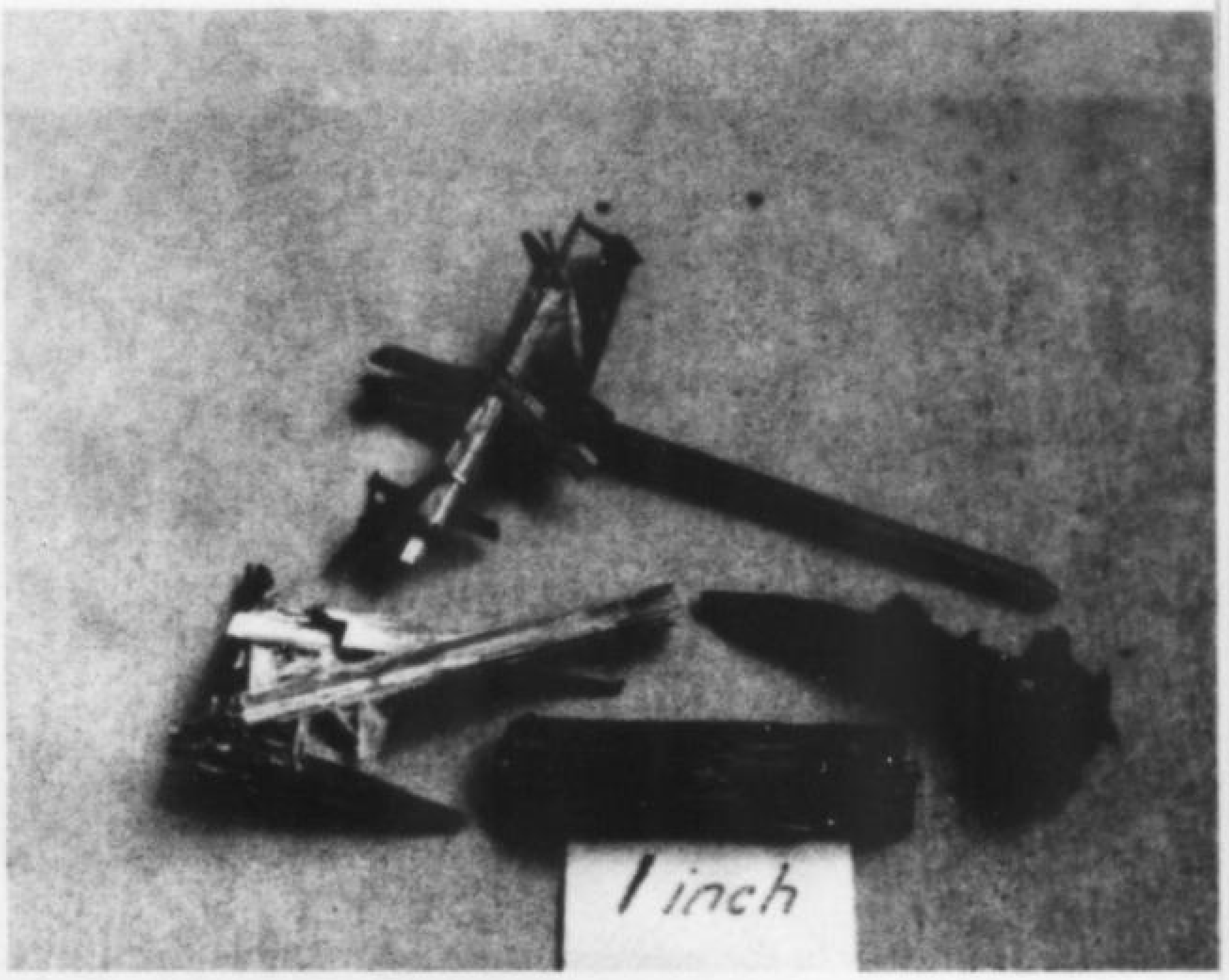


Fig. 2. **Crocoite in long, pencil-like crystals. Dundas.**

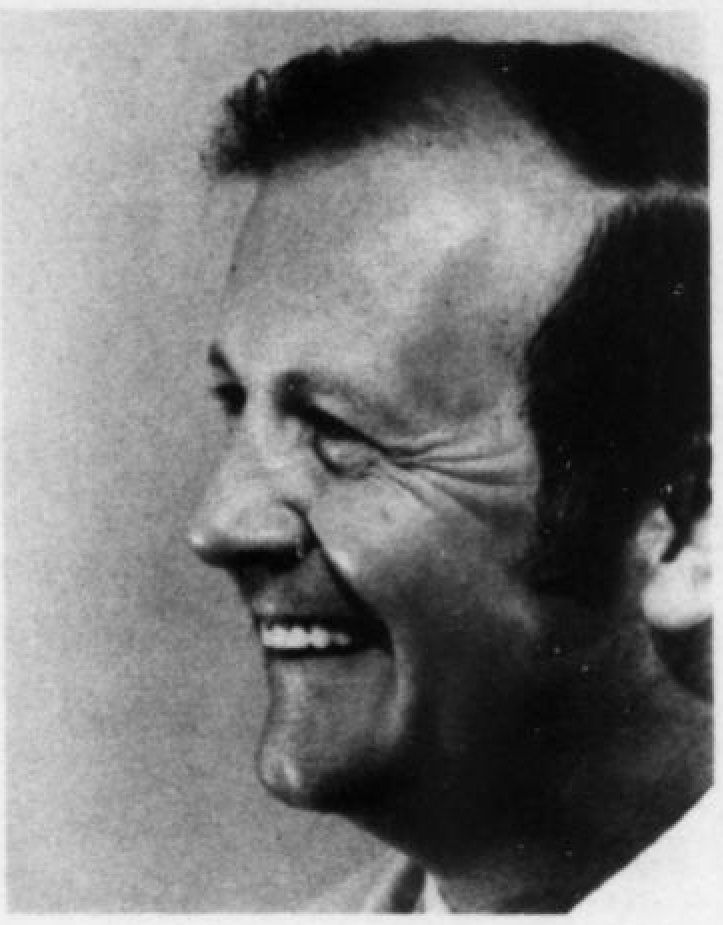
Fig. 3. **Clusters of Crocoite crystals of typical Dundas habit.**

Fig. 4. **Chrome cerussite. Dundas.**

Fig. 5. **Crocoite, in small crystals, invested with dundasite. Dundas.**

The Museum Record

by Paul E. Desautels



In the process of getting ready for an excursion to the Rocky Mountain Federation Show in Phoenix, I was reviewing in my mind the strength of the hobby in the State of Arizona. None of us really needs to be reminded that the fermentation and distillation of all this Arizona activity resulted eventually in the incomparable Tucson Show. It seems only natural, then, that Arizona should have some sort of serious museum activity going also. As expected, there are two such centers of importance although, admittedly, neither is yet of major National stature. At the moment the better of these two is in Tucson. Surprisingly, many collectors who attend the annual show there in February aren't even aware of the fine mineral collection which is on display in the Geology Building of the University of Arizona. From many experiences with mineral collections located in geology departments across the country my natural tendency is to avoid all of them as a gross waste of time. However, I am constitutionally unable to pass anywhere near any collection without a quick look. The University of Arizona collection proved well worth the first effort and now, each year, I make a point of returning to it for at least a short visit.

The Geology Building is on the North Drive of the campus and the collection is very near the entrance. Visiting hours to this free museum are from 8:30 A.M. to 4:30 P.M., and 8:00 A.M. to 12:00 noon on Saturdays. Clean, neat, well kept, well lighted and well housed are terms seldom used to describe such collections but they all fit in this case. With no apologies to the general public a "Dana" type classification and arrangement system is used for the display of specimens. I'll make no detailed description of the specimens here except that it is only fair to warn Dr. Anthony and Mrs. Murchison, who are directly responsible for the museum, that I have a little list of those specimens I feel belong in the National Collection — including a Japanese law quartz twin from Washington Camp and a certain jackstraw cerussite from the Flux Mine. The collection is rich in these and other Arizona and Mexico specimens but it is also a world wide collection rich in species. Just to prove that their tastes are catholic the museum staff has also seen fit to include some paleontological exhibits and a fluorescent mineral display. There are even some fine original oil paintings of early-day mining in Arizona and the Southwest presented by Dr. P.G. Beckett, former Vice President of the Phelps Dodge Corporation.

The museum collection was built around the private collection of former Professor and Dean G. Montague Butler. He established the museum in 1919 and eventually gave his specimens to it. During the intervening years many additions have been made and the present specimen total exceeds 10,000 of which approximately 2,000 are on display. Suffering from the usual shortage of specimen purchase funds there has been continuous reliance on private donations of specimens for updating the collection. Some of the copper minerals donated by Dr. P.G. Beckett are highly prized by the museum.. The Tucson Gem and Mineral Society has made a series of gifts. Local private collectors and even mineral dealers such as Davis Minerals have all done their part to help. The result is a fine collection, not overpowering in size or quality, but far better than most municipalities in the United States can offer.

The other museum, called the Arizona Mineral Museum, is at the State Fairgrounds in Phoenix. Along with local support it has the backing of the Arizona Mining Association. They have been trying very hard in recent years to bring about a major revolution and expansion of the museum effort. Anyone who has seen some of the specimens brought to Tucson each year by the curator, Lee Hammons, has had a sampling of the fine things in the collection. At the moment I have in hand a letter from Lee in which he outlines the A.L. Flagg Foundation and its purposes in support of the museum effort. The Foundation is named after a former friend and a remarkably knowledgeable man who, at the Arizona State Museum before his death, was totally dedicated to assisting others in learning about minerals. Appropriately, the foundation exists for the purpose of informing the general public, students and teachers on all aspects of geology, mineralogy and other earth sciences. The foundation attempts to acquire collections and specimens, by donation or purchase, which are especially significant from Arizona occurrences. Eventually the foundation hopes to establish an Earth Science Institute which will contain a museum, library, research and training facilities. Meanwhile, parts of the Foundation's collections are on display at the Arizona Mineral Museum. Admittedly, space there is much too cramped and the exhibit situation is generally not good. However, it does allow for temporary display quarters until the pro-

continued on page 134

tennantite - tetrahedrite from naica, chihuahua, mexico

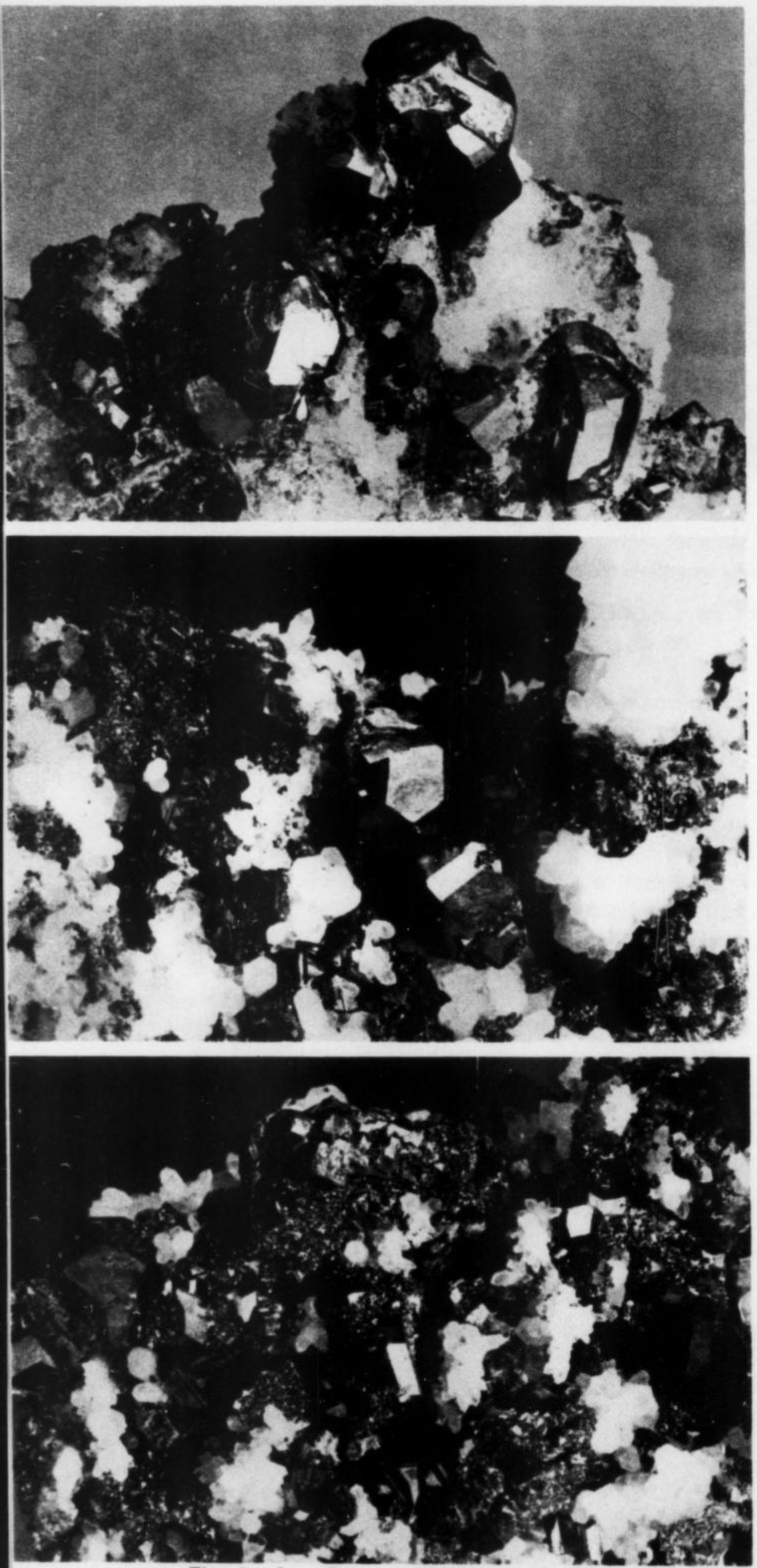
by John S. White Jr.
(with microprobe analysis by Joseph A. Nelen)

Smithsonian Institution • Washington, D.C. 20560

About two years ago a mineral sample from Naica, Chihuahua, Mexico, looking very much like tetrahedrite from the classic old locality of Kapnik (now Cavnic or Capnic), Rumania, was sent to the National Museum of Natural History, Smithsonian Institution, for identification, by Jack Young of Lyko Mineral and Gem, El Paso, Texas. It consisted of semi-isolated, relatively unmodified tetrahedra of dark gray, metallic crystals perched upon flat plates of milky quartz crystals. A portion of one crystal was x-rayed, routinely identified as tetrahedrite, and Mr. Young was subsequently notified of the results.

Sone weeks later the same material was seen in considerable quantity at a mineral show — all labelled tennantite. Questioning of the dealers handling it produced only vague statements that someone had identified it as tennantite. Upon my return to the Museum, I x-rayed some new samples only to find that I was unable to obtain an x-ray pattern that was uniquely that of tetrahedrite. It was also not uniquely that of tennantite. Actually the patterns of both end members of the series were present on the same film! Figure 1 shows a portion of a powder pattern in which tetrahedrite and tennantite lines are clearly superimposed, appearing as pairs. In this case tennantite is the dominant phase, represented by the darker lines of each pair. The lack of sharply defined lines and the gray areas between each pair suggest that lesser amounts of the series, more intermediate between tennantite and tetrahedrite, are also present in the sample.

Fig. 1. **X-ray powder pattern of tennantite-tetrahedrite from Naica, showing line doubling.**



Figs. 2a, b, c. **Large tennantite-tetrahedrite-covered chalcopyrite crystals on quartz, three views of the same specimen from Naica. Fig. 2c shows the drusy pyrite. Smithsonian Institution specimen #122994. Photos by Joel E. Arem**

NATURE OF THE CRYSTALS

The crystals average about 1/2 inch in diameter but reach 1 inch on many specimens (Figs. 2 a,b,c). Every specimen appears to contain some crystals with perfectly smooth surfaces and others with an etched, frosted appearance. There is no difference between the powder patterns of either type.

After examining a large number of broken crystals, and actually breaking some of them myself under the microscope, it became obvious that most, if not all, of this tennantite-tetrahedrite is merely an oriented overgrowth over single crystals of chalcopyrite. Epitaxy has not been proven here but these minerals are so similar both structurally and morphologically that it is certainly to be expected. Numerous examples of chalcopyrite-tetrahedrite epitaxy are documented (Palache *et al,* p. 380). The layer of tennantite-tetrahedrite over the chalcopyrite is remarkably uniform in thickness, about 0.5 mm, wherever observed.

While the crystals appear to be solid, many of them are actually hollow or at least partly hollow shells of tennantite-tetrahedrite. The inner surfaces of the shells are rough and irregular, appearing severely etched. The interior may be partially filled with one or more of the following minerals: sphalerite, chalcopyrite, and pyrite. Sphalerite and chalcopyrite were no doubt present before the layer of tennantite-tetrahedrite crystallized over them. It seems obvious that tennantite-tetrahedrite formed epitaxially on sphalerite as well as chalcopyrite, a phenomenon also observed on specimens from other localities (Palache *et al,* p. 380). Where chalcopyrite and sphalerite occur in contact, the former is always the first to have formed. While uncoated sphalerite euhedrons are rather plentiful on these specimens, no uncoated chalcopyrite has been observed. The surface of the sphalerite crystals is dull grey-black but the crystals are typically resin-colored when broken.

The hollow crystals of tennantite-tetrahedrite are due to dissolution of chalcopyrite, and possibly sphalerite too. Many of the hollow crystals contain remnants of etched-appearing, deeply embayed chalcopyrite coated by a thin dark-green alteration product.

Pyrite occurs only in microcrystalline druses both inside tennantite-tetrahedrite shells and erratically disseminated over the quartz crystals. Drusy-surfaced, hollow-centered balls of pyrite, when found inside the shells, are always attached to tennantite-tetrahedrite. These balls are surrounded by, but usually not in contact with, massive chalcopyrite (Figs. 3, 4).

Small amounts of galena are present and these are usually found completely enclosed by sphalerite. Some galena crystals have been observed exposed on quartz and the surfaces of these are the typical dull-gray of etched galena.

The x-ray diffraction powder camera is a very useful tool in mineral identification but it is not the answer to all identification problems. Often it can do no more than place

Fig. 3. **A broken section through one of the large Naica crystals. The main mass is chalcopyrite (Cf = freshly broken chalcopyrite, Co = oxidized surface of etched chalcopyrite). The continuous thin shell of tennantite-tetrahedrite (T) is clearly shown. Contacts are inked for emphasis. Smithsonian Institution specimen #123091. Photo by Ben Kinkead**

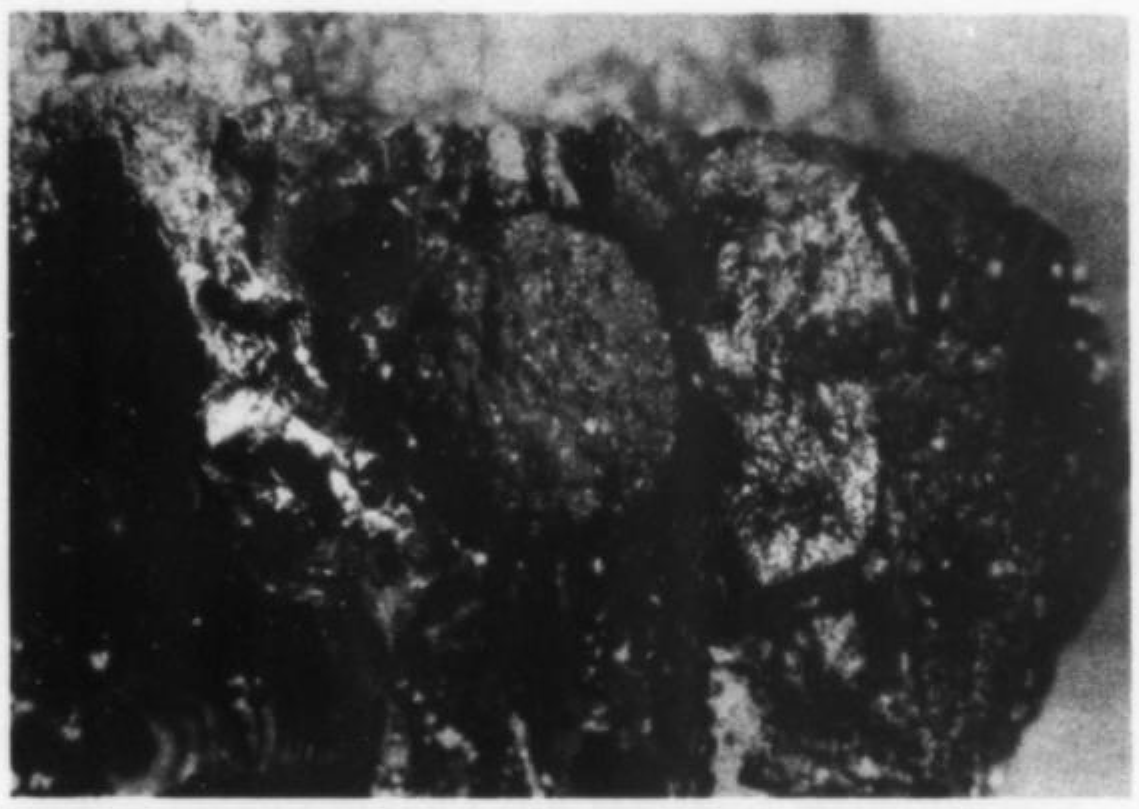


Fig. 4. **A drusy-surfaced ball of pyrite surrounded by chalcopyrite. Note that the two minerals are not in contact. K. C. Brannock specimen. Photo by Ben Kinkead**

an unknown within a particular family of minerals. In the case of this Naica material, x-ray patterns demonstrated clearly that it is heterogeneous, and that it probably consists of a mixture of tennantite and tetrahedrite, with some having a more intermediate composition. But this interpretation is not the only one possible. For example, argentian (silver-rich) tennantite has nearly the same cell size (about 10.3Å[1]) as tetrahedrite (10.33Å , Palache *et al,* p. 374). Thus the Naica unknown could also be a mixture of tennantite and argentian tennantite, which would produce a line-pairing indistinguishable from that of a tennantite-tetrahedrite mixture. Further, a powder pattern does not reveal anything about the *nature* of the heterogeneity; is it concentric zoning (as one would expect), or is it randomly spotty? If it is zoning, is it simple or complex? For the answers to these questions it was necessary to turn to another powerul investigative tool, the electron microprobe. This instrument, as valuable as it may be, also does not provide all of the answers by itself. But when it is used in conjunction with x-ray diffraction, the mysteries of the Naica tennantite-tetrahedrite are readily understood.

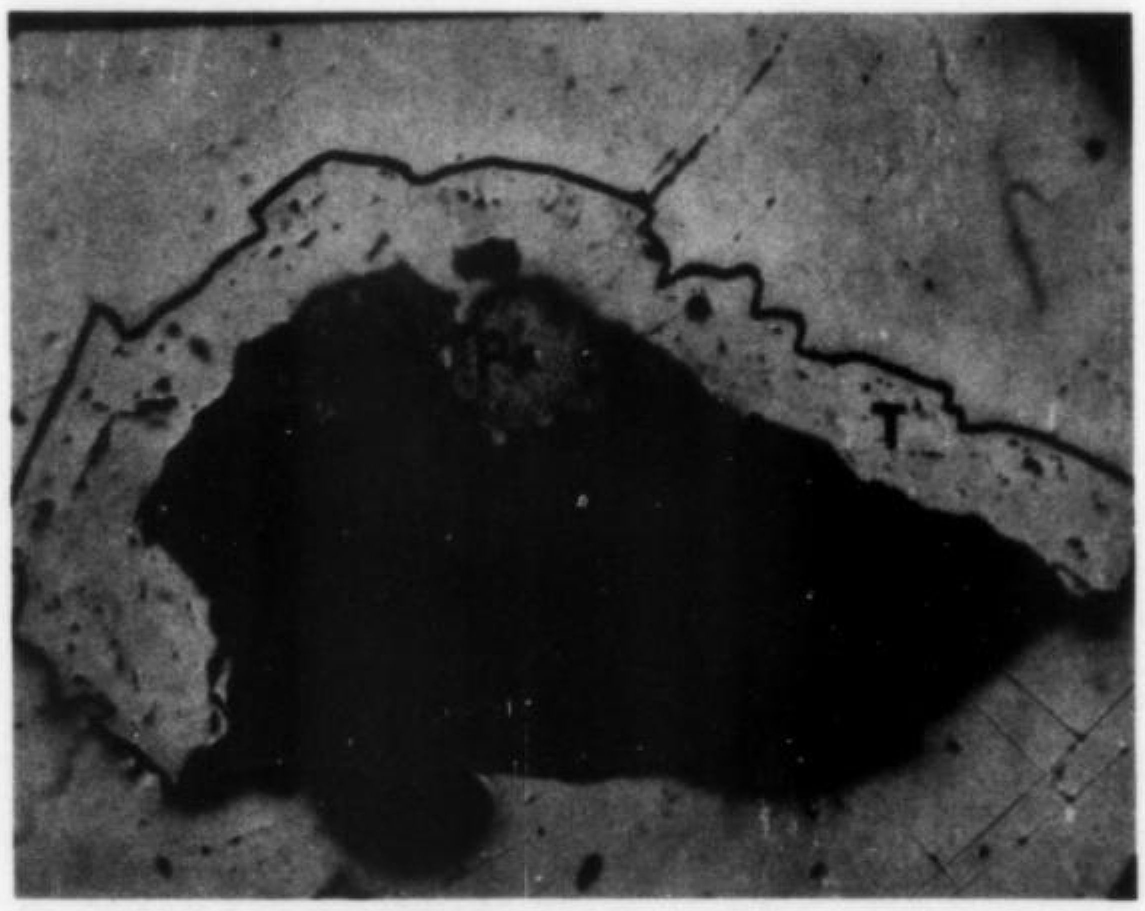


Fig. 5. **Polished section showing tennantite-tetrahedrite (T), chalcopyrite (C), and pyrite (P). The tennantite-tetrahedrite shell is approximately 0.5 mm thick. Smithsonian Institution specimen #123091. Photo by Joseph A. Nelen**

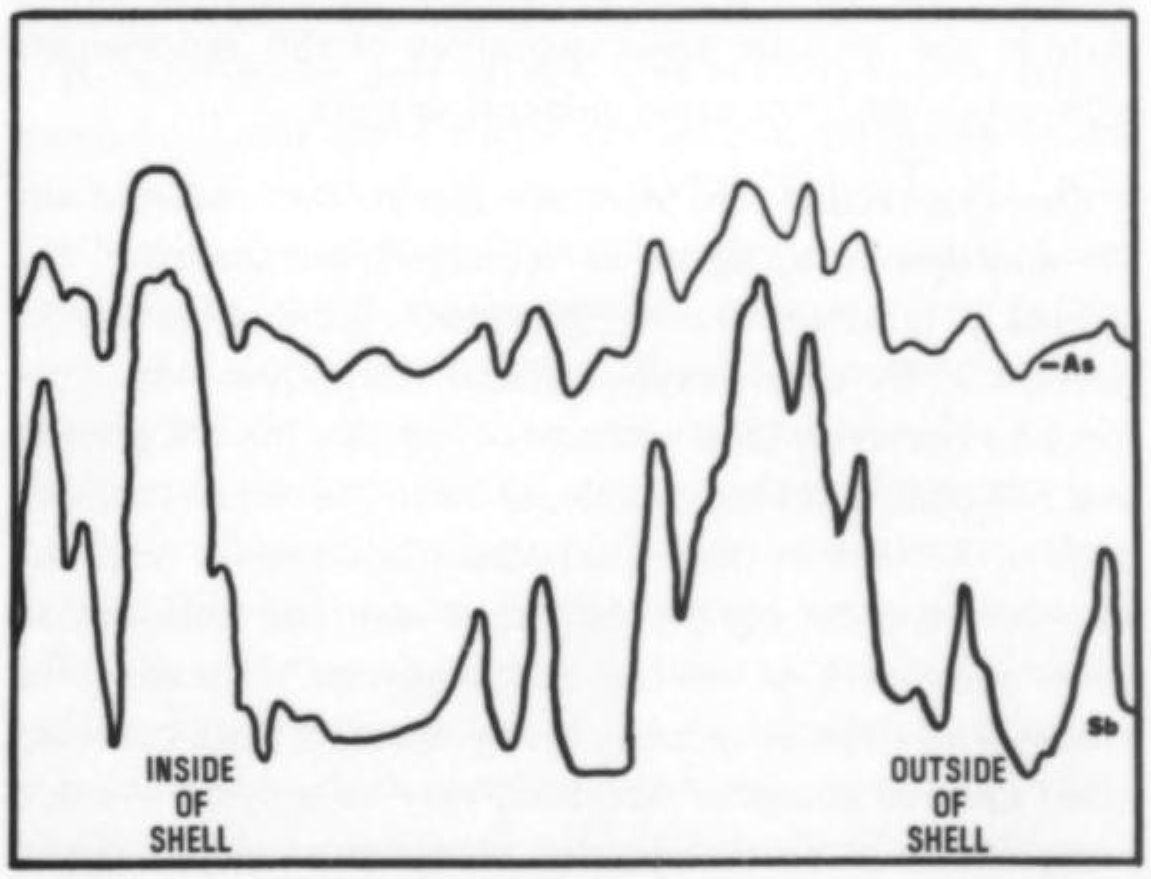


Fig. 6. **Graph of microprobe traverse across the tennantite-tetrahedrite shell showing the inverse relationship of the antimony (Sb) and arsenic (As) content. The arsenic curve has been "flipped" over to emphasize its similarity to the antimony curve**

A small segment of the shell of a hollow crystal (NMNH #123091) was mounted so that it could be analysed on the probe. The mounted sample contained some pyrite and chalcopyrite attached to the inner side (Fig. 5). With a spectrometer first set for antimony, and then arsenic, traverses were made across the shell. The responses were printed upon graphs, the graphs combined and reproduced here as Fig. 6. PLEASE NOTE that the arsenic curve has

---

[1] Estimated on the basis of the difference between the cell sizes of tetrahedrite and argentian tetrahedrite.

been "flipped" over to show more readily how it corresponds to the antimony curve. As the concentration of antimony rises, the arsenic content goes down and *vice versa.* The formula for the tennantite-tetrahedrite series may be written $(Cu, Fe)_{12}(As,Sb)_4S_{13}$. Figure 6 shows that the shell alternates repeatedly between tennantite (As>Sb) and tetrahedrite (Sb>As). This evidence further suggests zoning but it does not prove it. The alternate interpretation of random heterogeneity is still acceptable, even though improbable. Therefore a portion of the shell was selected for mapping the concentration of several of its constituent elements. The microprobe was made to scan a specific area. With the spectrometer set for antimony, high concentrations of antimony were recorded on Polaroid film as light areas, low concentrations as dark areas. This was repeated for arsenic, and then for zinc and copper. The results, shown in Fig. 7 a,b,c,d,e, demonstrate clearly that the shell is concentrically, and complexly, zoned. Note also that there is a broad band of high arsenic tennantite, thus accounting for the darker tennantite lines on the powder pattern. The evidence is now overwhelming and the interpretation is no longer ambiguous.

The factors which led to this zoning are not understood and are beyond the scope of this investigation. Perhaps a reader will care to pursue this problem and, if so, the time is ripe because large quantities of the material are now available from many mineral dealers.

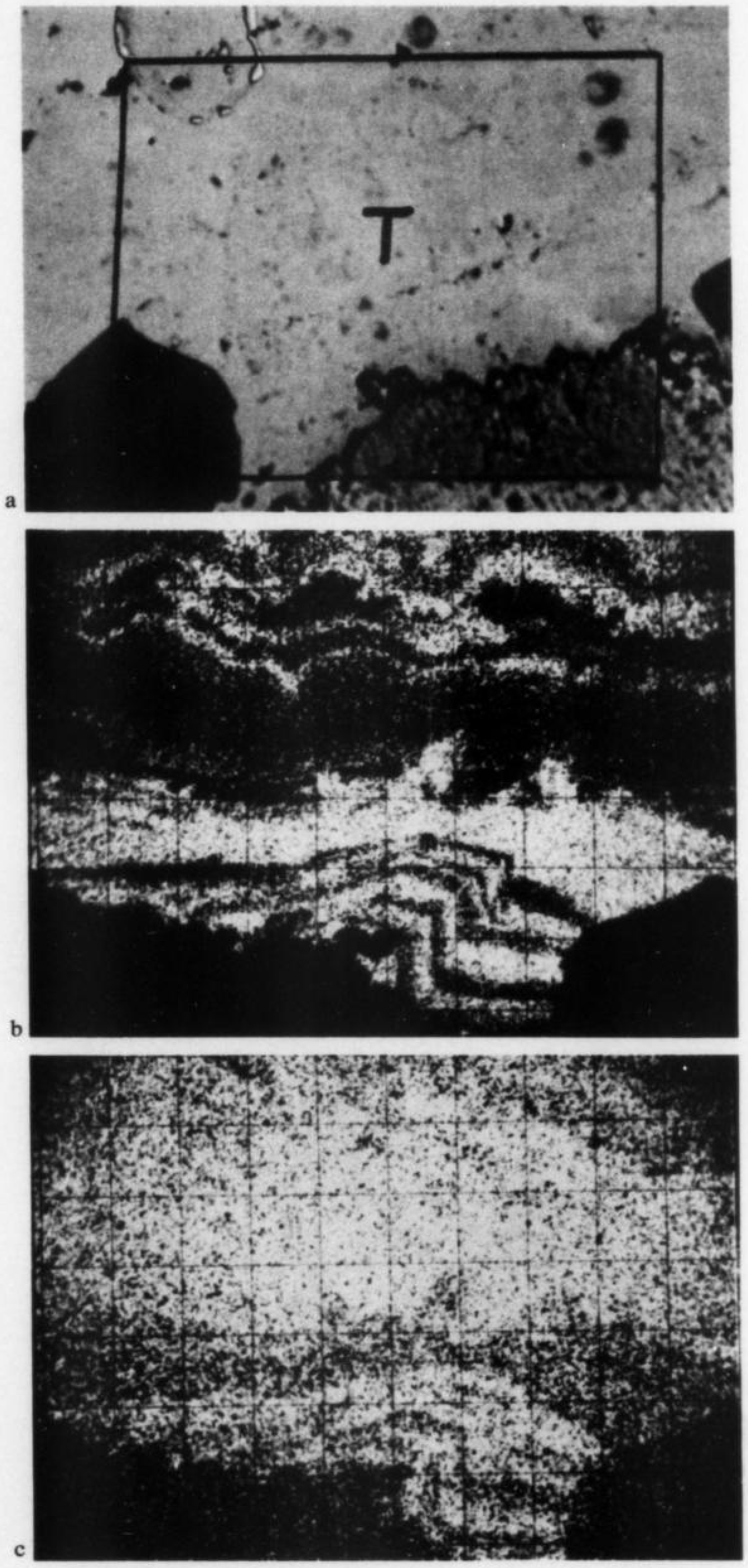
One can readily see, from this report, that many of the pre-microprobe analyses of tennantite-tetrahedrite, and indeed all minerals, are highly suspect. Most of these were performed by classic wet-chemical techniques which required a relatively large amount of sample. Inhomogeneity was difficult, if not impossible, to test. Therefore samples, such as the shell of the crystals described herein, from the same or neighboring crystals were assumed uniform, so were combined, powdered and analyzed. If zoning, or other forms of heterogeneity, was present, it went unrecognized and the analysis, therefore, may be only an average composition of several phases. A classical wet-chemical analysis, in this case, would not be at all meaningful in terms of revealing the true nature of the sample.

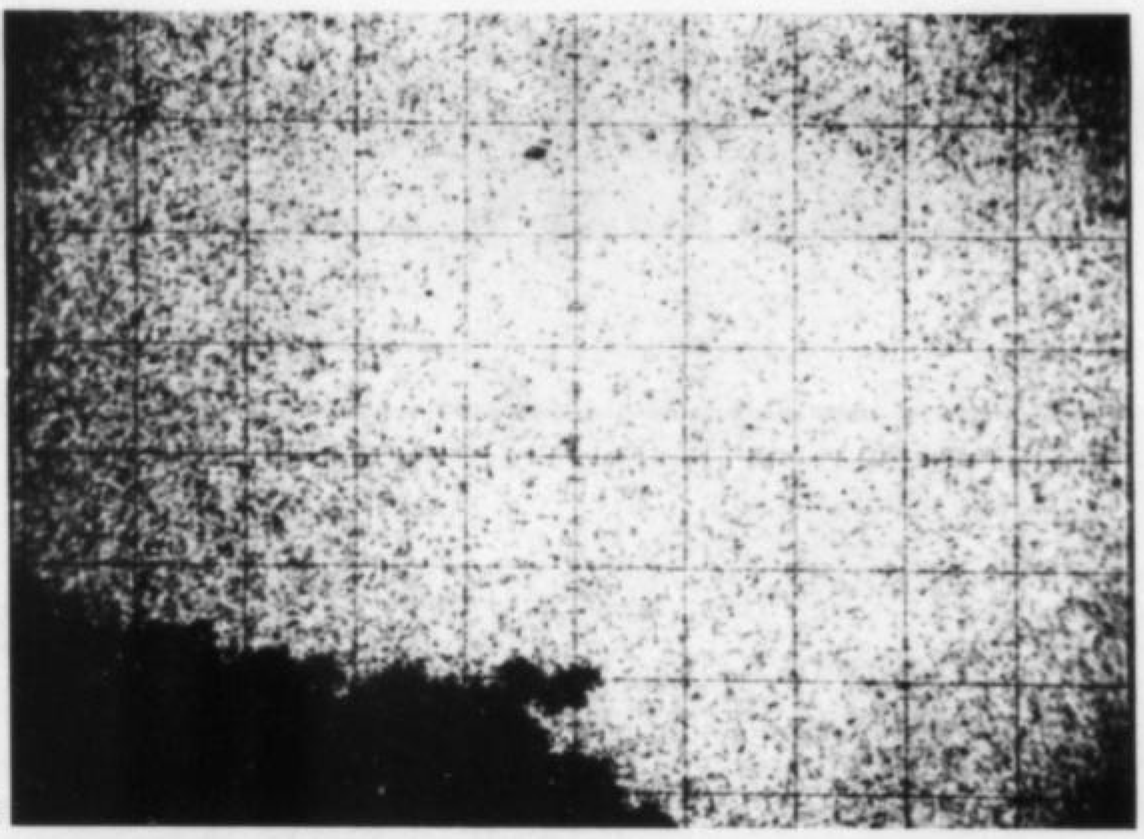
The microprobe is also capable of quantitative analyses. While it is impossible in such a zoned specimen to obtain a meaningful average composition, it is worthwhile to establish the maximum antimony content (how near to pure tetrahedrite do the zones get?) and the maximum arsenic content (how near to pure tennantite?) of the new specimens. Ideally pure tetrahedrite contains 29.22% antimony; the highest antimony content recorded for the Naica material is 22.7%. Pure tennantite would contain 20.26% arsenic; the Naica material went up to 14.3%. Copper varied in amount from 35% to 45% and zinc from about 4% to 9%. There appears to be a subtle parallelism of the copper and antimony contents and the zinc and arsenic contents, but only five spots in one traverse were analyzed for each of these elements, so the data are not sufficient to establish this relationship.

NAMING THE MINERAL(S)

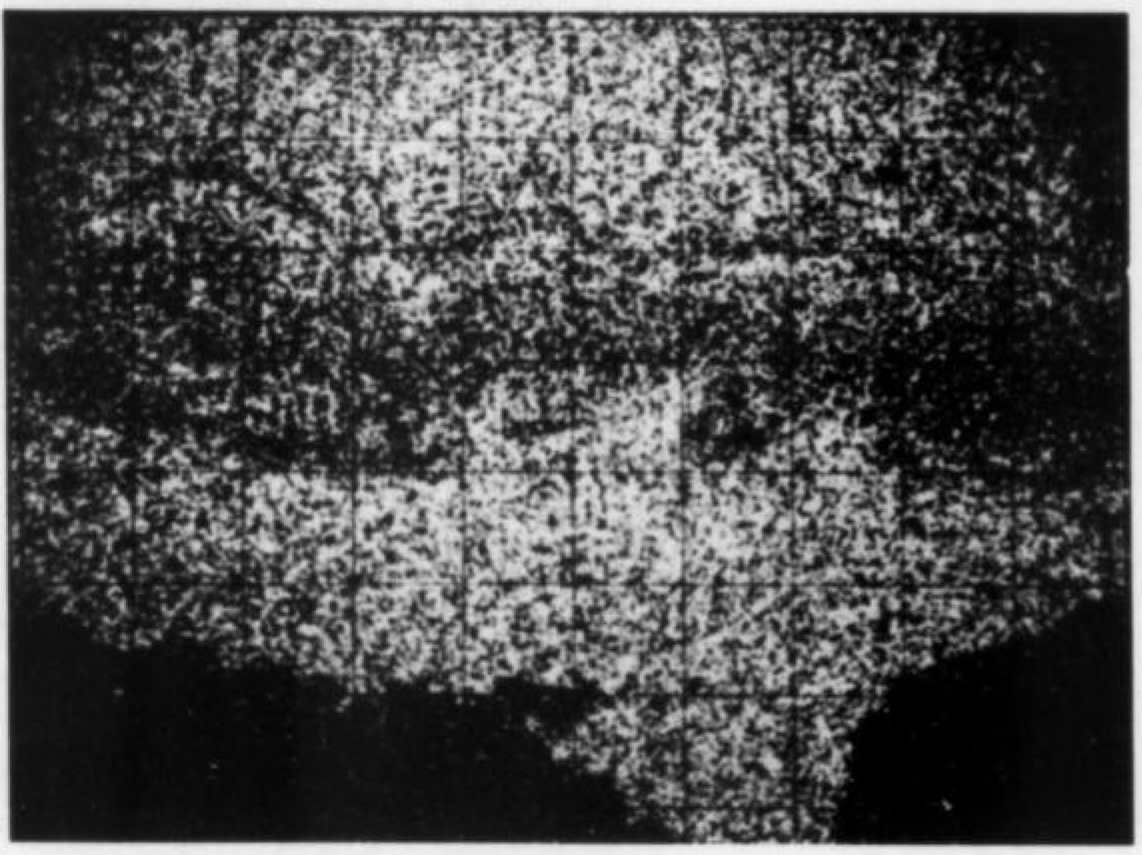
The data show clearly that it would be wrong to call this material tetrahedrite because as much as half, or more,

***Fig. 7a.* Polished section showing the area over which the microprobe scanned. T is tennantite-tetrahedrite, the lower left phase is pyrite, and the lower right phase is chalcopyrite. Analysed area outlined in ink. 7b shows the antimony distribution as revealed by the microprobe scan (light areas indicate high concentrations). 7c shows the arsenic distribution, 7d the copper distribution, and 7e the zinc distribution. Smithsonian Institution specimen #123091. Photos by Joseph A. Nelen**





d



e

of the shell may actually be tennantite. We cannot call it tennantite for the same reason, in reverse. Since there is no special name for an intermediate "average" composition, I see no alternative but to refer to the shell material as tennantite-tetrahedrite, or tennantite and tetrahedrite (ordered alpahbetically). However even this label ignores the probability that the dominant mineral, apart from quartz, is chalcopyrite. Therefore the ideal label should be something like "Oriented overgrowths of tennantite and tetrahedrite on chalcopyrite and sphalerite with galena and quartz."

REFERENCE

Palache, C., H. Berman, and C. Frondel (1951), *The System of Mineralogy,* seventh edition, vol. I.

NEW TRAILS BLAZED AT THE CHESTER COUNTY HISTORICAL SOCIETY

"To blaze some new trails" was the way Mrs. Hugh McKinstry phrased it when she first approached Travis Coxe, director of the Chester County Historical Society, 225 North High Street, West Chester, Pa. with her idea of a gift. That was three years ago. Countless delays and frustrations later, the permanent exhibit area for the Society's mineral collection, Elizabeth McKinstry's gift to the Society, will be unveiled in October, 1972.

Excitingly and imaginatively designed by Mr. Franklin Beltrando, nationally known expert in the field of diorama design, the new display will provide a setting consistent with the high quality of the Society's mineral collection. "Blazing some new trails" in display, Mr. Beltrando has set a pace with some original techniques which will include dioramas, lucite cylinders and dramatic lighting.

Acting as advisors to the Historical Society's staff in the cataloguing and selection of the minerals were: Dr. Clifford Frondel of Harvard; Dr. Arthur Montgomery of Lafayette College; Dr. Donald T. Hoff, Curator of Earth Sciences at the William Penn Museum, and Paul E. Desautels, Curator of Gems and Minerals at the Smithsonian.

and Paul E. Desautels, Curator of Gems and Minerals at the Smithsonian.

Housed in the new exhibit area will be representative examples from the 4 major collections belonging to the Society. Given to the Society by Mr. Brinton, Mr. Gay, Dr. McKinstry, and Mr. Rose, all former residents of Chester County, these collections had been virtually hidden away in a cluttered outdated display. Recent interest in the Earth Sciences and Geology inspired Mrs. McKinstry to "blaze some new trails" at the Society in memory of her late husband, Dr. Hugh McKinstry, Professor of Geology at Harvard, whose first published paper was on the minerals of Brinton's quarry in Chester County. By underwriting the reorganization of the 4 Major mineral collections in a way which provides optimum educational value, she has made a contribution not only to the Chester County Historical Society, but to the general public as well.

writing the reorganization of the 4 major mineral collec-

Eventually other collections in possession of the Society may be worked into the exhibit.

Visitors are welcome at the Society Mondays and Tuesdays, 1-5; Wednesdays, 1-9; Thursdays and Fridays, 10-5.

Background material on the donors of the four major mineral collections belonging to the Chester County Historical Society.

1.*Dr. Hugh Exton McKinstry* was born in West Chester, Chester County, Pennsylvania in 1896. A graduate of Haverford College, he held a master's degree from the Massachusetts Institute of Technology, and a Ph. D. from Harvard University, where he was Professor of Geology at the time of his death in 1961.

continued on page 134

Mineral Collecti

by Francesco Bedogné
Via Goriza 11
23100 Sondrio, Italy

and Renato Pagano
Viale S. Marco 38
I-34074 Monfalcone, Italy

INTRODUCTION

Val Malenco, one of the classic Italian mineral districts, has been known to mineralogists and collectors the world over for almost one century. Its reputation is due mainly to the superb andradite (demantoid) crystals which add beauty and interest to many collections; many other mineral species though, some of them quite rare, make collecting in Val Malenco very interesting.

Val Malenco (130 km north of Milan, in the province of Sondrio, Italy) is a valley which cuts deeply into the southern slope of the Bernina group, the highest of the Central Alps (Fig. 1).

The main rock formations in the central area of Val Malenco are serpentinites and serpentine schists (usually antigorite schists), which often include minor formations of talc schists and chlorite schists.

The best crystallized minerals, such as demantoid, perovskite, magnetite, ilmenite and artinite, are found in clefts occurring in the serpentines. The crystals line the walls of the clefts or are included in the asbestos or calcite which usually fill these cavities.

The serpentinite masses of central Val Malenco are surrounded by various other rock formations, which may be subdivided as follows:

a — granodiorites and quartz diorites with aplites and beryl and almandine pegmatites.
b — amphibolites and calcium-silicate rocks with contact minerals (garnet, vesuvianite, epidote, diopside, spinel).
c — gneiss and mica schist with Alpine cleft minerals (quartz, adularia, anatase, rutile, brookite, titanite).

Mineral collecting takes place mainly in the various talc and asbestos quarries operating in the area, in the dumps of worked-out quarries and in the morainic detritus at altitudes of 2000 to 3000 meters above sea level.

The most outstanding systematic regional collections of Val Malenco are those of the late P. Sigismund of Milan, now exhibited at the Zurich Institute of Crystallography, and that of Prof. F. Grazioli of Sondrio.

The variety and complexity of the rock formations in Val Malenco accounts for the occurrence of a large num-

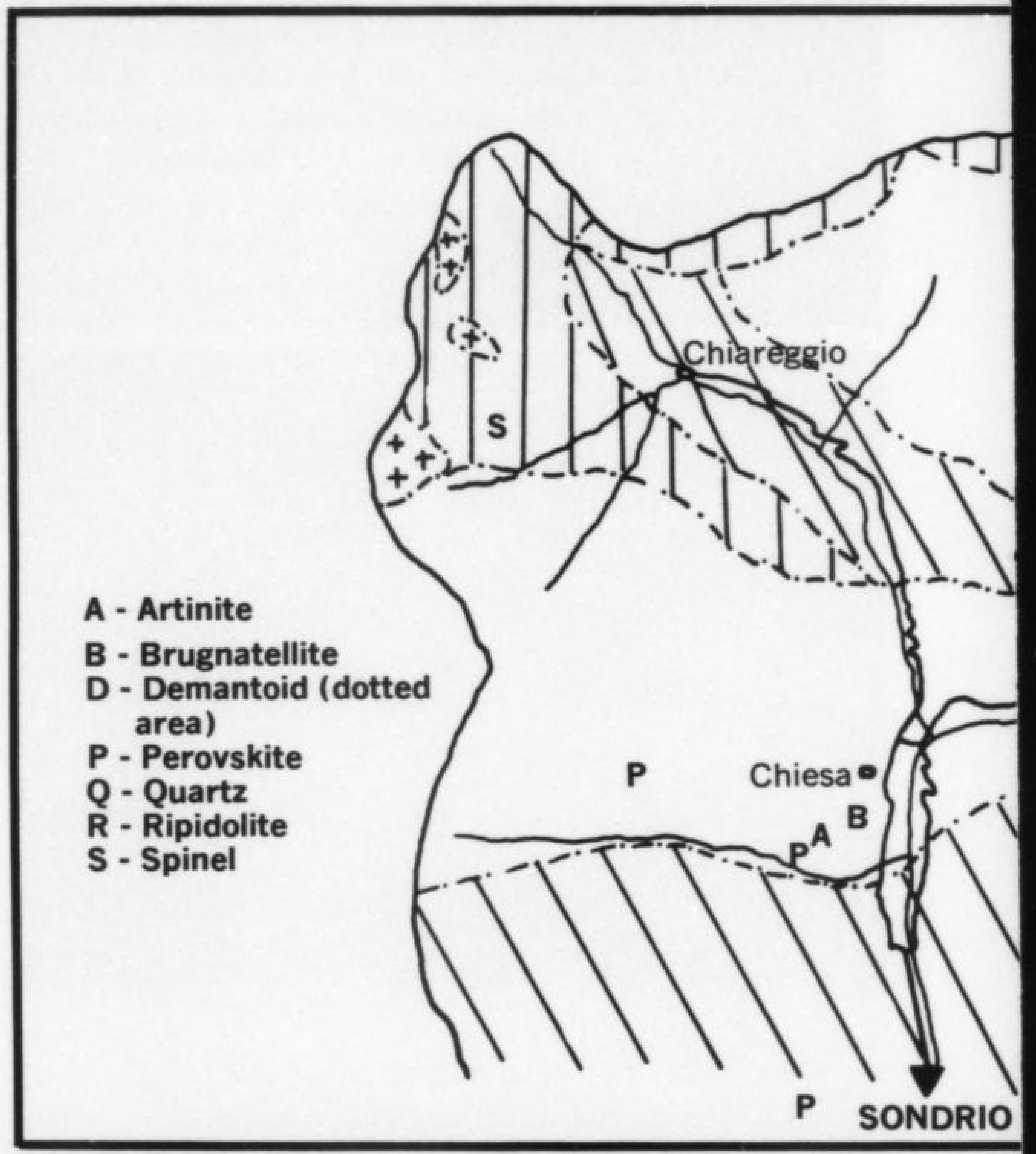


Fig. 2. **Demantoid crystals with asbestos on serpentine matrix, Sferlu**

ng in Val Malenco

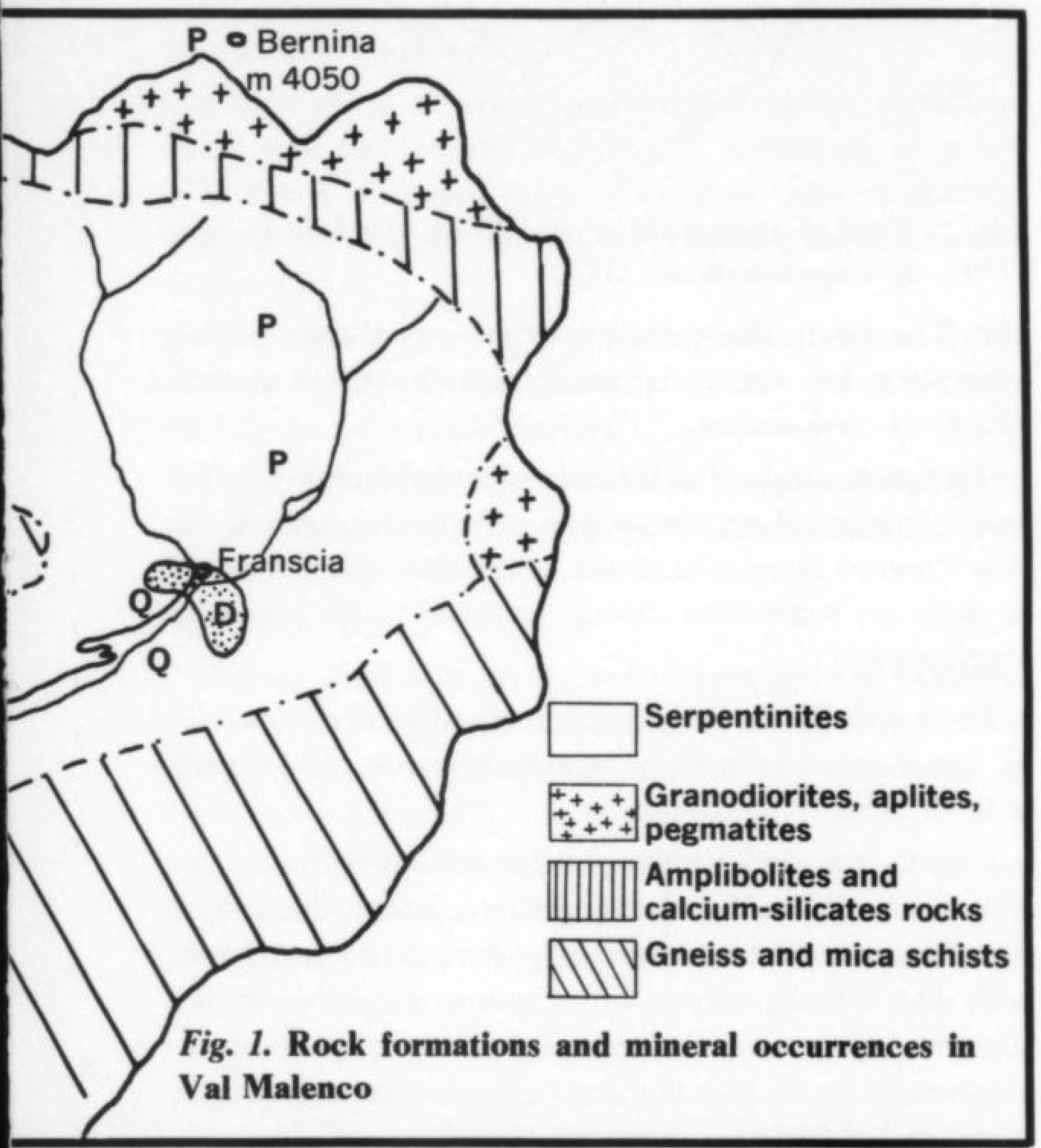
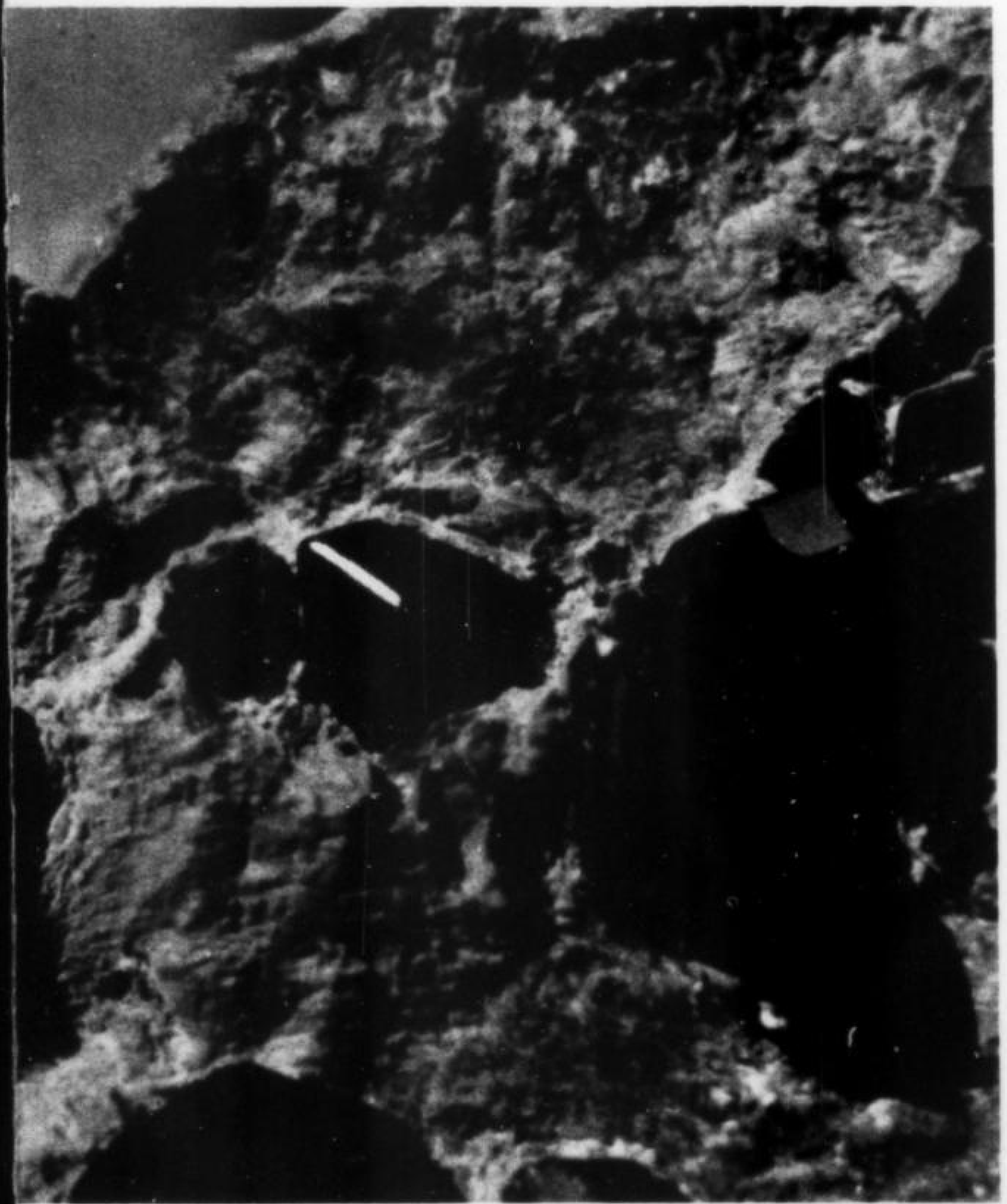


Fig. 1. **Rock formations and mineral occurrences in Val Malenco**

, Val Malenco. The largest crystal is 16 mm across (F. Bedogné Coll.)



ber of minerals (about 140 different species are reported from this area) (1,2,3).

No attempt will be made here to describe — or even list — all the Val Malenco minerals, some of them quite rare, recognized so far. Rather, the species of outstanding collecting interest, which are obtainable through personal collecting, purchase or exchange, are considered, stress being placed on those minerals which are typical of Val Malenco and not of the whole Alpine region in general.

DEMANTOID

Demantoid, a green variety of the calcium-iron garnet, andradite, is found in sometimes splendid crystals in the asbestos-filled lithoclases of the serpentinite outcrops in the central part of Val Malenco.

Demantoid usually occurs in lenticular nodules, roughly radiated in structure, which the local miners call "acorns" or "seeds of the asbestos". These nodules are generally two to three centimetres in diameter, but much larger nodules may be found: exceptionally, nodules weighing about 2000 grams (over four pounds) are encountered.

Demantoid "acorns" formed by sharp, clear crystals measuring 1 to 5 millimeters are quite attractive and prized by collectors.

Clear, loose demantoid crystals up to two centimeters across are also found in the asbestos; their occurrence is identical to that of the demantoid nodules. It may be interesting to note that the largest crystal of demantoid is known only through its cast in a crust of asbestos mixed with calcite. The cast is 48 mm in diameter.

Demantoid crystals, when clear and free of cracks or other imperfections, make very attractive gemstones, remarkable both for their color, which varies from olive-green to yellowish-green to emerald-green in the smaller crystals, and for their luster and fire.

The latter characteristics are due to the high refractive index and dispersion of this mineral, even stronger than that of diamond, from which the name "demantoid" is derived.

Often demantoid crystals line the faces of the cavities (Fig. 2). Crystals may be scattered irregularly on the serpentine matrix, or may be gathered in round clusters or, at times, may be roughly aligned in parallel rows. Usually the lithoclases are perpendicular to the schistosity of the serpentinous rock. This makes the digging of good specimens quite difficult, since the serpentine tends to break into elongated pieces, with a relatively small crystal-bearing surface at one end. Quite often collectors and dealers saw off their specimens on a plane transversal to that of the schistosity, to reduce the amount of matrix.

The habit of the crystals is always dodecahedral, but trapezohedron faces, finely striated lengthwise, almost always occur (Fig. 3).

The dodecahedron faces often show small pits, shaped as very flat rhombic pyramids, with the base edges parallel to the crystal edges.

Sometimes the crystals cover small magnetite grains which, seen through the garnet, make its color look darker.

The finest specimens were found in the asbestos quarry called "Sferlun". This locality, quite impervious and difficult to reach, still affords some good specimens.

Good to modest specimens were also found in perhaps a dozen minor localities in Val Malenco.

The interest of the demantoid specimens to the collectors has sometimes resulted in small-scale mining operations to procure good quality material. Excellent results were obtained by the late L. Magistretti, a well known collector from Milan, who in 1947 followed directions by P. Sigismund and secured a good deal of superb specimens.

Various groups of miners have been active, and sometimes rather successful, during the last ten years. This activity yields demantoid specimens which may be purchased locally.

OTHER GARNETS

It should be mentioned that, although demantoid is the best known, and certainly most attractive garnet found in Val Malenco, many other species of garnet also occur (4). In fact, all of the main garnet species except pyrope, and numerous varieties, have been reported, and some of them occur in rather fine crystals.

Even the uncommon uvarovite occurs in Val Malenco, although it is extremely rare. Usually this garnet is associated with other chromium-bearing minerals such as chromite and kammererite, and with asbestos and magnetite. The small, sharp dodecahedral crystals are a deep emerald color, accounted for by the chromium in their chemical composition.

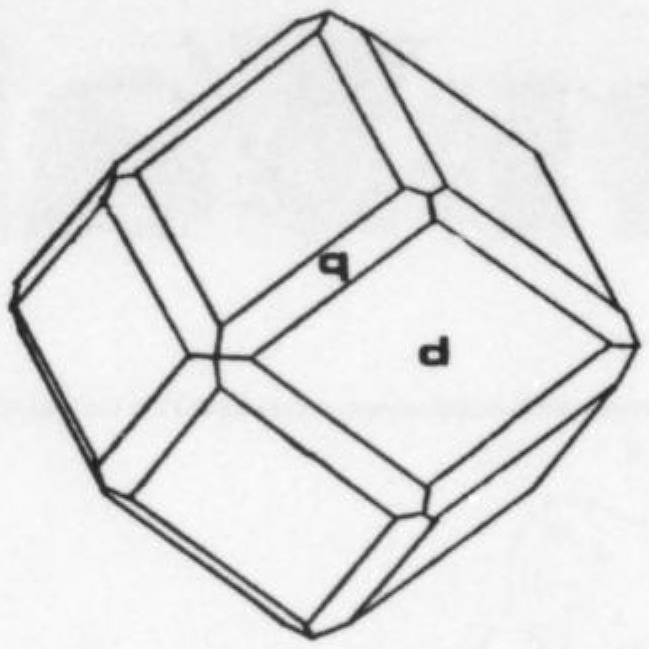


Fig. 3. **Typical demantoid crystal habit (d=rombohedron {*110*}, q=trapezohedron {211})**

Fig. 4. **Perovskite crystals, Ciappanico, Val Malenco. The largest crystal has a 20 mm edge (F. Bedogné Coll.)**

The green color of demantoid is probably due to other causes, since no chromium has ever been found in the Val Malenco samples analyzed so far, although demantoid crystals are sometimes closely associated with chromite.

PEROVSKITE

Perovskite (5) has been found in about a dozen localities in Val Malenco; almost always each source yielded only a small number of specimens.

Usually the crystals line calcite filled cavities in the serpentine. By acid treating the specimens the calcite can be removed to reveal sharp pseudo cubic crystals with flat, shining faces, honey-yellow to coffee-brown. The size of the crystals is usually a few millimeters, exceptionally up to 12 millimeters. The largest crystal ever found in Val Malenco measures 21 millimeters. The crystals are usually scattered on the matrix (Fig. 4), but sometimes groups of close, small individuals of two to three millimeters are encountered.

The cube-like perovskite crystals sometimes show small faces corresponding to the octahedron and dodecahedron. The only locality which, at present, is known to yield good specimens of perovskite is close to the village of Ciappanico, in the low part of Val Malenco. Here the perovskite crystals occur in a violet granatite; fragments of this granatite, consisting of melanite (titanian garnet) and often covered by a layer of clinochlore, are scattered among morainic detritus.

Perovskite is usually associated with melanite in sharp, bright crystals up to 15 millimeters, diopside, magnetite, vesuvianite and ilmenite.

QUARTZ

Quartz (6), abundant in many Alpine localities, occurs in good specimens also in Val Malenco. The best specimens come from a ridge called "Dosso dei Cristalli", which may be considered one of the classic European quartz localities.

The finest crystals are perfectly clear, colorless and sharp, gathered in very attractive groups. Individuals 30 cm in length, or even longer, have been found.

Often the quartz crystals are partly or even completely covered by yellowish brown magnesite in lenticular or stout prismatic crystals usually 5 to 6 mm in size. Occasionally, crystals twice this size have been encountered.

SPINEL

Spinel occurs in the calcareous schist outcrops of the northwestern part of Val Malenco, at an altitude of 2500 meters above sea level.

Black, green or violet octahedral crystals, sometimes quite well formed and translucent, measuring to a few millimeters diameter, are contained in veins of granular calcite, sometimes scattered, other times grouped together in the matrix.

The black and green crystals can be attributed to the ferroan variety of spinel called pleonaste, the violet crystals to the ruby-spinel variety.

Spinel crystals are associated with orange-colored grains of chondrodite, violet phlogopite, bluish corundum and humite.

RIPIDOLITE

Rather abundant in the serpentines of Val Malenco, this mineral of the chlorite group occurs in well formed, dark-green, six-sided tabular crystals, often in stacks or fan-shaped groups (7).

Sometimes the ripidolite laminae show on their surface a perfect equilateral triangle, with sides up to 2 centimeters. Often a larger triangle is associated with several other smaller triangles, arranged in a regular pattern. The sides of the triangles are always parallel to three of the six edges of the pseudo-hexagonal laminae (Fig. 5). Sometimes a sharp hexagonal figure, rather than a triangular one, is inscribed in the laminae.

ARTINITE

Artinite occurs as white fibrous-radiated crusts or in small groups of silky acicular crystals, up to 2 centimeters long, coating rounded serpentine fragments cemented together in a morainic deposit (Fig. 6). The finest specimens are found where a fissure or cavity is left between the serpentine fragments.

Val Malenco is the type locality for artinite. This magnesium carbonate, similar to hydromagnesite but rarer and better crystallized, was first found in 1902 and described by L. Brugnatelli. He named it after the late E. Artini, professor of mineralogy at the Milan Polytechnic, director of the Natural History Museum of Milan and one of the greatest Italian mineralogists (8).

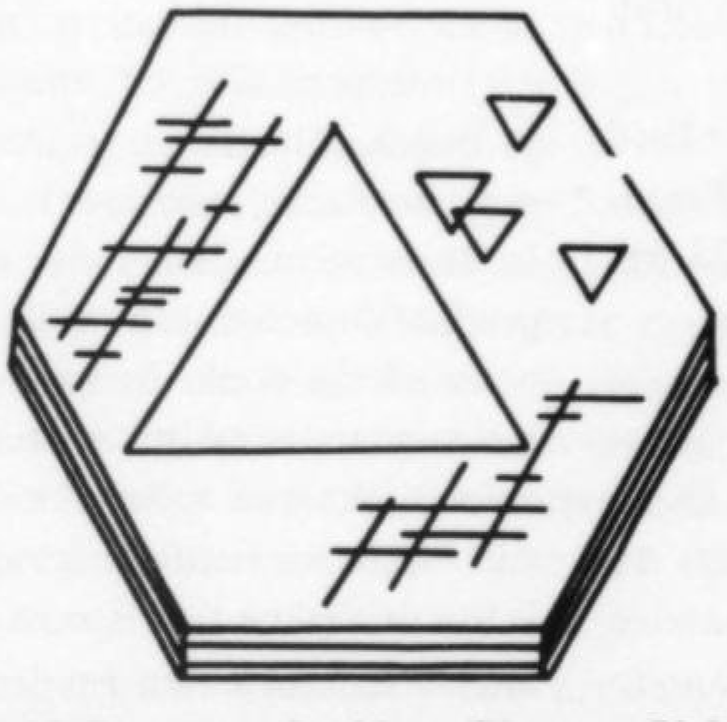


Fig. 5. **Ripidolite crystal. Alpe Girosso, Val Malenco.**

BRUGNATELLITE

This magnesium and iron carbonate, occurring in pinkish-brown laminae and crusts, was also found for the first time in Val Malenco by E. Artini, who described it in 1909 and named it after his colleague and friend L. Brugnatelli (9). No specimens of brugnatellite are known to have been found in the type locality in recent years.

REFERENCES

1 — GRAMACCIOLI, C.M., 1962, I minerali valtellinesi nella raccolta di Pietro Sigismund: Ed. Privata. Milano.

2 — BOSCARDIN, M., DE MICHELE, V., SCAINI, G., 1970 — Itinerari mineralogici della Lombardia: Museo Civ. St. Nat. e Soc. It. Sc. Nat., Milano.

3 — BEDOGNE', F., 1972, Elenco dei minerali rinvenuti in provincia di Sondrio. Rass. Econom. C.C.I.A., Jan. 1972, p.27.

4 — SIGISMUND, P., 1948, Granato e Vesuvianite di Val Malenco: Atti Soc. It. Sc. Nat., v. 87, p.145.

5 — SIGISMUND, P., 1949, Perovskite di Val Malenco: Rendic. S.M.I., Anno V, p.8.

6 — ARTINI, E., 1888, Quarzo di Val Malenco: Memorie R. Acc. Lincei, Anno CCLXXXV, ser. IV, v.5, p.4.

7 — SIGISMUND, P., 1949, Titanclinohumite, Olivina e Ripidolite di Val Malenco: Atti Soc. It. Sc. Nat., v. 88, p.l.

8 — BRUGNATELLI, L., 1902, Sopra un nuovo minerale delle cave di amianto della Valle Lanterna: Rend. Ist. Lombardo, v. 35, p.869.

Fig. 6. **Artinite with hydromagnesite on serpentine, Rocca di Castellaccio, Val Malenco. (F. Bedogné Coll.)**

The Record Bookshelf

by Joel E. Arem

In this issue, the Record Bookshelf is devoted to brief reviews of some recent technical books. While many of these contain little information of benefit to the amateur, they represent current efforts in their respective fields, and are worthy of more than passing attention. The reviews are meant to convey content and level of technicality, rather than provide a detailed critique of each work cited.

***Contemporary Crystallography*, by Martin J. Buerger. McGraw Hill Book Co., New York, 1970, 364 pp., (12.50)**

This book contains, in a sense, the essence of most of M.J. Buerger's other (now standard) works in the field of crystallography and X-ray diffraction. It is clearly written, comprehensive and marvelously illustrated. The chapters lead the reader through the geometry of crystalline structures, an introduction to the methods of X-ray diffraction techniques and a brief look at structure-solving methods. Of special interest are numerous pages of reproductions of precession X-ray photographs, illustrating the symmetry encountered in all the crystal systems. The first half of the book is almost entirely nonmathematical and can be read profitably by any interested student. The index is very complete and detailed, and the book can easily serve as a single general reference to the basics and intricacies of modern crystallography.

***Chemical Equilibria in the Earth*, by Wallace S. Broecker and Virginia M. Oversby. McGraw Hill Book Co., New York, 1971, 318 pp. ($16.50)**

A grasp of basic physical chemistry is essential in understanding geochemical processes. The role of thermodynamics in geology is well explained in the first chapter of this fine book. The treatment of specific topics, such as volume, entropy, equilibrium, mineral transformations, melting phenomena and solid state reactions is mathematical, but the equations will be familiar to the graduate student in gelology. What is appealing about this book for the geologist is its specifically geological orientation. Most existing treatments of chemical thermodynamics are geared to the chemist, and motivation for the geology student to study non-geologic processes is often difficult to provide. Topics of special interest that are discussed include isotopic fractionation and trace element distribution, evaporite deposition, solid solution in alkali feldspars and cooling rates in iron meteorites.

***Moon Rocks and Minerals*, by Alfred A. Levinson and S. Ross Taylor. Pergamon Press, New York, 1971, 222 pp. ($11.50).**

The authors of this book are amply qualified to produce this excellent summary of the first findings about lunar geology, based on Apollo 11 samples. Levinson edited the massive 3-volume *Proceedings of the Apollo 11 Lunar Science Conference*, and Taylor is a principal investigator of lunar rocks. *Moon Rocks and Minerals* is both readable and informative, and attempts to speak to both the layman and the professional scientist not engaged in studies of lunar materials. The book discusses the rocks, soils and minerals brought back in sample bags by Apollo 11, and also hints at early results of the Apollo 12 sample studies. The book is thus somewhat dated in that many of the early theories proposed have now been modified or rejected, but the book remains a comprehensive summary of the early work. Some of the illustrations are very striking, and the casual reader is sure to come away with a better-than-average knowledge of lunar geology, as well as an insight into the excitement and frustrations of lunar research.

***Field Ion Microscopy*, by Erwin W. Müller and Tien Tzou Tsong. American Elsevier Pub. Co., New York, 1969, 314 pp. ($19.00).**

Field ion microscopy is a field not familiar to the average geoscientist. Yet it offers a sense of direct encounter with the actual atoms making up the surface of a solid. Although developed as recently as 1951, almost entirely by Müller, the field ion microscope was somewhat slow to gain acceptance as a general research tool. Yet the astonishing views of crystal surfaces it affords, in which individual atoms are distinctly visible, provide fascination not shared by any other scientific instrument.

This book covers the early development, theory and techniques of field ion microscopy, design of the instrument and its limitation, and details on interpretation of the images it provides. The book is mathematical only in places, and much of the text is descriptive. The field ion micrographs depicted are well worth the price of the book. In spite of current instrumental sophistication, this particular technique seems, to the writer, still within the realm of science fiction. It is a discipline that is sure to interest any science-oriented reader.

continued on page 133

What's New in Minerals?

Photos by Joel E. Arem

BARYLITE

I have written before of the great excitement of encountering a specimen of a mineral so exceptionally superior to any specimen of the mineral previously seen. The latest to come to my attention is barylite from Colorado. A single crystal (Figs. 1-4) was sent to me at the Smithsonian by Mr. Clarence Coil, of Colorado Springs, Colorado. He requested that we identify the 1 3/4 x 7/8 x 5/8 inch grey-blue crystal for him.

In many respects it looked most like celestite or barite — the color was typical of so much celestite-barite and the specific gravity (it was obviously high) seemed to confirm this guess. However, Mr. Coil's letter eliminated this simple conclusion. He stated that the crystal is very hard and that it was found by him in an amazonite pocket in Park County, Colorado!

A tiny chip was then x-rayed but not immediately identified because I would not believe the mineral that the x-ray pattern kept suggesting. Thus the optics were checked, the specific gravity and hardness measured, and the breaking characteristics (cleavage) observed. All properties supported the "impossible" result of the x-ray diffraction analysis. Finally a chip was analysed by electron microprobe and when this revealed the proper amounts of barium and silicon present, I could no longer deny that the crystal is *barylite!*

Heretofore the only barylite with which I was familiar was found as micro crystals at Långban, Sweden and Franklin, New Jersey, and in massive form at Seal Lake, Labrador (*Amer. Min., 47,* 758-763, 1962). Here it is a major component of fine-grained quartz and albite veinlets cutting gneiss and as disseminated grains (up to 5 mm) in the gneiss itself. This reference led to one of another occurrence in the Vishnevye Mountains, USSR, where crystals of unstated dimensions are found growing on fissure cavity walls. The barylite is, in turn, overgrown by milk-white calcite. The locality is an alkali complex. Långban and Franklin barylite fluoresce, Seal Lake and Park County barylite do not.

According to Mr. Coil, only two crystals of barylite were found in the pocket. He has donated the smaller, but more perfect, of the pair (that described herein) to the Smithsonian. The larger crystal measures 2 x 1 1/2 x 1/2 and it is still in his possession. Apart from microcline (amazonite), colorless barite crystals were also found in the pocket.

Barium is not usually found in pegmatites in any concentration, so it is difficult to understand how these two barylite crystals came into being. The occurrence is totally unlike those earlier reported for barylite.

BAKERITE on DATOLITE

I have looked at thousands of danburite specimens from Charcas, San Luis Potosi, Mexico, but the specimen shown in Fig. 5 is unique in my experience. The artistically grouped crystals

continued on page 132

Fig. 1 Barylite

Yedlin on Micromounting

We've been visiting. First to Washington, D.C. to tell the Mineral Society about the mining and minerals of Laurium, Greece; then to tell the assembled celebrants of the 25th anniversary of the American Federation of Mineralogical Societies about the 85 year old New York Mineralogical Club, and finally to attend the spring roundup of the Micromineralogists of the District of Columbia.

We'll discuss in detail the Laurium, Greece history at a later date; it's a fascinating place with some 7 million tons of dumps having been piled up since about 500 B. C. Two types of micromount material are available: the ore minerals from the mines — oxides, sulphides, carbonates and sulphates; and the alteration and newly formed ones from the partially processed slags that were, after silver extraction, dumped into the sea — oxychlorides, carbonate chlorides and others. More anon.

At the reception we bragged about the New York Mineralogical Club...founded in 1886, when Grover Cleveland was president, when only 39 states had been admitted to the Union, and when the Statue of Liberty had been presented to the United States by the Republic of France. New minerals and varieties (kunzite, hiddenite) were named for 26 members, and it was recorded that at the second meeting of the club in October, 1886, A. C. Hamlin lectured about and displayed specimens of the fabulous tourmalines of the famous Mt. Mica, Maine. Attending this session were Kunz, Martin, Schernikow, Roebling and other prominent men in the field of mineralogy. Enough of name dropping. Let's go on.

The spring roundup of the Micromineralogists of the District of Columbia was the club's second such affair, and the plans are that it will be an annual event. Dr. Joel Arem discoursed on zeolites — what and why. Paul Seel discussed the crystallography of the zeolites, projecting slides of the minerals and their crystal forms. As an adjunct Curt Segeler talked of his collecting trips through Germany, with emphasis on the barite locality at Dernbach. As a preliminary to the meeting there was a reception for early arrivals. Here additional talks were given, with color slides of micromounts, on subjects other than the designated theme minerals. Segeler, Yedlin, Rothstein and Roe participated in the demonstrations.

Such meetings are wonderful. You see new material, discuss localities, techniques, instrumentation, and you swap ideas and minerals.

However, the best of our Washington trip were the two days spent at the Smithsonian, putting in time with Desautels, White, Arem, Melson, Switzer and Mason. A full day was spent with the museum's collection of micromounfs, and the rest of the time with minerals of the Foote mine at Kings Mountain, North Carolina, and some of the phosphates from New Hampshire and South Dakota.

A week later we were in Toronto. Ross Anderson, president of the Walker Club, one of the best in North America, met us at the airport and drove to Kitchener, where the Kitchener-Waterloo clubs were holding a show at Conestoga College. Much enthusiasm, many fine exhibits, and best of all a long table, half a dozen 'scopes ensconced thereon, with beautiful micromounts for all to see. This was the work of the Scarborough Micromount Society, a group of avid and eager collectors. A revolving turntable, was available with some 30 mounts implanted at the outer edge. All specimens were in focus, with each mount visible with but a slight turn of the stage. We recalled that Phil Cosminsky had developed a similar tool many years ago.

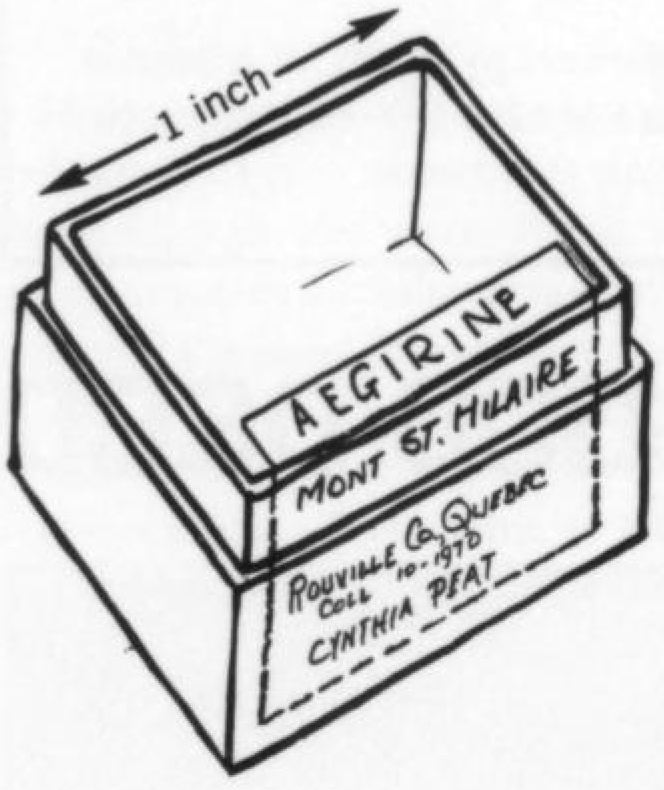
At Toronto we viewed the collection of Cynthia Peat, rich in the minerals of Mt. St. Hilaire. Again 2 wonderful days, this time at the Royal Ontario Museum, where Drs. Joe Mandarino, Bob Gait and the fine staff were great hosts, permitting us free rein. The museum has acquired the micromounts of the late Dick Pospesel and is building a collection, presently the work of Bob Gait, to augment its acquisition. We went over some Mt. St. Hilaire material and were again impressed by the quality and quantity of the superb mineral specimens available from this locality. Additionally there were new pale green grossulars from Thetford, Quebec, scapolites and prehnites from the Jeffrey mine at Asbestos, proustite and xanthoconite from Sudbury, and sperrylite cubes in matrix included in the collection.

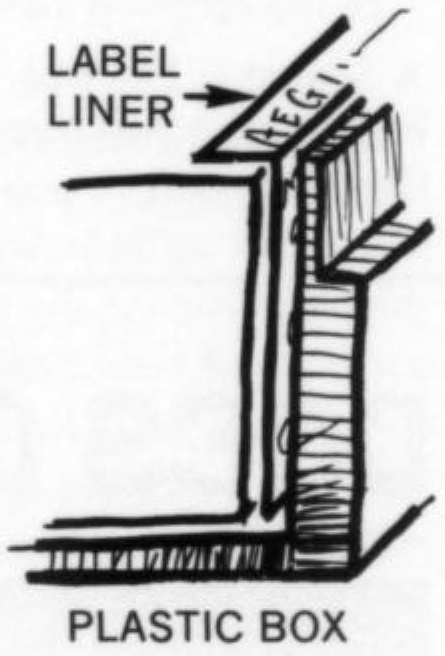
Part of our time was spent in cracking and examining small rounded nodules of Laurium slags, a shipment of which had been received by the museum within the past year or so. A French company had reworked these slags during the years around 1912, reclaiming much silver and lead, for the extraction processes were far from perfect 2500 years ago.

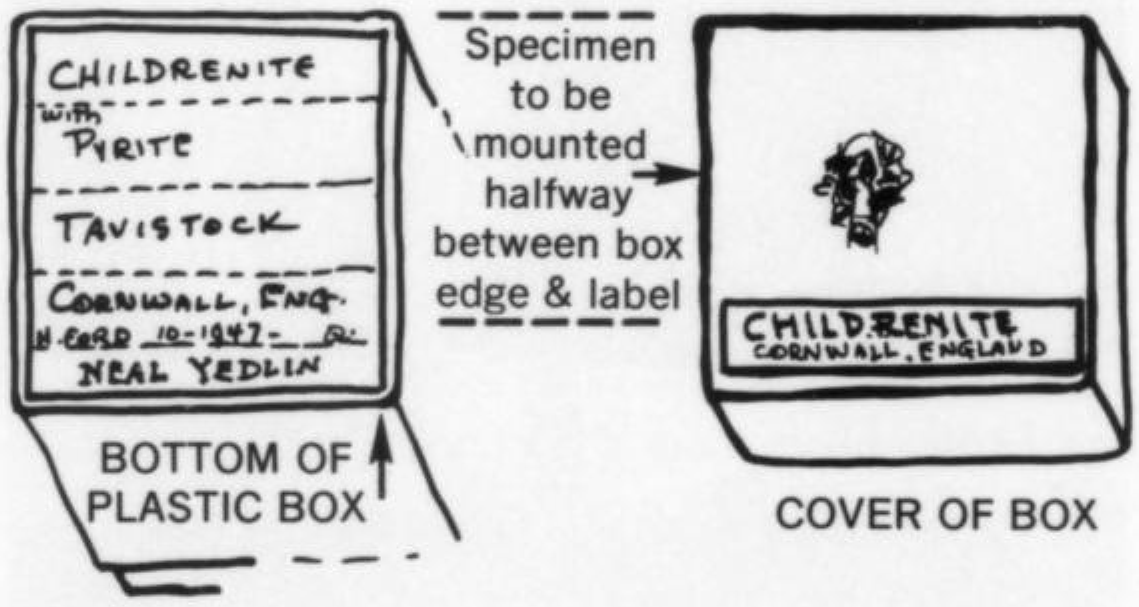
These new nodules are comparatively light in weight, as most of the lead is gone. They're not as productive of micro minerals as the original heavy slags. Nevertheless in breaking several pounds of them into fragments to expose the gas bubbles and vugs, and then examining them thru a 'scope at about 30X there were revealed a few laurionites, much twinned cerussite, aragonite, several phosgenites, and a blue mineral, very minute, in what appeared at 80X to be cubes — possibly boleite. We'd encountered this in a lot of similar slags at the Smithsonian.

The Royal Ontario Museum uses a plastic box one inch square, paper line in white or black, depending on the mineral to be mounted, and an efficient label which we'd described elsewhere some time ago. We'll sketch it. This is a good system, for the label is *inside* the box where it cannot be damaged or obliterated from rough usage, and it permits a good deal of information to be recorded.

For those who paint the insides of the boxes, or who use black containers this system won't work. Our own method is to cement a label on the lower part of the cover and on the bottom of the box. The former has the name of the primary mineral and its locality; the latter has name, variety, associations, detailed locality, date and source of acquisition. (We can write pretty small.) The new "press on" labels are sized to cover a standard plastic box, and can be cut into 3 parts to handle the cover. A neat trick is to use a small piece of clear scotch tape to fasten the cover to the box. The tape acts as a hinge, doesn't show, and insures that the two units do not become separated.







There's no "must" about this. Put your labels on anyway you choose. But DO put them on that portion of the mount that contains the specimen, so that the essential elements, the label and mineral, do not become separated, ever. And leave as much of the cover as clear as possible, so that you can easily identify a particular mount among a multitude of similars.

One of the fine features of the Royal Ontario Museum is the periodic set up of exhibits other than the general permanent ones. At a prior visit we were impressed with streetside cases, outside the museum, free standing, plate glass, with viewing lights, containing dozens of outstanding large mineral specimens. No guards, no alarms; nothing but confidence and trust in the integrety of the local populace. (Presently the cases hold antique pottery.) In what other community is this feasable? In addition, within the museum Dr. Bob Gait has an exhibit of quartz. Colored diagrams of the various crystal forms adjoin actual quartz crystals, exhibiting the same habits. For any mineral collector this is truly an educational experience. Prism, negative and positive rhombohedra, "s", "x" and "M" faces, right and left handed crystals, various types of twinning, twisting — the works — are explained. This is a great mineral collection. Dr. Mandarino, department chief, and his entire staff are to be complimented for the concepts and exhibitions of modern techniques and displays.

We deplaned at Bradley Field and visited Bentley's Minerals, about 15 minutes away. Ron Bentley had just returned from an English collecting trip, and had some specimens to prove it. He'd toured Leadhills and Strontian in Scotland; Cumberland, Drygill, Weardale, and Roughtongill to the north; and Redruth and St. Agnes in Cornwall. He reported good collecting in some old-time areas and practically none at all in others. He hand toted some 80 pounds of minerals back and advised that more were on the way. He showed us excellent campylite, superb green fluorite, brilliant black sphalerite and quartz, galena and others. Leadhills, once the source of fine leadhillite, matlockite, lanarkite, linarite and caledonite is no more. And Cornish minerals are hard to come by unless a great deal of time is available, or you "silver pick" for tin. European dealers are demanding more and more specimens, and paying higher and higher prices, so that collectors are extremely active. All over the world to-day there is a sellers' market. Minerals are a fine capital investment, but we decry acquisition of specimens merely for this purpose.

We've been looking at some old dealer labels. It had been our belief that once a dealer had become stocked, or once a collector had filled his cellar with mineral material he remained put — anchored — fini. But we've looked at a series of lables of one famous purveyor of specimens, and this is what we've seen:

Collection of George L. English	Shelby, North Carolina
Geo. L. English & Co.	1512 Chestnut St., Philadelphia, Pa.
George L. English & Co.	64 East 12th Street, New York
George L. English & Co. Mineralogists,	201 East 16th Street, New York City
George L. English & Co.	3 and 5 West 18th Street, New York
George L. English & Co.	733 and 735 Broadway, New York
George L. English & Co.	812 and 814 Greenwich Street, New York

Either the mineral business was so bad that it was difficult to pay the rent, or it was so good that increasingly larger quarters were needed. In the case of English we surmise the latter.

English, of course, was induced to head Ward's Natural Science Establishment in Rochester, N.Y., and was instrumental in acquiring the finest in mineral specimens for distribution by this so important organization. He was, too, a micromounter, and we were privileged to see part of his collection and a catalog of the entire assemblage when, in 1959, it was sent to Paul E. Desautels for possible acquisition by the Smithsonian. As we vaguely recall, there were some 2000 specimens in all, the property of the son of English, and the museum did not acquire the collection.

If there are any G. L. English labels in collections, other than the ones herein listed we'd like to know about them, or acquire them or a photo-copy.

We'd mentioned possible collinsite crystals in the January-February issue of the RECORD, sent by Forrest Cureton. They were determined to be apatite, similar to the ones at the Foote quarry in North Carolina. Sorry. But they're fine micros on their own.

Buy and use a good mineral book, affix a permanent label to your specimens, and subscribe for 3 years to the MINERALOGICAL RECORD.

Neal Yedlin
129 Englewood Drive
New Haven, Connecticut 06515

ARTICLES COMING SOON......

Apophyllite and Associated Minerals at the Fairfax Quarry, Centreville, Virginia—Medici, J.

Boron Minerals and Deposits (2 Parts)—Aristarain, L. F. and Hurlbut, C. S. Jr.

The Electron Microscopes and Electron Probe (State of the Art)—Wilson, W. E.

A Scanning Electron Microscopy Study of Minerals in Geodes from Chihuahua, Mexico—Finkelman, R., *et al.*

OSAGE HILLS CLUB DOES GOOD DEED

The Osage Hills Gem & Mineral Society (Bartlesville, Oklahoma), in furtherance of its avowed purpose of supplying educational materials, as well as lectures and exhibits to school children, so that they will have a background and an interest in the fields of gem and mineral identification, collecting and other facets of the discipline, presented two cases containing specimens of the three main categories of rocks and minerals, i.e. — metamorphic, sedimentary and igneous, to the earth science classes of the Lincoln Elementary School, and the Central Junior High School of Bartlesville, Oklahoma.

Leonard Bush made the boxes and Dr. John Hillyer prepared and arranged the specimens. The boxes were well received by Bob Lewis of Lincoln, and Caywood Gilbert of Central Junior High.

The club plans to have similar boxes at the Diamond Jubilee Celebration in Bartlesville, Oklahoma, and at the Jubilee of Gems, the biennial show of the club in November 18-19. Prizes will be given to the first junior (under 18 years of age) who correctly identifies the categories and to the junior who correctly identifies the most individual rocks.

Leonard Bush (left) and John Hillyer with the cases of rocks and minerals donated to schools in Bartlesville, Oklahoma.

THE COLLECTOR

by Richard A. Bideaux

Sometimes what would have made good crystal specimens are broken by natural forces in the earth before they are even seen. Many others are necessarily broken during mining or collecting. Some of the few that come through intact and go into collections are later accidentally broken. In all of these cases, rather than destroying or disposing of the specimens, attempts are often made to repair them. At best, when the break is a cleavage plane and no material has been lost, the resulting repair may be virtually impossible to find.

Many collectors will not own a repaired specimen (if they know of it — sometimes they don't). Others, myself included, take the more liberal view that an inconspicuously repaired but otherwise worthwhile specimen, admittedly not the most desirable, can nevertheless find a place in the collection. Such specimens should be labelled, or at least cataloged as repaired; to do otherwise is a misrepresentation. Their value is affected to some degree, but sometimes surprisingly little. Reconstructed specimens of gem pegmatite minerals, which are commonly fractured after formation, may command astonishingly high prices.

Unfortunately it is but a short step from repair to manufacture of specimens. An abundance of loose crystals and the right type of matrix often provides an opportunity to a sharp operator right at the locality. Much effort has been expended in every country towards the outright manufacture of specimens, and while they are infrequently encountered, the collector must be constantly on guard for them. They can be seen not only in new finds, but as material dating back into the 1800's as well.

Some classics are South African diamonds embedded in kimberlite matrix; Colombian emeralds with their bases worked into the characteristic pyritized limestone, and Austrian epidotes with their bases hidden in a mat of byssolite. Brazilian euclase or brazilianite on muscovite, with a little powdered quartz or limonite around their bases, Mexican legrandites, Arizona wulfenites and vanadinites, Swiss titanites, "Herkimer diamonds" from New York, Tsumeb azurites, wire silver from a multitude of localities, and so on, provide some of the many examples that I have seen.

Adding a crystal to matrix can enhance its value from around five to twenty times. To be worth the trouble, a manufactured specimen will often apparently have a substantial value. Therefore, the higher the value, the more one should be curious.

The most obvious tipoff of course is visible excess glue, or mismatching of the crystal's base with the matrix, but these defects are often hidden under powdered material. Unnatural placement, such as crystals lined up like fenceposts, is a more subtle clue. The crystals chosen for this treatment are often large for the occurrence, while the matrix, lending authenticity, may have much smaller crystals already in place. A few large crystals scattered on smaller crystals apparently of another generation should at least provoke closer inspection.

A related area is specimen enhancement, often carried far beyond simple cleaning. Attempts are occasionally made to pass off as authentic natural crystals with faces which have been polished. Complete absence of growth steps, hillocks or depressions at the microscopic scale is almost unheard of except in some micromounts. Crystals unterminated, because of breaks or growth across a pocket, are sometimes given finishing touches on a lap. In addition to their unnatural smoothness, the faces so cut will usually not be in a crystallographically likely position. However, just as crystal models are cut to the proper angles, so may simulated crystals be. Recently I have seen several Arizona olivines displayed as natural crystals. These appear to be close to angle true, and of proper symmetry, but with frosted faces. Until closer examination convinces me otherwise, I believe these to be cut but not fully polished in simulation of natural crystal faces.

Miners at Franklin learned how to repair broken franklinite crystals with plaster of Paris and coal black so that the two materials, natural and artificial, were indistinguishable. Later, entire crystals were manufactured, but these can be detected by their low density.

Water soluble synthetics can be easily grown on a matrix. Homegrown copper sulfate hydrate, potassium chromate and potassium dichromate, corresponding to the natural minerals chalcanthite and the very rare tarapacaite and lopezite, are sometimes even seen in competitive displays.

Several years ago some material presented as gypsum and malachite from Naica, Mexico reached the market. These had an attractive appearance with shining druses of microgypsum overgrowing a green-incrusted matrix. These

continued on page 135

QA column

Q. What is the present status of the proposed species "blanchardite", a green-fibrous acicular mineral, which occurs with linarite at the Blanchard mine, Bingham, New Mexico? What is its approximate composition?

John S. Whatley, Jr.
Macon, Georgia

A. We are allowing the use of the name "blanchardite" in this question only because it has already been given so much exposure in print. The premature use of any proposed mineral name should be avoided. It is very important that proper procedures be followed in introducing new mineral names. The first step is the presentation to the New Minerals and New Mineral Names Commission, I.M.A., of an abstract of the description of the new mineral. The abstract should contain sufficient data to support the claim to new mineral status. This has never been done in the case of "blanchardite". Owing to the widespread popularity of Mrs. Ora Blanchard (now deceased), who was the owner of the mine, the name has been spread far and wide for a green mineral found there. Unfortunately we know nothing about the mineral except that it does appear to be a new species.

It is altogether possible that the same mineral will be found elsewhere, properly described and named, and "blanchardite" will then be relegated to the synonomy. The author is entitled to name the mineral he describes and it is unlikely that this mineral, found elsewhere, will be named "blanchardite". The first name to be properly introduced and approved is the one that will be accepted by mineralogists.

The Commission cannot, of course, punish those who bypass established procedures and introduce names improperly. They can only voice their strong objections to such behaviour. There is a very good reason behind the adoption of these procedures. It prevents the proliferation of inadequated descriptions of new minerals and the further cluttering of the mineral nomenclature.

Mineralogists should be wary about revealing their anticipated name for a mineral they are working on. One, who was describing the green mineral from the Blanchard mine, made the mistake of writing a letter to a collector informing her of his intention to name the mineral after Mrs. Blanchard, if it proved to be new. His letter was quoted in an article written and published by this collector. Collectors should always be mindful of the disservice such irresponsible acts do to both the science and the hobby. It is to the advantage of all of us to help to keep the mineral nomenclature as uncluttered as possible.

Q. Is there a standard color chart for describing minerals? Shouldn't there be?

Carl Francis
Amherst, Massachusetts

A. (Supplied by Peter G. Embrey, British Museum) I'm glad you asked, and I hope the Editor will let me give a longer answer than is usual. I agree that there should be a standard colour chart for describing minerals and, in fact, I asked Dr. Fleischer this February to raise the matter for discussion by the I.M.A. Data Commission in Montreal this Fall.

Unfortunately, the measurement of colour is not easy and there are several systems in use: the two main ones are C.I.E. (Commission Internationale de l'Eclairage) and Munsell. Equally unfortunate is the price of the charts - I don't know if C.I.E. produces any, but the Munsell set sells in the U.K. for 105 pounds ($262), or 150 pounds ($375) de luxe. They may be a bit cheaper in the U.S.A., ordered direct from the Munsell Color Company Inc., Baltimore, Md 21218.

Shorter colour charts, entirely satisfactory for mineralogical use and very much cheaper, are readily available. The "Methuen Handbook of Colour", translated from the Danish of Kornerup and Wanscher (London, 2nd ed., 1967), is marketed in the U.S.A. by Barnes and Noble, New York 10003. It contains 30 plates, each of 48 colors, a discussion of colour measurement, and tables giving both names of the colours and the Munsell equivalents; the U.K. price is 2.75 pounds (about $7). I prefer the colour charts published by the Royal Horticultural Society of London (5.25 pounds the set, plus postage), not because I'm British but because I find them very much easier to use: 202 strips of 4 colours each are arranged in four fans, enabling one to compare colours more readily than by flipping pages: C.I.E. and not Munsell equivalents are given.

R. Ridgway's "Color Standards and Color Nomenclature" (Washington, D.C., 1912) was once widely used — and occasionally still is — but it predates modern colour measurement, the charts have "gone off" with time depending on how carefully the book has been treated, and it is out of print.

Mineral colours, even of streaks, are not generally so invariable that we need high precision for their description, but we do need something better than "dark green" and more helpful than "dark cinnabar green" or "invisible green" (Ridgway, plate XIX)! Few of us can afford several hundred bucks just to describe a colour, but almost anyone can afford *both* the cheaper charts. For this reason I hope that both of them (one C.I.E., one Munsell) will be adopted as acceptable standards for descriptive mineralogy.

Q. I have noticed that lately numerous excellent quality specimens originating in the Eastern European countries, particularly Rumania, are appearing on the market. In general, are these specimens newly mined or has a thaw in trade restrictions resulted in increased availability of older specimens?

G. E. Maccubbin, Jr.
Alexandria, Va.

A. Many appear to be newly mined and perhaps an equal number are older specimens being brought out of hiding by an increasing interest in specimens. Within the last few years more and more mineral dealers have ceased daydreaming of visiting these countries and actually have been going there, and some quite frequently. There does not seem to have been any change in trade restrictions. When the word spread that specimens can be exported, it didn't take long for the mineral dealer traffic to increase. After successful trips dealers were emboldened to try to bring larger numbers of specimens out. Naturally, when the miners found a ready market, the number of available specimens also increased.

Q. Cold vinegar will dissolve calcite. Will it dissolve aragonite? In other words, is this a distinguishing test?

Mrs. C. H. Weber, Jr.
Fairfield, Connecticut

A. The solubility of calcite and aragonite in weak acids is effectively the same so this would not be of any help in distinguishing one from the other.

Q. I was tremendously impressed by the cover photo on the July/August 1971 issue of the *Mineralogical Record*. However, its description as "elbaite" was new to me and your reference in the editorial to elbaite, dravite and schorl as distinct species sent me looking up references. Strunz (1970) gives chemical compositions and ranges of colors and *Chemical Abstracts* for the last ten years is not much help. As a collector without sophisticated testing at my disposal, I would like to characterize my thirty or so tourmalines correctly. Are all brown tourmalines schorl? Are all light colored ones elbaite? What about the green ones from Brazil, etc. Does habit enter into it?

Martin Plotkin
Massapequa Park, New York

A. Please refer to the Question and Answer relating to the tourmaline group in Vol. III, p. 16. A slight elaboration of that discussion follows. As is true of the garnets, sight identification alone is usually not sufficient to classify all of the tourmalines. The nature of the occurrence is more helpful. The blue, green, red, and other colorful tourmalines found in pegmatites are always elbaite, but schorl (black) is common in pegmatites too. Some very dark elbaites may appear black. The brown to tan tourmalines of calc-silicates (marbles and skarns) are dravite, but elbaite may also be brown. Common environments of schorl are quartzite, schist and gneiss. Pegmatitic tourmalines may be zoned, part elbaite and part schorl. This presents a difficult labelling problem. Buergerite, also brown, has been found in only one locality where the matrix is rhyolite. Habit does not seem to be a useful guide except that dravites do not appear morphologically hemimorphic, as do other tourmalines.

So to return to your question, some tourmalines are easily characterized and some are not. Descriptions in the literature should prove helpful if many of your specimens are from well known localities. In a relatively small number of cases you may simply have to guess and place a question mark (?) after the name. This is a practice many of us have often followed with garnets, and there is nothing wrong with it.

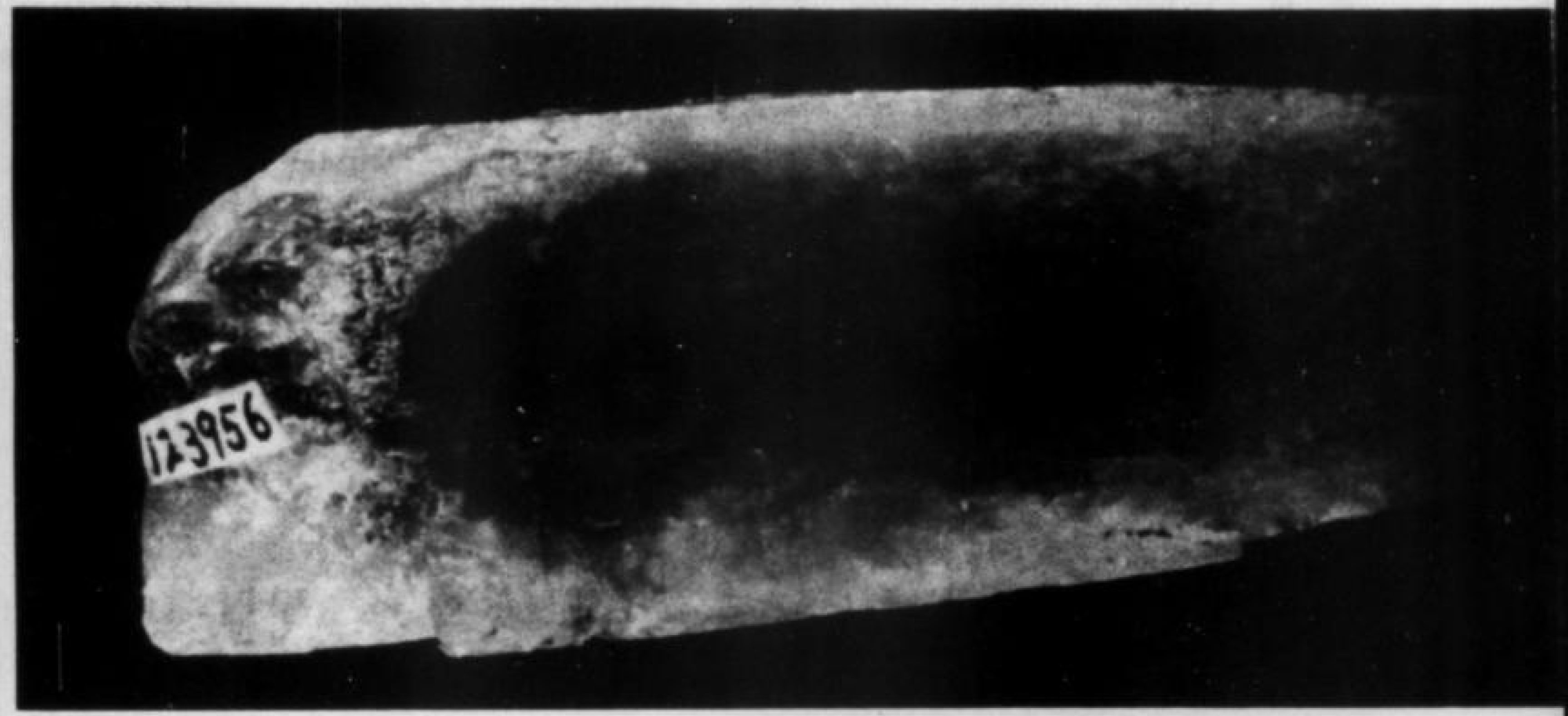
Q. What is the mineral some of the dealers have labeled simply DENNERITE, MEXICO? It is in translucent, well-formed yellow-brown prisms which have pyramidal terminations. The rock matrix seems to be altered to a pinkish white clay mineral. What is the location for the stuff? They show well at 60X.

John S. Whatley, Jr.
Macon, Georgia

A. There is no mineral name spelled DENNERITE. The closest spelling to it is a rare manganese tellurium mineral DENNINGITE, from the Moctezuma mine, Sonora. It is yellowish brown in color but terminated crystals are rare and the matrix is milky quartz, at least for those I have seen.

RETIREMENT DINNER FOR C.S. HURLBUT, JR.

More than 50 friends and colleagues of Cornelius S. Hurlbut, Jr., of Harvard University, gathered in the Gem Hall of the Smithsonian Institution on June 19, 1972, to honor one of mineralogy's great teachers. Although Professor Hurlbut is retiring this year after more than 30 years at Harvard, he has plans to continue work in mineralogy and to devote some time to writing. He is perhaps best known among students of mineralogy for his revised editions of *Dana's Handbook of Mineralogy*. The evening featured a catered dinner followed by reminiscences and tributes from George Switzer (Smithsonian), Hatten Yoder (Mineralogical Society of America, President), Paul Seel (American Federation of Mineralogical Societies), David Wones (U. S. Geological Survey), Clifford Frondel (Harvard), Don Deneck (John Wiley & Sons), and Joel E. Arem (who read letters of greeting and well wishes from many friends of Professor Hurlbut who could not attend). David Stewart of the Geological Survey introduced the speakers. Those who attended will long remember this truly glittering event.



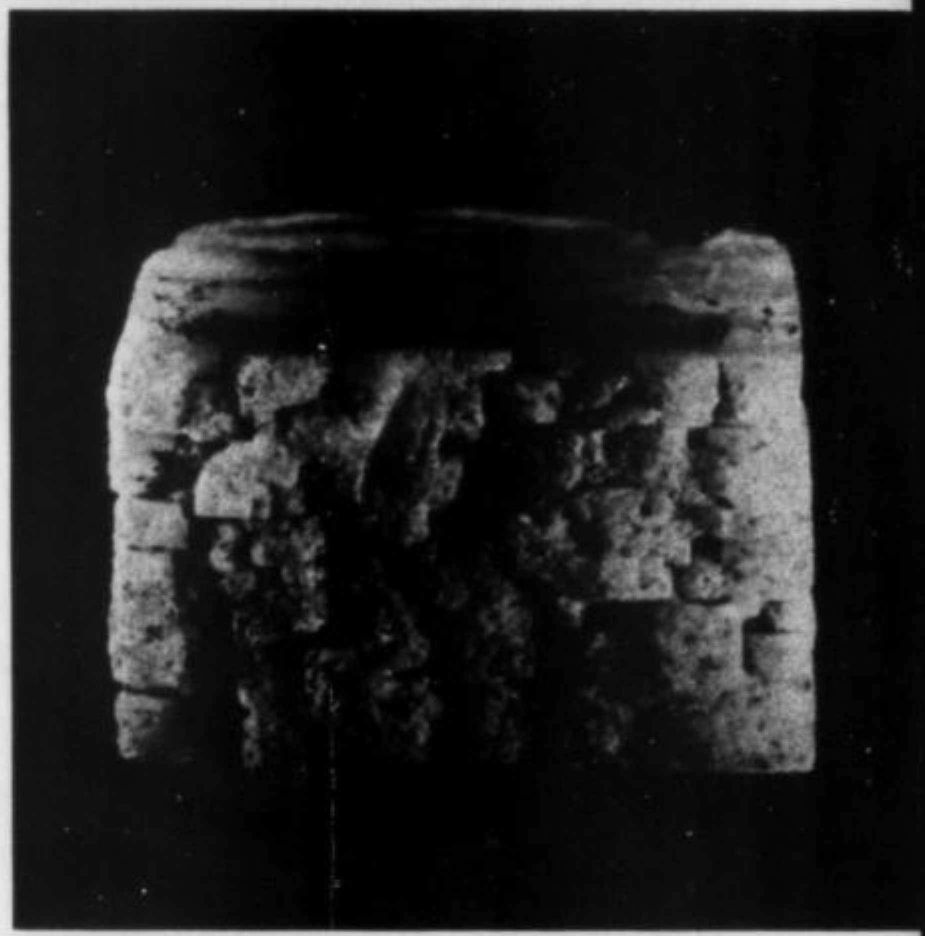


Fig. 2 Barylite – Front View
Fig. 3 Barylite – Side View
Fig. 4 Barylite – Top View

Whats New in Minerals, continued from page 125

of danburite are quite enough in themselves to please most collectors. However, the specimen derives much added appeal from the snow-white, soft and blistered-looking crust of bakerite which covers nearly all of it.

Bakerite and datolite are almost isochemical:

bakerite $Ca_4B_4(BO_4)(SiO_4)_3(OH)_3 \cdot H_2O$

datolite $Ca_4B_4(SiO_4)_4(OH)_4$

and they are also structurally nearly identical. The x-ray diffraction powder patterns, therefore, are difficult to tell apart but there are subtle differences and on this basis the crust was identified as bakerite.

The specimen measures 5 1/2 inches across.

RHODOCHROSITE

The most exciting mineral at the show in Rochester, New York in May of this year was the rhodochrosite from the South African manganese mine, Hotazel (pronounced "hot as hell"), near Kuruman, South Africa. Prosper J. Williams, a mineral dealer from Toronto, Canada, had just received shipment of a lot of these specimens he recently purchased in South Africa. To the delight of all the visitors he filled a display case with about 10 of the finest specimens. Most resemble red gum-drops. They are formed in rounded clusters of frosted appearing crystals. Nearly all are perched on pitch-black but lustrous pyrolusite(?) and the contrast of the red on black is very striking. Several of the specimens present a different habit. They are transparent red, rounded half-scalenohedra which have the look of limpid red cones. One particularly exciting specimen consists of a large colorless gypsum crystal with perhaps a hundred small red cones scattered over one large gypsum crystal face. The rhodochrosite covered face is about 5 by 2 inches in size.

Fig. 5 Bakerite on Danburite – Top

I am pleased to have received the following communication from Howard T. Evans, Jr., of the U.S. Geological Survey, in which he provides additional information concerning the copper sulfide polymorphs chalcocite, djurleite and digenite. I quote...

I noted with interest the remarks concerning chalcocite that were quoted in "What's New in Minerals" (V. III, no. 1, p. 15) from a thesis by Dr. William R. Cook, Jr.. Dr. Cook has studied synthetic copper-sulfide systems extensively, and also examined many natural specimens. I find I agree with his observations concerning natural chalcocite, but not entirely with his interpretation of them. In short, I do not believe that low chalcocite or djurleite are subject to such rapid changes in chemical or crystallographic properties at ordinary temperatures as he suggests. These minerals are really quite stable in the collection drawer.

The confusion arises mainly, I believe, from the fact that the existence of djurleite was unknown before 1958 when it was first detected in synthetic preparations by Seved Djurle at Uppsala University, Sweden, and was only confirmed as a mineral species in 1962 by Eugene Roseboom of the U.S. Geological Survey and by Nobuo Morimoto at Tokyo University, Japan. Djurleite has proved to be a relatively common mineral, but is so closely similar to chalcocite in physical and chemical properties that the two can be positively distinguished only by x-ray methods. Thus, any specimen labeled "chacocite" may actually be (and always have been) djurleite, or a coalescent mixture of chalcocite and djurleite, or even a mixture of djurleite and digenite. Before 1962 all djurleite was labeled "chalcocite", and probably most djurleite has been so labeled since that time as well.

According to Dr. Roseboom, whose work is generally confirmed by Dr. Cook's more recent studies, three species of the type $Cu_{2-X}S$ *with X near to zero are stable at room temperature:* $Cu_{2.00}S$ *(low chalcocite),* $Cu_{1.96}S$ *(djurleite) and* $Cu_{1.80}S$ *(digenite). All are transformed to other phases reversibly above about 100° C. All are based on a close-packed framework of sulfur atoms and so readily intergrow and coalesce epitaxially with each other. Thus, a small change in copper-sulfur ratio will strongly affect which species or mixture of species is formed.*

Dr. Roseboom and I have found that finely crushed samples of low chalcocite in loosely covered containers remain in the sample drawers for many months or even years without showing any tarnish or evidence of change as shown by x-ray tests. Thus, one sample from Bristol, Conn. prepared in 1963, consisting mostly of grains $\backsim$ *0.02 mm in size, gave a nearly pure low chalcocite x-ray diffraction pattern in May 1972, identical to that made in 1963. Experiments have shown that slow oxidation of digenite does occur on heating, but only above 200° C, and for chalcocite, oxidation is detected only above 500°C.*

My experience suggests that the crystal habits of chalcocite and djurleite are distinctive, that of the former having an elongated form with strong dome development, while the latter has crystals that emphasize pseudohexagonal, tabular shapes. Chalcocite often shows surface tarnish and oxidation (not penetrating the interior) while djurleite crystals are usually fresh and bright. Nevertheless, an x-ray examination is necessary for positive identification.

Record Bookshelf, from page 124

***Crystals and X-rays,* by H.S. Lipson. Springer-Verlag, New York, 1970, 197 pp. ($4.80) Paperback — Wykeham Science Series.**

The aim of this book is to present X-ray diffraction theory in the simplest possible terms, and in this it succeeds remarkably well. The text begins with a very familiar instrumental technique — light microscopy, and shows how optical systems break down at very high magnifications. The rest of the book follows a historical approach, with the discovery of X-rays and their gradual adoption in diffraction work with crystals. Other chapters include notes on the determination of some simple structures, Fourier methods, information derived from crystal structures, comparison of X-ray and optical diffraction and the uses of X-ray and other radiations. Of special merit is a final chapter on future applications of X-ray diffraction, with great insight regarding current problems and their possible solutions. Of all the introductory books on diffraction available, this one surely merits the attention of both professionals and amateur mineralogists. The text is entirely nonmathematical, reads easily and is well illustrated. The low price makes *Crystals and X-rays* within reach of any book budget.

***Color and Symmetry,* by Arthur Loeb. Wiley-Interscience, New York, 1971, 179 pp. ($14.95)**

The author of this book is concerned with patterns and their repetition. He confines his discussion to 3 rather unique dimensions: the 2 spatial dimensions of a plane, and color. Since many crystals can be considered as "stacks" of packed 2-dimensional arrays, the scope of this treatment is practical as well as fascinating. The book is chiefly concerned with a systematic derivation of all the possible planar colored configurations, and computers have been relied on heavily for assistance. As might be expected, the treatment is quite mathematical. Nonetheless, many passages are purely descriptive and the reader will become thoroughly acquainted with the basic laws and operations of symmetry. In this sense, the book is an ideal introduction to the more specialized case of crystal symmetry and structure. The text is profusely illustrated with superbly chosen examples, and further contains a lively full-color appendix that presents all known color configurations. This is mandatory reading for any would-be wallpaper designer. But the esthetic appeal of symmetrical patterns makes both the content of this book and the logic of its presentation things of beauty and well worth more than a casual glance.

Museum Record, continued from page 114

posed Institute becomes a fact. Naturally, the Foundation will be delighted to receive any financial support it can get. Lee Hammons will be glad to have checks sent and tells me that the Foundation definitely has tax-exempt status. Any checks over $5,000. you won't even need to mail. Lee will be happy to come collect them in person.

There are certainly other mineral museums of some sort in the State of Arizona. For example, I am reminded of a small, non-descript collection out in the Desert Museum near Tucson. This collection will never win any prizes for anything but there are two or three very surprising things in it. I remember, for example, a dust covered but excellent specimen of diaboleite from the Mammoth Mine. There aren't too many museums that have one as good.

I'd be happy to hear of other museums in the State that I've missed or slighted. Not only will I be glad to hear of them but I'll dutifully report on them and very likely pay a personal visit. Never let it be said that there is a mineral collection in the United States that I won't go out of my way to see if humanly possible.

Chester County Historical Society, continued from page 119

Dr. McKinstry was the author of "Mining Geology", the authorative text in the field. He worked for 17 years as a full-time professional mining geologist and gold specialist in the United States, South America, Canada, South Africa and Australia. He served in Washington with the Board of Economic welfare and as chief of the Minerals Division of the Foreign Economic Administration.

His wife, the former Elizabeth Farwell, has given the new minerals Exhibit Area to the Chester County Historical Society as a memorial to her husband and his parents.

2. *Willard Cope Brinton,* born in West Chester, Chester County, Pennsylvania, in 1880, was graduated cum laude in mechanical engineering at Lawrence Scientific School (Harvard). A consulting engineer, he was associated with several well-known American companies before becoming president and treasurer of Terminal Engineering Co., Lawrence Safety Brake Co.

During his career, he worked in various parts of the United States, Europe, China and Japan. He published two books on Graphic Methods, as well as numerous articles.

Mr. Brinton was a member of the American Society of Mechanical Engineers and served as president of the American Statistical Society in 1931-32. In 1939 he gave his large mineral collection to the Chester County Historical Society. At the time of his death in 1957, he was a resident of New York.

3.*Dr. John F. Rose,* born in Philadelphia in 1841, was graduated from Hahnemann Medical College. In 1866 he moved to Oxford, Chester County, Pa., where he practiced as a country doctor. He was also a mineralalogist of note, both in the United States and Europe. Roseite, a strange type of mica, which he discovered in the "barrens" near Oxford, bears his name. Dr. Rose was listed in standard works on Geology for years. His outstanding private collection of minerals was given to the Chester County Historical Society by his estate after his death in 1920.

4.*Thomas Ward Gay,* born in Cornwall, England in 1824, came to America in 1849. He was employed as a mine boss and captain of mines by the Phoenix Iron Co. in Phoenixville, Chester County, Pa. He died in Norristown in 1913. His fine collection of minerals was presented to the Historical Society by his grandson, William Morris Gay.

The Collector, continued from page 129

minerals however were incrusting all sides of the matrix, with no place showing where the specimens had been broken out. The matrix mineral was found to be concentrically-banded calcite stalacite portions. The selenite could be confirmed by x-ray diffraction, but the green material proved to be an artificial copper-nickel sulfate not in the powder diffraction index. The incrusting crystals might have been found to grow in pools of acid mine water if a supply of calcite (from a cave nearby or in the same mine?) were made available.

A rather difficult category of synthetics to spot are those grown, usually accidentally, as byproducts of large scale industrial processes. Occasionally a nickel plating vat may be cleaned out, and clusters of large green, dioptase-like crystals, nickel sulfate hydrate, improperly labelled morenosite, may enter the market shortly after. Some years ago specimens of "willemite" imported from Morocco were being sold at East Coast shows. These were masses of micro-zincite produced as a furnace byproduct.

Porcelainous lumps of red lead oxide, the mineral minium if natural occurring, are to be found in many major collections, labelled as from Arizona or Mexico. These would represent by far the finest occurrence of this mineral, except that they are absolutely devoid of any other species or gangue. They are almost certainly discarded fire-assaying reagent. Brownish fishtail twins of gypsum were found at Welland House in Ontario, Canada during dismantling of an industrial boiler. These crystals, in groups up to several inches in length, would be virtually impossible to spot as synthetics except that the base of the clusters is a little too smooth and has a regular curve; also there is no gangue adhering.

Various electrolytic products are sometimes seen for sale as natural specimens. Silicon carbide, carborundum, is perhaps the synthetic that the collector will first come in contact with. Silver and copper wires and trees are quite a bit harder to spot as synthetics, but their identical form when seen in quantity, and absence of any other minerals should be a clue.

Some gold specimens from Mexico were once offered in very limited supply. These showed flattened gold crystals on quartz crystals in vugs in the matrix. These proved to have been meticulously hand painted! One of the most effective fakes I have ever seen was also "gold" in rhodochrosite-quartz-fluorite matrix from Colorado. Considerable amounts of the matrix minerals, with fine crystals, had reached the market previously; why suddenly an abundance of rich wire gold with only crystalline gangue? The gold was clean and perhaps not as golden a color as might be expected in such circumstances. X-ray diffraction showed the gold to be brass powder, apparently in an acid-resistant plastic binder, extruded into place. Thus the material would pass an acid and malleability test. An interesting piece of work, but a dangerous one in Colorado where more than one person has been sent to prison for violation of a state law against faking gold.

Perhaps you have read of the multimillion dollar Texas private collection of old masters which proved to be almost entirely forgeries. The time necessary in Nature's laboratory to make our mineral specimens precludes any such massive problem for even an inexperienced collector, but there have been some surprisingly large accumulations of faked minerals. One collection, now at Harvard, was stored in a damp basement for some time after the death of the owner. When the curator saw the collection just prior to moving it, a large number of the specimens had crystals actually pushed out on pedestals of glue, apparently softened and expanded by the moist atmosphere. Another collection, deposited in the American Museum of Natural History, was found to contain several hundred fakes, including a classic, a diamond crystal set in lapis-lazuli matrix.

A little knowledge of mineral paragenesis can be of great assistance in spotting such abominations. One collector, as a joke, has had a cartoon drawn showing a "specimen" with a dozen of very interesting collector's species associated without regard to mutual stabilities. He was quite surpirsed to receive a letter insisting that a photograph of this specimen must be sent to be included in the correspondent's new picture book of exceptional pieces!

MEETINGS & SHOWS

WHO & WHAT	WHEN	WHERE	CONTACT
1972			
San Francisco Gem & Mineral Society — 19th ann. show	**Aug. 12-13**	Hall of Flowers, Golden Gate Park, San Francisco	**Mrs. Carl H. Riesen,** 295 Stonecrest Dr., San Francisco, CA 94132
Int'l Geological Congress (24th)	**Aug. 21-30**	Montreal, Canada	**J. E. Armstrong,** 601 Booth Street, Ottawa 4, Canada
3rd Annual Black Hills Micromount Symposium	**Aug. 26-27**	School of Mines, Rapid City, South Dakota	**Scott C. Moses,** P. O. Box 492, Deadwood, South Dakota 57732
Clay Minerals Society, annual meeting	**Sept. 11-14**	Woods Hole, Massachusetts	**R. T. Martin,** Rm 1—343A, Dept. of Civil Engineering, M.I.T., Cambridge, MA 02139
Danbury Mineralogical Soc., show	**Sept. 16-17**	Elks Hall, 346 Main St., Danbury, Connecticut	**Alfred Krampe,** 78 Hillandale Rd., Danbury, CT 06810
Baltimore Mineral Society, 16th Annual Micromount Symposium	**Sept. 23-24**	Stemmers Run Junior High School, Baltimore, Maryland	**H. V. Corbett,** 3220 Berkshire Rd., Baltimore, MD 21214
Northern Berkshire Mineral Club, 9th Annual Gem & Mineral Show	**Sept. 23-24**	V.F.W. Hall, Adams, Massachusetts	**Mrs. James Hancock,** Bracewell Ave. North Adams, Mass. 01247
S.E. Massachusetts Mineral Club, 3rd Annual Gem & Mineral Show	**Sept. 30 — Oct. 1**	Bridgewater State College, Bridgewater, Mass.	**Bruce Wadleigh,** 50 Winslow Ave., Norwood, Mass. 02062
Greater Detroit Int'l Gem & Mineral Show	**Oct. 13-15**	Light Guard Armory, Detroit, Michigan	**Abel J. Selburn,** 24700 Northwestern Hwy, Suite 410, Southfield, Michigan 48075
Gem Cutters' Guild of Baltimore, 9th Ann. Atlantic Coast Gem & Mineral Exhibition	**Oct. 14-15**	Pikesville Armory, Pikesville, Maryland	**W. James Hull,** Hulls' Half Acre, Darlington, MD 21034
Central Michigan Lapidary & Mineral Society, 7th Annual Gem & Mineral Show	**Oct. 20-22**	Michigan National Guard Armory, Lansing, Mich.	**William B. Rogers,** R #3, St. Johns, Mich., 48879
Middlesex Mineral Club, Annual Show	**Oct. 21-22**	Holiday Inn, Meriden, Connecticut	**Charles Malloy,** 87 Swain St., Meriden, Connecticut, 06450
Indiana Geology and Gem Society; Gem, Mineral and Handicraft Show	**Oct. 21-22**	Glendale Auditorium and Mall, Glendale Shopping Center, Indianapolis, Indiana	**Dave Folger,** 7719 Bluffwood Drive, Indianapolis, IN 46208
Eastern Federation Show and Convention	**Nov. 3-5**	Sheraton Park Hotel, Washington, D.C.	**Host Club:** Gem, Lapidary & Mineral Society of Washington, D.C., Inc.
Mineralogical Society of Southern California, annual show	**Nov. 4-5**	Pasadena City College, Pasadena, California	**Bob Pedersen,** 645 Maryanna Lane, Monrovia, Calif. 91016
Waterford Gem & Mineral Club, Annual Show	**Nov. 4-5**	C.A.I. Building, Waterford, Michigan	**J. J. Root,** 6861 Desmond, Waterford, Michigan, 48095
Geological Soc. of America and Mineralogical Soc. of America, ann. mtg.	**Nov. 13-15**	Minneapolis, Minn.	**GSA Headquarters,** Box 1719 Boulder, Colorado 80302
Osage Hills Gem & Mineral Society, bienniel show	**Nov. 18-19**	Fairgrounds Building, Dewey, Oklahoma	**John Alf,** 816 Whippoorwill Ct., Bartlesville, Oklahoma 74003
1973			
Geological Soc. of America, *Cordilleran Section,* ann. mtg.	**Mar. 22-24**	Portland, Oregon	**Dept. of Earth Sciences** Portland State University, Box 751 Portland, Oregon 97207
Amer. Fed. Of Min. Societies & Eastern Fed. of Min. Societies Show	**Jun. 28-Jul.1**	Charlotte Merchandise Mart, Charlotte, N.C.	**Al Lewis,** P.O. Box 712 Charlotte, North Carolina 28201
Midwest Fed. of Mineralogical & Geological Societies, Convention & Show	**Jul. 26-29**	Cincinnati Convention-Exposition Center, Cincinnati, Ohio	**Terry E. Huizing,** 5341 Thrasher Dr. Cincinnati, Ohio 45239
Geological Soc. of America & Mineralogical Soc. of America, ann. mtg.	**Nov. 12-14**	Dallas, Texas	**Geological Soc. of America,** Box 1719 Boulder, Colorado 80302

(MEETINGS & SHOWS WILL APPEAR IN ALTERNATE ISSUES)

To the Editor

PASTING LABELS ON SPECIMENS

Dear Sir:

How much I agree with Neal Yedlin, (*Min. Rec.,* 1972, Vol. 2, p.260) for all his use of the regal plural, in his plea that one should paste a label on every specimen. Richard Bideaux and Jack Halpern are on the right lines but they do not take things far enough.

Whilst one is in possession of one's own collection, it is unlikely, although not unknown, that the catalogue will be lost. However, on one's decease it is quite common for one's estate to be handled by a relative with little or no knowledge of minerals, and such a person cannot be expected to appreciate the value of a manuscript notebook and a heap of old rocks. Even Sotheby's, at their first sale of minerals on Tuesday, the 9th. of July, 1968, committed the sin of offering the manuscript catalogue of the collection of Her Grace, the Third Duchess of Northumberland, as a separate lot. In my opinion, the numbering of specimens is insufficient. What happens when specimens are traded and change hands several times?

I have been conducting a Yedlin-type crusade, in a modest way, in England for several years but it is sad to relate that I have had little response. Even close friends and collectors of the first order have not yet heeded my pleas. Whereas my collection is quite modest, it is at least labelled properly.

I learnt to label specimens correctly from Bob King of Leicester, one of Britain's foremost mineralogists, and the method described here is essentially his. As Neal Yedlin says, most specimens have a poor side, and modern clear adhesives have a long life; in England we have Bostik No. 1 (my favourite) and Durafix (Bob King's favourite) and in America you have Duco cement. With a fine mapping pen, fairly thin white paper, India ink and a little practice, one can soon develop a fine legible script of almost microscopic proportions, enabling one to pack a surprising amount of information on a label 1/2"x1/4". I write the label on a large piece of paper then trim it down to size. I then decide where the label is to go and if the surface of the specimen is rough, I press the label on to the specimen without adhesive, thus shaping it to fit the specimen. A dob of Bostik is squeezed on to the specimen and the label gently pressed into the adhesive. The excess adhesive, which comes up round the edges, is smeared over the surface of the label, thereby rendering it waterproof. If there is insufficient adhesive to cover the label completely, an additional dob can be squeezed on and smeared over.

With practice, it is possible to write a label giving the name, the locality and the date of collection or acquisition for the backside of a 1/2"x1/2" specimen. If the specimens are large, short essays can be included on the labels. Where possible, I like to get the history of a specimen on its label.

For instance, I once did an exchange for a West Cumberland calcite. It had been acquired from Sir Arthur Russell who had obtained it from Amos Treloare, Senior, when he was at Nenthead in 1947, and the specimen had originally been collected by Amos Treloare, Junior. All this information, running to 31 words, I have placed on the label, albeit a large one (1"x1/2"). If this specimen ever leaves my collection, with or without my consent, its pedigree will go with it. The rest of my collection is labelled in like manner.

Bob King experimented with a modification of the manuscript technique. He typed the data for several specimens on a single sheet of paper and photographed the sheet on 35mm. film. A print was then made to the required size and the individual labels cut out. However, this method proved rather time consuming, somewhat expensive and the photographic paper was too stiff to mould properly to the contours of the specimens. Also, the labels lacked personality; just as Russell labels are unmistakable, so are Bob's.

I would conclude by repeating Neal Yedlin's plea to get a label, with as much information as possible, on the specimen. By all means, give the specimen a number and keep a manuscript catalogue and, if desired, sit the specimen on a loose label as well, but please, please, stick a label on to the actual specimen.

Roger S. Harker,
36, Oxford Street,
Leicester,
England.

P.S. Somebody said, in a past issue of the *Record,* that though they knew of Dana collectors, they had not heard of a Hey collector. There is a postman of my acquaintance in Northampton, England, forming a Hey collection and I am sure he is not unique in Britain.

HELP WANTED

Dear Sir:

I am compiling an article for the *Record* on lighting equipment for underground collecting, and would like to hear from readers about the equipment they use, its cost to buy and where, its approximate cost to run per hour (if known) and any advantages and disadvantages they find in it and others they've tried. I am especially interested in hearing from anyone using homemade or modified equipment, but I'd like to get opinions on every possible variety of commercial lighting as well (send photos or drawings for publication if possible). As collectors know, there is a wide variety of lighting available, and each is good and bad in its own way. By calling upon the wide experience of *Mineralogical Record* readers I hope to make this article complete, valuable, and enlightening to everyone.

For replies to the above as well as for readers of my article on the Apache mine (Vol. II, no. 6) who have not been able to contact me, my corrected address is given below. I will not have any vanadinite trading material until January.

Wendell E. Wilson
Dept. of Geology and Geophysics
University of Minnesota
Minneapolis, Minnesota 55455

BUERGERITE OMITTED

Dear Sir:

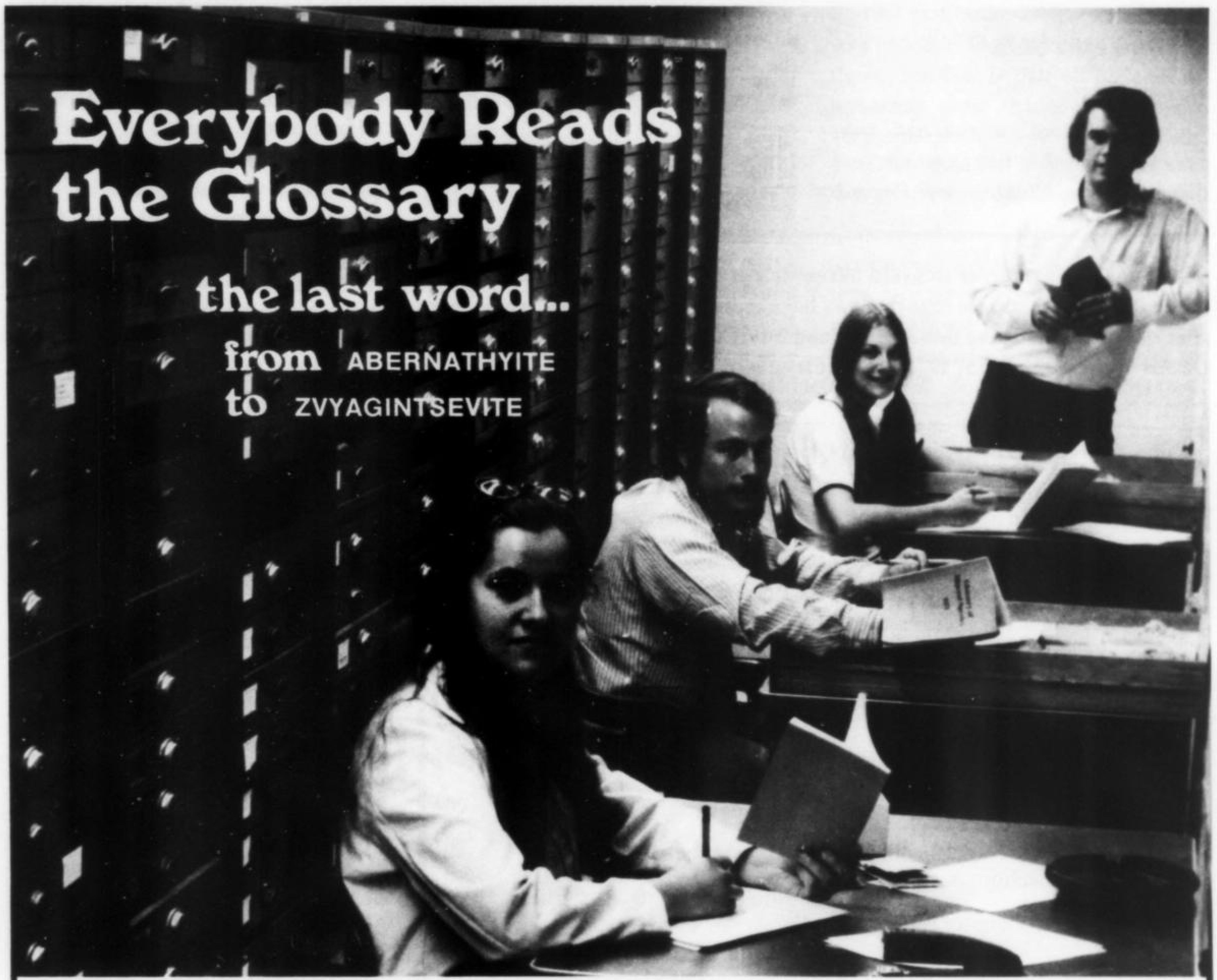
In regards your editorial on variety versus group nomenclature: I agree that we certainly need some kind of standardization, and sure don't feel qualified to determine what form it should take, only that it be consistent.

I am surprised and disappointed, however, that you failed to include buergerite in your list of tourmaline species both in the original editorial and in the answer to Mr. Cajori in the latest issue (Vol. III, no. 1). This was described as a separate species in the *American Mineralogist,* Vol. 51, page 198. It is accepted by the I.M.A. names commission. I feel that this kind of omission is a serious fault in view of the aims of the magazine...

Ralph E. Merrill
Ridgecrest, California

You are quite right and the oversight will be corrected in a forthcoming Q/A. Ed.

continued on page 140


Everybody Reads the Glossary
the last word...
from ABERNATHYITE
to ZVYAGINTSEVITE

To the Editor, continued from page 138

STEREO PICTURES

Dear Sir:

Congratulations to you and your associates on the fine job you are doing with the *Mineralogical Record.*

You may be willing to accept some adverse criticism as regards the stereophotos in No. 1, 1972. But first let me emphasize that I favor such pictures where they are of real help, and I trust you will use them at suitable places in the future.

When you reproduce stereophotos it is important to use a fine screen — say 300 mesh. Then avoid such things as exhibited by Fig. 2 (p. 9) where different parts (depths) of the crystal are in sharp focus; this creates an unpleasant retinal confusion. The apparent iridescence of an upper crystal face in Fig. 3 is caused by a strong light reflection from this face in the left photo, but almost no reflection in the right photo; a somewhat similar condition appears in Fig. 5. Figs 1, 6 and 7 are all good, but Fig. 1 is perhaps the only picture that is really greatly improved by being in stereo.

Conclusion: use stereo in critical fashion; that is, only if it really adds to the effectiveness. A good single photo is much easier to obtain than a good stereo; thus Figs. 3 and 5 would make good single photos. The imperfections on the shiny face of the left photo of Fig. 5 which do not appear in the right photo serve to emphasize how critical the lighting is in stereo work.

Please don't take these remarks as carping; I am trying to make constructive suggestions. Keep up the good work.

D. Jerome Fisher, Professor
Arizona State University
Tempe, Arizona

Dear Sir:

First, an additional compliment on your outstanding publication. Second, an approval of the publication of stereopair photographs (Raade's paper in the Jan-Feb 72 issue).

SUGGESTION: In order to avoid having to cut out pages of your copies of the *Mineralogical Record,* we urge that you have these revisions copied (Xerox, etc.), trim the copies along the dotted lines, and insert the copies in your GLOSSARY OF MINERAL SPECIES, 1971, by M. Fleischer.

Corrections and Additions to Glossary of Mineral Species, 1971

By Michael Fleischer*

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

Despite careful proofreading by three persons, a number of misprints, omissions, and other errors have been found in the Glossary, some by several readers. My aplogies for these errors; I am grateful to the sixteen readers who have informed me of these for their careful scrutiny.

I have also listed new mineral names and new information published between July 1, 1971 and June 25, 1972.

12. Botallackite, $Cu_2Cl(OH)_3$

21. Cousinite, $MgO \cdot 2UO_3 \cdot 2MoO_3 \cdot 6H_2O$ (?)

26. Eakerite, $Ca_2SnAl_2Si_6O_{16}(OH)_6$

29. Feitknechtite is misspelled

32. Freudenbergite, $Na_2(Ti, Fe)_8O_{16}$

Gageite, $(Mn, Mg, Zn)_7Si_2O_6(O)(OH)_8$

34. Gismondine, not Gismondite

37. Hammarite, $Pb_2Cu_2Bi_4S_9$

38. Add Hematolite, $(Mn, Mg)_{13}Al_2As^{+3}(AsO_4)_2(OH)_{21}O_4$

Hemimorphite, $Zn_4Si_2O_7(OH)_2 \cdot H_2O$

42. Add Ice, H_2O

44. Jade = Jadeite or Nephrite

51. Add Lime, CaO

53. Luzonite, tetragonal Cu_3AsS_4, dimorphous with Enargite

54. Madocite, $Pb_{17}(Sb, As)_{16}S_{41}$

58. Add Meta-uranocircite, $Ba(UO_2)_2(PO_4)_2 \cdot 8H_2O$

68. Pascoite, $Ca_3(V_{10}O_{28}) \cdot 17H_2O$

76. Add Rhönite, $Ca_2(Mg, Ti, Al, Fe)_6(Si, Al)_6O_{20}$,

compare Aenigmatite

78. Sakuraiite, $(Cu, Fe, Zn)_3(In, Sn)S_4$

79. Add Sarcolite, $(Ca, Na)_4OAl_3(Al, Si)_3Si_6O_{24}$ (?)

80. Schorl, $NaFe^{+2}_3Al_6(BO_3)_3Si_6O_{15}(OH)_4$, Tourmaline group

Third, an exception to your note in that paper that special glasses are required for achieving the three-dimensional effect. I, and many others, have trained myself to view stereo pairs without such glasses, a trick quite easy to master and immensely useful and satisfying. Of course, this can only be accomplished with pairs of printed separation of less-than-or-equal-to interpupillary distance, maximum about 65 mm. Your readers should find instruction for this trick in several texts on photogrammetry.

Howard C. Jack
Washington, D.C.

SPECIES COLLECTORS

Dear Sir:

Your editorial chiding species collectors has probably brought out several rebuttals. As a non-species collector, I too feel it was in error in several basic aspects.

Apparently your criticism was based on three implied assumptions:
1. That museums, and more specifically national museums, are better equipped to preserve rare species than private collectors. 2. That museums are more capable of doing research work than private collectors. 3. That more people can see and appreciate minerals when kept in museums. All of these assumptions would be fine — if true. Unfortunately, history doesn't lend much backing to them. The fact is that all collections, including great national ones, are very vulnerable to a variety of ills. I will discuss a few of these ills in relation to each of the assumptions.

Preservation. Large museum collections are highly subject to destruction, primarily from war. Ten thousand years of history indicates that these museums not only might be destroyed, but most probably will

Corrections and Additions to Glossary (continued)

Schuetteite, $Hg_3(SO_4)O_2$
81. Add Selenium, Se
Senaite, $Pb(Ti, Fe, Mn)_{22}O_{38}$
83. Sogdianite, not Sogdianovite
86. Stilpnomelane is misspelled
88. Taaffeite is misspelled
94. Delete Uranocircite
100. Yamatoite is misspelled
102. Amphibole Group. Magnophorite is misspelled
Garnet Group. Schorlomite is misspelled
103. Pyroxene group, add Bustamite, Rhodonite
Zeolite Group. Thomsonite is misspelled

Additions to Glossary

2. Alloclasite, (Co, Fe)AsS, recently validated
9. Benjaminite, recently reported to be a mixture of Berryite + Matildite + Lindströmite
11. Bolivarite, $Al_2(PO_4)(OH)_3 \cdot 4\text{-}5H_2O$, recently validated
13. Bukovite, $Cu_{3+x}Tl_2FeSe_{4-x}$
15. Carlsbergite, CrN
18. Clinosafflorite, monoclinic $CoAs_2$, dimorphous with Safflorite
24. Derriksite, $Cu_4(UO_2)(SeO_3)_2(OH)_6 \cdot H_2O$
25. Dittmarite, $(NH_4)MgPO_4 \cdot H_2O$, recently validated
27. Elyite, $Pb_4Cu(SO_4)(OH)_8$
28. Erlichmanite, OsS_2
30. Fischesserite, Ag_3AuSe_2
35. Grimselite, $K_3Na(UO_2)(CO_3)_3 \cdot H_2O$
37. Haycockite, $Cu_4Fe_5S_8$

be. In the last forty years alone there are many tragic examples of destruction through war. If all the Japanese stibnite had been preserved in the museum at Hiroshima, where would we be now? More recently, the national museum in Budapest was the center of a fierce battle during the Hungarian revolution. How many European museums were destroyed or suffered severe damage during World War II? True, private collections also suffered, but any mineral which was concentrated in only one spot may no longer exist.

Projecting the past into the future, who can say that our own national museum, the Smithsonian, is not in a critical spot in case of all out war? Washington, D.C. would be a prime target, and atomic weapons are notoriously non-selective. It can't happen, you say? Doomsday talk? Perhaps, but what happened to Washington in 1812, and nearly repeated during the early days of the Civil War? I have yet to see any real evidence that man has turned away from a warlike attitude, despite the peace marches in fad today.

Corrections and Additions to Glossary (continued)

38. Hemusite, Cu_6SnMoS_8

Heyrovskyite, $Pb_6Bi_2S_9$

41. Hydroromarchite, $5SnO \cdot 2H_2O$

42. Hydroxyl-ellestadite, $Ce_{10}(SiO_4)_3(SO_4)_3(OH, Cl, F)_2$, Apatite group

Ilmajokite, $Na_2TiSi_3O_9 \cdot 6H_2O$

46. Kawazulite, $BiTe_2Se$

Khlopinite = tantalian Samarskite

47. Komarovite, $(Ca, Mn)Nb_2Si_2O_7(O, F)_3 \cdot 3\frac{1}{2}H_2O$

49. Langisite, $(Co, Ni)As$

53. Ludlockite, $(Fe, Pb)As_2O_6$

61. Mooihoekite, $Cu_9Fe_9S_{16}$

63. Natrophosphate, $Na_6H(PO_4)_2F \cdot 17H_2O$

67. Paradocrasite, $Sb_2(Sb, As)_2$

77. Romarchite, SnO

80. Schoenfliesite, $MgSn(OH)_6$

81. Seeligerite, $Pb_3Cl_3O(IO_3)$

83. Sinnerite, $Cu_6As_4S_9$, new data

Sodium betpakdalite, $(Na, Ca)_3Fe_2[(As_2O_4)(MoO_4)_6] \cdot 15H_2O$

88. Tadzhikite, $Ca_3(Ce, Y)_2(Ti, Al, Fe)B_4Si_4O_{22}$

Takanelite, $(Mn^{+2}, Ca)Mn^{+4}_4O_9 \cdot H_2O$, compare Rancieite

Takovite, $Ni_5Al_4O_2(OH)_{18} \cdot 6H_2O$ (?)

91. Tochilinite, $2(Fe_{0.9}S) \cdot 1.67(Mg, Fe)(OH)_2$, compare Valleriite

92. Trudellite, recently found to be a mixture of chloraluminite + Natroalunite

Tsumcorite, $PbZnFe(AsO_4)_2 \cdot H_2O$

97. Wakabayashilite, $(As, Sb)_{11}S_{18}$

98. Westerveldite, $(Fe, Ni, Co)As$

100. Zapatalite, $Cu_3Al_4(PO_4)_3(OH)_9 \cdot 4H_2O$

Museum preservation of specimens is also subject to more prosaic problems, such as curatorship and funding. We are all familiar with the "once great museum" phenomenon. Museums, like collectors, have periods of major activity, but many have been known to decay badly later. Again citing the Smithsonian — while it is a truly great museum now, who is to say what would happen if Congress cut finds drastically for many years? These are real problems worth pondering.

Research work. Large museums have a rather spotty record in regard to research work done on their material. Some have done excellent work, others are merely storage vaults for minerals. For instance, the huge Långban collection in the Swedish Natural History Museum appears to be receiving little attention in relationship to the work needed and the quantity of material available for study. It is interesting to note that much of the recent work on Långban was done by a visiting American. Obviously much work remains, but I doubt seriously that it will be speeded up because it is held in a national repository rather than having some of it made available to private researchers and collectors.

On the other hand, amateur collectors and dealers have been very instrumental in finding and identifying new minerals and even adding to more basic research. In fact, it would appear that the percentage of research work attributable to sources outside of museums is increasing all the time. Often, much of this work is connected with a university or governmental agency, but more and more we see private collectors providing the material and the push — and even much of the real work — with the professional mineralogist providing access to expensive equipment and some expertise. A policy of hoarding specimens in museums — as advocated by the editorial — tends to retard research rather than advance it.

Display. Museums have a tendency to display only the large and/or flashy specimens. Realistically, they can't do much else, and I really wouldn't want it different. However, this still means that huge quantities of smaller or less attractive specimens are kept in the back room, only to be seen by a select few. Even when superb display pieces are acquired by large museums, it takes several years before they reach the public display areas.

On the other hand, the very extensive "Rock Show" phenomenon has allowed millions to view common and rare, beautiful and drab. I have seen more rare Crestmore minerals (generally not noted for flashiness) in local shows than were ever displayed in major museums.

It is only fair to say the editorial did voice some valid complaints. Many species collectors want a rare mineral just to possess it — not to study, display or disseminate knowledge about it. Private collections are often less well cared for and catalogued than museum collections. Many private collections are boxed in the garage, doing no one any good, including their owners. Many are passed on to heirs in ways that destroy their value and usefulness.

My criticism of the editorial is that while the species collector (and all collectors for that matter) have serious flaws, the museums certainly do also. In light of what I view as a very real problem in the destruction of museums in time of war, I think it is far better to disseminate rare minerals as broadly as possible rather than hoard them in one vulnerable spot. Both private and public collections must play a part in specimen preservation and research if collecting is to remain alive. Countries that have relegated collecting only to museums and public institutions have also nearly destroyed the supply of specimens. The USSR is all the example that is needed to emphasize this point.

We must not degrade the purpose and goals of the museums and professionals, but neither should we ignore the fact that the museums are great only when the private sector is healthy and growing.

James Minette
Boron, California

The writer of this letter, it would appear, has built a strong case. However, his arguments derive from a gross misunderstanding of the editorial (Vol. III, no. 1) and great naivete as to the role of museums in specimen preservation and support of research. All things considered, the odds favor better care for specimens in national museums than in private collections. In the case of priceless type specimens and important research materials, all collectors should feel compelled to place them where they are most likely to be well cared for. There is no absolute guarantee of protection no matter where they are deposited. Would Mr. Minette favor burying them in the vault with the gold at Fort Knox? They would be tranquil there but absolutely unavailable to researchers. The U. S. National Museum provides hundreds of samples to researchers all over the world annually. There is no obligation upon the curators to perform research with the specimens in their care. It is customary that curators will adopt research projects of limited scope. They may not even draw from the collections in the course of their work. Often they will go into the field and collect the materials to be used, thereby enriching the collections. What is important is that they understand the necessity for preserving and making available to other researchers the irreplaceable minerals that come into their hands. This is NOT hoarding. The specimens are doled out to qualified scientists (and this includes amateurs in some cases) when their legitimate research needs require them. A large number of scientists are not even aware of the availability of these research materials. Can you imagine how difficult it would be for them to learn that John Smith in Topeka, Kansas has some of a needed type specimen and Joe Jones in Chicago has some, etc.? How would Mr. Minette, if he were a curator of a major mineral collection, like to have to write a letter to an eminent mineralogist explaining that he cannot send him 1 gram of mineral X because he only had 2 grams in the first place and just traded away 1/2 gram each to three species collectors? Would each of these collectors, or even 2/3's of them, be willing to give up their specimens for research without compensation? I doubt it very much. It is this sort of material that was alluded to in the editorial. The problem of display material is an entirely different matter and a discussion of it is not appropriate in this context. Mr. Minette points out that museums really can't display the unspectacular specimens, and few have any interest in doing this. The display is usually for the benefit of the public and the competition for display space is keen. There would be no point in placing rather dull looking research specimens on exhibit. Even mineralogists would quickly become bored with a display of such specimens unless they happened to coincide with their particular research interests. An exhaustive display of Crestmore minerals might be appropriate for the California Division of Mines but it would not be at all appropriate for any national museum. Crestmore students most certainly can manage to arrange a visit to the study collections to view the Crestmore minerals, usually a far more satisfying experience than viewing them through glass in a display case where they cannot be handled. Imagine their dismay if they found that all of the good duplicate material had been traded away to species collectors! So, in summary, I still believe in the correctness of the editorial. We can ill afford to disperse an important study suite to species collectors just so they can "round out" their collections. If they have a legitimate need for certain samples they probably can obtain them simply by asking. In the event of a nuclear war it probably doesn't matter where the specimens are housed. At least the "American" was able to obtain access to the "huge Langban collection in the Swedish Natural History Museum" and his work resulted in the introduction of some half-dozen new species. Suppose he found that the Langban collection was reduced to a small number of specimens because it had been disseminated to a large number of private collectors. Is this the alternative that you are proposing? I hope not. Ed.

ERRATA...

Volume III, Number 2, page 84. The caption for Fig. 3 should read: Single crystal of emmonsite, Moctezuma mine, Moctezuma, Sonora, Mexico. This crystal is similar to that sent to Prof. Josef Zemann for single crystal x-ray studies.

1972 GREATER DETROIT GEM & MINERAL SHOW

International

Host - MICHIGAN MINERALOGICAL SOCIETY

OCT. 13, 14, 15

Friday, October 13th - 6 to 10 P.M.
Saturday, October 14th - 10 A.M. to 10 P.M.
Sunday, October 15th - 10 A.M. to 6 P.M.

THE DETROIT LIGHT GUARD ARMORY

4400 East Eight Mile Road • Detroit, Michigan • (Between Ryan and Mound)

In Cooperation with:

- Family Lapidary Club of Drayton Plains
- Mt. Clemens Gem and Mineral Club
- Great Lakes Rock Club of Lincoln Park
- Rock Exchange Club of Dearborn Heights
- Michigan Lapidary Society of Ferndale
- Windsor Mineralogical Society of Canada

SPECIAL FEATURE PROGAM

FRIDAY

OCTOBER 13TH 8:00 PM

"GEM MINES OF SAN DIEGO COUNTY, CALIFORNIA"
By: John Sinkankas of San Diego, California

SATURDAY

OCTOBER 14TH 1:00 TO 5:00 PM

"MEET THE MINERAL EXPERT"
A 'Friends of Mineralogy' Feature in connection with Michigan Mineralogical Society and The Mineralogical Record Magazine

OCTOBER 14TH 8:00 PM

"THE WORLD'S FINEST MINERALS AND CRYSTALS"
By: Dr. Peter Bancroft of Ramona, California

SUNDAY

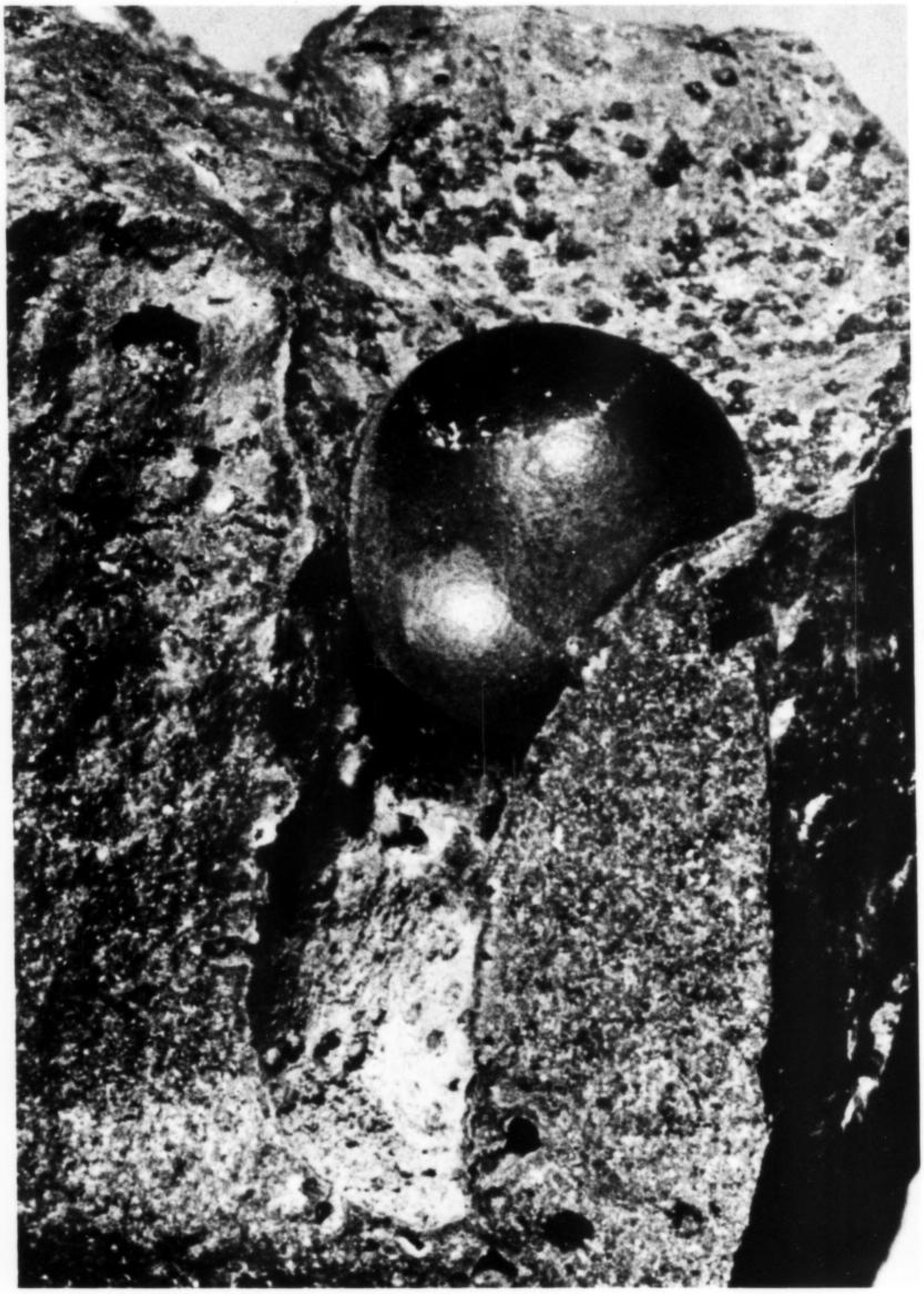
OCTOBER 15TH 1:30 PM

"A TOUR THROUGH EUROPEAN MUSEUM MINERAL DISPLAYS"
By: Richard Bideaux of Tucson, Arizona

OCTOBER 15TH 3:30 PM

"THE MORGAN COLLECTION OF MINERALS AND GEMS"
A Unique Contribution to Mineralogy
By: Dr. Vincent Manson - American Museum of Natural History

For Information Contact Show Chairman Mr. Abel J. Selburn, 24700 Northwestern Hwy., Southfield, Mich. 48075



SIDERITE from Spokane, Washington.
This nearly perfect, 7/8's inch diameter,
sphere formed in a cavity in basalt.
Globular masses of siderite are well known
in this area. When they are broken they reveal
a fibrous radial structure. It is easy to understand why
the early name for siderite was *spherosiderite*.
Smithsonian Institution specimen.
Photo by Joel E. Arem.