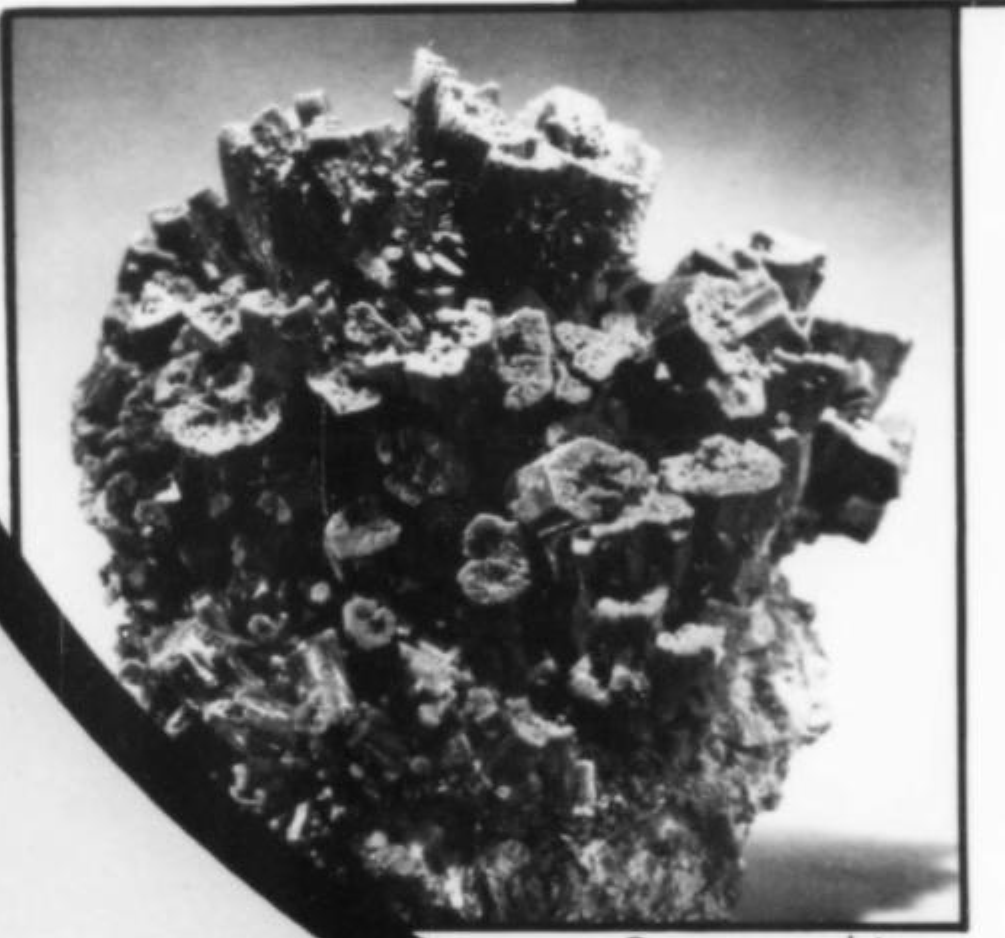
the Mineralogical Record

Volume Eight/Number Five
September-October 1977 $3.00

SHOWS
Houston-Se.9-11
Bisbee - Oct. 9-12
Detroit - Oct. 14-16
Pasadena - Nov. 19-20
Tucson - February

Tourmaline-
Golconda mine,
Minas Gerais, Brazil

Sulfur-
Perticara, Romagna, Italy



Pyromorphite-
Wheatley mine,
Phoenixville,
Pa.

Hours: Wed-Sat. 10-5
Sunday 12-5 [evenings
by appointment only]

KRISTALLE

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

affiliated with the Friends of Mineralogy

the Mineralogical Record

Volume Eight/Number Five
SEPTEMBER —OCTOBER 1977

feature articles

departments

COVER: RHODOCHROSITE on quartz, Cananea, Mexico (3.5 cm tall), from the collection of Miriam and Julius Zweibel. Photo by W.W.

subscriptions

The Mineralogical Record costs $10.00 per year, domestic and foreign.

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 afore-mentioned 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 20715

foreign payments

Remittance may be made in local currency to the following:
Canada: Mrs. J.W. Peat, 36 Deepwood Crescent, Don Mills, Ontario M3C1N8
England: Dr. R.S. Harker, 2, Wellsic Lane, Rothley, Leicestershire LE 7 7QB England
South Africa: Horst Windisch, 30 van Wouw St., Groenkloof, Pretoria

the Mineralogical Record, Post Office Box 783, Bowie, Maryland 20715 Telephone: Editorial Office 301-261-3912
Subscription Office 301-262-8583
Second class postage paid at Bowie, Md.

a Note from the Circulation Manager

I've corresponded with many of you already about various problems that have arisen but the editor thought it would be useful to address all of our subscribers at once regarding typical difficulties and how they can be avoided, explained or overcome.

(1) Missing issues: The causes of missing issues are many. The post office undoubtedly loses a few. The machine that cuts up our mailing list and glues the labels to envelopes has been known to "eat" all of Washington (the tail end of the list)! Our computer has also been known to inexplicably drop small blocks of subscribers from time to time. Difficulties can arise if you wait until the last minute to renew your subscription; if your name, address and code number have just been dropped by the computer for non-renewal and I then try to re-enter you by your code number, the computer will ignore it. Even a new subscriber is occasionally ignored by the computer; he will receive his first issue (which I send out personally) but no more until he writes in about the problem.

We are doing our best here to identify and prevent these problems. Envelopes heavier than the white ones we used for so long are now being used, because the white ones sometimes tore in the mail and issues were lost. A person now stands guard over the mailing label machine at all times while it is cutting and gluing. We proofread copies of all new computer entries after each issue's mailing list is compiled. We receive a duplicate set of labels to use for reference when missing issues are reported. Nevertheless, some errors will never be brought to our attention unless the subscriber writes to us about them. When writing in about a problem there is no need to be either apprehensive or insistent; we value all of our subscribers and will go to extra lengths to see that they are happy and satisfied. Any missing or damaged issue will be cheerfully replaced at no charge. We do ask that you wait long enough before writing to be certain that your issue is really missing. Sometimes we are a little behind schedule in mailing an issue, or the post office (particularly foreign post offices) will delay delivery but the issue will eventually reach you.

(2) Sold-out issues : With the recent increase in the circulation we find that some of our recent issues are being sold out. The press run for current and future issues has been increased, but there is nothing we can do about the sold-out issues. There is no possibility of reprinting them (especially the color issues) because of the enormous expense. Please do not presume that we have a few extra copies stashed away for the most insistent requests; *we don't*. Si and Ann Frazier (see their ad) may be able to provide you with sold-out issues.

(3) Renewal time: Please note that a peculiar problem has developed regarding renewal time. To give an example, suppose you sent in a new subscription in February of 1977. Your first issue would be the January-February issue, and your *last* issue would be the November-December 1977 issue. However, since you subscribed in February of 1977 (02 77) your mailing label will list your renewal date as February of 1978 (02 78). Obviously this is off by two months at least. In previous years we were always at least two months behind schedule in mailing each issue, so it balanced out. But now we are essentially on schedule (each issue is usually mailed out in the first week of the first month printed on the issue...the November-December issue, for instance, is mailed out during the first week in November). Therefore, to prevent missing any issues because your name has been removed from the mailing list, send your renewal as soon as the first notice is received. *Under no circumstances will you be paying twice for any issue if you renew early or, on the other hand, receive any extra issues by renewing late.* If your name is dropped from the mailing list and then re-entered there is always the chance for new errors to be introduced. One day we may make the attempt to have all renewal dates in the computer moved back by two months, but our programmer is reluctant to try it for fear that something might go wrong and create a monumental mess.

(4) Foreign subscribers: Have a problem? Please write in English! Whenever payment is made for anything, please send either a U.S. Postal Money Order or a check drawn on a United States bank. *Otherwise*, please add $3.00 for each check sent.

If any other problems arise subscribers are always urged to write to me about them or simply to give me a quick call *(301-262-8583)*. I am anxious to help anyone who is not receiving perfect service. The *Record* is not some enormous, impersonal, totally automated corporation; we care about our subscribers and are ready and willing to give personal service whenever there is a problem.

Mary Lynn White

NOTES FROM THE EDITOR

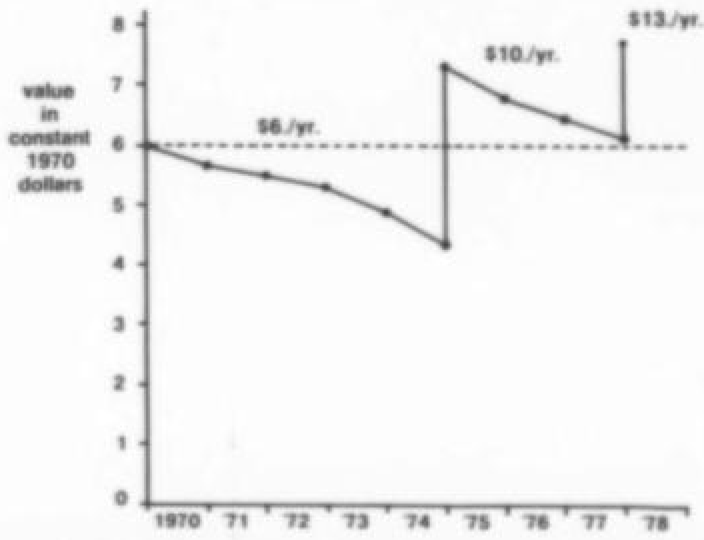
This issue contains some new features, as you have already seen. Mary Lynn White, who has been circulation manager of the *Record* since its inception in 1970, will occasionally communicate directly (as in this issue).

Also in this issue are no less than five new departments! *Bob Sullivan's Letter from Europe* is written (as you may have guessed) by Bob Sullivan, an American collector/dealer living in Switzerland. He will keep us informed of goings-on in Europe...it should be interesting. Ron Bentley's new column, the *Historical Record*, will deal with the history of collecting, especially label collecting. Some of the illustrations for his column in this issue are taken from his enormous collection of old mineral labels, one of the finest in the world. For the species collectors there is Bill Pinch's *Rare Minerals Report*; in my opinion, no one is better qualified to write such a column, so I asked him if he would, and he agreed. *Notes for Collectors* is a new column that will be open to anyone having something to say on practical aspects of collecting. Finally there is *News from the ROM* by Bob Gait, curator of minerals at the Royal Ontario Museum. He will cover interesting new acquisitions made by the ROM, and also new mineral discoveries made in Canada.

Some of our earlier columnists simply ran out of things to say on their subject; others became too busy with other matters to continue to write; some did not feel the reader response had justified additional installments. On the plus side, it is gratifying to see so many qualified people ready to share their enthusiasm with *Record* readers through new columns. It was a surprise to see five new ideas for columns come to maturity in the same issue, however! These new writers, I am sure, will add a fresh new dimension to the *Record*.

We do not stand on rigid formality, of course. The various columns will appear semi-regularly...whenever the columnist has something to say and *we* have space to print it. Space is a critical item; it is only because of the success of the **Mineralogical Record Auction** at the Tucson Show last February that, for this issue at least, we can add *24* more pages. We need continuing support at our annual auction in order to provide such extra services as more pages and more color.

Unfortunately there is nothing our supportive readers can do to stop inflation for us, and so it will come as no surprise that on January 1,* 1978, we will have to raise our subscription price by $3 in order to keep pace with rising production costs applicable to our standard 64-page, black and white issue. This increase puts our subscription cost, in terms of actual buying power, back to approximately the same level as it was in 1975. The accompanying graph shows the effect inflation has had on the money we receive from subscribers. By the end of 1974 the value of the original $6 subscription price had fallen to about $4. This month the value of $10 will be about the same as the value of the original $6 subscription in 1970. By making minimal increases in the subscription rate (probably an increase of $3 every 3 years) to compensate for inflation we can then use most of the other income from donations and increased advertising to make the *Record* bigger and better.



The effect of inflation on the value of the subscription price of the *Mineralogical Record*.

Before readers consider complaining about the increase I hope they will remember that 288 pages (all black and white) of the *Record* were published in 1972, whereas 1977 will see the publication of at least 500 pages, many of which are in full color, and each page of which carries over 20% more information due to the format change. This amounts to approximately a *doubling* of value received by the readers! During the first six years of the *Record*, people continually cried "More pages! More color! Come out monthly instead of bi-monthly!" This has been achieved (except that it is easier for us to produce an issue of double size than two separate issues of regular size) with what I consider to be a very minimal increase in the subscription cost, and I hope the readers will agree that the *Record* is still the best buy in mineral collecting. To prove it, look over the last six issues of the *Record* and ask yourself whether you could have obtained as much enjoyment and information from a $13 mineral specimen instead.

W.E.W.

---

*Subscription renewals of $10 will be accepted until this date. After this date the rate will be $13.

Neal Yedlin, an Associate Editor and columnist for the Mineralogical Record, a micromounter and mineralogist, is presently recovering from a serious stroke, in a recuperative center specializing in post-stroke recovery. Neal is completely paralyzed, and cannot speak, however, he is alert, full of the usual good humor, and can communicate very effectively through response to *yes* and *no* questions by means of controlled blinking of his eyes. Friends of Neal can help to make his recovery a more pleasant one by communicating their activities to him. This can be done in two ways. One, of course, is to write letters to him at the below-noted address. The letters are then read to him by his wife or visitors. The second way to communicate your message is by tape. Neal has a small cassette tape recorder in his room and his nurses will play any tape sent to him. Neal enjoys such tapes very much. His new address is: **Soundview Specialized Care Center, Care Lane, West Haven Connecticut, 06516.** The Visiting hours at Soundview are from 11:00 A.M. until 8:P.M. every day. Neal has personally approved all of the above statements and would like very much to hear from his friends, especially the *mineral people*. He is most interested in what you are doing, the shows, the hobby, what is new with you, your family, new ideas, and all the various happenings in the *Mineral World.* In addition to his excellent hearing and eye-blinking communication, Neal can still laugh and does so quite frequently. He would enjoy hearing from you.

P.J.D.

GUSSEN'S MINERALS

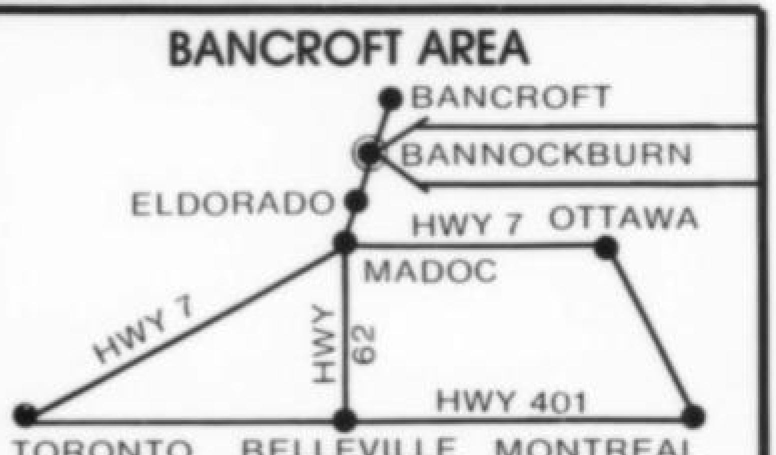
Over 5,000 thumbnail to museum size specimens in stock. Individual price lists are available for mineral specimens from; British Columbia, Canada, Franklin & Ogdensburg, N.J., Missouri, World-Wide Specimens or a Fluorescent Mineral List. **Send 26¢ in stamps for each individual list.** 50¢ credit on your first order. Specific inquiries always welcomed.

Shop and Display Room: **8892 Vinup Road, Lynden, Washington 98264.**

DALTON'S MINERALS

fine mineral specimens
free list
P.O. Box 17232,
Tucson, Arizona 85731

BANCROFT AREA



FINE MINERALS
HAWTHORNEDEN
RR #1, El Dorado,
Ontario, Canada KOK IYO
(613-473-4325) Frank & Wendy Melanson

from the
NEW SPAULDING POCKET

Ramona, California: bright new Topaz, Tourmaline, Cleavelandite, and more.
The best-kept secret of 1976.
Suite of 8 specimens available (including above), $50, $25, and $12.50, postpaid.

THE ERSKINE COLLECTION
307 Rosemont Street
La Jolla, California 92037

1/3 OFF EPIDOTE GREEN MONSTER
Mountain, Alaska.

Just purchased 26 flats collected in 1973, and you know how specimen prices have inflated in the past four years

1973 Price	1/3 Off Price
$ 5.00	*$ 3.33*
$ 7.50	*$ 5.00*
$10.00	*$ 6.67*
$12.50	*$ 8.33*
$15.00	*$10.00*
$17.50	*$11.67*
$20.00	*$13.33*
$25.00	*$16.67*
$30.00	*$20.00*

Finer, more expensive specimens also available at 1/3 off; Please include $1.00 postage. Dealers inquiries invited.

JEWELTRAIN
1960 Gomes Road
Fremont, Cal. 94538

WANTED: PSEUDOMORPHS AFTER TOURMALINE AND NON-IRON p/a PYRITE. TRADE OR BUY. Prof. D. K. Alpern, Box 363, John Jay College, 445 West 59 Street, New York City 10019.

Pink **apophyllite**, St. Andreasberg, Harz; raspberry red **rhodochrosite**, "Wolf" mine, Herdorf, Siegerland, brown **pyromorphite**, "Friedrichssegen" mine, Bad Ems; brilliant **manganite**, Ilfeld, Saxony; **stephanite**, "Himmelsfurst" mine, Freiberg, Saxony; **proustite**, Niederschlema near Schneeberg/Erzgebirge; and **other rare minerals** from classic localities in Europe.

Please write us or drop in when in Europe:

DIE KRISTALLDRUSE
D-8000 München 2
Oberanger 6, (near Stadtmuseum)
West Germany
Tel. 089260-3662

FLUORITE, Florence Mtn Az., green cubic xls on matrix, 2in .75
LINARITE, Klondyke, Az., brilliant blue drusies on matrix, 3in 1.90
CROCOITE, Dundas, deep red xls, 2in 3.00 to 12.00
BARITE, Hartsell Co., single blue xls, 2in 1.00, 1in .40
HYDROZINCITE, Ojuela Mi, white micro xls covering matrix, 3in 2.00
VANADINITE, Florence Mt Az, deep red xls on matrix, 2in .85
NATROLITE, Horseshoe Dam Az, clear xls in basalt vugs, 2in .85
AZURITE, Copper Basin Az, micro xls in tuffs on matrix, 2in .80
WULFENITE, Red Cloud Mi, 1in-1½in single xls, .75 to 2.50 each
OKENITE, India, new white puff balls, 1 1 2in 1.00
ZUNYITE, Quartzite Az, 2mm xls in matrix, 2in .90, 3in 1.30
Over 200 mineral specimens at reasonable prices. Send stamp for list.

DAVID M. SHANNON, MINERALS
1727 W. Drake Cir., Mesa, Ariz 85202

MINERAL SPECIMENS
WHOLESALE ONLY

Some people think that all the major wholesale mineral dealers are in El Paso, Texas. There are, however, alternatives.

JTI has imported and sold more dioptase xl. clusters than anyone else in the U.S. or Canada.

JTI has imported and sold more okenite puffballs and other Indian zeolite specimens than any other dealer.

JTI is importing more mineral specimens from Peru than anyone. More than five 55-gallon drums in the last shipment alone.

And that's not all. Whether you are looking for competition-grade specimens, museum pieces, decorator specimens, rare cut gems, or boxes to house them in, JTI may have something for you. Partial list on request. See me in the wholesale section at:

Amer. Fed. Show, Ogden, Aug. 17-21
Detroit Show Oct. 15-17

JEWEL TUNNEL IMPORTS
Box 8252, San Marino, CA 91108
Tel. 213-287-6352 (near Los Angeles)

AL FALSTER - MINERALS
510 BERNARD ST.
WAUSAU, WISCONSIN 54401
Micromounts, List for Stamps

OFFERS INVITED

FOR the collection of 3500 Micro Minerals of the late Mr. E.M. Skea. Catalogue available at 12 American Dollars.

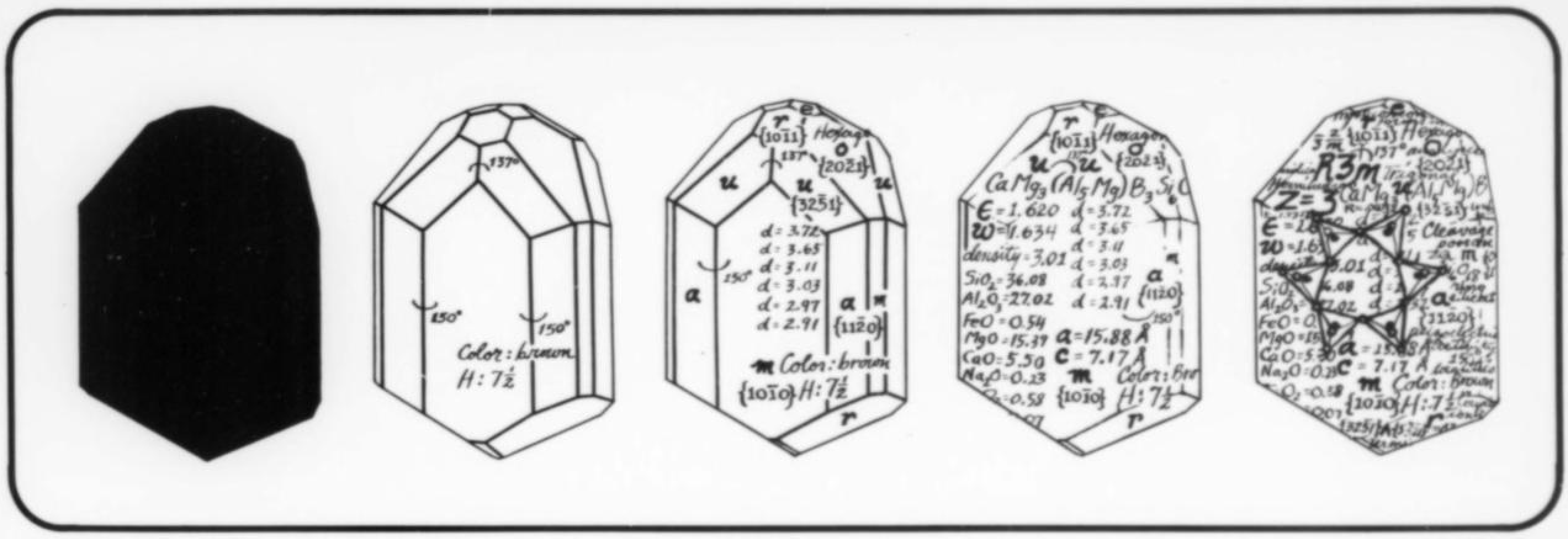
R.E. Skea
P.O. Box 94
Graskop, South Africa. 1270.
Telephone Graskop 74.

Since 1939 — A Reputation for Service and Integrity

Clarence P. Maier
AUCTIONEER

P.O. Box 432, Montgomeryville, Pa. 18936
Telephone (215) 855-5388

NATIONAL AUCTIONEERS ASSOCIATION



(sketches by
Wendell Wilson)

from
UNKNOWN to KNOWN

The characterization of new mineral species

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

INTRODUCTION

The characterization of a new mineral species is an exciting, challenging, frustrating, arduous, and delightfully satisfying task. This paper was prepared at the request of the editor of the *Mineralogical Record* to acquaint the mineral collector and amateur mineralogist with procedures which should be followed to accurately and responsibly characterize a new mineral species. New mineral species are not rare; in fact they are quite abundant in major collections everywhere. Although the discovery of new species readily available to the average collector might seem to be proceeding slowly, there are in fact a large number of possible new minerals submitted to the IMA (International Mineralogical Association) Commission on New Minerals and Mineral Names each year. For example, there were 63 submitted in 1974, 37 in 1975, and 58 in 1976. The number of new species a scientist may discover and characterize is, at the present time, limited only by the number of "unknowns" he or she can acquire to work on, a certain amount of luck, and the amount of time and energy available to apply to their characterization. A rigorous discipline is required, for short-cuts can be extremely hazardous, and the intensive initial process consists of attempting to *prove* the unknown to be a *known* species. Hence, only by failing to identify an unknown can a new mineral be discovered.

THE UNKNOWN MINERAL

In the beginning...there must come together an unknown mineral and a mineralogist, the latter having the experience and knowledge necessary to unravel the mysteries of the former. Some new minerals are found by geologists, either in the field during the investigation of an ore deposit, or as part of a detailed laboratory examination of a particular paragenesis. A large number of unknowns come to the professional mineralogist through mineral collectors of all persuasions and inclinations. Of particularly strong interest to the scientist are unknowns from very knowledgeable and astute collectors who have already done some preliminary work and given some thought to the available chemistry before sending the mineral to a mineralogist.

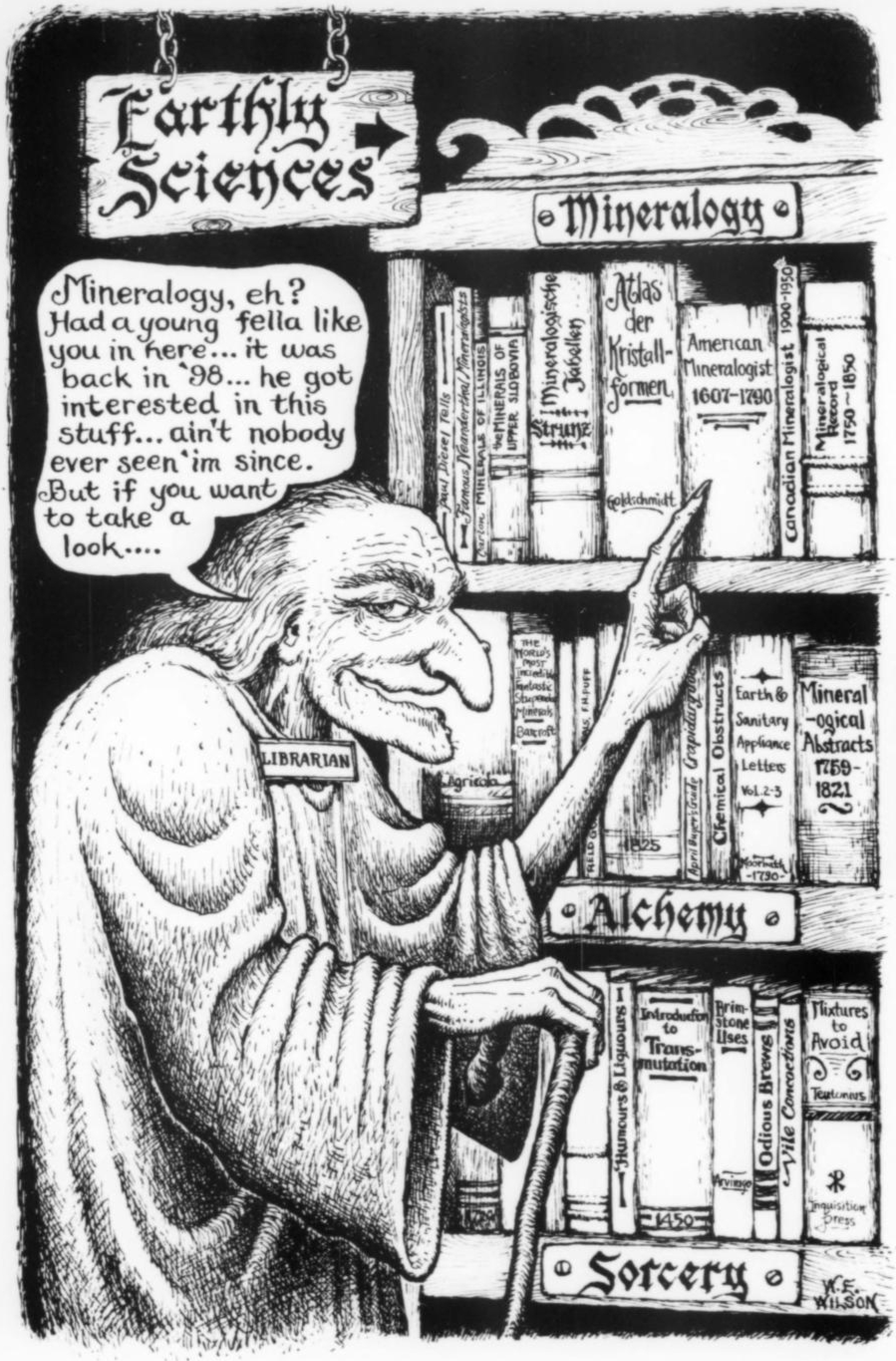
The mineral collector is a vital part of the process and his contributions are increasingly recognized. For advice on what to do with an unknown, the reader is referred to the guest editorial entitled *"So You Think You Have A New Mineral?"* (Dunn, 1975).

The role of the mineral dealer cannot be ignored because many new minerals have been recognized after having stimulated the interest of a dealer who was familiar with a particular deposit, and who took the effort to bring the mineral to a laboratory where it could be investigated.

Museum mineral collections provide many of the new species and the resident museum mineralogist has several advantages: the "unknowns" drawer is never empty, public inquiries are plentiful (astute ones less so), and the resources of the collection allow rapid and accurate comparisons. The museum collections also aid the mineralogist in the search for natural analogs of known species, establishing other relationships between a new mineral and similar species, and in providing additional samples from the locality of the unknown.

PHASE I - INITIAL ATTEMPTS

The initial attempt at identifying the unknown mineral is by



First the mineralogist must go to the library and search the literature.

eye, a careful observation of color, shape, luster, symmetry, cleavage and associated minerals will frequently suggest some possibilities and these are immediately checked before proceeding. The next step might be consultation with another mineralogist since experience is invaluable and a colleague may have seen similar material at some time in the past. Having thus far failed to identify the unknown, a perusal of other specimens of the associated species from the same locality or a similar paragenesis may suggest some possibilities which did not spring to mind initially. This initial attempt should be accompanied by a detailed writing down of one's observations. Since an active mineralogist may be pursuing 6-10 unknowns simultaneously (some being new species almost completely characterized), one should not rely too much on a mortal memory. While considering mortality, the taking of extensive notes also ensures that one's work may be used by another scientist in case of death. Hence, the sum of one's observations is always available.

Most important is the chemistry of the host rock and associated minerals, if any. One should always investigate all the possibilities suggested by the "comfortable chemistry" viewpoint; *chemically similar minerals frequently occur together.* Hence, in a calcium silicate deposit, one expects, and finds, many calcium silicate minerals. If the matrix or host mineral for a colorful unknown is a badly altered tennantite [$(Cu,Fe)_{12}As_4S_{13}$], which is assumed to have undergone supergene oxidation, one would pay particular attention to secondary copper and iron arsenates, sulfates, arsenate-sulfates, and oxides. The elements in the associated minerals should also be considered as they may mix during alteration. The dominant chemistry of the deposit may suggest some possibilities. An initial foray into the literature is now in order.

and available texts and reference works should be examined by looking up the minerals associated with the unknown and noting their "associates". Guidebooks to localities and detailed studies of the particular locality are sometimes available and may be most useful. Any leads are checked out as they develop by comparison of all diagnostic features and properties.

At this point, a reasonable argument can be advanced for putting the unknown and notes aside for a few days, and then returning to the accumulated data with a fresh viewpoint. By doing so, one might note features or relationships not noted during the initial observation. However, enthusiasm for the mineral is usually high and one might move immediately to Phase II.

PHASE II - THE ADVANCED METHODS

Having thus defied identification by the methods outlined above, the unknown is now worthy of a position on the roster of "things to be thoroughly investigated". The length of time the unknown awaits its turn for investigation may depend on a position determined by chronology (first come, first served), the whims or enthusiasm of the investigator, or any number of more or less important factors, including the full or empty condition of the office candy-jar. Many who describe new species must do so in spare time and must await convenience.

The method of approach may vary from laboratory to laboratory, from mineralogist to mineralogist. The method chosen will usually be the one that is most likely to result in an accurate identification in the minimum amount of time. Efficiency has its rewards; if the mineralogist is efficient he is able to move on to the next challenge sooner.

He runs some simple tests.

In practice, most laboratories rely on X-ray identification by the powder method as the initial sophisticated approach; this yields a crystallographic "fingerprint" of a sort. Alternatively, a scientist in a laboratory with a very convenient spectrographic analysis instrument may choose to obtain a "spec" analysis first; this tells which elements are present in the unknown. One who relies primarily on optical data may choose an optical approach. Here, too, the choice of method may depend upon convenience; if the investigator is engaged in much X-ray work, it may be more convenient to put the unknown with the samples to be X-rayed than to set-up for just one "spec" analysis, and vice versa.

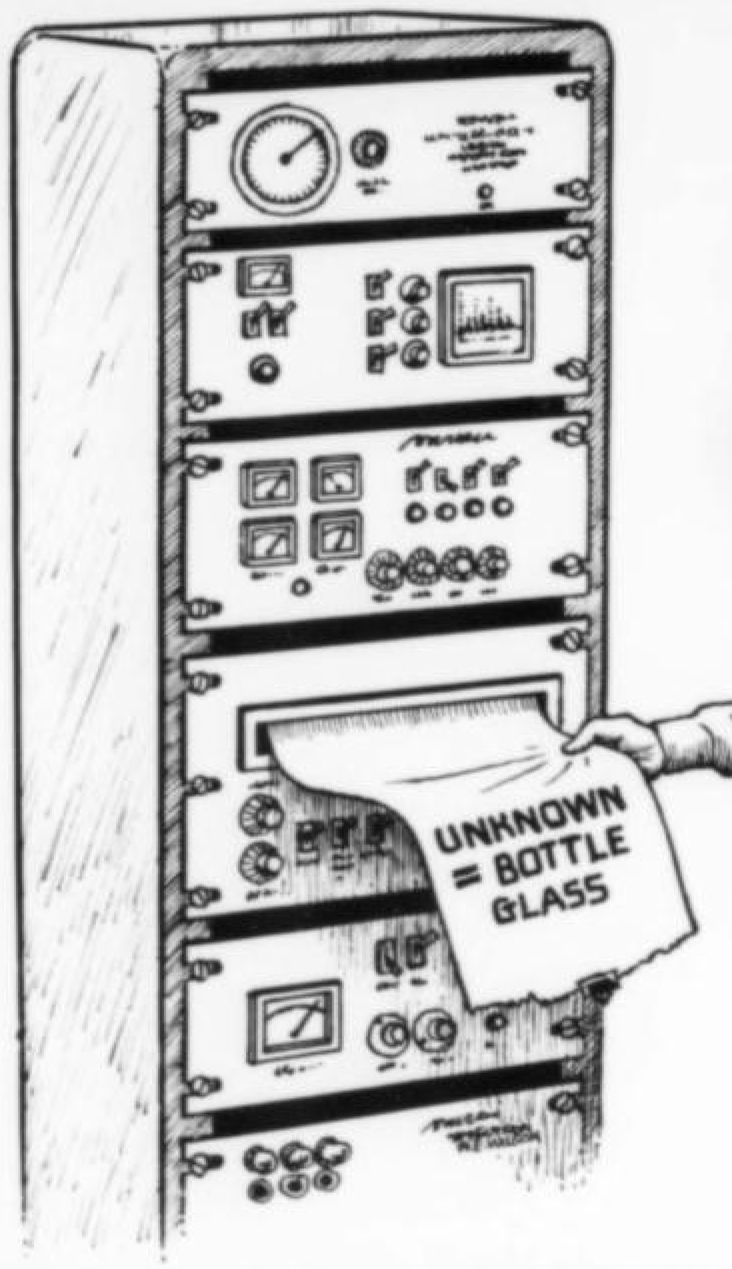
Assuming that the powder X-ray method is chosen, as it frequently is here at the National Museum, one crystal fragment of the unknown is removed and examined under the microscope in an immersion oil, for possible inclusions, inhomogeneity, twinning, and other subtle features. During this initial examination, a crude estimation of index of refraction and other salient optical features is also made. The crystal is then powdered, irradiated with X-rays of known wave-length, and a "pattern" is obtained of *d* values, which are then ranked in order of decreasing intensity. For a comprehensive explanation of the X-ray method, see *The State of the Art: X-ray Crystallography-Part III: The Powder Method*, (Arem, 1972).

Returning to our data obtained from the powder method, we now have a list of figures representing interplanar spacings (*d*) for the unknown mineral and have arranged them according to relative intensity. Hence the data may appear as:

d(Å)	Intensity
4.850	100
3.145	85
4.336	78
7.190	78
3.480	75
2.665	63

These spacings, also called "lines" or "d's" are then sought-for in the standard X-ray reference works in hope of finding a compound or mineral whose spacings match those of the unknown. Our search may be firstly centered on the JCPDS (Joint Committee on Powder Diffraction Standards) *Search Manual for Selected Powder Diffraction Data for Minerals*. Failing to find mineral data matching that of our unknown, we might then turn to the JCPDS *Search Manual for Inorganic Compounds* which contains all known reliable powder data for inorganic compounds, most of which have not yet been discovered as minerals. In addition, one would search in all other available compilations of X-ray powder data, some privately published. Many laboratories also maintain special files of powder data on minerals for which no data has been published and on their own unknowns, and these may be consulted as well. Usually this process leads to a known mineral but the powder data *alone* are not a truly definitive identification inasmuch as it gives us only a "fingerprint" of the structure. Different minerals may give almost identical diffraction patterns, as is the case with datolite and herderite, gypsum and pharmacolite, etc., etc., *ad confusiam*! Hence, all other determinations must be taken into account in the process of identification and verification. Most frequently, the X-ray pattern of an unknown will, if it does not lead to an identification, at least lead us to related species. For example, if the data suggest beudantite, but do not match the data for beudantite perfectly, one would then compare the data for the other members of the beudantite group: corkite, hidalgoite, hinsdalite, kemmlitzite, svanbergite, weilerite, and woodhouseite. If our data then still suggests beudantite as the most likely candidate, one must still proceed with caution for other chemically dissimilar minerals such as beaverite give a similar pattern.

The above discussion could be continued at great length. The procedure outlined above is but a microcosm of the arduous



task of surveying all the available X-ray data; a procedure which may take 10-15 hours for a particularly difficult problem!

CHEMISTRY

If the unknown has endured this much scrutiny and remains unknown, the heart of the investigator beats a little faster and his enthusiasm takes a distinctly perceptible jump. The possible new mineral is next subjected to a preliminary chemical investigation to determine its chief constituents and, if possible, their relative proportions. In most cases, the mineral is subjected to a spectrographic analysis to determine which elements are present. As an alternative, especially where there is too little material for a "spec" analysis, we may "scan" the mineral with the electron microprobe, but this will not give us any proof of the presence or absence of elements with atomic number below 9. Hence, lithium, boron, carbon, and beryllium would not be detected by microprobe but would be by a spectrographic analysis. The quantity of material available for this analysis sometimes determines which method is to be used, for the probe is nondestructive.

With X-ray data and chemical components in hand, the mineralogist now has the information needed to either identify the mineral as a known species, or to ascertain that it is indeed a naturally occurring, inorganic crystalline substance possibly found for the first time in the earth — a new mineral!

Considering the first possibility, the failure to identify the mineral earlier in this sample sequence of events could have been due to a number of factors. It might be a mineral which was originally poorly described, or for which X-ray data had never been published (there are many), or perhaps it was only known before in the metamict state. Regardless of the reasons, if the mineral now has been identified, a note can be published in the literature to clear up the confusion or supplement the data for the species.

Let us now return to a mineral which is still unknown. For the sake of discussion, let us assume it is a copper sulfate mineral. Armed with the preliminary chemistry and the X-ray data one must look up the powder data for all known copper sulfate compounds, natural or man-made, in the JCPDS *Search Manual for Inorganic Compounds*, this time using the volume that is arranged by chemistry. If this attempt at identification is unsuccessful, we can proceed on the assumption that we have a new mineral.

A rigorous attempt must now be made to characterize this substance as comprehensively as possible. The composition, crystallography, optical and physical properties, locality, paragenesis, mode of occurrence, salient and subtle features, and relationship to other known species, must all be determined as accurately as possible, and the mineral should be given a name. The effort is often multi-pronged; a chemist may be pursuing the composition quantitatively, a crystallographer may be ascertaining the crystallographic constants, and a descriptive mineralogist may be pursuing the rest. In spite of the approach methods, or order of their initiation or completion, the first move is to the library and a careful, meticulous perusal of the literature to date.

☞ ***He must then resort to more sophisticated techniques.***

THE LITERATURE

A vital and extremely important part of any scientific research effort is the examination of previous work on the subject at hand, related efforts, and their relationship to the problem under investigation. For the purpose of discussion, let us assume that we are investigating a probable new mineral which is a copper sulfate occuring in the oxidized zone of a lead-copper deposit in Massachusetts and which, by the similarity of X-ray powder patterns, composition, and mode of occurrence seems likely to be related to langite and posnjakite; both of which are basic hydrated copper sulfates.

When seeking references on mineral matter, the first place to look is in *Mineralogical Abstracts*, which abstracts most papers dealing with minerals back to 1920. Since we are examining a copper sulfate, as described above, from a now defunct mine in western Massachusetts, one should examine the indices to the above publication under headings of copper sulfates, langite, posnjakite, ktenasite, Massachusetts, and other such possible related topics. This effort will result in a list of related papers which must be read, and which lead in turn to other papers possibly pertinent to the present investigation. Aside from *Mineralogical Abstracts*, the elements present in our mineral should be sought for in the indices to *Chemical Abstracts* and these sought-for references lead in turn to others and on and on. Additional references may be sought for in regional bibliographies. All available references on mining in the locality in question (in this case, Massachusetts) and papers on the local geology, hydrology, and the history of local mining efforts must be accumulated, read, distilled, and assimilated. A perusal of several references on the paragenesis and formation of deposits similar to the one in which the mineral occurs might be most helpful. The possibility still exists that knowledge about our "new mineral" is roosting somewhere in the literature as a badly described and poorly characterized substance. Special attention must be paid to the existence of any poorly characterized species, especially those for which X-ray or chemical data are missing or doubtful. References to these are usually found in the *Chemical Index of Minerals* by Hey (1962) and subsequent appendices (1963, 1974), *The System of Mineralogy* by Dana (1896), *The System of Mineralogy* by Palache *et al.* (1944, 1951), *Der Handbuch der Mineralchemie* of Doelter (1912-1931), and *Der Handbuch der Mineralogie* of Hintze (1904-present), to name but a few, and the best. Additional references must also be sought on secondary mineralization in such a deposit, the possible synthesis of the compound under investigation, possible industrial applications or uses for the compound, and work on similar crystal structures. If the compound has been previously found as a synthetic, the characterization is greatly facilitated.

The above is but a guideline. Special problems suggest and require special efforts and there is no one easy format. It is only to acquaint the reader with the magnitude of the task that this much has been written here.

Having thus compiled and read the related literature, one is armed with a knowledge of what is known and what is not known, and the time is at hand to begin the characterization of a new mineral.

THE DESCRIPTION

Describing a new species is sometimes a one-scientist operation but, increasingly, more and more minerals are characterized by several scientists working in cooperation with each other. In some cases, one may do the chemistry, another the crystallography, and another the physical description, etc. The following division of the complete description into discrete steps is of necessity, quite arbitrary. Each mineral is different and special problems require special approaches. When one considers that most of the "easy" minerals have already been described (although there are several new "easy" ones found each year), what remains may be very complex minerals requiring an enormous amount of time and effort to unravel. The chemical composition and the crystallographic data are the two most important things required to characterize a new species. The other "parts" considered here are also important, but slightly less so.

The mineralogist must work with potentially hazardous equipment.

THE CHEMICAL COMPOSITION

The spectrographic analysis of the new mineral has revealed which elements are present, and may have also indicated their approximate relative abundance in the mineral. It now remains to ascertain, as precisely as possible, the exact proportion of each measureable element in the new mineral. Ideally, this would be done by a wet-chemical analysis but the paucity of material frequently dictates that other methods must be used. In cases where only a few microcrystals exist, non-destructive techniques are required. Even wet-chemistry may present problems requiring special techniques. With any method samples of the new mineral are usually analyzed at the same time as "control" samples of known similar composition.

Electron microprobe analysis has many advantages; in addition to being non-destructive, it permits the detection of compositional zoning over areas only 10-20 microns in width, and most importantly, allows the mineralogist to analyze samples which were too tiny for analytical work just a few years ago. The microprobe and scanning electron microscope are valuable tools to the modern mineralogist, and are essential in characterizing the extremely minute crystals which comprise most new species. For a detailed explanation of these instruments, the reader is referred to *The State of the Art: The Electron Microscopes and Electron Microprobe* (Wilson, 1972).

The process of microprobe analysis involves the comparison of the composition of our mineral with the accurately known compositions of standards containing the same elements. The selection of standards for uncommon elements must be made with great care, with careful cross-checking of compositions and any possible inhomogeneities. Complex and tedious mathematical corrections for fluorescence, backscatter, and absorption in the sample can now be made with computers, and are quite reliable. Other analytical methods, including atomic absorption, flame photometry, ion microprobe, etc., may be used for certain light elements. The final analysis must represent, as accurately as possible, the true composition of the new mineral. The methods used to obtain it must be stated together with any variation which may be present, accuracy of the determinations, and real and idealized formulas.

The analyses are usually presented in terms of oxides in weight percent; otherwise as elements by weight percent. This facilitates comparisons with the literature since older analyses were done wet-chemically and often the results were published as the precipitated oxide. For example, such an analysis, obtainable by diverse methods, would be given as Li_2O : 2.8%, Na_2O : 5.9%, ZrO_2 : 21.84%, HfO_2 : 0.50%, TiO_2 : 0.75%, SiO_2 : 68.24% = Sum 100.04% (Table 1, column 2). Our next step is the calculation of the tentative, or empirical formula. Any mineral formula is, of necessity, tentative until a determination of the crystal structure has been made. Tentative formulas are usually given in the format suggested by the structure of related minerals.

The analysis can be stated in terms of the number of atoms and a formula written. (In this example the idealized formula is $LiNaZrSi_6O_{15}$.) Most frequently, the number of cations is adjusted based on a fixed number of anions, such as 15 oxygens in the above example.

The above formula and its derivation represent a very simple case. Ionic substitution is common in minerals, and minerals with rather straight-forward "clean" chemistry are not often encountered. Among the other complications is the possibility that some cations, for example, iron and manganese, may exist in several oxidation states within the same mineral and this cannot be detected with the microprobe. As a result, the true nature of such compounds might not be known until the oxidation state of all elements has been determined, and the structure has been determined.

Mineral formulas must be electrostatically neutral. The positively charged ions must balance the negatively charged ions. In the case cited above, the ionic charges do balance, as shown below:

$$Na^{+1} \quad Li^{+1} \quad Zr^{+4} \quad Si_6^{+24} \quad O_{15}^{-30}$$

Other problems also exist, such as extensive simple ionic substitution (e.g. Mg^{+2} for Fe^{+2}), or coupled ionic substitution (involving ions of differing charge) in which there may be two substitutions taking place simultaneously to ensure electrostatic neutrality. For example, in mixtures between dravite $[NaMg_3Al_6B_3Si_6O_{27}(OH,F)(OH)_3]$ and uvite $[CaMg_3(Al_5Mg)B_3Si_6O_{27}(OH,F)(OH)_3]$, there is a concommitant substitution of magnesium^{+2} for aluminum^{+3} to compensate for the substitution of calcium^{+2} for sodium^{+1}.

Solving the structure is usually a separate problem.

The above section is admittedly oversimplified, much more could be written but is not necessary to give the reader an overview of the procedure and the elementary methodology. Suffice to say that the determination of the composition of every new mineral is a rather unique experience, full of potential pitfalls, and one must proceed very, very carefully. For a more detailed exposition of procedure, the reader is referred to the work of Hey (1939). Another part of the chemical description is determining the solubility of our mineral in acids or alkalis, characteristic reactions, its behavior when heated, the melting point, etc.

Not *all* of the foregoing topics are *necessary* for the description of a new mineral species; but where possible, it is best to describe the mineral as completely as possible.

THE CRYSTALLOGRAPHY

The crystallographic part of the description of a new mineral can be simplified for the sake of this discussion, and divided into two sections: the morphological crystallography and the X-ray crystallography.

MORPHOLOGY

The word morphology means the study of shape, and the first part of the description should include very basic information such as size (in mm or cm), habit (blocky, stout, acicular, etc.), and the axial orientation of any tabularity or elongation. All salient and latent features of the crystals should be noted with great care and precision. Examples of such features include the luster of the crystal faces, the degree of perfection of the crystals, whether they are euhedral, anhedral or subhedral, any obvious hemimorphism, any apparent dissolution and the evidence for it (rounded edges, etc.), etch pits and their orientation and symmetry, striations and their orientation, selective coloration or encrustation of stains or solid mineral matter, etc. This section of the description is most important, but is receiving less attention as the years go by and mineralogists, trained in advanced techniques, forget or omit precise physical descriptions based on visual observations. Nothing is too trivial to be included in the crystal description. If the crystals are visually attractive or basically ugly, that too is part of their description and must be included. If they visually resemble crystals of another species, that, too, must be noted.

The morphological description should also include a listing of the forms present on the crystals, their relative dominance, perfection of development and, in some cases, relative rarity. It is here that differential lusters on different forms should be carefully noted. Forms should be given in terms of their Miller indices, and may also be noted by the form names.

The absence as well as the presence of features such as those cited above should be included in any complete description, but seldom is today. This is indeed unfortunate for the reader of the description is given less information, and has no way of knowing if features not mentioned were absent, or simply not noted. Variation in the appearance and habit of crystals from different specimens, or such variation in association with certain other minerals, must be noted with care. If the mineral occurs as massive chunks or coatings instead of, or in addition to, fine crystals, this should be very carefully noted. In the absence of crystals, extreme detail should be given to the massive material including, but not limited to, its texture, cohesion or friability, toughness, parallelism or randomness of individual grains, and any other salient or latent features which aid in recognizing the mineral. Assuming that the crystals are euhedral, crystal drawings, photographs, or sketches should be included, the projection constants and an angle table might be calculated. Aberrations of form development which are best expressed in terms of forms or zones may be included here. Twinning of crystals, if obvious from external morphology, should be noted with maximum precision. The type of twinning, composition plane, or axis of revolution should be carefully noted along with any new physical description warranted by the shape of the resultant twinned crystals.

X-RAY CRYSTALLOGRAPHY

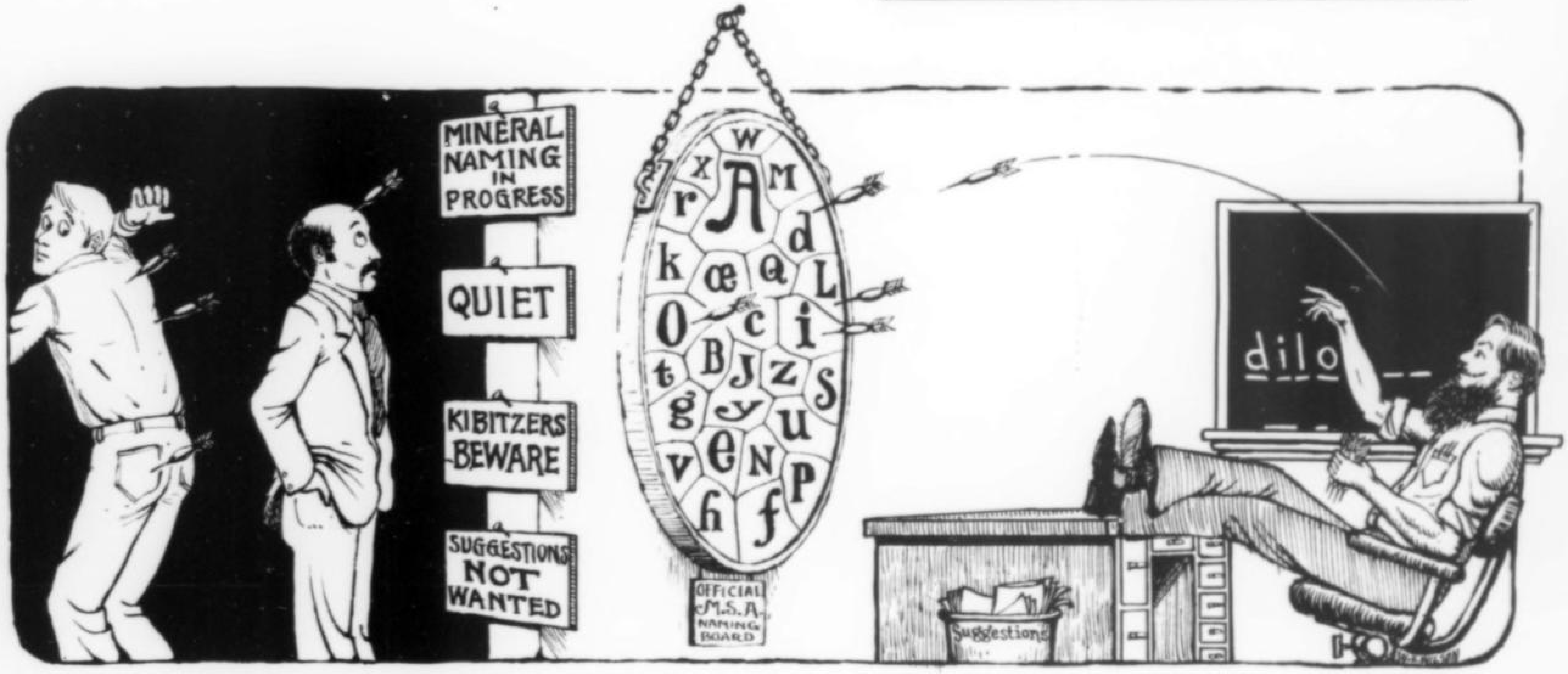
Morphological studies may sometimes serve to establish the point-group symmetry, but a detailed single-crystal X-ray study is usually required to establish the true crystal system, symmetry, space group and precise unit-cell constants (the dimensions, symmetry, and angular relations). Several different methods may be used to make these determinations and the procedure can be extremely arduous. The reflections evidenced by peaks or lines on the X-ray powder pattern are indexed on the basis of the determined cell constants, and the observed and calculated values must agree to within small limits of error. Twinning noted by X-rays but not evidenced by morphology or optical study should now be described as comprehensively as possible. A final refinement of the cell parameters obtained by single-crystal X-ray methods is accomplished using the data obtained from the powder method or single crystal diffractometer, or a back-reflection Weissenberg camera. This is usually done with the assistance of computers by least-squares refinement of a series of precise measurements of diffraction angles made by a variety of specialized techniques.

Although the solution of the crystal structure is *not* essential to the characterization of a new species, it is the most accurate statement on the true nature of the mineral. Any formula must be considered to be tentative until the crystal structure is determined.

PHYSICAL PROPERTIES

The determination of luster (both of cleavage planes and fracture surfaces), streak (when powdered for x-ray), and color is observational and not too complicated. Although there is no single agreed-upon standard system for describing color, the color charts of the Royal Horticultural Society in London and the color charts of the Geological Society of America are sometimes used. Relative hardness can be estimated easily only when the crystals are large. For microcrystals, more ingenious methods must be used, including Vickers micro-hardness testing instruments, the use of micro-chips of known minerals affixed to needles by epoxy, the rubbing of the new mineral between glass slides or cleavage surfaces of one of the known standard hardness minerals, and by other methods.

☞ *A modern mineral naming facility.*



The density determination is very important and must be very carefully done. If the mineral occurs in clean pure grains from 10-25 mg, the determination can be made with a Berman balance, employing a temperature correction. If this is not possible, the density can be ascertained by flotation in Clerici's Solution, a mixture of thallium malonate and thallium formate. The liquid is diluted with distilled water, with the attendant lowering of density, until our mineral grain is suspended at equilibria in the solution. A plot of the density of this solution *vs.* its index of refraction is a straight-line graph and one can measure the index of refraction of the liquid with a refractometer and obtain an accurate density for the mineral. The use of heavy liquids for flotation tests is quite extensive and with this method, the density of the liquid can be checked with a Westphal balance. Density determinations for minerals too heavy for the flotation method and occuring in crystals too small for the hydrostatic method may be estimated by the rate of sinking relative to that of known standards or by using a pycnometer.

And now a moment of truth has come; for the calculated and measured densities should match within a small error. The formula for calculating the density of our mineral is:

$$\frac{\text{Total molecular weight x Z x 1.66}}{\text{cell volume}}$$

The total molecular weight is simply the sum of the atomic weights of the elements in the formula. "Z" is the number of formula-units in the unit cell, and is usually a small whole number which is in accordance with the space-group symmetry of the mineral. The figure 1.66 is the reciprocal of Avogadro's number and cell volume is the volume of the unit cell, determined by simple geometry, and expressed in cubic angstrom units (Å^3). A substantial disparity between the calculated and observed density values suggests an error either in the observation of the density, or the experimental work to date, and demands a scrupulous rechecking of the data.

Cleavage observations are rather straightforward but extremely small crystals may pose special problems in orientation, which can usually be resolved by reorientation of the fragments by single-crystal methods. The cleavages should be given in terms of their Miller indices, quality, facility of development, and angular relationships between them.

Parting, magnetism, pyroelectricity, piezoelectricity, and all other physical properties should be included here, as well as a statement on the rarity or abundance of the mineral.

OPTICAL PROPERTIES

The determination of the optical properties includes the recording of the color, transparency, indices of refraction, birefringence, optic sign, 2V, the orientation of the principal vibration directions relative to the crystallographic axes, pleochroism, dispersion, sign of elongation, twinning, and all other features noted during the optical examination. Any variation or consistency in the indices should also be noted. Particular attention must be called to any diagnostic optical properties which serve to distinguish the mineral from related or similar species. The luminescence of the mineral in long and short-wave ultraviolet radiation, and x-radiation, and any phosphorescence must be detailed, both as to color and intensity.

If the mineral is opaque, the optical characteristics in reflected light should be noted, including color in air and oil, reflectivity and its dispersion, anisotropism, internal reflections, and the polishing hardness.

A second moment of truth has now arrived and the mean (average) refractive index we have determined should agree, within small limits, with a calculated mean index using the formula of Gladstone and Dale (Larsen, 1921) with subsequent observations as summarized by Mandarino (1976).

THE LOCALITY

An extremely important part of the description of a new mineral is an accurate and precise account of the place where it was found. This should be expressed in a very detailed and specific manner, although in some countries (the USSR, for example) it is not. This should be as detailed as possible, even to the position of the mineral in the pocket or vug and the physical relationships of the surrounding rock. The associated minerals and the order of their deposition and/or alteration should be detailed. Previous works on local geology, the ore deposit, etc., should be cited and the geochemistry of the surrounding rocks should be examined for any clues to the origin of the mineral. Locality data should ideally include all pertinent local, state, and national geographic data, and longitude and latitude as well, for the course of history may change place-names but is not likely to change the shape of the Earth. One can't be too specific in this most important matter; after all, the formal mineral description is usually the only opportunity to accurately and definitively set down the precise locality in print.

NAMING THE MINERAL

Having thus described a naturally occurring inorganic substance unknown to man, it is customary, and now essential, to give the material a name. The name customarily is chosen by the senior author. If named for a person still alive, his/her consent *must be obtained.* It is best if the mineral name ends in "ite", is not unpronounceable, does not sound like the names of known minerals, and can be translated into foreign alphabets, like the Cyrillic, without difficulty. Nonetheless, several difficult-to-pronounce mineral names are chosen every year. Particular attention should be given to the statement of Permingeat on the naming of minerals and modifications of nomenclatures in Hey *et al.* (1961), and for those well versed in French, the entire work is well worth reading. Much could be written here on the naming of minerals, but it is a Pandora's Box that shall not be reopened today!

TO THE IMA COMMISSION FOR APPROVAL

Having thus collected all possible data on the mineral, and having convinced oneself that it is a valid new mineral with a good name, it now remains to convince others!

The initial step in this process is the preparation of an abstract of the data on the new mineral and the submission of this abstract to the IMA (International Mineralogical Association) Commission on New Minerals and Mineral Names for a vote. In addition to the abstract, this submission should include the pronounciation of the name, its derivation, and the repository chosen for the "type" material (usually a national museum). For a statement on the procedure of the Commission, see Fleischer (1970), and for a statement on what should be sent to the Commission in the abstract, see Donnay and Fleischer (1970). The Commission members, one from each of about 30 countries, have 60 days in which to vote. A 2/3 majority of those voting is needed for approval of the mineral and a simple majority for approval of the name.

PUBLICATION

All new minerals are of interest to the scientist and collector alike and descriptions of them should be published. It is the privilege of the senior author to make the formal introduction of the mineral after the description and name have been approved by the Commission. It may be done verbally at a scientific meeting or symposium. Any responsible mineralogist will also take the time and trouble (and trouble it is!) to publish the results of the investigation and set the facts firmly in the literature for future generations.

The process is a sometimes tedious one beginning with the preparation of a manuscript (typescript) in the format and style preferred by the journal in which the author wishes to publish the work. The paper is subject to an initial tentative acceptance

TABLE I
A SAMPLE ANALYSIS OF
ZEKTZERITE, $LiNaZrSi_6O_{15}$

Oxide	Oxide Weight %	Element Weight %	Atomic Proportions	Atomic Ratio	Number of Atoms on the Basis of 15 Oxygens
Li_2O	2.8	1.30	.1874	1.00	.99
Na_2O	5.9	4.38	.1904	1.02	1.01
ZrO_2	21.84	16.17	.1772	1.01	1.00
TiO_2	0.75	0.45	.0094		
HfO_2	0.50	0.42	.0024		
SiO_2	68.24	31.88	1.1350	6.06	6.00
Total	100.03				

by the head editor, and is then usually sent to an associate editor (or several) for review and refereeing. Adjustments are usually recommended and the paper is returned to the author for such adjustments and revisions. Finally, the paper is accepted for publication and, after a period of 6-18 months, is published. The new mineral is now known!

PERSPECTIVE

The foregoing discussion is not intended to encompass all possible problems, nor to serve as a guide to the professional mineralogist inasmuch as the work of Hey *et al.* (1961), in French, and the publication of the rules of the All-Union Mineralogical Society, Academy of Sciences, USSR (1975), in Russian, serve this purpose well. Rather, it has been written with the mineral enthusiast in mind for the purpose of increasing his/her awareness of the immensity of the task, and the specific problems which face the contemporary mineralogist. Omissions have been selective and the general treatment of some subjects was intentional so as to aid the flow of thought and aid overall comprehension. Although the procedures have been described as separate parts of a whole, in the ideal case the morphology X-ray work, optics, density, analysis, and structure may be done on one single crystal.

Although the pace of the description of a new mineral seems tedious, many problems may be pursued simultaneously.

During the writing and rewriting of this paper, the author examined 41 unknowns, of which only eight survived identification by the steps up to and including powder X-ray methods. Of the surviving eight unknowns, six are still unknown to science after analysis and are very likely to be valid new mineral species. The other two will involve more time. The end is nowhere in sight! Some minerals are encountered which are too small and it is not yet possible to characterize them with today's technology. These are put aside for another day, and the available data filed carefully away, or possibly published, without a name. Better specimens may become available in the future, and the material can then be thoroughly characterized.

As was mentioned in the introduction, the process is both tedious, frustrating, and extremely exciting! To probe into a compound which is known only to the scientist and the Creator is a great privilege. I hope the reader has absorbed some of this excitement in the proceeding pages, and shall continue to contribute to the process, for the contributions of the collector are indeed quite significant.

☞ *Achieving publication has its own frustrations.*

ACKNOWLEDGEMENTS

The author is indebted to the following scientists who graciously consented to read the original manuscript and offer criticisms which led to improvement. Many thanks to Daniel Appleman, Paul Desautels, Richard Erd, Richard Gaines, Joseph Mandarino, Mary Mrose, John S. White, and Wendell Wilson.

REFERENCES

AREM, J. A. (1971) The state of the art: X-ray crystallography - Part III: the powder method. *Mineral. Rec.* **2**; 174-179.

DANA, E. S. (1892) *The System of Mineralogy.* John Wiley and Sons, New York, U.S.A.

DOELTER, C. (1912-1931) *Der Handbuch der Mineralchemie.* Verlag Theodor Steinkopff, Dresden, Germany.

DONNAY, G., FLEISCHER, M. (1970) Suggested outline for new mineral descriptions. *Amer. Mineral.* **55**; 1017-1018.

DUNN, P. J. (1975) Guest editorial: So you think you have found a new mineral? *Mineral. Rec.* **6**; 220.

FLEISCHER, M. (1970) Procedure of the International Mineralogical Association Commission of New Minerals and Mineral Names. *Amer. Mineral.* **55**; 1016-1017.

HEY, M. H. (1962) *An Index of Mineral Species and Varieties*, 2nd Ed. The British Museum, London, England.

__________(1963) *Appendix to the Second Edition of an Index of Mineral Species and Varieties.* The British Museum (N.H.), London, England.

__________(1974) *A Second Appendix to the Second Edition of an Index of Mineral Species and Varieties.* The British Museum (N.H.), London, England.

__________(1939) On the presentation of chemical analyses of minerals. *Mineral. Mag.* **25**; 402-412.

__________, GUILLEMIN, C., PERMINGEAT, F., de ROEVER, J. P., (1961) Sur la nomenclature mineralogique. *Bull Soc. franc. Miner. Crist.* **84**; 96-105.

HINTZE, C. (1904-PRESENT) *Handbuch der Mineralogie.* Walter de Gruyter Co., Berlin, Germany.

LARSON, E. S. (1921) The microscopic determination of the nonopaque minerals. *U.S.G.S. Bull.* **679**; 30-32.

MANDARINO, J. (1976) The Gladstone-Dale relationship. Part 1.: derivation of new constants. *Can. Mineral.* **14**; 498-502.

PALACHE, C., BERMAN, H., FRONDEL, C., (1944, 1951) *The System of Mineralogy.* Vol. I, and II. John Wiley & Sons, New York, U.S.A.

WILSON, W. E. (1972) The state of the art: the electron microscope and electron microprobe. *Mineral. Rec.* **3**; 151-164.

**Selected Powder Diffraction Data for Minerals, Search Manual* (1974)

**Powder Diffraction File Search Manual, Hanawalt Method, Inorganic* (1976)

**Powder Diffraction File Search Manual, Alphabetical Listing, Inorganic* (1976)

*All published by the Joint Commission on Powder Diffraction Standards 1601 Park Lane, Swarthmore, Pennsylvania 19081.

On the course of approval and the requirements for characterization of new minerals (1975). *Zap. Vses. Min. Obshch.* **104**, (5), 521-525.

Twinning in minerals

by
Alice Blount - Newark Museum, Newark, N. J. 07101
and
Will Shulman - 47 Falcon Rd., Livingston, N. J. 07039

Crystals have often been referred to as "flowers of the mineral kingdom." Their symmetry is a pleasure to observe. Many amateur mineralogists collect crystals but only a few have extended their efforts into the fascinating and challenging field of twinned crystals. This is possibly due to a great extent to the inadequate and often misleading treatment of this subject in the literature designed for the amateur. Indeed, the professional crystallographer may well have a subconscious aversion to twinned crystals because twinning will generally bring to a quick halt any thoughts of determining the crystal structure (i.e. the arrangement of atoms or ions in the solid) of that crystal or at least make such determination difficult (see *Mineralogical Record* **2**, 111 for further discussion of this). While no single article can begin to describe all the details of twinning, nor enable the reader to immediately recognize all types of twins, it is hoped at least to introduce this fascinating aspect of mineralogy and to challenge the reader's observational powers when he or she looks at minerals in the future.

What is the difference between a single crystal and a twin?

One can immediately observe a difference in the calcite shown in Figure 1 as compared with the calcite in Figure 2. Are these any different from the calcite in Figure 3? Before discussing these figures let us review what we know about crystals. A *crystal* is a polyhedral form, bounded by plane surfaces, which is the outward expression of a periodic or regularly repeating internal arrangement of atoms. For example, in sodium chloride (halite) each sodium is surrounded by six chlorine atoms, and *vice versa*. This is true for every atom in the mineral except for the few at the surface. A subatomic observer located at one chlorine atom would not be able to distinguish his position from a position on any other chlorine atom in the crystal, each chlorine having an identical environment. This regular arrangement of sodium and chlorine will give rise to a cubic shape (Figure 4).

In 1669 Nicolaus Steno made the observation that the angles between similar faces on different crystals of the same substance are always equal. Lists of interfacial angles are given in mineralogy books and are useful in identification. More recently, x-rays have permitted crystallographers to examine the arrangement of atoms which gives rise to this external symmetry. In 1912 Max von Laue performed the experiments which showed that x-rays were "reflected" (the more accurate term is "diffracted") from atomic planes, giving rise to patterns which contain information about the orderly internal arrangement of atoms in crystals.

This brief review can hopefully help us understand twinning. First, there must be two or more individual crystals involved. It is at this point that a misunderstanding often arises. What is an "individual" crystal? Figure 5 is presented to help clarify this point. Consider the circles as spherical atoms. Let us once again send in our subatomic observer but this time let us assume he has a compass so as to determine his direction relative to fixed points in space. If the observer is placed at a point on a large atom in Figure 5a, on the left side and then on the right side of the line marked *m*, he would not be able to distinguish that he had charged positions because the surrounding atoms would appear exactly the same in size, type and position. Notice, however, that in Figure 5b this would not be true. He would notice a change in direction of the small atoms relative to the fixed points of the compass. A crystallographer would, consequently, recognize that Figure 5a represents a single crystal and Figure 5b represents two individual crystals.

The second important aspect is that in crystallography twins are more adequately described as "Siamese twins" than as "twins"; they must share certain structures. In other words, certain atoms must belong equally to both individual crystals. In Figure 5b we see that the atoms along the line marked *m* belong to both individuals and act in the same capacity in each crystal. In considering Figure 5c, one will notice that although there are two individuals they do not share atoms and, thus, this diagram does not show any twinning. Now we can return to Figures 1, 2 and 3. The calcite in Figure 1 is a single crystal and the calcite in Figure 2 is a twinned crystal. The specimen in Figure 3 is similar to the case shown in Figure 5a where the atomic planes of all the "crystals" are parallel and where there are reentrant angles. This is designated a "parallel growth." Notice that no new symmetry elements have been produced. If the individuals grow next to one another but are not quite parallel the group is called an "intergrowth." Additional photographs of calcite are shown in Figures 6 through 9. See if you can determine which illustrate single crystals, twins, parallel growths and intergrowths before referring to the captions.

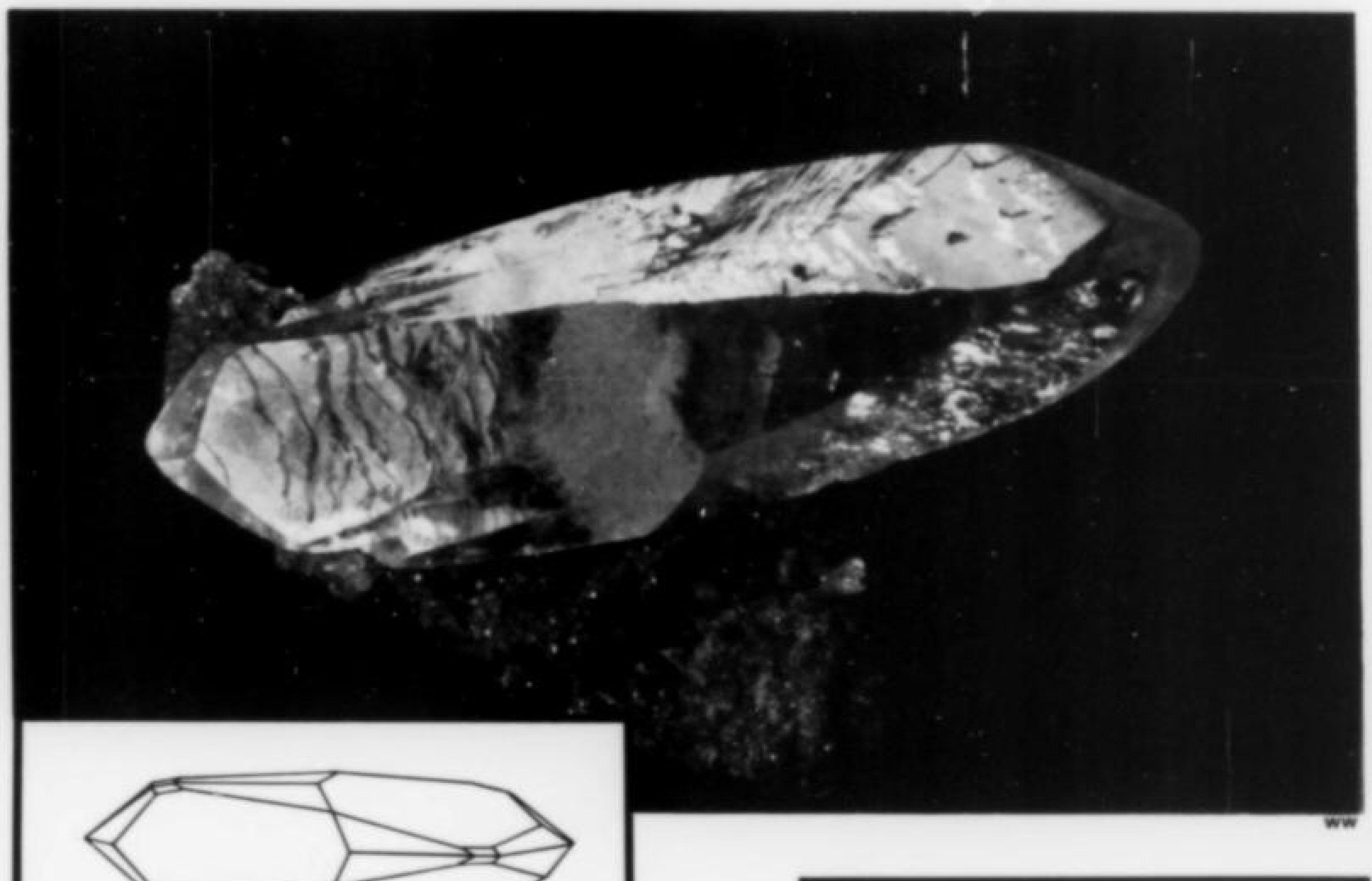
Twins are generally defined as crystalline substances which are intergrown in such a way that the individuals are related by mirror-symmetry planes, symmetry axes or centers of symmetry and, further, these symmetry elements must be in addition to those already existing in the crystal. The features described in the definition of twinned crystals are a direct outcome of the two aspects just described. The external symmetry of a crystal is a result of the internal arrangement of atoms. One intuitively would expect that since twinning is a direct result of internal arrangement, the related individuals would be in some definite symmetrical relation to one another. This can be clearly seen in Figure 5b. The line *m* represents a mirror plane. When twinned crystals have smooth faces the angle between the twinned individuals can be measured. This is a **constant angle** for a given type of twin in a given mineral. The constancy of twinning angle can be equated with Steno's law concerning interfacial angles in single crystals. Many twin laws have been given names such as Japan twins in quartz and Carlsbad twins in feldspar (Figure 10), etc. Finally, if one examines Figure 5a one will understand why a twin cannot be related by a previously existing symmetry element (*m* again represents a mirror plane). The atomic structure continues across the plane and the crystal would be considered to be a "single" crystal or parallel growth. Reentrant (or inward pointing) angles are often cited as criteria to distinguish twins. Figure 5a is especially drawn to show that reentrant angles need not always indicate twinning.

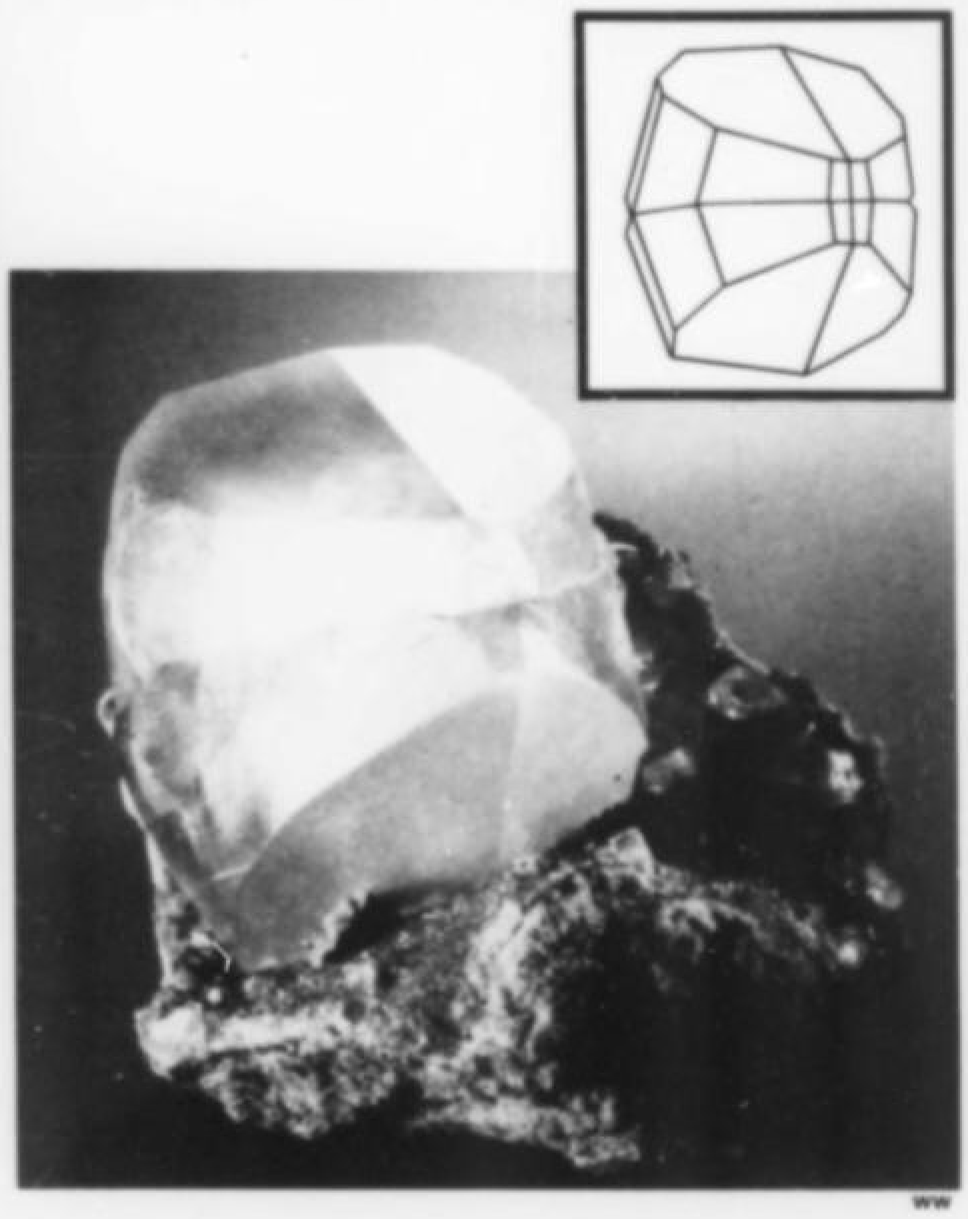
Dana's definition of twinned crystals summarizes well what we have been trying to say in this section. "Twinned crystals may be defined as intergrowths of two or more individuals in such a way as to yield parallelism in the case of certain parts of different individuals, and at the same time other parts of different individuals are in reverse positions in respect to each other." In looking at a mineral specimen, to determine if twinning is present, one should look for faces which are "reversed" on one crystal compared to the other.

Classification of Twins

To this point, we have directed our attention to briefly describing the basic factors behind the concept of twinning. Now let us observe actual minerals. One should recognize that it is often much easier to say theoretically what twins are, than to recognize them in actual practice.

Twinned individuals join one another in several ways. If the crystals are joined at one plane, the crystal is a **contact twin**.





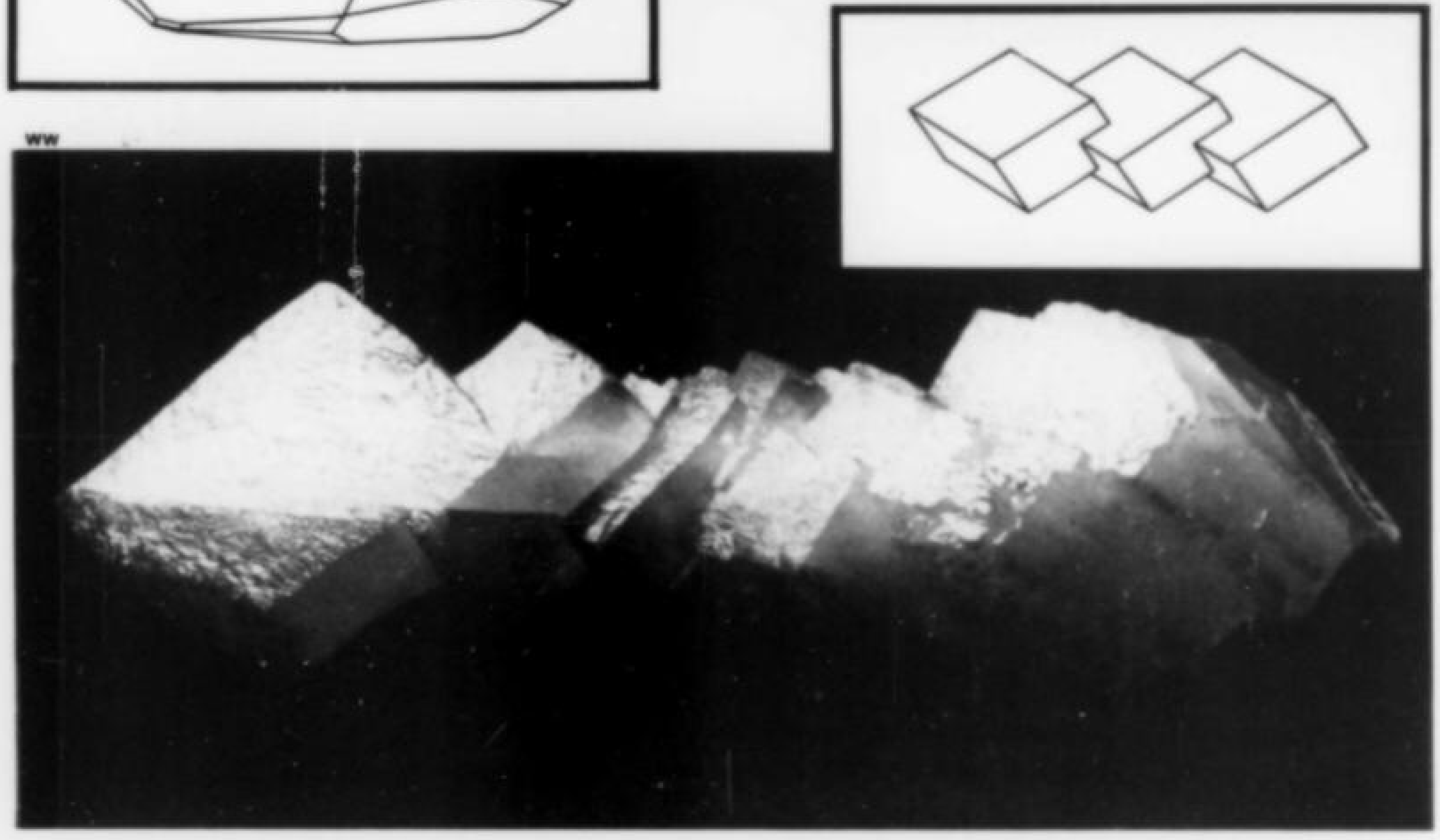


Figure 1. (above left) **Untwinned calcite (Viburnum trend, Missouri; pale yellow; 4.3 cm long; W.E. Wilson collection).**

Figure 2. (above) **Calcite twinned on the (0112) plane (Anderson, Indiana; golden yellow; 3.2 cm tall; U.S.N.M. (Smithsonian) #134330).**

Figure 3. (left) **Parallel growth of calcite (Charcas, San Luis Potosi, Mexico; white; 11.2 cm long; U.S.N.M. #117066).**

The atoms at the plane of contact (**composition plane**) are shared by both individuals. The plane may be a mirror plane of symmetry for the crystals or there may be an axis of symmetry parallel or perpendicular to the contact plane which relates the two individuals. The specimen shown in Figure 6 is an example of a contact twin. The composition plane is (0001)*, the basal plane. In figure 2 the composition plane is (0112), a possible rhombohedral face, and the *c* axes are at an angle of 127°30′. In the butterfly twin, figure 9, the angle of the *c* axes is 90°47′. Notice that the crystallographic relations are quite specific. If one is able to measure the angular relations of the faces, there should be little doubt about whether one has a twinned crystal or about which type of twinning is represented. (In some cases x-ray diffraction measurements are necessary to determine the twin law.) Unfortunately it is often difficult to determine twinning by mere observation of a single specimen without measuring.

When one crystal "fits" into the other in such a way that the two crystals seem to occupy the same space, as shown by orthoclase in Figure 10, the crystal is a **penetration twin**. This type of twin also has planes in which the atoms are shared between two individuals.

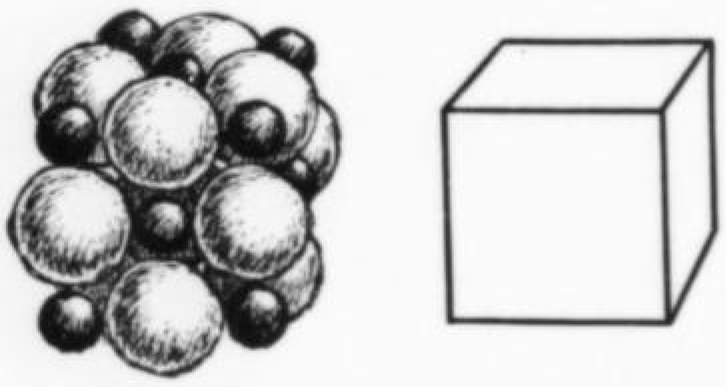


Figure 4. **Arrangement of sodium and chlorine ions in halite. The large circles represent chlorine and the small black circles represent sodium.**

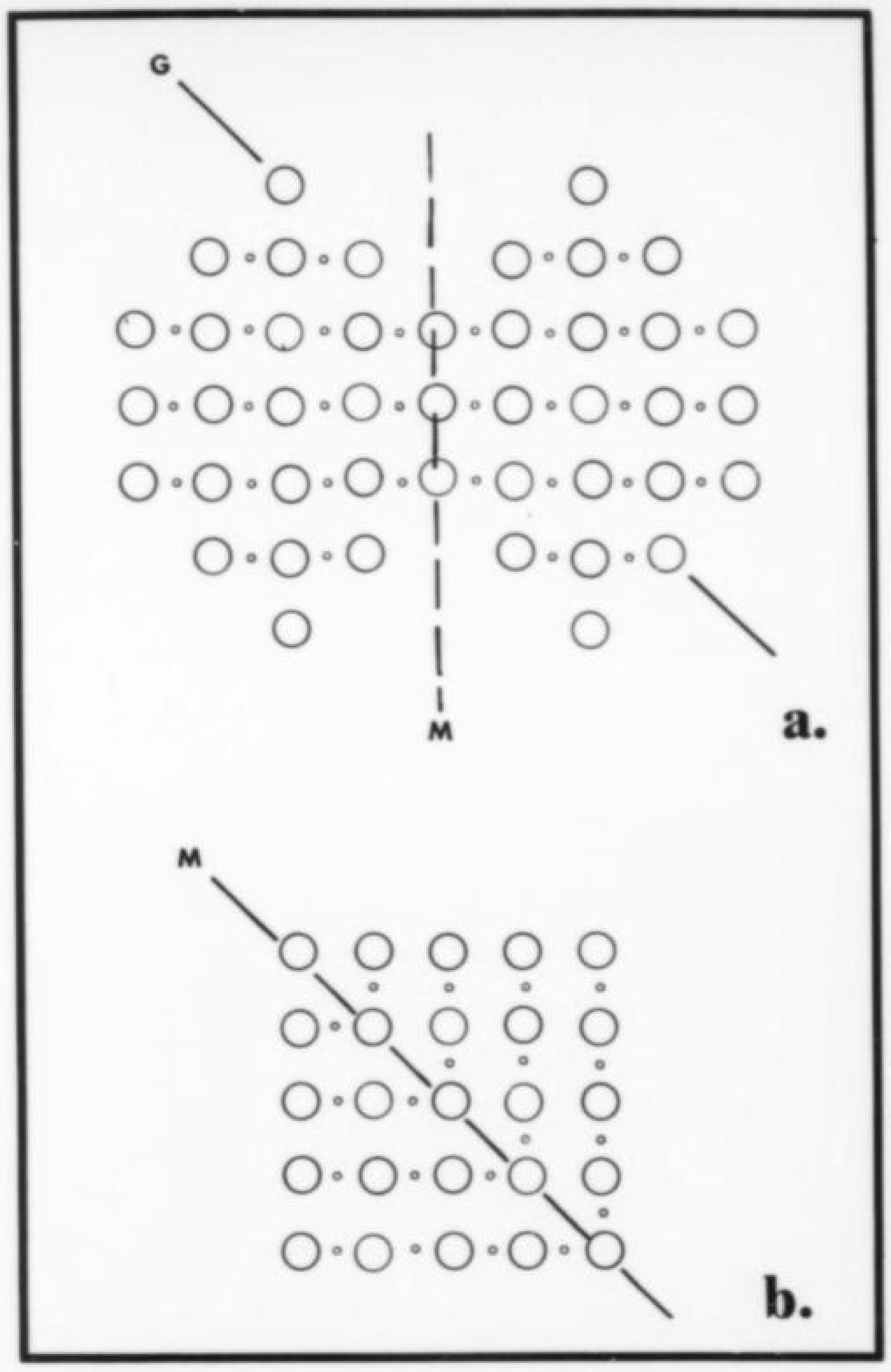


Figure 5. **Two-dimensional diagram illustrating (a) a single crystal and (b) a twinned crystal.**

Some minerals show repeated twinning that involves many individual crystals. Figures 14 and 18 illustrate examples of this type of twinning. Repeated twinning of three or more individuals according to the same twin law is referred to as **cyclic twinning**. Cyclic twins often simulate high symmetry such as four-fold, five-fold, six-fold or eight-fold rotations. Figure 14 is a cyclic twin in rutile. Eight individuals form a complete "ring." **Polysynthetic twinning** arises where the twin planes are parallel and the individual crystals are in the form of thin sheets stacked together like a deck of cards in which, for instance, every other card is up-side-down. In certain minerals, such as plagioclase feldspars, this type of twinning is so common that it is used as a criteron for identification.

In addition to classifying twins according to the manner in which they physically fit together, they may be classified according to the type of symmetry exhibited. If two individuals are rotated about a line in a crystal, the axis is a twin axis and the individuals are ***rotation twins***. In the vast majority of cases the twin axis is a two-fold rotation axis (repeats every 180°). The axis may lie in the composition plane or be perpendicular to that plane in contact twins. In other crystals the twins may be related by a mirror plane which is called the twin plane. These are ***reflection twins***. The composition plane and the twin plane may be the same but need not be in all cases.

Examples of Twins in the Six Crystal Systems

Twinned crystals occur in every crystal system. Since symme-

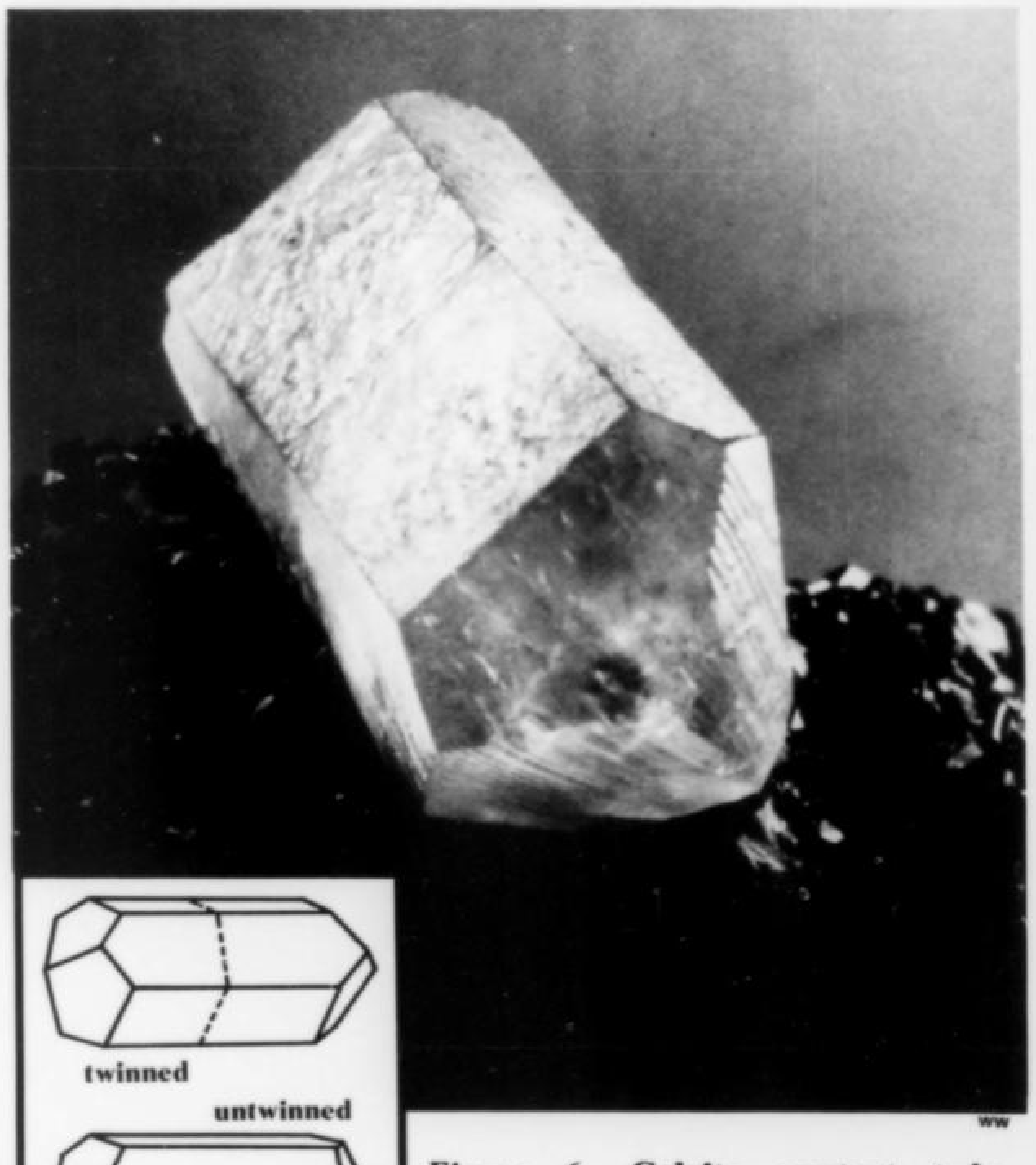


Figure 6. **Calcite contact twin, twinned by rotation about the *c* axis. The composition plane (plane of contact) can be seen as a narrow groove circling the center of the prism (Missouri; pale yellow; 3 cm long; U.S.N.M. #125345).**

---

*Figures such as these are called "Miller indices." They are used to specifically refer to various planar directions on or in crystals, relative to the crystals' axes. See any mineralogy text for a further discussion.

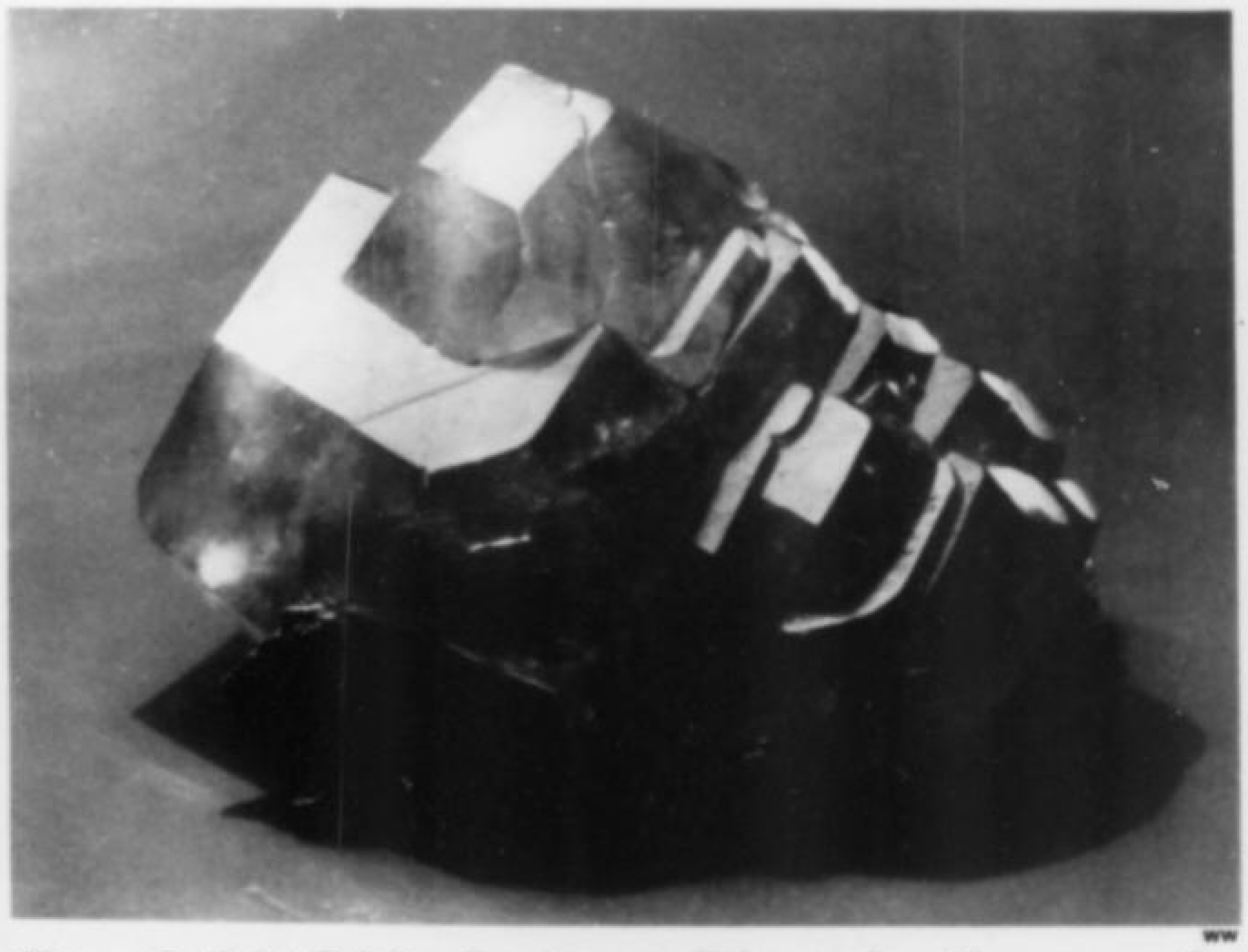
try elements introduced by twinning cannot coincide with previously existing symmetry, there are more possibilities for twin laws in the triclinic system than in the isometric (cubic) system.

ISOMETRIC SYSTEM TWINNING

Many common minerals in the isometric system, such as pyrite and fluorite, show twinning. Penetration twins result in forms which appear to be very complex (Figure 12b). Often the individuals involved in natural twins may not be equally developed in size or the centers may not coincide. Figure 12b illustrates an "iron cross" in the mineral pyrite. Each individual is a perfect pyritohedron with the center point of one coinciding with the center point of the other. Figure 12a shows an "iron cross" from Vlotho, Minden, Germany in which there is some distortion of the individuals. This crystal shows the cubic form in addition to the pyritohedron. The flat "cross" is formed by two intersecting cube faces. The tetrahedrite in Figure 13 shows a disparity of size in the two individuals related by twinning. This twin is formed by rotating the tetrahedron 60° around one apex. Fluorite often shows twinning in which the individuals differ greatly in size and in which one of the individuals appears to be "growing" from the side of the other. If the subsidiary crystal is at the proper angle the group is considered to be a twin.

Some isometric minerals, such as magnetite, possess polysynthetic twinning. This can be observed as striations (parallel lines) on the octahedral faces. Galena will also show striations on the cleavage surfaces due to lamellar twinning.

ww



ww

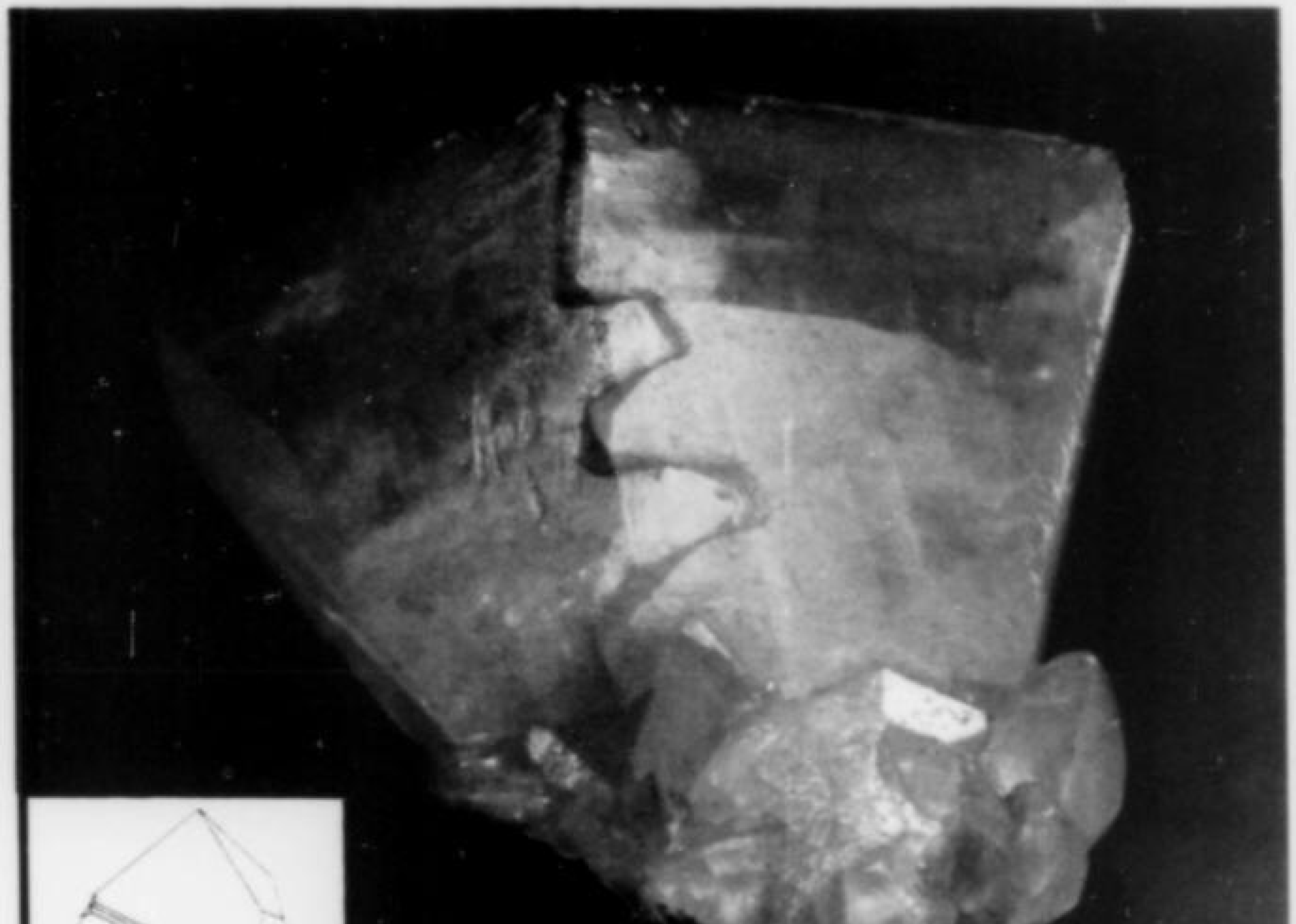
Figure 7. (left) **Calcite showing parallel growth with a curve (La Mojina mine, Gallegos, Chihuahua, Mexico; white; 3.5 cm across tips; U.S.N.M. #127590).**

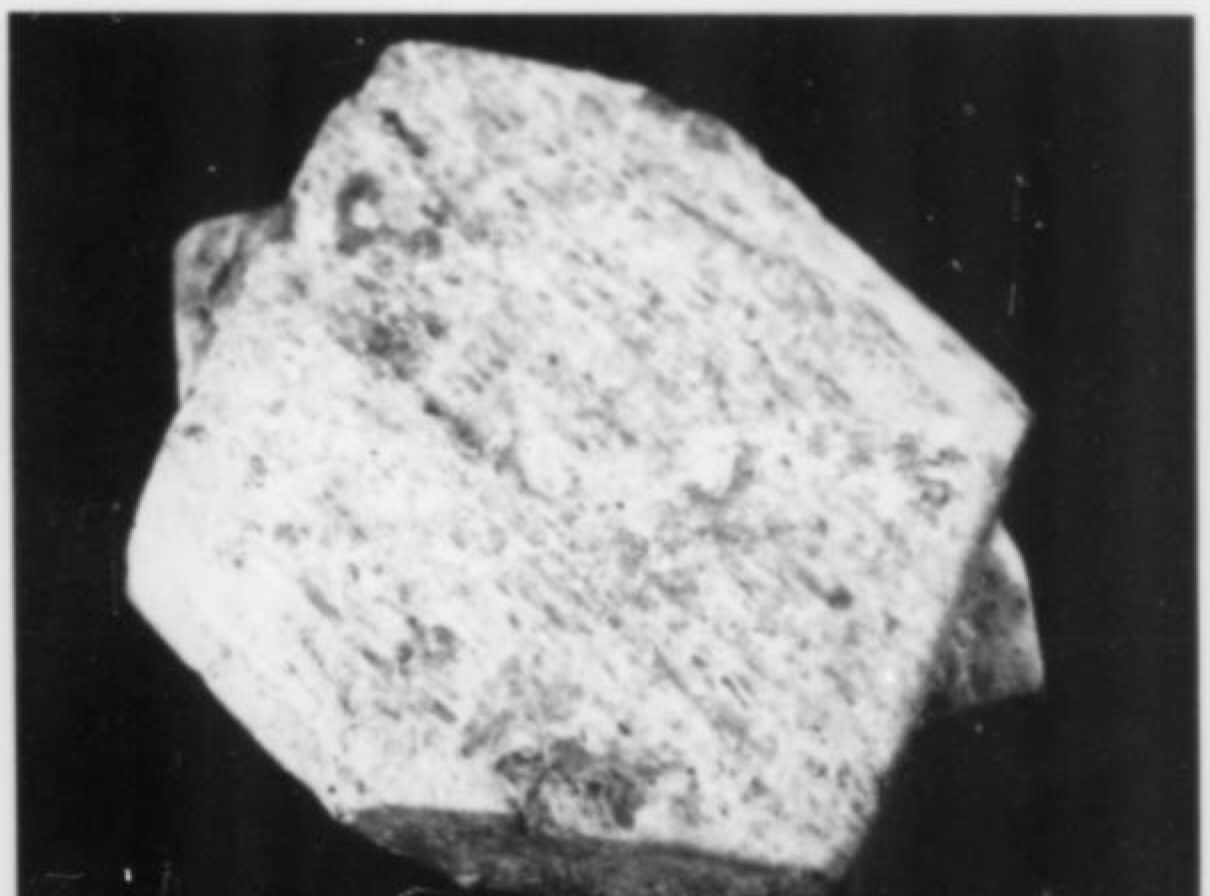
Figure 8. (above) **Calcite showing parallel growth (North Vernon, Indiana; golden yellow; 6.4 cm wide; U.S.N.M. #R12056).**

Figure 9. (below left) **Calcite "butterfly twin," twinned on $(10\bar{1}1)$ (Guanajuato, Mexico; white; 6.6 cm across; U.S.N.M. #C1899).**

Figure 10. (below) **Orthoclase "Carlsbad" twin, twinned about the *c* axis (Viterbo, Italy; white; Schulman collection).**

ww





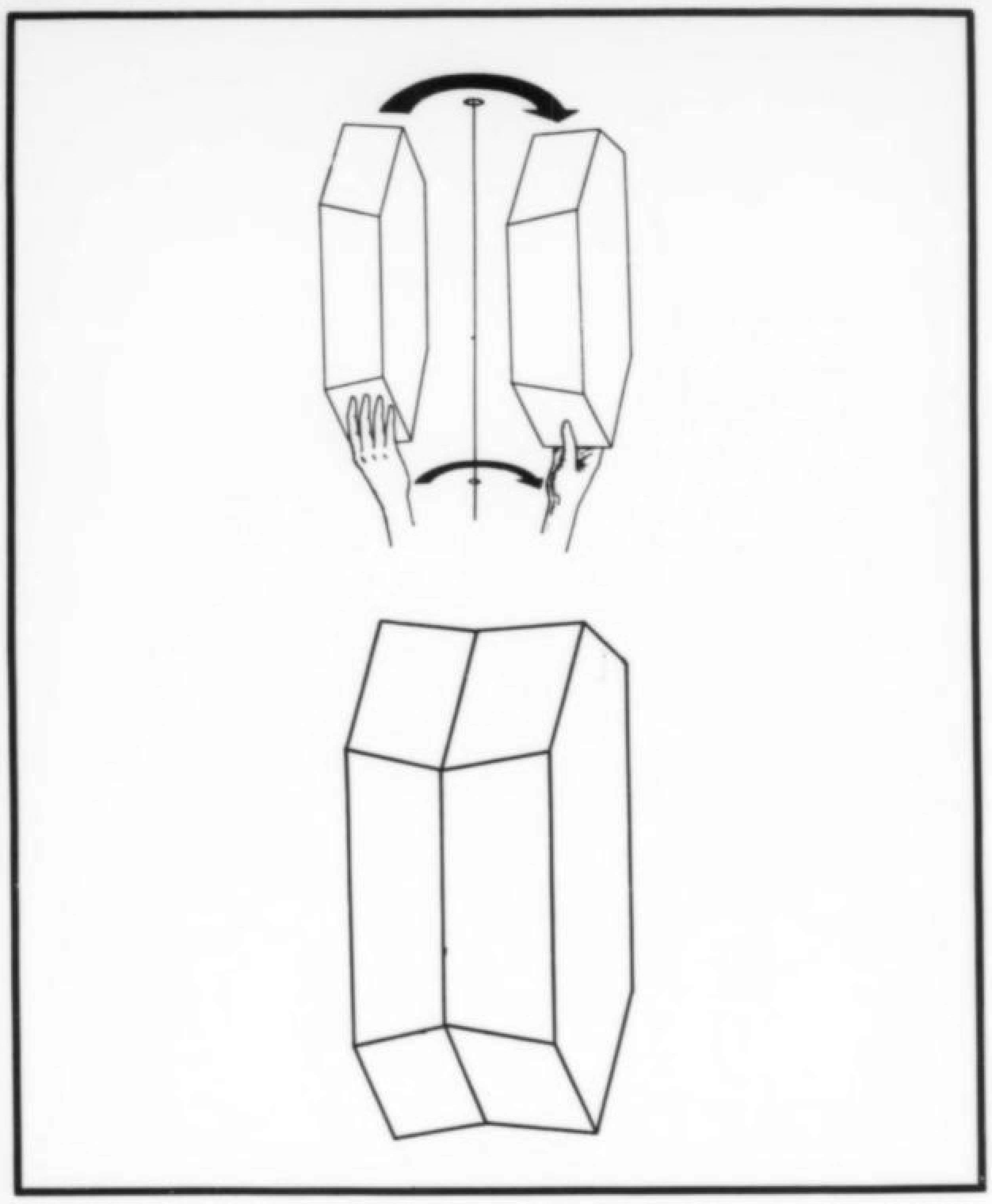


Figure 11. **Albite twinning may be described as a rotation about a two-fold axis or as a reflection across a mirror plane. The hands are included in the diagram to emphasize the rotation relation. Notice that in the two-fold rotation the same hand appears with only a change in position, whereas the hands would appear right and left if reflected across a plane.**

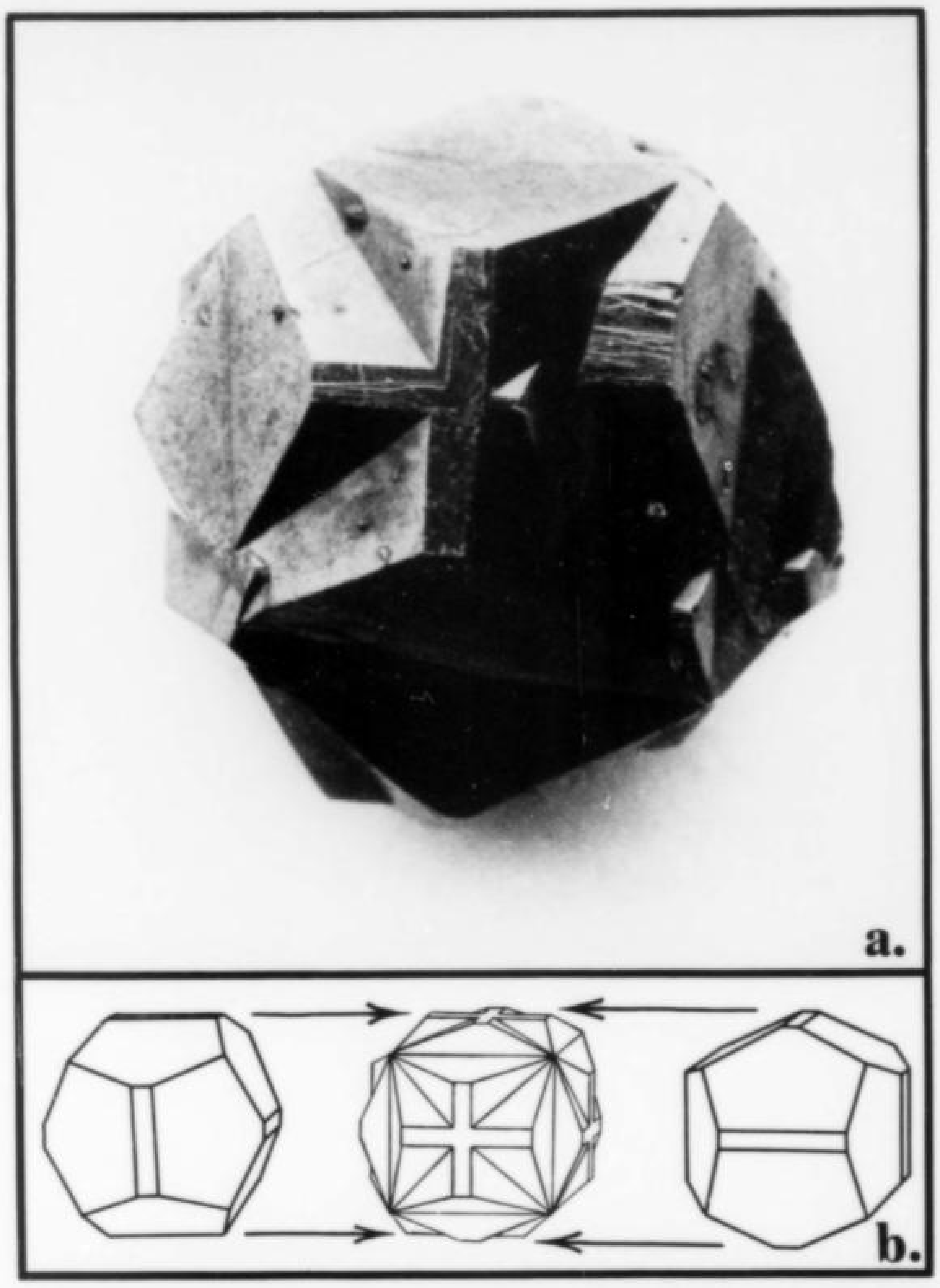


Figure 12. **(a) Pyrite "iron cross" penetration twin (Vlotho, Minden, Germany; brassy yellow; 7 mm; Schulman collection). (b) Diagram of an ideal iron cross twin showing how the two pyritohedrons with small cube modifications "penetrate" each other to form the twin.**

TETRAGONAL SYSTEM TWINNING

Rutile, mentioned previously, is a good example of twinning in the tetragonal system. Repeated twinning may produce geniculate (knee-shaped) forms in rutile instead of a closed form as is shown in the photograph (Figure 14). Knee-shaped offsets are so common in this mineral that they may be used as a diagnostic feature for identification.

In rutile cyclic twins may be either sixlings or eightlings (see Figure 14b and c). It is a truly amazing thing that nature produces such crystal forms. A sixling requires a twin plane to slope in opposite directions at each end of the crystal. Figure 15 shows an individual crystal in which the possible twin planes are numbered. These are also possible crystal faces. In a sixling if plane *1* appears at the top then plane *3* must be at the bottom of each crystal segment. This produces a closed form with six segments since the angle between the individuals is about 120° (actually 114°25′). In eightlings all four possible twin planes actually become planes of contact. The *3* and the *1* form a contact between two individuals and the *2* and *4* form the next contact. In the eightling these two sets must alternate without errors all the way around. Although these rules may be difficult to visualize, one can easily appreciate what nature has accomplished in producing this cyclic form.

HEXAGONAL SYSTEM TWINNING

The minerals of the hexagonal system show many types of twinning. Several types of twinning in calcite have been briefly described. Quartz also has many different ways of twinning. In the famous Japan law twin the *c* axes in the two individuals are inclined to one another at an angle of 84°33′. Frondel (1962) lists fifteen twin laws in quartz which show inclined axes. Commonly, however, the crystallographic axes in quartz are parallel in the two individuals of the twin. In this case the twin will resemble a single crystal unless the faces are examined carefully. The Brazil twin (Figure 17) is an example. Notice that face *x′* is a reflection of *x*. This cannot occur on a single crystal of quartz. Calcite twinned on the basal plane (Figure 6) is another example of this. We will discuss other interesting aspects of quartz below.

ORTHORHOMBIC SYSTEM TWINNING

There are many twins to be found in the orthorhombic system. Often cyclic twins in this system appear to be hexagonal in form. They may be with or without reentrant angles (Figures 18, 19 and 20.) Where the reentrant angles are absent the twinned nature can often be seen in striations on certain crystal faces as shown in the diagrams accompanying the photographs of aragonite and cerussite. Cerrusite is almost universally twinned. Branching (reticulated) aggregates are very common (Figure 21). Each segment of the "branch" is in twinned relation to the next. The twin law is the same as that in the cyclic twin shown previously. The heart-shaped twin shown in Figure 22 is less common. Cruciform twins (sometimes called "fairy crosses") are very common in staurolite (Figure 23). The cross arm may form a right angle or may be inclined at about 60°.

MONOCLINIC SYSTEM TWINNING

The Carlsbad twin in orthoclase feldspar, illustrated before (Figure 10), belongs to the monoclinic system. The twin axis is *c*. Figure 10 shows an interpenetrating twin. Carlsbad twins can also be joined as contact twins (Figure 11). Adularia is another feldspar often showing twinning (Figure 24). The "swallow-tail"

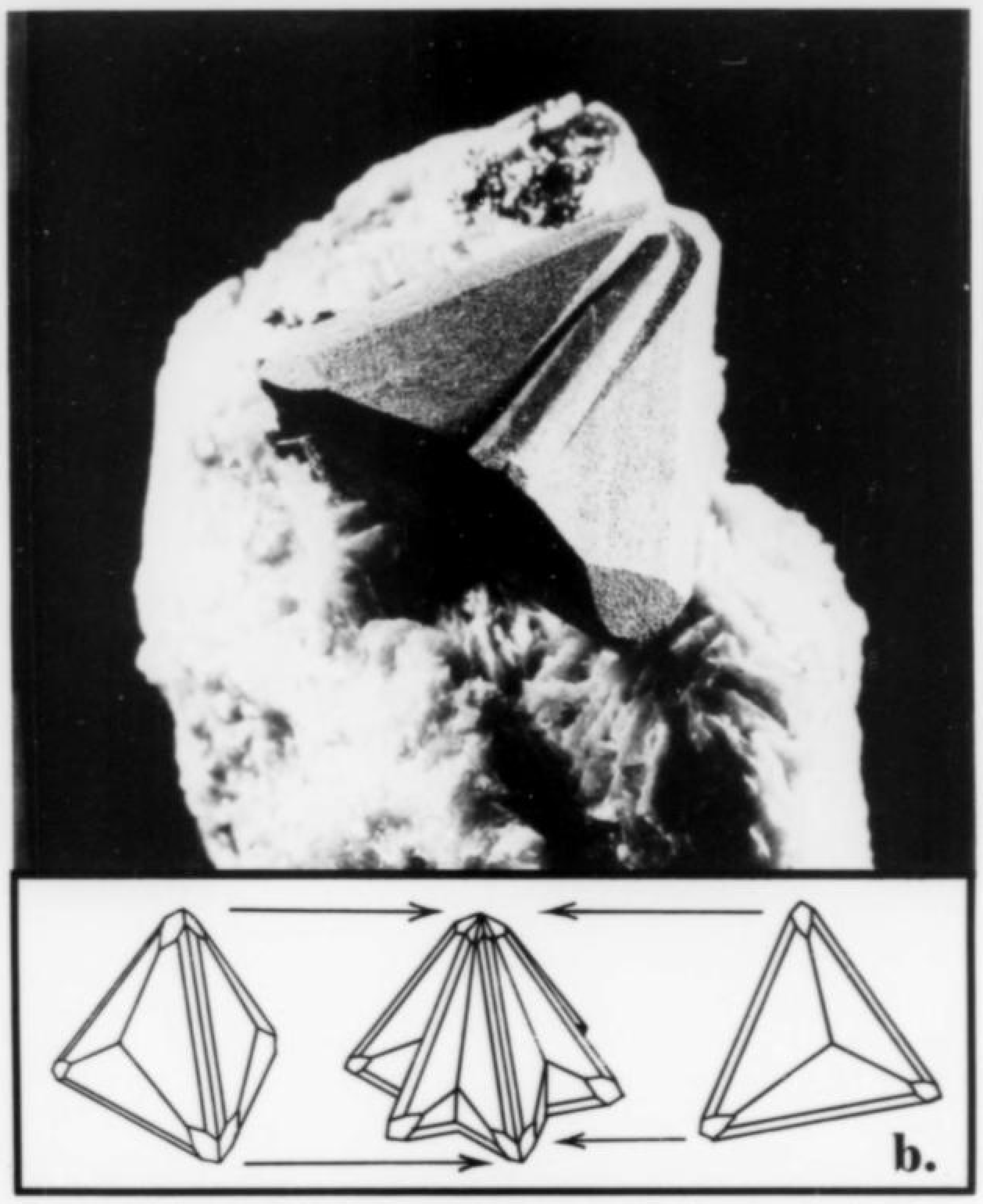


Figure 13. **(a) Tetrahedrite twin in which there is unequal development of the two interpenetrating members of the twin (Harz Mountains, Germany; coated with brassy chalcopyrite; 2.2 x 2.5 cm; U.S.N.M. #B10987). (b) Diagram of an idealized twin illustrating how the two tetrahedrite crystals "penetrate" each other to form the twin.**

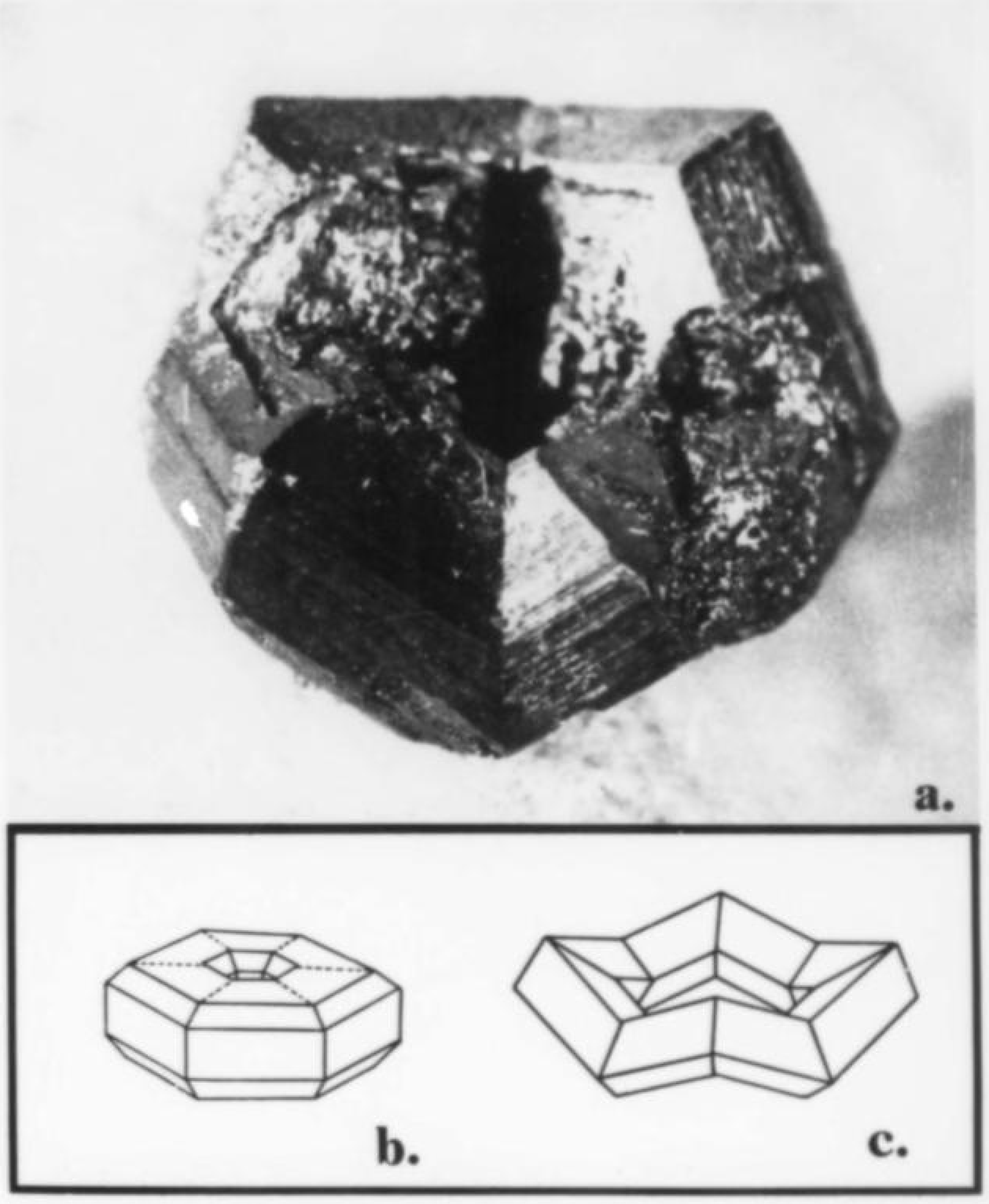


Figure 14. **(a) Rutile showing cyclic twinning (Magnet Cove, Arkansas; black; 2.5 cm; Schulman collection). (b) Diagram illustrating a rutile sixling and (c) eightling.**

gypsum crystal is a familiar twin in this system (Figure 25). The contact plane is (100). Two rarer types of twinning in gypsum are shown in Figures 26 and 27. The (010) and (010) planes are shaded and have been so designated to emphasize the relation of these twins.

TRICLINIC SYSTEM TWINNING

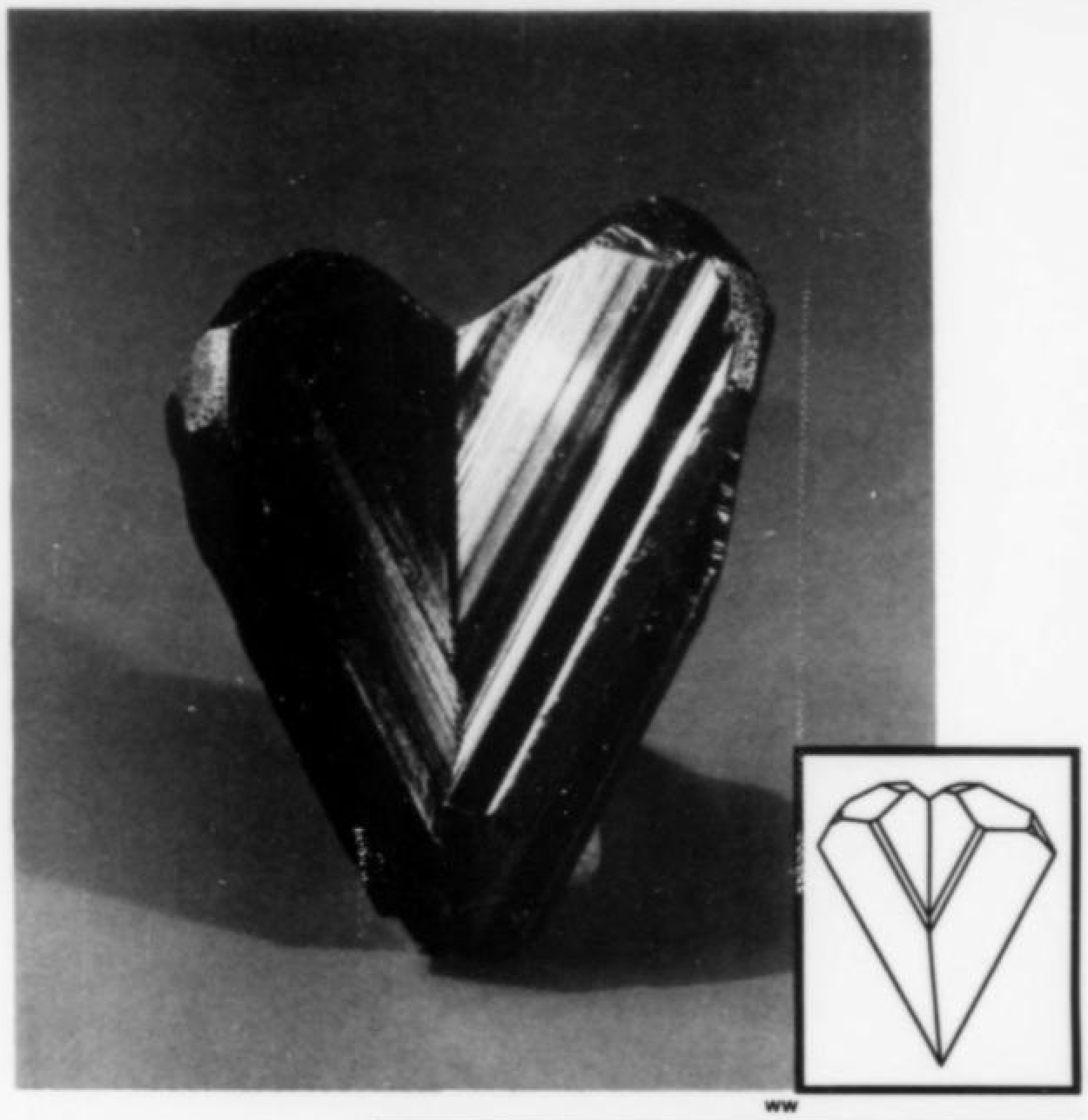
There are no symmetry planes or symmetry axes in the triclinic crystals; therefore, a very large number of planes with simple parameters may act as twin planes and very many directions may act as twin axes. Laboradorite belongs to this system. In most plagioclase feldspars lamellar twins can be seen as parallel striations on the cleavage surface.

Causes of Twinning

There are three ways which twins form. Many twins originate as *growth twins*. As the crystal forms, it grows a layer at a time parallel to the crystal faces. As a new layer forms a mistake can be made leading to a twin. To describe this let us use Figure 5 again. Reference will be made to north, south, east and west as if we were looking at a map view. The crystal grows along the face marked *g* (Figure 5a). A row of large atoms is added and then a row of small atoms, etc. This leads to a pattern such that the small atoms lie to the east and west of the large atoms. Now suppose that after a row of large atoms had formed, a small atom slipped into a position north of the large atom. This position is almost the same as the position to the east. The other atoms reaching the surface then follow the lead of the first one. Now the pattern has changed to that shown in Figure 5b and we have a twinned crystal. A small mistake during growth leads to twinned crystals. This simplified illustration demonstrates what happens in larger and more complex three-dimensional crystals.

Certain materials exist in more than one crystalline form depending upon the temperature. Under certain conditions these substances can form *transformation twins* when they change from one form to another. The Dauphiné twin in quartz is an example (Figure 29). In this twin the parts are related by rotation of 180° but are the same "hand." At high temperature (above 573°C), quartz exists in its high temperature form but as it cools below the inversion temperature the symmetry becomes lower. Some nucleation centers have an internal atomic structure rotated by 180° from the others. When these centers "grow" together the complex Dauphiné twinning arises. In other words, a solid already existed. Transformation in its structure took place in different parts and spread together. If a rotated structure or a different handedness is equally likely for the crystal, then twinning will be a quite probable outcome of this transformation.

A third type of twinning results from gliding. *Glide twinning* is a result of pressure being exerted along certain planes of the crystal. Twinning of this type is common in metamorphosed limestones and is due to the deformation process. Twinned calcite can be distinguished from twinned dolomite by means of these twinning striations. In the former mineral the lines are parallel to the long diagonal of the rhombohedral face (Figure 30) while on the latter they are parallel to the short diagonal. Stibnite often exhibits bent crystals which may be erroneously designated "glide twins." The plane in which the movement takes place is the base, *c* (001). Pressure perpendicular to the plane of perfect cleavage, *b* (010), and parallel to the basal plane will produce slipping of the molecules without separation. This



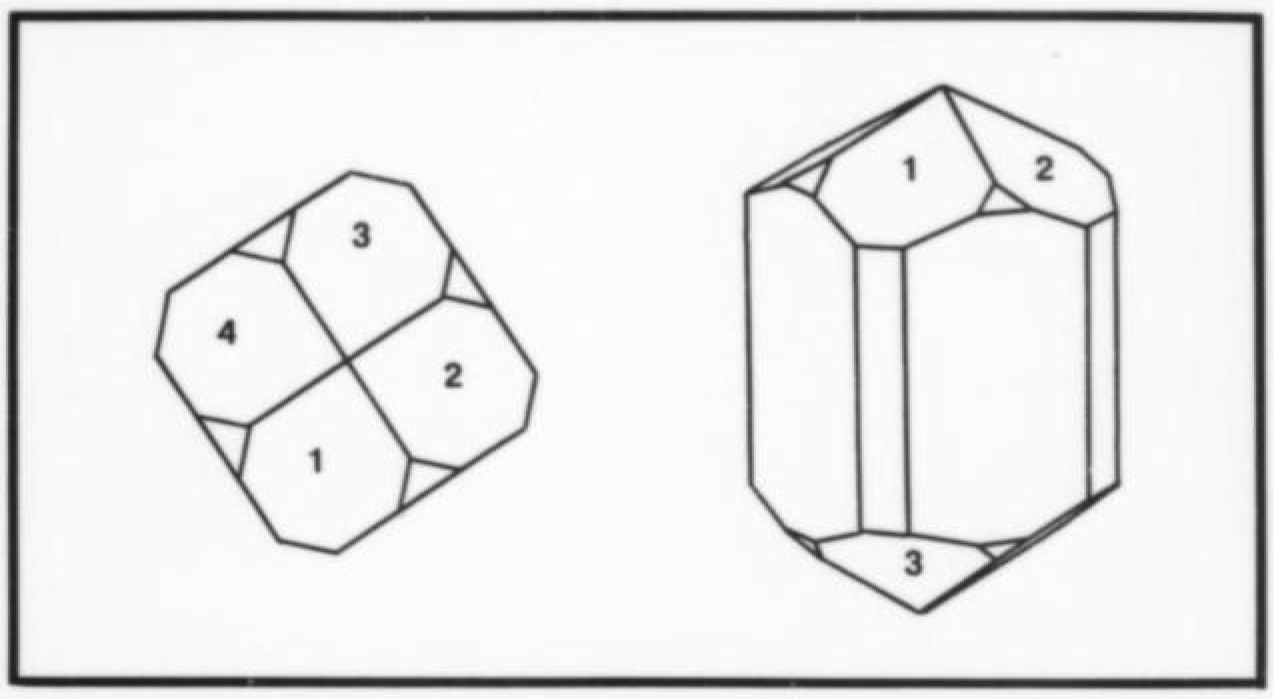


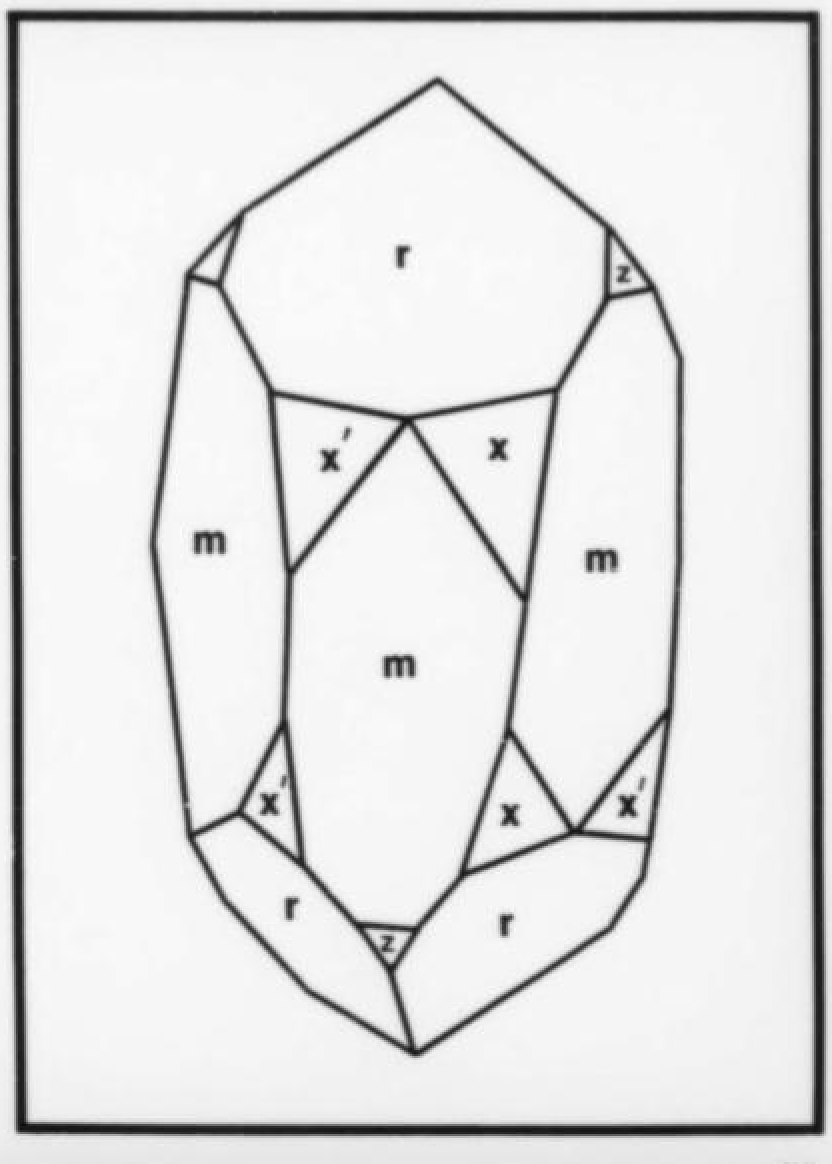
Figure 15. (above) **Diagram of a rutile single crystal. The numbered faces are possible twin planes. The planes are arbitrarily numbered such that plane 1 on the top is parallel to plane 1 on the bottom, and so on. See text for details.**

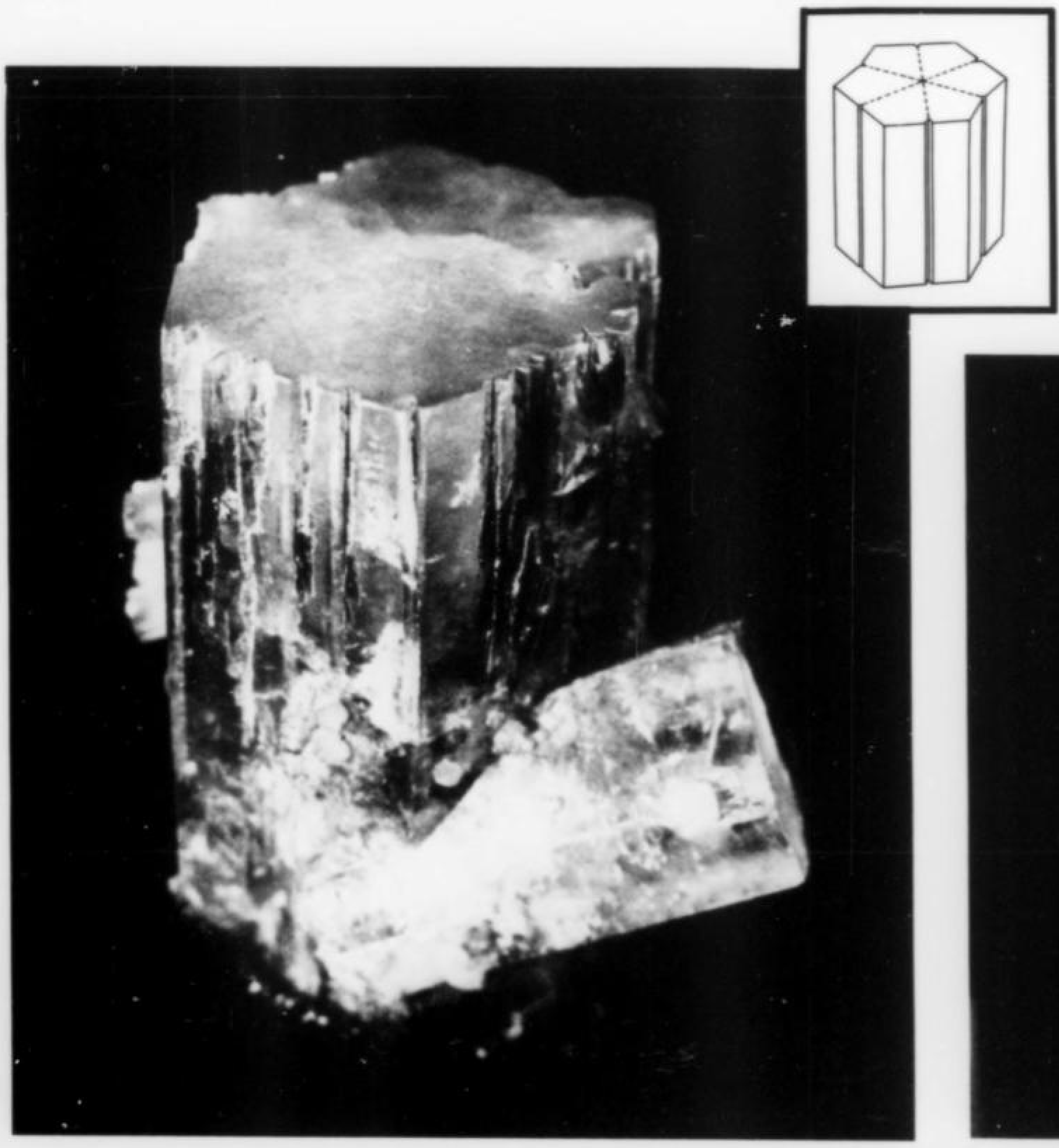
Figure 16. (above right) **Rutile twinned on (031) (Brazil; very dark red; 2.8 x 3.7 cm; U.S.N.M. #C5985).**

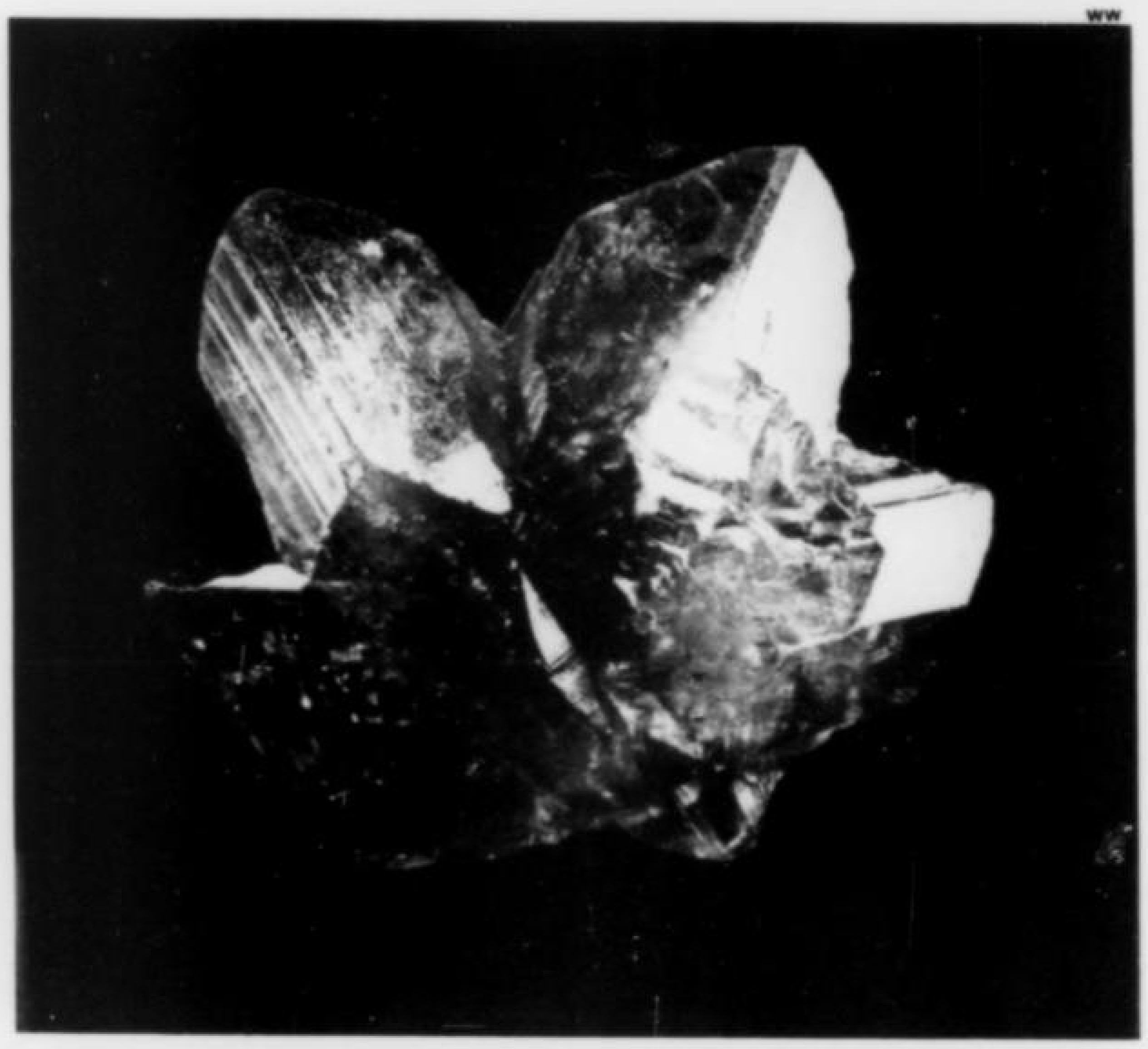
Figure 17. (right) **Diagram of the quartz Brazil twin.**

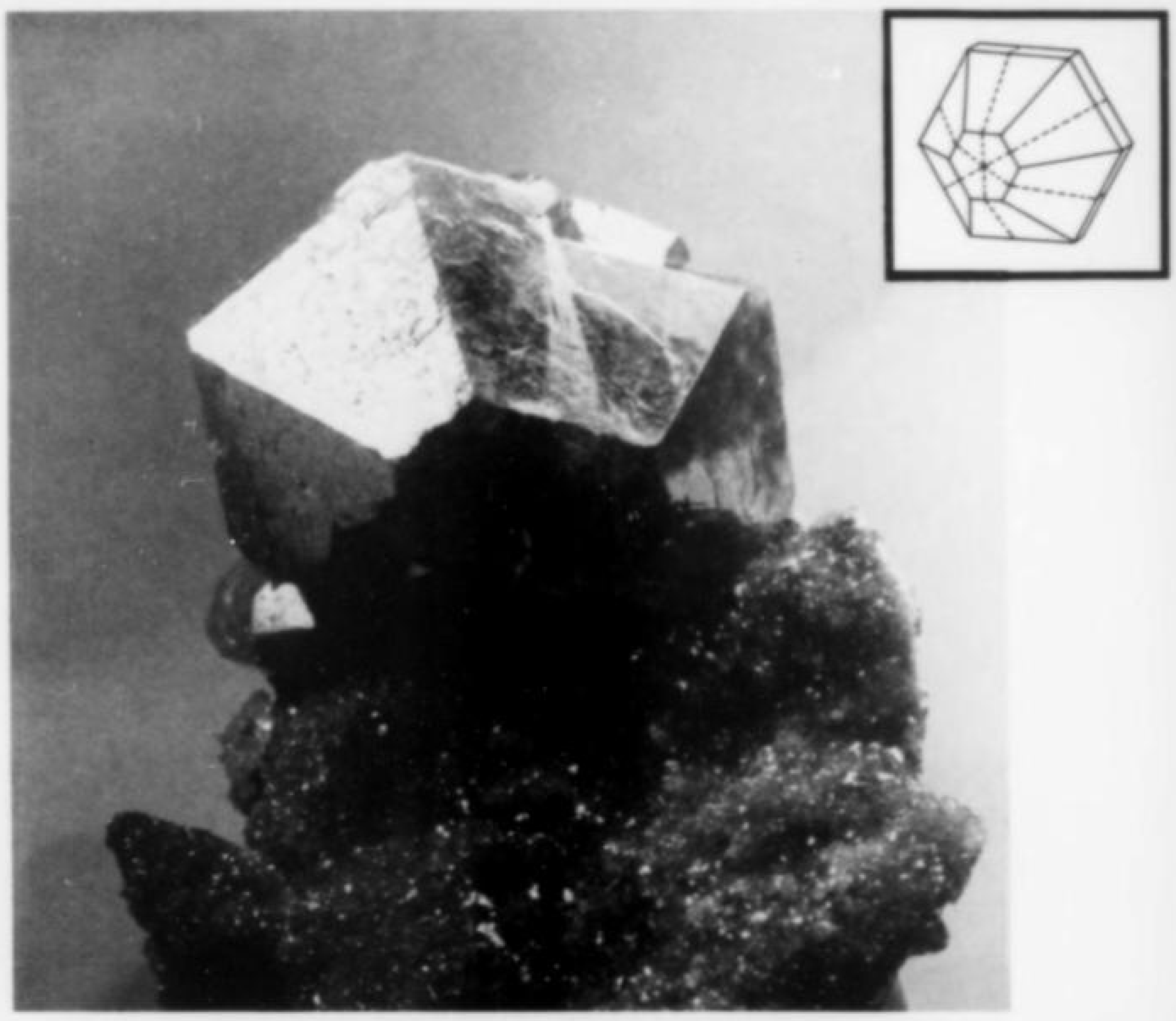
Figure 18. (below) **Aragonite often shows a pseudo-hexagonal symmetry when it is twinned. The six-sided "crystals" actually consist of three individuals penetrating each other at nearly 60° angles (Molina de Aragon, Spain; pale brownish violet; 3 cm tall; Schulman collection).**

Figure 19. (below right) **Chrysoberyl cyclic twin (Tancredo, Espirito Santo, Minas Gerais, Brazil; yellow-green; 3.1 x 3.6 cm; U.S.N.M. #123578).**









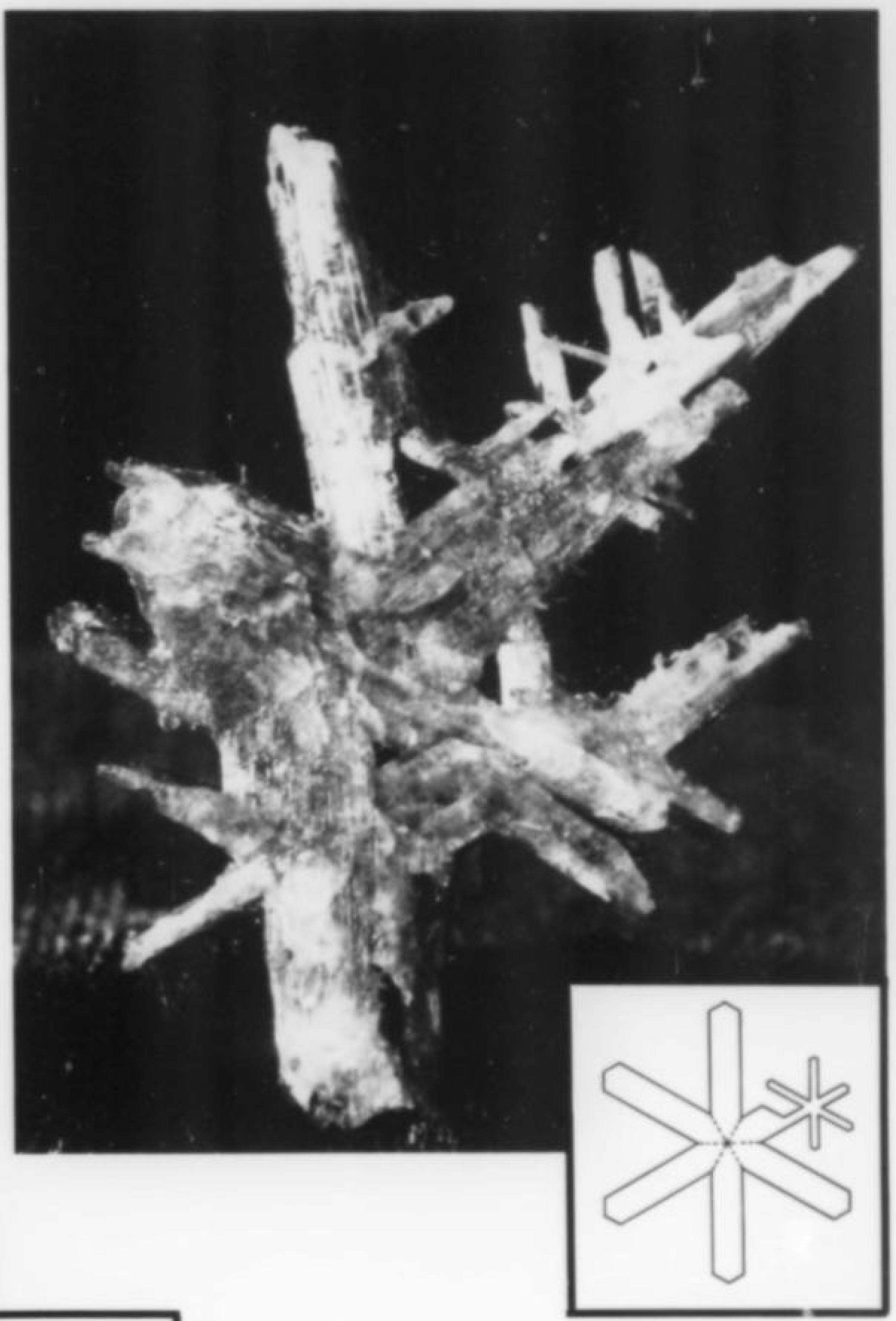
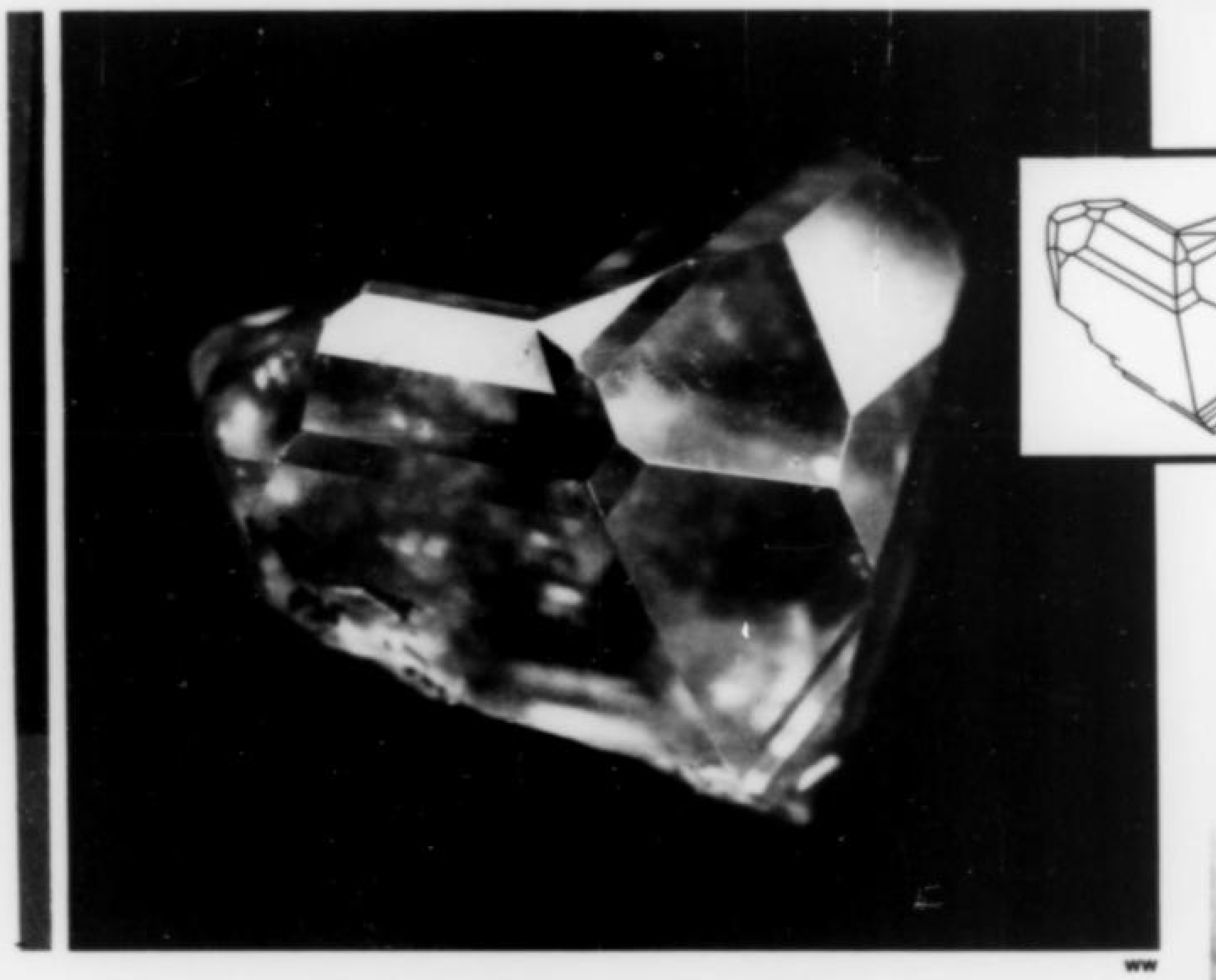


Figure 20. (above) **Cerussite cyclic twin (Tsumeb, Southwest Africa; grayish brown; 3 cm; U.S.N.M. #C6682).**

Figure 21. (right) **Repeated twinning in cerussite gives rise to a trellis ("reticulated") pattern (Tsumeb, Southwest Africa; white; 3.8 cm; Schulman collection).**



ww

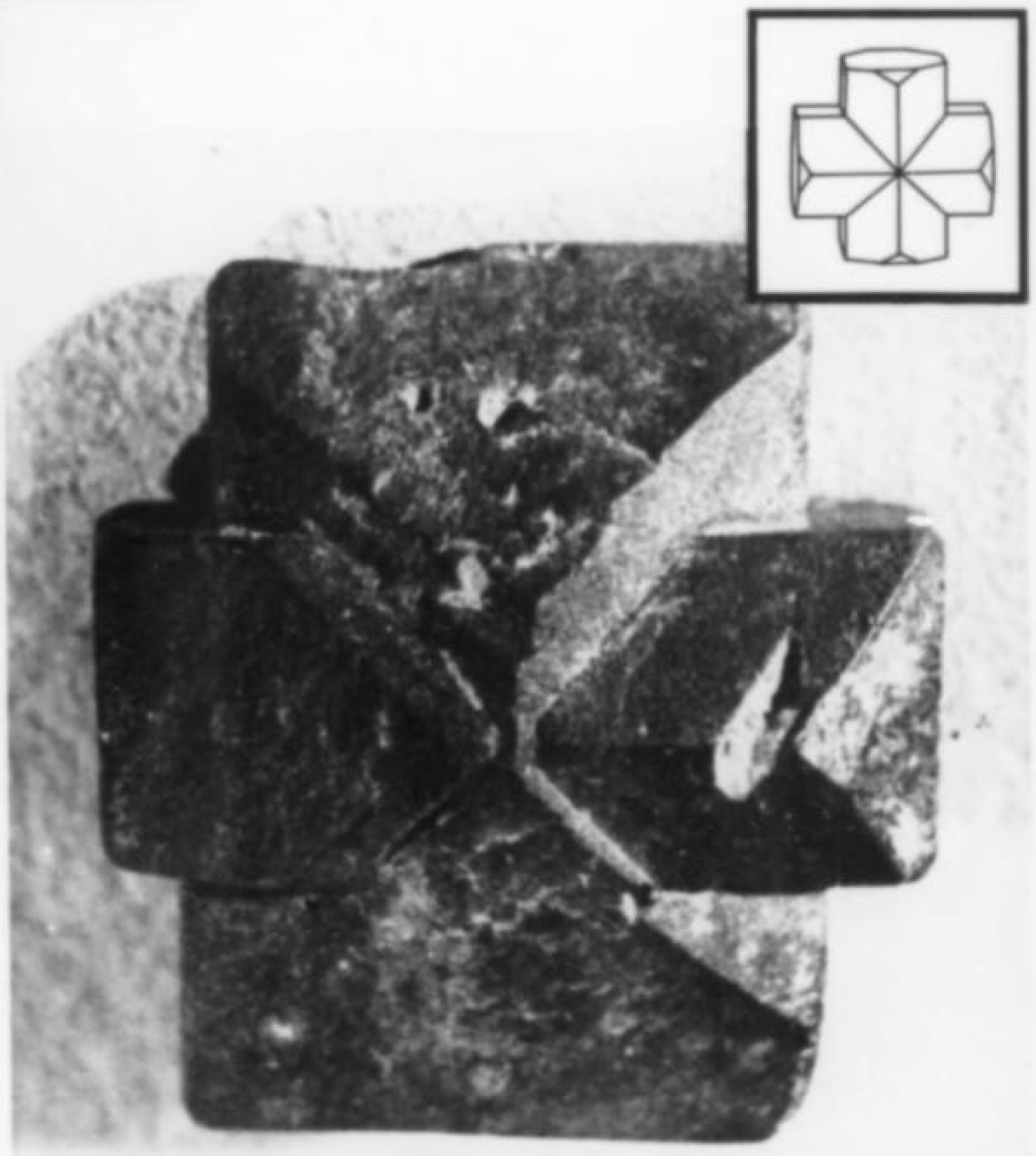


Figure 22. (above) **Cerussite twinned on (130); notice how faces are not equally well developed on each member of the twin (Tsumeb, Southwest Africa; colorless; 3 cm; U.S.N.M. #122520).**

Figure 23. (right) **Staurolite penetration twin composed of two crystals penetrating at about 90° to each other (brown; 2 cm; Schulman collection).**

is not a twin, however, because no additional symmetry is produced as a result of this gliding. Generally gliding in stibnite has been produced as the mineral is removed from the rock (Neff, 1916). Since glide twinning is not often encountered in mineral collecting, it will not be described further.

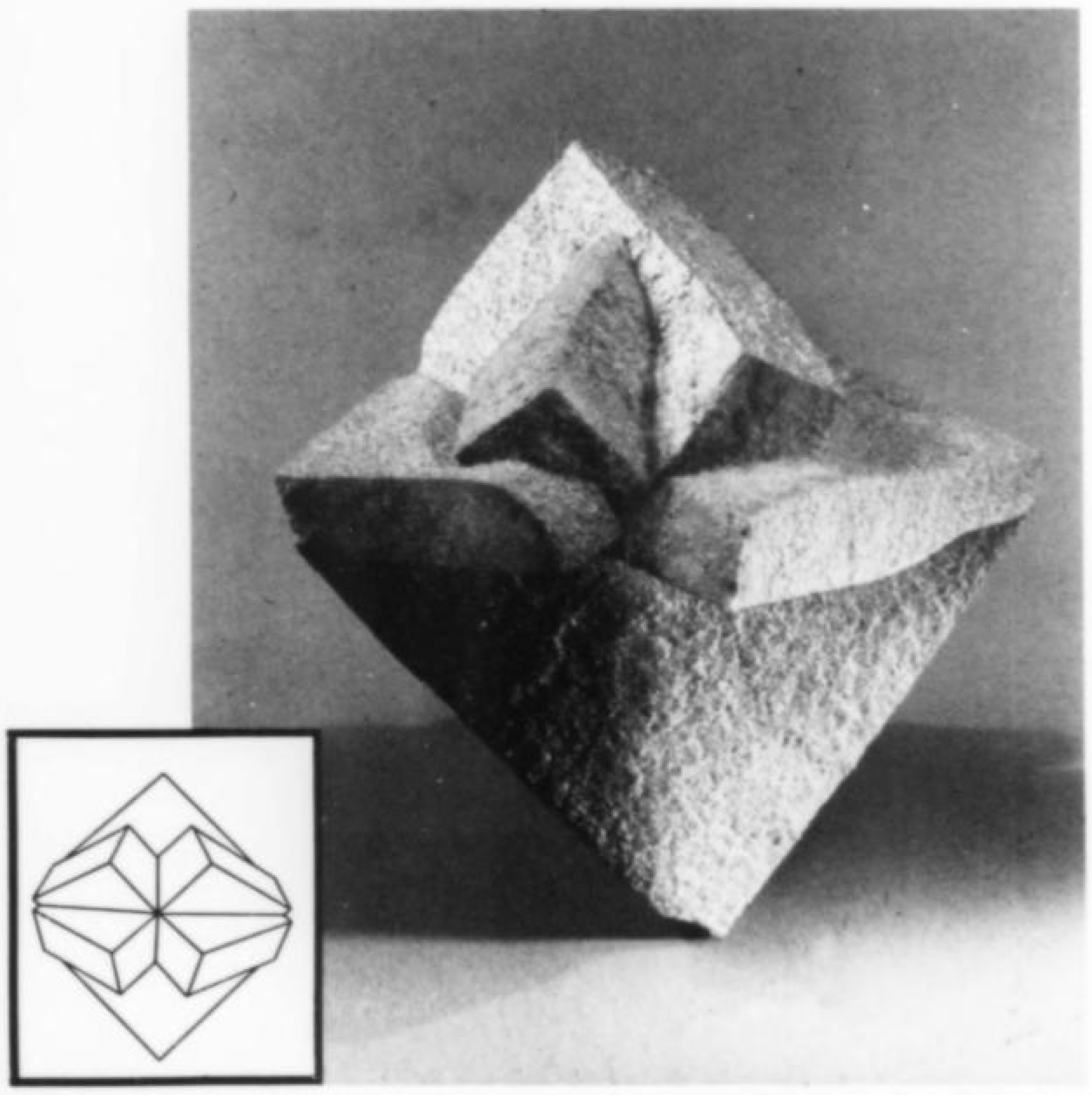


Figure 24. (above left) **Orthoclase (adularia) in a multiple Baveno twin (Scopi, Medelserthal, Switzerland; white; 3.8 cm; U.S.N.M. #B16137).**

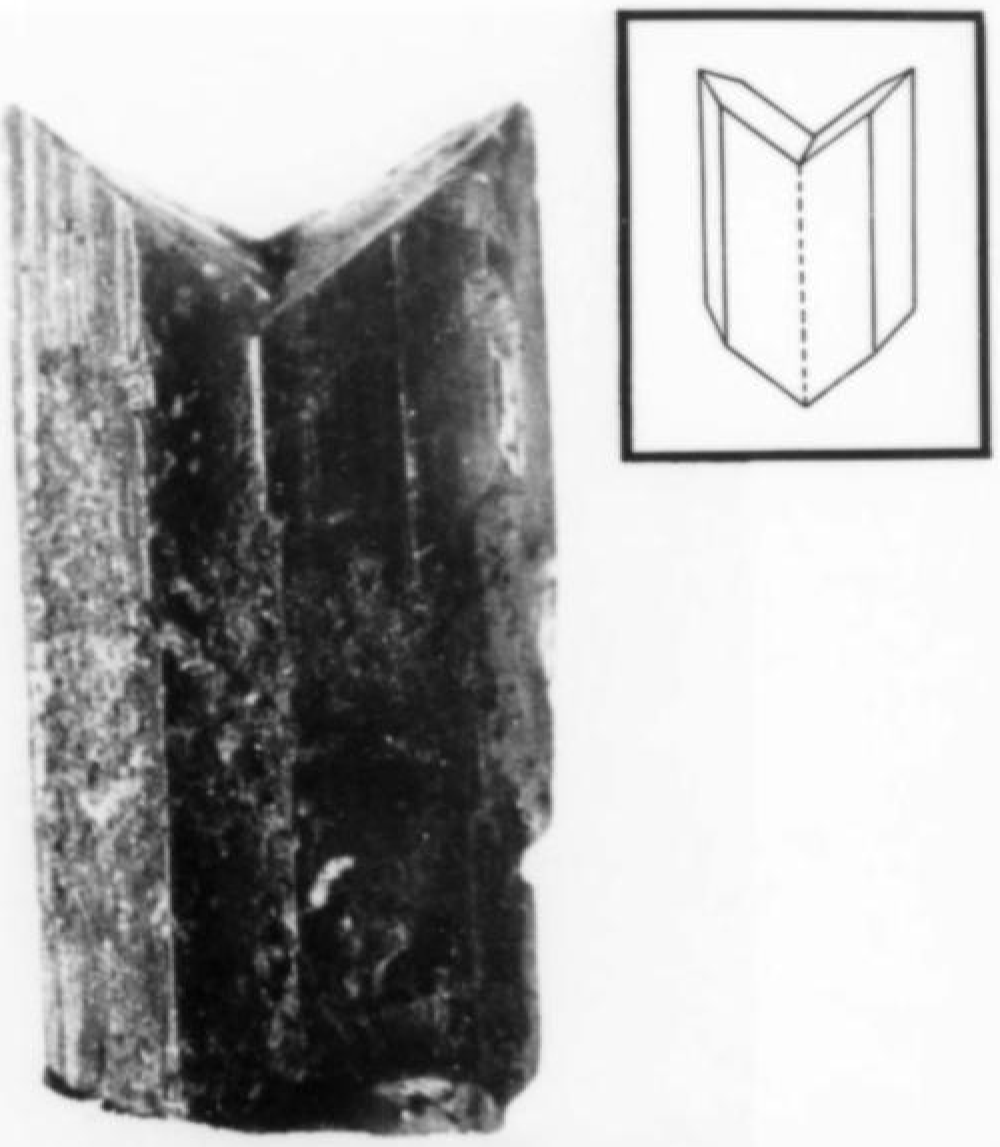


Figure 25. (above right) **A gypsum "swallow-tail" twin; the composition plane of this contact twin is where the mirror plane appears to be (Niagara Falls, New York; white; 2 cm; Schulman collection).**

Figure 26. (below left) **Gypsum twinned according to the Montmartre law (Germany; white; 2 cm; photo by Volker Betz).**

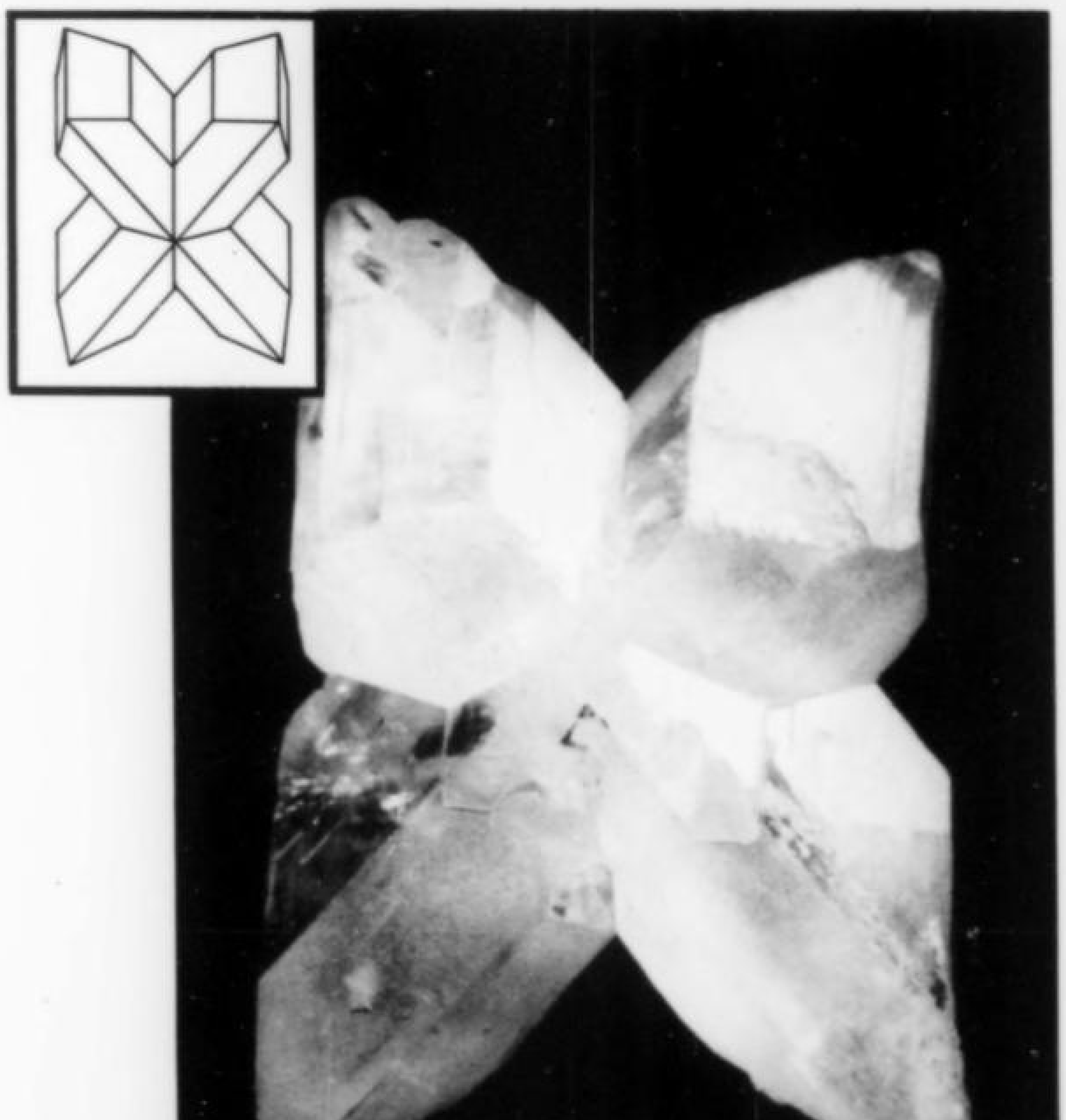


Figure 27. (below right) **Gypsum twinned on (101) (Germany; white; 2 cm; photo by Volker Betz).**

Is it a twin?

Some minerals which appear to be single crystals are in reality twins. These substances can, on occasion, give rise to difficulties even to the professional crystallographer. An interesting case of this is wulfenite. This mineral was described as tetragonal and belonging to a subdivision of the system which has a center of symmetry (Fig. 31a). Occasional crystals were found which indicated that wulfenite might not have a center of symmetry. If the mineral actually had no center, the crystals showing such a feature would be twins because, although one cannot see the division between individuals, there are faces in "reversed" position. Other tests to determine whether the mineral had a center of symmetry (i.e. etch-pit, piezoelectricity, etc.) indicated that the mineral did have such a center. Hurlbut (1955) reported that crystals of wulfenite from Schwarzenbach, Yugoslavia, were non-centrosymmetric (Figure 31b). Further, physical tests (etch-pit, piezoelectic, etc.) confirmed this external symmetry. Apparently the earlier tests had been misleading because the experiments had been done on twinned crystals. Most wulfenite "crystals", therefore, are twinned base-to-base.

Quartz, briefly discussed previously, is another mineral which often appears to be "single" when in reality it is twinned. A quartz crystal consisting of a hexagonal prism with a pyramid at the end (actually two rhombohedrons) can be a twin. If no subsidiary faces are present, one cannot distinguish this crystal form from a twinned crystal by mere visual observation of the mineral. Gault (1949) describes the investigation of such quartz crystals. Quartz when treated with hydrofluoric acid is etched in such a way that small pits are formed on the faces. These pits have definite shapes and can be used to determine the symmetry of the crystal. The reader is referred to the article by Gault for further details of the method. The conclusion of the study was that twinned quartz is more common than untwinned and that these twins were not distinguishable by the crystal shape alone.

Another problem is illustrated by crystals which appear to be twinned but are not. During the course of crystal growth, one crystal may grow up against another or even grow around it in a way suggestive of penetration twinning. In such examples the angle at which they meet is random and not related to the structure or symmetry of either crystal. There are no atoms at the juncture which each occupy analogous positions in each crystal in a regular way. Such "pseudo-twins" can usually be recognized by their lack of symmetry or by the angle at which they intersect; the angle of intersection of the two crystals will not be mentioned in references as characterizing a twin. However, if you find crystals intersecting at a certain angle *repeatedly* on a specimen or at a certain locality, and the angle is not mentioned in references, you may have discovered a new twin law!

Some Methods of Collecting and Displaying Twins

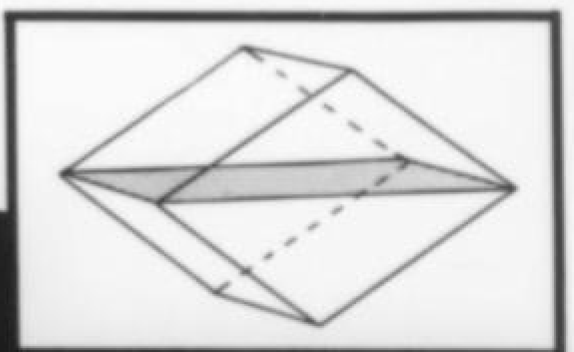
The collection and study of twins is an intriguing and challenging activity. Anyone who has attempted to collect crystals knows how hard it is to acquire good single crystals and certainly the acquisition of fine twins is exceedingly difficult. Collectors acquainted with twins almost never dispose of them and museums are not at all anxious to part with any good twins. Most dealers and most collectors are not expert in the identification of twins and many professionals are reluctant to make identifications without instruments. This adds more difficulty to their acquisition. Finding twins in the field is accidental unless one is fortunate enough to be collecting in areas famous for their occurrence. Two outstanding areas in the United States are: Goodsprings, Nevada, known for its Carlsbad twins and Lancaster County, Pennsylvania, known for its reticulated rutile twins.

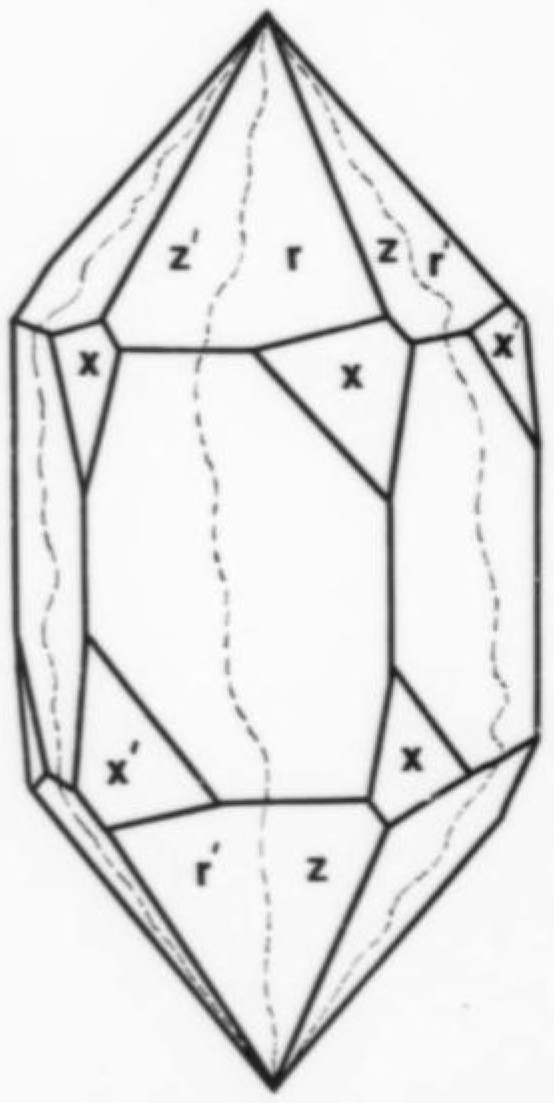
The collection of classic twins from classic localities is an interesting phase of this activity. Japan-law twins from Kai, Japan, fluorite penetration twins from Cumberland, England, and rutile eightlings from Magnet Cove, Arkansas, are only a few of the acquisitions one can consider prizes. Acquiring twins from their original name places is also quite thrilling, for example: Baveno, Italy, or Carlsbad, Czechoslovakia.

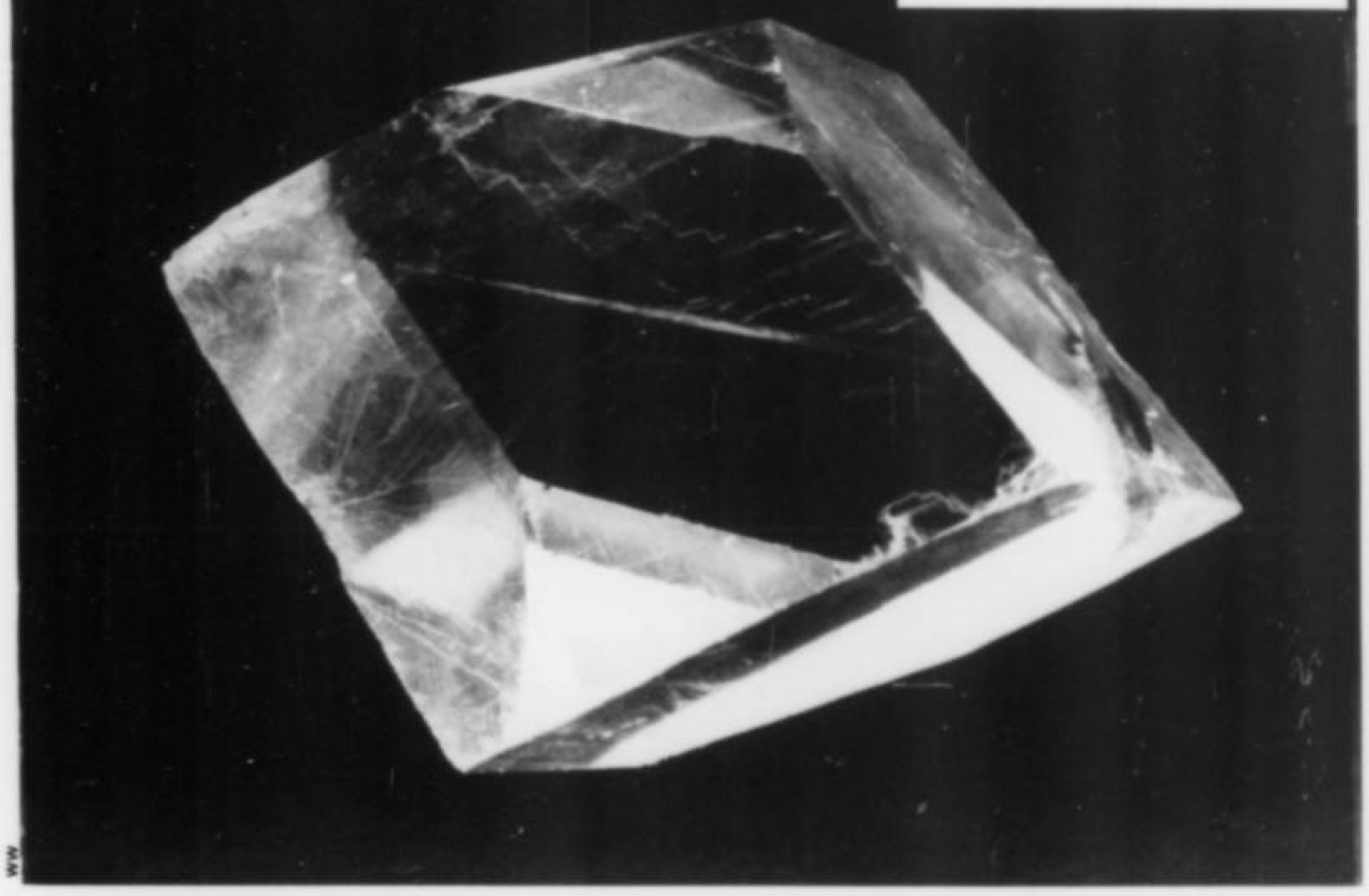
Collecting twins and being steward of the collection are not enough. Not only should the scientific knowledge acquired along

Figure 28. (below left) **Diagram illustrating the Dauphiné twin in quartz. The contacts between individuals are irregular as denoted by the wavy lines on the diagram.**

Figure 29. (below right) **Cleavage rhomb of "Iceland spar" calcite showing an internal twin plane parallel to the long diagonals. In calcite marble twins of this type are visible as striations (see text for further explanation).**







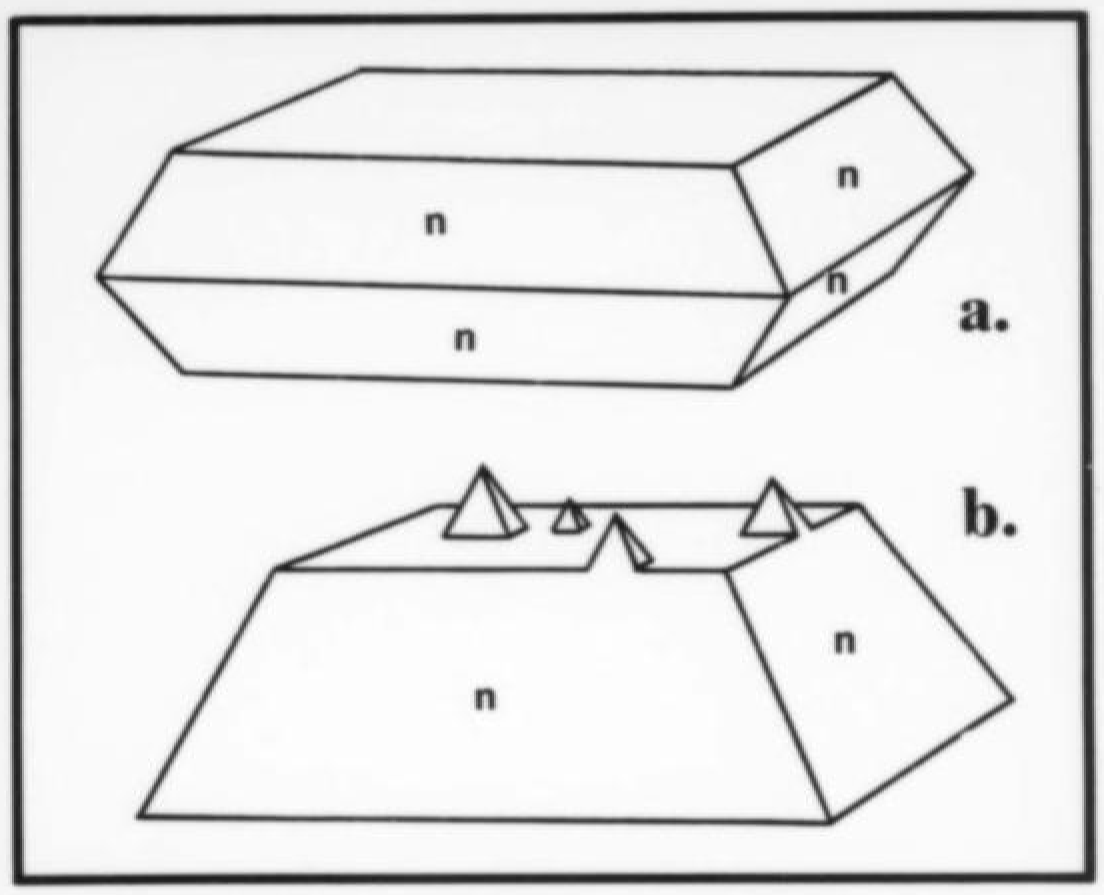
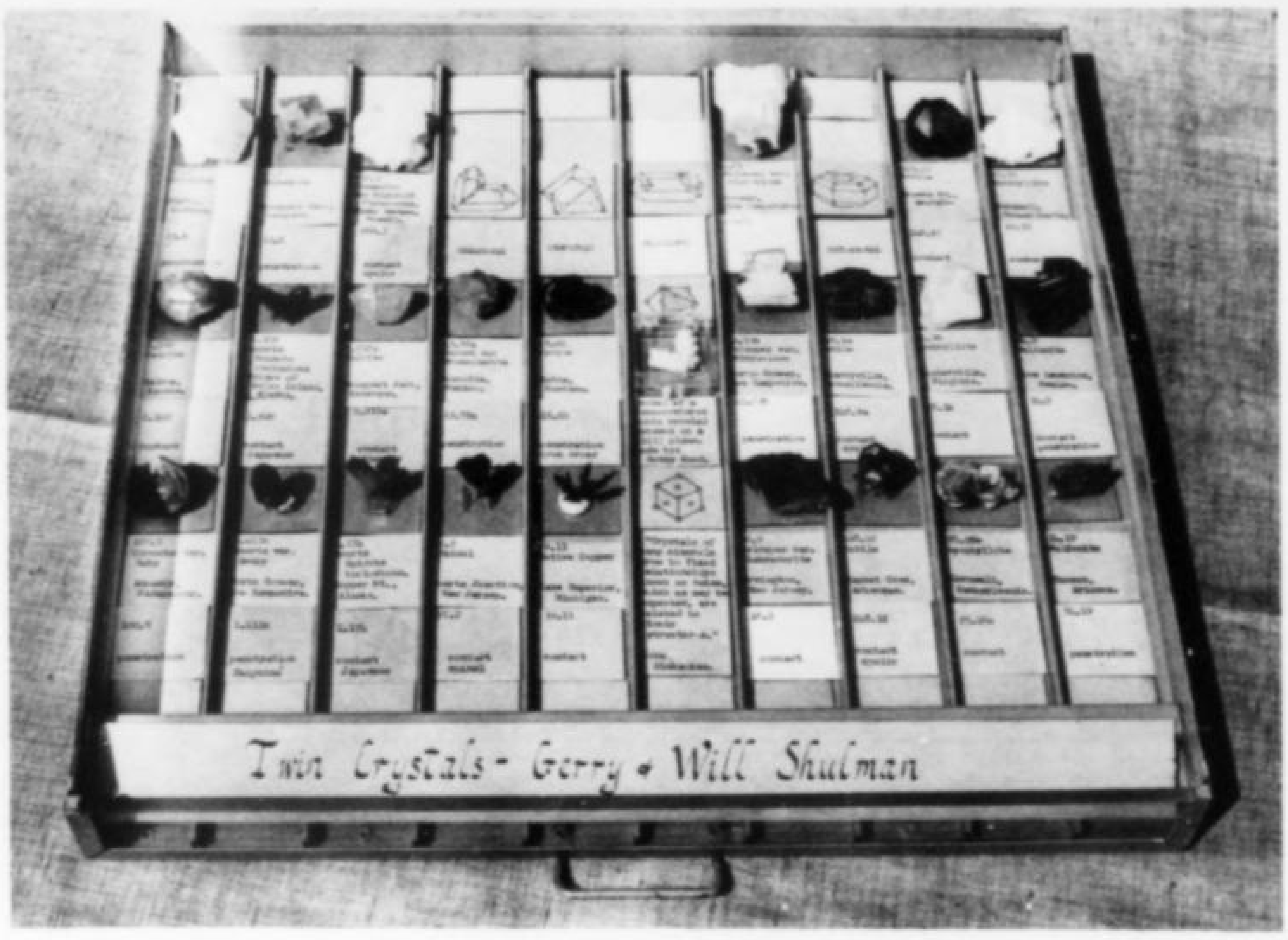


Figure 30. (above) **(a) Wulfenite crystal twinned on (001), and (b) an untwinned wulfenite crystal.**

Figure 31. (right) **Method of displaying twinned crystals (photo by Nick Machalaba).**



the way be shared, as we are attempting to do in this article, but the crystals should be visually shared with others. To this end we shall describe one method which has been successful with us and which was received with enthusiasm at the New Jersey Earth Science Show in August, 1975 and 1976, at Seton Hall University in South Orange.

Some years ago, we were able to purchase ten glass-fronted Clarke thread spool cases, each containing four drawers measuring 13¾ x 14¾ inches, divided into ten compartments 1¼ inches wide. The size of our drawers determined that we would exhibit small specimens which would fit on small plastic bases measuring 1⅛ x 1¼ inches. This was a fortunate choice as we found large twins exceeding rare and difficult to acquire. Next to micros the most perfect twins occurred in the aforementioned small dimensions. The twins were mounted on bases made of transparent vinyl which had been formed into little bridges by bending the plastic over an ordinary light bulb.

Because we frequently exchanged specimens between drawers, we made the labels giving species name and locality a uniform gray. For exhibit, we divided the specimens according to crystal systems and color coded them using discarded I. B. M. cards. All labels were cut the same size as the plastic bases, 1⅛ x 1¼ inches, and the name of each crystal system was printed on a label of the designated color and placed at the head of the compartment where the crystal system originated. A label of the designated color naming the type of twinning and the popular name of the particular twin was placed under the gray name locality label.

Several methods were used to further explain the exhibit. We showed a molecular model of a face-centered cube twinned on the (111) plane, graciously made for us by Betty Wood, crystallographer for the Bell Telephone Company. We also included a definition of twinning by John Sinkankas (1964). Because we were still missing some specimens in each class, we imposed on our artist friend, Carol Tauben, who made some fine crystal drawings which we placed at the head of the column where each system began, thus filling in the blanks (see Figure 32).

Our exhibit of two drawers, containing sixty twins, was placed in a case measuring 22½ x 38 inches, and in order to facilitate viewing, we used a flexible fluorescent magnifying lamp on a rotating base above our case. We were amazed at how few viewers had ever realized what twins were or what they really looked like.

In conclusion, let us say that one who dares collect twins must continually study. Despite the difficulty of their acquisition, collecting and classifying twins is an enriching and rewarding experience.

Acknowledgements

We wish to thank Paul E. Desautels, Curator of the Division of Mineralogy, Smithsonian Institution, for the lecture on twins which inspired this project and Andreas H. Vassiliou, Rutgers University, for helpful comments concerning the manuscript. Our thanks as well to Wendell E. Wilson for providing the crystal drawings and most of the specimen photos.

References

AREM, J. E. (1971) The state of the art: X-ray crystallography—Part II: single crystal methods, *Mineralogical Record*, **2**, 111-122.

BERRY, L. G. and MASON, B. (1959) *Mineralogy*, W. F. Freeman & Company, San Francisco, 630 p.

BLOSS, F. D. (1971) *Crystallography and Crystal Chemistry*, Holt, Rinehalt & Winston, Inc., New York.

DANA, E. S. (1892) *The System of Mineralogy of James Swight Dana 1837-1868*, John Wiley and Sons, Inc., New York.

FORD, W. E. (1932) *A Textbook of Mineralogy*, John Wiley and Sons, Inc., New York, 851 p.

FRONDEL, C. (1962) *The System of Mineralogy, Vol. III Silica Minerals*, John Wiley and Sons, Inc., New York.

GAULT, H. R. (1949) The frequency of twin types in quartz crystals, *American Mineralogist*, **34**, 142-162.

HURBURT, C. S. (1955) Wulfenite symmetry as shown on crystals from Jugoslavia, *American Mineralogist*, **40**, 857-860.

NEFF, O. (1916) Uber antimonit von Feldobanya, *Beitrage zur Krystallographie und Mineralogie*, **1**, 107-157.

SINKANKAS, J. (1964) *Mineralogy for Amateurs*, D. Van Nostrand Co., Inc., Princeton, New Jersey, 585 p.

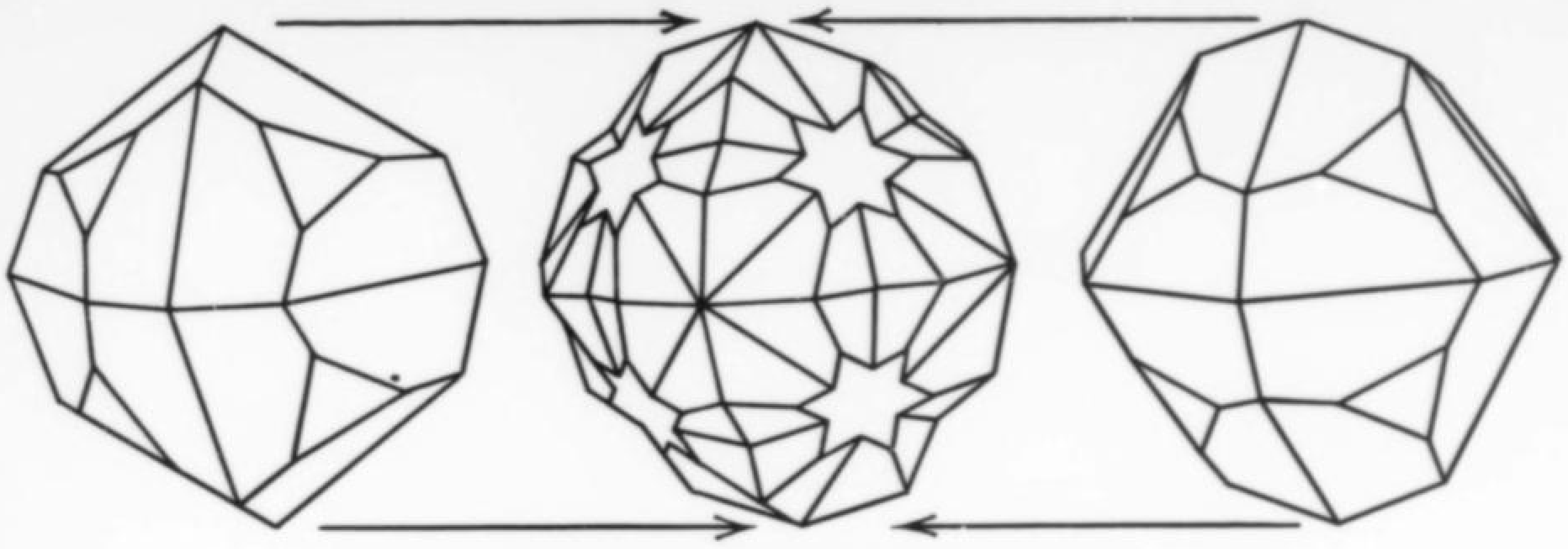


Figure 32. **Pyrite, from Elba, Italy.**

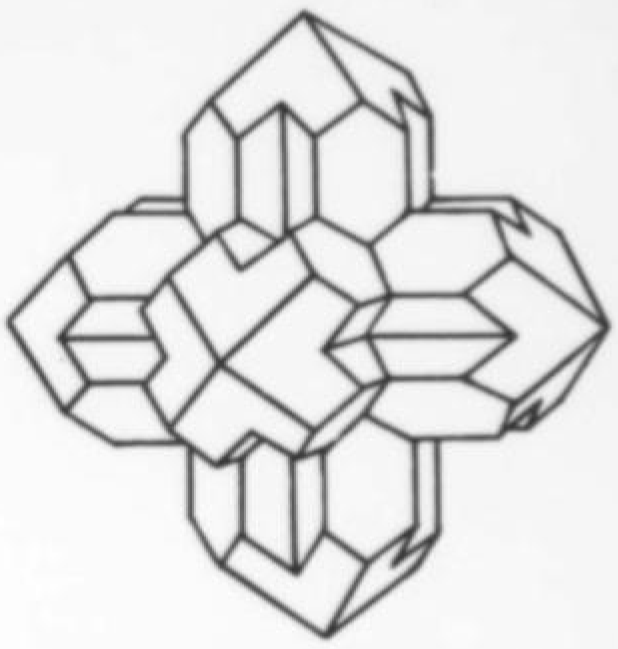


Figure 33. **Phillipsite, from Andreasberg, Harz Mountains, Germany.**

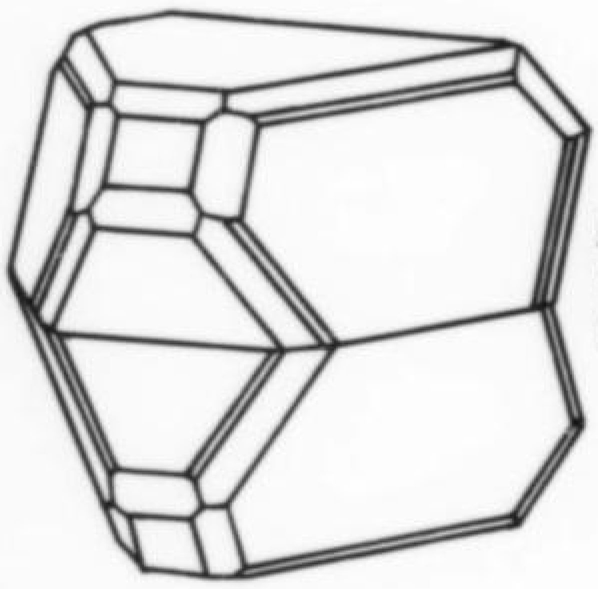


Figure 34.
Sphalerite,
from Schemnitz, Hungary.

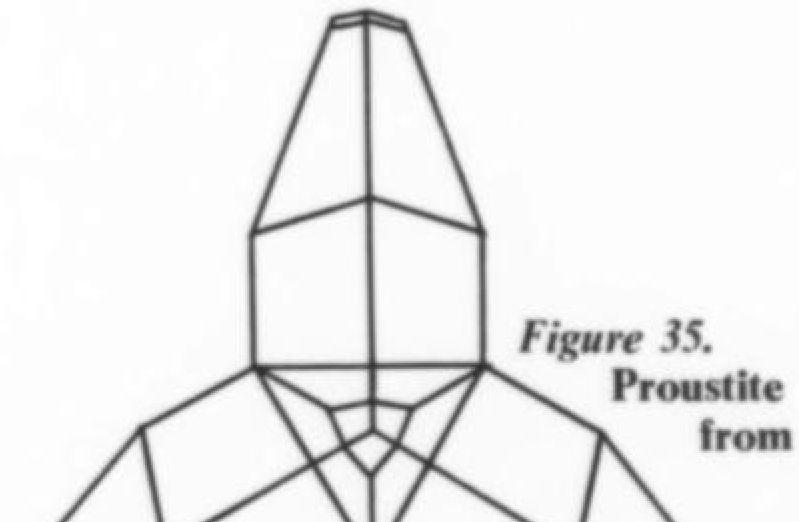


Figure 35.
Proustite
from Chanarcillo, Chile.

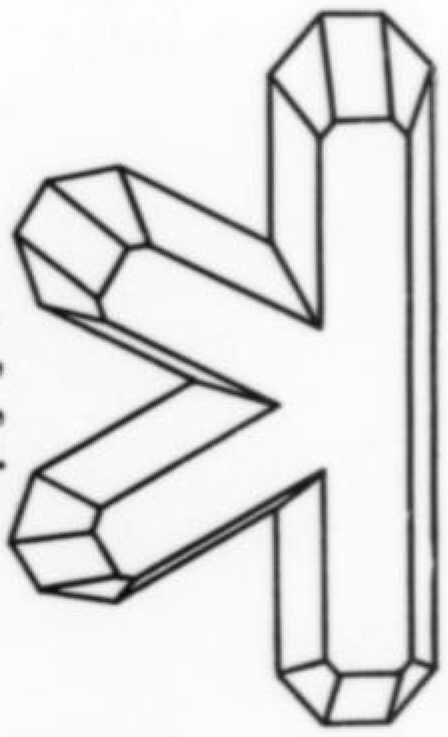


Figure 36.
Wolframite,
from Ivigtut,
Greenland.

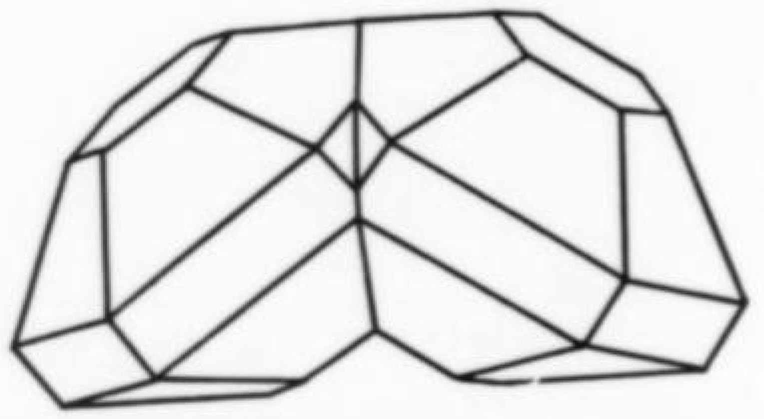


Figure 37. **Mimetite, from Johanngeorgenstadt, East Germany.**

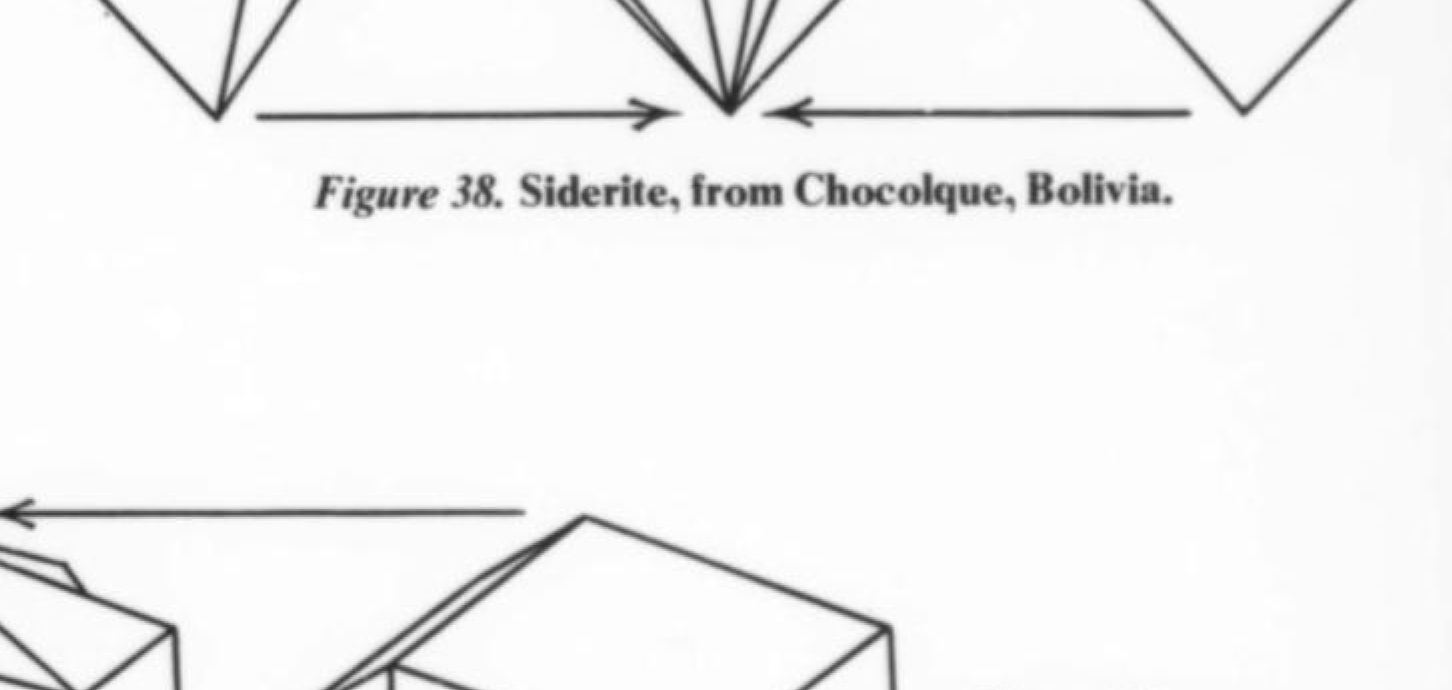


Figure 38. **Siderite, from Chocolque, Bolivia.**

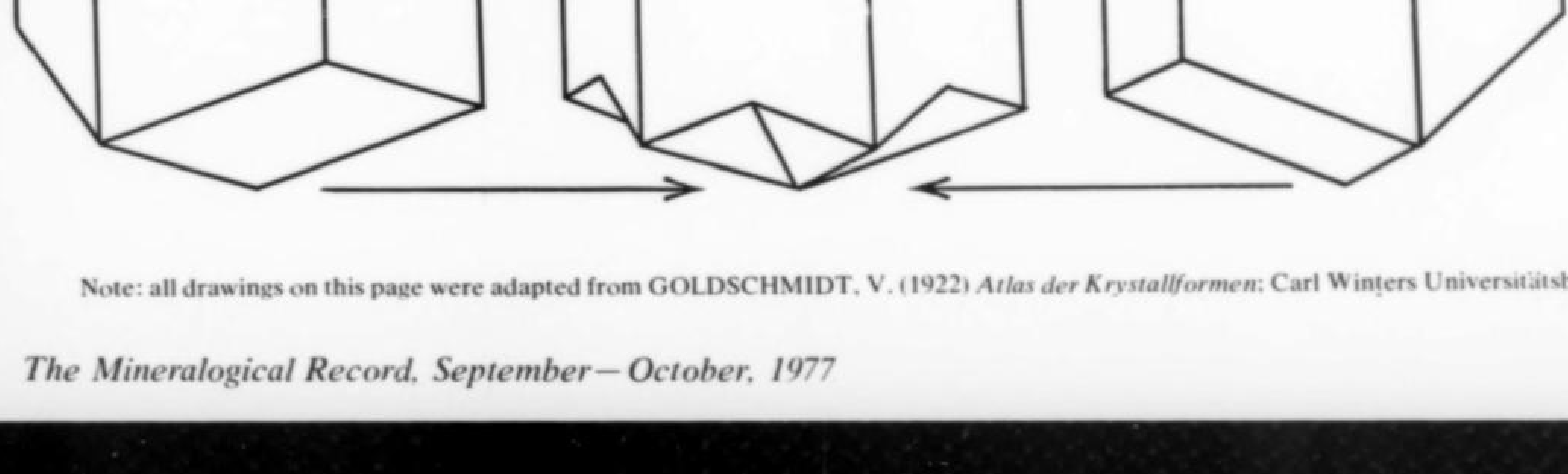


Figure 39.
Phenakite,
from Framont,
Vosges Mountains,
France.

Note: all drawings on this page were adapted from GOLDSCHMIDT, V. (1922) *Atlas der Krystallformen*: Carl Winters Universitätsbuchhandlung, Heidelberg.

MINERALS of RUSSIA

W. D. CHRISTIANSON - MINERALS

200 NAPIER ST., BARRIE, ONTARIO, CANADA, L4M 1W8
TELEPHONE 1-705-726-8713

IS PLEASED TO ANNOUNCE
That we have imported directly from RUSSIA
a variety of mineral species in quantity.

COLLECTORS - Write for list #R1
DEALERS - Write for Wholesale list #WR1
25¢ appreciated for list

Earth Forms

FINE MINERAL SPECIMENS

We invite you to consider our detailed listing of excellent specimens from world wide locales. Satisfaction guaranteed, of course.

Write for our list

EARTH FORMS
Box 5157
LITTLE ROCK, ARK. 72205

SCHNEIDER'S rocks & minerals

13021 Poway Road
Poway, California 92064
Phone (714) 748-3719
10 to 5 Wed. thru Sun.

please visit our shop in the San Diego area or see our booth at major shows

---

GOLD NUGGETS, RARE MINERALS, LISTS, from
Eltons, Sherwood Court,
Perth, Western Australia.

RARE SPECIES? BASIC MINERALS? COMMON ROCKS?

IF YOU ARE SIMPLY FASCINATED WITH MINERALS, YOU SHOULD HAVE OUR LISTS.

OUR CUSTOMERS SAY: "QUALITY MATERIAL, ACCURATE LABELS, EXCELLENT WRAPPING". FIND OUT WHY.

26¢ STAMPS BRINGS 20 PAGES OF LISTINGS. $1.00 PUTS YOU ON OUR MAILING LIST FOR A YEAR.

Minerals Unlimited, Dept. MR
P.O. Box 877 (127 No. Downs)
Ridgecrest, California 93555

bentley's minerals

Distinctive specimens— for museums and collectors

Write: P.O. Box 366
Windsor, Connecticut 06095
Telephone—(203) 688-1627

Mineral Micromount Cabinet

Efficient storage for your collection. Wheat color Formica-laminate finish. Inside dimension of drawer: 15⅜" x 13½" x 1³⁄₁₆".
30 W 4160 .... 92.50

Fine mineral and fossil specimen lists available. Special requests invited.

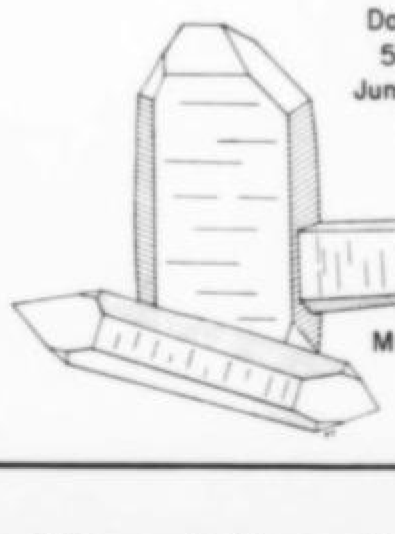
WARD'S

Ward's Natural Science Establishment, Inc.
P.O. Box 1712 Rochester, New York 14603

Select quality micromounts. Rare and well crystallized species from all over the world. Complete listing 1 Dollar. KÜMINERAL, 1, ch. Aug. Vilbert, 1218 Grand-Saconnex Geneva, Switzerland.

The Crystal Pocket of Juneau

Doug and Fran Toland
510 Kennedy Street
Juneau, Alaska 99801
907-586-2995



ORTHOCLASE FROM WEST MAROON PASS, COLORADO

by Henry A. Truebe
P.O. Box 227
Crested Butte, CO, 81224

A LOCALITY near West Maroon pass, in western Colorado, has produced some excellent examples of orthoclase. About 42% of the crystals are of simple habit, 55% are Carlsbad twins, and 3% are other twins or intergrowths. The best crystals are found in soil produced from the weathering of a partly altered porphyritic granodiorite dike. The locality is covered by a lode-mining claim and is being worked for the orthoclase crystals.

Introduction

An unusual abundance of good orthoclase crystals from West Maroon pass, Colorado, in the collection of Western State College aroused my curiosity. A bit of research on the Maroon Bells quadrangle (Bryant and Bruce, 1969) revealed that the only possible source of orthoclase near the pass was a porphyritic granodiorite dike.

Physical and Geological Setting

West Maroon pass is the high point (3800 metres) on the trail which runs up West Maroon creek from Aspen and down the East Fork of the South Fork of the Crystal River, to the town of Crystal (formerly Crystal City). The dike is about 400 metres southeast of the pass[1] at an altitude of 3840 metres. Access to the area is a long walk, and work is somewhat hampered by late snowmelt and frequent summer storms. At the outset of activity at the locality a lode-mining claim was staked to define the mineral rights.

The porphyritic granodiorite dike, which is the source of the crystals, is part of a northeast-trending system of dikes about 7 km in length[2]. The dikes cut the Maroon formation of Pennsylvanian-Permian age. At the locality the Maroon formation forms the upper plate of the Elk Range thrust fault and dips northeast at 20°. There is a 1-metre-wide mafic dike which is parallel to and about 2 metres northwest of the main granodiorite dike.

The dike is, in general, quite simple but, in detail, more complex. The dike caused minor baking effects at its contact with the Maroon formation but there is no evidence of chilling in the granodiorite in the vicinity of the contact. Within the dike the rock remains within the compositional constraints of a granodiorite but the tone and outcrop form reflect subtle differences in alteration which are important to the production of crystal specimens. In some areas the dike is hard and gray and crystals are either broken or embedded in solid rock. In other areas the rock has been altered to a dull greenish material which weathers easily to soil. The orthoclase in this rock is also altered to green pseudomorphs of calcite, "chlorite" and clay after orthoclase. The best orthoclase crystals come from a transitional phase, a brownish rock, in which alteration has softened the rock but has not altered the orthoclase.

Proper weathering conditions are essential to the preservation of the orthoclase. If the weathering is mainly physical (exfoliation, frost-wedging or thermal shock) the orthoclase tends to break up with the surrounding rock. Chemical weathering, on the other hand, tends to break down the plagioclase and Fe-Mg minerals in the rock before attacking the orthoclase. Hence, in outcrop areas, the amount of orthoclase that can be recovered is nil, whereas in areas of good soil accumulation the orthoclase is released slowly while the enclosing rock is completely broken down into soil. The occurence of good soil is determined largely by rock type (altered granodiorite) and by favorable exposure (north slope of optimum steepness).

Minerals

The West Maroon pass locality produces excellent specimens of one mineral — orthoclase. The other minerals of the locality will be briefly described for their incidental interest.

Orthoclase

The Orthoclase[3] crystals [$\mathbf{KAlSi_3O_8}$] from the West Maroon pass locality are of textbook quality. They range in size from a few millimetres to about 8 cm in maximum dimension. They are most commonly Carlsbad twins, with simple crystals being second in abundance. Based on a sample of 916 randomly selected crystals, 42% of the crystals are simple, 55% are Carlsbad twins, and 3% are complex intergrowths or twins by other laws.

Figure 1. **Location of the Maroon Bells quadrangle in western Colorado; circle is 100 km in diameter.**

The simple crystals are just that: simple (Fig. 2). The West Maroon pass orthoclase crystals seem to be more prismatic than the simple crystals commonly shown in textbooks. They usually show almost equal development of the *b* and *c* faces. Rarely, crystals are quite elongate parallel to the *a* axis and show a simple "termination" at one end and a Manebach or Baveno(?) "termination" at the other.

The Carlsbad twins are also rather uncomplicated (Fig. 3) but some distortion of crystal habit can be observed.

---

[1] The locality is precisely located within 100 metres of a point, 1.07 km SE of 39°2.5' N latitude and 107°0' W longitude, and 3.13 km SW of 39°2.5' N latitude and 106°57.5' W longitude, on the USGS Maroon Bells, Colorado, quadrangle.

[2] Similar dikes in the Capital Peak quadrangle are K-Ar dated at 31.2 ± 1.1 million years, by Obradovich, *et al* (1969).

[3] X-ray identified, Smithsonian Institution

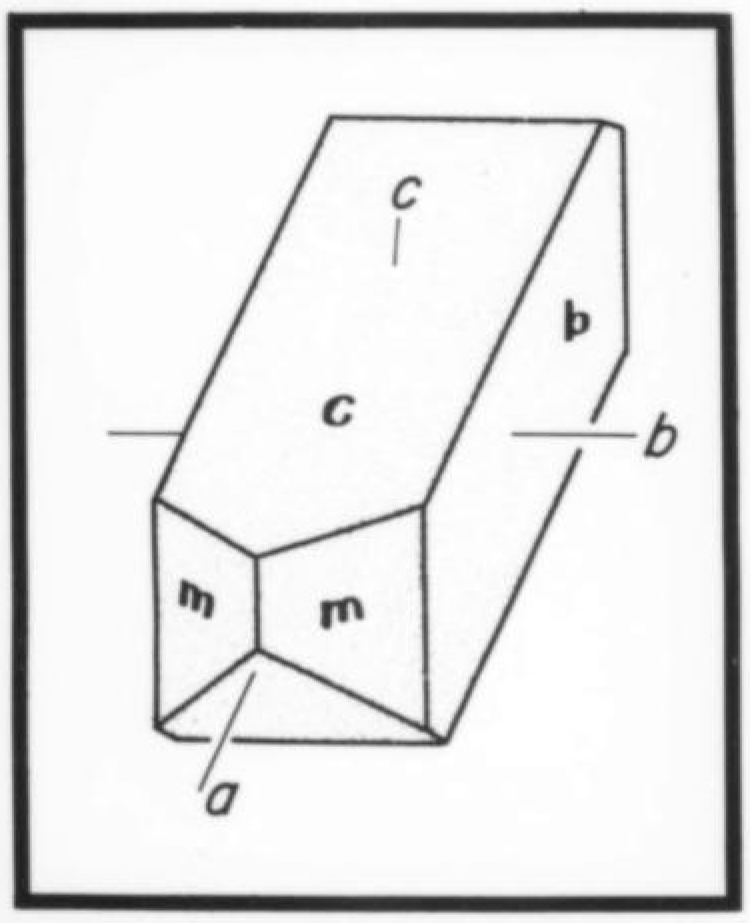
This is generally manifested in the "degree of tabularity" of the crystals involved in the twinning. In most cases, the individuals are flattened perpendicular to the *b* axis; but occasionally one or both of the crystals retains the simple habit. The ideal Carlsbad habit of some of the twins is modified by the presence of what appears to be a {011} face. Examples of both right-handed and left-handed Carlsbad twins were observed (Fig. 4) but no convention as to which-hand-is-which has been established.

The remaining 3% of the crystals make the mining interesting. This minority includes the Manebach twins (Fig. 5a and 5b), the Baveno(?) twins, the polysynthetic twins, undefined twins(?), and some rather bizzare intergrowths (Fig. 6a, 6b, 6c).

A small percentage of the orthoclase has been bent and/or broken. The most probable cause of this is that the dike was filled with surges of intrusive material and was pushed around during cooling. Another less likely cause of the bending and breaking could have been tectonic re-adjustments as the dike was cooling.

Figures 7, 8 and 9 show the distribution of the weights of simple crystals, Carlsbad twins and all other habits in a random sample of mine-run crystals. The weights of the crystals are approximately related to the sizes of the crystals.

Several transformations of the data were tried (log X, ln X, $X^{1/2}$, and $X^{1/3}$, where X = crystal weight) in order to determine which transformation would produce the most "normal" looking curve. Log X seemed to produce the best curve but it was decided to simply present the data without transformation. It will be noted in Figure 9 that the distribution of simple-crystal-



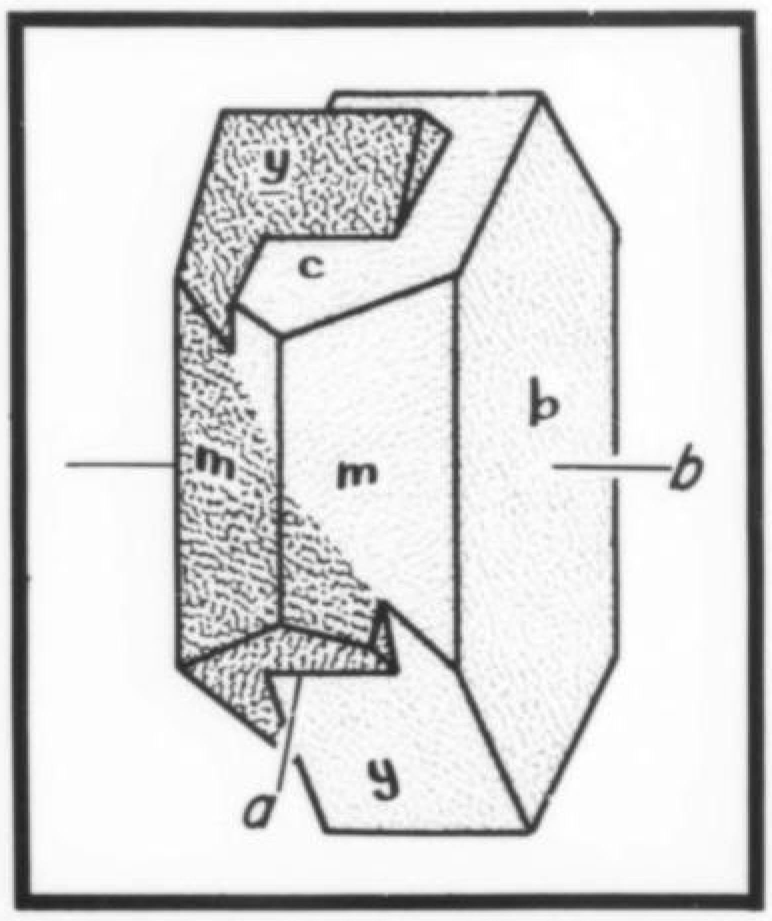


Figure 2. (far left) **Simple orthoclase crystal, *b* = {010}, *c* = {001}, *m* {110} (modified after figure 15-12a, Mason and Berry, 1968).**

Figure 3. (left) **Carlsbad twin orthoclase crystal, second crystal shown in darker tone; *b* = {010}, *c* = {001}, *m* = {110}, *x* = {101}, *y* = {201} (after Figure 15-12c, Mason Berry, 1968).**

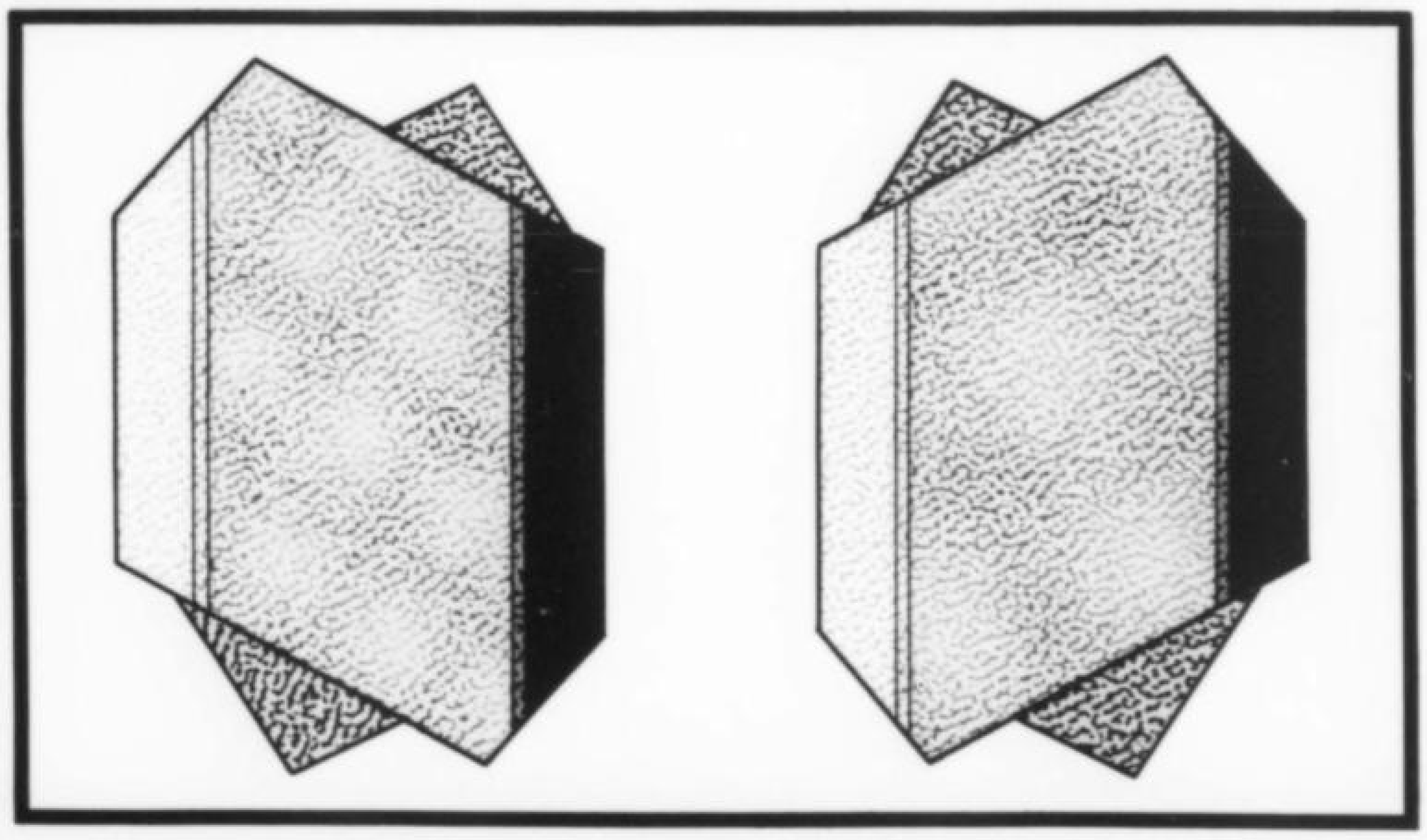


Figure 4. (left) **Right- and left-handed Carlsbad twin orthoclase crystals.**

Figure 5. **Manebach twin orthoclase crystal (4 cm along *a* axis), *(below left)* shows +*a* end, *(below right)* shows -*a* end.**

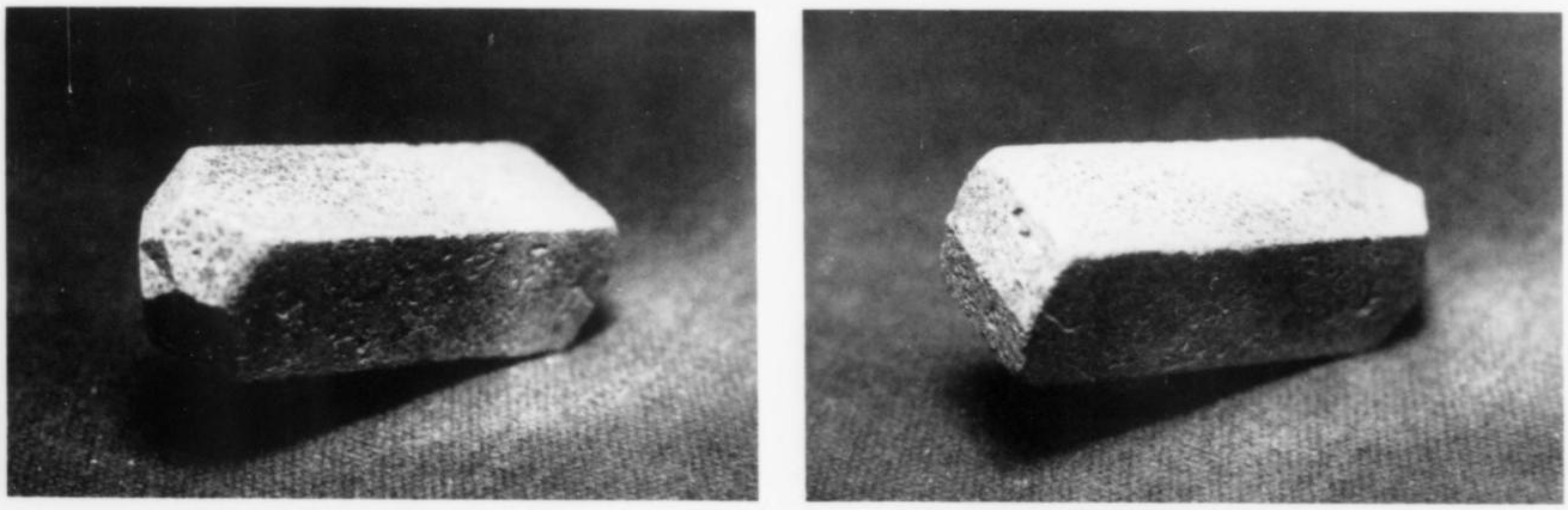
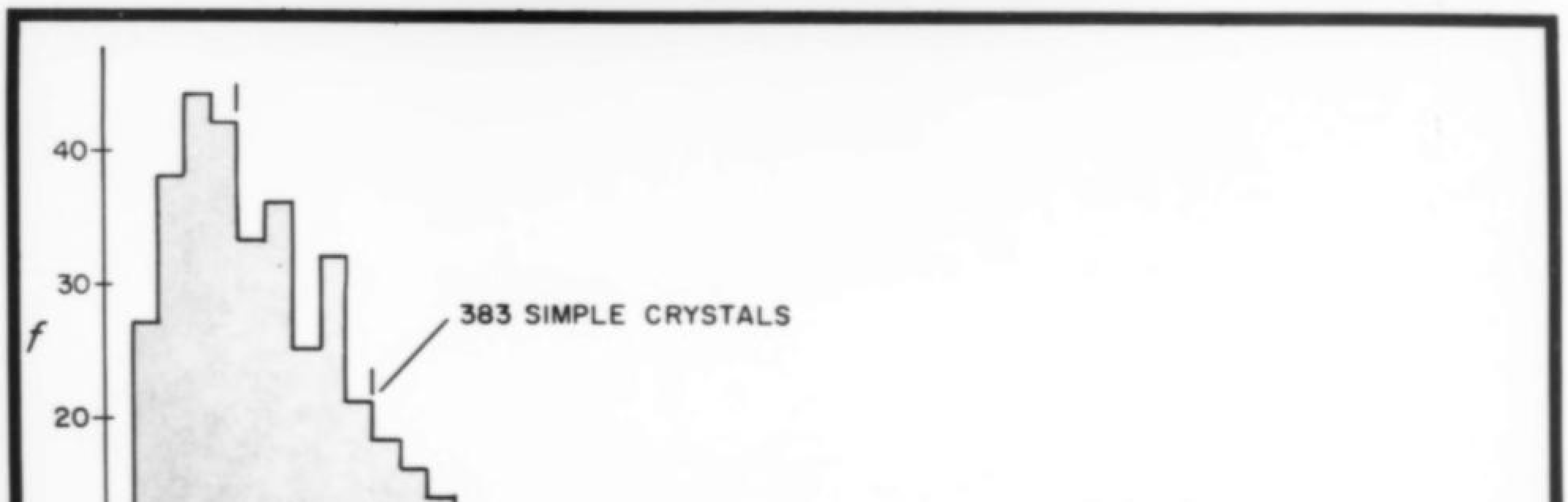
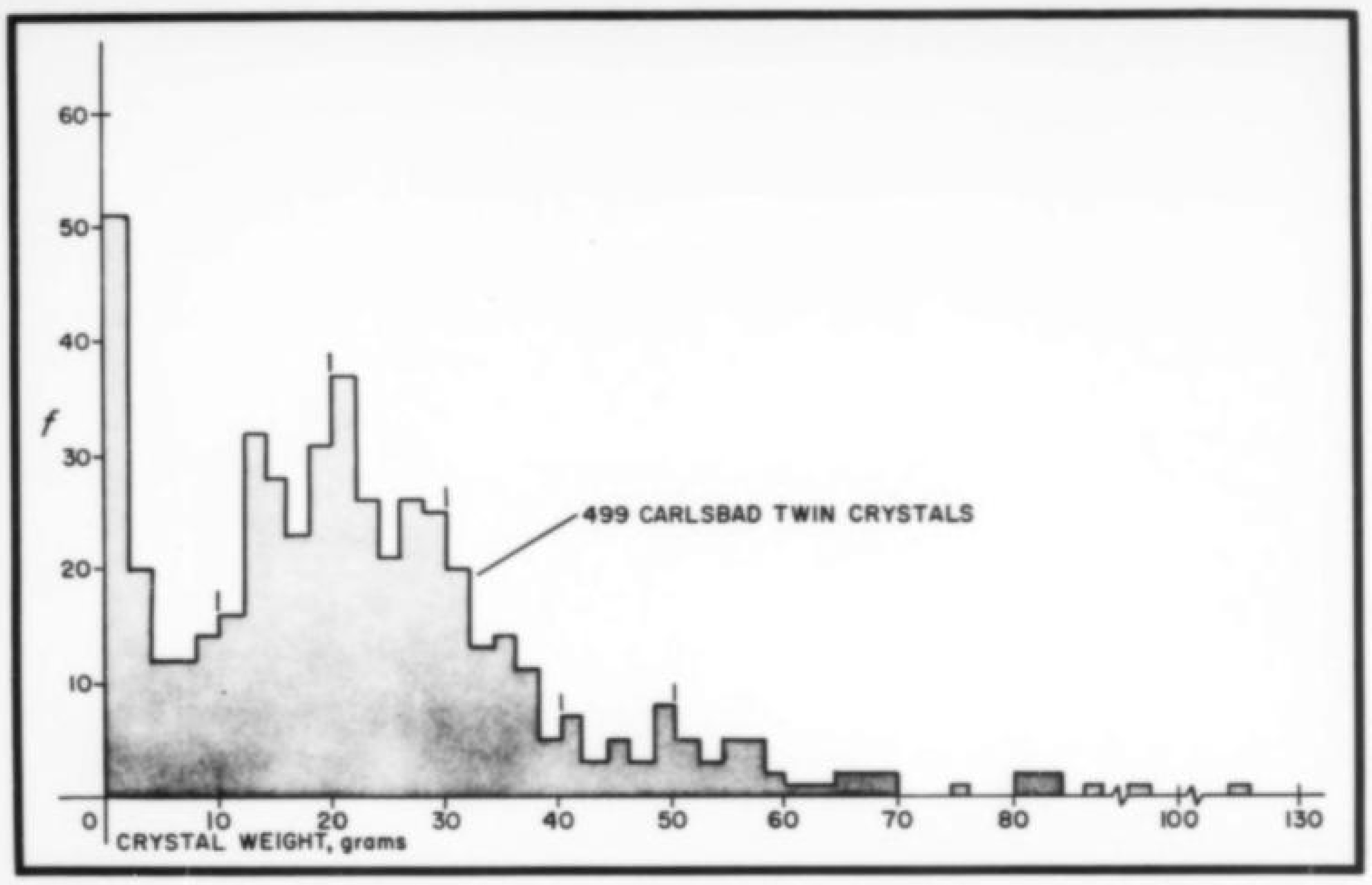
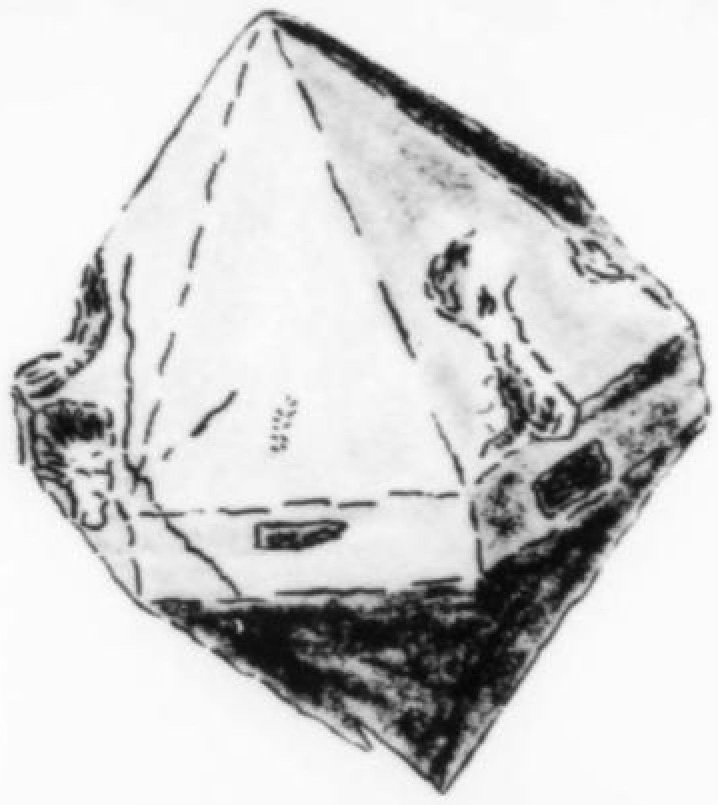


Figure 6. **Intergrowths of orthoclase crystals: a)** ***(top left)*** **simple-simple intergrowth (4 cm maximum dimension), b)** ***(top right)*** **Carlsbad-simple intergrowth (Carlsbad 5 cm in maximum dimension), c)** ***(left)*** **Carlsbad-Carlsbad intergrowth (view 3 cm wide).**

Figure 7. (below) **Frequency distribution of weights of 383 simple orthoclase crystals.**







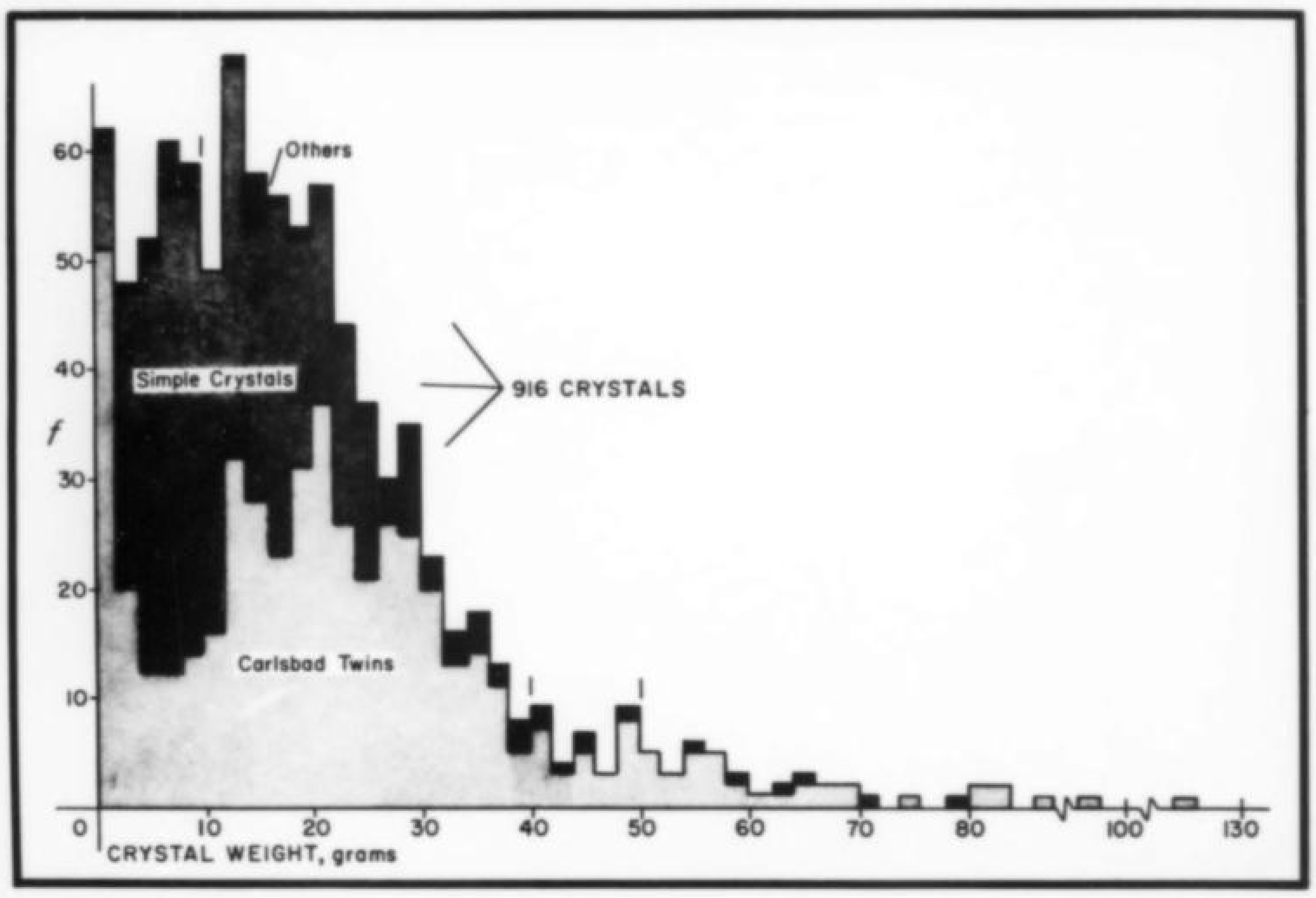


***Figure 8. (top left)* Frequency distribution of weights of 499 Carlsbad twin orthoclase crystals.**

***Figure 9 (above)* Frequency distribution of weights of 916 crystals of all habits.**

***Figure 10. (top right)* Dauphiné twin quartz crystal (model crystal about 1 cm in length, *c* axis).**

***Figure 11. (right)* Sampling at the orthoclase locality, West Maroon pass. Colorado.**

weights tends to complement the distribution of Carlsbad-twin-weights. The mode of the simple crystal distribution fits neatly into a low point in the Carlsbad distribution. This may have some implications in relation to crystal growth history.

Other Minerals

The other minerals at the locality are rock-forming minerals or alteration products. The most abundant rock-forming mineral, after orthoclase, is plagioclase [$\mathbf{(Na,Ca)Al(Al,Si)Si_2O_8}$] which occurs as anhedral crystals from 2 to 5 mm long. Even in the freshest rock the plagioclase is at least partly altered to unidentified clay minerals. Gray quartz crystals [$\mathbf{SiO_2}$], averaging about 1 cm in length, can be found in portions of the dike (Fig. 10). The crystals are ideal Dauphiné twins, both pyramidal terminations being mirror images of the other. The prism faces show only minor development. Minute, sharp, pseudo-hexagonal crystals of biotite [$\mathbf{K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2}$] about 1 mm in diameter can be found in the fresh porphyritic granodiorite.

The alteration of the dike was probably the result of the various pulses of material entering at different times. The alteration is low-grade and can best be described as deuteric. With the exception of calcite [$\mathbf{CaCO_3}$], which forms veinlets 1 to 2 cm wide in the granodiorite and cements broken orthoclase crystals, the alteration minerals have not been precisely identified. In the altered rock, clay minerals are abundant and "chlorite" is probably responsible for the green coloration. The biotite described above has been altered to muscovite(?). "Limonite" stain occurs locally and dendritic growths of "wad" can be seen on some of the calcite-"chlorite"-clay pseudomorphs after orthoclase.

Future Development

The locality has indicated reserves of several hundred thousand orthoclase crystals; and there is certainly a demand for them, particularly in the educational field. Future work at the locality will be aimed at the efficient production of specimen material. In addition to the problems of access and weather, the locality must be worked in a manner compatible with the *Wilderness Act of 1964*. This act requires that no power equipment be used, and that the mined areas be carefully reclaimed.

Sources of Information

BRYANT, B. (1969) Geologic Map of the Maroon Bells quadrangle, Pitkin and Gunnison Counties, Colorado; U.S. Geological Survey GQ 788.

MASON, B., and BERRY, L.G. (1968) *Elements of Mineralogy*; W.H. Freeman and Co, San Francisco, 630 p.

FLEISCHER, M. (1975) *1975 Glossary of Mineral Species*; Mineralogical Record, Inc., P.O. Box 783, Bowie, MD, 20715, 145 p.

OBRADOVICH, J.D., MUTSCHLER, F.E., and BRYANT, B. (1969) Potassium-Argon ages bearing on the igneous and tectonic history of the Elk Mountains and vicinity, Colorado; a preliminary report: *Geol. Soc. Amer. Bull.*, **80**, 1755-1762.

FINE MEXICAN MINERALS
Danburites 25.00, 50.00 with a few at $250.00
Datolites 25.00, 50.00 & $100.00
Bournonites 50.00 to 300.00
Plus other fine Mexican specimens
McGregor & Watkins, Route 8, Box 487
Hot Springs, Arkansas 71901
7 miles West on U.S. 70

Western Minerals
1260 E. Edison
Tucson, Arizona 85719
602-792-4854

Richard W Barstow

Dealer in high quality British & World Mineral Specimens for the advanced collector

Bi-monthly lists of fine specimens sent free on application

Callers Welcome

26 TREGESEAL, ST. JUST, PENZANCE,
CORNWALL, ENGLAND

FINE MINERAL SPECIMENS

We specialize in old Bisbee, Tiger and other Arizona material. Also crystals and crystal groups from all over the world. We also handle rare minerals, domestic and foreign. Azurite, wulfenite, kinoite, native copper, cuprite and many others available. Send us your wants, sizes, price range, etc.

BIDEAUX MINERALS
Telephone 624-2132
111 W. WASHINGTON ST.,
TUCSON, ARIZONA
85701

X RAY DIFFRACTION
Mineral Identification
Prices as Low as $8.75 per Sample
Send Stamp for Details
Geo ***XRD*** *Laboratory*
8469 W. Vassar Drive
Denver, Colorado 80227

New Acquisitions from:
France, Turkey,
Spain and other countries.
Good stock available of California
Nevada minerals
Retail-Wholesale
Foreign inquiries invited
Show room hours by appointment
8377 S. Palm Delhi, CA 95315
Tel. (209) 632-1341
GALAS MINERALS

NATURE'S TREASURES
P.O. Box 982
Hawthorne, CA. 90250

Fine mineral specimens in all sizes & prices. Also we buy fine collections.

* * *

See us in
San Diego 29-30 Oct.
Pasadena 19-20 Nov.
Tucson 11-18 Feb. 1978

* * *

Representing in the U.S.:
Kahn Mineralien of Germany.

D. Weber, Owner
Hours by appointment
(213) 373-3601

Minerals International

We specialize in select Crystallized Minerals

send for current price lists
25¢

304 W. Clovernook Lane
Glendale, Wisc. 53217
Tel. 414-352-3634

SILVERHORN
a new shop in Banff featuring
handcrafted jewellery • gemstones • mineral specimens

Mike and Carol Ridding

215 Banff Avenue
P.O. Box 1407
Banff, Alberta, Can.
(403) 762-3918

MINERALOGY OF THE GREEN RIVER FORMATION*

by Charles Milton
Department of Geology, George Washington University
Washington, D.C. 20052
and
U.S. Geological Survey, Reston, Va. 22092

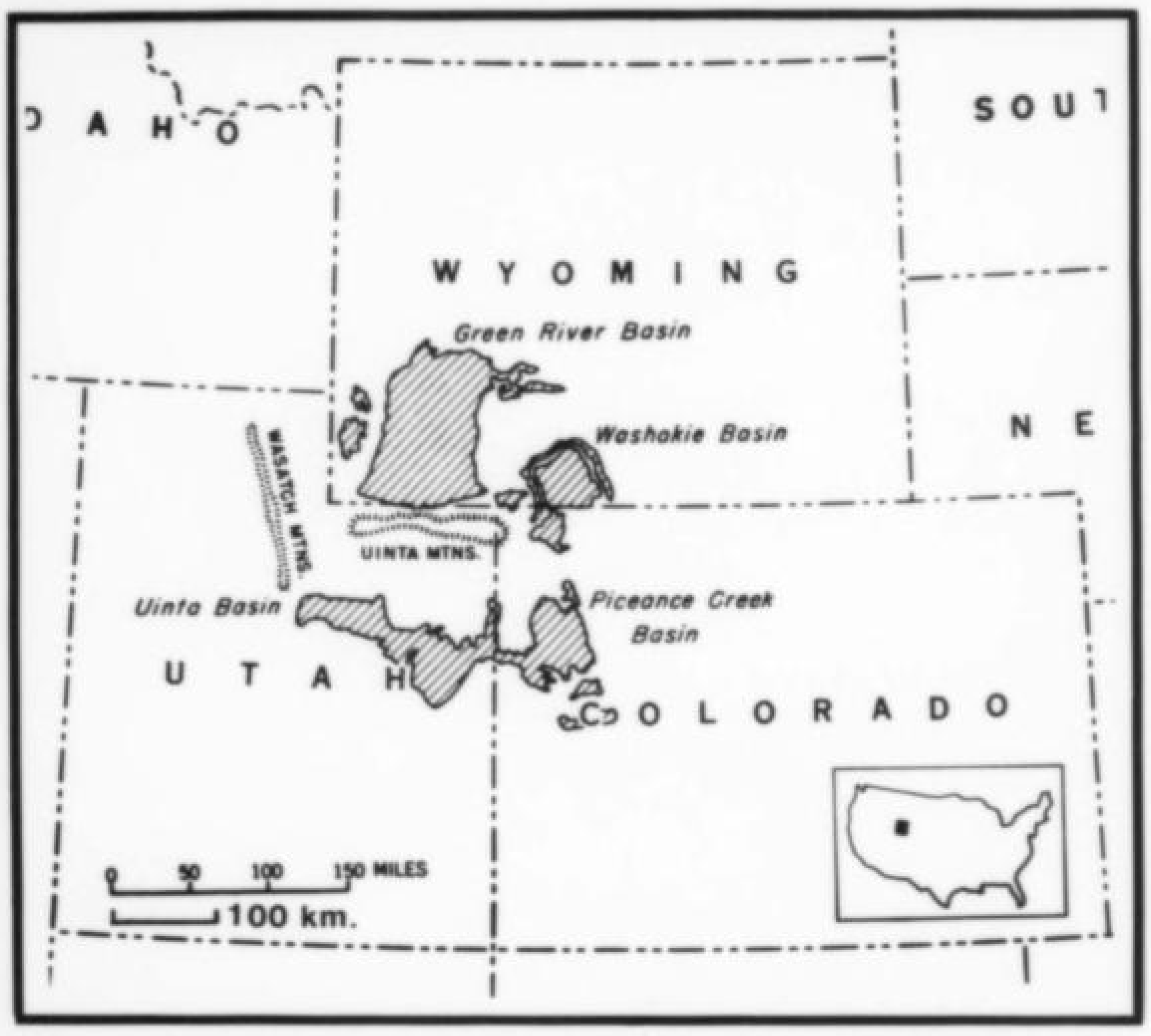


Figure 1. **Index map showing major structural basins containing lacustrine strata of the Green River formation of early and middle Eocene ages in northwestern Colorado, northeastern Utah, and southwestern Wyoming. Three basins each have a distinctive and differing type of mineralogy—the Green River (Bridger) Basin in Wyoming, the Uinta Basin in Utah, and the Piceance Creek Basin in Colorado.**

The Green River formation (lower and middle Eocene) of Colorado, Utah, and Wyoming is a vast sequence over 7,000 feet (2100 m) thick and extending over 16,000 square miles (41000 km^2) (Fig. 1). It consists of essentially horizontal dolomitic marlstones, sandstones, oil shales, and altered tuff beds, which contain the world's greatest reserves of oil shale, trona and nahcolite, and dawsonite. The oil-shale deposits of the Piceance Basin, in Rio Blanco and Moffat Counties, northwestern Colorado, are being developed as an energy source in several pilot plants, with provision for eventual aluminum production from the dawsonite-bearing oil shale; for many years most of the nation's needs for soda ash (sodium carbonate, a basic industrial chemical) have been supplied by several trona mines in Sweetwater County in southwestern Wyoming. Nahcolite, also a major sodium carbonate mineral, awaits exploitation.

Aside from the outstanding economic significance of these resources, the Green River formation is characterized by an extraordinary and unique mineralogy, first noted by Bradley (1929a,b); this mineralogy has attracted world-wide attention and been the subject of hundreds of publications. Over 80 authigenic (i.e. originating within the formation) species have been described, their number growing each year with further study. Although the Green River formation consists wholly of water-laid deposits, unaffected by any known igneous or magmatic activity, many of the authigenic mineral species are known elsewhere only as igneous or pegmatitic minerals, such as pyroxenes and amphiboles, various feldspars, and complex titano-silicates. Many of these minerals are known only from the Green River formation, whose geological history is complex and controversial (Sozansky, 1974; Eugster and Surdam, 1974). Indeed, Heinrich (1966, p. 127) referred to the Green River mineralogy as "slightly incredible...inter-shufflings of evaporite species with species from alkalic igneous assemblages."

Bradley and Eugster (1969) have discussed the authigenic Green River mineralogy in Wyoming; Milton and Eugster (1959) reviewed the mineralogy of the formation, with special reference to phase relations; Milton et al. (1960) summarized the silicate mineralogy, and Milton and Fahey (1960a) summarized the carbonate mineralogy. An historical account of Green River mineralogy appeared in Milton and Fahey (1960b); and brief summaries of the mineralogy appeared in Milton (1957, 1971).

Minerals now recognized as authigenic in the Green River formation are listed below. For each mineral the relative abundance and distribution are indicated by a number in parentheses, from 1 to 6; and, for many, reference to recent publications is given. Topical features of the geochemistry and mineralogy of the formation are also noted, with references enabling the reader to pursue these matters further. Where no reference is given, occurrence of the mineral in the Green River has not been specifically described in the literature, although it may have been noted in numerous publications or it may be recorded only in unpublished data.

Special Features of Mineralogy of the Green River Formation

Local Variations in Mineralogy

Besides the dozen or more species found so far only in the Green River formation, many of the others differ distinctively from other specimens of the same species found elsewhere; this is true of common species, such as pyrite, as well as rare species, such as leucosphenite. Pyrite, for instance, in the Wyoming Green River formation occurs in unique skeletal forms (Milton and Eugster, 1959; Pabst, 1970); leucosphenite in the Utah Green River formation invariably carries crystallographically oriented inclusions of the host rock (dolomitic marlstone), but not in Wyoming, where it crystallized in a completely different habit; and both types of leucosphenite are quite unlike

---

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

Figure 2. **Cores from the South Ouray Well, Uintal County, Utah, drilled in the late 1940's. This core, almost wholly destroyed when the dry-hole site was bulldozed and abandoned in the late 40's, contained an extraordinary suite of rare or unique minerals: shortite, elpidite, leucosphenite, loughlinite, reedmergnerite, neighborite, garrelsite. All these minerals were found later in scraps of core that were saved.**

the Greenland leucosphenite first described in 1901. In Colorado, leucosphenite has not been found at all.

Dawsonite, apparently restricted to the Piceance Creek Basin (Colorado and adjacent Utah) of the Green River formation, may form a major rock constituent in the lacustrine beds; elsewhere in the world it is usually a hydrothermal vein mineral associated with igneous rocks.

Zeolitization

Characteristic of Green River lithology is the extraordinary abundance and general distribution of analcime, first noted by Bradley (1929a,b). Other zeolites are remarkably few and of highly localized occurrence; clinoptilolite-mordenite, harmotome-wellsite, and natrolite are the only ones known to date. The later two are only known in single localities. Extensive silicification occurs with analcimization of tuff beds; bedded authigenic feldspar and possibly dawsonite also occur as major rock-forming minerals.

Inclusions

The paragenetic relationship of carbonate and silicate minerals is also of interest. Carbonate crystals in the Green River commonly contain authigenic, oriented inclusions of silicate minerals; similarly, crystals of the authigenic silicates often show carbonate inclusions. Thus in Wyoming, northupite and shortite contain acmite; Wyoming shortite crystals contain a fibrous mineral, perhaps loughlinite; and mckelveyite in Wyoming contains, in addition to organic matter, acmite, quartz, and biotite (or hematite?)—all believed to be authigenic, formed together with the host carbonate.

Phosphate Beds

The Green River formation in Wyoming contains extensive beds of an unusual type of phosphate deposit. Whereas other phosphate deposits are generally of marine-fossil origin, the Green River phosphate is a fresh-water chemical precipitate of (uraniferous) apatite disseminated sub-microscopically in a carbonate matrix. Elsewhere, much more sparingly disseminated uranium has been concentrated in secondary minerals by weathering processes. But despite examination of many miles of outcrop of the Green River uraniferous ledges, uranium has only been detected by radiometric measurement or chemical analysis, and never as a specific uranium mineral. (The occurrences of mckelveyite and ewaldite have no known relation to the bedded uraniferous phosphate.)

Zoning

From a study of many cores from the Piceance Basin, Smith and Milton (unpublished data, 1976) have found indications that, in Colorado, the Green River beds, which are several thousand feet thick, may be horizontally zoned by specific assemblages of authigenic minerals, with virtual constancy in overall chemical composition from top to bottom. Thus Na_2O, Al_2O_3, SiO_2, CO_2, CaO, etc., may at various horizons be represented by varying combinations of albite, analcime, dawsonite, calcite, quartz, etc., with relatively little change in bulk chemical composition, but with striking changes in mineralogy.

Ash Beds

Many ash beds are intercalated with the dominantly chemically precipitated deposits, and some may be traced for miles. The ash beds are, in many instances, optically homogeneous and isotropic, although they give X-ray patterns of feldspar. Detrital hornblende in these beds is often found with secondary rims varying from pale blue to deep blue-black, but detrital pyroxenes are very rare and show no secondary growth. Detrital biotite likewise is apparently unaffected. Plagioclase feldspar often has albitic rims; and there appears to be evidence of large-scale transformation of glass to potassic feldspar. Such minerals as magnetite and ilmenite are virtually absent, even as detrital minerals; the iron in the formation is present mostly as sulfides, and, perhaps, as ferroan dolomite.

Absence of Some Minerals

A geochemical enigma of the Green River formation is the as-yet-unexplained absence of certain minerals. No manganese minerals have been found in a vast sequence of sedimentary beds, much of which was deposited in closed basins. Despite the local abundance of boron, no tourmaline has been found; instead, the boron has entered searlesite and such exotic minerals as reedmergnerite, garrelsite, and leucosphenite. Likewise, several titanium minerals—such as labuntsovite, vinogradovite, and leucosphenite—occur, but none of the common species (rutile, brookite, sphene, or ilmenite); however, anatase is very rarely found in ash beds. Metallic minerals are restricted to iron sulfides (abundant pyrite and pyrrhotite, rare marcasite) and very minor though widespread zinc sulfide (wurtzite, but no sphalerite). Recently, a nickel mineral, abelsonite, has been found. Neither gypsum nor anhydrite is known from the unweathered Green River beds. However, as our knowledge of the Green River formation has grown, some minerals or elements previously unrecognized have been found. Phosphorus was once considered abnormally low in Green River beds, but now (uraniferous) apatite-bearing strata are known to be widespread in the Green River Basin in Wyoming (Love, 1964). Likewise Milton and Eugster (1959) noted the apparent absence of chlorides such as halite and sylvite, although northupite, $Na_3Mg(CO_3)_2Cl$, occurs abundantly in Utah and Wyoming; now halite beds many feet thick have been drilled in Wyoming, and, recently, bedded halite has been found also in Colorado and Utah. However, neither sylvite nor other potassium salts have been observed; potassium apparently is represented mainly by feldspar.

Conditions of Mineral Origin

Until recently, the petrology and mineralogy of the Green River formation were interpreted in the framework of a deep, stratified lake system, enduring over hundreds of thousands, if not millions, of years (Bradley, 1929, 1964). Over long periods of time, these great lakes were without drainage to the sea and consisted of fresh water—oxygenated and teeming with life—overlying stagnant lifeless water—devoid of oxygen, but charged with hydrogen sulfide, methane, and probably ammonia. Under these conditions there accumulated the organic-mineral debris that eventually formed oil shale and, in periods of drought, saline carbonate and chloride precipitates. Sulfate formation was inhibited by intense reducing conditions, sulfides (of iron) being formed instead. A different interpretation has been proposed by Eugster and Surdam (1973), Surdam and Wolfbauer (1975), and Lundell and Surdam (1975): deposition, both detrital and chemical, was in shallow water; it involved intermittent and frequent desiccation and seasonal, rather than permanent, stratification. In either case, under strongly reducing conditions, many thousands of feet of both detrital and chemical sediments accumulated, as shown both by the dominance of oil-shale hydrocarbons and iron sulfides and by the virtually complete absence of gypsum or anhydrite, or other sulfates.

The Green River formation includes fragmental material, such as siltstones and sandstones, fossiliferous limestones, and ash beds, as well as an extensive series of saline beds (mostly carbonate, but also chloride and phosphate). The latter represent evaporites and chemical precipitates. Diagenesis has reconstituted the constituents of the bedded deposits, forming silicates such as searlesite, reedmergnerite, leucosphenite, acmite, magnesioarfvedsonite, vinogradovite, catapleiite, elpidite, and labuntsovite. An obscure, but conceivably significant role in mineral formation may have been played by microscopic organisms in absorbing such trace elements as uranium, zirconium, niobium, rare earths, nickel, and zinc, with subsequent diagenetic crystallization into mineral structures. In the ecology of the ancient lakes, concentrations would be affected as these organisms became food for higher forms of life. Eventual deposition would be in the tissues of fish, which form characteristic fossils of many Green River beds. Following such biogenic concentration of rare elements and sedimentation of the nitrogeneous organic debris, fugitive substances such as methane, hydrogen sulfide, and ammonia generated in the bottom may have had a part in the special mineralization of the Green River formation. Indicative of the generally reducing conditions that governed Green River mineral formations is the virtually complete fixation of sulfur as sulfide rather than sulfate. Sulfates (gypsum, celestine, and siderotil) are only known as very minor,

Figure 3. **A few years later a core sample from another well drilled in the area showed a tiny crystal (edge of core, above figure 6 on centimetre scale) referred by Allan P. Bennison, geologist to the U.S. Geological Survey, for identification. It was found to be a complex titano-borosilicate, leucosphenite, an extremely rare mineral previously known only from alkalic pegmatites. Naturally, it was at first thought to be likewise of igneous origin, a detrital mineral washed into the Green River Lake in the Uinta Basin of Utah.**

recent weathering products; barite and burkeite, however, may be diagenetic. The oil shale itself was formed under reducing conditions. There have been reports, apparently reliable, of ammonia and hydrogen being found in some quantity in certain wells in Wyoming and Colorado. The existence of an ammonium feldspar, buddingtonite, in the geologically similar beds at Searles Lake and elsewhere in California suggests unstable predecessor ammonia compounds, with their ammonia now replaced by sodium.

A definite variation in authigenic mineral content or in morphology (e.g. leucosphenite and pyrite) of individual minerals exists from basin to basin in the Green River, presumably reflecting variations in conditions of sedimentation or, more probably, diagenesis. Extensive faulting in the Uinta Basin in Utah, with ensuing geothermal effects on the local ground waters, may have been responsible for the restricted local occurrence of such materials as reedmergnerite and eitelite.

Studies have been made of the physical chemistry of carbonate mineral systems in the Green River, notably by Eugster (Milton and Eugster, 1959). In the Green River formation temperatures could hardly have exceeded 250°C, with moderate pressures of, at most, a few thousand feet of overlying sediments.

***Figure 4.* Sinclair Mortenson No. 1 Uintah Co., Utah crystals of leucosphenite in shale matrix x 3**

The aspect of the isolated crystals was not opposed to this interpretation. It appeared most improbable that crystals of such complex composition, with major boron and titanium and barium, found in an apparently unaltered dolomitic shale practically devoid of these elements, could have any but a remote ("magmatic") source.

***Figure 5.* Leucosphenite crystals X 5 from Utah. The habit of leucosphenite in Wyoming is quite different— rosettes of thin platy crystals. No leucosphenite is known from Colorado.**

Following discovery of the boron-albite reedmergnerite, both it, and boron-biotite and other silicates, with boron replacing aluminum, have been synthesized. Many studies have been made of chemical systems related to Green River mineralogy, particularly in relation to soda-ash production by the Solvay process; thus, wegscheiderite was known as Wegscheider's salt for fifty years prior to its discovery in Wyoming and Colorado. Although the respective component systems had seemingly been exhaustively investigated, neither $Na_2Ca_2(CO_3)_3$, shortite, nor $NaBSi_3O_8$, reedmergnerite, were known prior to their discovery in the Green River formation; although they are anhydrous, they form only in hydrous systems (hydrothermal, synthetically, Eugster and McIver, 1959).

Deposits Similar to the Green River Formation

The trona-borax deposits of Searles Lake in California, and the trona deposits of Lake Magadi, in Kenya, and Lake Natron, in Tanzania, have interesting analogies to the Green River formation. It is also noteworthy that certain new minerals first found in the Green River formation have since been reported from igneous alkalic rock parageneses, e.g., reedmergnerite, eitelite, and norsethite. Burbankite, leucosphenite, labuntsovite, elpidite, catapleiite, and vinogradovite, the zeolites (analcime, wellsite-harmotome, and clinoptilolite-mordenite), acmite, and magnesioriebeckite had already been known but only in an alkalic-igneous paragenesis.

TABLE 1. AUTHIGENIC MINERALS IN THE GREEN RIVER FORMATION OF COLORADO, UTAH, AND WYOMING

Mineral Classification	Species	Formula	Abundance and Distribution*	References	Remarks
ELEMENTS	Sulfur	S	(5)		Occasionally seen as minute yellow crystals in weathered shale, with sulfates derived from oxidation of sulfides and with subsequent reduction by organic matter.
SULFIDES	Marcasite	FeS_2	(6)		Rarely found in weathered shale.

	Pyrite	FeS_2	(3)	Pabst, 1970	Nodular masses or small crystals, often with unusual habit simulating twinning.
	Pyrrhotite	$Fe_{1-x}S$	(3)		Bladed crystals
	Wurtzite	ZnS	(5)		Red to brown hemimorphic hexagonal crystals.
HALIDES	Cryolite	Na_3AlF_6	(5)		Thin beds or lenses in Colorado.
	Fluorite	CaF_2	(5)		
	Halite	NaCl	(4)	Deardorff, 1963	In deeper parts of the Formation.
	NEIGHBORITE**	$NaMgF_3$	(5)	Chao *et al.*, 1961	First found in Utah, later in Wyoming; also in metamorphosed tuff and clayey carbonate sediments in the U.S.S.R. (Efimov *et al.*, 1967).
OXIDES	Quartz	SiO_2	(1)		Ubiquitous. Crystallizes as minute stubby prisms with equally developed rhombohedra, free from visible inclusions
	Chalcedony	SiO_2	(1)		Ubiquitous. Forms thick cherty beds locally.
	Anatase	TiO_2	(5)	Bradley and Eugster 1969	Reported in Wyoming as tiny inclusions in potash feldspar in dolomite and marlstone; also occurs in Wyoming and Utah in tuff beds. J. Ward Smith (1971, personal comm.) notes that the Mahogany zone in Colorado contains 0.01 to 0.015 percent TiO_2 and the Wyoming oil shales, even more.
HYDROXIDE	Nordstrandite	$Al(OH)_3$	(6)	Milton *et al.*, 1975 (general account)	In Colorado, as minute crystals in veinlets in marlstone traversing bedding. "Excess alumina" higher than accountable by dawsonite and analcine, etc. Smith and Young, 1969), may indicate sub-

*Explanation of numbers used Table 1 to denote frequency and abundance.

(1) Ubiquitous and abundant
(2) Widespread and abundant locally
(3) Widespread but nowhere abundant
(4) Few known localities, but locally abundant
(5) Few known localities, nowhere abundant
(6) Single known locality, and there very scarce

**Species names in capital letters were first discovered in the Green River formation.

					microscopic nordstrandite.
CARBONATES	Nahcolite	$NaHCO_3$	(2)	Ertl,1947	Abundant in Colorado and Utah, but not in Wyoming
	Trona	$Na_3(CO_3)(HCO_3)\cdot 2H_2O$	(2)	Smith and Young, 1969 (evaluation in oil shale)	Major economic soda-ash source
	WEGSCHEIDERITE	$Na_5(CO_3)(HCO_3)_3$	(4)	Fahey and Yorks, 1963	Associated with trona and halite in Wyoming, Colorado, and Utah.
	Natron	$Na_2Co_3\cdot 10H_2O$	(5)		
	Calcite	$CaCO_3$	(1)		
	Magnesite	$MgCO_3$	(6)		Bedded in Utah.
	Strontianite	$SrCO_3$	(6)		
	Witherite	$BaCO_3$	(5)		
	Siderite	$FeCO_3$	(5)		
	Aragonite	$CaCO_3$	(4)		Thin beds; locally in Colorado and Wyoming.
	Dolomite	$CaMg(CO_3)_2$	(1)		Massive beds, also clear cuboid crystals.
	Dawsonite	$NaAlCO_3(OH)_2$	(2)	Smith and Milton, 1966 (general account); Estep and Karr, 1968 (infrared spectroscopy); Smith and Young, 1969 (evaluation in oil shale); Zen and Hammarstrom, 1975 (evaluation by X-ray)	
	FITELITE	$Na_2Mg(CO_3)_2$	(4)	Pabst, 1973	Abundant locally in Utah.
	SHORTITE	$Na_2Ca_2(CO_3)_3$	(1)	Watkinson and Chao, 1973 (occurrence in kimberlite in Canada)	Ubiquitous, but unknown elsewhere until found in Canada.
	Pirssonite	$Na_2Ca(CO_3)_2\cdot 2H_2O$	(3)		
	Gaylussite	$Na_2Ca(CO_3)_2\cdot 5H_2O$	(3)		
	Barytocalcite	$BaCa(CO_3)_2$	(4)		
	NORSETHITE	$BaMg(CO_3)_2$	(4)	Mrose *et al.*, 1961	Later found in Sweden in braun-

					ite ore (Sundius and Blix, 1964); in calcite veins in pyroxenite in the U.S.S.R. (Kapustin, 1965); and in Namibia zinc-lead deposit.
SILICATES					
Clay Minerals					
	Kaolinite	$Al_2Si_2O_5(OH)_4$	(4)		In altered ash beds.
	Montmorillonite	hydrous Mg-Fe-Al silicate	(4)	Surdam and Parker, 1972	In altered ash beds.
	Trioctahedral Smectite	hydrous Mg-Fe-Al silicate	(4)	Dyni, 1973	
	Nontronite	hydrous Fe-Al silicate	(4)		
	Illite	muscovite-montmorillonite	(3)		Also detrital.
Magnesium silicates					
	LOUGHLINITE	$Na_2Mg_3Si_6O_{16}\cdot 8H_2O$	(4)	Fahey *et al.*, 1960	
	Sepiolite	$Mg_4Si_6O_{15}(OH)_2\cdot 6H_2O$	(4)	Bradley, 1929a; Bradley and Eugster, 1969	
	Stevensite	$Mg_3Si_4O_{10}(OH)_2$	(4)	Bradley and Fahey, 1962	
	Talc	$Mg_3Si_4O_{10}(OH)_2$	(4)	Bradley 1964b	
	Chlorite	hydrous Fe-Mg-Al silicate	(5)	Bradley 1964b	
Lazurite		$Na_4(NaS_3\cdot Al)Al_2(SiO_4)_3$	(6)	Bradley 1964b	
Micas	Hydrobiotite?	hydrous Na-Fe-Mg-Al silicate	(6)	Milton, unpub. data	
	Biotite?	hydrous Na-Fe-Mg-Al silicate		1975	
Feldspars					
	Orthoclase	$KAlSi_3O_8$	(2)	Desborough, 1975	Sub-microscopically crystalline, replacing glass in ash beds. Albite is similar, but also occurs as euhedral *roctourne* twinned crystals in dolomitic beds. These feldspars are the dominant silicates in the formation.
	Albite	$NaAlSi_3O_8$	(2)	Moore, 1950 Desborough, 1975	
	REEDMERGNERITE	$NaBSi_3O_8$	(4)	Milton *et al.*, 1960; Clark and Appleman, 1960; Dusmatov *et al.* 1967	Only known from Utah in the Green River Formation, but recently reported from the U.S.S.R. in an alkalic pegmatite associated with acmite and leu-

					cosphenite as in Utah.
Borosilicates					
	Searlesite	$NaBSi_2O_6 \cdot H_2O$	(3)	Fahey, 1950	
	GARRELSITE	$Ba_3NaSi_2B_7O_{16}(OH)_4$	(5)	Milton and Pabst, 1974 Morgan and Erd, 1969	Also known from Searles Lake, California.
	Leucosphenite	$BaNa_4Ti_2B_2Si_{10}O_{30}$	(5)	Pabst and Milton, 1972	
Titanosilicates					
	Labuntsovite	$(K,Ba,Na)(Ti,Nb)(Si,Al)_2(O,OH)_7 \cdot H_2O$	(5)	Milton *et al.*, 1958; Mrose, unpub. data, 1975	
	Vinogradovite	$(Na,Ca,K)_4Ti_4AlSi6O_{23}(OH) \cdot 2H_2O$	(6)	Mrose, unpub. data, 1975	
Pyroxene					
	Acmite	$NaFeSi_2O_6$	(3)	Clark *et al.*, 1969	
Amphibole					
	Magnesioarfvedsonite	$(Na,Ca)_3(Mg,Fe,Al)_5$ $(Si,Al)_8O_{22}(OH,F)_2$	(5) (5)	Milton *et al.*, 1974; Milton and Eugster, 1959	Possibly other alkalic amphiboles may exist in the formation.
Zirconosilicates					
	Elpidite	$Na_2ZrSi_6O_{15} \cdot 3H_2O$	(6)		
	Catapleiite	$Na_2ZrSi_3O_9 \cdot 2H_2O$	(6)	Milton, unpub. data, 1977	
Zeolites					
	Analcime	$NaAlSi_2O_6 \cdot H_2O$	(2)	Hay, 1966; Iijima and Hay, 1968	Ubiquitous.
	Harmotome-wellsite	$(Ba,Ca,K_2)Al_2Si_6O_{10} \cdot 6H_2O$	(6)		Associated with barite in Colorado.
	Natrolite	$Na_2(Al_2Si_3)O_{10} \cdot 2H_2O$	(6)	Pabst, 1971	
	Clinoptilolite-mordenite	$(Na,K,Ca)_{2-3}Al_3(Al,Si)_2Si_{13}O_{36} \cdot 12H_2O$-$(Ca_1Na_2K_2)(Al_2Si_{10})O_{24} \cdot 7H_2O$	(4)	Goodwin and Surdam, 1967; Surdam and Parker, 1972	
	Apophyllite(?)	$KCa_4Si_8O_{20}(F,OH) \cdot 8H_2O$	(6)	Bradley, 1929a, 1931	Unconfirmed.
Sulfates					
	Barite	$BaSO_4$	(5)		In deep cores from Colorado, filling gashes and lining fissures. With burkeite also from Colorado, the only known primary sulfates from the Green River Formation
	Celestite	$SrSO_4$	(6)		This and those following are all

					secondary minerals formed by weathering processes.
	Siderotil	$FeSO_4 \cdot 5H_2O$	(6)		
	or Rozenite	$FeSO_4 \cdot 4H_2O$			
	Gypsum	$CaSO_4 \cdot 2H_2O$	(5)		
	Szomolnokite	$FeSO_4 \cdot H_2O$	(5)	Brobst and Tucker, 1973	
	Starkeyite	$MgSO_4 \cdot 4H_2O$	(5)	Brobst and Tucker, 1973	
	Bloedite	$Na_2Mg(SO_4) \cdot 4H_2O$	(5)	Brobst and Tucker, 1973	
	(also, Burkeite and Tychite)				(See carbonates, compound with other anions).
Phosphates					
	Fluorapatite	$Ca_{10}(PO_4)_6F_2$	(4)	Love, 1964	In extensive beds in Wyoming, where it is massive and uraniferous. Also in Wyoming, trona, crystallized.
	Collophanite	$Ca_{10}(PO_4)_6CO_3 \cdot H_2O$	(4)		In fish teeth and other fossils.
Hydrocarbons					
	Gilsonite			Crawford, 1957 Davis, 1957	Extensive vertical seams in Utah. Mined as industrial mineral, also for conversion to fuel.
	Uintahite, Utahite,			Hunt *et al.*, 1954	
	Tabbyite, Ozokerite			(discussion of origin Green River hydrocarbons)	
	Ingramite, Albertite			Merrow, 1957 (ozokerite)	
	Kerogen			Milton *et al.*, 1974	
	ABELSONITE	$C_{31}H_{36}N_4Ni$	(5)	Pabst *et al.*, 1975 Unpublished data, 1977	

Selected References

BRADLEY, W.H. (1929a) The occurrence and origin of analcite and meerschaum beds in the Green River formation of Utah, Colorado, and Wyoming: *U.S. Geol. Surv. Prof. Paper 158-A*, 1-8.

______________(1929b) The varves and climate of the Green River epoch: *U.S. Geol. Surv. Prof. Paper 158-E*, 87-110.

______________(1931) Origin and microfossils of the oil shale of the Green River formation of Colorado and Utah: *U.S. Geol. Surv. Prof. Paper 168*, 1-58.

______________(1936) The biography of an ancient American lake: *Scientific Monthly*, 42, 421-430.

______________(1948) Limnology and the Eocene lakes of the Rocky Mountain Region: *Geol. Soc. Amer. Bull.* 57, 635-648.

______________(1964a) Geology of Green River Formation and associated Eocene rocks in southwestern Wyoming and adjacent parts of Colorado and Utah, *U.S. Geol. Surv. Prof.*

Paper 496-A, 86 p.

______________(1964b) Lazurite, talc, and chlorite in the Green River Formation of Wyoming: *Amer. Mineral.* 49, 778-781.

______________and EUGSTER, H.P. (1969) Geochemistry and paleolimnology of the trona deposits and associated authigenic minerals of the Green River Formation of Wyoming: *U.S. Geol. Surv. Prof. Paper 496-B*, 71 p.

______________and FAHEY, JOSEPH J. (1962) Occurrence of stevensite in the Green River Formation of Wyoming: *Amer. Mineral.* 47, 996-998.

BROBST, D.A., and TUCKER, J.D. (1973) X-ray mineralogy of the Parachute Creek Member, Green River Formation, in the Northern Piceance Creek Basin, Colorado. *U.S. Geol. Surv. Prof. Paper 803*, 1-53.

CHAO, E.C.T., EVANS, H.T. Jr., SKINNER, B.J. and MILTON, C. (1961) Neighborite, $NaMgF_3$, A new mineral from the Green River Formation in Utah: *Amer. Mineral.* 46, 379-393.

CLARK, J.R., and APPLEMAN, D.E. (1960) Crystal structure refinement of reedmergnerite the boron analog of albite: *Science*, 132 (1442), 1837-1831.

__________, ______________and PAPIKE, J.J. (1969) Pyroxenes and amphiboles crystal chemistry and phase petrology - Crystal-Chemical characterization of clinopyroxenes based on eight new structure refinements: Special Paper No. 2, *Mineral. Soc. Amer.*, 31-50.

CRAWFORD, A.L. (1957) Gilsonite, its discovery and early history in the industry: Intermountain Assoc. Petrol. Geologists, Guidebook to the Uinta Basin, 8th Annual Field Conference, 149-151.

DAVIS, L.J. (1957) The Geology of gilsonite: Intermountain Assoc. Petroleum Geologists Guidebook to the Uinta Basin, 8th Annual Field Conference, 152-156.

DEARDORFF, D.L. (1963) Eocene salt in the Green River Basin, Wyoming: 176-195. Symposium on Salt, Northern Ohio Geol. Soc., editor A.C. Bersticker, Cleveland, Ohio.

DESBOROUGH, G.A. (1975) Authigenic albite and potassium feldspar in the Green River Formation, Colorado and Wyoming. *Amer. Mineral.* 60, 235-239.

DONNAY G. and DONNAY, J.D.H. (1971) Ewaldite, a new barium calcium carbonate, I, *Tschermak's Min. Petrog. Mitteil.* Series III 15, 185-200.

__________and PRESTON, H. (1971) Ewaldite, a new barium calcium carbonate, II, *Tschermak's Min. Petrog. Mitteil.* Series III 15, 201-212.

DUSMATOV, V.D., POPOVA, N.A. and KABANOVA, L.K. (1967) First discovery of reedmergnerite in the U.S.S.R.: *Doklady Akad. Nauk Tadzhik USSR* 10, 51-53 (in Russian).

DYNI, J.R. (1973) Trioctahedral smectite in the Green River Formation, Duchesne County, Utah: *U.S. Geol. Surv. Open-File Report*, 25 p.

EFIMOV, A.F., ESKOVA, E.M. and KATAEVA, S.T. (1967) On the first discovery of neighborite in the U.S.S.R.: *Doklady Akademia Nauk USSR*, 174, no. 5, 1182-1184 (in Russian).

ERTL, T. (1947) Sodium bicarbonate (nahcolite) from Colorado oil shale: *Amer. Mineral.* 32, 117-120.

ESTEP, P.A. and KARR, C. Jr. (1968) The infrared spectra of dawsonite: *Amer. Mineral.* 53, 305-309.

EUGSTER, H.P. and McIVER, N.C. (1959) Boron analogues of alkali feldspars and related silicates (abs.): *Geol. Soc. Amer. Bull.* 70, 1958.

______________and SURDAM, R.C. (1973) Depositional environment of the Green River Formation of Wyoming: a preliminary report: *Geol. Soc. Amer. Bull.* 84, 1115-1120.

__________, __________(1974) Depositional environment of the Green River Formation of Wyoming, Reply: *Geol. Soc. Amer. Bull.* 85, 1192.

FAHEY, J.J. (1941) Bradleyite, a new mineral, sodium phosphate-magnesium carbonate, with X-ray analysis by George Tunell: *Amer. Mineral.* 26, 646-650.

__________, ROSS, M. and AXELROD, J.M. (1960) Loughlinite, a new hydrous sodium magnesium silicate: *Amer. Mineral.* 45, 270-281.

__________(1950) Searlesite from the Green River formation of Wyoming (with X-ray notes by Joseph M. Axelrod): *Amer. Mineral.* 35, 1014-1020.

__________(1962) Saline minerals of the Green River formation. With a section on X-ray powder data for saline minerals of the Green River formation by Mary E. Mrose: *U.S. Geol. Surv. Prof. Paper* 405; 50 pages.

__________and YORKS, K.P. (1963) Wegscheiderite ($Na_2CO_3 \cdot 3NaHCO_3$). A new saline mineral from the Green River Formation, Wyoming: *Amer. Mineral.* 48, 400-403.

GOODWIN, J.H. and SURDAM, R.G. (1967) Zeolitization of tuffaceous rocks of the Green River Formation, Wyoming: *Science*, 157 (1957) 307-308.

HAY, R.L. (1966) Zeolites and zeolitic reactions in sedimentary rocks: *Geol. Soc. Amer. Spec. Paper 85*, 130 p.

HEINRICH, E.W. (1966) Geology of carbonatites, pp. 126-128. Rand McNally and Co., Chicago.

HUNT, J.M., STEWART, F., and DICKEY, P.A. (1954) Origin of hydrocarbons of Uinta Basin, Utah: *Bull. Amer. Assoc. Petrol. Geol.* 38, 1671-1698.

IIJIMA, A. and HAY, R.L. (1968) Analcime composition in tuffs of the Green River Formation of Wyoming: *Amer. Mineral.* 53, 184-200.

KAPUSTIN, Y.L., (1965) Norsethite-first discovery in U.S.S.R.: *Doklady Akad. Nauk USSR* 161, 922-924. *Chem. Abs.* 63, 352 (1965).

LOVE, J.D., (1964) Uraniferous phosphate lake beds of Eocene age in intermountain basins of Wyoming and Utah: *U.S. Geol. Surv. Prof. Paper 474-E*, 66 p.

LUNDELL, L.L. and SURDAM, R.C. (1975) Playa-lake deposition: Green River Formation, Piceance Creek Basin, Colrado: *Geology*, 3, 493-497.

MERROW, J. (1957) Ozokerite at Soldier Summit, Utah: Intermountain Assoc. Petrol. Geologists, Guidebook to the Uinta Basin, 8th Annual Field Conference, 161-163.

MILTON, C. (1957) Authigenic minerals of the Green River formation of the Uinta Basin, Utah: Intermountain Assoc. Petrol. Geologists, Guidebook to the Uinta Basin, 8th Field Conference, 136-143.

__________(1971) Authigenic minerals of the Green River Formation *in Contributions to Geology* - Trona Issue, University of Wyoming, 10, 57-63.

__________, CHAO, E.C.T., FAHEY, J.J., and MROSE, M.E. (1960) Silicate mineralogy of the Green River Formation of Wyoming, Utah, and Colorado: International Geological Congress, XXI Session, Norden, Part XXI, 171-184.

__________, __________, AXELROD, J.M., and GRIMALDI, F.S. (1960) Reedmergnerite, $NaBSi_3O_8$, the boron analogue of albite, from the Green River formation, Utah: *Amer. Mineral.* 45, 188-199.

__________, DWORNIK, E.J., and FINKELMAN, R.B. (1975)

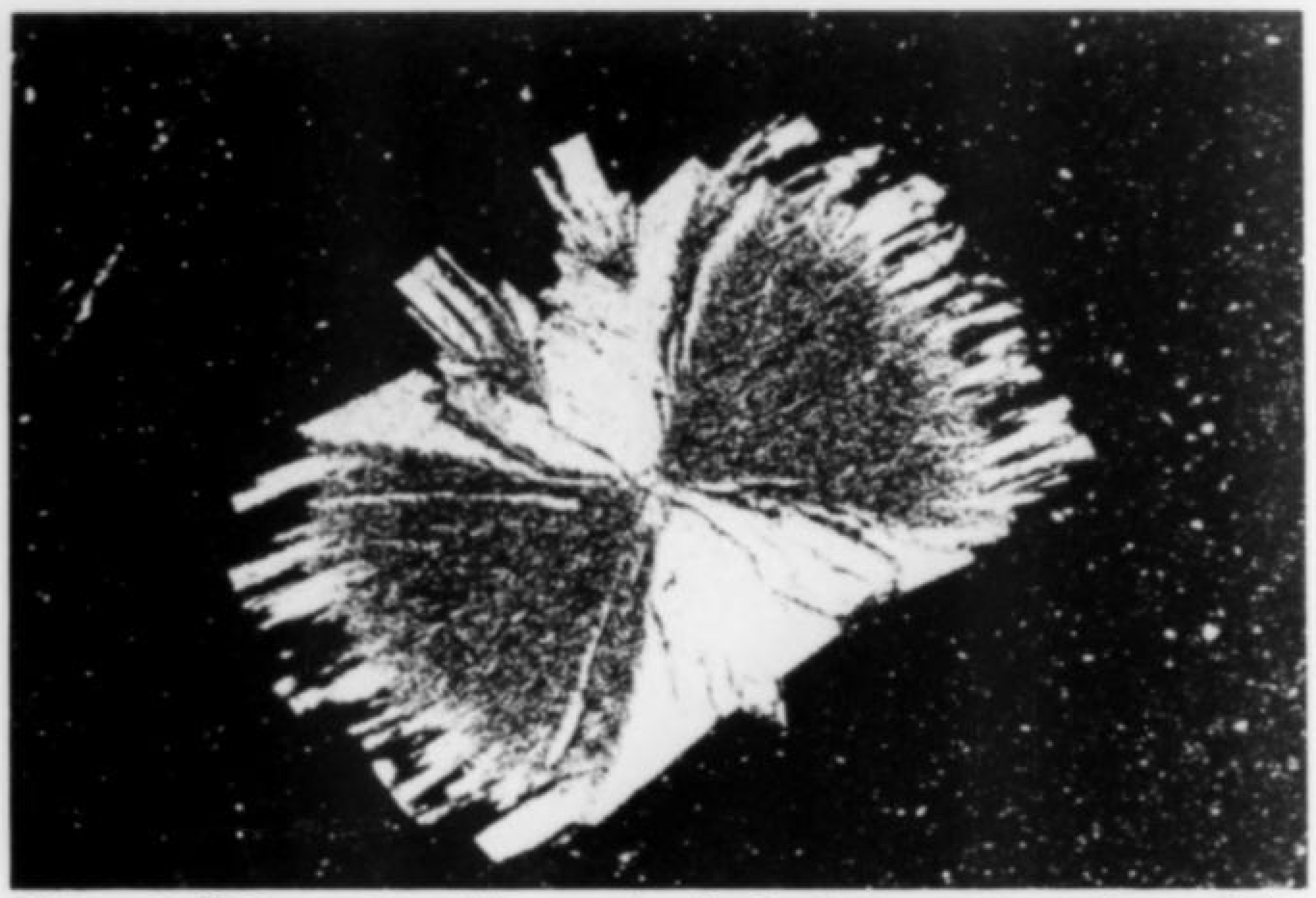


***Figure 6.* Thin section of leucosphenite in shale matrix ordinary light x 15 Elmer Moon #1 3371-2 Uintah County, Utah.**

However, the authigenic, not igneous, origin of leucosphenite in the Green River formation was established by these photomicrographs. The delicate feathery outgrowths showed no abrasion whatever, and such structures could never have survived aqueous transport.

Later many other minerals, till then only known in igneous paragenesis (alkalic syenites, igneous dikes, pegmatites) were found in the Green River formation, all of "cold-water" origin—not over 250°C.

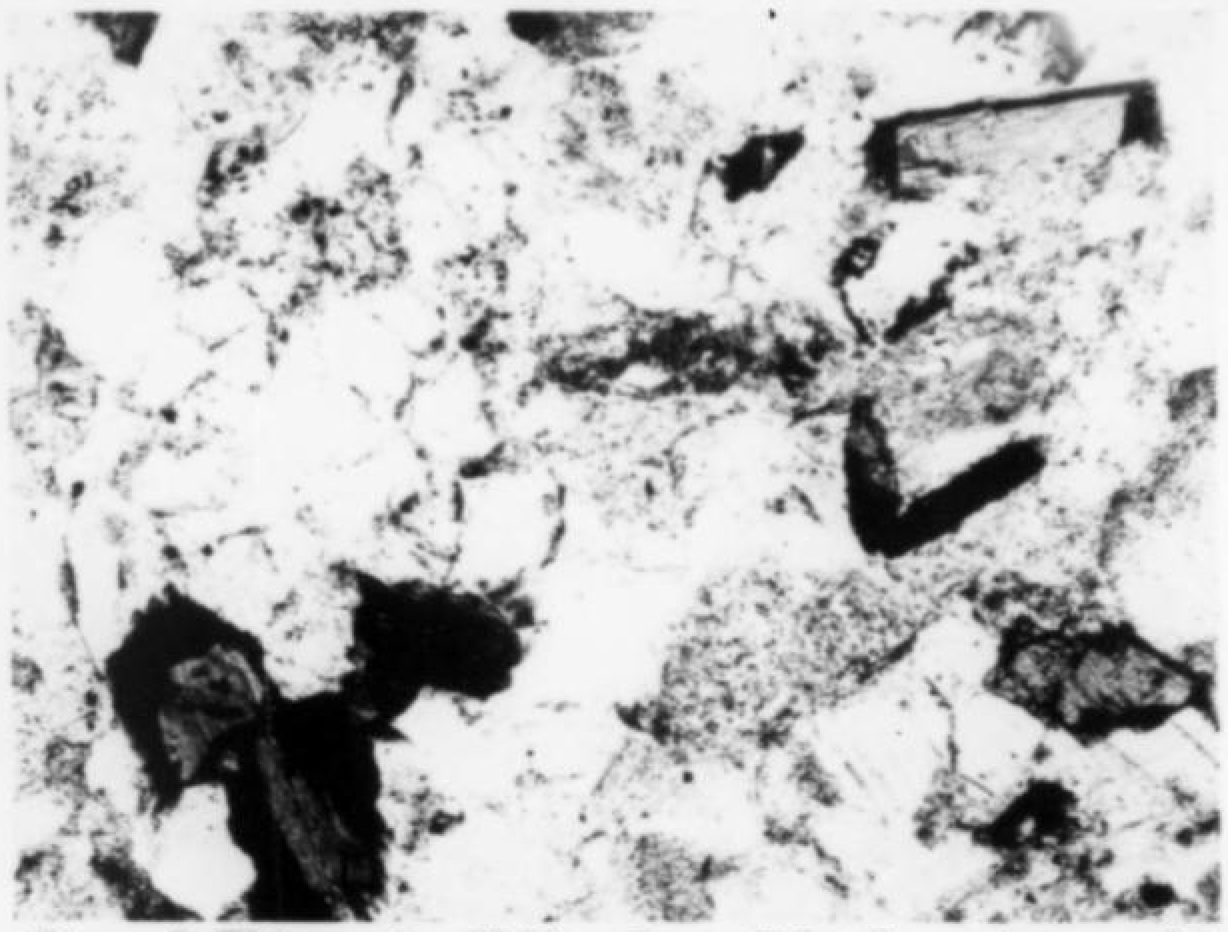


***Figure 7.* Thin section X 50 ordinary light. Secondary amphibole in sandstone of the Green River formation (Indian Canyon, Utah). Detrital, brown hornblende is mantled with deep-blue sodic amphibole, formed *after* deposition of the sandstone in the Green River Lake. The rounded contours of the water-worn brown hornblende prove sedimentary transport from its original igneous source, whereas the delicate feathery terminations of the new blue amphibole show that the composite crystal has not moved since formation of the new growth—i.e. it is authigenic, as is the leucosphenite found elsewhere in the formation.**

Such deep-blue sodic amphiboles are characteristic of alkalic igneous rocks.

Nordstrandite, $Al(OH)_3$, from the Green River Formation in Rio Blanco County, Colorado: *Amer. Mineral.* 60, 285-291.

——————and EUGSTER, H.P. (1959) Mineral assemblages of the Green River formation: *In* Researches in Geochemistry, P.H. Abelson, Ed. 118-150, New York, N.Y.

——————, and FAHEY, J.J. (1960a) Classification and association of the carbonate minerals of the Green River Formation: *Am. Journ. Sci.*, Bradley Volume 258-A, 242-246.

——————, ——————(1960b) Green River mineralogy—a historical account: *in* Wyoming Geol. Assoc. Guidebook, 15th Ann. Field Conf., 1960, 159-162.

——————, INGRAM, B. and BREGER, I. (1974) Authigenic magnesioarfvedsonite from the Green River Formation, Duchesne County, Utah: *Amer. Mineral.* 59, 830-836.

——————, ——————, CLARK, J.R. and DWORNIK, E.J. (1965) Mckelveyite, a new hydrous sodium barium rare-earth uranium carbonate, from the Green River Formation in Wyoming: *Amer. Mineral.* 50, 593-612.

——————and MEYROWITZ, R.L. (1964) Ferroan northupite $Na_2CO_3{\cdot}(Mg,Fe)CO_3{\cdot}NaCl$ in the Green River formation of Wyoming (abs.): *Geol. Soc. Amer. Bull.* 69, 1614-1615.

——————, MROSE, M., FAHEY, J.J., and CHAO, E.C.T. (1958) Labuntsovite from the Trona Mine, Sweetwater County, Wyoming (abst.): *Geol. Soc. Amer. Bull.* 69, 1614-1615.

——————and PABST, A. (1974) Garrelsite $NaBa_3Si_2B_7O_{16}(OH)_4$ from the Green River Formation of Utah: *U.S. Geol. Survey Jour. Research* 2, 213-218.

MOORE, F.E. (1950) Authigenic albite in the Green River Oil Shales: *Jour. Sed. Pet.* 20. 227-230.

MORGAN, V. and ERD, R.C. (1969) Minerals of the Kramer borate district, California, Pt. 1: *California Div. Mines and Geology Mineral Inf. Service*, 22, no. 9, 143-153; no. 10, 165-172.

MROSE, M.E., CHAO, E.C.T., FAHEY, J.J., and MILTON, C. (1961) Norsethite, $BaMg(CO_3)_2$, A new mineral from the Green River Formation, Wyoming: *Amer. Mineral.* 46, 420-429.

PABST, A. (1970) Pyrite of unusual habit simulating twinning from the Green River Formation of Wyoming: *Amer. Mineral.* 56, 133-145.

——————(1971) Natrolite from the Green River Formation of Colorado: *Amer. Mineral.* 56, 560-569.

——————, ESTEP-BARNES, P.A., DWORNIK, E.J., FINKELMAN, R.A., and MILTON, C. (1976) unpublished data: Abelsonite, nickel porphyrin, $C_{31}H_{36}N_4Ni$ from the Green River Formation, Uintah County, Utah.

——————and MILTON, C. (1972) Leucosphenite and its occurrence in the Green River Formation of Utah and Wyoming: *Amer. Mineral.* 57, 1801-1822.

SMITH, J.W. and MILTON, C. (1966) Dawsonite in the Green River Formation of Colorado: *Econ. Geol.* 61, 1029-1042.

——————and YOUNG, N.B. (1969) Determination of dawsonite and nahcolite in Green River Formation oil shale: Report of Investigations 7286, Bureau of Mines, U.S. Department of the Interior, 20 pages.

SOZANSKY, V.I. (1974) Depositional environment of the Green River Formation of Wyoming, Discussion: *Geol. Soc. Amer. Bull.* 85, 1191.

STEYN, J.G.D., and WATSON, M.D. (1967) new occurrence of norsethite, $BaMg(CO_3)_2$: *Amer. Mineral.* 52, 1770-1775.

SUNDIUS, N. and BLIX, R. (1964) Norsethite from Langban: *Arkiv for Mineralogi och Geologi Bd.* 4, No. 4, 277-278.

SURDAM, R.C., and PARKER, R.B. (1972) Authigenic aluminosilicate minerals in the tuffaceous rocks of the Green River Formation, Wyoming: *Geol. Soc. Amer. Bull.* 83, 689-700.

Figure 8. **The strongly alkaline (Na-rich) waters of the Green River Lake, or the muds deposited and later altered by diagenetic processes, caused detrital minerals of remote igneous origin, such as the (brown) hornblende crystals shown in Figure 7, to grow again in the new sedimentary environment, with secondary rims of dark-blue sodic amphibole.**

Nevertheless, the fossilized insect shown here is perfectly preserved, having remained unchanged while such "igneous" minerals as acmite (pyroxene), sodic hornblende (amphibole), feldspars, titano- and boro silicates crystallized in these rocks.

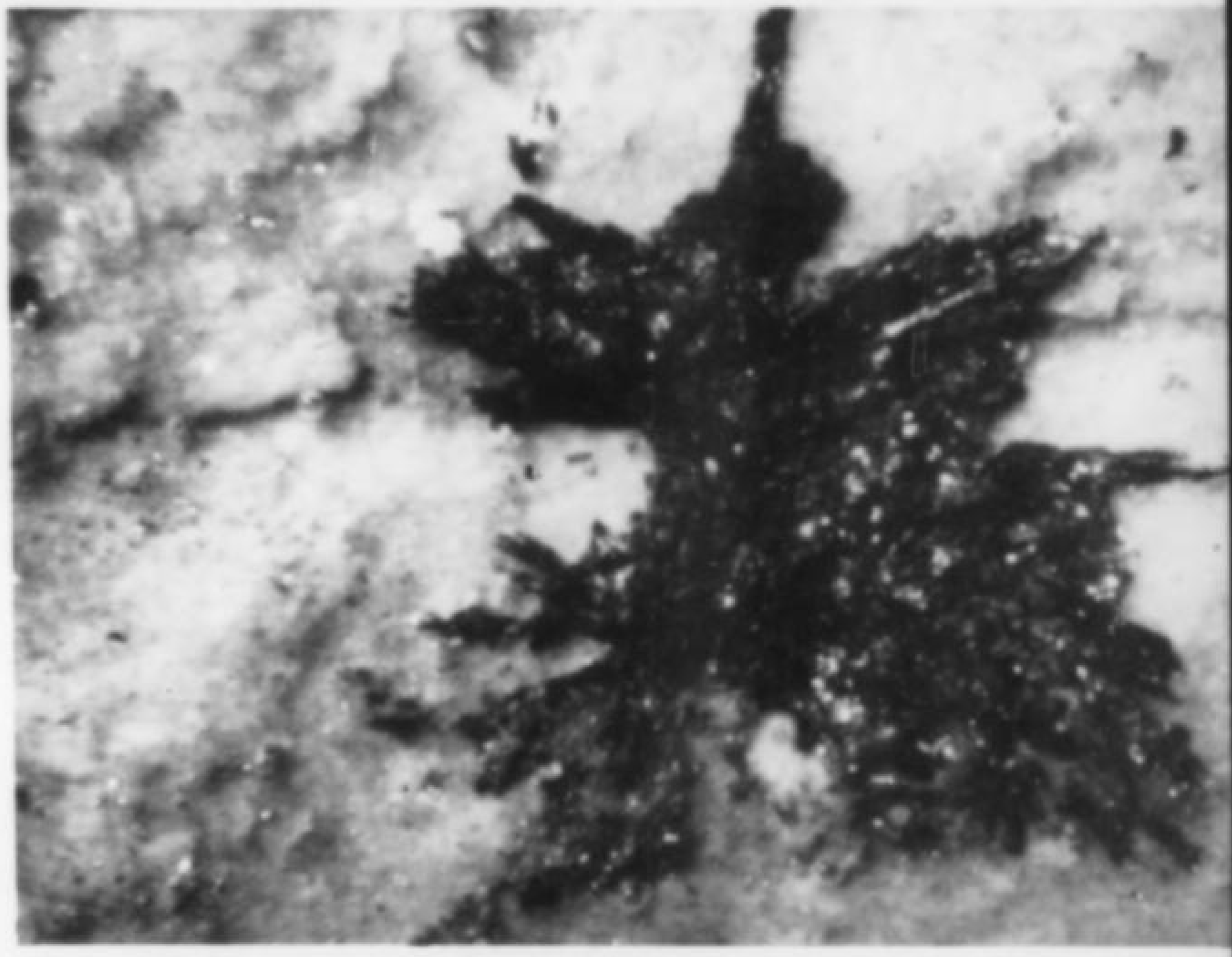


Figure 9. **Crystals of abelsonite, nickel porphyrin, in shale of the Green River formation ERDA/LERC No. feet. Uintah County, Utah.**

This is the first nickel mineral discovered in the Green River formation, and the first porphyrin ever to be found crystallized as a mineral. The biological red (hemoglobin) or green (chlorophyll) cell pigment, a complex carbon-hydrogen-nitrogen structure, has survived unchanged, as a fossil, for 40 million years.

____________ and WOLFBAUER, C.A. (1975) The Green River Formation - A playa-lake complex: *Geol. Soc. Amer. Bull.* 86, 335-345.

WATKINSON, D.H., and CHAO, G.Y. (1973) Shortite in kimberlite from the Upper Canada Gold mine, Ontario: *Jour. Geology* 81, 229-233.

ZEN, E. and HAMMERSTROM, J.G. (1975) Quantitative determination of dawsonite in Green River Shale by powder-sample X-ray diffraction: Effect of Grinding: *U.S. Geol. Survey Jour. Research* 3, 21-30.

Policy Statement for Collecting at the Prince of Wales Island Epidote Localities

As leasees of the Copper, Jumbo and Green Monster Mountain epidote claims, we have established a policy which is designed to prohibit both large scale and irresponsible collecting by other individuals and organizations. We foresee the necessity to protect the localities and our interests therein which are contracted with the owner, Eskil Anderson.

The policy is outlined as follows:

—A time limit for collecting and/or occupancy of seven days per season will be enforced.

—Collecting fee of $500 per season per individual, payable to the leasees in advance, or $100 per individual for a maximum collection and/or visitation period of two days will be charged.

—Blasting or use of motorized equipment for collecting is not permitted.

—Ten percent of all specimens collected by each individual will be consigned at the locality for the owner, Eskil Anderson.

—The owner and leasees are not responsible for the presence, logistical concerns and personal liabilities of visitors and collectors. All visitors and collectors will sign and honor a release to this effect.

—The leasees will reserve the right to direct collectors away from areas undergoing or soon to undergo development work.

—All collectors must expect to function independently of the leasees and their facilities. The leasees will be carefully working both groups of claims for the duration of the collecting season.

—Camps and premises will be clean and free of garbage upon departure of visiting collectors.

We regret the severity of the stipulations to collecting on these famous localities. However, we realize the need to preserve both localities for the sake of our livelihoods, and for the benefit of future collectors who may wish to pit their skill and endurance against the challenges of Prince of Wales Island.

Doug Toland
510 Kennedy Street
Juneau, Alaska 99801

Clayton Rasmussen
7933 Jewel Lake Road
Anchorage, Alaska 99502 ⊠

BUY IN
NEW YORK CITY

galatea
GEMS & MINERALS INC.

The Dawson Collection
for the discriminating collector

•

Direct Purchase from Brazil
Minos Garais, Goias, R.G. do Sul.

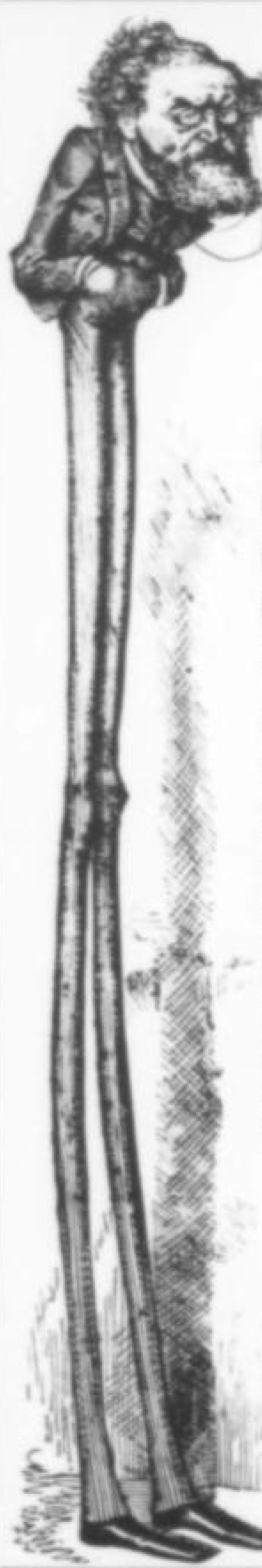
•

We offer choice mineral specimens from PALA VALLEY, CALIFORNIA • MINAS GERAIS, BRAZIL • CLASSIC EUROPEAN and OTHER WORLD-WIDE LOCALITIES.

The Galatea stock includes many clear gem crystals in Tourmalines, Aquamarine, other Beryls, precious Imperial Topaz, Kunzite, etc. Deep purple large Amethyst geodes, perfect top quality, suitable for decorative use also available

CALL FOR APPOINTMENT (212) 682-2700

galatea GEMS & MINERALS INC.
342 MADISON AVE. • 21st FLOOR • NEW YORK CITY 10017



Even mineralogists of great stature subscribe to the Record!

Collection
A. Giazotto

Request fine Amazonite with Smoky Quartz cabinet size groups.
very fine Pyrite groups and a few outstanding Demantoid groups for sale or exchange.

Write to A. Giazotto
Lungarno
Gambacorti, 39
Pisa,
Italy

TOM DAUGHERTY
1021 LAWTON ROAD
COVINGTON, KY. 41011

GEMS · MINERALS

IMPORT • EXPORT
WHOLESALE • RETAIL
SHOWS • MAIL ORDER

PHONE (606) 291-4427

Genuine Old Mining Stock
certificates from classic mining areas
perfect for framing
[$1.50 to $17.50]

send for current price list

We specialize in old mining memorabilia send us your want-list ~ periodic listings of fine mineral specimens also available ~ see me at the Desert Inn during the Tucson Show

Minerals International
don olson
304 w. clovernook lane glendale.wisconsin 53217

RUSTAM KOTHAVALA'S
CRYSTALS OF INDIA

featuring exquisite mineral specimens personally selected at the source on the Indian subcontinent.

- *the finest selection of green Apophyllite*
- *exceptional Mesolite sunbursts*
- *extremely rare crystals of Powellite with zeolites*
- *shiny crystals of Babingtonite*
- *slices of pleochroic Amethyst*
- *Heulandite, Calcite, Scolecite, Corundum, Zircon, Tourmaline, Stilbite, Mordenite, Gyrolite, Prehnite, Laumontite, Epidote*

*From **Russia**, rare specimens of Datolite, Ilvaite, Topaz.*

*In **Detroit** meet us at the **Hazel Park Holiday Inn**, Room 211, at 9 mile road and I-75, October 13-15, 1977.*

Mail: **1034 Carleton St., Berkeley, Calif. 94710**
Telephone: **415-236-9264 or 415-841-4492**
By appointment. Please write or call any day
10 am to 8 pm, but remember we're sometimes out
on the road for weeks or months at a time.
Sorry, no mail-order business

Axinite, hydromagnesite, amethyst

and other minerals from near Vitória da Conquista (Brazil)

Jacques P. & Jeannine O. Cassedanne Federal University of Rio de Janeiro & National Research Council (C.N.Pq.).

THE Vitória da Conquista area, in Southern Bahia, is not as famous as the Rio Doce or Jequitinhonha valleys in nearby Minas Gerais, but its geology is very similar and its deposits produce interesting or rare specimens for collectors. Described below are some of them.

INTRODUCTION

Vitória da Conquista is on the paved highway that joins Rio de Janeiro to Salvador (The "Rio-Bahia" highway). Access to Condeuba, the principal western regional center, is: from the North, by the unpaved road to Bom Jesus da Lapa, via Anagé (58 km) for the first 106 km, until Pé do Morro. There a municipal road forks to the left leading to Condeuba via Maetinga and Joanina. From the South, by the Rio-Bahia, to km 1065. From there a good unpaved road leads in 5 hours to Condeuba, via Belo Campo, Tremedal (56 km), Piripá (100 km) and Cordeiros. The highway Vitória-Ilheus crosses the eastern region. Other roads will be described with each occurrence.

The main roads are passable all the year round, but not after heavy rainfalls. The summer dirt changes to mud in winter. The best season to travel is July to October.

Conquista lies on a high plateau (*Planalto Baiano*) spreading toward the South at the elevation of about 1,000 metres and surrounded by gently undulating lowlands, where rise some little shredded mountains and inselbergs.

Caatinga, a dry, low, shrubby forest with cactus, is sparse in the North, thicker in the South and passes to *cerrado* (savannah) on the heights. Little villages are scattered about. The inhabitants are always hospitable.

The regional basement rock, Lower to Middle Precambrian in age, is mainly gneissic with mica schists and quartzites, amphibolitic lenses and granitic, pegmatitic and ultrabasic intrusions. It is overlain in disconformity by younger quartzites (Lençois formation of the Minas supergroup—Upper Precambrian), outcropping only in some areas (Montezuma, Jacaraci, Coruja). Sandy sediments occur in basement depressions.

AXINITE*

The occurrence lies in the *Fazenda* (farm) Baixa da Brauna, 4 km east of Santa Rosa (formerly Guajerú), to the WNW of Vitória da Conquista and SSW of Brumado. A good road, 34 km long, joins Condeuba to Santa Rosa. Afterwards, a bad 2 km track allows one to reach a flat valley by jeep. From there a footpath crossing pasture and high caatinga climbs up to the occurrence at the 820 m elevation, in a 45 minute walk.

The deposit, in a NNW-SSE trending mountain, is located in a 4 m wide sheared amphibolitic zone, striking N10°W, with a dip of 55°E. It is overlain by hard garnetiferous amphibolite and lies upon quartzite with spots of chlorite. The sheared zone shows a weathered rock of serpentine type, irregularly crossed by calcitic veins, with druses where the specimens are found. A short adit was driven along the fracture by *garimperos* (poor, independent miners), because amphibole was mistaken for tourmaline in the early days of the mining activity. Before being closed, after a brief period of activity, the property was mined for mineralogical samples only. Presently very good material may be found in the dumps: essentially axinite, hornblende and calcite, the paragenesis being very simple.

The axinite, present as parts of single crystals up to 10 cm, is more generally in flat aggregates grown on a hornblende matrix. It is also disseminated in a compact, cryptocrystalline white milky calcite ("chalcedony" of the garimperos). This carbonate must be dissolved by acid to liberate the silicates. During

---

*Ed. note: The term "axinite" is a group name, like the term "garnet." Recent analyses by Pete J. Dunn (pers. comm.) have shown axinite from this locality to be the species **ferroaxinite**, having Fe $>$ Mn.

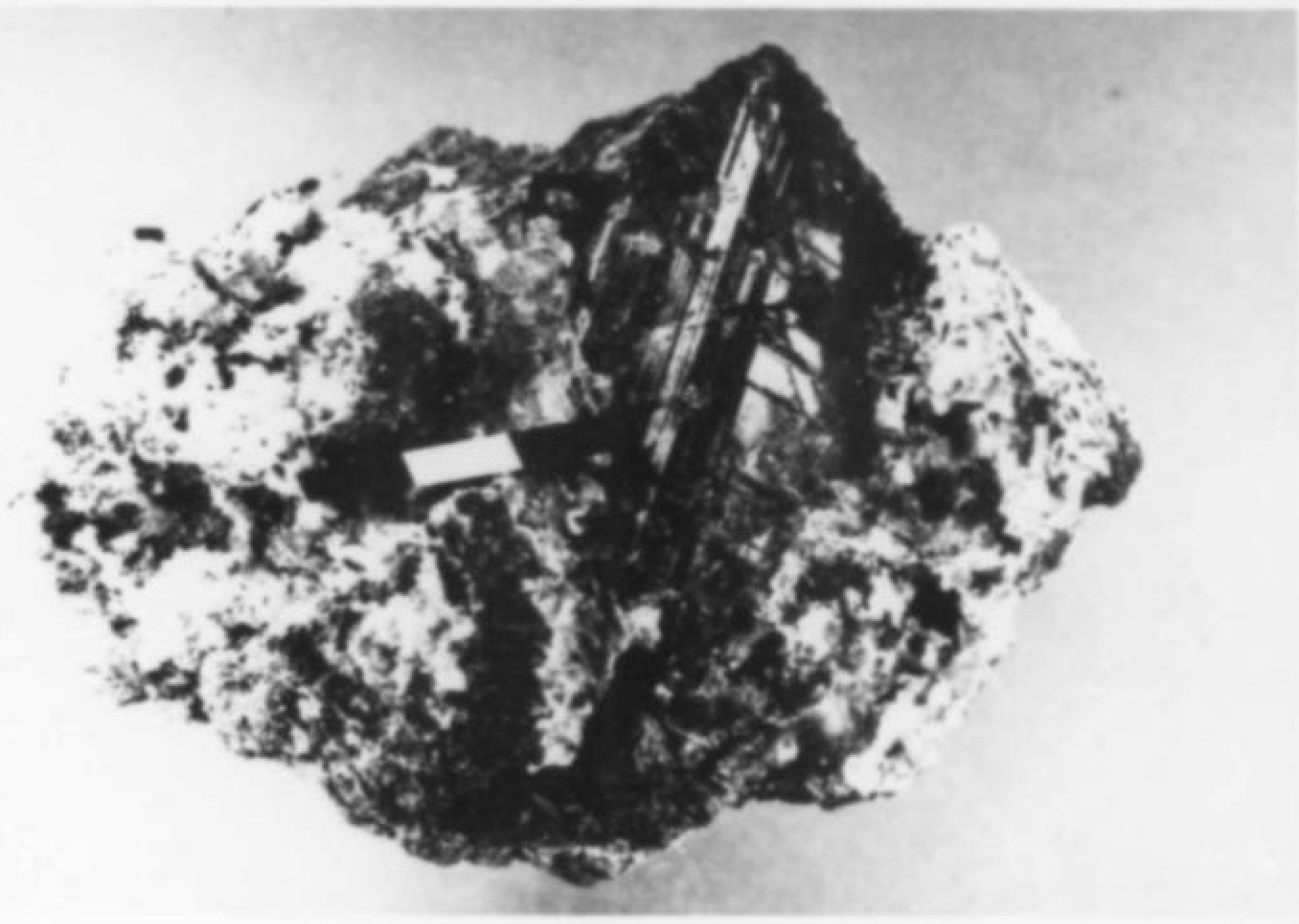


Figure 1. (right) **Part of a single axinite crystal on matrix. Baixa da Brauna.**

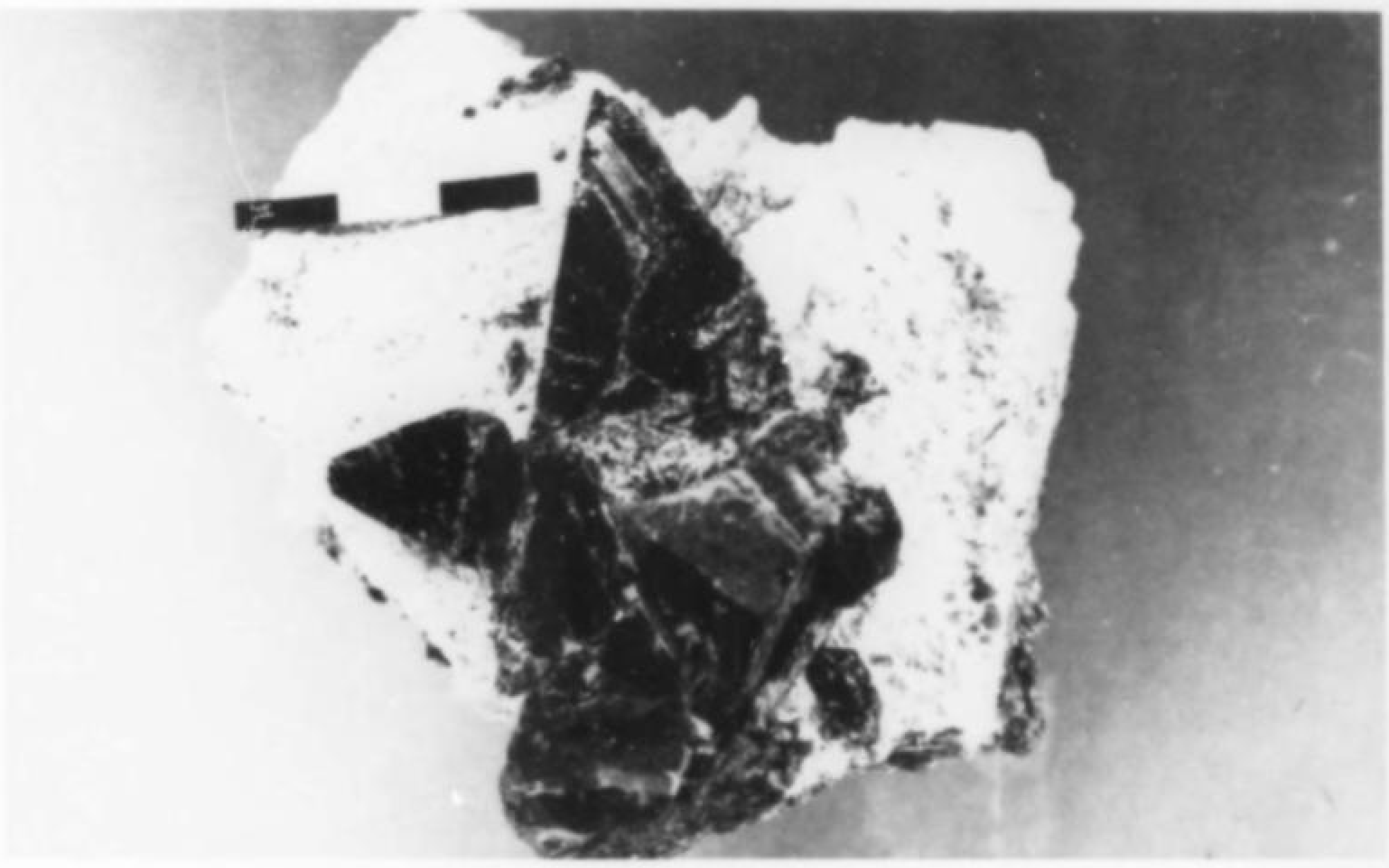


Figure 2. (below right) **Single axinite crystal upon matrix. Calcitic gangue partially removed by acid. Baixa da Brauna.**

this operation some bits of crystals, broken by tectonic stress and subsequently cemented by calcite, dissolve out. Very fine micromounts, sporadically of gem quality, may be recovered from the residual slime.

The color of the axinite is chestnut with a tinge of light purple. Physical properties are (J. P. & J. O. Cassedanne – in press):

Density: **3.26** ± 0.01
Hardness: **6.5**
Indices: n_{α} = **1.676** $n\beta$ = **1.684**
$n\gamma$ = **1.687** ± 0.001
Birefringence: **0.011**

Bibliographic compilation demonstrates that the Baixa da Brauna axinite deposit produces crystals that can compete with the best preserved in the great museums of the world (Cl. Guillemin – 1964 & 1972).

The hornblende is acicular or in short centimetric crystals well formed, sometimes broken, and cemented by calcite. This occurs either in large milky or translucent rhombohedra penetrated by hornblende but without axinite, or in saccharoidal masses with axinite and hornblende. Films and little groups of quartz crystals, hyalite opal, antigorite and dendrites may be also found.

José Moreira Sapulveda, from Santa Rosa, is a good guide to the deposit.

HYDROMAGNESITE

This mineral occurs in an abandoned mine called São Felix do Amianto, NW of Poções and near the base of the Baiano high plain. It is easily reached in 25 km by way of a good road that forks left at km 1139 of the Rio-Bahia highway.

Hydromagnesite is found in a large open pit, 500 m long and 30 m deep, where asbestos was worked in a cataclastic serpentinite. The excavation is today partially flooded.

The best collecting sites are in the northern part of the open pit, where the hydromagnesite appears as irregular veinlets, and in the South, in a small talc schist outcrop derived from a retromorphosed pyroxenite. Abundant antigorite veins cross the serpentine.

Hydromagnesite occurs as veinlets, without preferential direction, and as fibrous crystalline aggregates. Sporadically, in the druses, needles up to 30 mm, with a millimetric section, may be found. It is associated with white saccharoidal magnesite from which it seems to be derived.

Density: **2.20**
Hardness: **3.5**
Indices: n_{α} = **1.524** n = **1.528** $n\gamma$ = **1.547**
Biaxal positive

Other physical properties determined by X-ray, D.T.A. and T.G.A. are the same as those quoted in the literature for other occurrences (J. O. Cassedanne - 1967).

STAUROLITE

The deposit, known as Tapera do Rochedo, is near the head of the *Córrego* (Creek) Tamboril, about 12 km to the east of Cordeiros.

Access is either from Condeuba (45 minutes – 35 km) or from Conquista via Piripá (3 hours – 100 km) by way of the same road as far as 25 km beyond this last village. At this site a very sandy track forks to the left; it is jeepable for 3 km. The last 4 km must be covered on foot to the little settlement of Tapera Velha (elevation 930 m) with the Olavo (da Margarida) house. This farmer is an excellent guide. From Tapera to the occurrence is 45 minutes, going uphill. Be careful not to miss the way, because in the same vicinity is another Olavo (do José) house.

The deposit is a mica schist striking N100°E with a 30°S dip, outcropping more than 1 km in length and several tens of metres thick. The best collecting site is near elevation 1050 along small cliffs.

The staurolite crystals, up to 10 cm in length and 1 cm in section, are single, in irregular aggregates or in rare clusters. Differential erosion reveals them upon the schistose matrix while, on the contrary, it is quite impossible to extract them from the massive rock.

The crystals always remain on the matrix, as opposed to those of the Fazenda Gramiais (Minas Gerais), always more perfect and beautiful, which were previously described in the *Mineralogical Record* (J. P. & J. O. Cassedanne, 1974). Flat samples of several square decimetres are easy to obtain because of the good cleavage. A limonite film coats some specimens. Rounded or faceted millimetric almandine crystals are abundant in lenses, irregularly scattered both in the schist and in the staurolite.

Microscopic and X-ray studies show, in fact, that the Tapera crystals are pseudomorphs of the original staurolite, essentially

Figure 3. (left) **Hydromagnesite vein cutting cataclastic serpentine. São Felix do Amianto open pit.**

Figure 4. (below) **Hydromagnesite needles in veinlet. São Felix do Amianto.**

by quartz and sericite, identical to the main constituents of the host rock.

BERYL, var. **EMERALD**

There are some little occurrences near Vitória da Conquista, in Anagé township. The main ones are described below.

Açude Socêgo (=Nôzinho)

This occurrence lies NW of Vitória da Conquista and ESE of Brumado. Access is by way of the good unpaved road to Bom Jesus da Lapa for the first 41 km. From there a jeep road runs to the North and passes near the workings at 6 km distance.

Emerald is encountered in the base of a mica schist complex intruded by pegmatites, along the margin of a granitic dome spreading towards the SE.

Wall rock is a greenish mica schist interbedded with gneiss, tourmalinite and irregular pegmatitic lenses, striking N60°E, with a gentle NW dip. Emerald is only found in a very micaceous and undulating thin bed, near the contact with the pegmatite, associated with quartz, feldspar and black tourmaline. Emerald is either in short bi-terminated prisms, sometimes with longitudinal grooves, or in parallel aggregates now and then fractured. The gems, of poor quality, are translucent and only suitable for a collection or to make cabochons.

Density: **2.80** ±0.02

Hardness: **7.5**

Indices: n_ω = **1.576** n_ϵ = **1.584** ±0.002

Birefringence: **0.008**

Emerald does not fluoresce and its density and indices are a little higher than those of the Carnaiba specimens, from the same state (J. P. & J. O. Cassedanne, 1974).

Samples in the mica may be easily recovered in contrast to those included in feldspar or in saccharoidal quartz.

Fazenda do Pombo

The mine lies just on the side of the Bom Jesus da Lapa road, near km 44, on the slope of the Baiano high plain. Access by car is made in 45 minutes. There, gneiss with amphibolitic and mica schist intercalations surrounds a granitic dome spreading towards Vitória da Conquista. Workings, between elevation 520 and 550 m, are on the margin of a subvertical pegmatitic body cut into three lenses striking N70°E by transverse faulting. Wall rock, a greenish mica schist, sometimes graphitic, interbedded with ultrabasic altered sills, strikes ESE-WNW and dips 50-60°N. Near the contact with pegmatitic apophyses it has developed a thin micaceous banded bed in which emerald may be sporadically collected, associated with albite and quartz. Emerald is in 6-face prisms, frequently translucent apple-green, very suitable for collection and lapidation. Gems are presently rare but were extensively mined in the past.

ROSE CORUNDUM

This occurrence, known as Lagedinho, SSW of Vitória da Conquista, is located on the edge of the Baiano high plain. Access is by way of the paved road to Ilheus for the first 19 km (until km 255). From there a municipal road runs to Capão settlement (15 km), where it forks to the right as a 7 km jeep track leading to the workings at 760 m elevation. Travel is one hour from Conquista.

The deposit is in greenish, very folded schist surrounded by gneiss. Old large workings, mainly several elongated pits striking ENE-WSW, are presently flooded and several adits are caved in. Dark rose corundum fragments, very suitable for lapidary work, are recoverable by panning the dumps and, with luck, multicentimetric faceted single crystals can be found. Water for panning flows all the year round from a recent adit also caved in.

GREEN OPAL

The occurrence is in the Fazenda Brejinho, WSW of Boa Nova and NE of Vitória da Conquista. Access is by way of the Rio-Bahia highway for the first 87 km, and from there by a good unpaved road 14 km to Boa Nova. A 1.5 km jeep track leads to the *garimpo* (small mine) at 660 m elevation. Travel time from Conquista is 1½ hours.

Workings have irregularly stripped the upper silicified outcrops and eluvium of a small ultrabasic body intruded in gneiss and quartzites. Chalcedony with opal in metric irregular cavernous blocks is scattered on the ground or cuts the rare weathered outcrops.

Chalcedony is chestnut, beige or grey with rare milky spots or, locally, with delicate dendrites. This latter material is very suitable for making cabochons.

Opal, translucent, olive to peridot green, with clean uncracked fragments, occurs in veins irregularly crossing the chalcedony. Gem material is in scattered, multi-centimetric spots in the translucent opal. Properties of this are:

Density: **2.07** ±0.05
Hardness: **5.5**
Index: **1.450** ±0.002 (Na light)
Loss by ignition: **7.33%**

Color appears to be provided by nickel (R. V. Gaines investigation), because chromium was not detected.

BLACK QUARTZ

This occurrence, in the Fazenda Recruta, was previously described in the *Mineralogical Record* (J. P. & J. O. Cassedanne, 1973). In January, 1975, the dumps still allowed the collection of good large specimens and abundant miniatures.

ROSE QUARTZ

This deposit, also known as "Quartzo Róseo" is situated 2 km SW of Ribeirão do Largo village, SSE of Vitória da Conquista and SSW of Itambé. From this latter town, 45 km from Vitória by the Ilheus highway, access is by way of the rough road to Encruzilhada for the first 35 km, thence by the road to Ribeirão do Largo, 10 km, and finally by the track to Cândido Sales (formerly Nova Conquista) for 4.5 km. From there a 1.5 km jeepable road leads to the workings at the elevation of 700 m. Travel time from Itambé to the mine is 1¾ hours.

The region around the occurrence is mainly gneissic with mica schist lenses. It is crossed by pegmatites. The deposit is one of these, subvertical and striking N50°E, mined through an elongated pit 25 m in length, 4 m in width and 8 m high in milky quartz in which rose quartz is scattered. The pegmatite with highly kaolinized feldspar, black tourmaline and muscovite does not present any other peculiarity.

This mine is presently abandoned, but several tons of good material very suitable for lapidary work, with large blocks without cracks or inclusions, are stockpiled near the pit. Caution must be taken to pick up only material from the base of the piles, because the intense sunlight has bleached the material on the top.

Very good rose quartz in a pegmatitic body also occurs in the Fazenda Mangerona, Macarani township. There, also, the workings are abandoned.

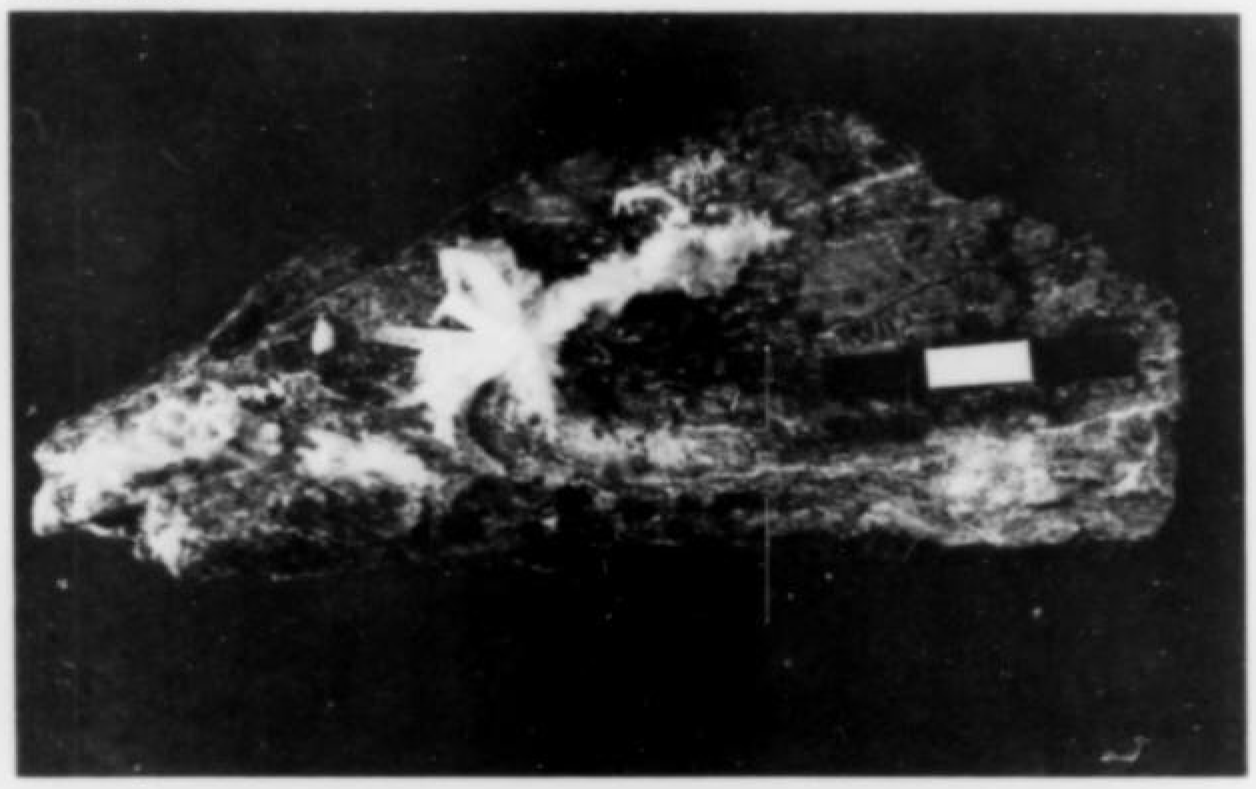


Figure 5. **Cluster of hydromagnesite needles. São Felix do Amianto.**

QUARTZ var. AMETHYST

There are several amethyst mines in the Vitória da Conquista area. They will be described below because interesting and good specimens are easily recoverable either in the dumps or in the mine workings. Three types of colored gems result from the treatment operations: purple, yellow to orange, and green. A locality producing each type will be described.

It may be stated that garimperos call the pyramidal amethyst *piões* and all other crystals *irregulares*, either elongated or without terminations.

Montezuma

This mine, the most important, in the Fazenda Tabua (Rio Pardo de Minas township) is situated east of Monte Azul and WSW of Vitória da Conquista. Access is generally from Condeuba, in 3 hours, by way of the unpaved road to Montezuma village (formerly Água Quente), for the first 105 km, via Erondiara, Jacaraci and Mortugaba. From there a 5 km jeepable track leads to the workings at the elevation of 1160 m. The mine is on the slope of the Serra Geral, a high mountain boundary between Minas Gerais and Bahia. There, quartzites are striking N20°W and dipping 60°S at the main adit entrance.

Figure 6. (above) **Staurolite crystals with almandine. Small sample from Córrego Tamboril.**

Figure 7. (below) **Bleached amethyst outcrop in veinlet parallel to the main vein. Joanina mine.**

Several hydrothermal veins were mined by shafts and levels: **Alberto, Waldir** (N45°W, subvertical, abandoned but with rich dumps), **Linha 3 faces** (N120°E, subvertical) and **Linha 6 faces** (= Boca da Gruna, oblique to the preceding). Only the last two are presently worked by an inclined adit to a depth of 45 m. The veins, some decimetres to 2 m wide, with large druses, only enclose one type of crystal: a three or six-faced pyramid. They are associated with kaolin and/or illite (Linha 3 faces: *tabatinga*) or with a breccia for the 6-faced (*mocoyoio*). The specimens, reaching up to 20 cm, frequently in clusters of single crystals, are very good collection samples and, after cutting, valuable gems. The mocoyoio breccia of amethyst fragments cemented by red chalcedony gives unusual blocks for carving or ornamental purposes.

Daily production is 20 kg in each vein. The gems extracted are of high quality (super extra type). Cutting is done in Rio de Janeiro.

Finally it must be emphasized that Montezuma amethyst, by heating, turns green. This product, transparent, without high brightness, is known as "peridine" in the jewelry trade, but is not very popular. The transformation by heating was previously described by F. H. Pough (1958).

Coruja

This mine lies in the serra of the same name, SW of Cordeiros and WSW from Conquista near the boundary with Minas Gerais. Access is from Condeuba in 2¼ hours by way of the São Pedro da Barra road for the first 33 km. There another road forks to the left leading in 13 km to the mining property entrance. Then a 4 km very bad track climbs up the serra to the mine at 1060 m elevation.

It is enclosed in subvertical, soft quartzite, of the Lençois formation where, of several veins outcropping, three were worked. The main, NS and subvertical is 1 m wide and is mined by a 26 m shaft and two levels.

Amethyst crystals are either elongated or broad. Crystallized samples suitable for collections are rare but it is very easy to obtain large, compact, colored pieces up to 20 x 10 x 10 cm very suitable for cutting, polishing or carving. Present monthly production is about 25 tons of which 1.3% is of gem quality.

It must be emphasized that Coruja amethyst turns yellow to orange brown by heating ("whisky" and "brandy" qualities). The fine gems resulting are traded as "Bahia topaz."

Near Coruja mine, the Baixinha prospect is abandoned. It

Figure 8. **Gem amethyst three-faced crystal coated by thin limonite film. Linha 3 faces. Montezuma mine.**

Figure 9. (above) **Other view of the same crystal showing the trigonal symmetry. Linha 3 Faces. Montezuma mine.**

Figure 10. (below) **Large vug in amethyst vein. Black is impure clay filling the cavity. Linha 3 faces, level minus 45. Montezuma mine.**

worked underground a N45°W, subvertical vein. Large but weakly colored amethyst crystals up to 25 cm may be recovered from the dumps.

Joanina

This mine is located 15 km NE of Joanina and WSW of Vitória da Conquista. Access is from the first village (formerly Presidente Jânio Quadros) by way of Maetinga road. At 23 km a track reaches the workings in 2 km at 720 m elevation. Travel time is 3 hours from Anagé.

The deposit is a subvertical, N150°E, 0.2 to 1 m wide banded vein with chalcedony in the central vugs. Wall rock is a tectonized highly feldspathic gneiss, striking N45°E and subvertical. A pink granitic dike borders the vein on the east. Workings are a 10 m shaft, 2 levels and surficial cuts. The amethyst crystals are elongated, grey to greenish with a violet cap, up to 10 cm, and do not change by heating. Good chalcedony samples also may be collected.

Several of the preceding deposits belong to Mineração Badin S.A., Avenida Augusto Severo 146/150, Rio de Janeiro, who should be contacted for permission to visit them and all mining inquiries.

Many thanks to our colleague R. V. Gaines who kindly revised the English manuscript.

All specimens and photos by J. P. Cassedanne.

REFERENCES

CASSEDANNE, J.P., and CASSEDANNE, J.O. (1973) Black quartz from Vitória da Conquista, Brazil. *Mineralogical Record*, **4**, 264-266.

__________ and __________ (1974) Mineral collecting localities from the Capelinha-Malacacheta area (State of Minas Gerais - Brazil). *Mineralogical Record*, **5**, 225-232.

__________ and __________ (1974) Note sur la mine d'émeraude de Carnaiba. *Bull. Assoc. franç. Gemmologie*, **40**, 4-8.

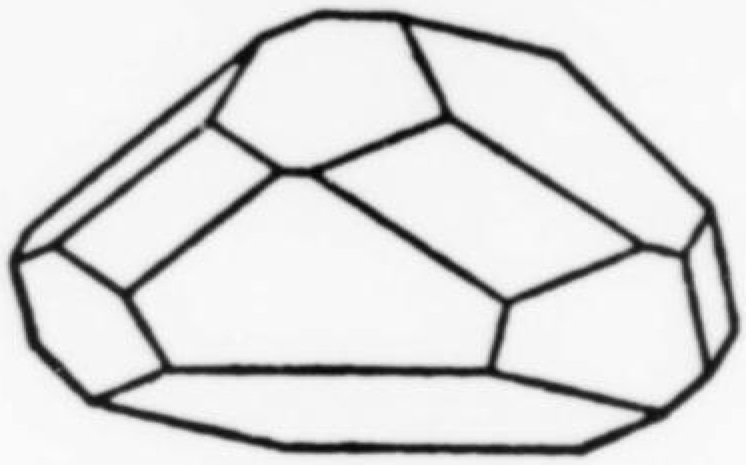
__________ and __________ (in press) - Le gîte d'axinite de Santa Rosa (Bahia - Brésil). *Bull. Soc. franç. Minér. & Crist.*

__________ (1967) Etude de l'hydromagnésite de São Felix (Bahia). *Anais Acad. bras. Ciências*, **39**, 261-265.

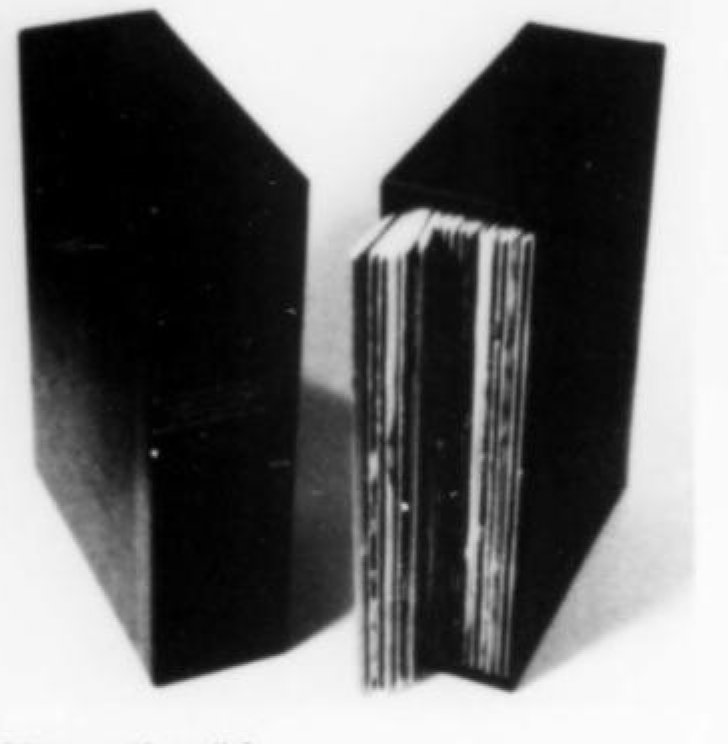
GUILLEMIN, C. (1964) *En visitant les grandes collections minéralogiques mondiales*, 192 p. Publ. B.R.G.M., Paris.

__________ (1972) *En visitant les grandes collections mondiales (Complément à la publication 1964)*. 136 p., Publ. B.R.G.M., Paris.

POUGH, F. H. (1958) Ametista esverdeada. *Gemologia Ano III*, **12**, 24-25. Translation São Paulo.

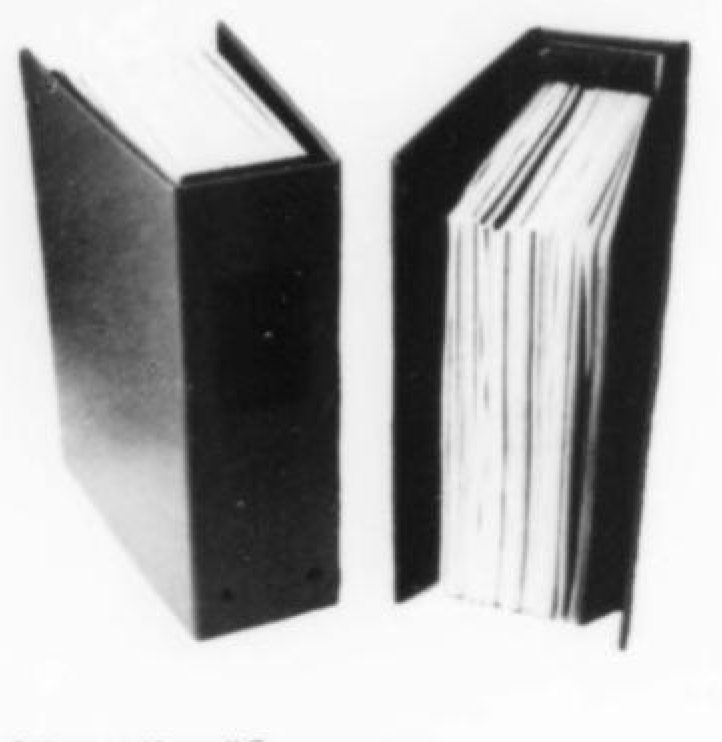


Finally! Record BINDERS



Alternative #1:
The Deluxe Magazine File
(shown above)

Advantages: (a) Economical price...for only $9.75 you can accommodate all past issues of the *Record* plus all issues through 1978!
(b) Each issue of the *Record* can be easily extracted and read *individually*.
(c) Looks nice on your shelf too... gold-embossed title on black spine, plus press-on gold-leaf numbers to add the years.



Alternative #2:
The Blade-Lock Binder
(shown above)

Advantages: (a) Holds a *variable number* of issues for greatest economy. All issues through 1978 can be held in three binders at a cost (including 2 pkgs. of extra blades) of $35.76.
(b) Accommodates *variable-thickness* issues easily, even the Tsumeb issue. Issues need not be drilled or mutilated in any way.
(c) High-quality gray buckram book cloth over heavy-duty binder's boards...we thought our readers would like this better than cheap vinyl. Label cards provided give title and years, and slip into label holder on the spine.

For years our readers have cried out "Give us binders!" Could we ignore their cries forever? Certainly not. So we scoured the world looking for just the right product to offer... and came up with not one but *two* for you to choose from! How many other magazines would do that for their readers, hm? Both of these products come from the same company that supplies binders for *Smithsonian* magazine.

HOW TO ORDER:

Both the file boxes and the binders are 3 inches thick. **One box or one binder** will hold Volumes 1-4 (22 issues), Volumes 5-7 (18 issues), or Volumes 8-9 (12 issues). (You can see that the *Record* has grown consistently thicker over the years!) Therefore you will probably want to order three or perhaps even four of either the boxes or the binders.

NOTE: Each binder comes with 12 blades to hold 12 issues. **You must order extra blades** if you wish to put more than 12 issues in a binder. Extra blades come in packages of 12.

Please specify catalog number and "Mineralogical Record" when you order:

Deluxe Magazine File—Title: The Mineralogical Record
Black only (# **23-220A**). . . . . $3.85 each postpaid
$3.25 each for 3 or more

Blade-Lock Binder—Title card: The Mineralogical Record
Gray only (# **A52-572A**) . . . $10.00 each postpaid
Package of 12 extra blades
(# **A52-565A**). . . . . $2.88 per package

Send Order Directly To
(and make checks payable to)

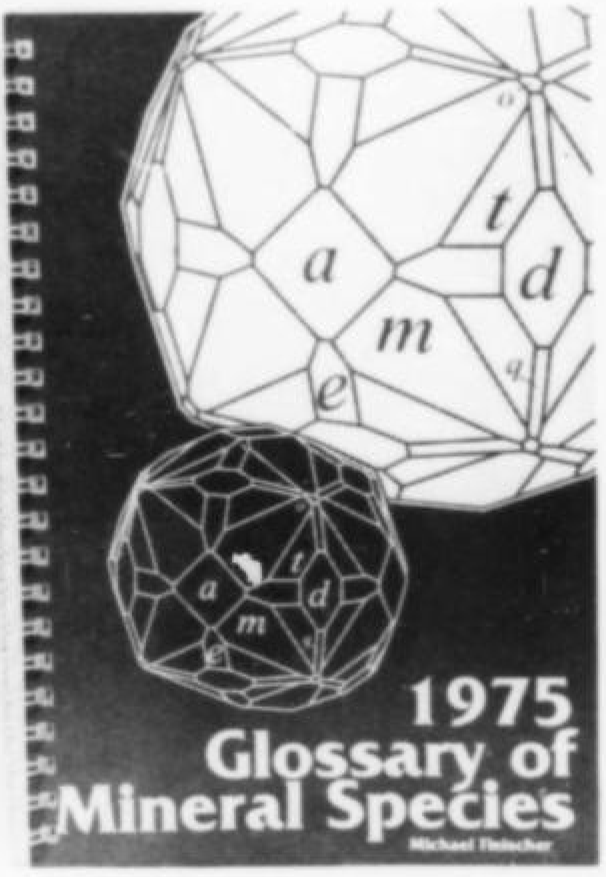
THE HIGHSMITH COMPANY
P.O. Box 25M
Fort Atkinson, WI 53538

(a catalog of other items is available on request)

Glossary of Mineral Species

by Michael Fleischer

PUBLICATION AUTHORIZATION BY THE DIRECTOR U.S. GEOLOGICAL SURVEY



$4 (postage free with prepaid orders)

(ASK ABOUT DEALER'S DISCOUNT!)

send to:

Glossary
P.O. Box 10404
Alexandria, VA 22310

-- *Every mineral species* known to man...*2357* of them.
-- *Chemical composition* of every species.
-- *Crystal system* of every species.
-- *The best reference* in english for many species.
-- *441 group names, varietal names, discredited names and synonyms.*
-- *Notations* regarding analogous species.
-- Separate tabulations of all the species in each of *33 mineral groups*.
-- *A table of the elements* and their chemical symbols for reference.

CLUBS NOTE: $3 each for 10 copies or more prepaid

Back issues of the *RECORD*

ALL BACK ISSUES ARE $2 EACH

AVAILABLE ISSUES:

VOL. III (1972)	(#1,2,3,4,5,6)
VOL. IV (1973)	(#1,2,3, 5,6)
VOL. V (1974)	(#2,3,4,5,6)
VOL. VI (1975)	(#1,2,3,4,5,6)
VOL. VII (1976)	(#1,2, 4)
VOL. VIII (1977)	(#2,4,5)

#3(TSUMEB ISSUE) $5.50 each
to subscribers and dealers.
$8.45 to all others.

Don't delay. Order from: **Mineralogical Record**
P.O. Box 783—H
Bowie, MD 20715

NOTE: Si & Ann Frazier (see their ad) are now handling all out-of-print issues of *the Record*.

What's New in Minerals?

The **Washington (D.C.) International Gem and Mineral Show** was held this May. Although a few people had previously voiced worry that the *mineral* aspect of the show (vs. the *gem* aspect) was on the decline, it turned out to be an even better show than last year. Many foreign buyers and dealers were in attendance as well as most of the major American mineral dealers. The show organizers made a minimal effort in the direction of promoting and arranging the mineral aspect but it seemed to take care of itself. One can only wonder what a truly spectacular show it could be if more official emphasis was given to minerals.

Although a beautiful selection of fine minerals was available there was relatively little that could be considered *new* enough for mention in this column. Oceanside Imports had a large number of fine new **tourmaline crystals** from Virgem da Lapa; the crystals were bi-colored but not on matrix. Colors ranged from green through various peculiar greenish purplish gray shades to red. One specimen that indicated great promise for the future was a **translucent to gemmy rose-lavender apatite crystal** about 2 inches wide and nearly an inch thick. It was actually only half of a six-sided crystal, broken rather cleanly perpendicular to *c*. Hilda Sklar of Oceanside said that this was the only crystal to survive intact so far because the miners routinely run all specimens through an acid bath, which has destroyed some incredibly fine apatite matrix pieces. Hopefully the miners will wake up long enough to realize this is costing them a lot of money. The crystal I examined had a pair of *c* faces, a first order, low-angle hexagonal dipyramid, and a second order hexagonal prism all about equally developed.

Also at Oceanside were no less than five fine **tanzanite crystals** in the ½—1 inch range, very reasonably priced. Hilda said they were not recently mined. ("Tanzanite" = blue gemmy zoisite from Arusha, Tanzania.)

I mentioned to Hilda that it certainly would be nice if someone would find a way to **dissolve lepidolite away without harming tourmaline**, since much Virgem da Lapa tourmaline is coated on one or all sides with lepidolite. To my surprise she informed me that there *is* a way but she rarely uses it because of the hazards involved. Hydroflouric acid (HF), she says, will cause lepidolite to soften and crumble away without harming the tourmaline. Nevertheless, I would be inclined to wax up as much of the exposed tourmaline as possible as a safeguard, and then dissolve the wax off with carbon tetrachloride. However, here we have two of the most dangerous chemicals you might ever be inclined to use. Hydroflouric acid may seem deceptively weak in most reactions but it is perhaps the most vicious acid when in contact with human skin; the fumes can be equally dangerous. Carbon tetrachloride is not much better. Although short contact with the skin can be tolerated the fumes are exceedingly toxic; people who have consumed an alcoholic drink after working with carbon tetrachloride have been known to die in seconds; the two chemicals combine in the bloodstream to form an even more lethal and faster acting poison! And yet the method of waxing parts of a specimen, treating it in acid to dissolve away unwanted portions, then dissolving away the wax in carbon tetrachloride is such an elegant procedure. I once asked a chemist friend of mine to name for me a *safe* organic solvent for removing wax; his terse answer was that there *is* no safe organic solvent. Therefore, if one is to use this procedure, all precautions must be meticulously observed. This means that all work with these chemicals is done under a fume hood, wearing protective eye-shields, and wearing appropriate laboratory gloves. Don't forget to *avoid* glass beakers when using hydrofluoric acid...they dissolve in it. Teflon, Nalgene, or other non-glass beakers work fine.

W.E.W.

Phenakite from Marathon County, Wisconsin

The following information is from Al Falster (510 Bernard Street, Wausau, Wisconsin 54401).

Phenakite is a rather rare beryllium mineral (**Be_2SiO_4**) occasionally found in pegmatites and miarolitic cavities in granite and also rarely in metamorphic rocks. Well known localities include San Miguel di Piracicaba, Minas Gerais, Brazil; Mount Antero, Cheyenne Mountain, Colorado; near Stoneham, Maine; in the Ural Mountains, USSR; and several other localities.

In July of 1975 phenakite was discovered by the author in a pocket in a disintegrated quartz syenite just a few metres north of Highway N in the town of Rib Mountain, Marathon County, Wisconsin. The collapsed pocket measured 1.5 x 2 m in width and perhaps 50—75 cm in depth. It contained mostly very dark smoky quartz crystals and microcline crystals; also included were many clear, colorless phenakite crystals (see photos), most of which were found loose in the pocket-fill. All of the phenacite crystals were penetration twins with obvious re-entrant angles at the terminations. All crystals were elongated parallel to *c*. The pocket yielded about 23 phenakite crystals exceeding 10

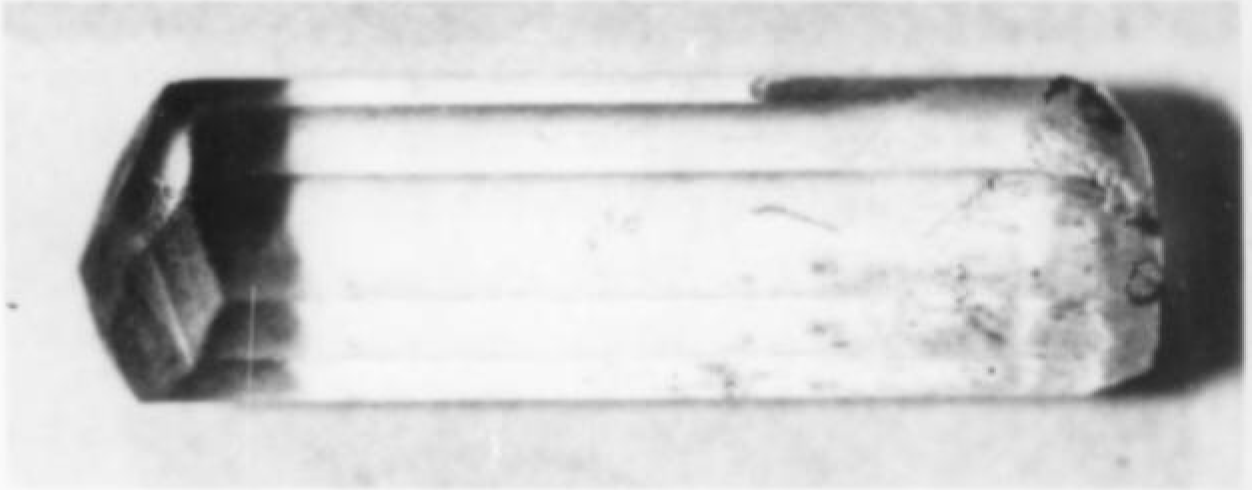
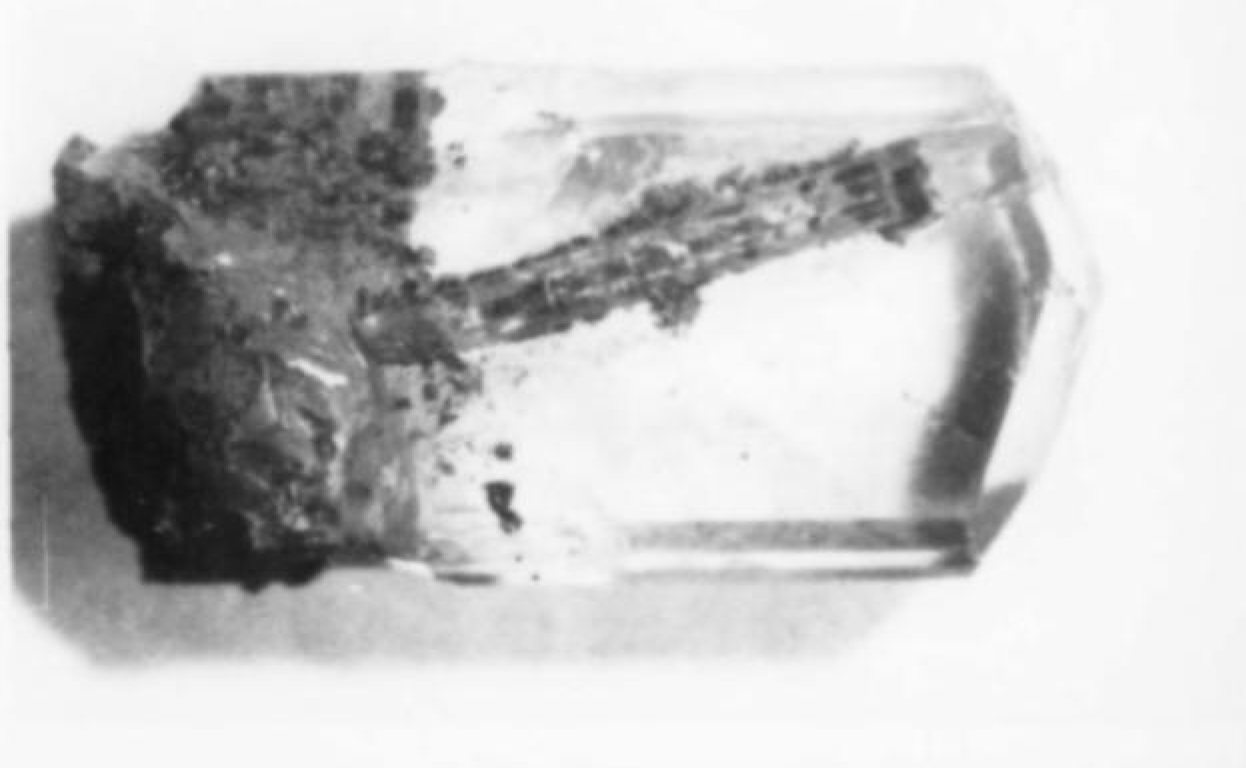


Figure 1. (left) **Phenakite crystal, Marathon County, Wisconsin; colorless, 11 x 2.5 mm. Specimen and photo: Al Falster.**

Figure 2. (below) **Phenakite crystal with small, pale blue beryl crystal, Marathon County, Wisconsin; colorless, 7.5 x 4 mm. Specimen and photo: Al Falster.**



mm in size, and more than 50 which were smaller than 10 mm. Most crystals were loose but some were on quartz. Associated minerals included anatase (black crystals to 0.1 mm), hematite, goethite, calcite, siderite, beryl (only two crystals found), albite and biotite.

Near the end of October of 1975 a second, much larger pocket was discovered which measured approximately 6 x 4.5 x 1 m. Several layers of microcline and quartz surrounded a quartz core. Well crystallized specimens of microcline and quartz were very common. Some specimens contained small, short prismatic phenakite crystals never exceeding 3 mm in size, but very clear, colorless and beautiful as micromounts. This pocket, too, is essentially exhausted but the author has a large number of these phenakite micromounts available for exchange with private individuals or museums.

Rare Minerals Report

The editor has requested that I write something for the species collectors in the audience, and I am happy to comply. As far as I know, this will be the first regular feature of any magazine that has been devoted exclusively to rare minerals of interest to species collectors. Museums and researchers may also find information here to be of value to them. Some things to bear in mind: it is next to impossible for most species collectors to add to their list of species by personal collecting in the field. This means that very nearly all new specimens must be obtained from dealers who get a small lot of new discoveries. For this reason I will mention the dealers' names, in case readers would like to get in touch with them about specific species (although I cannot guarantee that the dealers will have any left by the time this reaches print). Of course these may not be the *only* dealers carrying these species...they just happen to be the first dealers I encountered with the material. Anyone is invited to let me know when they obtain something they think rare enough to be mentioned here. I won't often go so far as to mention dealers' addresses here, though; most are advertisers in *M.R.* and those that aren't should be. Another item: when reading this column try to have your *Glossary of Mineral Species* close at hand. I will rarely quote a formula, and you will probably be interested in looking many of these rare species up to see exactly what they are. If you do not already have a copy of the *Glossary*, you should be ashamed of yourself; you are forbidden from reading this column until this gross inadequacy on your part has been corrected! (see ad in this issue.)

In mentioning rare species that I see on the market I must exercise some judgement in deciding which to omit and which to mention. The result will be subjective, I admit, but in general I will mention **(a)** *extremely rare species* whose mere appearance is significant, even if only a single specimen was seen, and **(b)** *very rare species* if a fair number of specimens were seen.

Many of the following species were seen at the last Tucson Show, but others were noted more recently. I'll go through my notes dealer-by-dealer.

Nature's Treasures had specimens of **zemannite** and **moctezumite**, both from the Moctezuma mine, Sonora, Mexico; they also had **foggite** from Milgun Station, W. Australia. *Kahn Mineralien*, the German associate of Nature's Treasures, had some very rare Tsumeb minerals: **fleischerite, tsumebite, arsentsumebite, alamosite, kegelite, tsumcorite** and **arsenbrackebuschite**. (All of these I have confirmed by X-ray analysis.) Also at *Nature's Treasures* were some other rarities: **sorensenite** and **tugtupite** (fluorescent) from Ilimaussaq, Greenland; **rauenthalite** from the Gabegottes mine, Rauenthal, Alsace, France; **althausite** from Amot, Modum, Norway; **coulsonite** from Buena Vista Hills, Lovelock, Nevada; **leonite** crystals to 7 cm with **syngenite** and halite from Laliwerk Sigmundshal, Bokeloh bei Wunstorf, West Germany (the leonite crystals were exceptional: tabular, clear, white to cream-colored and perched on halite crystals.

Al McGuiness had **posnjakite** from Drakewalls mine, Gunnislake, Cornwall, **leiteite** (1977) from Tsumeb, about 20 specimens; **herschelite** from Aci Castello, Etna, Sicily, Italy; type material of **hafnon** from Muiane mines, Morrua, Mozambique; massive lavender **leucophoenicite** from Hotazel, South Africa; crystallized **franckeite** from Oruro, Bolivia; **paracelsian** from Benallt mine, Caernarronshire, Wales, England; tiny vials of **laurite** (Ruthenium sulfide!) from Cala, Colombia; **klebelsbergite** crystals on stibnite from Felsobanya, Romania; **iranite** from Anarak, Iran; **trolleite** from the Mono County mine, Mono County, California; **cafarsite** from Valais, Switzerland; **stellerite** from Grant County, Oregon; **raguinite** with **lorandite** from Allchar, Macedonia; fine **natrochalcite** from Chuquicamata, Chile; and **anthoinite** from Zaire.

John Saul had one specimen of **söhngeite** from Tsumeb (I bought it).

Howard Ehrle, a collector from Warren, Montana, had a large amount of superb **tyuyamunite** crystals on calcite from Warren, Montana. The crystals were beautiful, sharp, up to 2 mm in size, and *very* abundant! A $10 specimen would have yielded perhaps 100 excellent micromounts.

David Garske had type specimens of **texasite** from Baringer Hill, Llano, Texas; **kellyite** and **galaxite** from North Carolina; **teallite** and **cylindrite** from Poopo, Bolivia; **sampleite** (very fine) from Chuquicamata, Chile; extremely rare **jouravskite** from the Tachgagalt #2 vein, Anti-Atlas Mountains, Morocco; and **getchellite** with superb black cubes of **galkhaite** from the Getchell mine, Nevada (the latter acquired from Galas minerals).

Galas minerals minerals had specimens of **rhodochrosite** that I was totally convinced were from the new strike in South Africa, however they turned out to be from the Mouanda mine, Gabon. Gilbert Gauthier, who lives in Gabon, has visited the mine and confirms the occurrence.

Gilbert Gauthier is one of the best people to know for rare species although he is rather hard to find most of the time. The best course is usually to catch him in his room at the Desert Inn during the Tucson Show. This year he had **derriksite, guilleminite, marthozite** and **demesmaekerite**, all rare uranium selenites from the Musonoi mine, Kolwezi, Zaire; **marokite** from the above-mentioned Tachgagalt #2 vein; extremely rare **schuilingite** crystals from Kasompi, Katanga, Zaire; some excellent Gabon **rhodochrosite; francevillite, vanuralite, curienite** and **mounanaite** from Franceville, Mounana, Gabon; specimens of the finest **billietite** in the world (golden, 3-4 mm, pseudohexagonal crystals on cabinet-size matrix) from the Shinkolobwe mine, Katanga, Zaire; **saleeite, rutherfordine** and **masuyite**, also from Shinkolobwe; **thoreaulite** from Manono, Katanga, Zaire; and **duranusite** from the type locality of Duranus, France.

Sharon Cisneros (Mineralogical Research Co.) had **jagowerite** from the Hess River, Northern Yukon Territories, Canada; superb **cuprostibite** from Greenland, the only specimens I have ever known to have been sold; **ktenasite** and **althausite** from Skutterud, Modum, Norway; **leiteite** and **beudantite** from Tsumeb; **schmitterite, tlalocite** and **carlfriesite** from the Moctezuma mine, Sonora, Mexico; **calumetite** from the Centennial mine, Calumet, Michigan; **heterogenite** from Tsumeb; and

kozulite from the Tanohata mine, Iwate Prefecture, Japan (the type locality).

John Metteer (Mineral Mailbox) had **hillebrandite** from Nugrah, Saudi Arabia; **slavikite** from Le Kaymar, Aveyron, France; **wellsite** from Clackamas River, Estacada, Oregon; **rauenthalite, guerinite** and **sainfeldite** from the Gabegottes mine, Rauenthal, Alsace, France; a material long called "*kasompiite*" (green, radiating clusters of crystals) from Kasompi, Katanga, Zaire, which has turned out to be **glaukosphaerite; guettardite** from the Brobdignag mine, Red Mountain, Colorado; choice **kleinite** (sharp, 1-2 mm, stubby, yellow-orange, terminated hexagonal crystals) from the Cordero mine, Humboldt County, Nevada—these are far superior to crystals from the only previously known locality, Terlingua, Texas; **liskeardite** from Cornwall, England; and **roquesite** (copper-indium-sulfide) from Charrier, Allier, France.

David New had some superb, brilliant, doubly terminated, 1-cm crystals of **sylvanite** with other tellurides and native gold from the Emperor mine, Vatukoula, Viti Levu, Fiji Islands.

Richard Gaines and Carlos Barbosa had an incredible specimen, possibly the most noteworthy of the show: a pair of 9-cm crystals of **geocronite** twinned at about 60°! It is without doubt the finest geocronite in the world; no other crystals much more than a millimetre in size are known. The specimen is from Virgem da Lapa, Minas Gerais, Brazil.

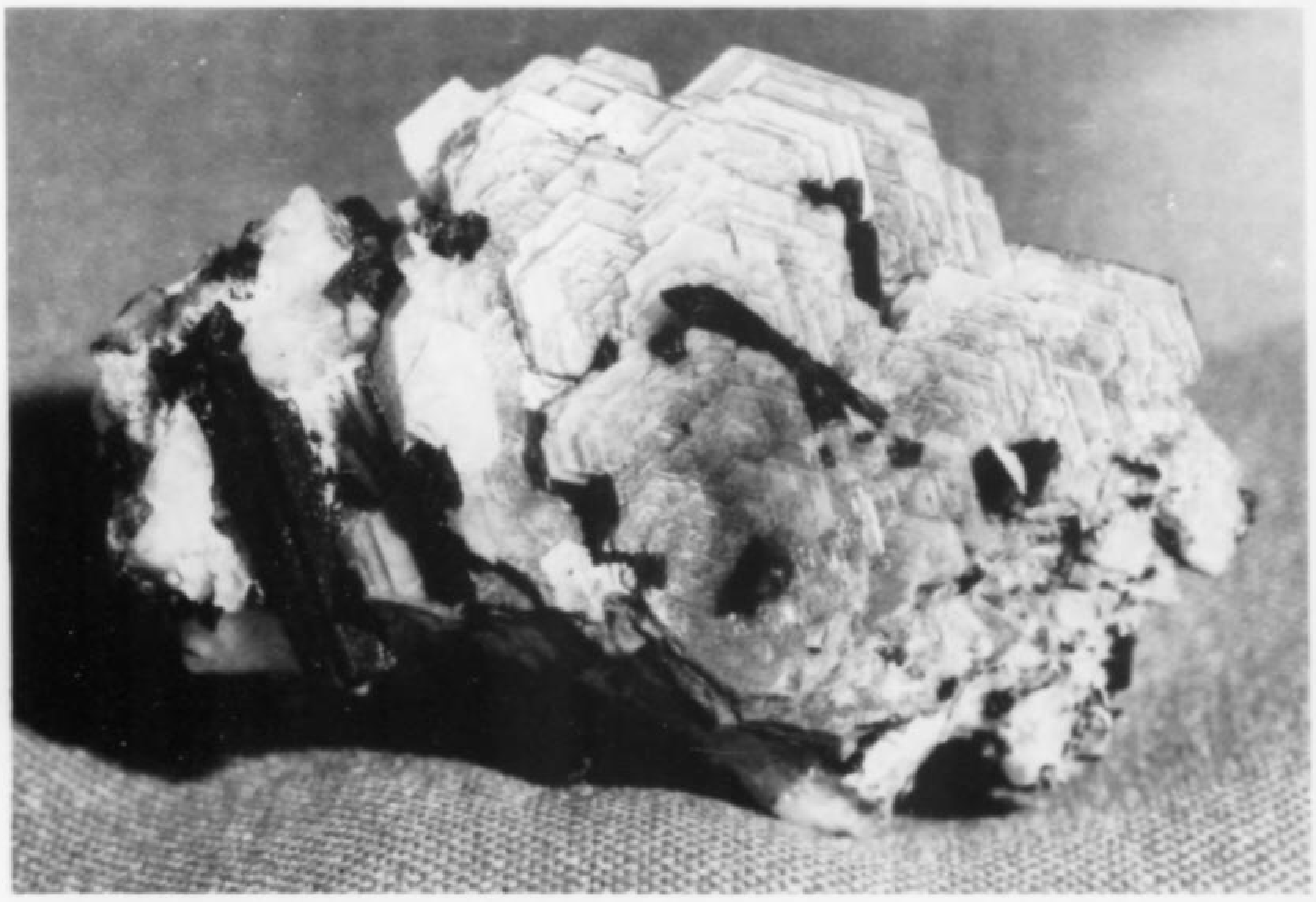
Throughout the Tucson Show species collectors continually approached me with the greeting "Have you been to *Charlie's* room yet?" *Charles Key and Sid Pieters* had specimens of the world's finest **jeremejevite**...the crystals are a gemmy electric blue and reach 7 cm in length, from mile 72 near Swakopmund, Southwest Africa. Prosper Williams has some of these too. Charlie also had an incredible crystal of **nambulite**, clear, gemmy, brilliant red, flawless, and measuring about 3 x 3 cm (from Southwest Africa). He had a few smaller crystals too.

All in all, Tucson in February is one of the best places to go broke increasing the size of your species collection. Many of these dealers offer free lists as well, and I strongly suggest that you ask to be placed on their mailing list because there will no doubt be many things I do not mention that you might be interested in. Through this column, however, I will try to keep you posted on the more rare minerals which become available.

by William W. Pinch
82 Kensington Court
Rochester, NY 14612

News from the ROM

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



The above photograph is of a magnificent specimen of catapleiite from Mont St. Hilaire, Rouville County, Quebec, Canada. It was acquired in August 1976 from the Michael J. Ridding collection and is one of the Royal Ontario Museum's more important acquisitions during that year.

The rosette of bright, slightly iridescent, tan-colored crystals is about 7 x 5 cm, and 2 cm thick, set on a matrix of white natrolite with a few black aegirine prisms. The catapleiite crystals are sharp hexagonal plates with pyramidal modifications. The crystals are stacked together to form a slightly concave "dish-shaped" rosette which adds considerably to the aesthetic value of the specimen. Its overall size is 10 x 6 x 5 cm and it is believed to be one of the five or six finest specimens of this species known at the present time.

Mineralogical Notes

HINSDALITE FROM THE ZEEHAN AREA, TASMANIA

A new find of the rare phosphate-sulphate hinsdalite, $\mathbf{(Pb,Sr)Al_3(PO_4)(SO_4)(OH)_6}$, has recently been made in the Zeehan area of Tasmania. The mineral occurs as cream-colored pseudomorphs after pyromorphite crystals up to 6 mm long (Fig. 1) in the eastern (original) workings of the **Sylvester mine**.

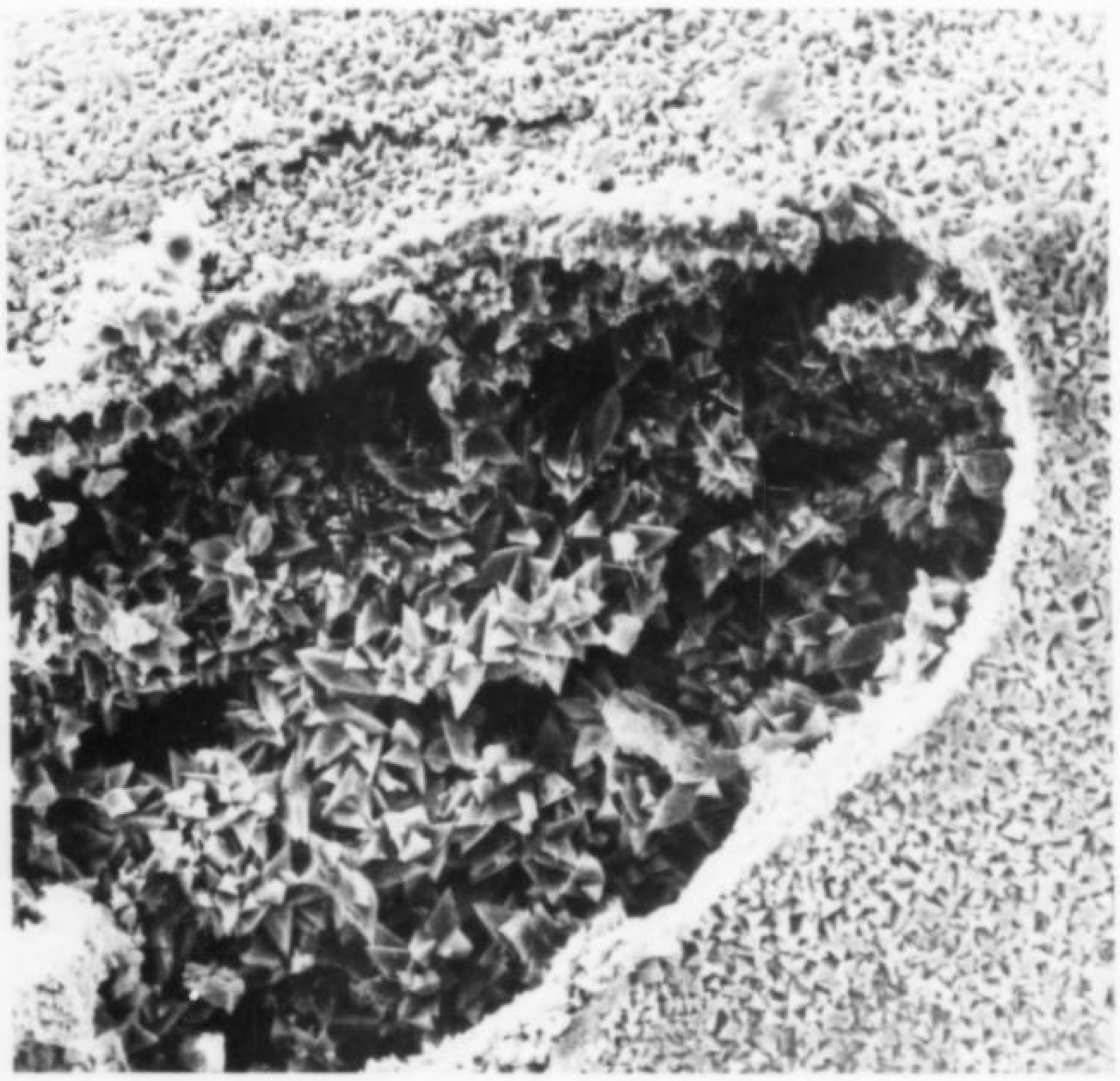
The crystals occur lining fissures and cavities approximately 10 metres down on a sub-lode which cuts obliquely across the main lode (of gossanous silver/lead ore). The matrix is soft and clayey and specimens are quite fragile. Unaltered dark green pyromorphite occurs at deeper levels in the mine and the hinsdalite pseudomorphs may well have been mistaken for "bleached" or pale-colored pyromorphite during the original operations.

The nature of the pseudomorphing process is shown in the scanning electron microscope photographs (Figs. 2 and 3). Figure 2 shows the external surface, consisting of a skin of small rhombohedral hinsdalite crystals, surrounding a cavernous interior containing aggregates of slightly larger crystals. These are shown enlarged in Figure 3. The pseudomorphing process is not always complete and some specimens show gradations between unaltered yellow-green pyromorphite and hinsdalite. Preliminary chemical data provided by Ralph Segnit (C.S.I.R.O. Division of Mineral Chemistry) indicates that there is no replacement of Pb by Sr in the hinsdalite.

Hinsdalite (replacing pyromorphite) has been recorded from one other mine in the area. *The Catalogue of the Minerals of Tasmania* (Geological Survey Record No. 9, 1970) quotes the occurrence as the **West Comet mine**, near Dundas, but according to Rod Williams, who discovered the Sylvester hinsdalite and is currently mining it, this should be the **Comet mine**.

I am grateful to Rod Williams of Rosebery for much of the information in this note, to Ralph Segnit for the S.E.M. photographs and to the *Australian Mineralogist* for the photograph in Figure 1.

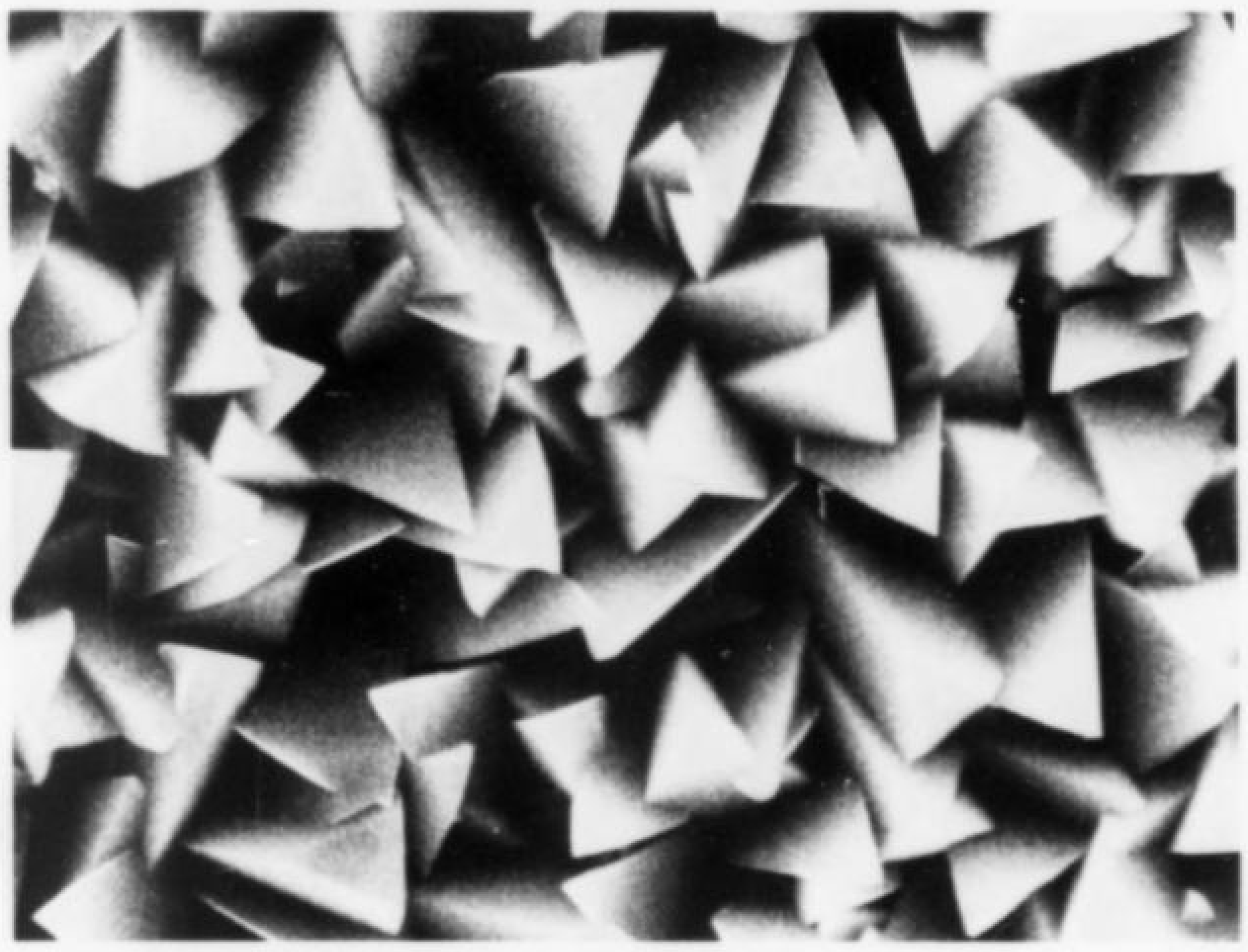
Bill Birch
Curator of Minerals
National Museum of Victoria
285-321 Russel Street
Melbourne, Victoria
Australia 3000



Above: Hinsdalite after pyromorphite, Sylvester mine, Zeehan, Tasmania. (Field of view width equals 1.4 cm.)

Left: Hinsdalite, Sylvester mine, Zeehan, Tasmania. (Field of view width equals 0.27 mm.)

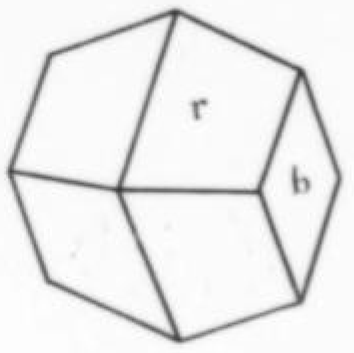
Below: Hinsdalite, Sylvester mine, Zeehan, Tasmania. (Field of view width equals 0.037 mm.)



FLUELLITE FROM NORTH CAROLINA

Fluellite, **Al$_2$(PO$_4$)F$_2$(OH)·7H$_2$O**, is a rare mineral originally described from Stenna Gwyn, near St. Austell, Cornwell, England, by Lévy (1824). At the type locality fluellite occurs as microcrystals (about 1.0 mm) on quartz with fluorite, torbernite and other species. A second occurrence is associated with strengite and phosphosiderite at Kreuzberg, Pleystein, in the Oberpfalz, Bavaria, Germany. The material at Kreuzberg was originally called kreuzbergite (Laubmann and Steinmetz, 1920) but this was shown to be fluellite by Scholz and Strunz (1940). Although fluellite and kreuzbergite were originally thought to be hydrated aluminum fluorides, a recent investigation by Guy and Jeffrey (1966) of the crystal structure of fluellite from Cornwall indicated the presence of essential phosphorus and resulted in the determination of the formula given herein.

Fluellite from the Carolina Pyrophyllite mine, Staley, Randolph County, North Carolina.



The occurrence in North Carolina is at the **Carolina Pyrophyllite mine**, Staley, Randolph County, North Carolina. There is, at this time, only one specimen, and it was sent to the author by Rodney Leftwich of Swannanoa, North Carolina, who first noted the crystals.

The North Carolina fluellite occurs in a cavity in pyrophyllite, and is associated with dark red rutile crystals, small spherules of variscite, radiating sprays of wavellite, and white, opaque veins of fluorapatite. The fluellite crystals are of simple morphology and attain a maximum size of 3-4 mm. Many crystals are intergrown in what appears to be a random manner, with no evidence of twin-laws or epitaxial relationships with other species.

The X-ray powder pattern is identical to that of Cornish fluellite. The fluellite and associated species were semi-quantitatively analyzed by electron microprobe. The fluellite contains phosphorus, fluorine, and aluminum. The variscite, in addition to aluminum and phosphorus, contains 0.8% iron. The wavellite, as might be expected when associated with fluorine minerals, contains about 2.2% fluorine and is thus a fluorian wavellite. Both the fluellite and the fluorapatite fluoresce under ultraviolet radiation. The fluellite fluoresces a creamy white color in longwave ultraviolet and the fluorapatite fluoresces a light orange color in both long and shortwave ultraviolet. There is no phosphorescence in either wavelength for either mineral.

This occurrence of fluellite in North Carolina is significant because of the rarity of the mineral and the exceptionally large size of the crystals when compared with those from the type locality. Hopefully, this note will encourage collectors to examine their North Carolina pyrophyllite specimens very carefully.

References

GUY, B.B., JEFFREY, G.A. (1966) The crystal structure of fluellite, $Al_2PO_4F_2(OH)\cdot 7H_2O$. *Amer. Mineral.* **51**, 1579-1592.

LAUBMANN, H., STEINMETZ, H. (1920) Phosphatführende Pegmatite des Oberfälzer und Bayerischen Waldes. *Zeit. Krist.* **55**, 549-557.

LÉVY, A. (1824) On a new mineral substance. *Annals of Philosophy (.s.)* **8**, 241-245.

SCHOLZ, A., STRUNZ, H. (1940) Identität von Kreuzbergite mit Fluellite. *Zentr. Mineral. 1940a*, 133-137.

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

FERBERITE FROM PANASQUEIRA, PORTUGAL AND WOLFRAMITE FROM KOREA

Among the exciting specimens available to museums and collectors over the last ten years has been a moderate abundance of "wolframite" from Panasqueira, Portugal, and Tong Wha, Korea.

The crystals from Panasqueira have already been described by Gaines *et al.* (1971) who noted the associated muscovite, siderite, and fluorapatite. The Korean crystals are frequently coated with quartz, dolomite, and scheelite; some specimens with uniformly deposited quartz druses are very beautiful.

The wolframite group was thoroughly investigated some 60 years ago by Hess and Schaller (1914) and their work is recommended to the reader who seeks a comprehensive and very readable treatment of the group. The nomenclature conventions proposed by Hess and Schaller are still in use. They divided the group into three names as follows:

ferberite — $FeWO_4$ — **iron** tungstate
wolframite — $(Fe,Mn)WO_4$ — **iron manganese** tungstate
huebnerite — $MnWO_4$ — **manganese** tungstate

Ferberite from Panasqueira, Portugal (black, 3.5 cm). JEA

The division between ferberite and huebnerite was based on the iron/manganese ratio. Ferberite has from **100-80%** of the iron end-member, wolframite from **80-20%** of the iron end-member, and huebnerite **0-20%** of the iron end-member. Sanmartinite, zinc tungstate, is a rare member of the group which was discovered in 1948.

Chemistry

Since the compositions of "wolframite" from the herein studied localities have not been previously established, it was decided to analyze specimens from both localities to ascertain their compositions and, in turn, their correct mineral names. Nine crystals from the Smithsonian collections were analyzed with an electron microprobe using an operating voltage of 15kV and a beam current of 0.15μA. Standards used were synthetic scheelite for tungsten, hornblende for iron, calcium and magnesium, and manganite for manganese. These analyses are presented in Table 1. There is no substitution of calcium or magnesium for iron in any of the samples, nor any substitution of molybdenum for tungsten. The given analyses are averages of many sample points and thus represent an averaging of the slight compositional zoning.

It is immediately apparent that the **Panasqueira** crystals are remarkably uniform in composition. The analyses indicate that these crystals contain ~**90%** of the iron end-member and, adopting the nomenclature definitions of Hess and Schaller (1914), they should be termed **ferberite**. Compositional zoning is gradual with manganese more abundant in the interior of the crystals but not exceeding 4.50% MnO. The exteriors of the crystals are the most iron-rich with manganese content as low as 1.80% MnO.

The composition of the crystals from **Tong Wha, Korea,** varies within small limits (± 2% FeO/MnO). The Korean crystals are near the midpoint in the ferberite-huebnerite series with a **Mn:Fe ratio of 51:49** for an average of the 3 analyses. They should be termed **wolframite**. No compositional zoning was noticed in the crystals examined.

Out of curiosity, a specimen labelled "reinite" (a variety of feberite, pseudomorphous after scheelite) from Kimpuzan, Yamanashi Prefecture, Japan, was also examined. It is a dull black crude dipyramidal crystal about 5 x 4 x 4 cm in size. The

Table 1.
Microprobe Analyses of Ferberite and Wolframite

	Locality	NMNH #	FeO	MnO	WO_3	Total	% Ferberite
Ferberite	**Panasqueira, Portugal**	120730	21.84	3.95	76.58	102.37	**92**
Ferberite	**Panasqueira, Portugal**	R17435	21.32	3.99	76.44	101.76	**90**
Ferberite	**Panasqueira, Portugal**	128084	21.45	3.80	76.38	101.64	**91**
Wolframite	**Tong Wha, Korea**	127349	11.57	13.29	77.03	101.89	**49**
Wolframite	**Tong Wha, Korea**	127346	9.60	15.19	76.35	101.14	**41**
Wolframite	**Tong Wha, Korea**	126086	10.00	15.28	76.11	101.39	**42**
Ferberite	**Kimpuzan, Japan**	134635	24.72	0.42	74.61	99.75	**100**

Total iron calculated as FeO. Accuracy of data ± 3% relative.

analysis is given in Table 1. This crystal is almost pure ferberite with only 0.42% MnO.

In summary, the "wolframite" of Panasqueira, Portugal, is ferberite, and the "wolframite" of Tong Wha, Korea, is wolframite. It should be noted in passing that Panasqueira ferberite is very heat sensitive and cleaves on {010} quite spontaneously when heated or sawn with a diamond blade.

References

GAINES, R.V., THADEU, D. (1971) The minerals of Panasqueira, Portugal. *The Mineralogical Record* **2**, 73-78.

HESS, F.L. and SCHALLER, W.T. (1914) Colorado ferberite and the wolframite series. *U.S. Geol. Surv. Bull.* 583.

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

HUTCHINSONITE FROM QUIRUVILCA, PERU

The initial occurrence of hutchinsonite was at the Lengenbach quarry, Binntal, Valais, Switzerland (see articles in the last issue of *M.R.*), where it is associated with dolomite, pyrite, realgar, orpiment and complex sulfosalts.

In recent years, splendid crystals of hutchinsonite, $(PbTl)_2As_5S_9$, have been found at Quiruvilca, Peru, associated with orpiment and fine enargite crystals. The crystals attain dimensions of 2 x 16 mm and are superbly formed. Quiruvilca hutchinsonite gives an X-ray powder pattern identical to the Binntal material. The Quiruvilca material was semi-quantitatively analyzed with an ARL-SEMQ electron microprobe to determine whether it was compositionally different from the Binntal material but there is little difference. The thallium/lead substitution is within the limits of that observed on Binntal material (Palache *et al.*, 1944). The iron and sulfur content is about the same at both localities. Copper, manganese, iron, calcium, and phosphorus are either absent or present only as traces.

Reference

PALACHE, C., BERMAN, H., FRONDEL, C. (1944) *The System of Mineralogy* 7th Ed., *1*, 468.

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

SCHEELITE FROM KOREA

Superb specimens of scheelite have come from Korea in recent years, and have fast become collector's items. The crystals occur as sharp, tetragonal dipyramids and are usually associated with quartz and wolframite.

Inasmuch as no analyses of these Korean specimens have been published, it was decided to analyze ten specimens from the Smithsonian collections to establish their composition and any variation therein. The specimens analyzed were from localities given as Tae Wha mine, Nongam-ni, Korea; Koendo, Korea; Tong Wha, Korea, and Tae Wha mine, Chongju, Korea. The localities for these fine Korean scheelites have been the subject of some controversy (see *M.R.* **6**, p. 96; **5**, p. 222) and the above localities are as they appear on specimen labels. They have no other claim to accuracy or validity.

The analyses were performed using an ARL-SEMQ electron microprobe. Standards used were synthetic scheelite for calcium

ww

Left: Hutchinsonite crystals, length of crystals is about 1 cm. Smithsonian specimen.

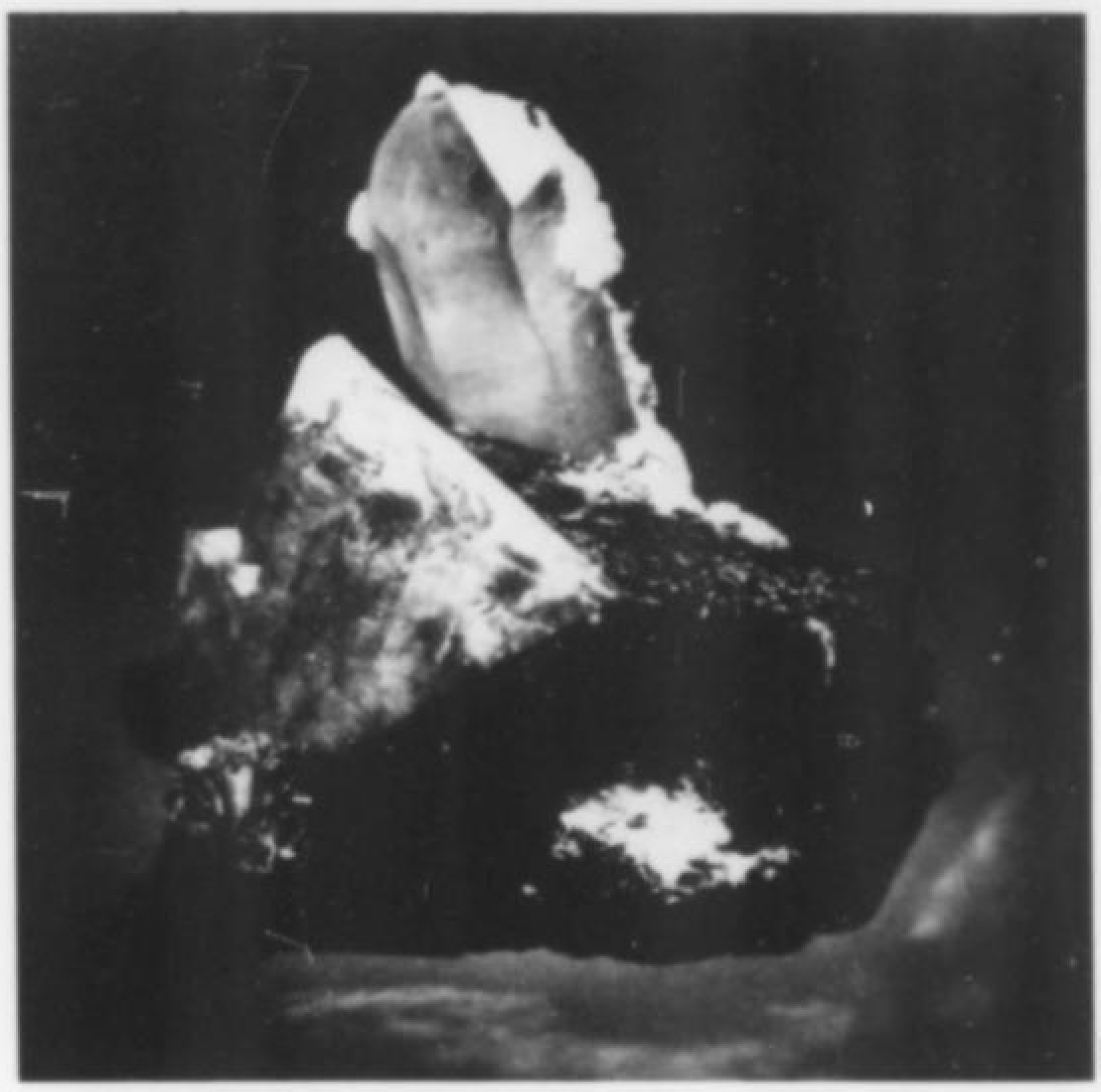
Right: The Smithsonian's new Naturalist Center.

and tungsten, synthetic wulfenite for molybdenum, magnetite for iron, and manganite for manganese.

Iron and manganese, although abundant in the geochemical environment of some of the samples, is not present in significant amounts, nor is molybdenum. Although samples of different colors (gray, orange, yellow) were chosen, there was no significant difference in the compositions of any of the Korean scheelites, and the gross chemistry did not suggest the cause of the coloration. A sample from Tong-Wha, Korea, gave FeO—**0.38%**, CaO—**19.45%**, MnO—**0.39%**, WO_3—**79.55%**, and MoO_3—**0.19%**, total = **99.96%**. Other samples from Tong Wha and other Korean localities were found to have extremely similar compositions; publication of the additional analyses is therefore unnecessary.

In conclusion, Korean scheelite is quite consistent in composition and conforms to the theoretical composition with little isomorphic substitution.

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



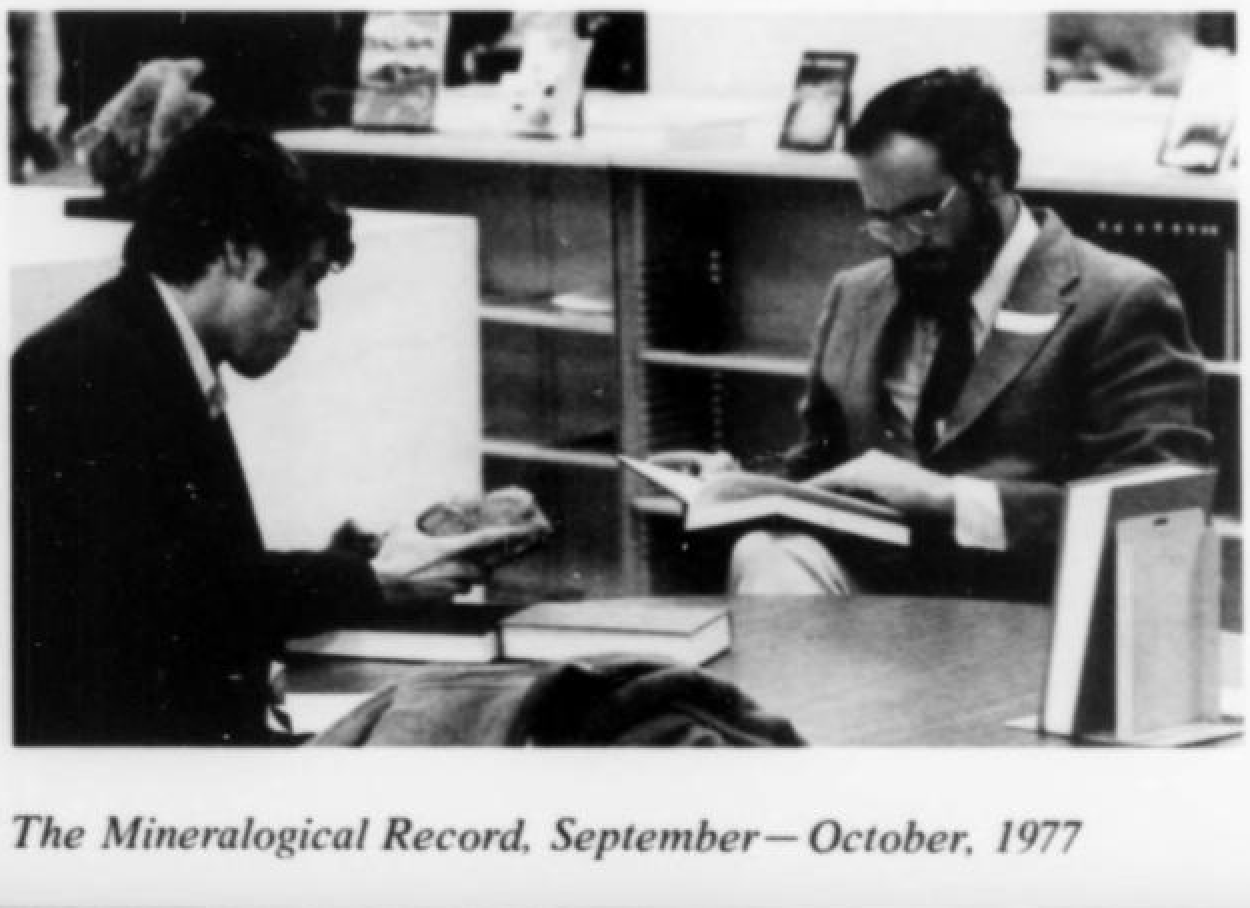
Scheelite with quartz (4 cm tall), Tong Wha, Korea. Smithsonian specimen.

THE SMITHSONIAN'S NEW NATURALIST CENTER

Can a Natural History Museum offer something more to the serious student of natural history materials than what the average visitor sees? The Smithsonian believes it can, and has demonstrated this belief in a variety of ways, most of which have been manifested through its "Smithsonian Associates" program in the form of special classes, field trips, lectures and the very successful *Smithsonian* magazine. In addition to these activities, a totally new program has just been added by the National Museum of Natural History (the home of the National Mineral and Gem Collection). It is called the Naturalist Center and it may very well represent a dramatically new approach to getting the public and more specimens together.

The Naturalist Center is a facility which occupies 7,500 square feet of space in the west wing of the Natural History building. It contains collections of plants, animals, fossils, minerals, and ethnographic materials that are available for direct comparison and study. These collections are in drawers in cabinets much like their parent collections within the various departmental research areas throughout the building. The precise nature of the collections may vary from one discipline to another, and are expected to change considerably as the facility matures, but the initial emphasis has been placed on establishing systematic and regional collections. There are also books, slides, taped lectures, sound recordings (bird calls!) and other resources available for use.

Mineral enthusiasts will find several collections into which they may delve. The largest is the micromount collection of Cecil Graves of Colorado, recently donated to the Smithsonian (8,000 mounts). Next in size is a systematic collection of minerals arranged by composition (after Dana) containing approximately 2,000 specimens. There is also a smaller collection of typical specimens from the Washington, D.C. area found within a radius of about 50 miles. Where else can local collectors sit and study a systematic collection of minerals at their leisure? What other large micromount collection is available for public inspection, complete with a good microscope? Obviously, the Center will most benefit those who live within easy commuting distance of the Museum but others may use it as well when they visit Washington. The Center is staffed by a fulltime professional manager with scientific training as well as a large number of volunteers who have received special training in specific disciplines. These people will work closely with visitors to the Center.



The specimens for the Naturalist Center have come mostly from collections within the Museum. They are being supplemented by donations from collectors and it is anticipated that eventually the Center will be able to afford to purchase specimens as well.

The development of the facility will depend very much upon grants or gifts of funds, and upon the generosity of scientific supply houses and other manufacturers in providing equipment, furniture, reference books, charts, scientific tools and furnishings. One of the earliest and most important donations to the mineral section was a set of 5 universal cabinets containing 10 drawers each, from Ward's Natural Science Establishment, through the efforts of Bert Vander Schaaff, manager of the Geological Sciences Division. Additional specimens, equipment and furniture for improvements will have to be contributed, however, as only partial funding is available through the Natural History budget.

Anyone who is interested in attending or supporting the Naturalist Center should write to:

Mrs. Joan C. Madden
Room C219
National Museum of Natural History
Smithsonian Institution
Washington, D.C. 20560

→

OBSERVATIONS ON UGANDA TYCHITE

Abstract

Tychite, $Na_6Mg_2(SO_4(CO_3)_4$, crystals have been found to exist at an average depth of 10 cm below the bed of Lake Katwe in western Uganda. The shape of these crystals varies from perfect octahedra to cases where the corners of the octahedra are replaced by cube faces. The largest crystals observed are about 8 mm from end to end, but only the smallest appear clear and nearly free from inclusions. The density varies much from sample to sample, but the refractive index and the unit cell size do not vary significantly.

INTRODUCTION

It seems that the only known source of tychite is Searles Lake (or Borax Lake), San Bernardino County, California; see, for example, Palache, Berman and Frondel (1951). Recently, the authors came across beautiful crystals from Lake Katwe in western Uganda. On identification, by x-ray powder diffractometry, the crystals turned out to be tychite, as a comparison between our data and those of Keester, Johnson and Vand (1969) clearly shows. Unfortunately, most of the crystals so far observed have inclusions; only the smallest appear clear.

A considerable variation in the density has been observed, but the refractive index and the unit cell size do not show much variation.

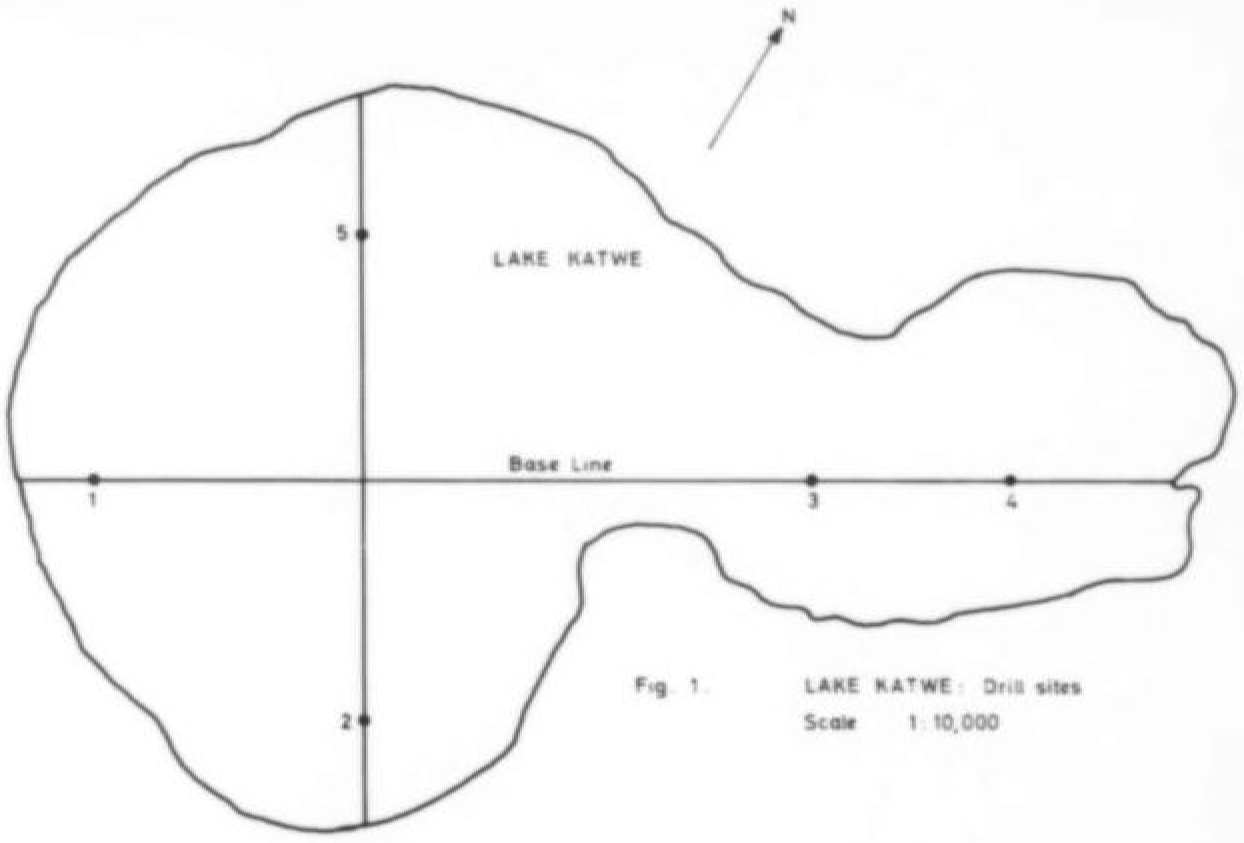
OCCURRENCE

Lake Katwe is the largest (about 260 hectares) of several saline, shallow crater lakes situated in the western Rift Valley. High evaporation rates and low rainfall (about 76 cm per annum) have concentrated salts in the lake brine, resulting in deposition of up to 43 m of salts mixed with clay on the bed of the lake. The deposit is divisible into three stratigraphic zones: the Upper Zone which is a relatively thin crust of mixed salts but dominated by trona, $Na_2CO_3 \cdot NaHCO_3 \cdot 2H_2O$, and halite; the Middle Zone characterized by layers of burkeite, $Na_4CO_3 \cdot 2NaSO_4$, and trona mixed with clay; and the thick Lower Zone mainly consisting of trona, with a number of layers of tychite and northupite, $MgCO_3 \cdot Na_2CO_3 \cdot NaCl$.

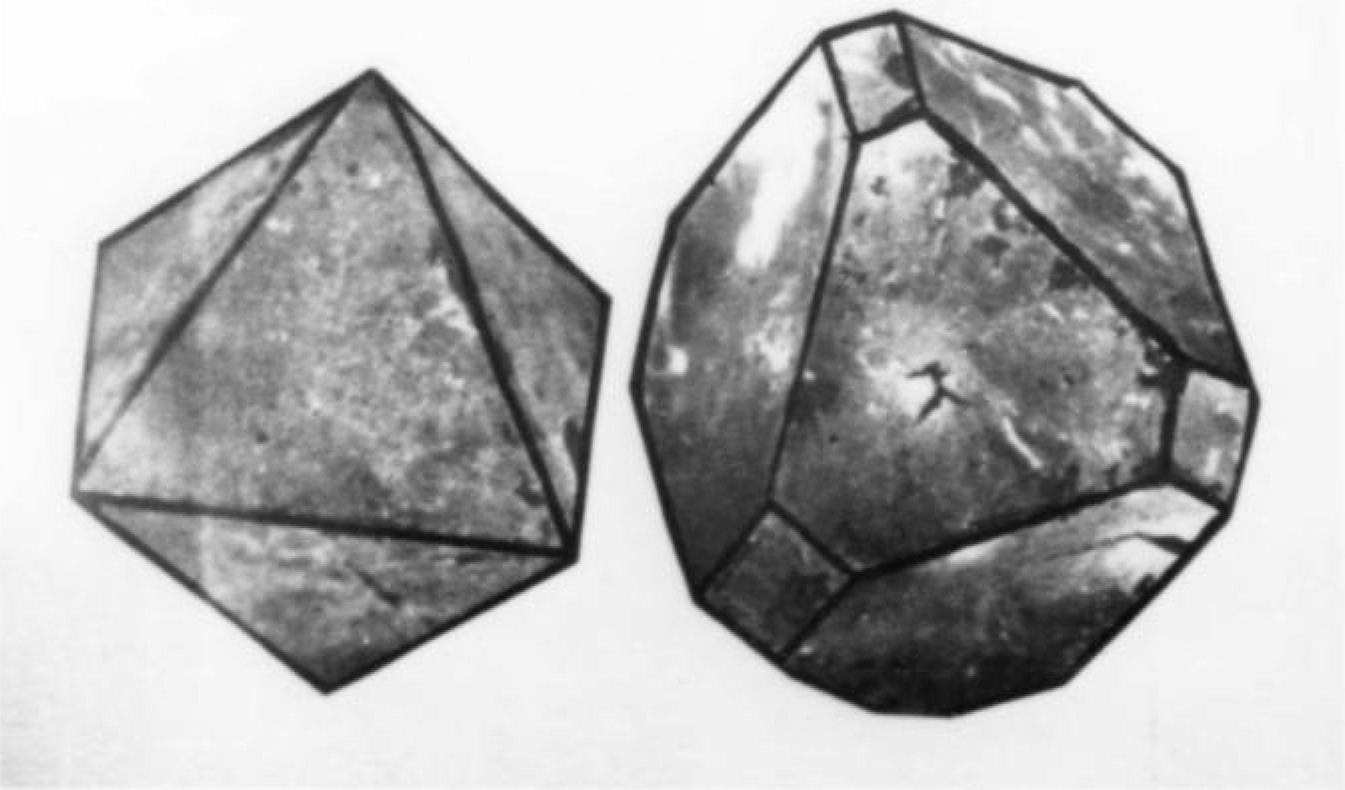
Figure 1 is a sketch of Lake Katwe and shows the boreholes from which the crystals were obtained during a dry season. Samples from the same depths in different pits have similar compositions.

Figure 2a shows a crystal sample having an unmodified octahedron shape, and 2b shows a sample with severely truncated corners. The majority of the samples have shapes lying between these extremes. The powder x-ray diffraction data used for identification were obtained with a Philips diffractometer. Additional, very weak, lines were observed with the following *d* values: 3.48, 1.458, 1.395, 1.363, 1.296 and 1.206 Å. The inclusions giving rise to these lines have not been clearly identified, but some of these lines could be ascribed to kaolin.

For four crystal samples examined, the density was observed to vary from 2.367 g/cm³ to 2.743 g/cm³ at 25°C. Slight variations in the unit cell size have been observed, the smallest value being 13.880 Å and the biggest 13.942 Å.



Above: Map of Lake Katwe showing location of boreholes.
Below: Tychite crystals, Lake Katwe, Uganda.



ACKNOWLEDGEMENTS

The authors are grateful to the Research and Publication These values were obtained both by least squares fit and by using an extrapolation function. The refractive index, obtained by the liquid immersion method, has been found to be very near the value 1.510 at 25°C, for all the samples. Grants Committee of Makerere University for providing the funds used in this investigation. They are also grateful to L. Onega, of the Uganda Geological Surveys Department, who drew their attention to the crystals and provided the geological information on Lake Katwe.

REFERENCES

PALACHE, C., H. BERMAN and C. FRONDEL (1951), *Dana's System of Mineralogy, Vol. II*, John Wiley and Sons, New York, p. 294.

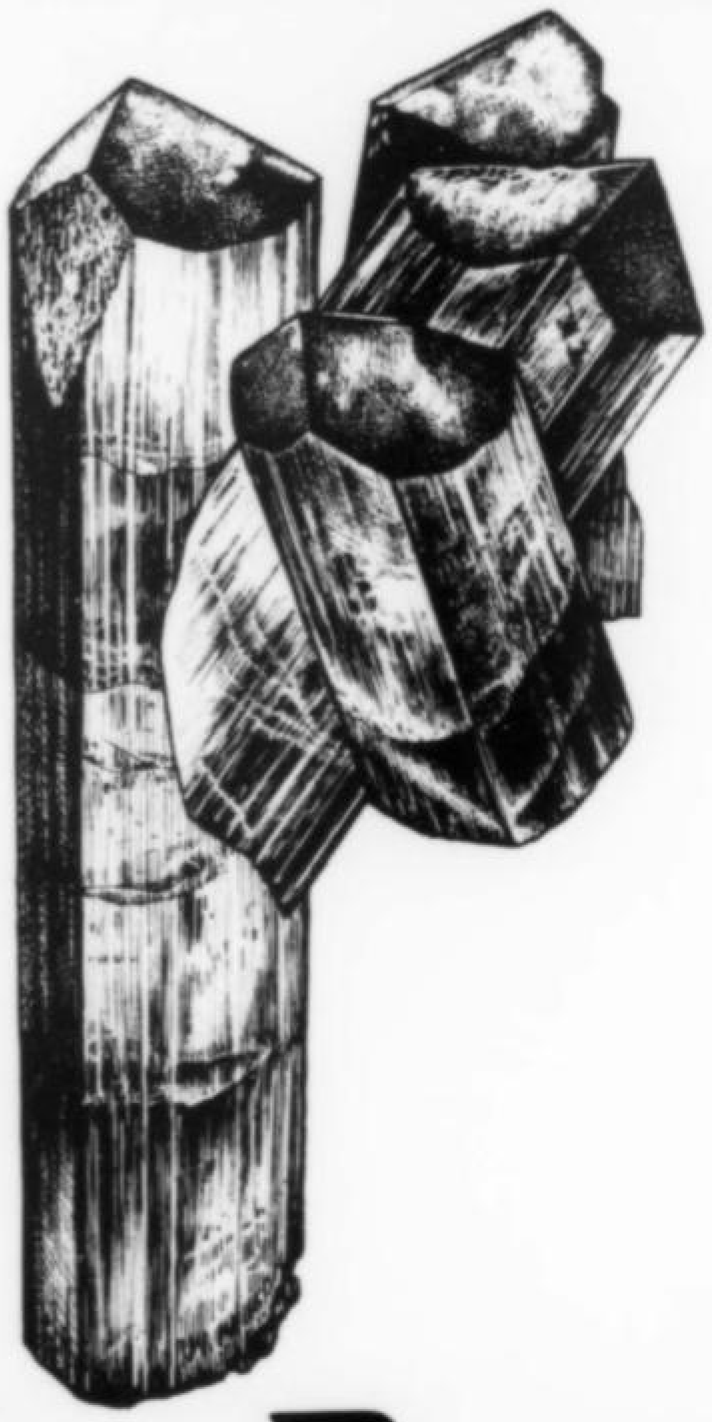
KEESTER, K. L., G. G. JOHNSON, JR. and V. VAND (1969), New data on tychite. *Amer. Mineral.*, 54: 302-305.

J. MWANJE AND Y. KAAHWA
P.O. Box 7062,
Kampala, UGANDA

THE COLLECTOR · FALLBROOK · BEVERLY HILLS · THE COLLECTOR · FALLBROOK · BEVERLY HILLS ·

THE COLLECTOR · FALLBROOK · BEVERLY HILLS ·

THE COLLECTOR · FALLBROOK · BEVERLY HILLS ·



EXPANDING TO SERVE YOU!

Pala Properties brings imagination and ingenuity to serve the collector and decorator. We endeavor to constantly up-grade and bring you the finest of specimens and gems. Our **Collector** shops in Fallbrook and Beverly Hills maintain a line of custom-made creative jewelry, art forms and specimens. Constant influx of new material gives you a new and pleasant experience each time you visit one of our distinctive **Collector** shops. With our tourmaline mines, world travels and quality cutters we bring to you the unusual in fine precious and semi-precious gemstones.

IMAGINATION AND INGENUITY,
PALA PROPERTIES INTERNATIONAL.

WHOLESALE: Minerals/Gemstones/California Tourmaline
RETAIL: THE COLLECTOR in Fallbrook and Beverly Hills, California
Bank of America/135 East Ivy St./Fallbrook, CA 92028

PALA PROPERTIES INTERNATIONAL

PETROLOGICAL THIN SECTIONS

Send us the rocks and we'll prepare the sections mounted on 30x40mm. slides. Individual sections $4.25; 5 from one sample, $3.50 each; 10 from one sample, $2.75 each, including airmail postage (we do not return the surplus rock). Individual quotations given for soft or friable rocks which require impregnation.

We hold in stock thin sections of over 40 British rock types @$2.50 each, inc. airmail postage. Write for list or send $3.00 for our full geological catalogue (refundable on first purchase).

LYTHE MINERALS

Geological Suppliers
36-38, Oxford Street,
Leicester LE1 5XW
England.

TATE MINERALS
833 E. 38th Street
Austin, Texas 78705
(512) 478-4713
by appointment only

The Crystal Habit

Specializing in fine minerals
from
Midwestern locales

BARITE, CALCITE, GALENA
FLUORITE, WITHERITE, ETC.
SPECIFIC INQUIRIES INVITED

P.O. BOX 4041 PORTLAND, MAINE 04101

Dyck's Minerals
95-719 Kipapa Drive No. 37
Mililani, Hawaii 96789
(808) 623-2322
Lists 25¢

Alta Crystal Gallery
MEL AND JOAN REID

*

FINE MINERAL SPECIMENS
FOR COLLECTORS
FROM WORLDWIDE LOCALITIES

*

Open Tuesday thru Saturday
9 a.m. to 5 p.m.
or call for appointment

*

Special requests invited
No mineral lists available

*

(303) 985-2212
3110 South Wadsworth Blvd. —Suite 306
Denver, Colorado 80227

If you want complete information about TSUMEB
G. Söhnge: *Tsumeb, a historical sketch* **$8**— inc.airmail
Bartelke-Fahle: *Tsumeb, list of minerals (179)* **$3**— inc. airmail

OKAVANGO

Put the money in an envelope and send to:
R. Fahle, Klenzestr.-4, D-8 München 5, West-Germany
Specialist in information and minerals from TSUMEB

Second List of Additions and Corrections to Glossary of Mineral Species, 1975

by

Michael Fleischer

A year ago [*Mineralogical Record* 7, 91-95 (1976)], a list of additions and corrections to the 1975 Glossary was published. Since then, some 43 new minerals have been described, and publication of new data has required that formulas be changed or symmetry be corrected. The present list attempts to keep you informed of such changes and to correct errors previously made.

PAGE	MINERAL
1	**Abelsonite**, add *61*, 502 (1976)
1	**Acetamide**, add *61*, 338 (1976)
2	**Agrellite**, $NaCa_2Si_4O_{10}F$, tric., *62*, 173 (1977)
3	**Alloclasite**, change orth. to mon.
3	**Alstonite**, change orth to tric., ps. orth.
3	**Althausite**, add *61*, 502 (1976)
4	**Analcime**, formula $NaAlSi_2O_6 \cdot H_2O$
4	**Anapaite**, formula $Ca_2Fe(PO_4)_2 \cdot 4H_2O$
7	**Arsenopalladinite**, change formula to $Pd_8(As,Sb)_3$, *Can. Mineral. 15*, 70-73 (1977)
8	**Atokite**, add *61*, 338 (1976)
9	**Balipholite**, add *61*, 338 (1976)
9	**Baratovite**, $KCa_8Li_2(Ti,Zr)_2Si_{12}O_{37}F$, mon., ps. hex., *61*, 1053 (1976)
10	**Baricite**, $(Mg,Fe^{+2},Fe^{+3})_3(PO_4)_2(OH)_8 \cdot (8-x)H_2O$, mon., compare **Vivianite**, *61*, 1053 (1976)
10	**Barrerite**, $(Na,K,Ca)_7(Al_2Si_7)O_{18} \cdot 7H_2O$, orth., **Zeolite** group, *61*, 1053 (1976)
10	**Baumite**, add *61*, 174 (1976)
11	**Baylissite**, $K_2Mg(CO_3)_2 \cdot 4H_2O$, mon.
11	**Bazirite**, add *61*, 175 (1976)
11	**Benitoite**, add compare **Bazirite**, **Pabstite**
14	**Biteplapallidite** = **Merenskyite**, *61*, 174 (1976)
14	**Biteplatinite** = **Moncheite**, *61*, 174 (1976)
14	**Bjarebyite**, add compare **Kulanite, Perloffite**
15	**Bonaccordite**, add *61*, 502 (1976)
15	**Borcarite**, change mon. to tric.
15	**Borishanskiite**, add *61*, 502 (1976)
15	**Bornemanite**, add *61*, 338 (1976)
16	**Bredigite**, $Ca_{14}Mg_2(SiO_4)_8$, orth., ps. hex., *33*, 786, (1948), *61*, 74-87 (1976)
17	**Buetschliite**, add dimorph. with **Fairchildite**
20	**Carlfriesite**, add *61*, 1053 (1976)
20	**Carrboydite**, $(Ni,Cu)_{14}Al_9(SO_4,CO_3)_6(OH)_{43} \cdot 7H_2O$, hex., green, *61*, 366-372 (1976)
21	**Caysichite**, add *61*, 174-175 (1976)
21	**Ceruleite**, $Cu_2Al_7(AsO_4)_4(OH)_{13} \cdot 11\ \frac{1}{2}H_2O$, tric., turquoise-blue
26	**Cobalt-zippeite**, $Co(UO_2)_6(SO_4)_3(OH)_{10} \cdot 16H_2O$, orth., yellow, *Can. Mineral. 14*, 429-436 (1976)
28	**Creaseyite**, add *61*, 503 (1976)
28	**Crichtonite**, $(Sr,La,Ce,Y)(Ti,Fe,Mn)_{21}O_{38}$, trig., *61*, 1203-1212 (1976), compare **Senaite**
30	**Daomanite**, add *61*, 184 (1976)
31	**Darapiosite**, $KNa_2LiMnZnZrSi_{12}O_{30}$, hex., **Osumilite** group, *61*, 1053-1054 (1976)
31	**Dayingite**, add *61*, 184 (1976)
31	**Deerite**, $(Fe^{+2},Fe^{+3},Mn)_{12}Si_8(O,OH)_{32}$, mon., ps. orth., *50*, 278 (1965)
31	**Delorenzite** = **Tanteuxenite**, *45*, 756 (1960)
32	**Derbylite**, $Fe_4^{+3}Ti_3Sb^{+3}O_{13}(OH)$, mon.,
35	**Eglestonite**, formula $Hg_6Cl_3O_2H$
37	**Eskebornite**, $CuFeSe_2$, tet., forms a series with **Chalcopyrite**, *57*, 1560 (1972)
38	**Falcondoite**, $(Ni,Mg)_8Si_6O_{15}(OH)_2 \cdot 6H_2O$, orth., green, compare **Sepiolite**
38	**Fedorovskite**, $Ca_2Mg_2B_4O_7(OH)_6$, orth., forms a series with **Roweite**, *62*, 173 (1977)
38	**Fengluangite** = antimonian **Guanglinite**, *61*, 184 (1976)
39	**Feroxyhyte**, FeO(OH), hex., polymorph, with **Goethite**, **Lepidocrocite**, and **Akaganeite**
40	**Fersmanite**, $(Ca,Na)_4(Ti,Nb)_2Si_2O_{11}(F,OH)_2$, tric., *16*, 92 (1931), *Can. Mineral. 15*, 87-91 (1977).
41	**Fraipontite**, $(Zn,Al)_6(Si,Al)_4O_{10}(OH)_8$, mon., **Kaolinite-Serpentine** group, *62*, 175 (1977)
41	**Francoanellite**, $H_6K_3Al_5(PO_4)_{18} \cdot 13H_2O$, hex., *61*, 1054 (1976)
44	**Gerstmannite**, $(Mg,Mn)_2Zn(SiO_4)(OH)_2$, orth., pink, *62*, 51-59 (1977)
44	**Gladite**, add *61*, 15-20 (1976)
47	**Guanglinite**, add *61*, 184 (1976)
47	**Guanine**, $C_5H_3(NH_2)N_4O$, mon. (2-amino-6-hydroxypurine)
48	**Hafnon**, add *61*, 175 (1976)
48	**Hammarite**, add *61*, 15-20 (1976)
48	**Harmotome**, change formula to $(Ba,K)_{1-2}(Al,Si)_8O_{16} \cdot 6H_2O$
50	**Hemihedrite**, add compare **Iranite**
51	**Hexatestibiopanickelite**, add *61*, 182 (1976)
52	**Hollingworthite**, add forms a series with **Irarsite**, *61*, 186 (1976)
52	**Hongquiite**, add *61*, 184 (1976)
52	**Hongshiite**, add *61*, 185 (1976)
53	**Hulsite**, add *61*, 116-122 (1976)
54	**Hydrochlorborite**, $Ca_4B_8O_{15}Cl_2 \cdot 22H_2O$, mon., *50*, 2099 (1965), *62*, 147-150 (1977)
56	**Idaite**, change formula to probably Cu_3FeS_4, add *60*, 1013-1018 (1975)
57	**Iraqite**, $K(La,Ce,Th)_2(Ca,La,Na)_5Si_{16}O_{40}$, tet. pale greenish-yellow, compare **Ekanite**, *61*, 1054 (1976)
57	**Irarsite**, add forms a series with **Hollingworthite**, *61*, 186 (1976)
57	**Iridarsenite**, add *61*, 177 (1976)
58	**Isoferroplatinum**, add *61*, 338-339 (1976)
58	**Isostannite** = **Kesterite**, *62*, 176 (1977)
58	**Jagowerite**, add *61*, 175 (1976)
59	**Joaquinite**, in formula change $(OH,F)_2$ to (OH,F)
59	**Joliotite**, $(UO_2)CO_3 \cdot nH_2O$, n near 2, orth., yellow.
59	**Jordanite**, change formula to $Pb_{14}As_6S_{23}$
60	**Junitoite**, $CaZn_2Si_2O_7$, orth., hemimorph., *61*, 1255-1258 (1976)
60	**Jurbanite**, $Al(SO_4)(OH) \cdot 5H_2O$, mon., *61*, 1-4 (1976)
61	**Kankite**, $FeAsO_4 \cdot 3\frac{1}{2}H_2O$, mon., yellow-green
61	**Kegelite**, add *62*, 175-176 (1977)
62	**Keyite**, $(Cu,Zn,Cd)_3(AsO_4)_2$, mono, *Mineral. Rec. 8*, #3, 87-90.
62	**Khuniite**, add *61*, 186 (1976)
64	**Krautite**, add *61*, 503 (1976)
64	**Krutovite**, $NiAs_2$, cub., *67*, 173-174 (1977)
65	**Kulanite**, $Ba(Fe^{+2},Mn,Mg)_2Al_2(PO_4)_3(OH)_3$, tric., blue to green, compare **Bjarebyite**, **Perloffite** *67*, 174 (1977)
65	**Kuranakhite**. add *61*, 339 (1976)
65	**Kusuite**, $(Ce^{+3},Pb^{+2},Pb^{+4})VO_4$, tet., black

65 **Laihunite**, $Fe_3^{+3}Fe_2^{+2}(SiO_4)_3$(?)orth., black
67 **Lazurite**, change formula to $(Na,Ca)_{7-8}(Al,Si)_{12}(O,S)_{24}[SO_4,Cl_2,(OH)_2]_2$
67 **Leiteite**, $(Zn,Fe)As_2O_4$, mono., *Mineral. Rec. 8*, #3, 95-97.
67 **Lemoynite**, formula $(Na,K)_2CaZr_2Si_{10}O_{26}\cdot 5\text{-}6H_2O$
68 **Levyne**, change formula to $(Ca,Na_2,K_2)_3(Al_6Si_{12})O_{36}\cdot 18H_2O$, add *61*, 853-863 (1976)
69 **Lindströmite**, add *61*, 15-20 (1976)
71 **Magnesioaxinite**, add *61*, 503 (1976)
72 **Magnesium-zippeite**, $Mg_2(UO_2)_6(SO_4)_3(OH)_{10}\cdot 16H_2O$, orth., yellow, *Can. Mineral. 14*, 429-436 (1976)
72 **Majakite**, PdNiAs, hex.
72 **Malanite**, add *61*, 185 (1976)
73 **Mangan-neptunite**, formula $Na_2KLi(Mn,Fe)_2Ti_2Si_8O_{24}$
74 **Masutomilite**, $K(Li,Mn,Al,Fe)_3(Si,Al)_4O_{10}(F,OH)_2$, mon., pink, Mica group
75 **Mawsonite**, $Cu_6Fe_2^{+3}SnS_8$, tet.
75 **Mazzite**, add *60*, 340 (1975)
75 **Meixnerite**, add *61*, 176 (1976)
78 **Metavoltine**, formula $K_2Na_6Fe^{+2}Fe_6^{+3}(SO_4)_{12}O_2\cdot 18H_2O$
82 **Nakauriite**, $Cu_8(SO_4)_4(CO_3)OH)_6\cdot 48H_2O$, orth., fib., sky-blue
83 **Nanlingite**, $CaMg_3(AsO_3)_2F$, trig., brownish-red
83 **Natisite**, add *61*, 339 (1976)
83 **Natrosilite**, $Na_2Si_2O_5$, mon., *61*. 339-340 (1976)
83 **Naujakasite**, formula $Na_6(Fe^{+2},Mn)Al_4Si_8O_{26}$
84 **Nickelhexahydrite**, delete hyphen in name
84 **Nickel-zippeite**, $Ni_2(UO_2)_6(SO_4)_3(OH)_{10}\cdot 16H_2O$, orth., yellow, *Can. Mineral. 14*, 429-436 (1976)
86 **Offretite**, formula $(K_2,Ca)_5(Al_{10}Si_{26})O_{72}\cdot 30\text{-}32H_2O$, add *61*, 853-863 (1976)
87 **Olmsteadite**, $K_2Fe_4^{+2}(Nb,Ta)_2(PO_4)_4\cdot 4H_2O$, orth., deep brown to black, *61*, 5-11 (1976)
87 **Orpheite**, add *61*, 176 (1976)
89 **Pabstite**, add compare with **Bazirite** and **Benitoite**
89 **Painite**, $CaZrBAl_9O_{18}$, hex., red, *42*, 580 (1957), *61*, 88-94 (1976)
89 **Palladobismutharsenide**, $Pd_2(As,Bi)$, orth., *Can. Mineral. 14*, 410-413 (1976)
89 **Palygorskite**, add compare **Yofortierite**
90 **Parakeldyshite**, $Na_2ZrSi_2O_7$, tric., Can Mineral. 15, 102-107 (1977)
90 **Parapierrotite**, add *61*, 504 (1976)
90 **Paraveatchite** = **p-Veatchite**
91 **Parwelite**, formula $(Mn,Mg)_5SbSiAsO_{12}$
91 **Pekoite**, $PbCuBi_{11}(S,Se)_{18}$, orth., *61*, 15-20 (1976)
92 **Perloffite**, $Ba(Mn,Fe)_2^{2+}Fe_2^{3+}(PO_4)_3(OH)_3$, mono., *Mineral. Rec. 8*, 112-114. Compare **Bjarebyite**, **Kulanite**.
92 **Petrovicite**, $PbHgCu_3BiSe_5$, orth.
93 **Pinchite**, add *61*, 340 (1976)
94 **Plombierite**, references should be *38*, 735-736 (1953), *39*, 1038 (1954)
96 **Proudite**, $Cu_{0-1}Pb_{7.5}Bi_{9.5}(S,Se)_{22}$, mon., *61*, 839-852 (1976)
99 **Rhodium**, add *61*, 340 (1976)
101 **Roweite**, add forms a series with **Fedorovskite**
101 **Roscoelite**, formula $K(V,Al,Mg)_2(AlSi_3)O_{10}(OH)_2$
101 **Rozhkovite**, $(Cu,Pd)_{3-x}Au_2$, orth.
102 **Rustenburgite**, add *61*, 340 (1976)
105 **Schreyerite**, $V_2Ti_3O_9$, mon.
106 **Seinäjokite**, $(Fe,Ni)(Sb,As)_2$, orth.
106 **Senaite**, $Pb(Ti,Fe,Mn)_{21}O_{38}$, trig., black, *61*, 1203-1212 (1976), compare **Crichtonite**
106 **Senegalite**, $Al_2(PO_4)(OH)_3\cdot H_2O$, orth.
107 **Sepiolite**, add compare **Falcondoite**
107 **Serendibite**, formula $Ca_2(Mg,Al)_6(Si,Al,B)_6O_{20}$
107 **Sherwoodite**, formula $Ca_5AlV_3^{+4}V_{11}^{+5}O_{40}\cdot 28H_2O$
108 **Slawsonite**, $(Sr,Ca)Al_2Si_2O_8$, mon., **Feldspar** group
109 **Sobolevskite**, PdBi, hex., *61*, 1054 (1976)
109 **Sobotkite**, add *61*, 177 (1976)
109 **Sodium boltwoodite**, add *61*, 1054 (1976)
109 **Sodium-zippeite**, $Na_4(UO_2)_6(SO_4)_3(OH)_{10}\cdot 4H_2O$, orth., yellow *Can. Mineral. 14*, 429-436 (1976)
109 **Solongoite**, formula $Ca_2B_3O_4(OH)_4Cl$
112 **Stratlingite**, $Ca_2Al_2SiO_7\cdot 8H_2O$, trig., dark green.
112 **Stringhamite**, $CaCuSiO_4\cdot 2H_2O$, mon., azure-blue, *61*, 189-19 (1976)
113 **Sudburyite**, add *61*, 178 (1976)
113 **Sugilite**, $(K,Na)(Na,Fe^{+3})_2(Li_2Fe^{+3})Si_{12}O_{30}$, hex., **Osumilite** group
113 **Surinamite**, $(Al,Mg,Fe)_3(Si,Al)_2(O,OH)_8$, blue, *61*, 193-199 (1976)
114 **Svetlozarite**, $(Ca,K_2,Na_2)(Al_2Si_{12})O_{28}\cdot 6H_2O$, orth., **Zeolite** group
114 **Tacharanite**, add *61*, 1055 (1976)
117 **Testibiopalladite**, add *61*, 182 (1976)
117 **Tetraferroplatinum**, add *61*, 341 (1976)
117 **Tetranatrolite**, $Na_2(Al_2Si_3)O_{10}\cdot 2H_2O$, tet., **Zeolite** group
117 **Thalcusite**, $Cu_{3-x}Tl_2Fe_{1+x}S_4$, tet.
118 **Tlalocite**, add *61*, 504 (1976)
121 **Tvalchrelidzeite**, $Hg_{12}(Sb,As)_8S_{15}$, mon., *62*, 177 (1977)
122 **Uricite**, $C_5H_4N_4O_3$(2,6,8-trihydroxy purine) mon.
123 **Urantsevite**, $Pd(Bi,Pb)_2$, hex.
123 **Uvite**, $CaMg_3(Al_5Mg)(BO_3)_3Si_6O_{18}(OH)_4$, trig., **Tourmaline** group, *Mineral. Rec.* **8**, 100 (1977).
126 **Vivianite**, add compare **Baricite**.
126 **Vuagnatite**, $CaAl(SiO_4)(OH)$, orth., *61*, 825-838 (1976)
128 **Weibullite**, $Pb_5Bi_8(S,Se)_{17}$, orth., *61*, 839-852 (1976)
128 **Widenmannite**, formula $Pb_2(UO_2)(CO_3)_3$
129 **Wittite**, $Pb_9Bi_{12}(S,Se)_{27}$, mon., 61, 839-852 (1976)
130 **Wroewolfeite**, add *61*, 185 (1976)
130 **Xocomecatlite**, add *61*, 504 (1976)
131 **Yeatmanite**, formula $(Mn,Zn)_{15}Sb_2^{+5}Si_4O_{28}$
131 **Yixunite**, add *61*, 185 (1976)
131 **Yofortierite**, add *61*, 341 (1976)
131 **Yttrocrasite**, formula $(Y,Th,U,Ca)Ti_2(O,OH)_6$
131 **Yuksporite**, $(Na,K)_2(Ca,Sr,Ba)_2Ti_2Si_2O_8F\cdot 2H_2O$ (?), mon. (?) fib., rose-colored.
131 **Zairite**, $Bi(Fe,Al)_3(PO_4)_2(OH)_6$, trig., greenish, **Crandallite** group, *67*, 174-175 (1977)
132 **Zinc-zippeite**, $Zn_2(UO_2)_6(SO_4)_3(OH)_{10}\cdot 16H_2O$, orth., yellow, *Can. Mineral. 14*, 429-436 (1976)
132 **Zippeite**, $K_4(UO_2)_6(SO_4)_3(OH)_{10}\cdot 4H_2O$, orth., yellow, *Can. Mineral. 14*, 429-436 (1976)
134 **Alunite** group. Add Beaverite, **Osarizawaite**
137 **Crandallite** group. Add **Zairite**
137 **Dolomite** subgroup. Add **Norsethite**
138 **Feldspar** group, add **Slawsonite**
139 **Kaolinite-Serpentine** group. Add **Fraipontite**
140 **Mica** group. Add **Masutomilite**, **Tarasovite** X = K, Na, Ca, Ba; Y = Al, Fe^{+3}Cr, V^{+3}, Mg,Fe^{+2},Mn,Zn,Li
142 **Osumilite** group. Add **Darapiosite**, **Sugilite**
145 **Tourmaline** group. Add Uvite
145 **Zeolite** group. Add **Barrerite, Svetlozarite, Tetranatrolite**

NOTES for Collectors

SPECIMEN BASES FOR DISPLAY

Collectors have wrestled with the problem of specimen bases for many years. One often finds that a specimen will not naturally sit in its most aesthetic orientation without some kind of base to hold it there. Even if the specimen does sit well by itself, it may be prone to falling over, with potentially disastrous results to itself or neighboring specimens; in such cases a stabilizing base is also needed. Ten methods currently in use are listed below.

(1) **Wax.** A wax base can be formed by first heating the wax in hot water or in the hand until it becomes soft and pliable enough to form into a base. This base is then pressed onto the back of the specimen and adheres (usually). The main disadvantages of this method are (a) the wax becomes soft under the hot lights of a mineral display and may weaken enough to allow the specimen to fall over, and (b) the wax is not especially aesthetic in color or luster.

(2) **Oil-base clay.** A medium which is easier to work than wax is oil-base clay. It often comes in a variety of colors (I have even found white) which can be mixed and selected to complement or match the color of the matrix. Such clay is not as glossy as wax either, and is therefore more aesthetic. However it shares the disadvantage of wax in that it can soften under hot lights and collapse. It has a more serious disadvantage in that the oil may seep into the matrix or the crystals and discolor them with time, sometimes irreversibly. It also tends to stick to the specimen and is very difficult to completely remove from porous or finely irregular surfaces. In addition it can stain the case liner cloth.

(3) **Plaster.** Display designers at the Smithsonian Institution have long preferred plaster-of-Paris for making specimen bases. It never softens and it presents a non-distracting, dull white surface. The plaster can be painted with watercolors to match the matrix of the specimen. However it requires a certain extra amount of skill and patience. The plaster must be poured into a small mold. The specimen then is wrapped around the bottom with Saran-wrap and is pressed down into the plaster until the plaster hardens. The specimen is removed and the thin plastic sheet is peeled off. The plaster block, with form-fitting indentation on the top, is removed from its mold and must be filed down with plaster-working tools until an aesthetically smooth and rounded form is achieved. This process is messy enough, but there are added disadvantages. The plaster is quite brittle, will leave a chalky residue on cloth liners, and it is impossible to glue anything onto the plaster. Even the current curators at the Smithsonian feel this process is too time-consuming and difficult to use in the future.

(4) **Bases with pegs.** The method now under consideration at the Smithsonian is the manufacture of flat block bases with small pegs inserted into drilled holes in the base. These pegs then brace the specimen in the desired position. The disadvantage is that some collectors may find these even more difficult to make than the plaster bases since they require drilling, forming and finishing of wood or plexiglas for which the amateur may not possess the necessary tools. The pegs, which are visible in the front, are also thought to be unaesthetic by some critics.

(5) **Styrofoam.** The most popular base with collectors today is styrofoam. The procedure is to chop out a section of the styrofoam block in which the base of the specimen will fit, and the specimen is then glued in. There are a variety of advantages. (a) The styrofoam is inexpensive and easy to work. (b) Sometimes awkward portions of the specimen can be buried out of sight in the styrofoam. (c) The bases are essentially immune to upset if the case is bumped by the ubiquitous clumsy spectator. (d) The base can be easily removed because it dissolves completely and quickly in acetone. (e) The base provides a convenient place to attach the display label. No acceptable method has yet been found to paint styrofoam or otherwise make its rough texture agreeable to the eye, but the common solution is to simply wrap the styrofoam base block with a cloth such as velvet. Such bases are somewhat cumbersome, however, and cannot be used easily with small specimens such as thumbnails and small miniatures which one may wish to group closely together.

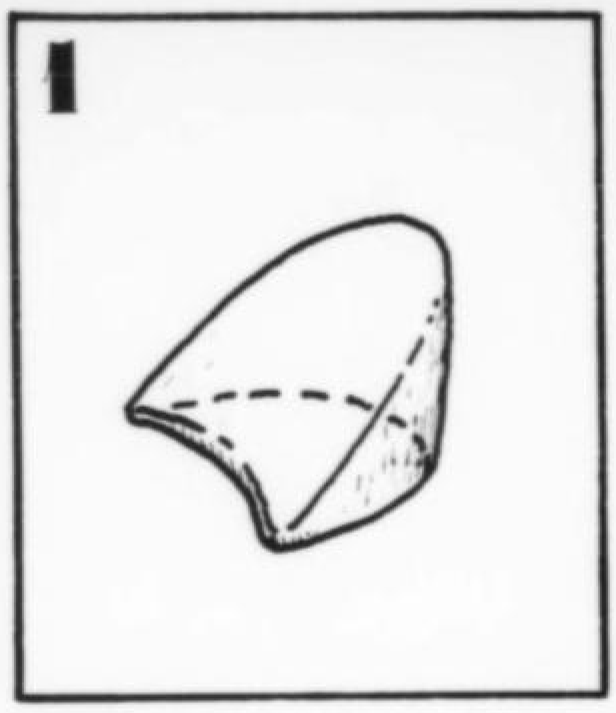
(6) **Silicone rubber.** Some dealers have lately been using silicone rubber, which is clear or white and comes in a tube, to attach specimens to a small square of clear plexiglas. It can be peeled off with only a little difficulty, but is not always aesthetic, nor is the plexiglas base in many cases. Water soluble white glue (such as Elmer's) has also been used in this way, but a great deal of it must usually be used and it is a nuisance to remove.

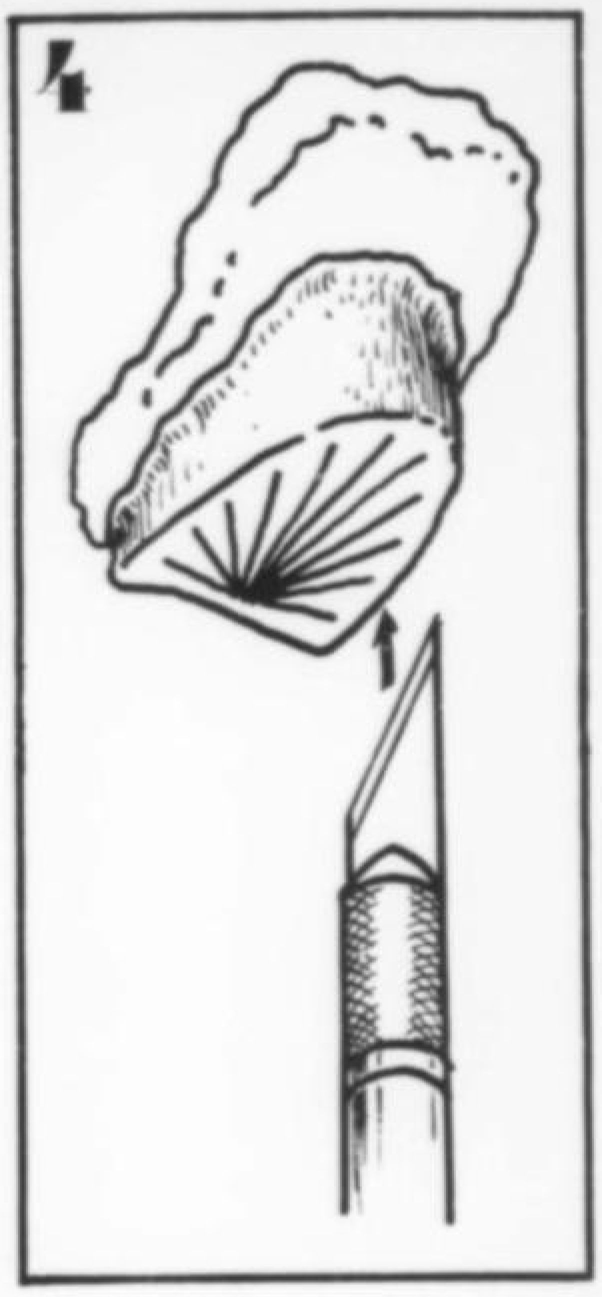
(7) **Pegs on the specimen.** Some museums and a few collectors, especially thumbnail collectors and micromounters, prefer to glue a peg, bar, post, nail or needle to the specimen itself and then insert this into a base. The only drawback of this method is that the specimen simply cannot be displayed on a hard surface such as a glass case, because the peg or nail must be inserted into something. The method is of great value for small pieces and for large specimens which one might desire to balance on a corner for dramatic effect, but for most miniature and larger specimens it can be impractical.

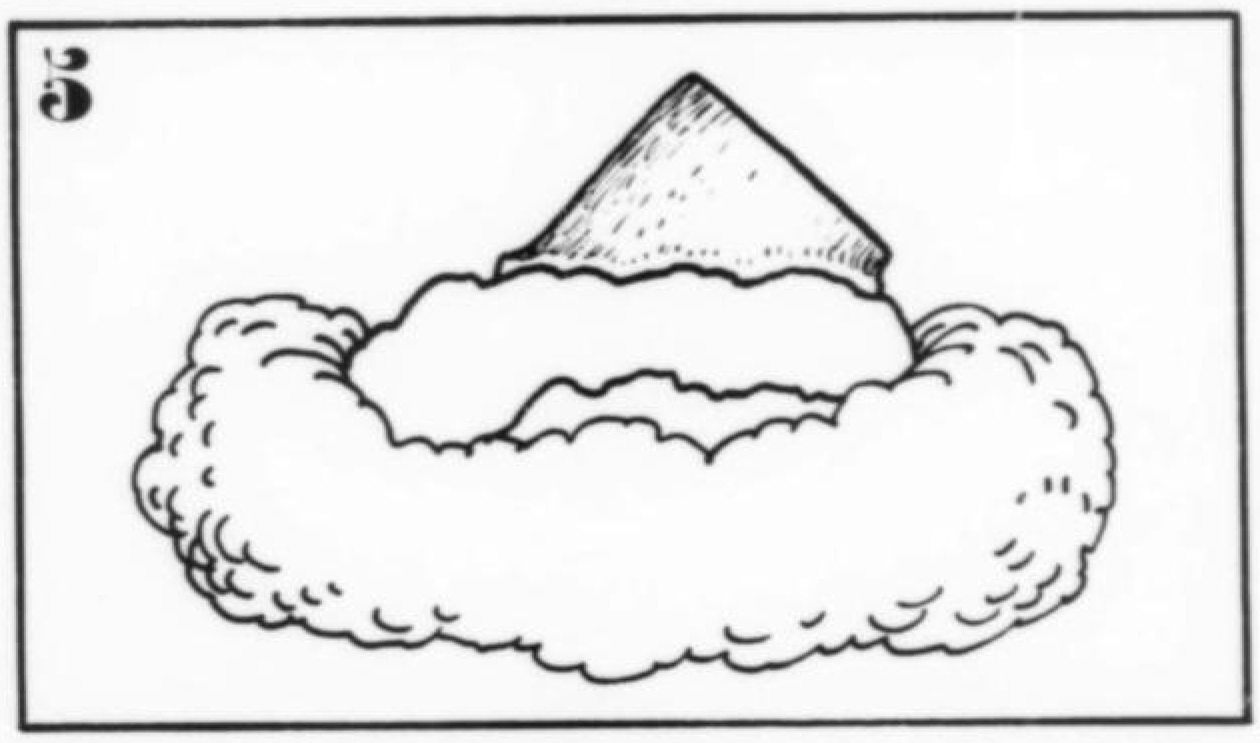
(8) **Wire.** It is possible to bend thick or thin wire into a structure that will hold a specimen upright. Prongs are usually visible on the front and can be unattractive.

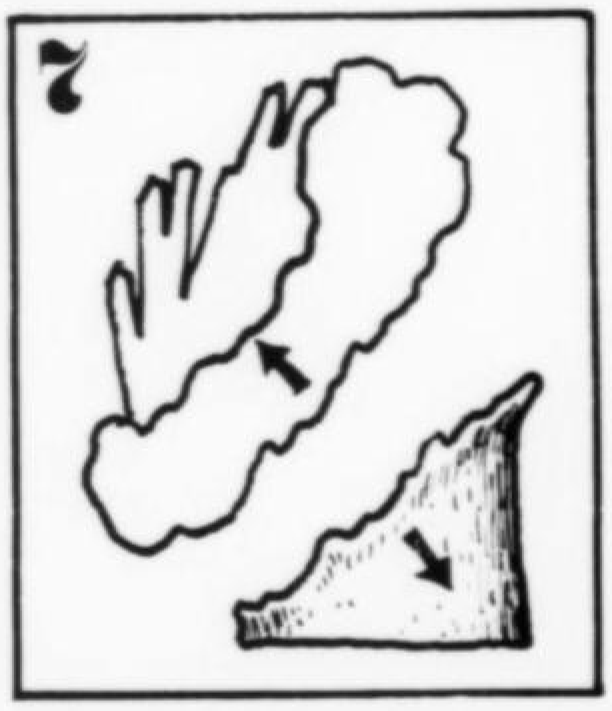
(9) **Commercially made bases.** There are several commercially made bases that have been offered. A base of the peg-on-the-specimen type was marketed as *E.S.P. bases* ("esthetic specimen presentation") by Blakely Minerals, but they are not currently available. Alpha Forms Ltd. and several other manufacturers offer a wide variety of plastic cubes, brass sculptures and the like which appeal mainly to interior decorators rather than collectors.

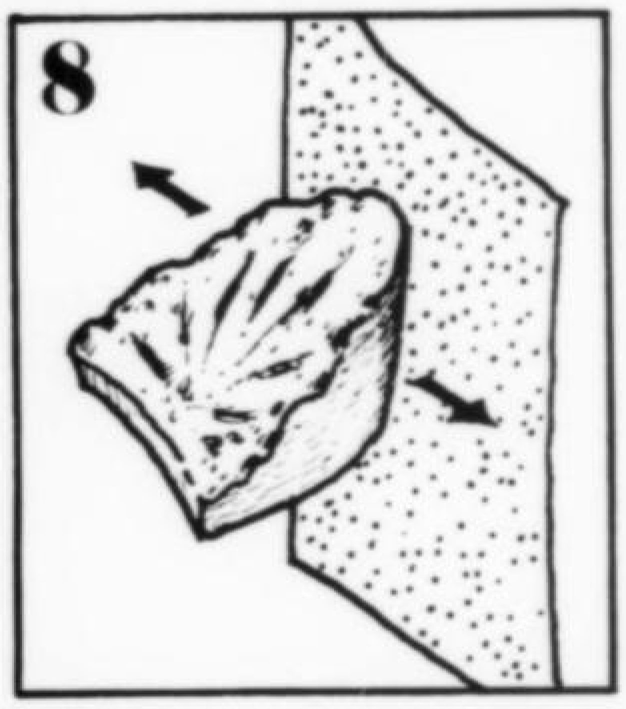
(10) **Hardening water-base clay.** This method is my own favorite, although it is not in common use for some reason. **Play-Doh** is the most readily available brand, and it comes in white. One must form a base by hand and press it onto the base of the specimen. The main disadvantage is that this clay shrinks upon hardening, but this characteristic can be overcome by a simple technique: the interior of the base is cut with an X-acto knife to form shrinkage cracks where they cannot be seen. As the clay dries these slits will open up but the outside dimensions of the base will remain essentially constant. The clay requires 2-3 days to harden, depending on local humidity, and the specimen with attached base must be stored base-up in a nest of cotton while the base dries so that the weight of the specimen does not distort the soft clay before it hardens. After the base is hard it may be left on the specimen or popped off and re-attached with white glue. The final step is to lay a sheet of sandpaper face-up on a perfectly flat surface such as a sheet of glass, and rub the specimen base across it to produce a smooth, flat bottom

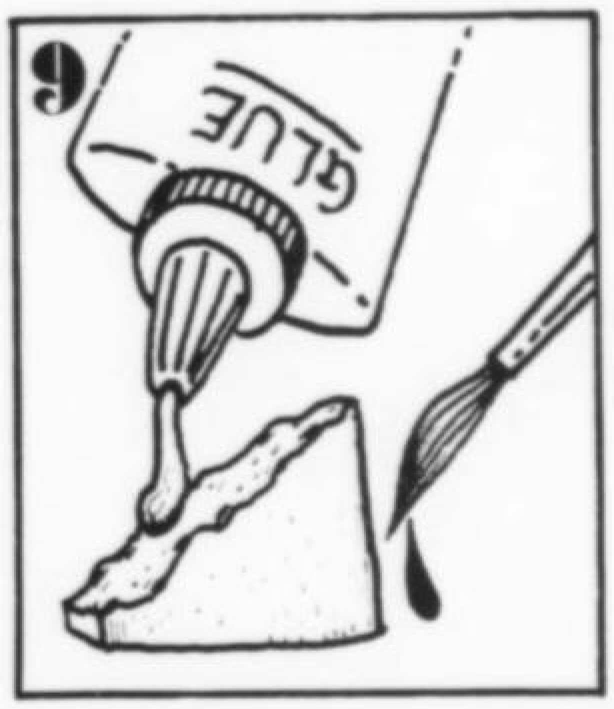












Steps in preparing a Play-Doh specimen base

1. Form a heel-shaped piece of soft clay
2. Press the heel onto the specimen
3. See that specimen sits in the proper orientation
4. Cut expansion cracks with X-acto knife
5. Allow to dry up-side-down for 2-3 days
6. Note widening of expansion cracks when dry
7. Separate base from specimen (optional)
8. Sand to desired smoothness and shape (optional)
9. Paint to desired color (optional) and apply glue
10. Re-attach to specimen
11. Sand bottom on flat surface

on the base. There are significant advantages. (a) The clay will not soften under any amount of heat. (b) The clay completely disintegrates in water after soaking for an hour or two. (c) The base can be sanded with sandpaper to a smooth, agreeable contour before it is re-attached to the specimen. (d) The material is a dull white with the same visual properties as plaster. (e) Glue will adhere to it. (f) It can be painted to match the matrix. (g) It will not stain specimens or liner cloth. (h) It can be formed to the minimum size and is therefore not cumbersome. (i) Specimens so mounted can be placed in any kind of display, either hard or soft bottomed, and arranged as closely together as desired. (j) The method is applicable to any size except micromounts. The only disadvantage is that it requires a little practice in the finger-shaping of the bases, but once mastered it becomes a very convenient mounting method devoid of the usual drawbacks of other methods. I recommend it to all readers.

W.E.W.

NOTE: Reader contributions for this feature are invited. It will appear as often as both the information and the space are available. A very wide variety of topics will be considered for this feature. Correspondence should be directed to the editor.

BOB SULLIVAN'S

LETTER from EUROPE

Spring means many different things to many people, but to the European mineral collector it signals the beginning of a new season. Unlike in the States, where shows run mostly year round, European *bourses* (shows) are concentrated mostly in the Fall. But by mid-December the circuit is dead and collectors must wait for the few Spring bourses that start in March to learn what's new in minerals.

The Heidelberg, Germany, bourse in mid-March and the five-day Easter bourse at Bourg d'Oisans, France, start things off for the German and French mineral enthusiasts but other European collectors must wait until late April or early May to see what new "goodies" the worldwide-roaming European dealers have brought back from their traditional January and February Expeditions. By the way, the majority of European dealers are also serious collectors who act as part-timers to obtain the means with which to build up their collections and to finance an annual "Mineralogical Adventure" during their vacation periods.

While Europe itself still produces a substantial quantity of mineral specimens the demand far exceeds the supply and dealers must, of necessity, head for many distant lands to obtain material. The situation worsened several years ago with Romania formally closing—and severely policing—its borders to the export of minerals specimens, thus cutting off a seemingly endless supply of both beautiful and rare minerals.

As a result some dealers headed for Africa in search of Tsumeb and other African minerals and for a while Morrocco, with its dazzling arrays of vanadinite, skutterudite, azurite, cerussite, etc., had its day in the sun. With the onset a couple of years ago of the recession or depression—call it what you will—collectors pretty much stopped upgrading their collections and could only be tempted by "new" specimens or, in some instances, minerals from new localities.

Brazil, Mexico and the U.S.A. became the focal points of dealers' annual trips with in-between exploratory trips to nearer countries such as Greece, Turkey, Iran, Yugoslavia, and even "forbidden countries" like Hungary, Czechoslavakia, Russia and Bulgaria. To my knowledge, no one has ever dared tackled Albania—yet! Unfortunately for the collector these latter dealer trips proved mostly unproductive or uneconomical but some of the tales that were brought back were indeed most interesting and some quite harrowing.

I know of one dealer-collector who spent four days in a Turkish jail for trying to smuggle out of the country "gold" he had dug. He was finally released when his brother flew in and successfully convinced the authorities that the "gold" was actually pyrite! The tale had a happy ending, however, as he was allowed to keep the pyrites, a large collection of those unique single octahedral crystals that now grace many European and American collections.

I sometimes wonder if collectors are aware of what dealers occasionally experience in their never-ending search for new specimens. Some of the strange tales we have heard would make a book in itself and I hope to occasionally mention in future letters a few "classics".

Those of you fortunate enough to attend the Tucson show this February no doubt became aware of the strange mixture of languages, accents and arm waving that went on day and night, mostly in the dealer rooms of motels surrounding the Community Center. This year the European dealers, some 100 strong, invaded Tucson in a buying and trading spree which many an American dealer will long remember. Several said frankly that without the Europeans they would not have been able to survive over the last year or so in the lean American market. Perhaps some of those dealers who never reply to overseas inquiries—two out of three by actual count—would find it worthwhile to change their tune?

This year at the Heidelberg and Bourg d'Oisans bourses a tremendous quantity of American and Mexican minerals was in evidence at dealers' tables and in many respects their displays were quite the "look alikes." Brazilian material was also plentiful but at very high prices. Outside of Brazil, I think the U.S.A. is the best place to buy Brazilian specimens and during our recent Tucson trip my wife Maudine and I added to our collections a number of fine, reasonably priced pieces.

Two fine "new" minerals did make their appearance this Spring to cause some considerable excitement amongst the early-bird collectors at Heidelberg and Bourg d'Oisans. At Heidelberg it was Turkish kämmererite that stole the show and sent many a collector scurrying to his books to find out what it is. It also appeared at Tucson, and was mentioned briefly, with a sketch, in last issue's *What's New in Minerals?* column. A limited number of superbly crystallized matrix specimens appeared on one dealer-collector's table in mostly 2—8 cm sizes. The kämmererite occurred as brilliant, gemmy, purplish-red, stubby, pseudo-hexagonal crystals up to several mm in diameter and generously sprinkled on a chromite matrix. Some specimens were also lightly sprinkled with 1—2 mm, doubly terminated, white calcite crystals to add a pleasing contrast to the underlying red kämmererite. Twinned crystals, long needle-like crystals, and an occasional colorless crystal (penninite) were also in evidence. It is the presence of chromium in substitution for iron and aluminum that distinguishes kämmererite from penninite.

The dealer reported that in his own collection he had several pieces with small rosettes of white brucite crystals on the kämmererite, "a previously unreported form." *M.R.* associate editor of photography Olaf Medenbach has taken some marvelous color photos of this kämmererite which just may appear in a future issue of *M.R.* "Like red Tsumeb dioptase" is the way one collector described the impact of this mineral...quite a fitting description!

The locality was given as Kop Duglari, near Erzerum, in East Anatolia, Turkey. The dealer who had been to this remote area last summer said it was "like a trip to the moon." He was reluctant to say much else about his find except to say that the kämmererite did not come from a mine. He was also rather pessimistic about possible future occurrences in the area. Certainly the little that has appeared so far has not been nearly enough to satisfy collectors who go all out when something rare and beautiful does appear.

Disappointingly, the Bourg d'Oisans bourse failed to produce any of those hoped-for superb axinites which have occasionally appeared now for almost a hundred years. Most of the many mines in the area were long ago closed but a few are still being worked for specimens by local collectors. However, in the amateur section two young lads, who had just returned from a three-month digging jaunt in Australia, showed some Tasmanian axinite that was extremely good. The large, gemmy crystals were up to 1.5 cm, on matrix and were a very attractive purplish brown color—it is one to watch for in the future.

Maudine added a very nice "mesitite" (ferroan magnesite) from the nearby "Mine De La Mur" to her miniature collection and many other fine specimens of it were in evidence. The "mesitite" varied from a light tan to a deep brown in color, occasionally iridescent, and the thin discoidal 1—2.5 cm crystals were attractively dispersed amongst clusters of beautiful, clear needle-quartz 3—15 mm in length. The high quality of the Bourg d'Oisans quartz was really a surprise. It comes in all sizes.

I really enjoy the spirit of the French bourses which are run in a very informal manner. Amateurs and traders are most welcome and are granted a metre or two of table space at a very nominal fee. Tailgaters are not chased away and the parade of collectors and "strahlers" (those who dig for minerals) up and down the aisles, each carrying their boxes of trading or sales material, seemed endless. One of these boxes (a miner's) produced a fantastic bournonite—over a dozen brilliant, large 1-2 cm twins on matrix from the famous Isere region—the likes of which I had never seen before. A smart French collector bought it right out from under my nose while I was still standing there with my mouth open!

From a number of the amateurs I was able to obtain a very representative collection of the 40 odd minerals from the Bourg d'Oisans area and at very modest prices. The famous anatase and beautiful dark green discoidal crystals of prehnite on matrix were among the prizes. I couldn't help but think of what a bonanza some of the American micromounters could have had at this show, as material was plentiful, cheap and virtually no European micromounters were around to compete with. Visiting Americans, of which we see many each year, should try to hit some of the smaller shows outside the big city areas and in particular in the mining areas for relatively new and cheaper specimens. During the summer months there are some wonderful small shows, in southern France, for example, and similarly in Italy. The countryside is beautiful, food much better and lodgings far cheaper; in addition, many specimens can be found which never reach the big cities.

Most European bourses are good hunting grounds for the micromounter, for the fascinating hobby of collecting micromounts is still in its infancy here. Two things are accelerating its growth, however. One is the recession and the resultant reduced spending ability of the collector—he can get a lot of mileage for a few franks or marks spent on micromounts. The other is the deliberate effort by several Japanese microscope manufacturers to display their wares to the prospective micromounter even at many of the smaller mineral bourses. Their displays are most informative and anywhere from a dozen to 20 or more setups, complete with micromounts, can be viewed at most bourses these days. Sales are brisk and, as a result, many mineral dealers are now offering micromounts—though not yet in the sophisticated fashion of the Americans.

As we said, a French bourse is more like a circus—also the Italian ones—and with the exception of the hours between 12 and 2 p.m. when all the French proceed reverently to their 2-hour mid-day meal, activity is always at a peak. The French, who have a flair for doing business with many people at a time, have no trouble simultaneously haggling with several different prospective customers over the price of a mineral and closing a deal with a strahler who meanwhile came by with a box of minerals to sell.

Frequently there will be a sudden gathering of collectors, dealers and interested bystanders in various parts of the hall with much commotion, arm waving and many excited voices—usually signalling the arrival of one of those box-bearing boys with something particularly exciting. It was at one of these quick cyclonic gatherings that the hit of the Bourg d'Oisans Bourse surfaced. Maudine made her way with some difficulty to the center of one of these "storms" and 20 minutes later came joyfully back with several of the finest green pyromorphite specimens that I have ever seen.

The "Mine Des Farges" in the department (province) of Correze has for years sporadically produced some really good pyromorphite. The material is in high demand in France and has seldom been exported, even to other European countries. Several years ago a fair quantity of deep green, fern-like, small crystal aggregates appeared and some of it did find its way to the States. I still remember the superb, large specimen of this material Steven Smale displayed in his winning McDole Trophy competition case at Tucson a couple of years back! The older specimens were very aesthetic but lacked brilliance and the crystal sizes were on the smallish side. Nonetheless, it became the standard, particularly colorwise, by which the "Mine Des Farges" pyromorphite has been judged over the last few years. Yield was sporadic however.

The mine now seems to be "alive" again and quite a number of specimens with brilliant, barrel-shaped crystals 2 or more cm in size, attractively clustered on matrix (sometimes of barite) were in evidence on several dealers' tables at Bourg d'Oisans. Unfortunately the material lacked the traditional green color one looks for in pyromorphite and varied from a mustard yellow-brown to a greenish brown, but all very brilliant. Still, they were truly attractive specimens.

The pieces which Maudine uncovered were nearly identical in form and crystal size but the color varied from a brilliant grass-green in crystals up to 1 cm to an equally brilliant olive-green in the larger crystals (up to about 2 cm). The largest green crystal was an unbelievable 2.5 cm beauty. Some of the specimens were very attractive stalactitic clusters 4—7 cm long showing only a few points of attachment. Most specimens were of small to medium size and the largest was a superb plate 10 x 12 cm, completely covered with brilliant grass-green crystals! It was sold to a Paris dealer (for $1200) who claimed it would bring nearly $3000 on the traditionally high Paris market.

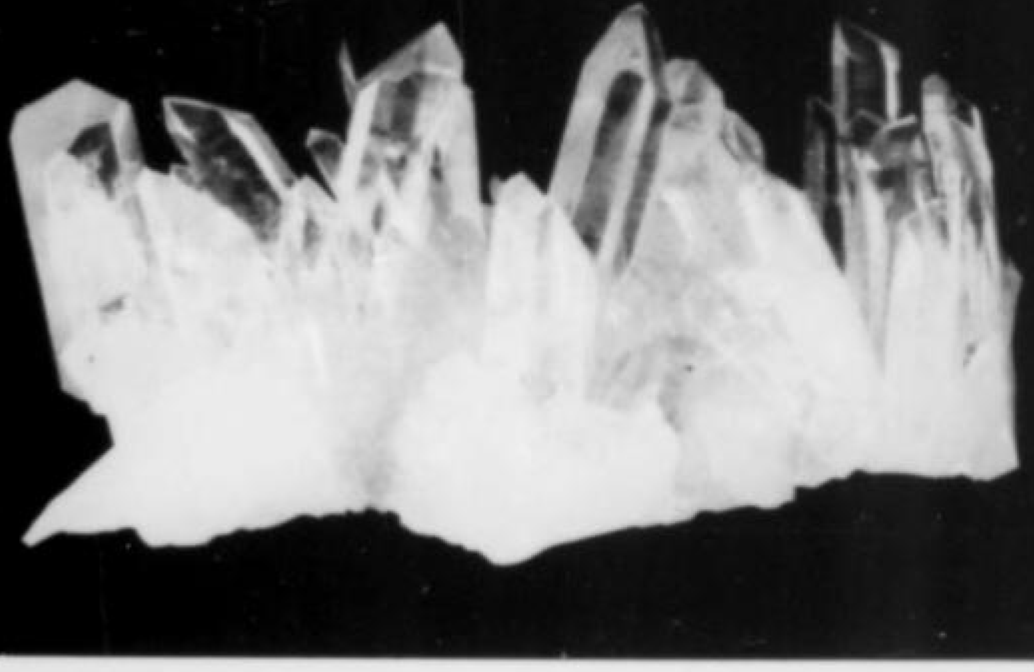
The bearer of this pyromorphite claimed they were picked by the miners only a few weeks before from several small pockets in the "Mine Des Farges" and some 50—60 really good green pieces were recovered. A few of these went directly to American dealers so keep your eyes open, for in our opinion this pyromorphite does rank with the world's best. Let's hope there will be more.

A final "story." The morning after Wendell Wilson's letter arrived confirming the establishment of *this* letter as a column in the *Record*, Maudine and I sat at the breakfast table chewing over possible material, format etc. Our ten-year-old son Bobby, who has travelled to many bourses with us, sat intently and patiently listening to this discussion, but finally interrupted to have his say. "Well Dad, I know how you can start the letter—just say, Hi Rockhounds!." With that I leave you.

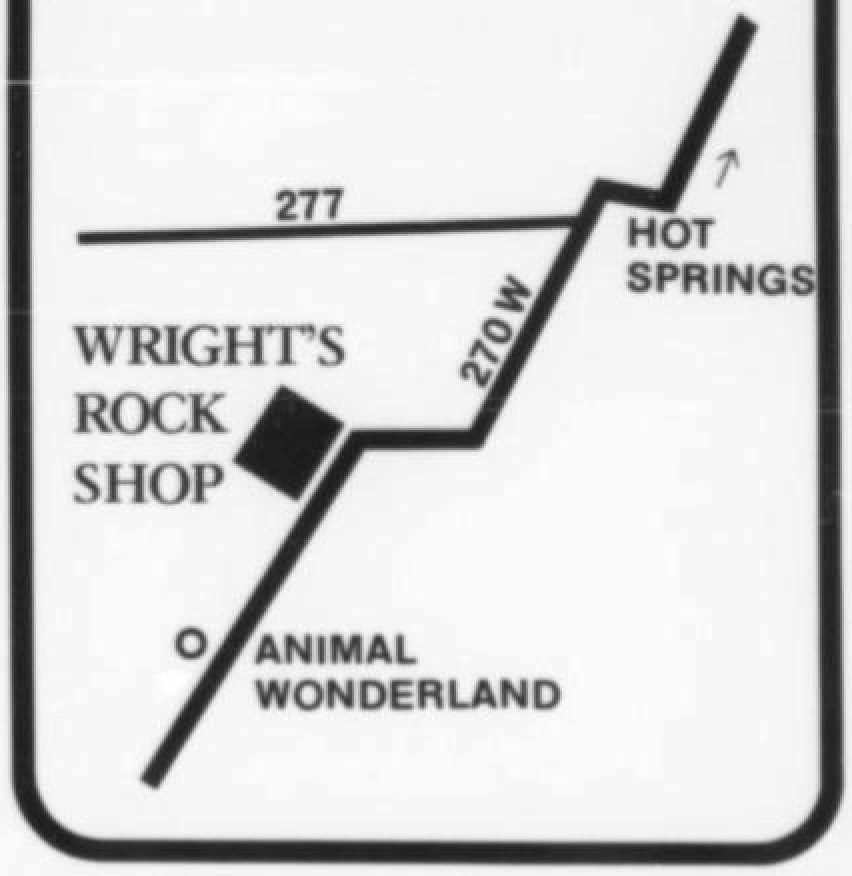
Cheers,

Bob Sullivan

Alte Bühlhofstrasse 10
8303 Oberwil, Switzerland



QUARTZ
HOT SPRINGS,
ARKANSAS



Valuable protection for INVALUABLE COLLECTIONS!

PERMANENT
SPECIMEN PRESERVATION

with Lane

Geology & Mineralogical
SPECIMEN CABINETS

- Double Wall Construction
- Pest-Proof and Air Tight Seal
- Double Panel Door
- Lift-Off Safe Type Hinge

Lane
SCIENCE EQUIPMENT CORP.
105 Chambers Street, New York, N.Y. 10007

Lane Science Equipment Corp., Dept. MR
105 Chambers St., New York, N.Y. 10007

Please send complete details on Lane Geology and Mineralogical Specimen Cabinets to:

Name__________ Title__________

Address__________

____

City__________ Zone____ State__________

HANSEN MINERALS

Dr. Gary R. Hansen
1223 Port Royal, St. Louis, Missouri 63141

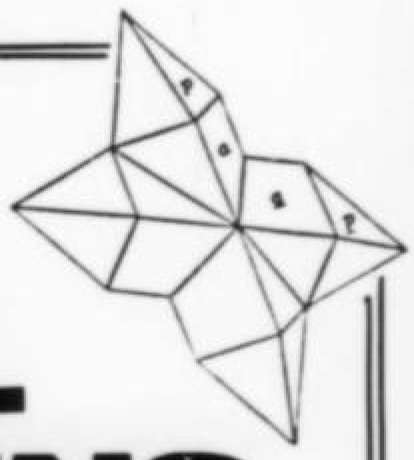
Mineralogical specimens
for museums, private collectors
Reference sets
Investment Gemstones

NOTICE: ESTATE LIQUIDATION OF A FINE

MINERAL COLLECTION

We are acting as the agent for the sale of a very fine collection involved in a property settlement. There are 151 pieces, small cabinet specimens to miniatures, including many excellent wulfenites. A descriptive list with retail appraisals is available. The collection must be sold as a unit; the selling price is $34,000, which is 60% of the appraised retail value.

Agent: Hansen Minerals, Dr. Gary R. Hansen
1223 Port Royal, St. Louis, Missouri
63141
Tel. 314-569-0842



FINE MINERAL SPECIMENS

Visit Our Booth at
MAJOR WESTERN
U. S. SHOWS

New Selections Available:

Dioptase, *South West Africa*
Melanite Garnet, *California*
Lazulite, Wardite, Augelite, *Canada*
Rare Sulfosalts, *Republic of China*
Pyromorphite, *France*
Silver, *Mexico*

Rare Species and
SELECTED FINE MINERAL SPECIMENS
from Worldwide Locales

SEND 26¢ POSTAGE FOR LISTS

MINERALOGICAL RESEARCH COMPANY
15840 EAST ALTA VISTA WAY
SAN JOSE, CALIFORNIA 95127 U.S.A.

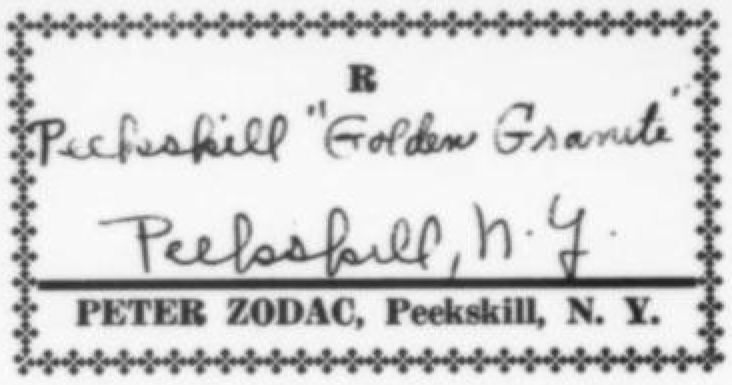
THE HISTORICAL RECORD

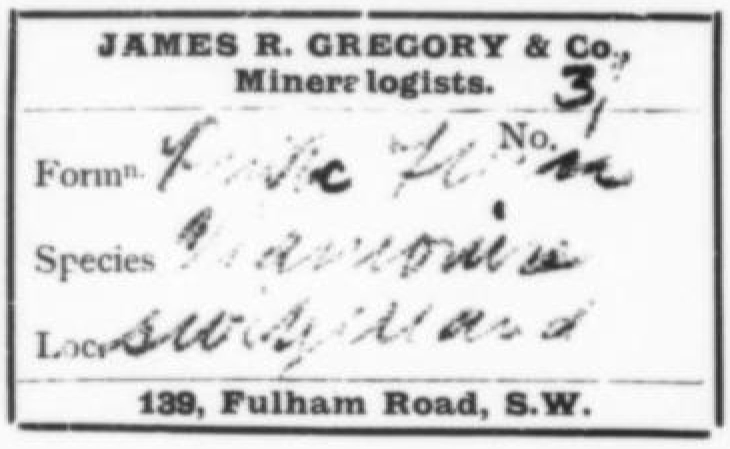
by
Ron Bentley

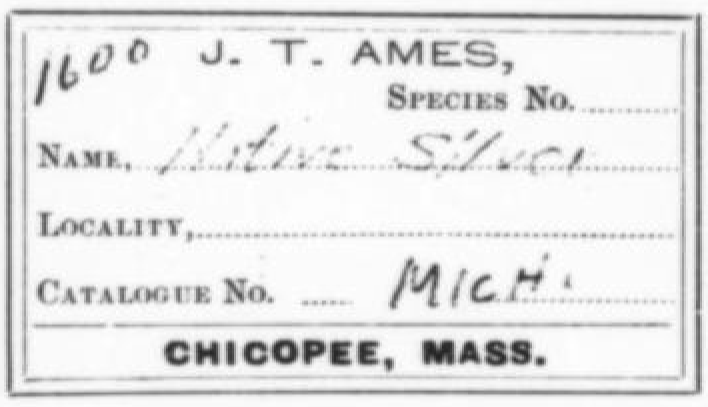
P.O. Box 366
Windsor, Connecticut 06095

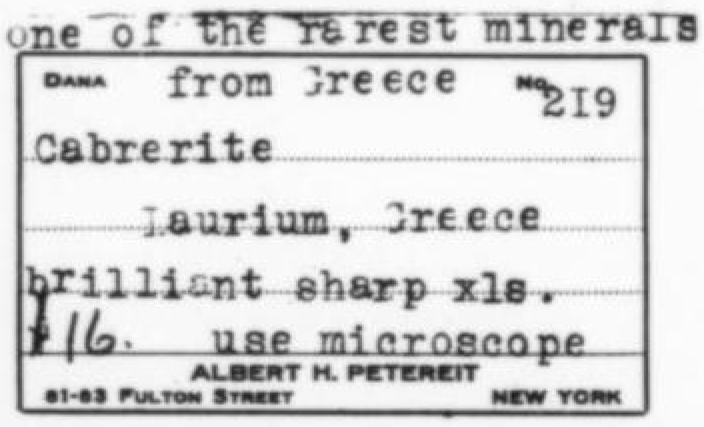
We're all aware that the hobby of mineral collecting has grown phenomenally within the last ten years. The fact that we have a publication such as the *Mineralogical Record* is evidence of that. With this growing interest there has also been a growing interest in the history of our hobby, enough, I think, to warrant a new column: the *Historical Record*. Basically, the *Historical Record* will be an informative column covering such diverse topics as old mineral labels, old mining lamps and equipment, old mineralogy books, biographies of old dealers and collectors; in short, anything that's old and has something to do with our mineral heritage. I also hope that you, the reader, will help make it your column by suggesting topics, disagreeing with my opinions, asking questions, sending in information, etc. As some of these areas may be unfamiliar to some of our readers, I plan to use the first few columns to lay a basic foundation on which to build. Thus, the focus of this first column will be on label collecting. Old labels have recently enjoyed a new popularity. When I started collecting them in 1971, most dealers looked at me rather strangely when I asked them for old labels. Today, however, I'm liable to find myself on a waiting list.

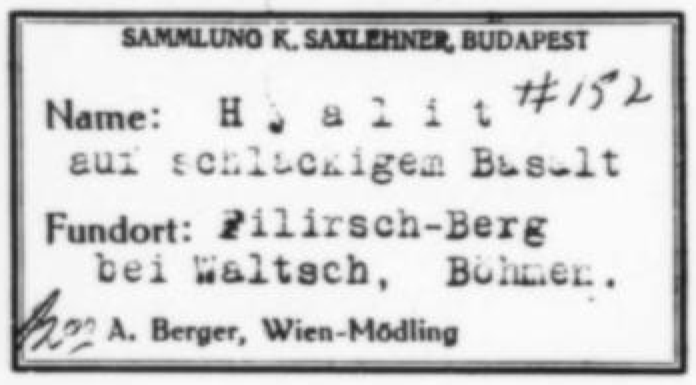
But let's look first at *today's* labels for a moment, before getting back to the old ones. In a small way, every collector who buys a specimen is a label collector in that he receives the dealer's and possibly earlier owners' labels with the specimen. It's unfortunate that,

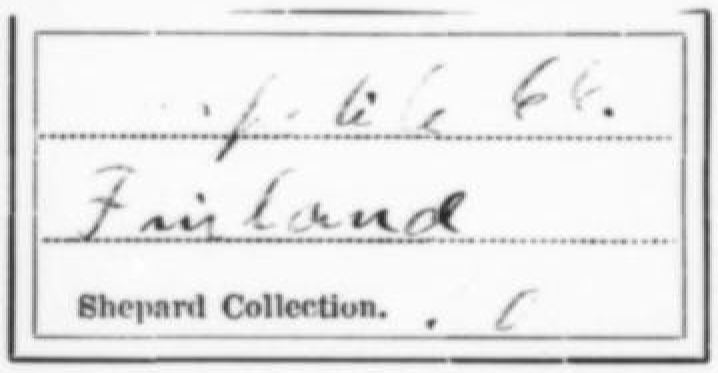

R
Peekskill "Golden Granite"
Peekskill, N.Y.
PETER ZODAC, Peekskill, N. Y.

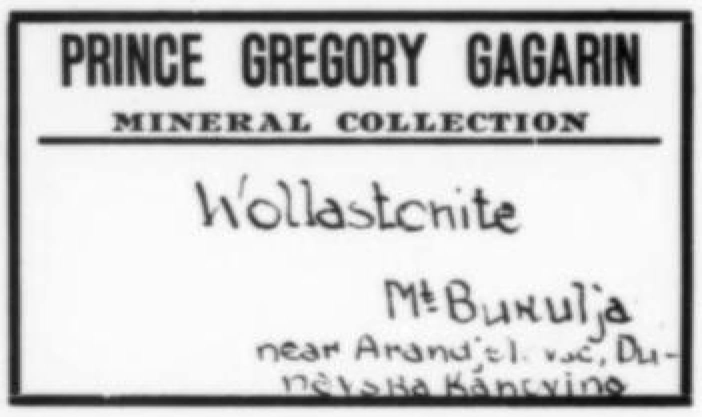

JAMES R. GREGORY & Co.,
Minera logists.
No. 3,
Formn. [illegible]
Species [illegible]
Loc. [illegible]
139, Fulham Road, S.W.

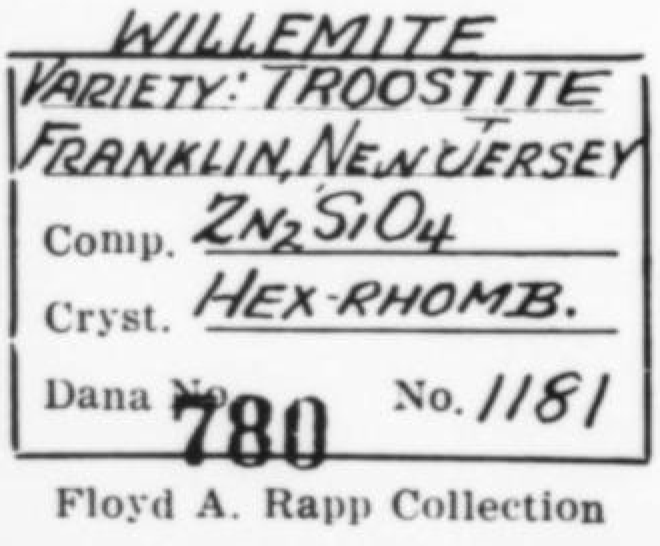

1600 J. T. AMES,
SPECIES No.
NAME. Native Silver
LOCALITY,
CATALOGUE No. Mich.
CHICOPEE, MASS.

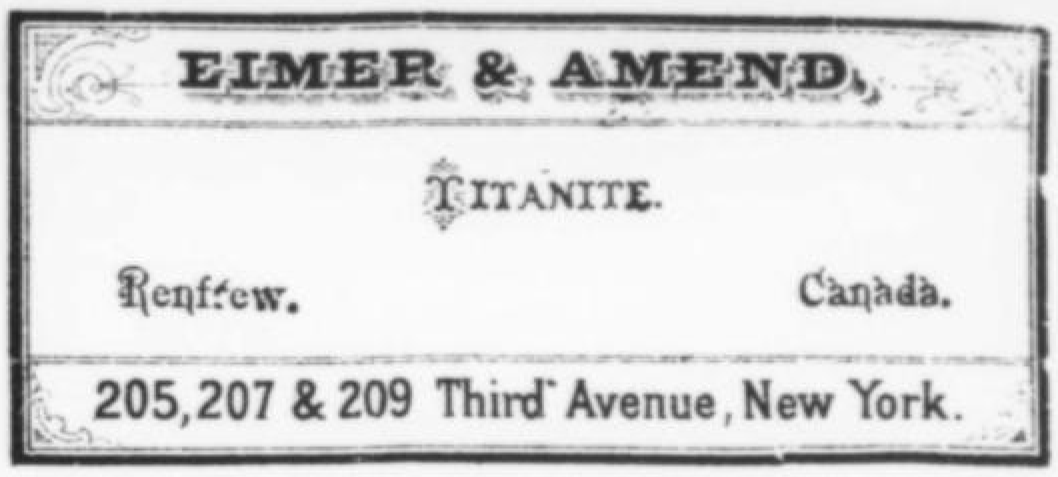

one of the rarest minerals
DANA from Greece No. 219
Cabrerite
Laurium, Greece
brilliant sharp xls.
$16. use microscope
ALBERT H. PETEREIT
61-63 FULTON STREET NEW YORK

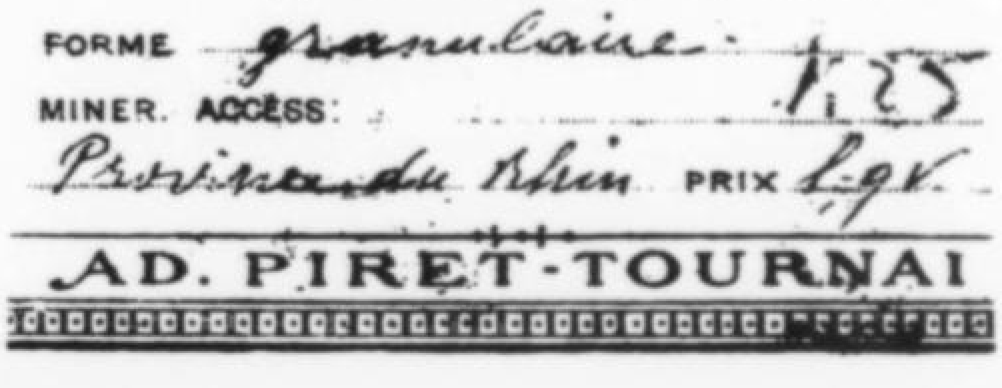

SAMMLUNG K. SAXLEHNER, BUDAPEST
Name: Hyalit #152
auf schlackigem Basalt
Fundort: Pilirsch-Berg
bei Waltsch, Böhmen.
A. Berger, Wien-Mödling


Finland
Shepard Collection.

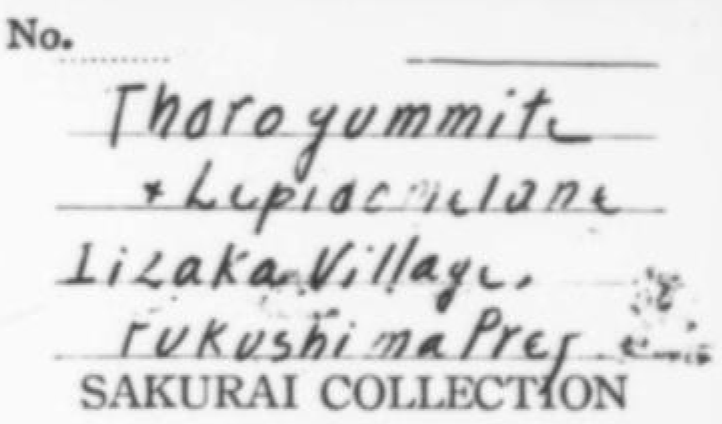

PRINCE GREGORY GAGARIN
MINERAL COLLECTION
Wollastonite
Mt. Bukulja
near Arandjelovac, Du-
[illegible]

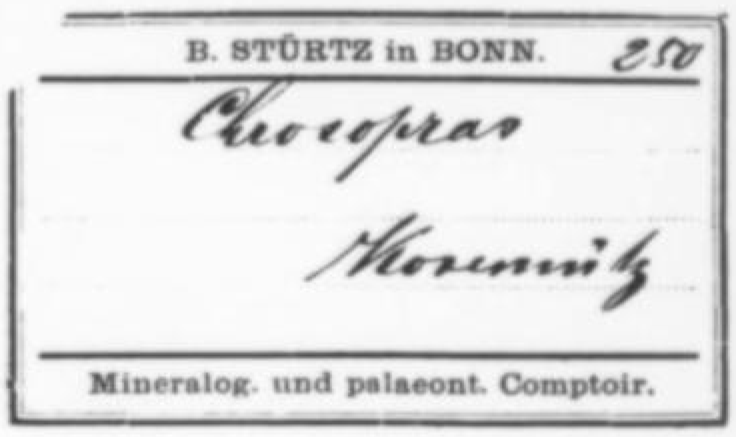

WILLEMITE
VARIETY: TROOSTITE
FRANKLIN, NEW JERSEY
Comp. Zn_2SiO_4
Cryst. HEX-RHOMB.
Dana No. 780 No. 1181
Floyd A. Rapp Collection

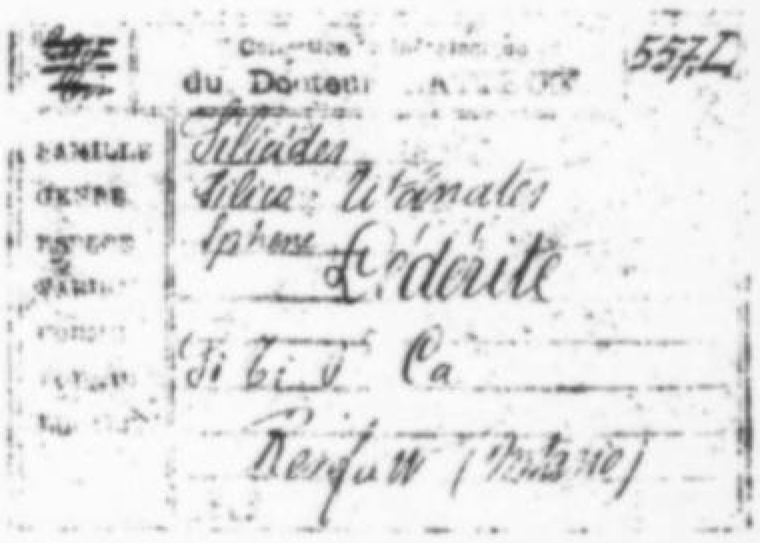

EIMER & AMEND,
TITANITE.
Renfrew. Canada.
205, 207 & 209 Third Avenue, New York.

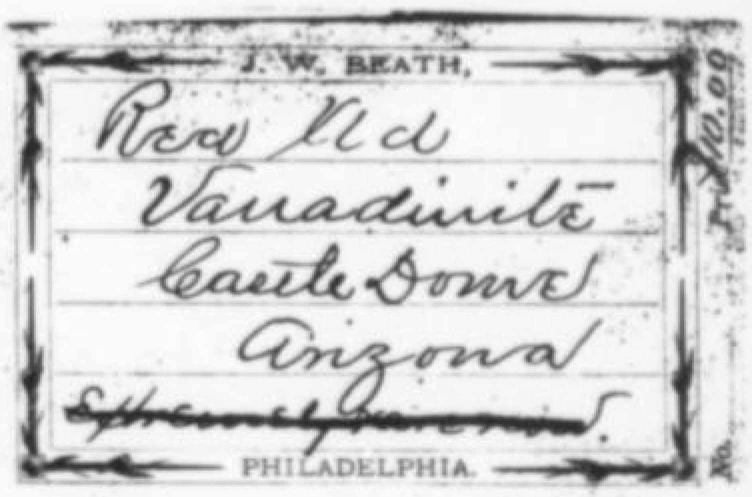

Péridot
FORME granulaire
MINER. ACCESS: 1.25
Province du Rhin PRIX l.g.v.
AD. PIRET-TOURNAI


7099
Phénacite ** AEE
Cheffee Co. (Colorado)
DEYROLLE
46. RUE DU BAC
PARIS
USINE & LABORATOIRES: 9, Rue Chanez PARIS

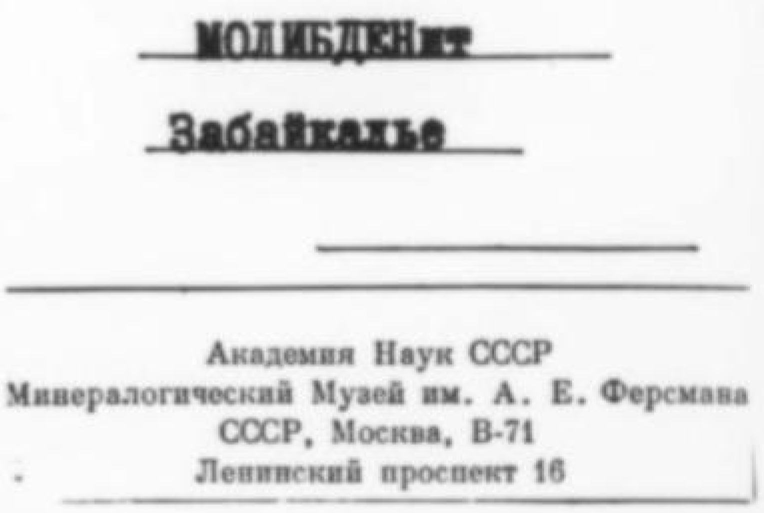

No.
Thorogummite
+ Lepidomelane
Iizaka Village,
Fukushima Pref.
SAKURAI COLLECTION

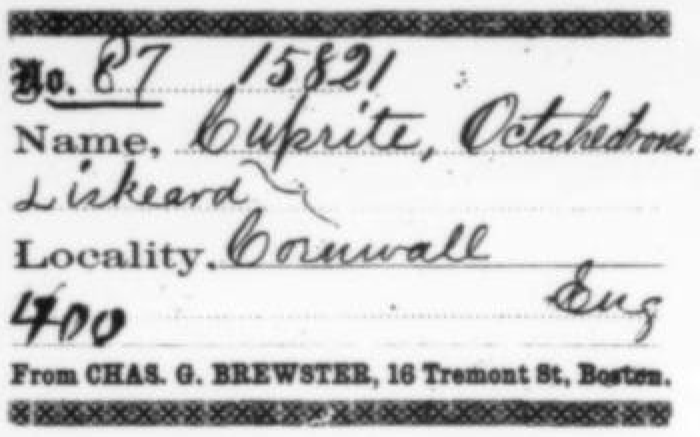

B. STÜRTZ in BONN. 250
Chrysopras
Kosemütz
Mineralog. und palaeont. Comptoir.

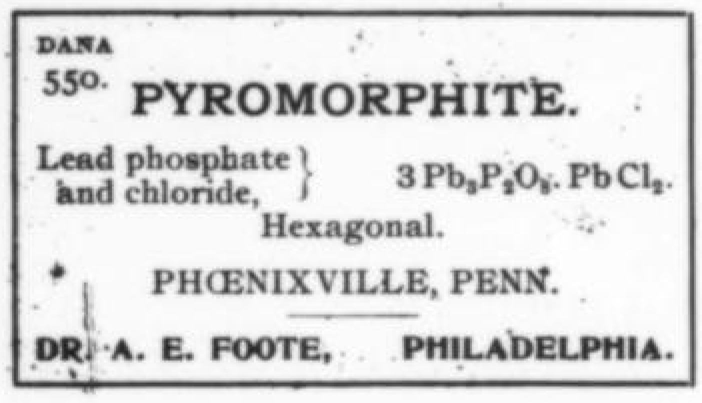

5572
du Docteur
FAMILLE
GENRE
ESPÈCE
Silicides
Silice. Titanates
Sphène Lédérite
Ti Si O Ca
Renfrew (Ontario)

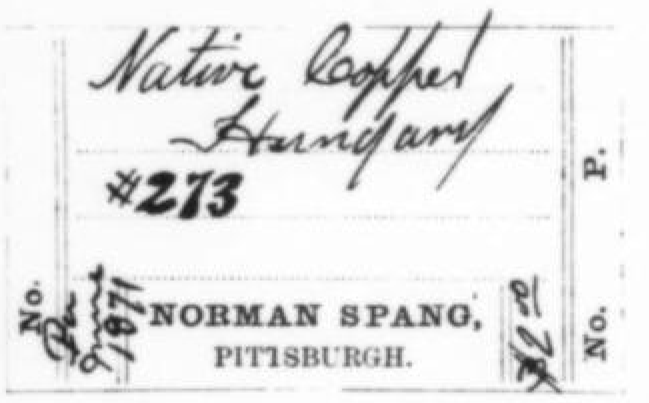

J. W. BEATH,
No. 10.09
Red Xld
Vanadinite
Castle Dome
Arizona
PHILADELPHIA.


Collection J. BÉHIER
No
ACTINOTE
et Tourmaline.
Localité : Madagascar.


МОЛИБДЕНит
Забайкалье
Академия Наук СССР
Минералогический Музей им. А. Е. Ферсмана
СССР, Москва, В-71
Ленинский проспект 16

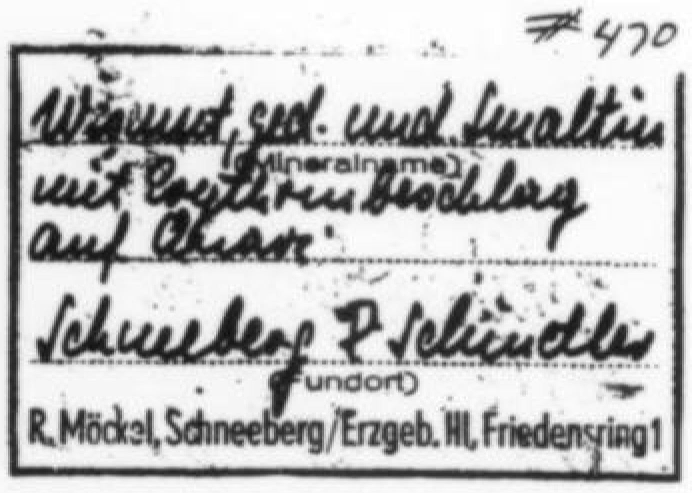

No. 87 15821
Name, Cuprite, Octahedrons
Liskeard
Locality. Cornwall
400 Eng
From CHAS. G. BREWSTER, 16 Tremont St, Boston.

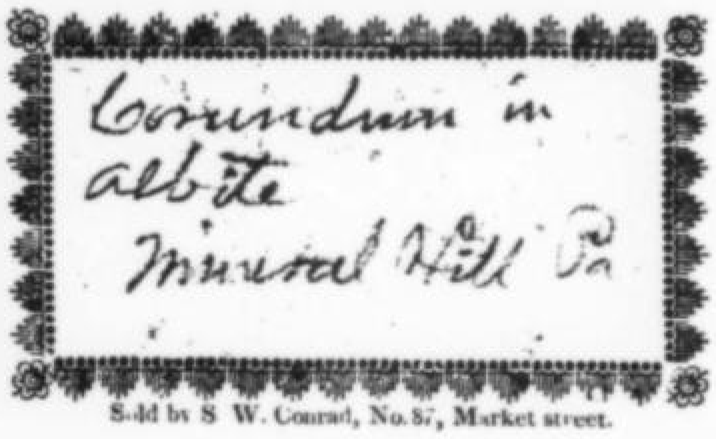

DANA
550. PYROMORPHITE.
Lead phosphate and chloride, $3Pb_3P_2O_8 . PbCl_2$.
Hexagonal.
PHŒNIXVILLE, PENN.
DR. A. E. FOOTE, PHILADELPHIA.

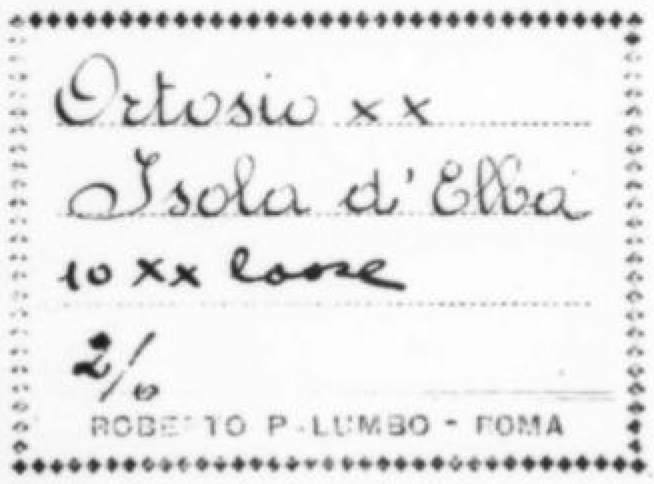

Native Copper
Hungary
#273
No. 1971
NORMAN SPANG,
PITTSBURGH.
No. P.


ÉMILE BERTRAND
Sylvine
Stassfurt Prusse
PARIS


11. Rashleighite 6/-
Bunny Mine (Engine Shaft dump)
St Austell, Cornwall.
Collected by Arthur Russell 1937.


#470
(Mineralname)
Schneeberg
(Fundort)
R. Möckel, Schneeberg/Erzgeb. III, Friedensring 1


Corundum in
albite
Mineral Hill Pa
Sold by S. W. Conrad, No. 87, Market street.

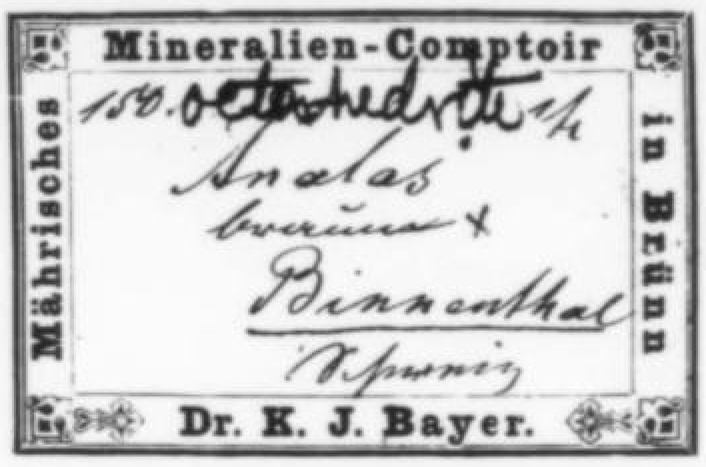

Ortosio xx
Isola d'Elba
10 xx loose
2/6
ROBERTO PALUMBO - ROMA

in probably more than half the cases, once the specimens have been cataloged by the new owner the labels get relegated to a box or drawer and, sooner or later, thrown out. It's easy to rationalize their loss by saying that the information was recorded and current labels don't have any significant historical value. But consider twenty, thirty, or more, years down the road when it comes time to sell your collection. Isn't it plausible that the collection's value could be enhanced if the specimens had their owners' record, their "pedigree," intact? What is commonplace today may be of valuable historical interest tomorrow. If I can do nothing else in this column than to make the point that labels should never be separated from their specimens, I'll be happy.

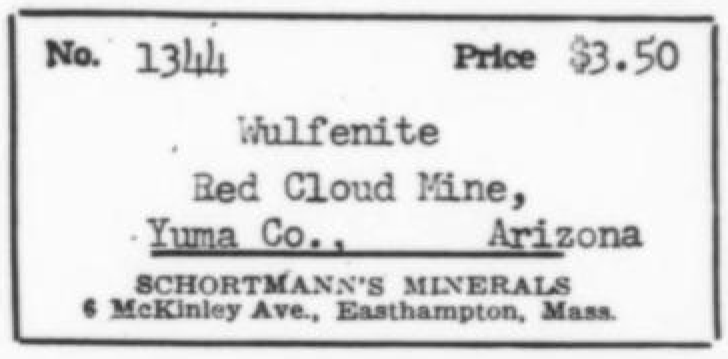
Okay, at my cajoling, you've decided to keep the labels—the next question is what's the easiest way? The simplest method is to get a 3x5 card file box at your drug store and some 3x5 glassine envelopes at your local stamp dealer. Then enclose the label, mark the specimen's catalog number on one corner of the glassine and file numerically. Or, if you're already using a card file system, just attach the glassine to the back of the catalog card, eliminating the need for a second file box. But however you do it, don't glue, staple or tape labels to your cards directly because with time they become very difficult to remove.

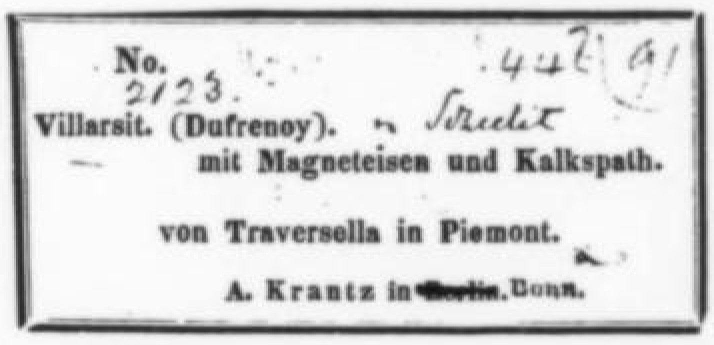
After diligently filing your present labels, you find you've succumbed to the "collecting bug" once again and decide to seriously engage in label collecting. I must offer a word of warning at this point; a true label collector has a worse lot in life than even the species collector. At last count, there were some 2500 accepted species for which the species collector must scrounge. A conservative estimate places the number of dealer, collector and museum labels prior to 1950 at over 15,000! The species collector needs only his well worn glossary and want list; the label collector, unless blessed with a photographic memory, has to haul around file boxes, ledgers, or pages of xeroxes in order to check for duplicates and variations. Variations also place the label collector a distant cousin to the stamp collector for, as with one stamp release, there may be a multitude of differences among one owner's labels. There may be changes in location, print size or type face, label size, color of stock or just printing errors.

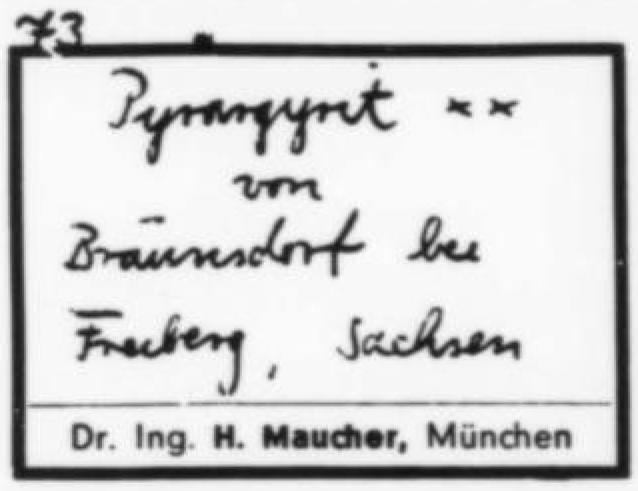

15/- Pyrargilit
Fundort
Fabrik und Handlung wissenschaftlicher Apparate
von G. A. Lenoir in Wien

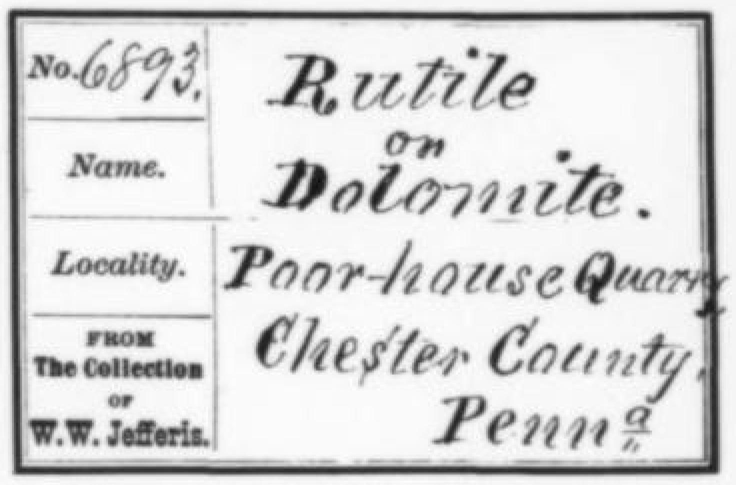

Mineralien-Comptoir
Mährisches in Brünn
Anatas
Binnenthal
Dr. K. J. Bayer.

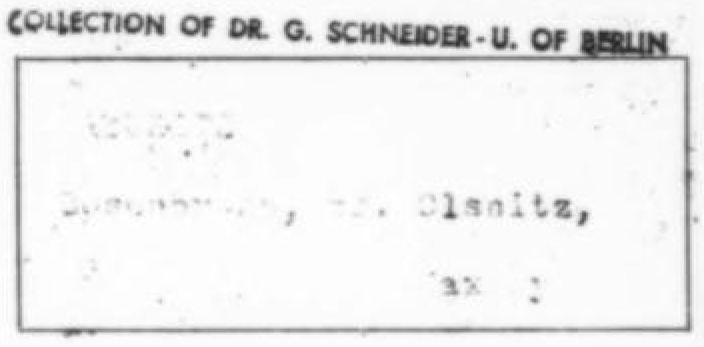

No. 2352
Prehnit
Harzburg, Harz
4.50
Heidelberger Mineralien-Comptoir.


No. 1344 Price $3.50
Wulfenite
Red Cloud Mine,
Yuma Co., Arizona
SCHORTMANN'S MINERALS
6 McKinley Ave., Easthampton, Mass.

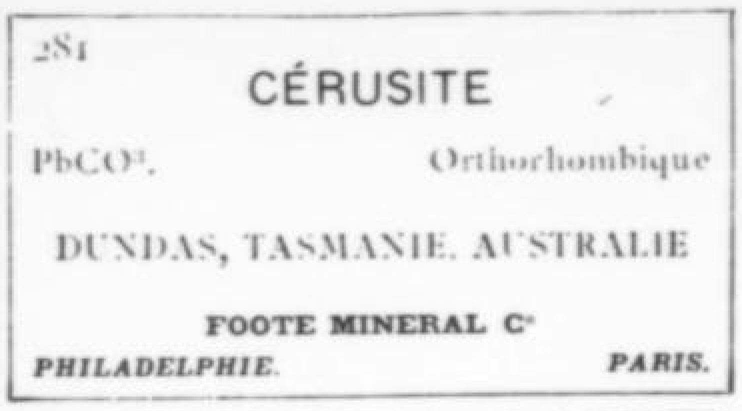

No. 2123.
Villarsit. (Dufrenoy).
mit Magneteisen und Kalkspath.
von Traversella in Piemont.
A. Krantz in ~~Berlin~~ Bonn.

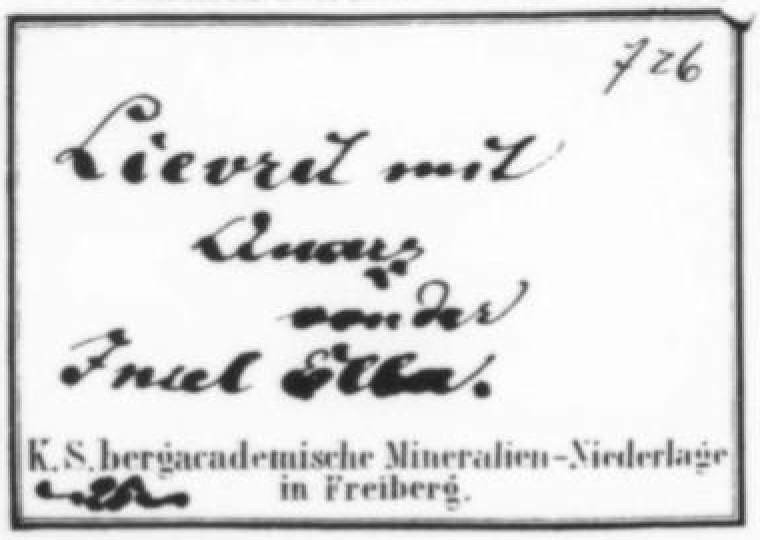

73
Pyrargyrit xx
von
Braunsdorf bei
Freiberg, Sachsen
Dr. Ing. H. Maucher, München

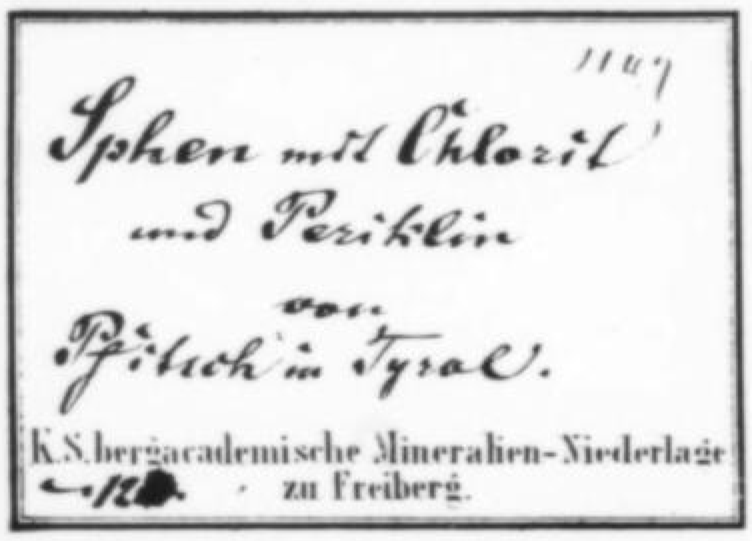

No. 6893.
Name. Rutile on Dolomite.
Locality. Poor-house Quarry
Chester County,
Penna
FROM The Collection OF W. W. Jefferis.

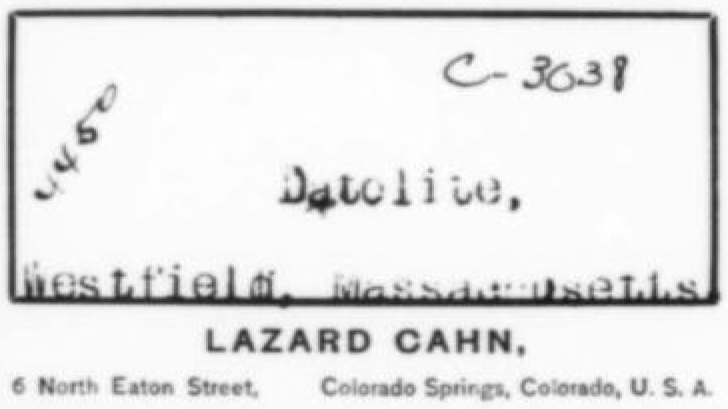

COLLECTION OF DR. G. SCHNEIDER - U. OF BERLIN
Olsnitz,

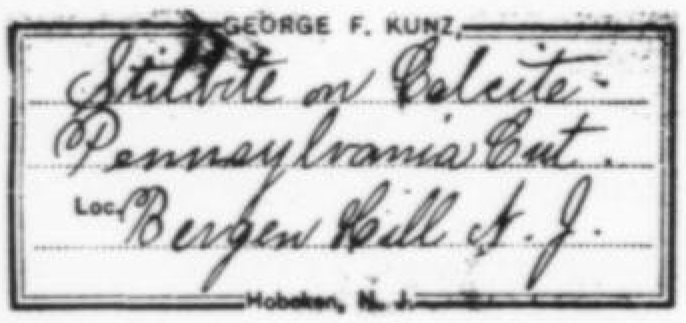

No
Serpentin nach
Monticellit
HUGO KEMNA,
Mineralien Niederlage zu Hannover.

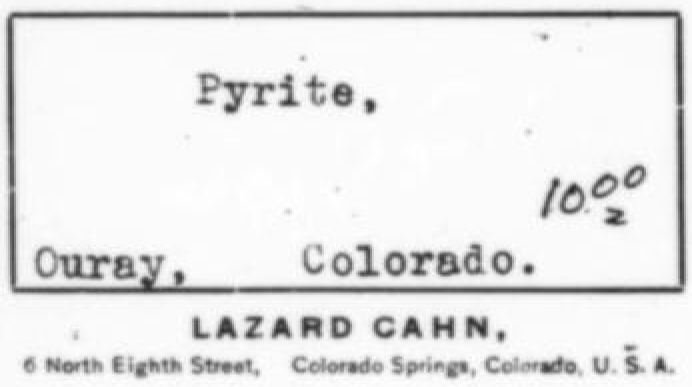

281
CÉRUSITE
PbCO³. Orthorhombique
DUNDAS, TASMANIE, AUSTRALIE
FOOTE MINERAL C°
PHILADELPHIE. PARIS.

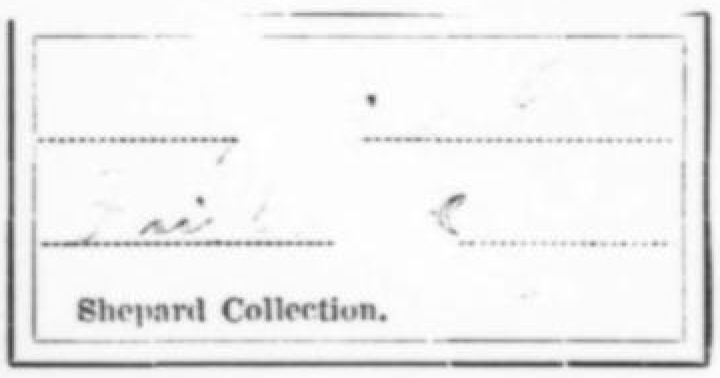

726
Lievrit mit
Quarz
von der
Insel Elba.
K.S. bergacademische Mineralien-Niederlage
in Freiberg.


1147
Sphen mit Chlorit
und Periklin
von
Pfitsch in Tyrol.
K.S. bergacademische Mineralien-Niederlage
zu Freiberg.

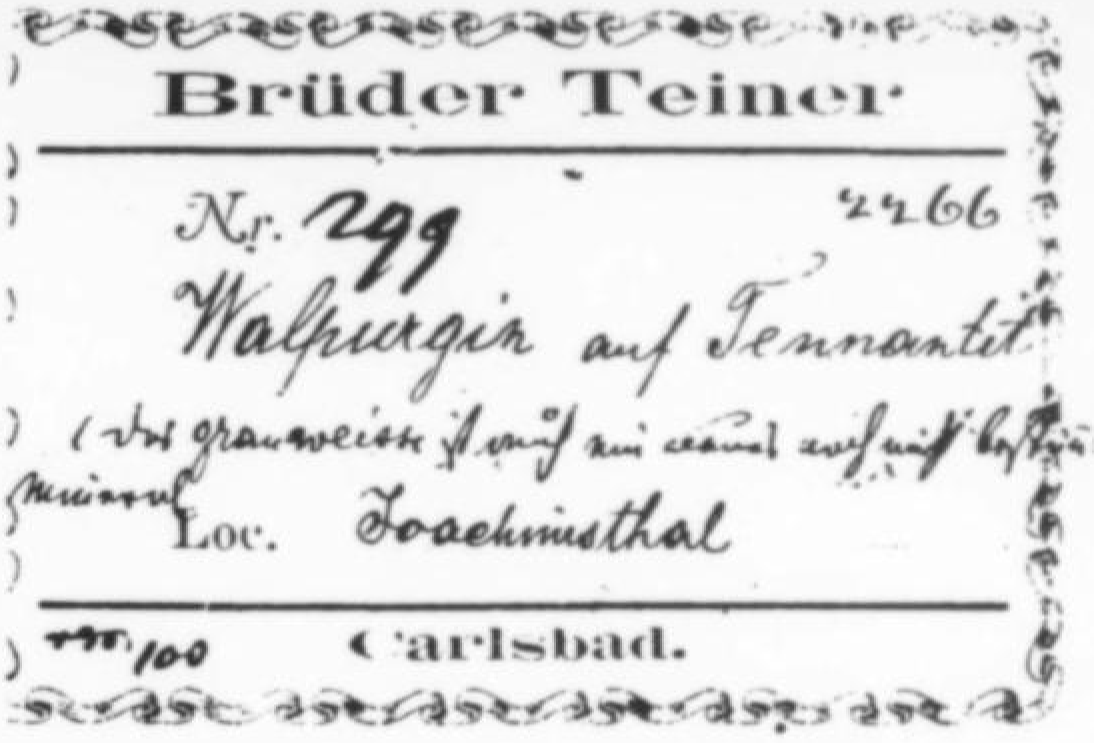

C-3638
Datolite,
Westfield, Massachusetts
LAZARD CAHN,
6 North Eaton Street, Colorado Springs, Colorado, U. S. A.


GEORGE F. KUNZ,
Stilbite on Calcite
Pennsylvania Cut.
Loc. Bergen Hill N. J.
Hoboken, N. J.


Pyrite,
10.00
Ouray, Colorado.
LAZARD CAHN,
6 North Eighth Street, Colorado Springs, Colorado, U. S. A.

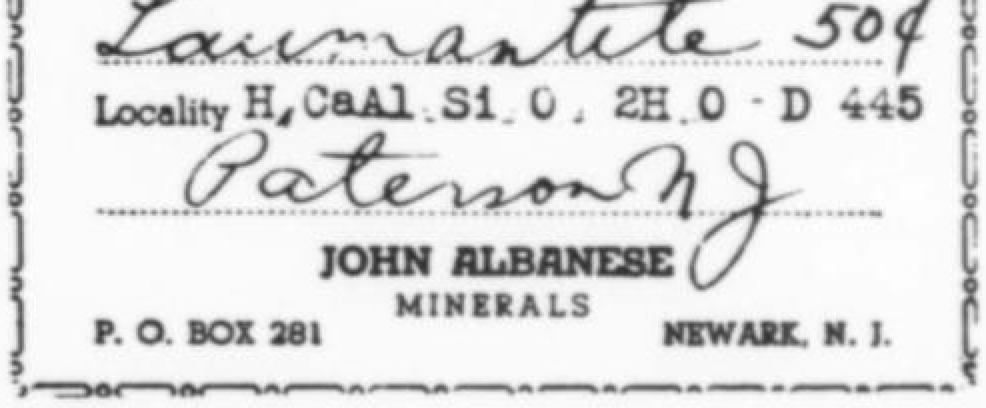

Shepard Collection.

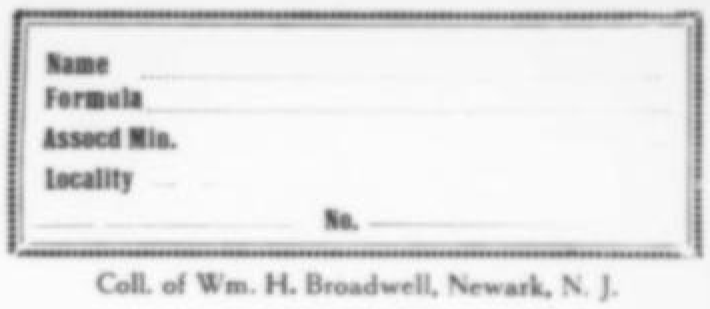

COMPTOIR MINÉRALOGIQUE ET GÉOLOGIQUE
Paris, r. de l'Ancienne-Comédie, 29
N° 333 2294
Nom Gahnite
Localité Fahlun, Swed.
F. PISANI 1867

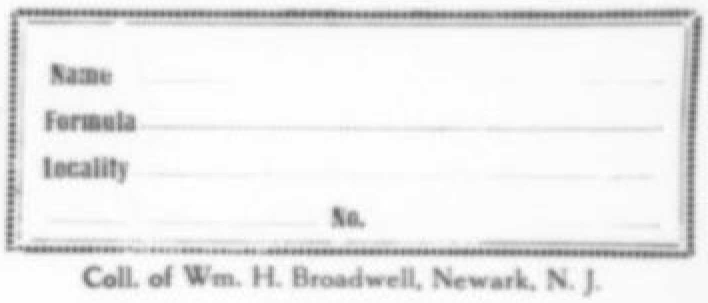

Brüder Teiner
Nr. 299 2266
Walpurgin auf Tennantit
Loc. Joachimsthal
100
Carlsbad.

Neal Yedlin, in a recent column, mentioned acquiring the Wm. H. Broadwell collection and questioning the use of many differently colored stocks, perhaps as a coding system. As it turns out, there was no secret code; Broadwell was a printer by trade and used whatever color stock he had left over for the printing of his own labels. I have included examples of variations in the labels bordering the text. For example, the two C. F. Pech labels are identical except that one uses the English abbreviation, *Loc.*, for locality, the other the German, *Fundort*. A similar variation is seen in the label of the K.S. (Konigl-Sachs) bergacademische, with the one bearing "*in Freiberg*", the other, "*zu Freiberg*". The "*6 North Eaton*" address for Lazard Cahn was a printing error and was later corrected to read "*6 North Eighth*." The Paris dealer, Pisani, also had his problems with the printers, as evidenced by the spelling of his name as *Psaini* on his earlier labels. Even Broadwell's two labels appear the same, until on closer examination you notice that *Assoc. Min.* was added on the second. Though all their labels are not included, noted dealers like Foote, Kunz and English all changed locations many times. Then, on some labels, like those of Martin Ehrmann, you can find two labels of the same type, the only difference being one is handwritten, the other typewritten.

Before I am besieged by accusations of being a hypocrite, I'd better take a moment to explain about collecting labels *without* the specimens. Throughout the years prior to the sixties it was commonplace for collectors, dealers and museums to separate labels from the specimens. Collectors did it as a matter of ease; dealers did it because often the earlier price was on the label and it could prove embarrassing; museums did it because each new curator seemed to feel his system of cataloging was better than his predecessor's, and had new labels made up. I personally know of one museum where there are drawers full of 18th and 19th century labels. Fortunately, the curator plans to rematch as many as he can to the specimens because of

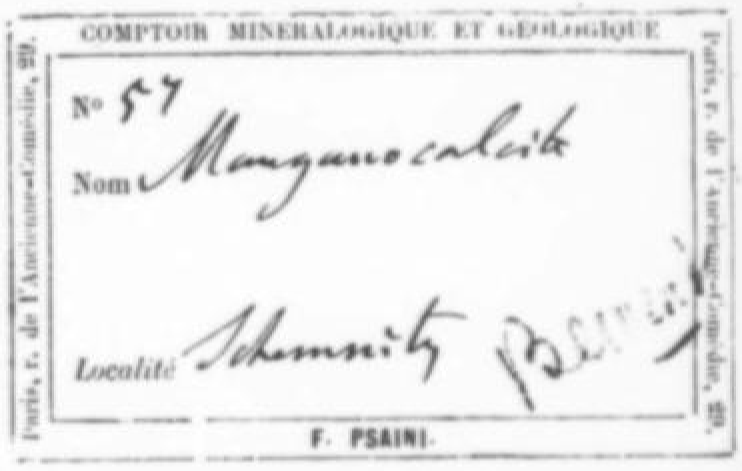

D 438
D 445
S No. 1001
Name Heulandite
Laumantite 50¢
Locality H,CaAl.Si.O. 2H.O - D 445
Paterson N.J.
JOHN ALBANESE
MINERALS
P. O. BOX 281 NEWARK, N. J.

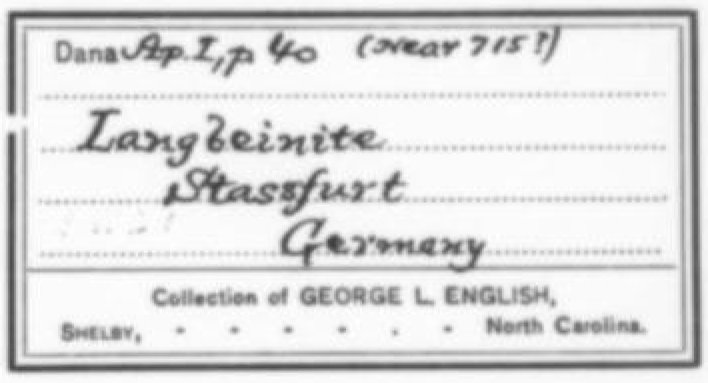

Name
Formula
Assocd Min.
Locality
No.
Coll. of Wm. H. Broadwell, Newark, N. J.


Name
Formula
locality
No.
Coll. of Wm. H. Broadwell, Newark, N. J.

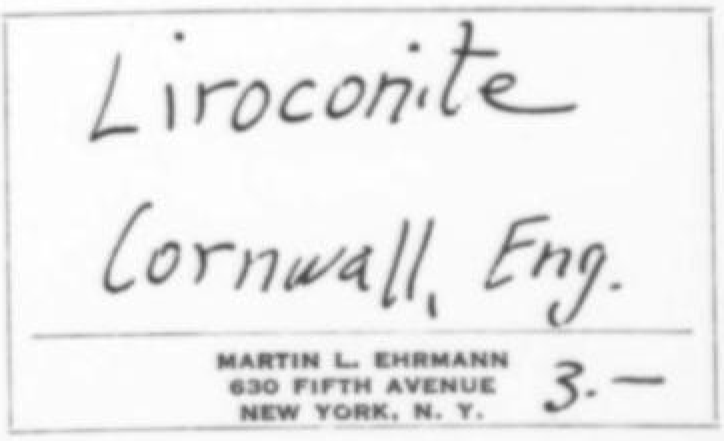

3.
Mineralien-Comptoir von C. F. PECH.
2331
Name Rajournofskin
Loc: Kosemitz
Frankenstein, Schlesien
BERLIN, N.-W. Unter den Linden 69.

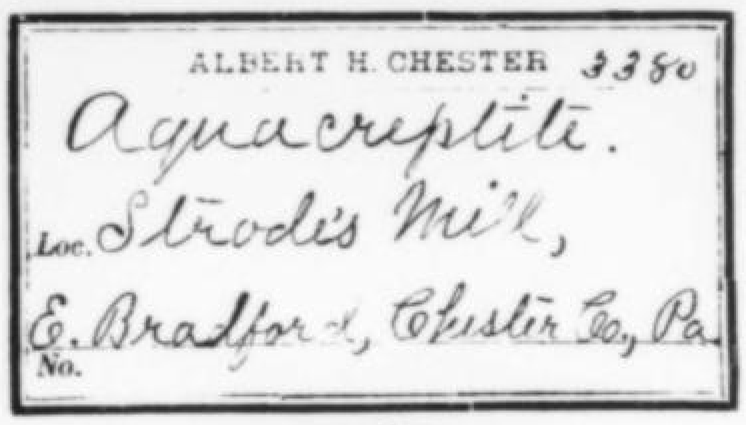

Mineralien-Comptoir von C. F. PECH.
2239
Name Krokoit
Fundort Beresowsk
Ural
BERLIN, N.-W. Unter den Linden 69.


COMPTOIR MINÉRALOGIQUE ET GÉOLOGIQUE
Paris, r. de l'Ancienne-Comédie, 29
N° 57
Nom Manganocalcite
Localité Schemnitz
F. PSAINI.

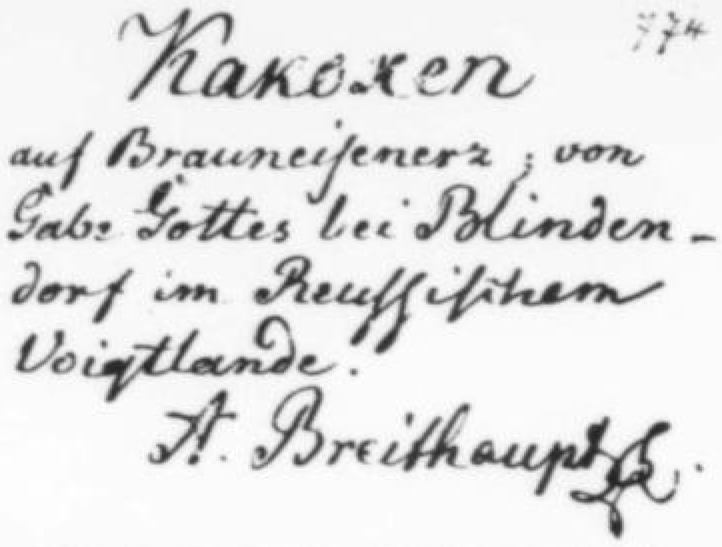

Dana Ap. I, p. 40 (near 715?)
Langbeinite
Stassfurt
Germany
Collection of GEORGE L. ENGLISH,
SHELBY, - - - - - - - North Carolina.


Rhodocrosite
Argentine
22134
MARTIN L. EHRMANN
630 FIFTH AVENUE
NEW YORK, N. Y.
4.00

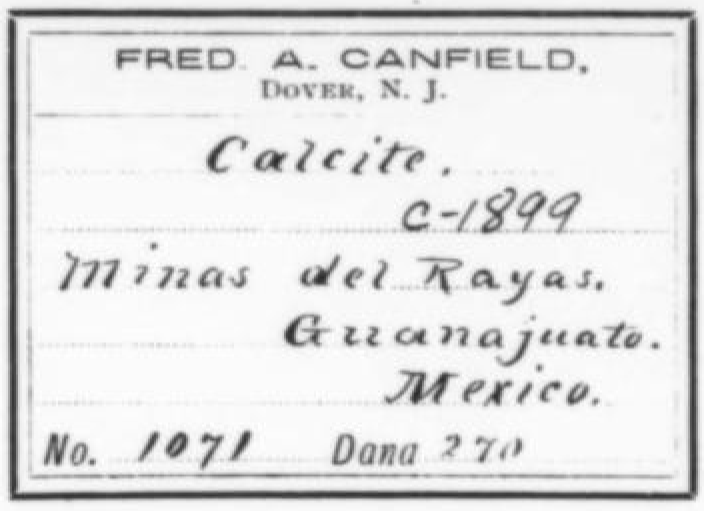

Liroconite
Cornwall, Eng.
MARTIN L. EHRMANN
630 FIFTH AVENUE
NEW YORK, N. Y.
3.—



ALBERT H. CHESTER 3380
Aquacreptite.
Loc. Strode's Mill,
E. Bradford, Chester Co., Pa.
No.

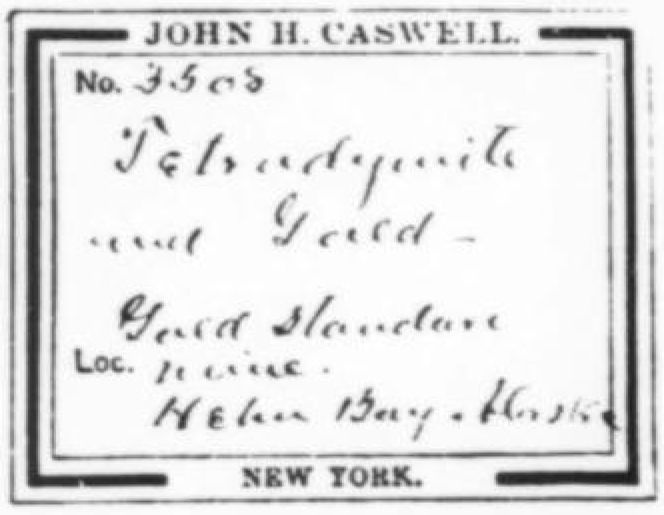


Kakoxen 774
auf Brauneisenerz ; von
Gab: Gottes bei Blinden-
dorf im Reussischem
Voigtlande.
A. Breithaupt

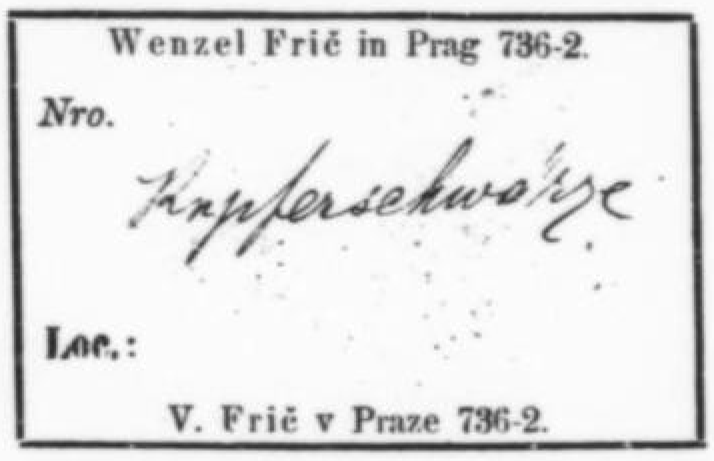


FRED. A. CANFIELD,
DOVER, N. J.
Calcite.
c-1899
Minas del Rayas.
Guanajuato.
Mexico.
No. 1071 Dana 270

Mineralien Comptoir
Passau Bavaria
1165
in Heidelberg.



JOHN H. CASWELL.
No. 3505
Tetradymite
and Gold -
Gold Standard
Loc. mine.
Helen Bay. Alaska
NEW YORK.



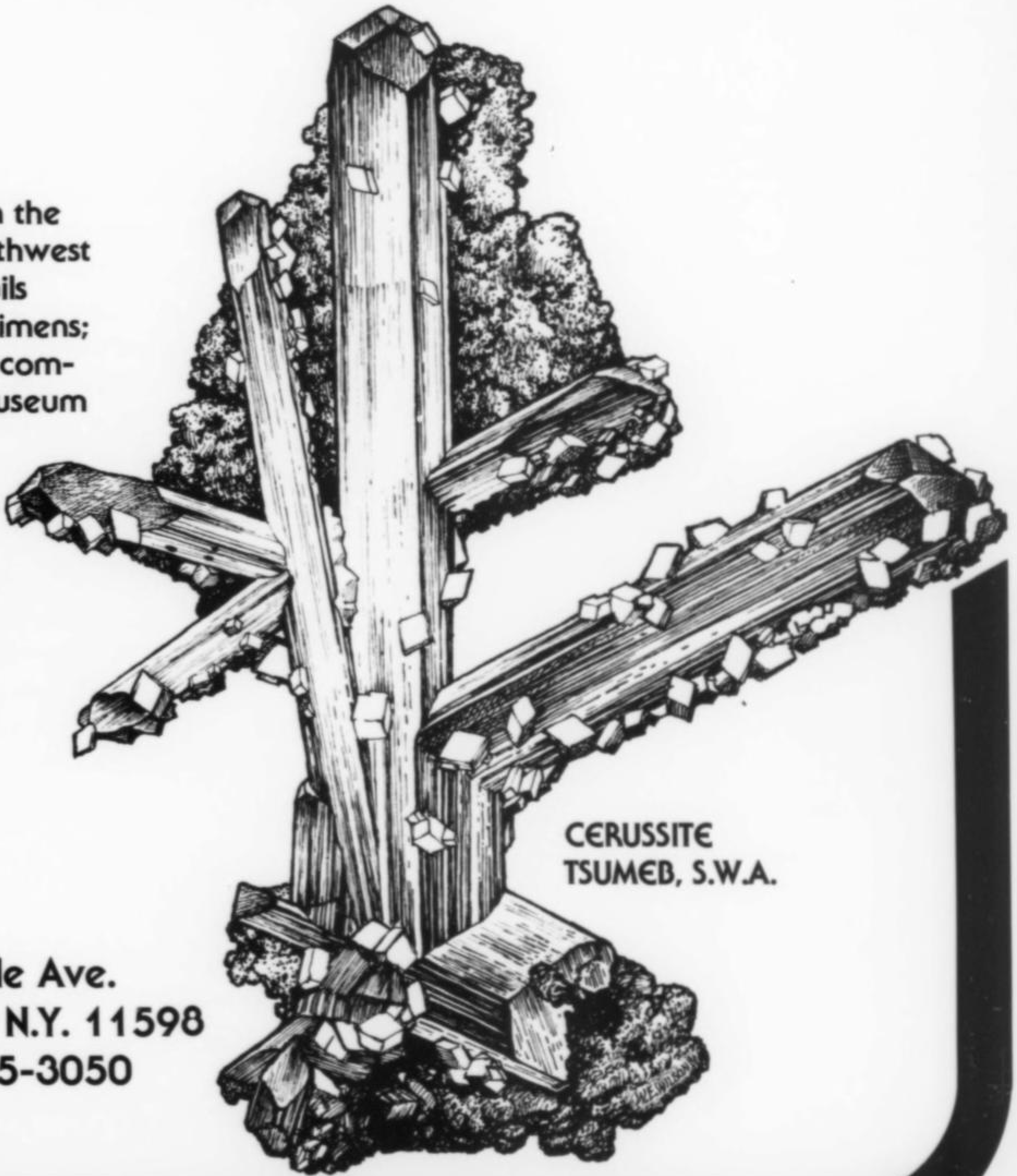
Wenzel Frič in Prag 736-2.
Nro.
Kupferschwärze
Loc.:
V. Frič v Praze 736-2.

their historical significance. Enough labels, however, have filtered out from these varied sources to allow one to collect a sizeable number of labels only. In my own collection of almost 2000 labels only about 300 are accompanied by their original specimens.

Now we reach the question that's been on everybody's mind, I'm sure; how much are they worth? Let me start off by saying that I don't intend to put prices on labels, only to give some direction to those who may be faced with having to buy them. In order to get a proper perspective, let's take a hypothetical situation. Imagine we're at a famous art auctioneer's and there are three items to be auctioned off. The first is an engraving by Leonardo daVinci. The second is another print of the daVinci engraving, identical in every detail except that it was not signed by the artist. The last item up for bid is a piece of paper bearing only daVinci's signature. For the sake of discussion, let's assume the signed daVinci brings $1 million. The second daVinci is missing the signature but is still recognizable for what it is. We can safely assume that it will bring close to the $1 million the first sold for. Last to be brought to auction is the autograph. Will it bring a million, $100,000?, 10,000? 1,000? The basic problem here is that the autograph has no real value as art, only a historical value; and how does one convert historical value into monetary value? The answer really depends on the market for autographs and not for art, although the autographer's fame may have come from his art. In any event the final figure will probably be a small percentage of the $1 million figure. I'm sure you're way ahead of me but let's go back to minerals and in place of the signed daVinci, put a California kunzite with a handwritten Kunz label; in place of the unsigned daVinci, another fine kunzite, identical to the first but without the label; and in place of the daVinci autograph, a Kunz label without specimen. Can't we assume that, as with the works of art, the two kunzites will command top dollar, and that whatever the label brings it will be a small fraction of the specimens' value, depending only on what we "feel" it is worth? The point I'm trying to put across is that a label does have historical value but if a price has been asked it's up to you to decide whether the label is worth that much *to you.* The "market" for mineral labels has not really been well established yet; perhaps we, like the beer can collectors, can decide that collecting labels is an interesting diversion but that we, the *creators of the market,* will *never allow* them to have a very high market value and spoil our fun! In any case, do use common sense and remember this little analogy.

Remember, too, that while a labeled specimen may be worth a premium, one shouldn't go overboard. Only a couple of years ago I was looking at a Mexican hemimorphite worth, in my opinion, about $50 with a $100 price tag on it. When asked, the dealer agreed, then pulled out a U.S. National Museum label for the piece and told me that the label was worth $50! I still can't believe he passed up my offer to sell him five right there for only $10 each!

Until next time, good collecting, and remember, preserve your labels. ⊠



CERUSSITE
TSUMEB, S.W.A.

RESPONSE: Mining Claims for the Mineral Collector

IN volume 8, number 1, of the *Mineralogical Record* there appeared an article which dealt with the filing of mining claims by people interested in mining for *specimens.* The laws regarding this are confusing, sometimes ill-defined, and often in the process of changing. We offer here, and will continue to offer in the future, feedback from readers as well as notices of changes in the law and other developments germane to claim staking for mineral specimens.

Ed.

Dear sir,

I would like to add some comments to Henry Truebe's article "Mining Claims for the Mineral Collector." As a BLM (Bureau of Land Management) geologist and mining claim investigator, I believe that I am qualified to add some information that will be of use to collectors who would like to stake claims on their discoveries.

The Materials Sales Act of 1947 did not remove sand, stone, gravel, etc. from locations. This was done by the Act of 1955, Public Law 167 or the Multiple Use Act. This act withdrew the "common variety" minerals that Truebe listed, and it provided for the multiple use of the surface of the mining claims that have been staked after passage of the act. Whereas the claimant of a mining claim that was staked before July 23, 1955 can block access by the public to his claim, the claimant of a "new" claim cannot. Recent decisions have continued to make this issue fuzzy. It is possible that only people who hold a valid license or permit from a local, state or federal agency may enter a claim; all others can be excluded. Pending appeals may clear up this matter, so that all members of the public can enter or cross a claim. Only those specific mineral materials that Truebe listed are considered to be common variety and were removed from location. Agate and jasper were listed in his article but have not been mentioned in any law as being saleable, not locateable. Presently geodes and thundereggs are clearly locateable. Obsidian is not locateable.

Truebe's remarks on the prudent man rule and estimating the value of mineral specimens in the ground brings up what may truly be a very difficult problem. As he points out this will be a new problem for BLM mineral investigators. I have asked for opinions from numerous BLM geologists, and they have assured me that claims located for mineral specimens **can** be valid. He greatly oversimplifies the prudent man rule. A claim is not necessarily valid just because sale of specimens will bring more money than mining cost. There must be a real profit shown, and a real interest in making the profit. The 1872 Mining Law was written to provide for the production of minerals not for the operation of one's hobby. That is, the weekend prospector (or mineral collector) who is not trying to make his living off of the claim and is only making a small profit does not necessarily meet the prudent man rule. The decision is up to a judge, not the mineral investigator.

All I can say about his statements about trying to determine if the ground is already claimed or not is "good luck." The records in county courthouses are notoriously poorly organized. But there is help on the way. The 1976 BLM Organic Act, requires that all mining claims be recorded with the State Office of the BLM in the state that the claim is located. All claims that are not recorded with the BLM will be considered to be abandoned and will be *null and void.* Claims that were staked before October 21, 1976, must be recorded within three years, and all new claims must be recorded within *90 days* of location. Each location must be described as to legal subdivisions or metes and bounds. That is, one must be able to actually find the claim from the description (a point that is generally overlooked in the 1872 Mining Law). Claims will be rejected that are not so described. The BLM will maintain a Township and Range file of the locations.

Discovery is still required for each mining claim. A claim that is located before there is an actual discovery that will meet the prudent man rule is useful in keeping others from locating on the same ground, but it is not valid according to the 1872 Mining Law. The federal government does not make a habit of investigating claims just for the fun of it, so claims that are located without a valid discovery probably will not be bothered by the government. They are still open to relocation (some may call this jumping) by another individual. If one collector finds a few small crystals and stakes a claim on the ground, his claim should keep the mineral rights in his ownership. But, remember, he does not yet have a discovery in the eyes of the law. Another collector could enter the same ground, find an economic deposit of crystals and stake a claim. The claim of collector number two will be valid, that of number one will not be. Experts from government and industry have said that it is likely that *up to 95% of all mining claims in the United States are invalid for lack of discovery.* A discovery is not just the occurrence of a few grains of gold, or a few good mineral specimens, but is the discovery of the minerals (or metals) in such a quantity that a prudent man would be justified in spending his time and money with the reasonable prospects of developing a paying mine. Simply put, you must know that the minerals are there, not just hope that they are. In the case of Truebe's large block of claims located in the hopes of finding a large disseminated ore body, the claims are invalid for lack of discovery until the ore body is found. The claims will probably keep other exploration companies from locating the same ground. If another company should enter the ground, drill the first holes and find the ore body, then they may stake claims on the ground where they found the ore and their claims will be the valid claims. Or the federal government may come along, if they should wish to withdraw the land for some reason (Wilderness Area, dam site, etc.), do a validity determination and challenge the claims if no ore has yet been found. Also, *each claim* must have a discovery, not just one in a block of claims.

The yearly assessment work must be filed with the BLM as well as with the county (the recordation of the Notice of Location and the assessment work must be made with the BLM for all claims on federal land, whether BLM or Forest Service). The BLM has also drafted regulations requiring that mining claimants file a *Notice of Intent* or *Plan of Operations* with the local BLM office before doing any surface-disturbing operations on the claims. The purpose of this is to minimize surface disturbance by requiring rehabilitation and, in some cases, more sensible approaches to the planned operation. The public lands are covered with various types of scars caused by prospecting that did not need to be made and could have been rehabilitated. The Forest Service already has these types of regulations in effect. The BLM regulations are not final, so mining claimants and prospectors who plan on doing any significant surface-disturbing operations should check with the local BLM or Forest Service office first. It may do all mineral collectors who plan on staking claims some good to read the regulations when they are finalized. If nothing else this may tell you what your rights are and prevent some over-protective land administrator from stopping your operations.

Patenting a mining claim is only becoming difficult because very few valid claims are ever applied for patent. If a claim is valid (that is, has a discovery that meets the prudent man rule) and the other criteria for patenting are met, then the BLM *must* issue patent. There is no choice in the matter. Mineral rights on unpatented claims can be bought, sold or inherited, but remember, if you are buying the mineral rights, is there really a discovery, and thus is the claim valid?

Lanny R. Ream
P.O. Box 1336
Cedar City, Utah 84720

Dear sir,

Mr. Ream's letter provides a very worthwhile amplification (and, in some cases, correction) of my article. He defines clearly the concepts of "prudent man," "discovery," and "assessment work," and clears my suspicion on agate and jasper claims (they can be valid). The concept of a second discovery being the valid discovery is fascinating, but I cannot see how it is applied, since, to my knowledge, the discoverer makes no statement that his claim is exclusively for one mineral. I would like to use this idea, but I can see the legal fees growing fast. I learned some things from his clear presentation. I wish he had said more about the 1976 BLM Organic act.

Henry Truebe
P.O. Box 227
Crested Butte, Colorado 81224

Dear sir,

I found some significant errors in the artile entitled "Mining Claims for the Mineral Collector". Vol. 8, #1. On p. 44, the author states "If no posts or monuments can be found, there is no valid claim, and you may proceed to stake your own claim." Sadly this is incorrect. If you are examining a recently filed claim on ground not subject to rockfall or avalanche, and do not find all the required corner posts and discovery notice, the author is correct. It should be noted, that at least in the state of Washington, the discovery monument and corner posts are to be of a permanent nature, but once in place, the claim holder is NOT required to maintain them. Usually, with dilligent search, at least one of the monuments will be discovered.

A warning regarding relocation: The burden of proof that the claim is lapsed for want of assessment work, or for any other reason such as failure to comply with the mining law rests with the relocator. There is also a period of time allowed to the original claim holder to correct the deficiencies.

Next we go to extralateral rights. In order to exercise these rights, the boundaries of the claim must be straight, no bends or jogs. You can follow the vein down dip only, the part of the outcrop of the vein that extends outside the boundaries of the claim cannot be worked by the claim holder if the ground is claimed by someone else. Simply put, you can proceed down dip, but not along the strike outside the boundaries of the claim.

Discovery notices are required in Washington state; the notice of location is to be placed at the discovery point, or as near as practible. A copy of the notice is to be filed with the County Recorder.

If the above proves confusing, get a lawyer familiar with mining law before proceeding. Filing on a valid claim is a sure way of making business for lawyers and the courts.

Jack Zektzer
6308½ 18th N.E.
Seattle, Wash. 98115

Dear sir,

Patent or perish is the focus of newly proposed Federal legislation. Washington plans to repeal the 1872 Mining Law. Small miners and prospectors will be given three years to patent their claims. Failure to patent may result in the loss of the claim. The 1872 Mining Law will be replaced by a leasing system similar to the gas/oil leasing system.

Three Bills are now before Congress: *H.R. 5806, the Mining Law of 1977*, introduced by Morris Udall, D-Ariz. This Bill would require owners of unpatented mining claims to make patent application within three years. If the owner failed to make patent application the claim could remain an unpatented mining claim or be converted to a mining lease. *H.R. 5831, the Mineral Development Act.* Small miners and prospectors must make patent application within five years or lose the claim. *S. 1248, the Federal Land Mining Act,* introduced by Senator Metcalf. Unpatented claim owners would have three years to apply for patent or their rights would be severely limited. H.R. 5831, the Mineral Development Act, introduced by Congressman Ruppe of Michigan is reportedly sponsored by the American Mining Congress. President Carter has stated his support for the repeal of the 1872 Mining Law. Secretary of the Interior Cecil Andrus also supports a leasing system over the present location/patent system.

Owners of unpatented mining claims are being urged to write the nearest regional office of the USGS and request a free copy of **"Exploration Assistance"** This program, created under Title 30, Chapter 17 Sections 641-646 of the U.S. Code could be useful to miners interested in complying with the proposed new laws. While the program is not adequately funded, pressure could be brought on Congress and the Secretary of the Interior to increase funding to meet the needs of small miners and prospectors who will be forced to patent their claims.

A seminar on patenting mining claims will be held at the University of San Francisco in September 1977. The purpose of the seminar is to help small miners and prospectors organize a patenting association. Organized compliance with the expected laws under the 1872 Mining Law not only provides numerous economic benefits but protects the individual from subjective Government action. The seminar outlines the methods used by Government Agencies in complying with laws and regulations similiar to those used in evaluating patent applications. Individuals interested in the seminar can get free information and registration forms by writing to me at the address given below.

The demand for the repeal of the 1872 Mining Law is the result of increased political pressure for wilderness recreational areas, a desire on the part of some Government Agencies to deal with large, economically responsible corporations, and a gradual change in political philosophy. The 1872 Mining Law is one of the few remaining laws that holds individual rights above bureaucratic regulation. The bureaucracies have gradually gained ascendency over the last 40 years. The 1872 Mining Law is the last obstacle to complete Government regulation of the mining industry. Its repeal is the stated objective of the present Administration.

William Cate
P.O. Box 1125
Pacifica, California 94044

PHILADELPHIA AREA
CAROUSEL
Gems and Minerals

FINE MINERAL SPECIMENS
SIZES TN'S TO CABINET.

2579 HUNTINGDON PIKE
HUNTINGDON VALLEY, PA. 19006

215-947-5323
TUES - SAT
10:30 - 4:30
FRI EVE 7-9

SEND SASE FOR LIST

AUSTRALIA
offers some of the rarest and most colorful minerals in the world; so why don't you add a piece of Australia to your collection. We are Australia's oldest established dealers in quality mineral specimens from MICROMOUNTS to ONE-OF-A-KIND Museum specimens.

KOVAC'S
Gems & Minerals Pty. Ltd.,
120-122 Commercial Road,
Prahran, 3181,
Melbourne, Vic., Australia.
Phone: 51 2021

MICROMOUNTS

Are our specialty.

Our current catalog contains about 400 listings of quality micro crystal specimens both mounted and unmounted. Also included are reference collections, supplies and a discussion of micromount preparation.

Catalog 30 cents.

HATFIELD GOUDEY
1145 West 31st Avenue
San Mateo, California 94403

2nd Annual Mineral & Gem Show

November 12th—10:00 AM to 7:00 PM
November 13th—10:00 AM to 5:00 PM

presented by

The Earth Science Teachers' Section—New Jersey Science Teachers' Association and the Middlesex County College Science Department

Middlesex County College, Woodbridge Avenue, Edison, New Jersey
Admission—Adults: $1, Under 18: 75¢; Senior Citizens: 50¢

RETAIL DEALERS

Heitman's Minerals—Missouri
Hawthorneden—Canada
Mineralogical Research—California
Excaliber Minerals—New Jersey
Willis' Earth Treasures—New Jersey
Laurel Gems—Connecticut
Dundorf's Minerals—Pennsylvania
Australian Mining Co.—Pennsylvania
Dr. David Garske—Illinois
Parker's Minerals—New Jersey
Arem Multifacet—Maryland
Stewart's Minerals—Connecticut
John MacDonald—New Jersey
Mineral Cabinet—New Jersey
The Gem Mine—New Jersey
Mineralogical Acquisitions—New Jersey
Lowell Mining & Mineral Co.—Massachusetts
The Gm-n-i—Florida
Copace Corporation—New York

MINERALOGICAL SYMPOSIUM

Saturday, November 12th
10:30 — **Wendell Wilson**: "Some Arizona Mineral Localities"
1:00 — **Peter Bancroft**: "The Minerals of South Africa"
2:45 — **Vandall King**: "The Apatite Group"
4:00 — **Hal Steacy**: "Classic mineral collecting localities of Ontario and Quebec"
6:00 — **Willard Roberts**: "Phosphates and Pegmatites of the Black Hills"
Sunday, November 13th
1:00 — **Peter Bancroft**: "Pegmatite Minerals of Brazil and California"
2:15 — **Violet Anderson**: "Minerals of the Francon and Mont St. Hilaire Quarries"
3:30 — **Joseph Mandarino**: "Phosphate Minerals of the Yukon"
4:45 — **Thomas Peters**: "Minerals of Paterson, New Jersey"
Pre-Registration— $7 for two days; $4 for one day
Banquet—Ramada Inn, Woodbridge Avenue, Edison, New Jersey
Saturday, November 12th—7:30-11:00 PM
Post-banquet discussion: "What's New in Minerals and Localities?"
Displays—Royal Ontario Museum, Paterson Museum, S.U.N.Y. at Buffalo, Peter Bancroft, Willard Roberts.
Special feature lecture by Dr. Carl Sagan, of Cornell University, Saturday and Sunday at 3:00 PM, **tickets** $5 in advance, $6 at the door.
For Information Contact Edward Murphy, 16 Tremont Place, Clifton, New Jersey, 07013 (201-778-4945)

The Record Bookshelf

***Mineralogy of Arizona*, by John W. Anthony, Sidney A. Williams and Richard A. Bideaux. The University of Arizona Press, P.O. Box 3398, Tucson Arizona, 85722, 255 pages, 7 x 10 inches, 70 color photographs, (1977). (Paperback: $9.75; hardcover: $22.50.)**

At long last the replacement for Galbraith and Brennan's venerable *Minerals of Arizona* (1959) has been released, making its premier appearance at the 1977 Tucson Show. It has been common knowledge among those interested in Arizona mineralogy that this work has been in progress for quite some time. To everyone's delight it was worth the wait! The work is now a book by itself rather than simply a bulletin; it is over twice as long as its predecessor, and is printed in a larger format (7 x 10 inches vs. 6 x 9 inches). There are 70 color photos, 74 crystal drawings, 15 pages of maps and a list of approximately 950 references; the earlier version had no photos, drawings, maps or references at all.

A short introduction updates the list of species found in Arizona to 605, tabulates species first discovered in Arizona, and discusses the history and rationale behind this study of Arizona mineralogy.

The second part of the book describes a variety of Arizona mineral deposits in a general way. Porphyry copper and related deposits (including Bisbee and Tiger), uranium and vanadium deposits, "mine fire" minerals of the United Verde mine, and Arizona meteorites are all given brief treatment.

The bulk of the book is devoted to a catalog of Arizona minerals, arranged alphabetically according to species. Each species entry is prefaced by the chemical composition and a sentence regarding its rarity and environment. Following that is a compilation of every locality in Arizona, grouped by county, in which the mineral has been found. Many references, analyses and short specimen descriptions are given, and the collections of seven major museums were studied for examples as well; even museum specimen numbers are given!

Following the lengthy bibliography is a series of maps showing the location of all of Arizona's mining districts. These maps should prove to be of enormous practical value to field collectors; districts are given in the mineral catalog section and may then be pinpointed on the maps using the numbered, alphabetical district index.

The pages have a clean, bright look to them, probably due to a combination of good paper and printing quality, as well as an easy to read size and style of type. To give a subjective impression, the book "feels" good.

The photos are generally excellent. Many are the work of Julius Weber (*M.R.* associate editor of photography) but several other photographers contributed equally fine work. The color photography was subsidized by a grant from Phelps Dodge Corporation.

There are the inevitable minor omissions and errors that always accompany a work of this scope, but none are sufficiently significant to mention in this review, or to concern the reader. The authors have created an exemplary work, one of the best studies ever made of a State's mineralogy. Comprehensive, readable, enjoyable, valuable and, above all, practical and useable, this work deserves a place on the book shelf of *every* mineral collector.

W.E.W.

***The Mineralogy of Michigan*, by E. William Heinrich. Published as Bulletin 6 of the Michigan Geological Survey (*address:* Publications Room, Geological Survey Division, Department of Natural Resources, P.O. Box 30028, Lansing, Michigan 48909). Softcover, 225 pages, 9 x 6 inches, (1976) ($3.00; Michigan residents add 4% sales tax; all orders must be prepaid).**

Even a most thorough search of the literature would previously have revealed that a systematic study or compilation of the minerals of Michigan did not exist. This glaring omission has been admirably corrected with the publication of *The Mineralogy of Michigan.* According to the author, the work has two goals: "1) to acquaint the layman mineral collector with the geological characteristics of the types of mineral deposits in Michigan, and 2) to record, for both layman and professional mineralogist, the significant mineral occurrences of the state."

The book begins with an introductory chapter describing the general geology of Michigan; then follows a series of chapters briefly describing specific types of occurrences: igneous deposits, native copper deposits, the White Pine deposit, sedimentary deposits, metamorphic deposits, and miscellaneous types of deposits. Most of the book (pages 35-212) is devoted to a compilation of the geographical mineralogy of Michigan, arranged in the traditional fashion: alphabetically by species, each species' occurrences subdivided according to county. Preceding each species section is the chemical composition and a brief description of the environment typical of that species. But the entries are not limited simply to locality information; a great deal of mineralogical detail is presented including, when available or especially interesting, chemical analyses, lists of crystal forms observed, physical and optical properties and history as well as frequent descriptions of specimens and numerous references to the literature. Localities are quoted with as much precision as possible; when a mine name cannot be used the location is pinpointed by Range and Township (a locality for covellite, for instance, is given as "Marquette County...Enchantment Lake, SW¼ NE¼ sec. 32, T48N, R25W" which narrows the locality down to somewhere within a square patch of ground 1300 feet on a side... probably sufficient for locating the outcrop). The edges of the pages are letter-indexed alphabetically so that it is a simple matter to quickly flip to a desired section... a thoughtful touch.

The geographical section is followed by a list of over 300 references to Michigan mineralogy that should prove valuable by itself to both collector and researcher.

Perhaps the book's only failing is that it is very poorly illustrated. No regional or geological reference maps are presented at all, a serious omission, and only 15 black and white mineral photos are included, one of which is a polished fossil, and only a few of which are justifiably informative. This is a failure of planning rather than of Mother Nature, as superbly photogenic Michigan minerals abound in museums and private collections. Even the cover photo, which is in color, shows a polished slab of nodular white datolite colored pink by microscopic copper inclusions...beloved of the local lapidary, no doubt, but scarcely the best choice for the one color photo to represent the beauty of Michigan's minerals.

Aside from this one drawback the work is a well-done and much-needed reference that all mineral collectors can benefit by owning, especially considering the exceptionally reasonable price.

W.E.W.

***Minerals of Washington*, by Bart Cannon. Cordilleran Press, 18 Holly Hill Drive, Mercer Island, Washington, 98040. Softcover, 184 pages, 5½ x 8½ inches, 3 maps, 91 specimen drawings (1975), ($4.95.)**

This volume includes a seven-page decription of the various mineral environments of Washington and their species suites, a six-page description of the mineral provinces of Washington, a short glossary, a cross-index of occurrences by county, and a bibliography of 69 references. The bulk of the book is a description of the mineral occurrences of Washington, alphabetically according to species. Each species section is subdivided into counties, and each county section is further subdivided according to specific mines and prospects. Many occurrences are referenced. Each species entry is prefaced by a short paragraph giving physical properties, chemical composition, habit and environment. In general the approach is similar to that of *Mineralogy of Arizona*, although Cannon's work appears to be the first of its kind for the state of Washington, and was not as lavishly funded as the Arizona study. Some of the most prominent collectors in Washington, as well as several professional mineralogists, assisted the author. *Minerals of Washington* is an excellent compilation of the state's mineralogy, and should prove useful to those interested.

W.E.W.

***A Field Guide to Rocks and Minerals*, by Frederick H. Pough. Houghton Mifflin Company (mail order dept.), 2 Park St., Boston, Massachusetts 02107. Hardcover, 317 pages, 4¾ x 7½ inches, 156 color photos, 112 black and white photos. Fourth edition (1976), ($9.95); (softcover: $5.95). (Include 85¢ shipping cost when ordering.)**

It is a pleasure to see the new edition of Pough's *Field Guide to Rocks and Minerals*. I purchased a copy of the previous 1960 edition shortly after it was published and, through my formative collecting years, used it so heavily that it now sits in shreds on my bookshelf, long overdue for replacement. The new edition has a few new species included and a number of photographs replaced, but otherwise remains basically unchanged (except for a fervent preface by the author editorializing on the pressing need for specimen preservation).

Pough's *Field Guide* is a peculiar book on today's market, a market saturated with exhaustive scholarly compilations on the one hand, lavishly beautiful mineral picture books on the other, and the monumental *Encyclopedia of Minerals* in the middle. For this reason it is rather difficult to review. Perhaps the most original aspect of the book is its reliance on mineral identification procedures that the amateur can learn to perform without recourse to expensive, modern instrumentation...the old blowpipe analyses, bead tests and wet chemical tests that were taught to mineralogy classes a century ago but are totally ignored in universities today. Pough has actually performed all of the recommended testing procedures and many of the methods are original.

The remainder of the book is similar to a miniature version of Sinkankas' hefty *Mineralogy for Amateurs*. Fifty-four pages are devoted to a miraculously concise and clear summary of important basics of collecting and mineralogy easily understandable by any amateur collector. Eleven more pages cover basic testing procedures. Photographs fill 46 pages, and are accompanied by 39 pages of crystal drawings. The quality of the specimens and the photography of the color plates are definitely inferior to that of the previous edition (color photos in the Third Edition were by Lee Boltin, but have been re-done by the author for the Fourth Edition), although in neither edition are the photos even remotely artistic. Except in a few obvious cases of underexposure and poor lighting the photos are nevertheless still very capable of aiding in the visual identification of specimens and, after all, the book never claims to present aesthetic photography... just *useful* photography. Happily, the quality of printing of the photos is vastly superior to that of the previous edition.

A total of 267 mineral species are described in the text. Data presented include chemical composition, crystal system and class, environment, crystal description, physical properties (optical properties not included), tests for identification, distinguishing characteristics, occurrences and, occasionally, related species or interesting facts. Given with the composition is the percentage of each of the chemical constituents. The occurrences sections are typically the longest and present a good selection of the best known localities and the characteristics of specimens from specific localities. A glossary, index, and list of recommended further reading complete the text.

Pough's *Field Guide* may find some actual use in the field that will not be enjoyed by any of the other well known mineralogy books, however its main value is to the intermediate mineral collector, possibly of High School age, who is past *The Golden Book of Rocks and Minerals* but not yet ready to tackle Dana's *System*. *Field Guide* is arranged chemically according to Dana, rather than alphabetically, which should lead to a gradual understanding of the chemical basis for mineral classification simply through regular use. The young collector bitten by the collecting bug can vent his energy enjoyably, and learn a great deal besides, by setting up his own mineral identification laboratory and performing the many simple tests outlined, on the new specimens he acquires. If and when he finally outgrows *Field Guide* he will be a full-fledged "serious collector." *Field Guide* may not have the enormous quantity of information or the photographic masterpieces of other works, but it does have a superbly balanced mix of information that can educate without intimidating. I strongly recommend it, perhaps even as a gift, for the intermediate collector.

W.E.W.

***Oddities of the Mineral World*, by William B. Sanborn, published by Van Nostrand Reinhold Co., New York, 1976, 142 pages ($9.95).**

Here, finally, is a book that is a good gift book for youngsters who are new to the mineral hobby, for adult hobbyists who are stalled at the lowest levels of mastery of mineralogy and need stimulation, or for anyone who might enjoy intriguing reading about aspects of minerals never before treated specifically in book form. Not the least of this book's accomplishments is making clear the message that there is more to mineralogy than just dry recitations of crystallography, physical properties, chemistry and details of occurrences. In many respects this is a pioneer effort, one that has been long overdue. The information provided is otherwise not available in a single reference work in the English language, and probably unavailable in any other language.

The book is a discourse on the odd, the unusual and the bizarre of the mineral world. There are descriptions of nearly all of the really exotic forms of minerals and the wondrous properties they possess, features which tend to fascinate people who have been fortunate enough to have seen them firsthand. Included are twisted and twinned crystals, phantoms, geodes, pseudomorphs, concretions, inclusions, fossilization, false fossils, fluorescence and cave phenomena; to mention only some of the subjects covered.

The book is profusely illustrated with mostly black and white photographs. A token section of twelve color photographs is provided, probably more to perpetuate the myth that every book needs color photographs than to actually enhance the book. Unfortunately all of the photographs are poor and constitute the most negative aspect of the book. Most are not of sufficient quality to justify being published in a book and many do not depict unusually fine examples of whatever they are supposed to illustrate. The author attempts to rationalize this deficiency by stating that "beautiful photographs...may...greatly distort or exaggerate the actual appearance of the specimen." I strongly disagree with this view and lament the absence of professional quality illustrations. Imagine trying to advance the argument that a stunning photograph of the Grand Canyon wouldn't be an asset in a book about U.S. National Parks.

There are a few other shortcomings. Regrettable omissions include "box quartz," "tiger eye," the chatoyance of labradorite, and the various dehydration polymorphs such as metatorbernite. The most logical explanation of the formation of "thunder eggs" and the most contemporary explanation of the mechanism operating in the petrification of wood are not included. There are errors, too; for example, agate and chalcedony are termed "amorphous", opal is stated to be a variety of quartz, and the attraction of wood buried in sediments for uranium is described as a mystery. While these shortcomings are indeed unfortunate, they do not greatly diminish the value of the book to the lay reader. I regard the book as the best nontechnical introduction to the "other side" of minerals yet written.

John Sampson White

OTHER TITLES RECEIVED

***Remote-Sensing Applications for Mineral Exploration*, edited by William L. Smith. Halsted Press, 605 Third Avenue, New York, New York, 10016. Hardcover, 391 pages, 8½ x 9½ inches, 16 color plates, many satellite photos (1977) ($50.00).**

This book consists of a collection of 15 chapters by various authors, all related to the use of photos from NASA's Earth Resource Technology Satellite (LANDSAT) for mineral exploration, geological research and mineral resources management. Not a textbook or a handbook but an overview of this new branch of earth science technology.

***The California Gold Rush*, by Gordon V. Axon. Mason/Charter Publishers, 641 Lexington Avenue, New York, New York, 10022. Hardcover, 136 pages, 5½ x 8½ inches (1976) ($6.95).**

Describes the history of the California Gold Rush of 1848, and discusses the economic impact.

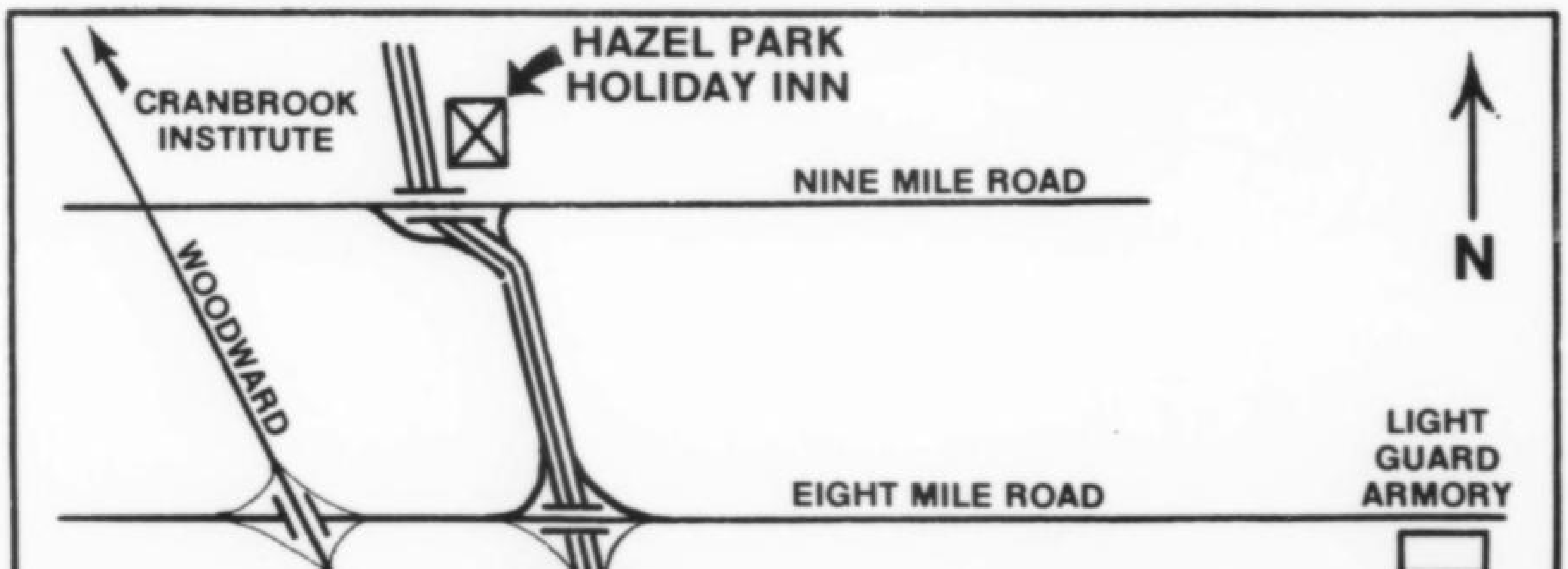
***Rocks and Routes of North County New York*, by Bradford P. VanDiver. W. F. Humphrey Press, Geneva, New York, 14456. Softcover, 205 pages, 6 x 9 inches (1976). Available directly from the author (4 Morningside Drive, Potsdam, New York, 13676) for $7.94.**

Basically a geological guidebook to the state with seven detailed field trips described. Chapter 12 (20 pages) is an updated version of the guidebook *Minerals of the St. Lawrence Valley* (1971) by Robinson and Alverson. Eight additional pages are devoted to brief mineral collecting notes for Warren, Essex, Clinton, Saratoga and Washington counties. The text is accompanied by a glossary, an index, and photos.

***Chemical Petrology*, by Robert F. Mueller and Surendra K. Saxena. Springer – Verlag New York Inc., 44 Hartz Way, Secaucus, New Jersey, 07094. Hardcover, 7½ x 10½ inches (1977) ($29.80).**

A textbook discussing the various aspects associated with chemical petrology. These include a heavy emphasis on physical chemistry and thermodynamics as well as experimental and theoretical research. Equilibrium of mineral systems, kinetics, rock classification schemes, chemical and petrogenic processes in space, meteorites, detailed discussions of the chemical petrology of Venus, Mercury, Mars and the moon, metamorphic mechanisms and minerals, the origin and differentiation of magmas, and volcanism are all covered. A modern look at the subject, including much recent research, makes this the most up-to-date chemical petrology text at the graduate level. Mathematical approaches are utilized throughout the book but an understanding of calculus is not essential.

***Annotated Bibliography of Minerals New to the Pennsylvania List 1965-1974*, by Juliet C. Reed. Published by the Mineralogical Society of Pennsylvania (c/o Juliet C. Reed, 336 Rockland Road, Wayne, Pennsylvania 19087). Softcover, 83 pages (1976) ($3.25).**


HAZEL PARK
HOLIDAY INN
CRANBROOK
INSTITUTE
NINE MILE ROAD
N
WOODWARD
LIGHT
GUARD
ARMORY
EIGHT MILE ROAD
75
DETROIT

Letters

FAN MAIL

Dear sir,

Recently I completed a thorough, cover-to-cover re-reading of the complete stack of *MinRec*. I have recommended doing this to several friends and suggest that other advanced collectors will find it quite rewarding. This is partly because a 7½-year time span is involved and during this time our mineralogical knowledge has expanded sufficiently to give us a greater perspective than we had back in *Issue #1* days. It also helps us older heads compete with the younger ones in the memory department. Finally, there are some factual jewels in that stack.

I should not miss this opportunity to explicitly praise the type of article which Pete Dunn contributes on nomenclature/classification. The apatite and helvite articles really revolutionized my collection, and the uvite article straightened out some other specimens (including a nice critter which I knew was mislabeled as andradite from Franklin...it was uvite from Pierrepont, and exactly matched my old "pierrepontite"...a great relief, as they are fine specimens).

John C. White
Renton, Washington

TSUMEB FAN MAIL

Dear readers,

Most of the purely complimentary letters we receive, though great moral boosters for the staff, are not published because they are relatively uninformative and may not interest most people...some readers characterize such letters as little more than "propaganda." However, the response to our recent book-issue on Tsumeb (v. 8, n. 3), has been unprecedented. In view of the special circumstances, perhaps the following indulgence can be forgiven: excerpts from some of the letters we have received are presented below.

Ed.

The Tsumeb issue is remarkable. At the time the magazine was started I never would have believed that any such thing would ever be possible.

Richard A. Bideaux
Oro Valley, Arizona

...all I can say is that you have finally arrived. The Tsumeb issue is the epitome of all I have hoped for *M.R.* since it began. Congratulations.

Jim Minette
Boran, California

Congratulations on the superb job done on the Tsumeb issue.

Paul B. Moore
Chicago, Illinois

...an exceptionally fine job.

E. M. Gunnell
Denver, Colorado

It is uncommon to get so much detail of value to the collector for one locality.

Martin Plotkin
Massapequa Park, New York

Here, for the first time, is a collection of data, easily read by the non-professional, which is not pedantic and which, I am sure, will stand the test of time.

David H. Wilson
Louisville, Kentucky

The Tsumeb issue is excellent beyond words!! ...something to keep handy and forever something to study.

Gertrude Houser
Cincinnati, Ohio

I must say that the Tsumeb issue is great. You did a very good job and even though I am a pegmatite man, I am in awe of this locality after seeing this issue.

Jack Lowell
Tempe, Arizona

Magnificent...you have provided me with a reference tool I had only hoped for but never expected to find.

Chris Inskeep
Hanscom AFB, Massachusetts

Congratulations on an excellent issue! It has already paid for itself several times over by helping me to identify some rare minerals.

David H. Garske
Elmhurst, Illinois

...comprehensive, concise, descriptive, enlightening...In my 25 years as a collector-dealer there is but one other publication I hold in the same esteem, Palache's *The Minerals of Franklin and Sterling Hill, Sussex Co., N.J.*

Arnold Gussen, Jr.
Lynden, Washington

Congratulations on the fantastic job you've done on the Tsumeb issue. I'm sure it will have great historical value and I have nothing but praise for *all* of the people who were involved.

Robert J. Glotfelty
Glenshaw, Pennsylvania

...outstanding, excellent... I wanted to write a book on Tsumeb once, based on the little we knew in 1913, but now I have your BIBLE.

Fred Cassirer
New York, New York

May I congratulate you on the presentation, the complete and thorough coverage of this world-famous mine. It must have been a terrific job to get together the wealth of information. And I, who am acquainted with that mine, now know considerably more than I formerly knew about it. Let me thank you for what will surely be a classic.

Heinz W. Eckert
Denver, Colorado

The Tsumeb issue is superb! I don't think anyone could beat it; goes to show that the *M.R.* is the best mineral magazine in the world. I should know, because I subscribe to the four top foreign publications as well but all are thoroughly outclassed. You and your co-workers did a splendid job.

Bruce Campbell
Scarboro, Ontario

What can I say...fantastic, extraordinary, marvelous, a legend in its own time, etc., etc. Many thanks to you, your authors, and your hard working staff for such a beautiful gift to us subscribers. (P.S. I can hardly wait for the Illinois Issue!)

Pat Carlon
Normal, Illinois

The What? Ed.

Emptor rejoicam! Libra Tsumeb est magnifica vehicula scientae mineralogia. Tsumeb libra, cum tanquam perfecte mista, motus rerum est rapidus extra locum in aras mineralogia.

Pete J. Dunn
Washington, D.C.

What? Ed

Beautiful! ...destined to be a collectors' item. Every serious mineral collector should have a copy.

Gary Lackie
Remus, Michigan

...a "complete" overview, as has long been necessary. *M.R.* is generally considered to be getting better and better; we are all talking about it. Of course you will be hard put to surpass the Tsumeb issue, but keep up the good work.

Kay Robertson
Los Angeles, California

Your grand issue has allowed us to enjoy seeing so many things that most of us could never acquire or even see in person, and has also, through the many articles by known and respected writers, given us a detailed description of the minerals and the locality itself...the very womb where Nature has formed these classic specimens. We wish the *Record* prosperity and a long and active life.

Albert H. Chapman and
Albert E. Gardner
Glebe Point, N.S.W., Australia

*On behalf of the 18 authors, 13 photographers, the **Record** staff, and especially the donors who helped with funding for the project, I would like to offer thanks to the many people who wrote in to express their appreciation for the Tsumeb issue.*

*Three letters offering some discussion on the Tsumeb matters have also come in (more would be welcomed) and will be published in the first installment of **Tsumeb Notes**. Readers who may have noticed errors, misprints, omissions or inconsistencies are strongly encouraged to bring them to our attention.*

*The **Letters** department is one of the most popular features of the **Record**. We publish nearly all of the letters received that are substantive in any way, and would like to receive more. Readers are invited to utilize this forum to communicate with fellow collectors, and to sound off on matters of importance or interest.*

Ed.

WORLDWIDE MINERAL AND GEM STAMPS

Dear sir,

I have started a small stamp collection specializing in mineral and gem stamps. As far as I know, a list of all such stamps ever issued worldwide has never been compiled. I would be pleased to coordinate such a compilation; interested readers are invited to send me a list of such stamps known to them, including the year of their issue (if known) and perhaps a xerox of the stamps themselves. In return I will send them my total compilation to date.

Eric Offermann
Lettenweg 16
CH 4144 Arlesheim
Switzerland

EXCHANGES

Dear sir,

I am anxious to exchange for or buy plagioclase feldspar crystal specimens of any size. All letters will be answered.

C.C. Rich
Boot Road
Newton Square, Pennsylvania 19073

Dear sir,

I am interested in exchanging for micro specimens of rare minerals or common species exhibiting unusual morphology. For exchange I can offer many rare or unusual micro specimens from the Southwest and Europe (e.g. murdochite, spangolite, brochantite, linarite, schoderite, and many others).

Ramon S. DeMark
9012 Hilton Ave., NE
Albuquerque, New Mexico 87111

Dear sir,

Will you let your readers know that all American readers of the *Record* can place FREE in our monthly bulletin an advertisement for the exchange of minerals or fossils?

R. Leemans, President
Cercle des Geologues de Belgique
36, Rue Felix Delhasse
B 1060 Bruxelles, Belgium

Dear sir,

I have very fine specimens from Trepča and Laurium that I will exchange for specimens from famous U.S. or Canadian mines, especially the Bluebell mine in British Columbia (which is very similar to Trepča).

Paul Riesinger
Kopernikustrasse 2
8 München 80
West Germany

BOUND FOR GLORY

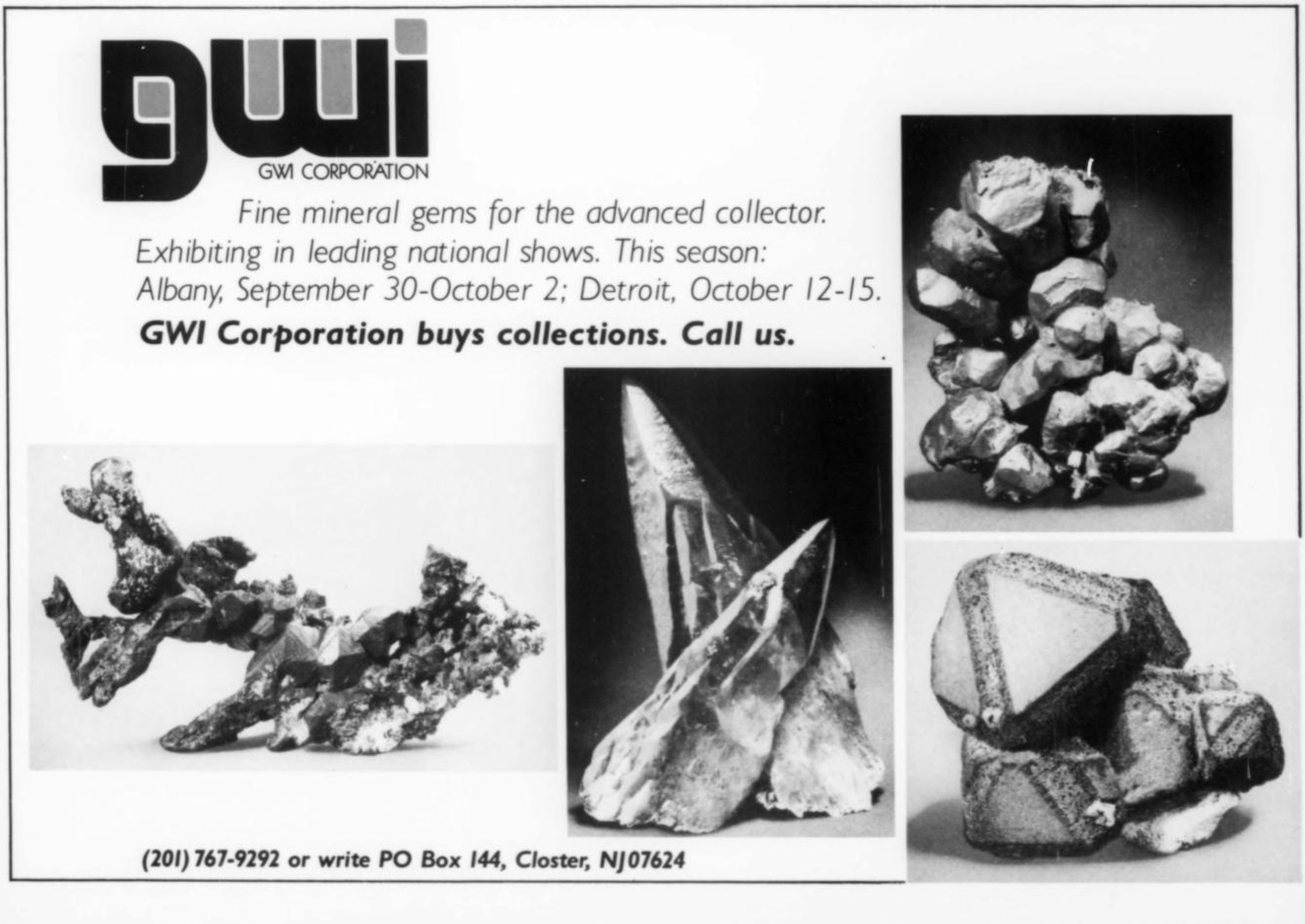
Dear sir,

I think your idea of having the Tsumeb issue hardbound is super. Would you by chance know of a good binder that could do this?

Louis Curinka
Melrose Park, Illinois

*No, I don't, but I know that many of our subscribers routinely have their volumes of the **Record** bound every year or two. If readers will send me the name and address of their favorite bindery, along with approximate cost and quality details, I will be pleased to publish the recommendations for everyone's use.*

Ed.

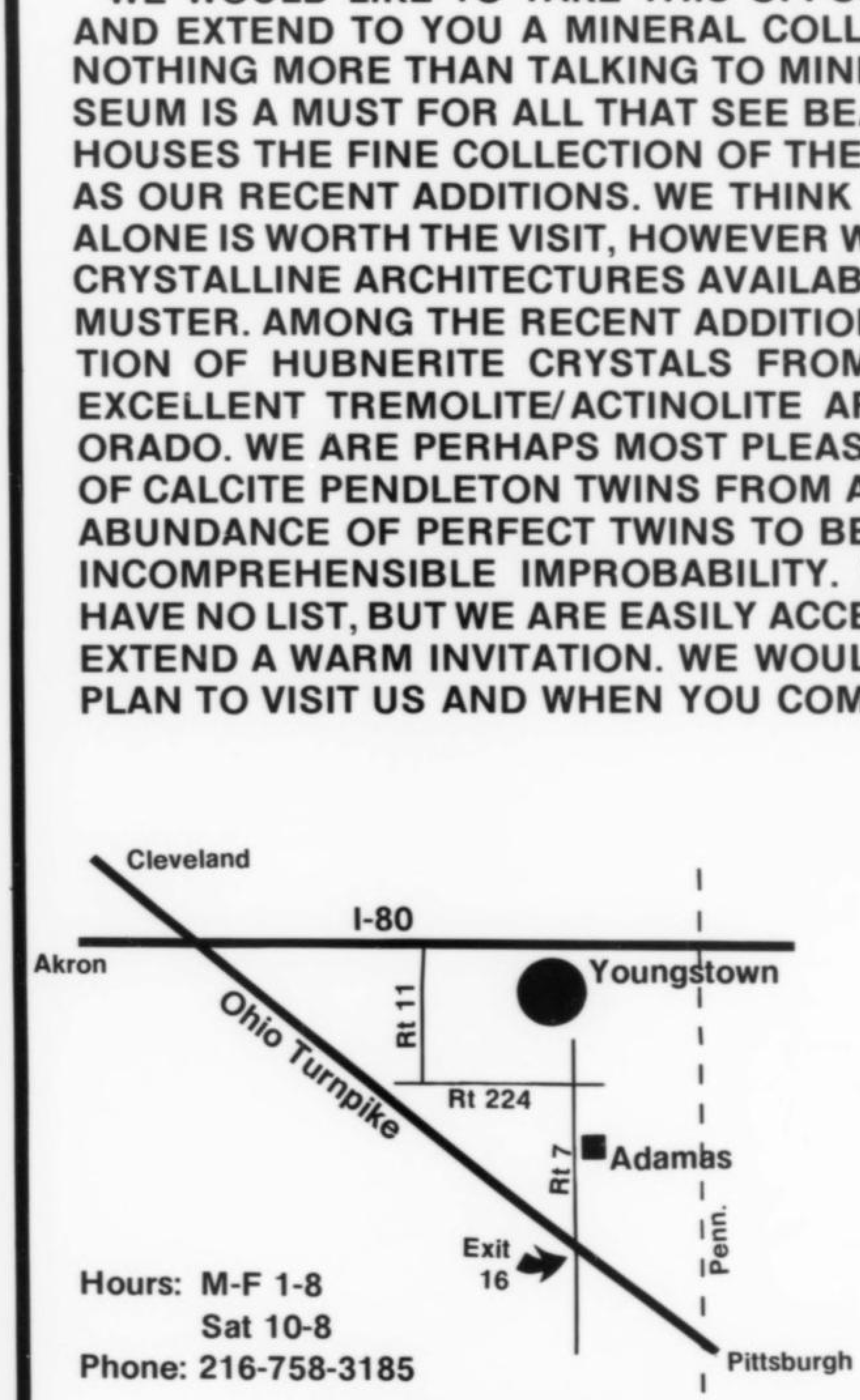


ADAMAS

"MINERALS FOR MINERAL COLLECTORS"

ADAMAS IS LOCATED 2 MILES NORTH OF THE OHIO TURNPIKE (EXIT 16) AND 20 MINUTES SOUTH FROM I-76 & 80. IF YOU PASS THROUGH YOUNGSTOWN GOING EAST OR WEST AND YOU ARE A MINERAL COLLECTOR, WE THINK YOU WILL FIND THE VISIT TO ADAMAS WORTHWHILE.

WE WOULD LIKE TO TAKE THIS OPPORTUNITY TO INTRODUCE OURSELVES AND EXTEND TO YOU A MINERAL COLLECTOR'S INVITATION, FOR WE ENJOY NOTHING MORE THAN TALKING TO MINERAL COLLECTORS. THE ADAMAS MUSEUM IS A MUST FOR ALL THAT SEE BEAUTY IN THE MINERAL KINGDOM AND HOUSES THE FINE COLLECTION OF THE LATE CLARENCE SMITH SR., AS WELL AS OUR RECENT ADDITIONS. WE THINK YOU WILL AGREE THAT THE MUSEUM ALONE IS WORTH THE VISIT, HOWEVER WE DO HAVE THE LARGEST VARIETY OF CRYSTALLINE ARCHITECTURES AVAILABLE TO THE COLLECTOR, THAT WE CAN MUSTER. AMONG THE RECENT ADDITIONS TO OUR STOCK ARE A FINE SELECTION OF HUBNERITE CRYSTALS FROM SILVERTON COLORADO AND SOME EXCELLENT TREMOLITE/ACTINOLITE AFTER PYROXENE FROM SALIDA, COLORADO. WE ARE PERHAPS MOST PLEASED TO OFFER YOU OUR ASSEMBLAGE OF CALCITE PENDLETON TWINS FROM ANDERSON, INDIANA. WE BELIEVE THE ABUNDANCE OF PERFECT TWINS TO BE NATURE'S ACCOMPLISHMENT OF AN INCOMPREHENSIBLE IMPROBABILITY. WE ARE NOT A SHOW DEALER AND HAVE NO LIST, BUT WE ARE EASILY ACCESSIBLE FROM MAJOR HIGHWAYS AND EXTEND A WARM INVITATION. WE WOULD BE PROUD TO SHOW YOU ADAMAS. PLAN TO VISIT US AND WHEN YOU COME TO YOUNGSTOWN; ASK FOR 'ANDY'.



Andrew J Love

Andrew J. Love
GEOLOGIC CONSULTANT

Hours: M-F 1-8
Sat 10-8
Phone: 216-758-3185

YOUNGSTOWN
OHIO

8391 Market St. **Youngstown, Ohio 44512**

PERSONALITY SKETCH

GERTRUDE (TRUDY) HOUSER

by
Rose Ann Fox
3476 Cornell Place
Cincinnati, Ohio 45220

"15,000 Fossils...and still counting." That's the report I received from Trudy Houser, member since 1959 of the Cincinnati Mineral, and Dry Dredger Societies. Despite entertaining more than a dozen visitors a week, methodical Trudy, whose cataloging zeal almost equals her collecting enthusiasm, found counting fossils and minerals a labor of love more than of necessity.

The nucleus of the Houser collection, which, in addition to fossils, includes 2500 cataloged minerals and crystals, was a miscellaneous group of about 350 "insufficiently labeled" minerals and fossils that Trudy's husband, a physician, had gathered on weekend excursions since the age of 12. "Even on a Sunday walk," says Trudy of their courting days, "we always carried a hammer and chisel." When her husband died in 1941 there were two daughters, 12 and 13, to raise. For diversion, the doctor's widow began researching the proper identification and labelling of the fossils by Phylum, Class, Order, Genus, Species and Location—quite an undertaking for someone untrained in the field, who, three months prior to graduation, had decided to marry, rather than to complete her History Of Art college major. A newspaper "for sale" offer of another doctor's bequeathed collection was the incentive for adding a new group of specimens. They came all wrapped in newspapers, "which," Trudy's blue eyes gleam at the history context, "were all dated from 1858 to 1884." One suspects that the journals received as thorough a study as the specimens.

Any reader who has gone to a major mineral show in recent years has probably met Trudy, who travels to at least four a year. She's the compact, nattily garbed, bright-eyed little woman, of vast energy, with an intriguing accent, who attends each lecture, field trip and banquet, and seems to be acquainted with every VIP lecturer, dealer and spectator.

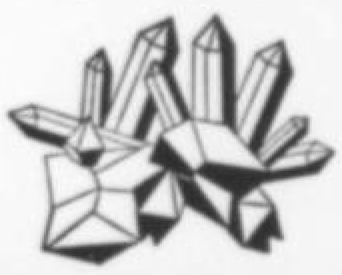
If, when in Cincinnati, one indicates a desire to view an outstanding local mineral and fossil collection, Trudy Houser's house is where one will usually be taken... and receive the warmest of welcomes—plus a choice of beverages and homemade cakes. Should the visitors linger over the crystals late into the evening, they may even be urged to stretch the mineral talkfest by accepting bed and breakfast. Specimens and travel mementos decorate every area. Two of the upstairs rooms are turned over completely to mineral displays. The basement, with noon-day illumination, is a small museum. The glass-front, lighted cases are arranged, assures the hostess, "according to the uniform rules." Label writing and printing, card indexing and cataloging are an unending labor. Labels and catalog provide full information—ledger or case access number, name, Dana volume number and page, and chemical composition of minerals, location, how acquired, and from whom, date, size, value and price if purchased. A cross-index card file is in alphabetical order...despite constant acquisitions, all are up-to-date!

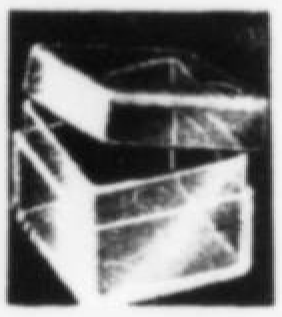
So, if breakfast is on the agenda, be warned. It will be ample, but early. To cope with her full schedule this ageless lady rises promptly at 5 A.M. Before 8, household chores completed, she is on her way to the Health Spa for a two hour exercise and swim session. By 10:30 A.M. she is free for appointments, shopping, or the pursuit of any of a dozen mineral-oriented occupations. In the Cincinnati Mineral Society Mrs. Houser has filled every office and chairmanship, from Publicity to President. At present she is program director, arranging for speakers for monthly meetings, and planning the program of six lectures for the group's annual, early April Mineral & Gem show. Her hospitality is legend with many groups, from Girl Scouts to Garden Clubs. In summer months a back yard patch provides fresh salad vegetables; a front lawn bed of scarlet canna lillies identifies her address for strangers. A luncheon and "museum tour" was a spring event for the University of Cincinnati's Alumni College Association, and no area school would miss the opportunity of a field trip to Mrs. Houser's house. For every child there's a take-home fossil or crystal. These used to be free, Trudy explains, but not valued too highly. "So now I make a charge of a penny or two—up to a dime, and months later, because they were paid for, the specimens are still cherished".

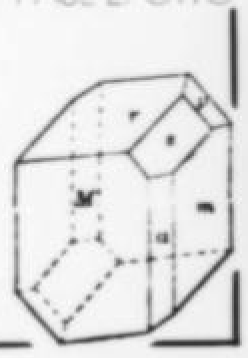
Mrs. Houser's status in the global Collectors' Archipelago is affirmed by a signature and address register which tallies an average of 650 guests a year, from every state and many countries around the world. To those who question "Why? What do you get from collecting?" Trudy's answer is, "consolation, and joy in the earth's beauty; and the fulfillment of a duty—to preserve that beauty for future generations. And," she smiles fondly, "pleasant evenings with strangers can grow into lifetime friendships."

Trudy recently delighted Smithsonian paleontologists with a gift of approximately 2000 fossil specimens, over *100* of which were not previously represented in the National Collections. Most of her donation will be housed in the Smithsonian's Naturalist Center (see *Mineralogical Notes* in this issue); the specimens will have special labels indicating them to be part of the Gertrude Houser collection, and a plaque is also being prepared. ☒

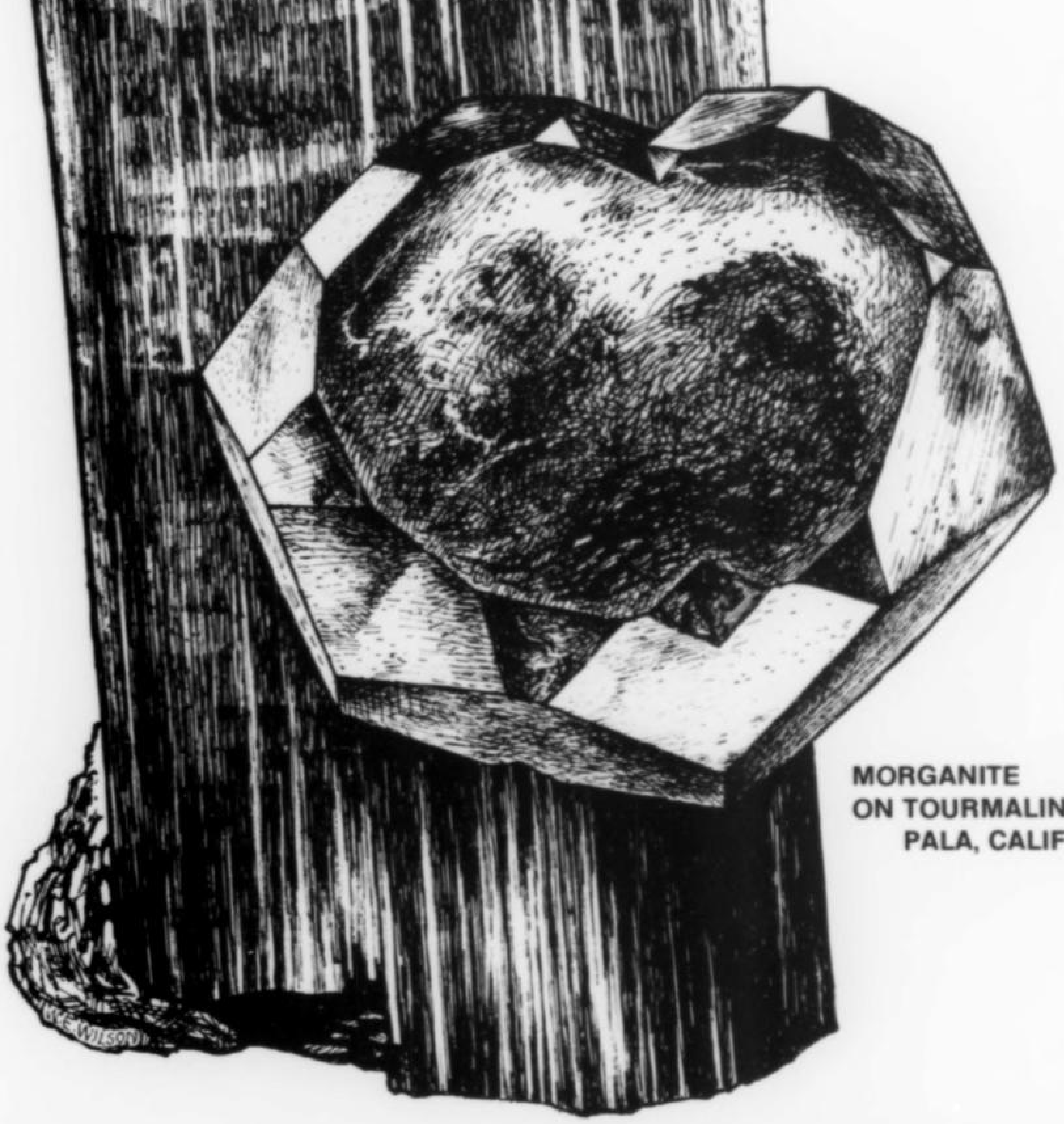
ROCKHOUND
75¢







ADVERTISERS INDEX



MORGANITE
ON TOURMALINE
PALA, CALIFORNIA

A UNIQUE GALLERY FOR THE
DISCRIMINATING COLLECTOR OF
MINERALS, FOSSILS, CARVINGS,
JEWELRY, SEASHELLS,
BUTTERFLIES AND OTHER
WONDERS OF NATURE.

120 GEARY STREET
(between Grant Avenue & Stockton Street)
SAN FRANCISCO, CALIFORNIA 94108
(415) 391-2900

OPEN TUESDAY THRU SATURDAY
9:30-5:30,
CLOSED SUNDAY & MONDAY

Mineral World

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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