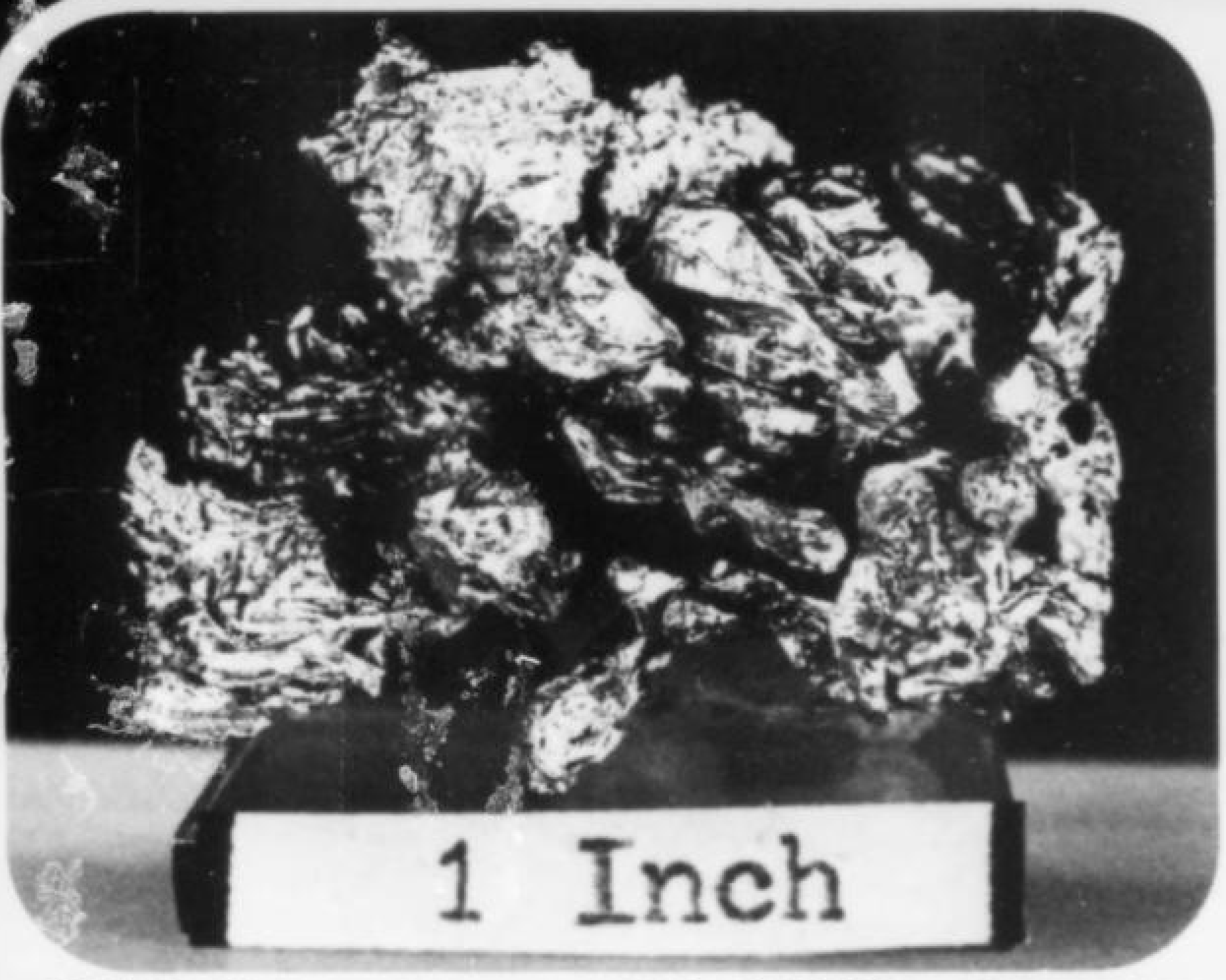
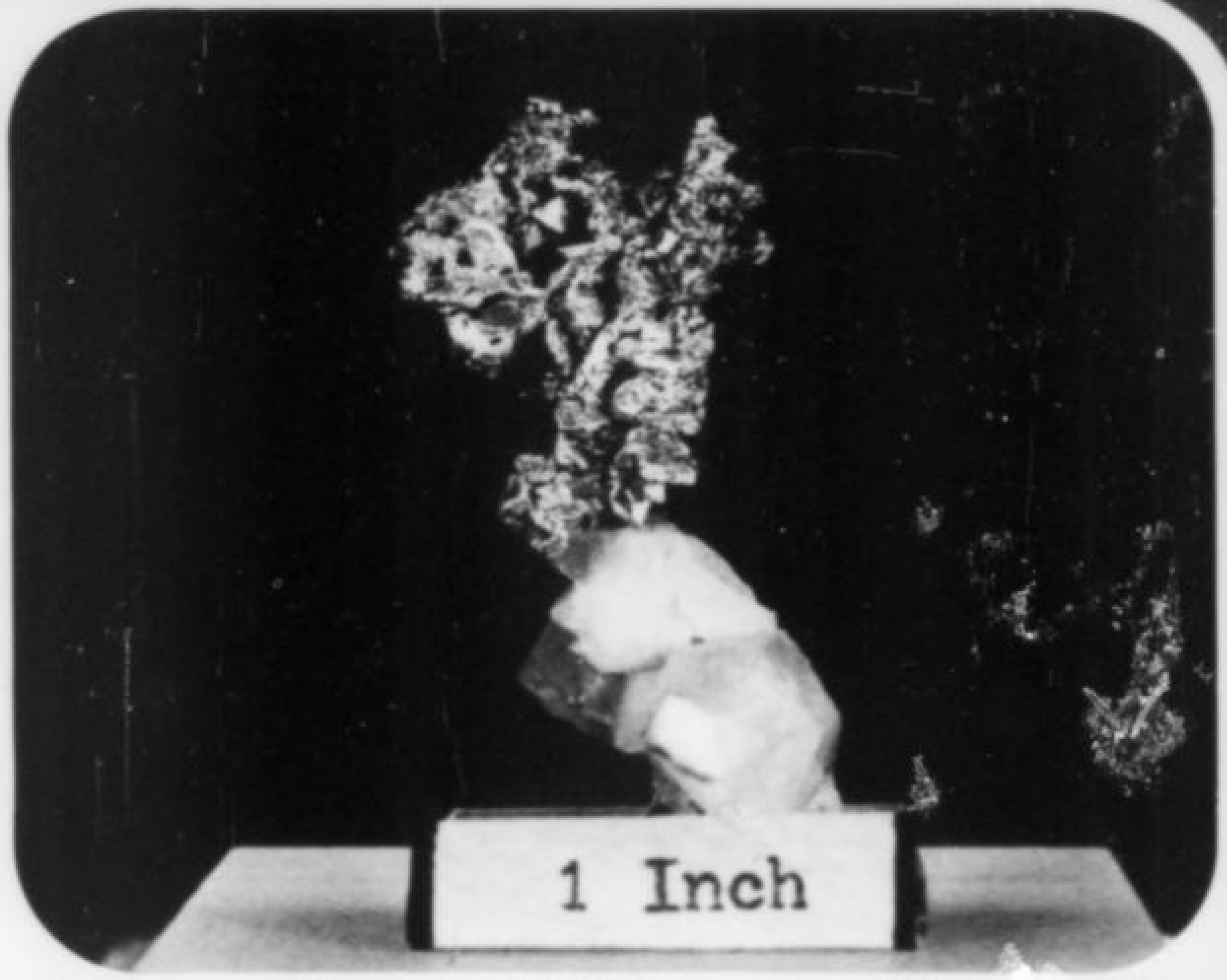
the Mineralogical Record

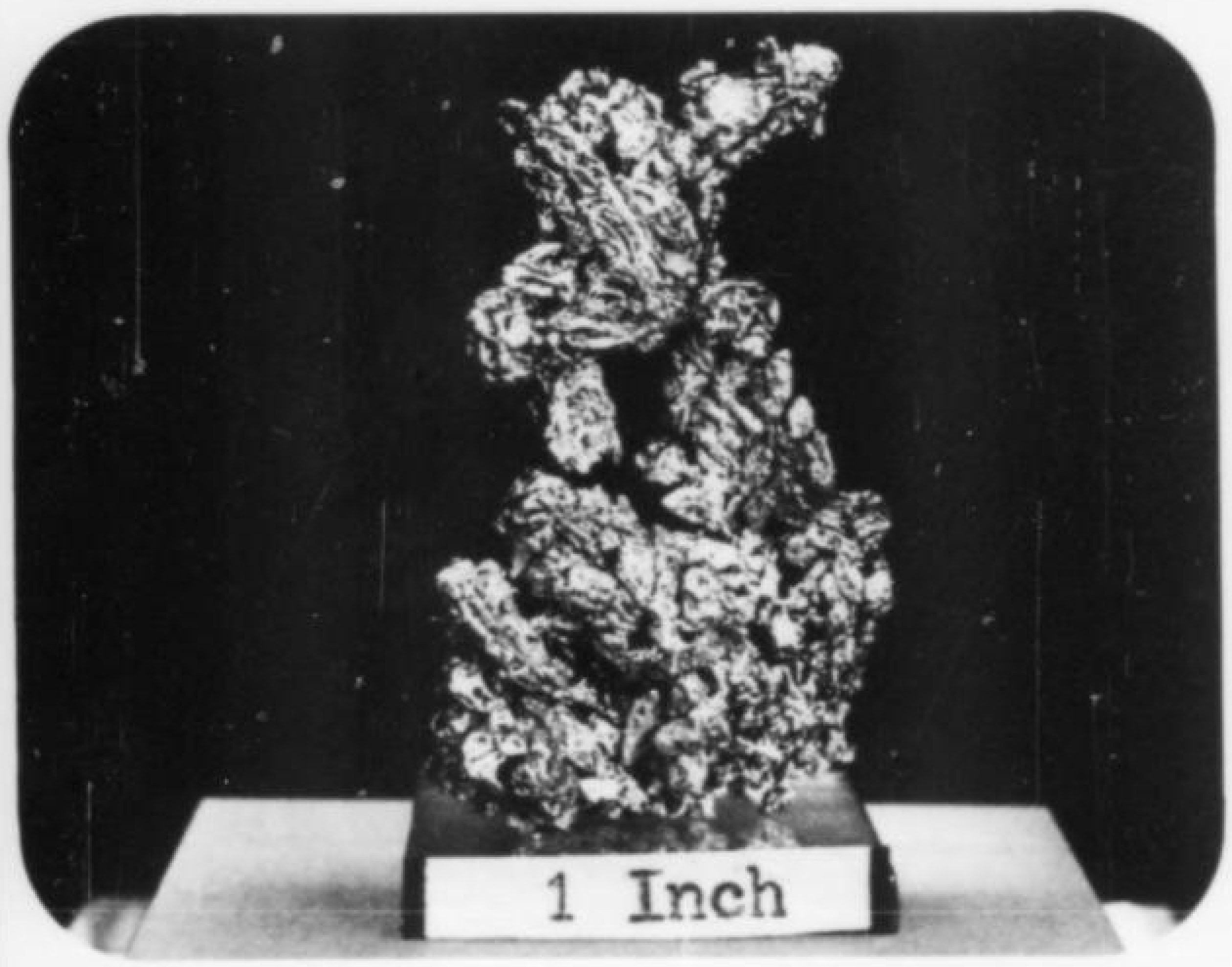
Volume Eight/Number One
JANUARY – FEBRUARY 1977 $2.00



GOLD—1 oz. - large crystals $3,500 - Calaveras County, Calif.



GOLD on Quartz—$1,400 Crystal Mine, Angels Camp, Calif.



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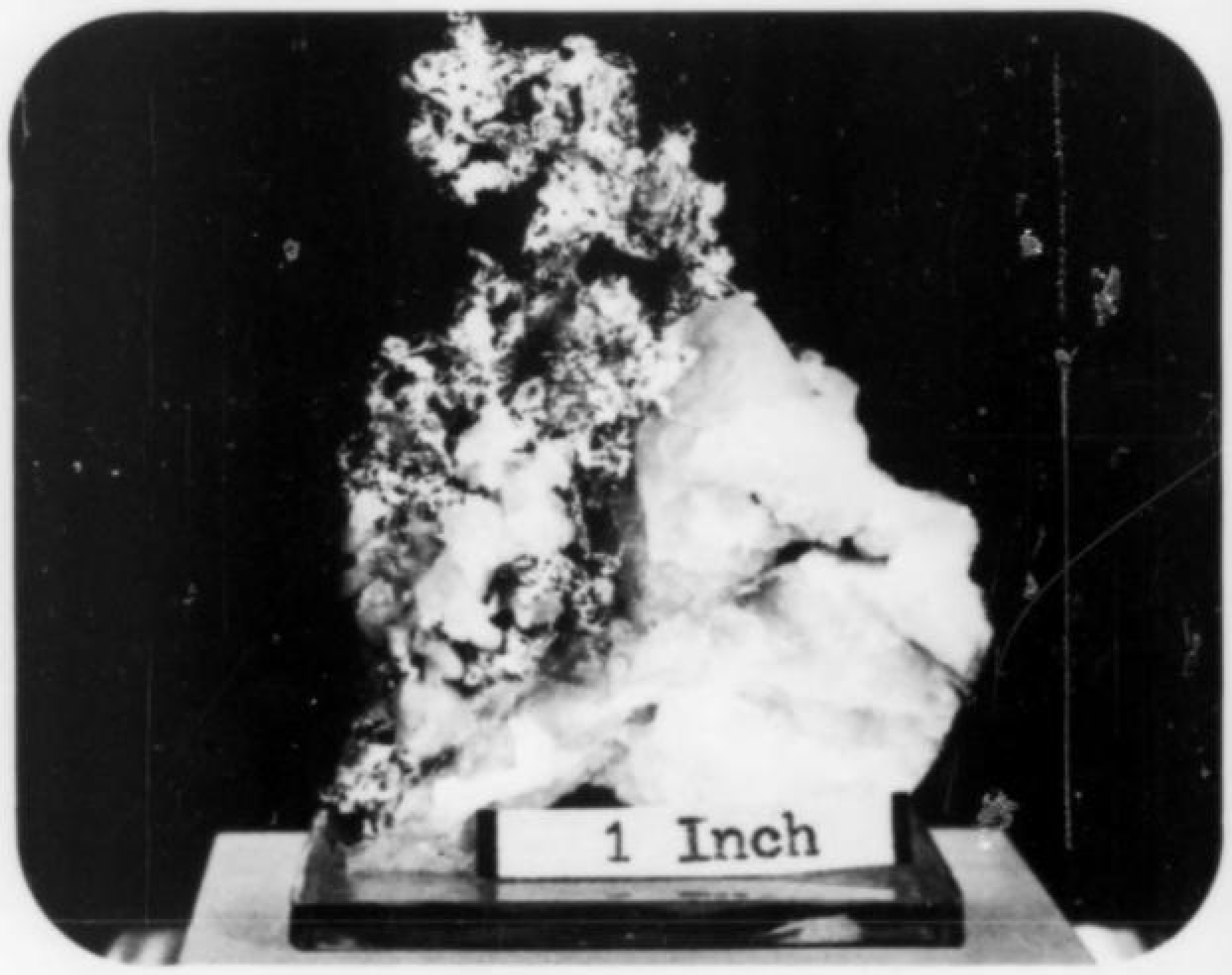

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affiliated with the Friends of Mineralogy

the Mineralogical Record

Volume Eight/Number One
January-February 1977

subscriptions

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

feature articles

departments

CALCITE with dolomite and chalcopyrite from the Viburnum Trend, Iron County, Missouri. Specimen is two inches tall.

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, 42 Oxford St., Leicester LE1 5XW
South Africa: Horst Windisch, 30 van Wouw St., Groenkloof, Pretoria

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

NOTES FROM THE EDITOR

Since becoming editor I have often felt the need for a space in which to keep readers informed on miscellaneous matters; such items do not really fall into the category of an editorial, nor can they easily be worked into the Letters column unless someone writes in with just the right question. This new department has therefore been created to open more direct communication between *M.R.* and its readers (especially when I can't think of anything controversial to write for an editorial).

Perhaps it would be good to start off by pointing out some of the changes I have been making in the magazine's format, in case readers have not already noticed. Beginning with Vol. 7, No. 4, the line spacing has been changed to allow more lines of type per page. Compare, for instance, page 133 (of No. 3) to page 212 (of No. 5). Beginning with No. 6, the page margins have been made narrower. These two changes now allow us to put as much type on four pages as had formerly required *five* pages. If an issue contains 30 pages of type, for instance, (excluding photos, titles and ads) the format change will yield an extra 7-8 pages in that issue...enough for an additional article.

We have had some criticism for getting too fancy with typefaces, so we are limiting that severely; the entire magazine text will all be in the same typeface from now on, and we will strive to keep titles elegant rather than gaudy. This is primarily a problem of restraining the graphics artists, who would go wild if we let them.

After a considerable period of shopping around we now feel we have found two printers (one for color issues, one for B&W) who can produce reasonably high quality at a lower price than we used to pay. With the help of this savings we now think that *M.R.* can afford to go to 64 pages on a regular basis (up from 48). This addition, coupled with the space-saving changes mentioned above, should allow us to publish plenty of photos and still publish more written information than ever before. Our readers pay much of our production costs, and we want to be certain that they receive their money's worth.

I've mentioned this before, and will continue to repeat it: we want and need feedback from readers. Send us your opinions, your likes and dislikes, your suggestions for improvement. Both John White and myself are very sensitive to letters from readers. Just indicate that you would like your letter withheld from the Letters column and it will remain private if you wish. We have already solicited several articles suggested by readers, and have made many adjustments and minor changes in response to letters. Remember, we only have about 4000 subscribers, unlike *Lapidary Journal*, for instance, with its 70,000 readers, so we can afford to give much more attention and consideration to each reader. And we do *not* give preferential treatment to letters from professionals or other groups...one subscription: one vote.

One caution: readers often assume that however an issue is "slanted", future issues will be more so. This is not true. It has never been possible to accurately predict a future issue on the basis of a past issue. Simply tell us what you like and don't like, and we will endeavor to maintain a good balance.

We knew Vol. 7, No. 5, was a fine issue, but none of us was prepared for the overwhelming response! It has performed superbly well for us in drawing new subscribers, and many of our readers have taken advantage of our offer to send a complimentary copy to anyone they choose for just $1. That offer is *still good* for any issue you would like sent. Why not send friends a copy of the Colorado issue? A card will be enclosed in your name. Furthermore, it appears that many readers have been showing their copies to friends because many new subscribers are requesting that their subscription start with Vol. 7, No. 5, even though the coded *M.R.* address indicates they are not responding to one of our ads in other magazines. So we can tell that our readers are helping us to increase subscriptions and we appreciate it very much.

Here's another way that readers can help the *Record*: pester your local mineral dealer to take an ad, if he hasn't one already. Ad revenues are important to us, but also remember that the *Record* performs a service for *all* dealers: it stimulates collectors and keeps their interest alive and active. The *Record* also publicizes new mineral discoveries in "What's New in Minerals?" at no cost to dealers; discoveries are often dispersed through many dealers, some of whom do not even advertise with us. The *Record* does a great service for the mineral business; the advertisers we *do* carry are essential to our existence, and deserve our readers' appreciation. There is also the fact, of course, that *Record* subscribers are, for the most part, exceptionally active buyers, and *Record* ads are therefore very productive for advertisers. Your dealer would no doubt be impressed if several of his customers pointed these facts out to him.

Beginning with the previous issue, we have introduced an index to advertisers at the end of each issue. To make it especially handy, we have included their telephone numbers in the index; this should make it easier to find and contact dealers whenever the buying mood strikes.

If you have $150, what will it buy? A fine miniature? Thirty pizzas? Half of Goldschmidt's *Atlas der Kristallformen*? Yes, but it will also buy something even better: a *lifetime* subscription to the *Mineralogical Record*. We've checked with some other magazines, and they feel that 15 years paid in advance will amount to a lifetime subscription if interest is figured in, so that's good enough for us. Try it and never get a subscription renewal notice again! Vic Yount was the first to buy a lifetime subscription, and he still wondered how we could do it. "Simple", I said; "when the 15 years are up we just have someone push you off a cliff."

The issue after next will be our long-awaited Tsumeb issue...but you can expect something unusual in your mailbox. It won't look exactly like a regular issue of *M.R.*, so pay attention to the credits or you might not even recognize it as Vol. 8, No. 3. Beyond that I will let it remain a surprise.

Two future issues we have planned and virtually completed are a Pegmatite Issue (possibly the first in a series of pegmatite issues) and an entire issue devoted to California minerals and localities. We would particularly like to do the California Issue in color, if we can obtain a benefactor for the extra expenses. Our color budget for the year will be spent on the Tsumeb issue.

We are also entertaining suggestions for the next edition of the *Glossary of Mineral Species* (planned for 1979), so send your thoughts to us or Michael Fleischer (c/o *M.R.*).

A variety of other projects and special issues are in progress, but we still need reader support. The more our readers do for us, the more we can do for them. So get involved; the *Record* is *your* magazine.

W.E.W.

friends of mineralogy

THIRD JOINT MSA-FM MEETING AND SYMPOSIUM

Tucson, Arizona
February 13-14, 1977
"CRYSTAL GROWTH AND HABIT"

In February of 1974 and 1976 joint meetings of the Mineralogical Society of America-Friends of Mineralogy were held in Tucson, Arizona in conjunction with the Annual Tucson Gem and Mineral Show. Last year's MSA-FM symposium on the "Crystal Chemistry and Paragenesis of the Gem Minerals" was so successful that the organizing committee has scheduled a third joint MSA-FM meeting and symposium to be held on February 13-14, 1977, in Tucson, Arizona.

The topic chosen for this year's symposium is "Crystal Growth and Habit." Dr. Kurt Nassau of Bell Laboratories will present the keynote address on the topic "Gems: Science, Beauty and Deception." Twenty-four titles have been solicited for the technical sessions which include Session I on crystal growth, morphology and compositional variations of minerals, natural and synthetic (12 papers) and Session II on general topics (12 papers). Each presentation shall be 30 minutes in length with an additional 10 minutes for discussion.

Because of the mixture of professional and non-professional mineralogists that will attend these technical sessions, general papers have been favored over highly specialized ones. Topics concerning crystal growth, chemical zonation, crystal morphology, the genesis of twinned crystals, and the occurrence and genesis of crystals of varied and unusual habit will be discussed.

Advance registration

Because of heavy attendance at the concurrent Tucson Gem and Mineral Show, prospective attendants of the Mineralogical Society of America-Friends of Mineralogy Third Joint Meeting are urged to request advance registration. The necessary forms can be obtained by writing to:

Dr. Authur Roe, General Chairman
MSA-FM Third Joint Meeting
Arizona-Sonora Desert Museum
Post Office Box 5607
Tucson, Arizona 85703

Micromount symposium

There will be a micromount symposium Monday night, Neal Yedlin chairman. No special registration is required for the micromount symposium.

FM Portland Symposium

Friends of Mineralogy, Region 12, Pacific Northwest, sponsored its Second Annual Mineral Symposium October 1-2, 1976, at the Sheraton Motor Motel, Portland, Oregon. The theme of the symposium was "PEGMATITES".

The symposium opened informally on Friday evening, October 1st, with a "no-host" social gathering. The purpose of this informal get-together was to permit F.M. members to renew acquaintances, visit, and to browse over the minerals on display by the three dealers who were in attendance.

The symposium opened officially on Saturday morning, October 2nd, when Bob Smith, Master of Ceremonies, introduced Fred Pough, noted author and mineralogist. Dr. Pough covered his topic, "Pegmatites," in a very well condensed and effective manner, giving a clear description of the various types of pegmatites and the various minerals that could be expected to be found in each type. Bill Roberts, co-author of "The Encyclopedia of Minerals," was the second speaker on the program. His topic, "Pegmatite Minerals of the Black Hills, South Dakota," was accompanied by a fine set of slides showing many of the rarer and unusual phosphate minerals found in that area. Next on the program was Anthony Kampf, from the University of Chicago, who gave a very informative discussion, also accompanied with slides, of "The Pegmatite Minerals of Palermo, New Hampshire." The last speaker, Richard Jahns from Stanford University, noted for his knowledge of pegmatites and pegmatite minerals, presented an outstanding lecture on "Pocket Pegmatites of Southern California." This was a most interesting lecture with slides of some of the more interesting gem minerals which occur in this area.

This concluded the Second Annual Mineral Symposium held by the Friends of Mineralogy in the Pacific Northwest. It was a success, as was the original symposium, and for the second time enough income was generated from this event to cover all costs. This particular symposium cost just over $1,600. For other regions interested in having a similar affair, the costs were as follows:

Speakers' travel expenses (4)	$ 800
Speakers rooms & meals (4)	260
Printing, postage & advertising	240
Security guard	60
Sheraton costs: hospitality room, coffee, etc.	240
Total	$1,600

The F.M. membership is rather low, fluctuating between 40 and 50 active members. Consequently, registrations were set at $9.00 per person and $100 per dealer with a maximum of three dealers. Only 79 registrations were accounted for, instead of the 120-125 which had been anticipated, so that the income from the dealers plus registrations totaled only a slight amount over $1,000.

The balance of the finances came from the mineral auction which was held in conjunction with the symposium. Each F.M. member donated one or more specimens and the auction was held as part of the program during the day. The annual auction this year was very helpful in that it brought over $550 and was largely responsible for helping to cover the remaining costs of the symposium.

Arrangements are now under way for the 3rd Annual Symposium. The enthusiasm and interest which the first two symposia generated is responsible for the optimism that now prevails in our membership and is why our region anticipates a bigger, better and more interesting symposium in 1977. The topic will be of interest to all those who are mineralogically oriented and the speakers will continue to be of the quality that has prevailed in the past.

Because these symposiums are educationally oriented, are directed toward collectors and are attended primarily by people interested in minerals, they seem to generate more enjoyment and satisfaction than a normal gem and mineral show.

Friends of Mineralogy in the Pacific Northwest is now making plans with the intent that eventually its symposium will become a well-known national event not to be missed by anyone who is seriously interested in minerals. Maybe you should plan to attend next October. Don't miss a good program!

MIKE GROBEN

FAMOUS MINERAL LOCALITIES:

PRINCE OF WALES ISLAND, ALASKA

by
Peter B. Leavens, Department of Geology, University of Delaware, Newark, Del. 19711
and
Richard W. Thomssen, 1077 Riverside Dr., Apt. 64, Reno, Nev. 89503

Introduction

The Copper Mountain mining district, Prince of Wales Island, Alaska, was active from 1902 until 1923 (Wright, 1915; Kennedy, 1953); since then there has been no production. The major mine in the district, the Jumbo, produced 5000 tons of copper, about one week's output of the great open pit copper mine at Bingham, Utah. Recently there has been some prospecting and drilling in the Jumbo mine area for possible low-grade ores.

This small isolated mining district (Fig. 1) is one of the great mineral localities of the world. The large, brilliant, greenish-black crystals of epidote found there are equalled only by the epidote from the extinct locality at Untersulzbach in Austria (Palache, 1902). The region around the Jumbo mine has produced matrix specimens and clusters of epidote crystals as well as good adularia. The diggings on Green Monster Mountain, several miles away, are most famous for large single crystals, although groups are found there too. In 1935 an expedition led by Arthur Montgomery and Edwin Over collected many fine specimens (Montgomery, 1937).

The National Geographic Society funds many expeditions which do not yield articles for their magazine; in 1967 they supported a Smithsonian Institution expedition to Prince of Wales Island for mineralogical field work (Leavens, 1972). George Switzer of the Smithsonian was the principal investigator. The authors, along with Douglas Toland, then an undergraduate at the University of Delaware, were the field party. We were on Prince of Wales Island for two months, from June 18 to August 17.

It is important to note that although Prince of Wales Island is part of Tongass National Forest, the mines and mineral deposits, including the epidote pockets, are on patented claims, that is, private property, and that unauthorized collecting is illegal.

Setting

Prince of Wales Island is in the Alexander Archipelago of the southeastern panhandle of Alaska, just north of the Canadian border (Fig. 2, 3). The Copper Mountain district is in the southern part of the island, at the head of Hetta Inlet, a narrow fjord which stretches some 25 km to Cordova Bay. Sixty-five km to the east of Copper Mountain is Ketchikan, one of the larger cities in Alaska, with a population of 7000 (1970 census); the Indian village of Hyadberg is 25 km distant by water. The small towns of Sulzer and Coppermount, and extensive mining construction including an aerial tram and an ore loading dock, were built in the district in mining days, but these are abandoned and collapsed now. Epidote specimens labeled Sulzer in old collections probably came from the skarn on Green Monster Mountain, about 8 km distant. A few of these are even labeled Ketchikan.

The topography is extremely steep and rugged (Fig. 4). The top of Copper Mountain, 1203 m, is about 3 km from Hetta Inlet. Lake Josephine and the other high lakes in the district were carved by glaciers only a few thousand years ago. The Jumbo mine is perched on the wall of a glacial cirque, Jumbo Basin, and near the mine and around the collecting localities on Green Monster Mountain slopes average about 40°, as steep as a house roof.

The climate is mild and wet; most of the time it is raining. Our log shows that it rained every day between June 30 and July 20, and most days it rained lightly but constantly. The mountains catch low clouds and much more rain falls in the area of the mine than in the valley below.

The vegetation is very lush. On the valley floors is a forest of alder, hemlock, spruce, and cedar. Some of the spruce trees are nearly 2 m in diameter, although logging operations in the past few years have removed most of these. On slopes the trees thin out and timberline is about 450 m, about the altitude of the Jumbo mine. Above timberline is a thick scrub of alder, willow, and other brush. This gives way at about 550 m to Alpine meadow with mosses, small growth, and a few stunted trees. Above 900 m extensive snow fields persist throughout the summer on the flanks of Copper Mountain (1203 m) and Mount Jumbo (1056 m).

In summary, if you can imagine digging through bushy hedge on a steep roof in the spring rain, that is what we spent our summer doing. Good days come in stretches of four or five between storms. Clear days are magnificent, warm but mild. However, on such days the bugs come out. We counted at least eight kinds of biters. The worst were not the three kinds of mosquitos but the black flies, which have an anesthetic and anticoagulant in their saliva - you don't know that you've been bitten until you notice that you are bleeding. The itching, which is terrific, starts later.

Access

The district may be reached most easily by pontoon-equipped airplane or by helicopter. Landing on the glacial lakes or mountain slopes is dangerous in windy or rainy weather; that is, most of the time. We were detained five days beyond our scheduled departure time by a storm, and ended up on a diet heavy on hard candy for a day or two when our food ran low.

The diggings on Green Monster Mountain are the easier to get to. Lee Myers of Wrangall, Alaska, has the rights to dig there. There is a ranger cabin on Lake Josephine which can be reserved for a few days, and the diggings are about an hour's climb.

Getting to the Jumbo mine area is more difficult. We landed on Hetta Inlet and hiked up. We were able to rebuild a partly collapsed tent-cabin left by prospectors the year before, and we stayed in that much of the time. It has now been destroyed by the heavy winter storms.

General Geology

The layered rocks of the Copper Mountain district are calcareous schists, marbles with interbedded slaty and schistose members, quartz mica schists, and greenstones (Wright, 1915). Buddington and Chapin (1929) considered these rocks part of the Wales group of pre-Silurian age. The rocks are metamorphosed and intensely folded. Structurally, they occupy the core of the Prince of Wales-Kuiu anticlinorium, a great structural

Figure 1. **Copper Mountain from the lower slopes of Green Monster Mountain overlooking Lake Josephine on a rare clear day.**

Figure 2. **Index map of Alaska (from Kennedy, 1953).**

arch which trends northwest several hundred miles through the Alaska coastal islands.

In the Copper Mountain district, a large igneous stock and several satellites of lower Cretaceous age cut the Wales group. The stocks are predominately granodiorite, but are composite and include rocks ranging from quartz gabbro to syenite (Kennedy, 1953). The folded rocks have been further deformed by the intrusion of the stocks and in the Jumbo Basin area axes of folds trend generally parallel to the contact between the intrusion and the metamorphosed sediments (Kennedy, 1953).

Aureoles or skarns of contact-metasomatic minerals have formed in the marbles and calcareous schist beds at the contacts with the intrusions. Locally the intrusions are so altered by assimilated marble that they form part of the skarn (Fig. 5). Small dikes with compositions ranging from granite to basalt and lamprophyre (a rock composed largely of coarse-grained augite) cut the layered rocks and aureoles. Some of these dikes were affected by the contact-metasomatic activity and therefore predate it; others are unaffected and therefore younger.

Jumbo Mine Area

On the west flank of Copper Mountain there is exposed a 3 km long roof pendant or inclusion of marble and schist which was engulfed by the granodiorite. Skarn is very well developed

Figure 3. (left) **Prince of Wales Island, with the Copper Mountain district shaded (from Kennedy, 1953).**

Figure 4. (below) **Topographic map of Copper Mountain and vicinity (from Wright, 1915).**

in a limestone-rich nose of this inclusion and in calcareous schists on the high slopes of Copper Mountain. Here silicon, aluminum, and iron diffusing from the magma of the stock reacted with the limestones and schists to form skarns rich in andradite-grossular garnet ($Ca_3(Fe,Al)_2Si_3O_{12}$), with magnetite, diopside, epidote, and uralite (amphibole pseudomorphs after diopside).

In the skarn, diopside is the earliest mineral to have formed. It is extensively replaced by uralite and garnet. Garnet is the dominant mineral in the skarn zone and, according to Kennedy (1953), constitutes about 80% of the silicates. The garnets are typically zoned. Lighter colored zones are higher in alumina (more grossular-rich) than darker, red or green zones. Table 1 gives microprobe analyses of andradite from a small cut above the main pit of the Jumbo mine. The garnets, up to 7 cm in diameter, are dark olive green and are composed of many thin shells which can be spalled off, like the layers of an onion. Under the microscope the garnet shows minor hematite inclusions and strong color zoning. The analyzed portions are almost pure andradite.

Outside the aureole the limestone has been extensively recrystallized to coarse-textured marble. Lenses of partly replaced and unreplaced marble are present within the aureole. The igneous rocks have been altered as well, and locally both the intrusive stock and small dikes are converted to albite and epidote.

The calcareous schists of the roof pendant, which are well exposed on the high slopes of Copper Mountain, have been extensively altered to garnet-rich rock with quartz, epidote, uralite, adularia, specular hematite and scapolite. This rock is quite porous and contains pockets large enough to crawl into or even sit in (Fig. 6). The size of the pockets suggests that considerable removal of material took place during pocket mineralization, although some show remnants of calcite filling, and all the pockets may originally have been filled with massive calcite.

Adularia crystals, from 0.5 to 5 cm in maximum dimension, are common in some of the pockets (Fig. 7). The crystals, although fresh, are not as translucent as those from the Alps. Many of the crystals are twinned according to the Baveno law. Actinolite and epidote are minor accessories.

Other pockets are quite different in their mineralogy, presumably reflecting differences in wall-rock composition. Andradite is the dominant species in most of these pockets. One large pocket contained crusts of dark green andradite, with adularia, quartz—some Japan-law twins—and pyrite cubes up to 4 cm on an edge (Fig. 8). The pyrite is now altered to goethite. Although pyrite was abundant in this pocket, sulfides were not seen in any quantity in the other pockets.

Pockets of adularia crystals, usually with well-formed uralite, were uncovered in several places within the northwest zone (discussed below) in the Jumbo mine area. The crystals range up to 25 cm parallel to [001]. A few pseudomorphs of epidote after adularia were found here. The largest pocket was nearly filled with calcite. Whether other pockets, now open, originally had calcite fillings is impossible to tell. In the vicinity of the mine the largest adularia crystals and pockets were found in proximity to the granodiorite skarn; a non-calcareous environment may have favored their formation.

Massive skarns dominated by garnet and diopside, like the ones in the Copper Mountain district, are common at the contacts between igneous intrusions and calcareous rocks. The skarn at Stanley Butte, Graham County, Arizona, produces pocket groups of andradite very much like the ones from Copper Mountain. The magnetite ore bodies at French Creek, Cornwall, and Morgantown, Pennsylvania, formed at the contacts between

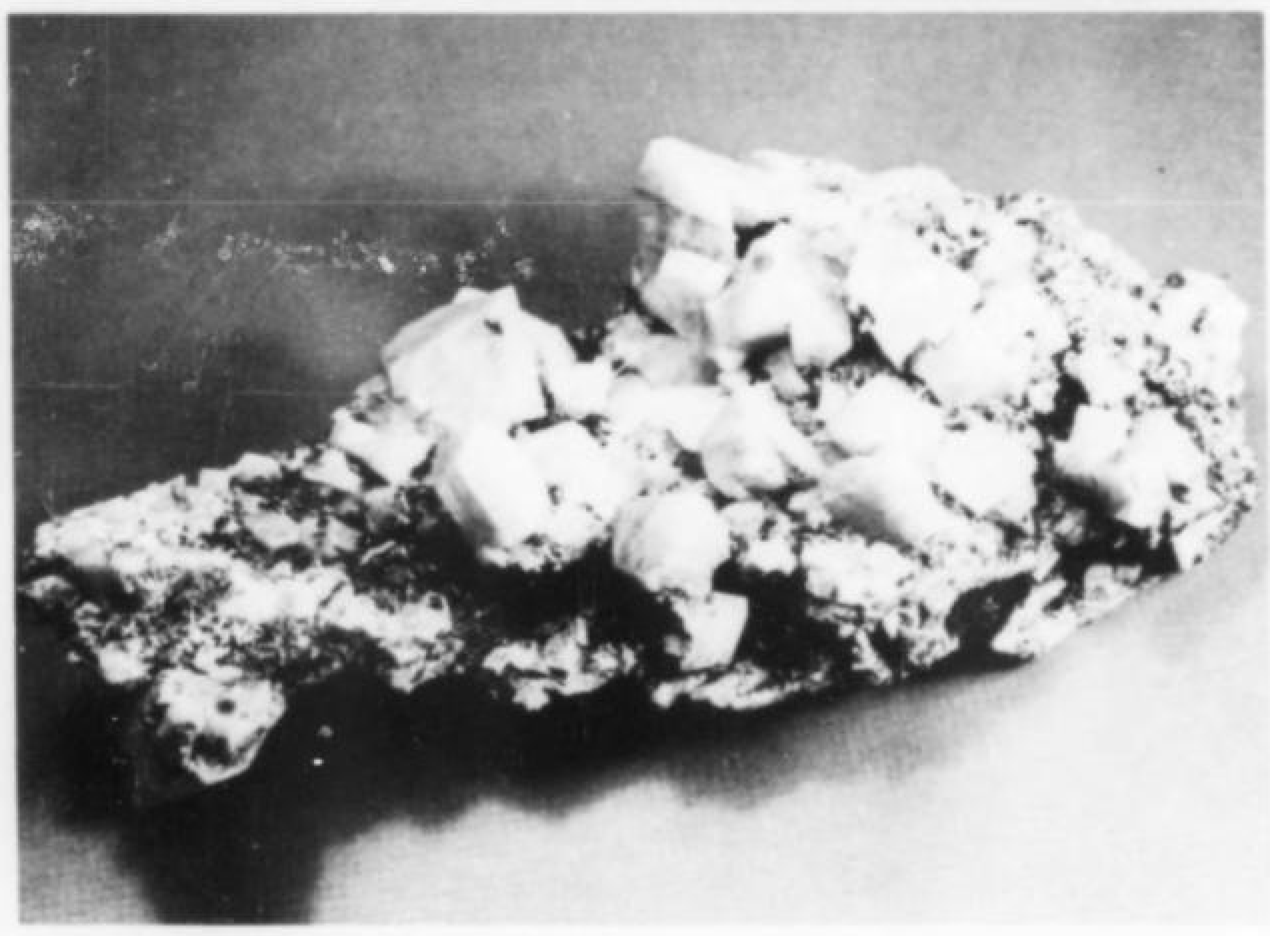


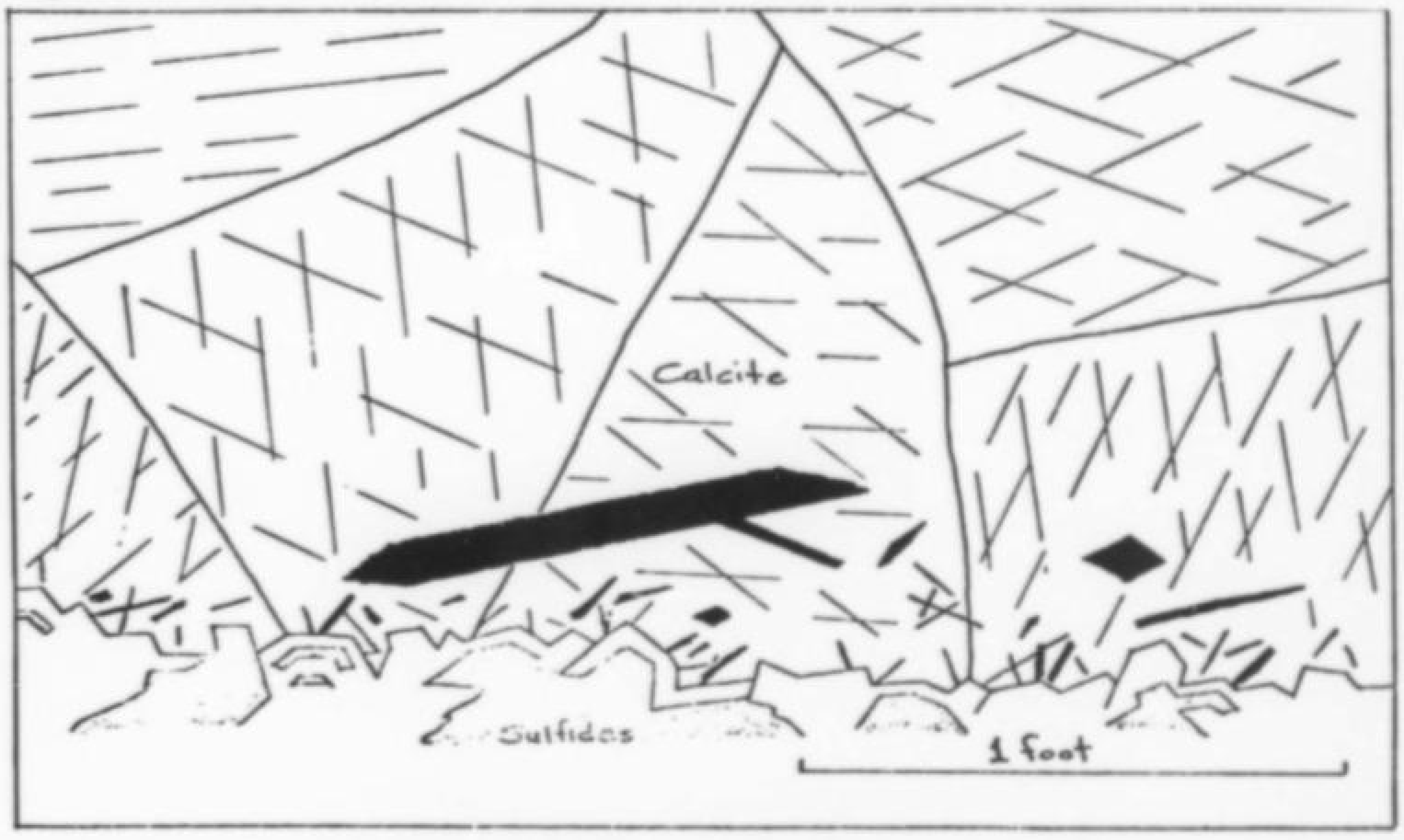
Figure 5. (top) **Copper Mountain during mining days, showing the ore-loading dock, aerial tram, and mine dump (white patch at left center), with overprint of geology. The igneous rock is labeled diorite, although predominately granodiorite (from Wright, 1915).**

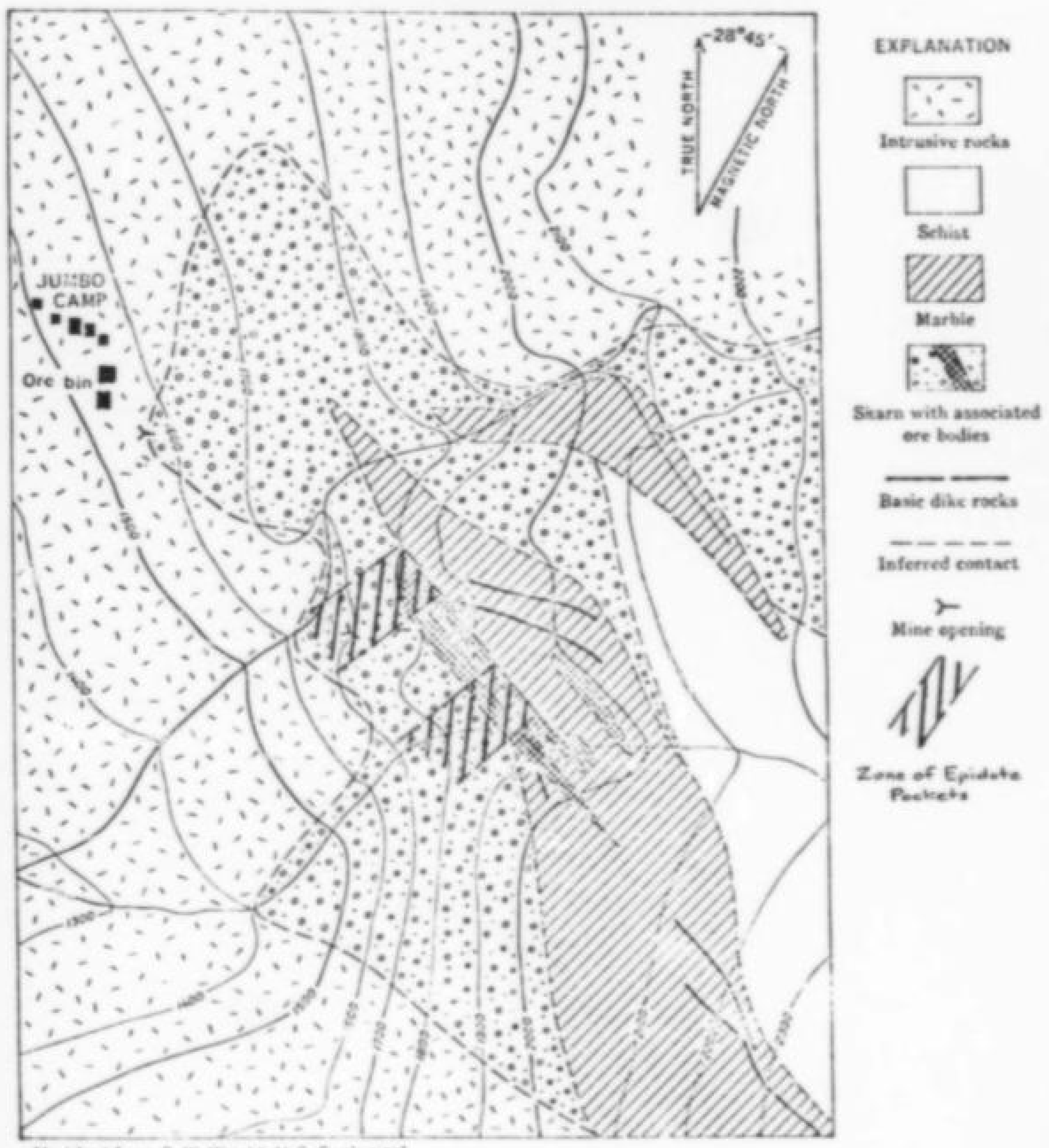
Figure 6. (middle) **A large pocket at about 1000 m altitude in calcareous schists. The authors. Don't say you weren't warned.**

Figure 7. (bottom) **Adularia. Copper Mountain, above the Jumbo mine. Maximum length 23 cm.**

Figure 8. (left) **Altered pyrite, with minor quartz and adularia, from the pocket shown in Fig. 6. Maximum width 12 cm.**

Figure 9. (below) **The occurrence of ilvaite in the Jumbo mine.**





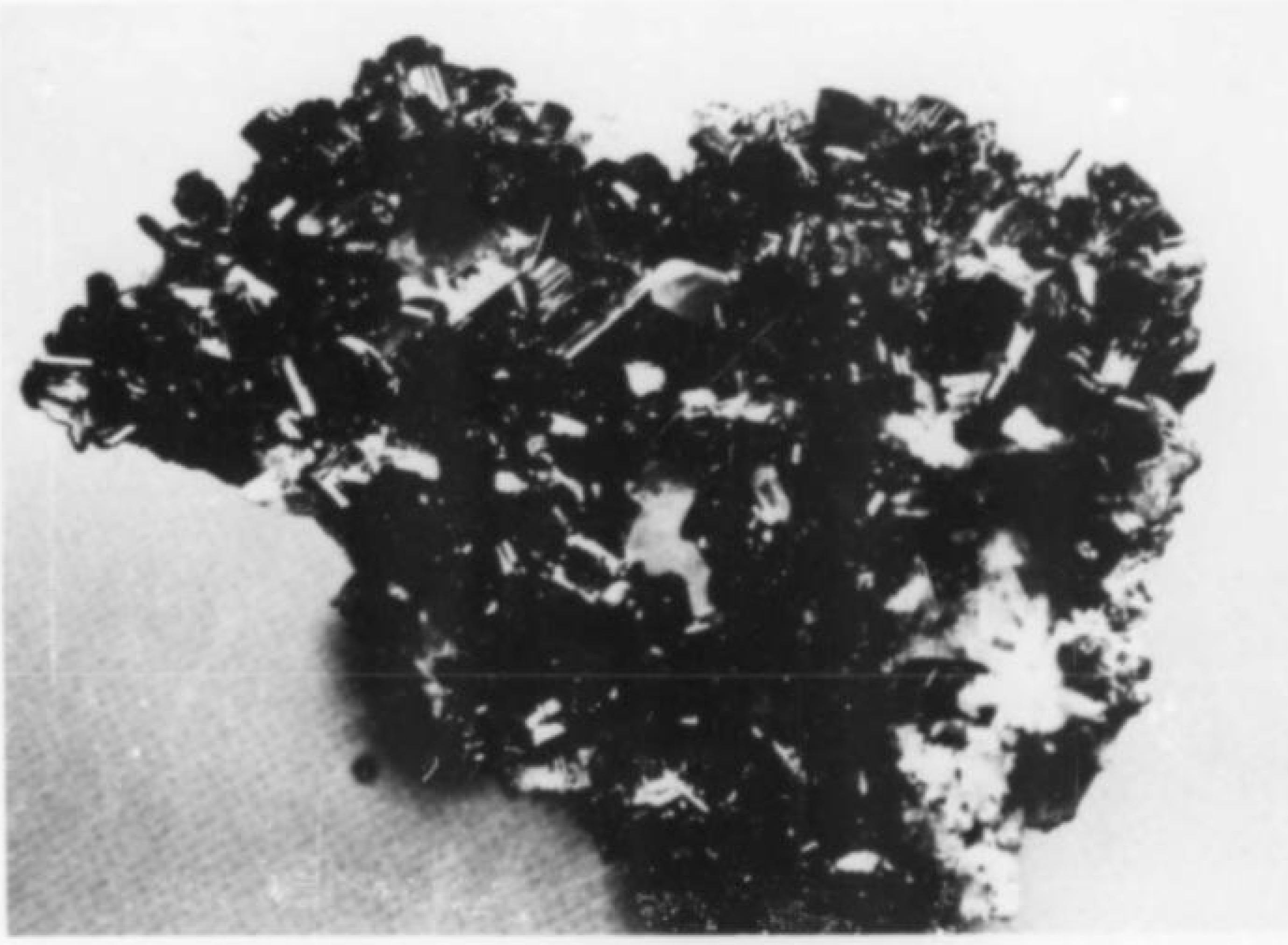


Figure 10. (above) **Zones of epidote pockets in the Jumbo mine area.**

Figure 11. (middle right) **Epidote crystals from the 1570-foot level, Jumbo mine. Maximum length 15 cm.**

Figure 12. (right) **Epidote with calcite and quartz - note Japan twin. Green Monster Mountain. Natural Size. The crystal on the right is twinned, the one on the lower left untwinned and shows a healed fracture.**

Figure 13. (above) **Epidote and quartz enclosing byssolite, Green Monster Mountain. Length of specimen 16 cm.**

Figure 14. (right) **Large epidote crystal in place. Green Monster Mountain. Note the dirt and plant rootlets and the fractured and decomposed garnet of the pocket wall.**

diabase and marble, and contain andradite, epidote, diopside, and actinolite in addition to the magnetite. Bateman (1951) and Park and MacDiarmid (1970) give additional examples. One characteristic of skarns of this kind is that they contain much more iron than either the igneous rock or the marble, but there is no satisfactory explanation for this enrichment.

Later solutions emanating from the stock replaced the silicates of the skarn with chalcopyrite and other sulfides. Ore bodies of this type in skarns are fairly common, although most are rather small. The lead-zinc ores of the Santa Rita district, New Mexico, are an example, and others are given in the references cited above. The deposition of the Copper Mountain district ores was structurally controlled; the richest deposits were formed at the nose of the Copper Mountain roof pendant. Kennedy (1955) notes that chalcopyrite is concentrated in two sets of fractures which cut the skarn zone in this nose. One set strikes about N 20° W and dips at low angles to the east; the other strikes about N 70° W and dips steeply to the north. The major ore body was irregular in shape and strikes about N 45° W. It was situated near the contact between skarn and marble; some lenses and veins of chalcopyrite extend into the marble. In addition to chalcopyrite, the ore includes minor molybdenite, pyrite, pyrrhotite, and sphalerite.

The high-grade ore of the Jumbo deposit is almost completely mined out, and reserves appear small. At the southeast end of the large open stope in the Jumbo mine, a patch of ore was left on the mine wall. In it, garnet is replaced by chalcopyrite and pyrite. It appears that certain zones within the garnets were more favorable to replacement than others. The remnant zones are generally of light color, indicating a high alumina (grossular) content; presumably the replaced zones were those high in iron (andradite). Crude crystals of ilvaite, $CaFe_2^{+2}Fe^{+3}Si_2O_8(OH)$, ranging up to 20 cm in length are found near the partly replaced garnets in this portion of the skarn. The spatial relationships of the various minerals are shown in Figure 9. Ilvaite occurs within coarse calcite outside the garnet skarns; either (1) it is contemporaneous with the garnet but formed at a slightly lower temperature or (2) it is contemporaneous with the sulfides, which seems unlikely, as it would require that ilvaite, with trivalent iron, be forming as the trivalent iron in andradite was reduced to divalent iron for the sulfides, or (3) ilvaite postdates the sulfides, which would explain why it was not replaced by sulfides. Microprobe analysis of this ilvaite (Table 1) shows that it conforms closely to the established formula.

Epidote is locally an abundant mineral in the skarn around the Jumbo mine. According to Kennedy (1953) epidote occurs as irregular grains and clots replacing garnet, as clusters of radiating crystals with quartz and calcite, and as large crystals in pockets. The first two modes are normal for epidote in skarns and are found in many contact metamorphic deposits, but the third mode appears unique, although similar in many respects to Alpine vein deposits. It is these pockets which have produced the magnificent epidote specimens for which Prince of Wales Island is so famous. Groups 25 cm across, composed of lustrous crystals with individuals up to 10 cm long, are preserved in the Smithsonian Institution collections. These groups were collected by the 1935 expedition; our luck was not as good. The pockets are very sporadic and irregular, despite the distribution patterns suggested below. Also, Ed Over blasted many feet of rubble over the richest collecting area when he left.

The epidote pockets have rims of punky, decomposed garnet quite unlike garnet in the more typical skarn zone pockets, which is fresh looking and euhedral. These pockets have clearly formed from the action of hydrothermal fluids on the garnet skarn, and are thus later than the skarn itself. Associated minerals include quartz, albite, actinolite, titanite, stilbite, and sericite. Some epidote pockets were found within a few feet of mafic dikes, suggesting a genetic relationship between them. We studied a diabase dike which cuts the skarn in a creek bed immediately east of the ilvaite occurrence. The dike is approximately 25 cm thick and, though offset by minor faults, can be traced for 25 meters. Its strike is northeasterly parallel to transverse fractures in the Jumbo anticline. Several epidote pockets occur along the trend of the dike. A sample was taken from the dike about two meters northeast of one epidote pocket. In thin section this rock is unaltered diabase. However, megascopically, as the epidote pocket is approached from about ½ metre away, the dike rock becomes progressively altered to a fibrous green amphibole. Within the pocket, the amphibole is well crystallized as actinolite (variety amianthus or byssolite) with epidote.

We conclude that the dikes associated with the epidote pockets are younger than the contact-metamorphism and the granodiorite stock, and that they are the most likely source of the hydrothermal fluids which produced the pockets.

In the Jumbo mine area, two rather distinct zones of epidote pockets were distinguished on the basis of crystal habit, although an intermediate band relatively barren of pockets also served to separate the two zones. The trend of the zones (Fig. 10) is northeasterly, and they are both approximately 50 m wide.

The northwest zone is characterized by pockets containing prismatic, twinned epidote crystals elongate parallel to [010]. Faces in the [010] zone of both members of the twin (twin plane {100}) are equally developed resulting in crystals with a pseudohexagonal cross-section parallel to {010}. In addition, coarse, bladed actinolite and radiate clusters of a micaceous mineral are frequently intergrown with the epidote crystals.

The southeast zone is characterized by epidote pockets containing both twinned and untwinned crystals with a flattened prismatic habit. The crystals are elongate parallel to [010] and are deeply striated to the point of appearing composite in this zone. Fibrous actinolite (byssolite) and tiny stilbite crystals are common associates of the epidote crystals in the southwest zone. Quartz and calcite crystals are ubiquitous to both zones, though calcite is commonly leached in pockets exposed at the surface.

Within the mine, two epidote pockets were seen in the long southernmost tunnel of the 1570-foot level. Both are shown, although not identified, on Kennedy's map of the mine (Kennedy, 1953, plate 7). The more northern pocket would lie in the southeast zone defined above. The crystals are bladed, and elongated parallel to [010]. Most of the crystals have pale, yellow-brown terminations, indicating low iron content. Accessories include minor albite, quartz, and stilbite, which coats broken surfaces of some of the epidote crystals, showing that it was deposited after some episode of fracturing. The southern pocket is outside the zone defined above, but the habit of the crystals conforms to it. The crystals, in thick coatings, average about 1.5 cm long and are exceptionally brilliant (Fig. 11). Neither of the zones is sharp and even within a zone individual pockets show distinctive features.

The epidote pockets or vugs are generally spherical to lensoid in shape with the long axes running roughly northeast parallel to the strike of associated dikes and the pocket zones. Since this direction is also parallel to the transverse fractures, a tension direction, circulation for solutions associated with the dikes would be favored along these fractures. Alpine veins or clefts typically occur as flattened pockets whose long axes are perpendicular to the schistosity of the enclosing rocks. These clefts are tension breaks and, to that extent, compare structurally with the transverse fractures in the Jumbo anticline.

Parker (1960) and Weibel (1966) note that epidote is commonly found in Alpine clefts associated with amphibolitic rocks, where it occurs characteristically with byssolite. These authors point out that the assemblages in the clefts show a dependence on the surrounding rock, and, indeed, the material composing the cleft minerals is demonstrably derived from the country rock. The epidote pockets of Prince of Wales Island are like the Alpine clefts in this respect also.

Green Monster Mountain Area

Five kilometres east of the Jumbo mine, on the southwest slope of Green Monster Mountain, is a second area of epidote pockets within a garnet-diopside skarn zone, formed along the eastern margin of the Copper Mountain stock. The association of late dikes and epidote pockets is apparent here, too. The northwest strike of the dikes is parallel to the trend of the skarn zone, which is nearly 100 m wide at this locality.

The epidote pockets are strung out along the trend of the dikes, which are generally altered to a fibrous amphibole. Thin stringers, 2-10 cm thick, of coarsely cleavable epidote connect the pockets. Most pockets contain twinned epidote crystals showing a wide variance in habit from prismatic elongate on [010] to square tabular on [100]. Adjacent pockets separated by as little as 25 cm of massive epidote have crystals of different habit. These epidote pockets are characterized by sceptered quartz crystals with phantom inclusions of white to pink clay and byssolite. Pyrite crystals partly altered to limonite are a relatively common associate of epidote.

Superposition relations among the three main minerals found in the pockets yields the paragenetic sequence: epidote, actinolite variety byssolite, quartz. Pseudomorphs of the amphibole after epidote crystals were common in several areas. Most of the phantoms in the quartz crystals are byssolite. In one pocket quartz crystals with four distinct periods of growth were found. Here the earliest-formed quartz is full of byssolite, which becomes progressively less abundant with each successive stage until the last is completely free of included material.

Crystals within the pockets are generally large (Fig. 11, 12). Single epidote crystals over 10 cm long and weighing more than 1 kg were found in three of the pockets. Table 1 gives a chemical analysis of large epidote crystals from Green Monster Mountain. Thin sections of these crystals show strong color zoning, presumably indicating compositional variation. The analysis is for the bulk composition, which closely approximates $Ca_2Al_2Fe(SiO_4)_3(OH)$.

Unfortunately, from the collector's point of view, most of the crystals occur detached from matrix and embedded within a dark brown, organic-rich mud invaded by plant roots (Fig. 14). Many of the crystals separated from the pocket walls during mineralization. The walls themselves are typically badly altered, punky garnet, which could hardly provide a sound matrix. Also, many of the crystals show healing, or later growth over broken surfaces. Quartz crystals grow over some of the breakage; some cement a breccia of shattered epidote; others grow on broken surfaces of epidote crystals. The epidote crystals and groups were further broken by frost wedging and root penetration, both of which are active on the steep, open slopes of the pocket area. These breaks are not healed. A number of twinned crystals are broken along the two intersecting [001] cleavage planes, showing in some cases a notch in the crystal.

A number of epitaxial growths of quartz on epidote were collected, with the c-axis of the quartz crystal parallel the b-axis of the epidote.

Formation of the Epidote Pockets

The pockets containing epidote are late hydrothermal alterations of the garnet skarn and late dikes which follow tension fissures in the skarn. They are quite unlike the earlier, garnet-bearing pockets which are found throughout the skarn.

The major difference in the genesis of the two kinds of pockets is almost certainly their temperatures of formation. The garnet-bearing pockets formed under conditions of the hornblende-hornfels facies, at temperatures in excess of 400°C; the epidote-rich pockets formed under conditions typical of the albite-epidote hornfels facies, with temperatures in the range 250°C

Figure a. (top left) **Epidote, Copper Mountain, Prince of Wales Island, Alaska. Dark green; 3.2 cm tall, Smithsonian specimen 126452.**

Figure b. (top right) **Epidote on quartz, Prince of Wales Island, Alaska. Blackish green, large crystal is 2.3 cm long. Smithsonian specimen 126653.**

Figure c. (bottom left) **Epidote, doubly terminated, Copper Mountain, Prince of Wales Island, Alaska. Greenish black, 5.5 cm wide, Smithsonian specimen 123649.**

Figure d. (bottom right) **Quartz (Japan-law twins) on epidote, Green Monster Mountain. Prince of Wales Island, Alaska. The large twin is 3 cm across, Smithsonian specimen 126654.**

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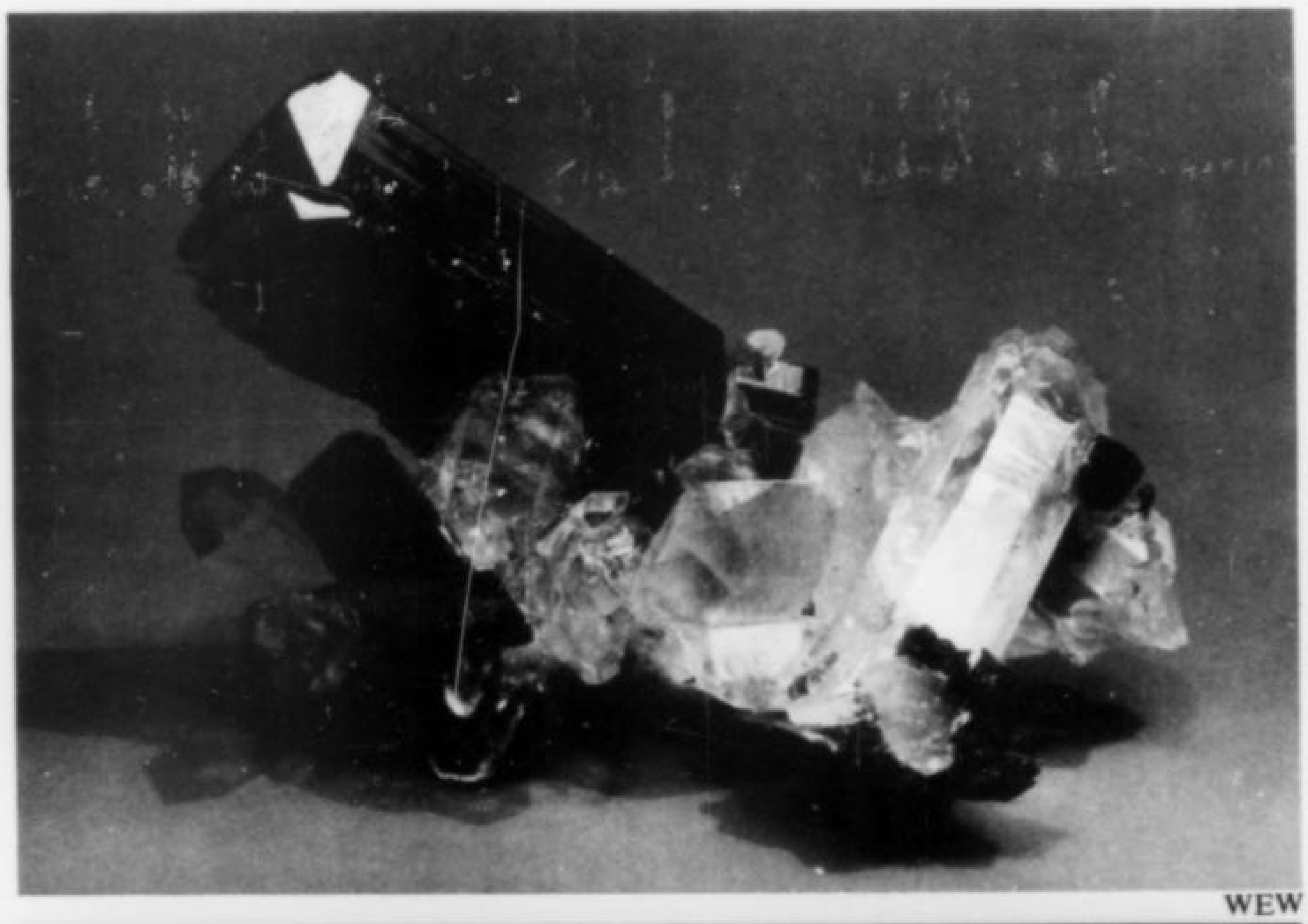

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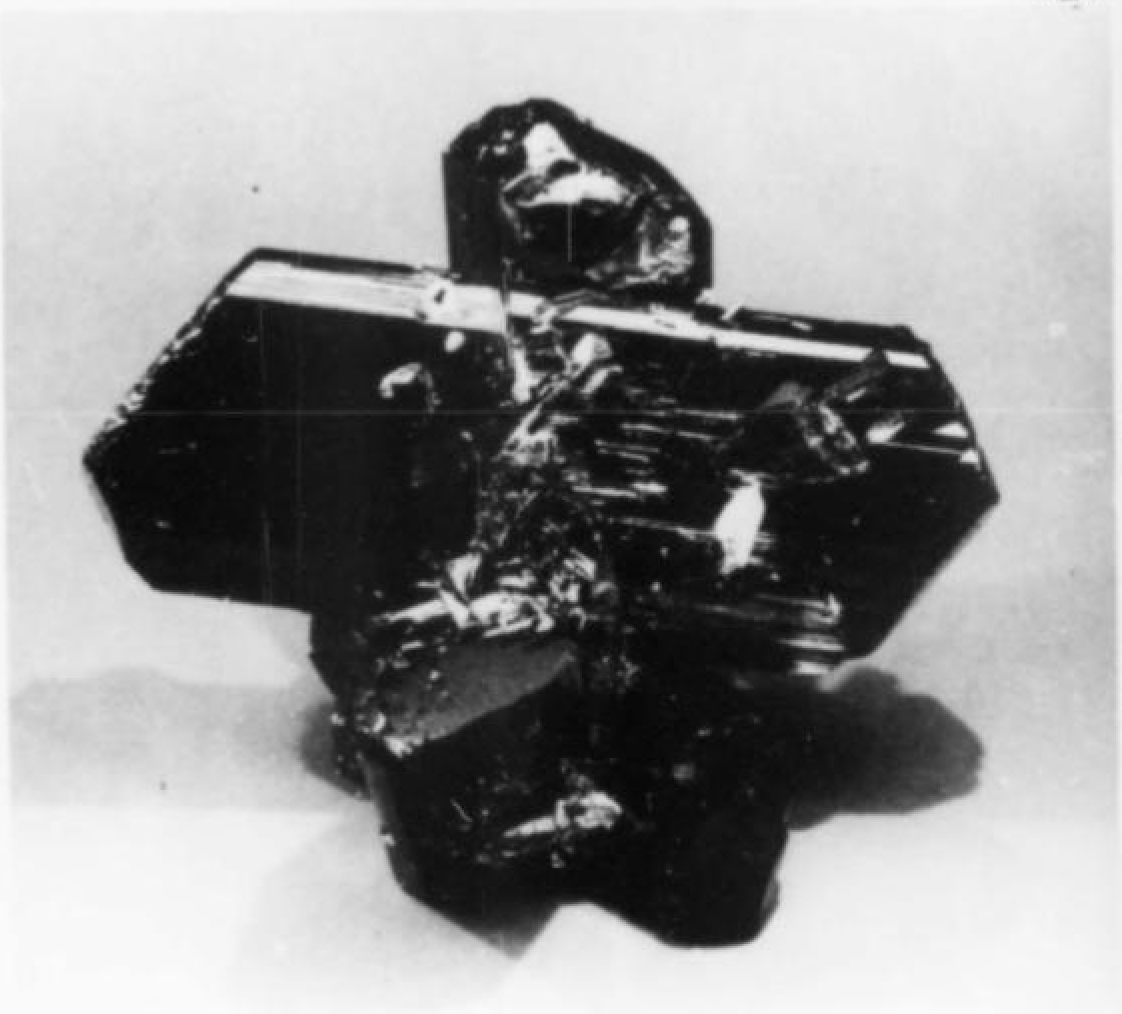

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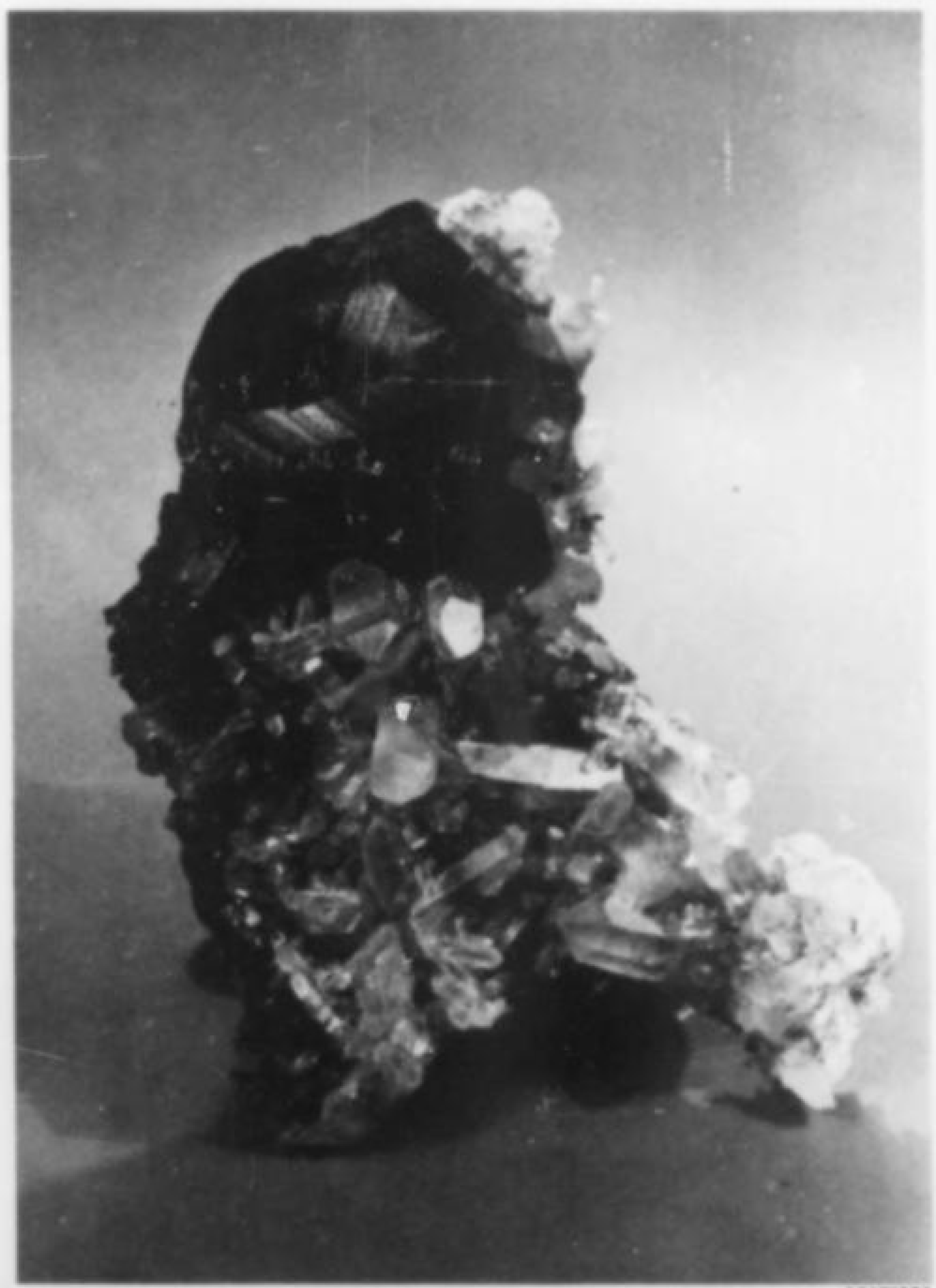
to 400°C. Toward the end of pocket formation, temperatures were even lower, for stilbite, a relatively low temperature zeolite, is found encrusted on the epidote in some pockets. The reactions to produce epidote from andradite-grossular garnet are fairly simple, as their formulas are similar: garnet $Ca_3(Fe, Al)_2Si_3O_{12}$, epidote $Ca_2(Al, Fe)_3Si_3O_{12}(OH)$. If no Fe or Al is introduced, some Ca and silica must be carried off in solution or precipitated as calcite and quartz. Certainly some solution took place to produce open pockets.

Somewhat similar pockets have been found at other localities. The most famous is Untersulzbach in the Austrian Alps, where the crystals occurred in crevices in an epidote schist, associated with byssolite, adularia, and apatite. At Cornog, Pennsylvania, veins in an amphibolite uncovered during quarrying in the 1960's yielded byssolite, crystals of clinozoisite or low-iron epidote up to 10 cm, axinite, and apatite. A third occurrence, not quite as similar, is at Centreville, Virginia, where a pipe of prehnite, with apophyllite (perhaps the finest in the world), byssolite, minor clinozoisite and sphene, developed in a diabase sill by the action of hydrothermal waters generated by the diabase. The minerals present, especially the abundant prehnite, suggest a temperature of formation less than 250°C., by analogy with metamorphic rocks. Small diabase dikes cut the garnet skarn in the vicinity of the epidote pockets on Prince of Wales Island and, as noted above, we believe that these are the source of the hydrothermal solutions which produced the pockets. This proposed origin explains the features of the Prince of Wales Island occurrence, including the fact that it is essentially unique.

At the crest of Green Monster Mountain, an entirely different kind of skarn is exposed. It contains few iron-rich minerals, but

Figure e. (below) **Epidote, greenish black, with quartz, Copper Mountain, Prince of Wales Island, Alaska. The group is 8 cm across, Smithsonian specimen R7782.**

Figure f. (right) **Epidote twin on quartz, Prince of Wales Island, Alaska. Greenish black, the twinned crystal is 1.7 cm wide (notice twin boundary on front face), Smithsonian specimen B8838.**



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is composed predominately of magnesium and calcium silicates, primarily forsterite, diopside, and monticellite. It was formed by the metasomatism of Si, minor Al, and possibly Mg from a small granitic stock into the surrounding marble, with movement of Ca from the marble into the igneous rock. This is a Crestmore, California, type skarn, and like the Crestmore skarn, it shows a distinct zoning: altered igneous rock, diopside skarn, a zone characterized by the minerals diopside, forsterite, calcite, spinel, talc, and xanthophyllite, an outer zone characterized by monticellite and xanthophyllite, and a zone of slightly altered brucite marbles with minor spinel and forsterite.

The grade of metamorphism is apparently not as high here as at Crestmore, since such high grade minerals as tilleyite, spurrite, and merwinite, which occur at Crestmore, were not found at Green Monster. However, exposure is somewhat limited, and excavation or just careful searching might well reveal some of these species. This kind of skarn is generally considered to be the highest temperature kind; however, the Green Monster stock is smaller, and more felsic than the Copper Mountain stock; it is probable that temperatures around it were lower than around the Copper Mountain stock, and that the formation of this zoned skarn represents conditions of low pressure at moderate temperature rather than high temperatures as compared to the garnet-rich skarn of the Copper Mountain stock.

Although this deposit yields a number of rare and interesting minerals, the only dramatic specimens we collected are thumbnails of clintonite. One seam yielded deep green, flowerlike crystal aggregates up to 2 cm across.

This is wild country still. Toward evening on one of our last days there, one of us (P.B.L) was collecting in the rain, alone, when a chorus of yapping and howling started on the shore of Summit Lake, far below. There are few places where one can hear wolves still; we hope this remains one of them.

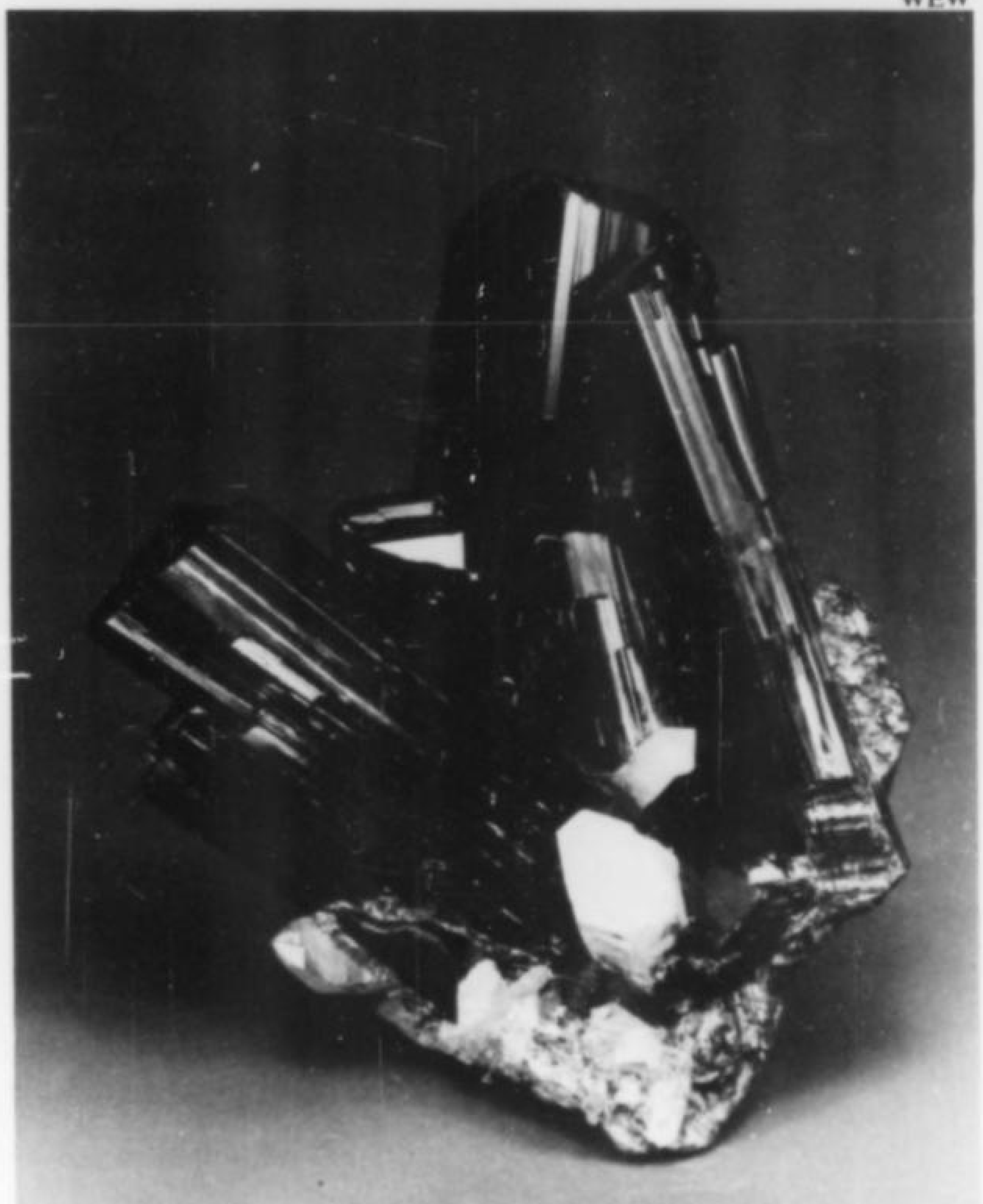

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Figure g. **Epidote with quartz, Copper Mountain, Prince of Wales Island, Alaska. Greenish black, 7 cm tall, Smithsonian specimen 116774.**

Acknowledgments

We wish to thank the owner of the Copper Mountain and Green Monster area claims, Eskil Anderson, for his cooperation in permitting exploration and collecting at the locality. John N. Patterson and Frank Ramboseh of the U.S. Forest Service, South Tongass National Forest, gave valuable advice and assistance in the field. Edward Henderson and Arthur Montgomery, members of the 1935 expedition to the Copper Mountain district, gave much helpful advice on field conditions.

Figure h. **Epidote, Copper Mountain, Prince of Wales Island, Alaska. Greenish brown, 3.0 cm tall, Smithsonian specimen R15210.**

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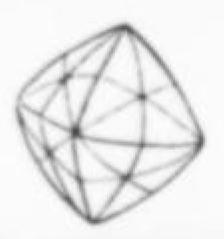

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DENNY MOUNTAIN QUARTZ

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Figure 1. (left) **Amethyst scepter on white quartz; the inclusions in the amethyst are crystals of goethite and lepidocrocite which give the amethyst a reddish internal sparkle leading to the nickname "strawberry quartz". Smithsonian specimen, about 5.5 cm tall.**

by Lanny R. Ream
P.O. Box 1336
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INTRODUCTION

The quartz and iron-rich skarn on the west side of Denny Mountain is possibly the greatest quartz-producing locality in Washington state. This deposit, which has been producing fine specimens for several decades, is well known to most Washington collectors. Of particular interest is a zone of numerous vugs in a skarn in a narrow, steep-sided canyon. Large quartz crystals over 30 cm in length, along with amethyst scepters and Japan-law twins, have been collected at this locality.

The deposit was first discovered and staked as a mining claim for iron and copper at the turn of the century by members of the Denny family. Denny iron claims, numbers 37 to 45, cover the area of interest and several magnetite occurrences to the south. Presently the surface rights of the claims belong to the U.S. Forest Service, but the mineral rights remain in private hands and have been leased to two collectors from Seattle. Collecting by individuals is allowed on a noncommercial basis.

Although the deposit is only an hour's drive east of Seattle on Interstate 90, access is difficult. To reach the deposit a collector must take the Denny Creek exit and follow the narrow road to the Melakwa Lake Trail. For those in good condition, it is about a 45 minute hike to the canyon that contains the skarn. Another 20 minutes is required to hike up the canyon or the trail on the north side of the canyon to reach the main collecting area.

The collecting area is only a few miles west of the crest of the Cascade Mountains, at an elevation between 3,000 and 4,500 feet. Deep snowfalls cover the area and snowslides from the cliffs above the main collecting area fill the canyon with over 50 feet of snow. Normally the winter weather makes access to the locality very difficult after October, and the snow usually does not melt out enough to allow access again until late August or September. Some years the snow never melts enough to allow access to the bottom of the canyon.

Quartz occurs in this very narrow, steep-sided canyon where the canyon is only 20 to 50 feet wide (Figure 3). The sides vary from nearly vertical to overhanging and are usually over 100 feet high. There are several steep, nearly unscalable, cliff areas and several areas where loose talus is deposited in the canyon bottom. Each time the author has been in the canyon, rocks have fallen from above, emphasizing the danger of the canyon.

To most collectors, this deposit is known as "Denny Mountain" or just "Denny", but to the U.S. Forest Service it is "Rockhound Gulch". Anxious collectors may have taken their toll of crystals, but the canyon has also taken its toll of collectors. Several of the author's friends in the Seattle area can name ten collectors who have lost their lives in the last 15 to 20 years in this canyon. Deaths have been caused by collectors falling from cliffs and being crushed by falling rocks and snow bridges. This locality is not for beginners. All visitors should be experienced in climbing steep terrain, should wear hardhats and should use climbing gear for safety.

GEOLOGY

Diorite of the Snoqualmie batholith intrudes carbonaceous sediments of Cretaceous and early Tertiary age. The skarn zone occurs in a hornfels near a diorite-limestone contact. Hornfels is the dominant rock in the canyon, but limestones with magnetite pods are abundant in a zone that extends from a point a few hundred feet south of the canyon, around Denny Mountain, to the hornfels cliffs on the south side of Denny Mountain, where it can be seen from Interstate 90.

Mineralizing fluids have formed several zones that are of interest to mineral collectors (Figure 2). Extending from the central part of the canyon to the quartz scepter locality, these are described in the order that the collector will encounter them while climbing up the canyon. One first enters the narrow part of the canyon where the walls consist of dark gray hornfels. The first interesting zone is a hornfels zone with masses of grossular and epidote. Mineral collecting is best near the contact with the next zone, the major magnetite zone in the canyon. The north wall is mostly massive magnetite with grossular and is black in color. The south wall contains more garnet and pyrite; iron

> "...ten collectors have lost their lives in this canyon."

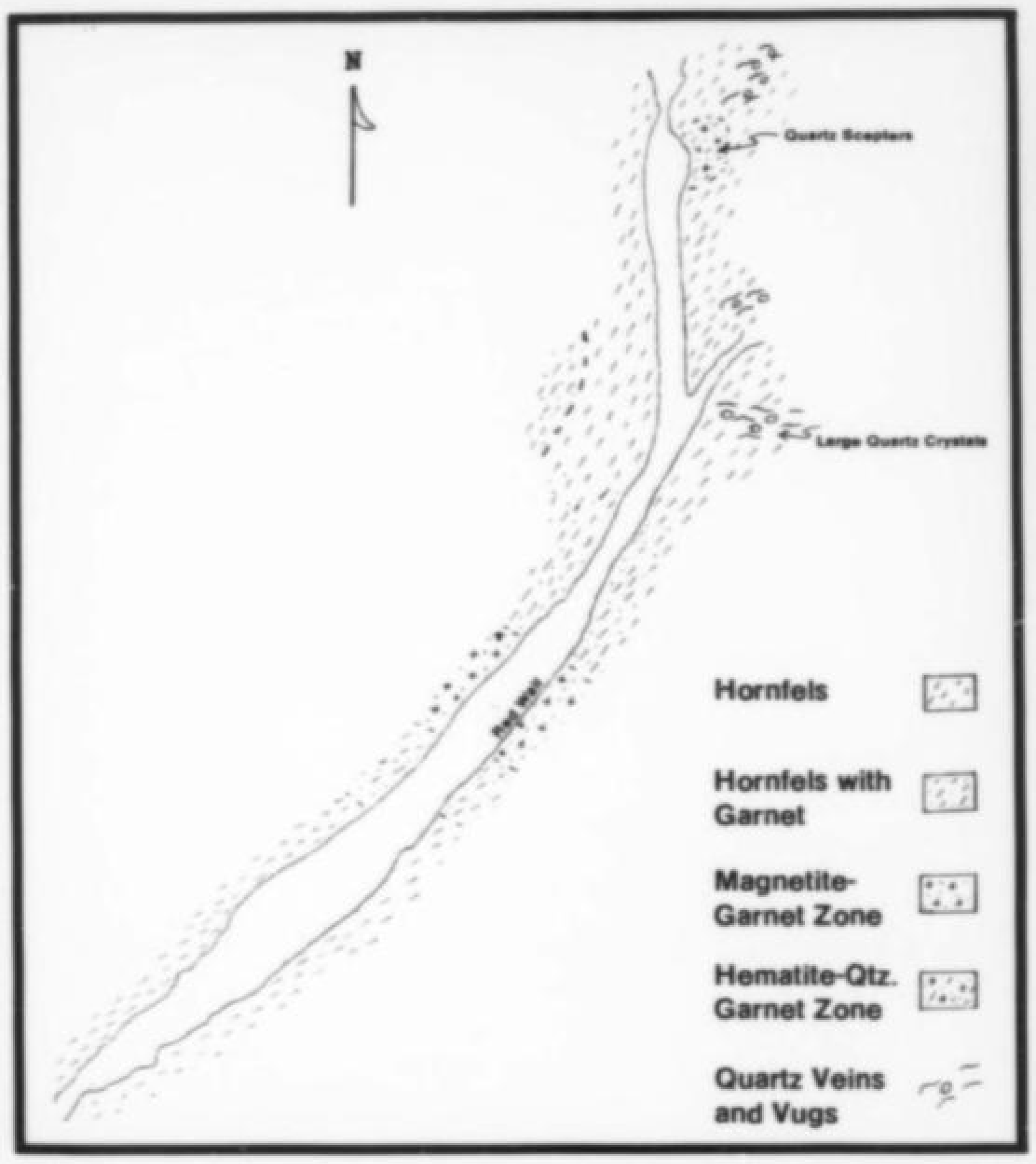

Figure 2. (above) **Geologic sketch map of the Denny Mountain quartz locality.**

Figure 3. (right) **Rockhound Gulch, Denny Mountain, looking up the canyon from a point below the Red Wall. The angle of the photo fails to show the true steepness of the canyon floor. Snow bridges, like the one shown, are a common hazard in September.**

oxides have stained it red. Collectors often refer to the "Red Wall" as a reference point when talking about mineral occurrences in the canyon (Figure 4).

Beyond this zone the hornfels contains grossular with some epidote and quartz. These minerals decrease in abundance up the canyon until the hornfels is essentially unmineralized. The best quartz zones occur in the hornfels above this zone.

The first major quartz zone is on the southeast side of the canyon where the canyon forks, the main part turning north. At this point there are several quartz veins extending up the south wall. Large vugs with crystals over 30 cm in length occur here.

To the north of this zone the hornfels contains another grossular-iron area with quartz, where the iron occurs as specular hematite. Vugs lined with quartz crystals are limited, but contain quartz scepters of an amethyst to raspberry red color (*Mineralogical Record*, **3**, 65-66). Quartz veins containing vugs extend up the cliffs above this zone.

MINERALOGY

The mineralogy will be described for each zone, with emphasis on minerals that occur as euhedral crystals. To the author's knowledge, there has been no detailed mineralogical study of this deposit except for the identification of the euhedral-occurring minerals by collectors. The author's studies have been limited to hand specimen studies and minimal microscope work. Nearly all collectors with whom the author has discussed the deposit have indicated greatest interest in the quartz with minor interest in grossular, pyrite and malachite.

Hornfels-Garnet Zones

The hornfels-garnet zones contain masses of grossular with vugs that are lined with crystals of a dark orange to brown color. Crystals average about 0.8 cm across and rarely exceed 2 cm. Very fine specimens of sharp euhedral crystals can be collected with epidote and clinozoisite of a dark green color. These two minerals occur as large crystals up to several centimetres long. Well-terminated crystals are rare because they usually extend across the vugs from wall to wall. Subhedral to euhedral crystals of adularia occur in many of these vugs. These are generally less than 1.5 cm in length and are partially intergrown with the other minerals so that only two or three faces are well formed.

Quartz is abundant in many of the larger vugs where it usually occurs with pyrite. The quartz is generally less than 1.5 cm in length and under 0.5 cm across. Most crystals are milky to gray in color and taper sharply from their bases to their terminations. Some fine specimens with garnet, epidote and pyrite can be obtained from these zones, but most of the quartz occurs with pyrite only.

A few crystals that are rose or light amethyst in color and with scepter or skeletal terminations occur in this zone. These are scarce and are usually found in vugs associated with rare pods of specular hematite. The crystals can be found embedded in the specular hematite or in limonite and other iron oxides.

Most of the pyrite cubes in these zones are very lustrous and have no striations on the faces. Few of these crystals are over 0.5 cm across, but they do occur up to and over 2 cm. Clusters are quite common. Pyrite is intergrown with quartz and is most abundant where grossular is least abundant.

Diopside is rare as green blocky crystals to 2 cm long, and scheelite occurs as well-formed to distorted, bipyrimidal, yellow crystals to 3.75 cm (Cannon, 1975). Both minerals occur with grossular, quartz and epidote.

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Figure 4. (above left) **Looking down the canyon from a point above the Red Wall (at left). Most of the canyon floor is snow-covered below this point.**

Figure 5. (bottom left) **Ed Molsee examining a vug from which he and the author removed 50 pounds of quartz crystals. The wall on his right shows bases of large quartz crystals broken by frost action.**

Figure 6. (above right) **"Reverse" scepter of amethyst (top) on white quartz. Smithsonian specimen, width of base about 1.2 cm.**

Figure 7. (bottom right) **"Strawberry quartz" amethyst scepter. Smithsonian specimen, about 6.5 cm tall.**

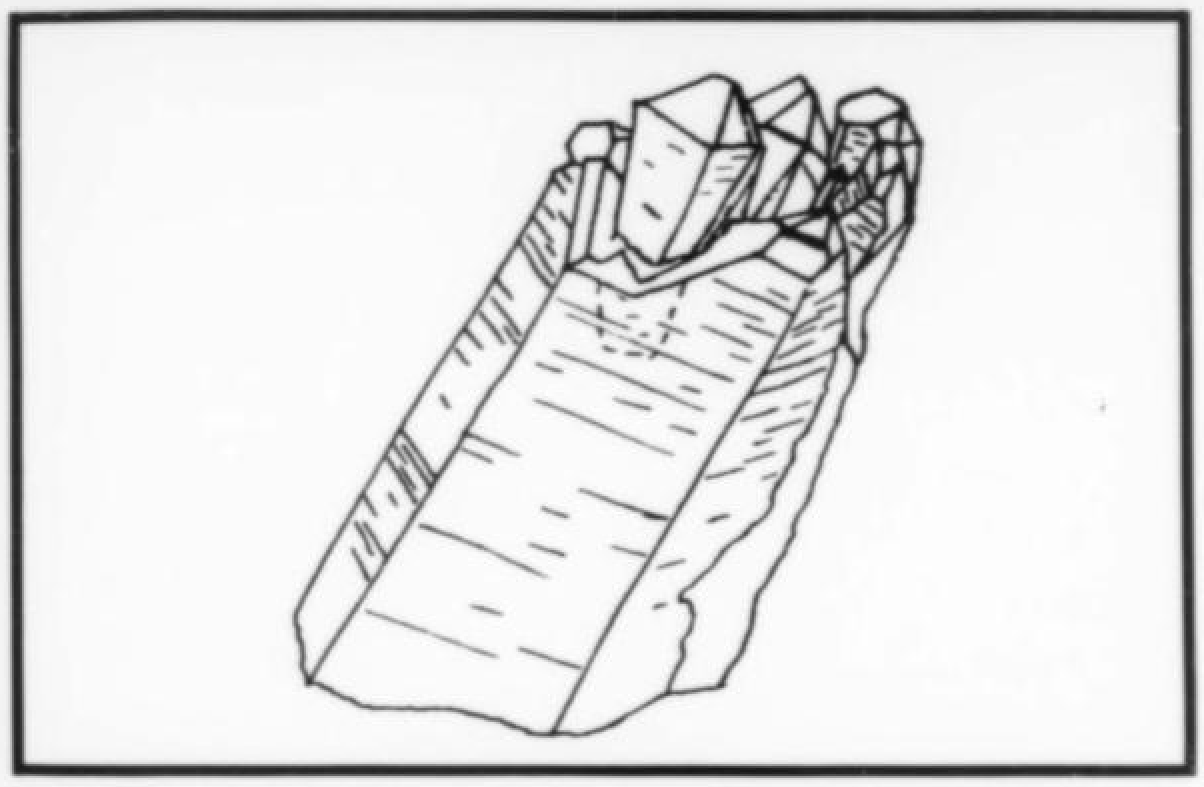


Figure 8. (top) **Quartz, light rose in color, with a skeletal termination; the specimen is about 7 cm long.**

Figure 9. (above) **Epidote and quartz on massive quartz from Denny Mountain. The specimen is about 9 cm tall.**

Magnetite-Garnet Zone

This zone has a mineralogy that is very similar to the previously described zone. Grossular is much less abundant; masses of magnetite are the most abundant mineral. The north wall has more garnet and magnetite and less quartz and pyrite than the "Red Wall".

Vugs are not very common, but are often larger than in the hornfels-garnet zone. Quartz occurs here in the same habit and size, but pyrite cubes are larger and more abundant.

Some chalcopyrite can be found as small grains and masses in the "Red Wall", and streaks of green copper stains color the sides of the canyon. Malachite is scarce as botryoidal and velvety crusts. Only a few specimens have been discovered, but they are very showy and up to 5 cm across.

Quartz Zone

Quartz crystals have been collected at this locality, where the canyon forks, since the deposit was first discovered. Numerous quartz veins with vugs over 1 metre across occur in this zone. Most vugs have been cleaned out and the walls show only crystal bases up to and over 4 cm across (Figure 5). When found by collectors, most of the crystals had been broken loose by freezing and thawing and were lying mixed with rocks and clay on the bottoms of the vugs. These crystals occurred in lengths up to and over 45 cm, but most were 10 to 20 cm long.

The quartz crystals are mostly milky to grayish in color. An outer layer displaying a rough, possibly etched, surface contains most of the color. Crystals taper from their bases to their terminations. Pyrite cubes, many of them partially altered to iron oxides occur as floaters or attached to the quartz.

These vugs occur where the wall is vertical and always wet. A coating of moss keeps it slippery and nearly inaccessible. Collectors scaling the wall with ropes have almost entirely cleaned out these vugs. Several collectors were incredulous when the author informed them of the crystals he and a friend removed from one of these vugs in 1974 (Fig. 5). Previous collectors had not bothered to dig through the mud in the bottom. The author's friend did and discovered that a clay-filled narrow vug extended downward, with crystals to 30 cm lining the walls. All crystals had broken loose from the vug but were held in place by the mud and clay filling. One fine cluster with a 30 cm crystal was removed along with numerous singles and some pyrite.

Garnet-Quartz-Hematite Zone

About 60 metres up the main canyon from the large quartz crystal zone is one of the most spectacular quartz occurrences in Washington. Very showy quartz scepters occur in a specular hematite-garnet zone. The scepters average about 3 cm in length and occur with crystals of the normal prismatic habit. Terminations are often over twice the diameter of the shaft, are well-developed and often skeletal.

Color of the terminations varies from light amethyst to raspberry red. The shafts and nonscepter crystals are milky and have skeletal overgrowths on three to four faces (Fig. 1). Scepter terminations contain abundant red and silver-colored inclusions. These plates and rods are reported to be goethite and lepidocrocite (Cannon, 1975 & personal communications).

These showy scepter crystals were mined during the summers of 1969 through 1973 by two Seattle collectors. They were removed as both singles and clusters on matrix. All specimens were recovered from a large vug and several small interconnecting vugs. Unless extensive rock removal uncovers similar vugs there will be no more of these unique quartz scepters.

Other minerals occur in this zone, similar to the hornfels-garnet zones. Epidote and clinozoisite have the same characteristics in both zones, but euhedral grossular crystals are scarce. Pyrite is rare to nonexistent.

Specular hematite occurs as large masses of micaceous habit with individual sheets often over 7 cm across. Fine clusters occur in masses of calcite and in finer grained hematite masses, some of which enclose euhedral rose to amethyst quartz scepters or skeletal quartz crystals, similar to those in the hornfels-garnet zone.

Other Quartz Zones

About 15 m above and 30 m north of this zone, a series of quartz veins and vugs extend up the canyon wall. These vugs are quartz-lined and partially filled with calcite masses. One of the lower vugs contains epidote crystals of a long prismatic habit. Fine specimens of diverging sprays, some on or growing out of quartz crystals, were removed from this vug (Fig. 9). Masses of unterminated crystals are common in the vug, but only a few good specimens of terminated crystals have been collected.

One of the vugs contains a narrow quartz vein on one side with few euhedral crystals. Most of the vug is filled with clay and iron oxides. Secondary copper minerals occur sporadically in the small vugs in the vein. The author has removed small botryoidal specimens of malachite and chrysocolla that have an unusual glassy luster.

The other vugs in this zone produce very little of interest. They contain very few quartz crystals. Generally only one or two faces have developed on the few crystals present because the crystals formed parallel to the vug walls.

South of this zone, on the ridge between the two forks of the canyon, there are numerous quartz veins containing small vugs.

These have not produced any crystals of good euhedral development or size. One vein contains a few vugs filled with large crystals and sericite. The crystals are milky and show an unusual skeletal development. They display numerous sharp ridges that wrap around and along the crystals. Apparently the quartz was intergrown with another mineral that has since weathered away.

One vug containing Japan-law twin quartz crystals was located in the narrow side canyon southeast of the scepter locality. This canyon is very narrow for the first few metres, after which it widens out and ends at vertical cliffs over a hundred metres high. Access is very difficult as cliffs must be negotiated over much of the length of this narrow side canyon.

This vug was cleaned out and no others have been found. It produced an unusual profusion of tabular Japan-law twins from micro size to over 2.5 cm across (Fig. 10 and 11). These occurred in fine clusters with sericite. Specimens with dozens of twins on a matrix only a few centimeters across are common. A few specimens composed of hundreds of interlocking twins were collected.

Other Zones of Interest

Several other skarn zones occur on the west side of Denny Mountain. Small outcrops of the garnet-hematite mineralogy can be found in the vicinity of the main canyon. Specimens of grossular and epidote can also be collected, but no good quartz occurrences have been reported.

A zone in Denny Creek south of the canyon contains vugs with epidote and grossular. The epidote is about equal in size to that in the main canyon, but the grossular crystals are often larger. Crystals to 3 cm in diameter are common.

A magnetite pod about a hundred metres above the main quartz zone produces fine pyrite crystals. This zone has only recently been discovered and very little is known about it. It is accessible only by technical rock climbing.

There are very likely other skarn zones of interest to mineral collectors in this area. Much of the rock is covered by colluvium and thick vegetation. Steep bare rock dominates the upper parts of the west side of the mountain; much of it is accessible only by rock climbing.

CONCLUSIONS

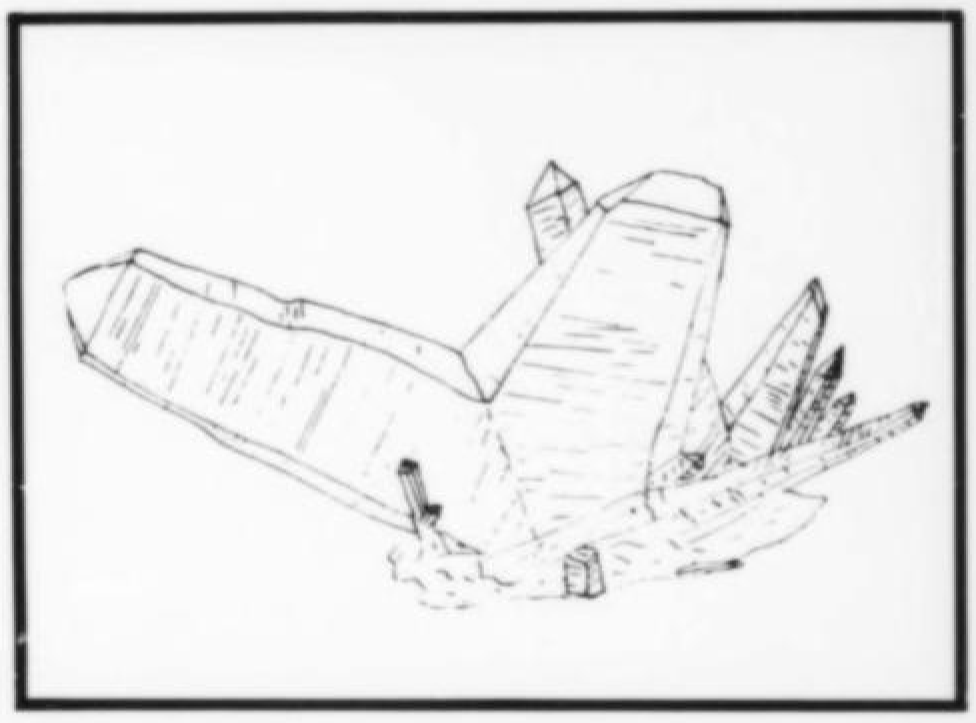
Denny Mountain has produced fine specimens of quartz, grossular, epidote, clinozoisite, scheelite, diopside, pyrite and malachite. Collectors for many years have been lured to this deposit to collect specimens under very dangerous conditions. The old popular collecting areas have been nearly cleaned out, but hard working collectors may discover new vugs by breaking hard rock in the old zones and by digging in interesting outcrops. All collectors should remember that the canyon and mountain are very dangerous. There are few, if any, collecting areas that have caused the death of as many mineral collectors as this locality has.

ACKNOWLEDGMENTS

The author would like to thank Ed Molsee for his assistance in gathering information during collecting trips to the area. The information provided by Bob Jackson, Gary Maykut, Lew Landers and other collectors is greatly appreciated.

Figure 10. (left) **Japan-law quartz twin (right) about 5 mm tall, from Denny Mountain.**

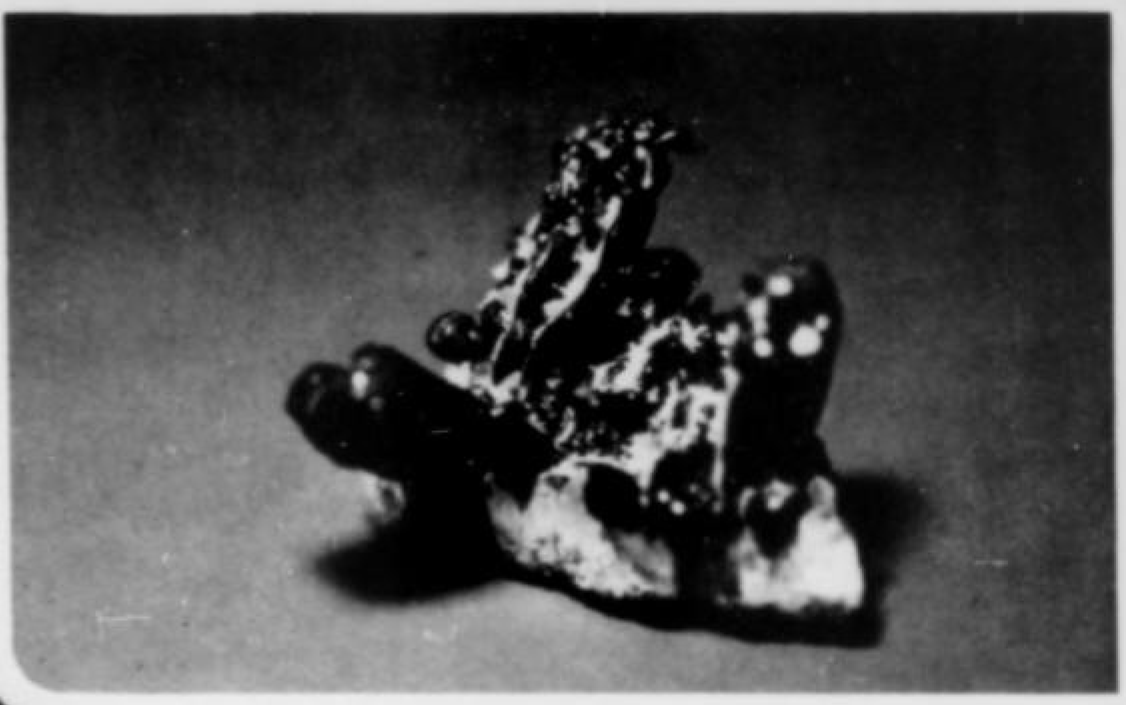
Figure 11. (below) **Japan-law quartz twin, about 3 cm wide, from Denny Mountain.**



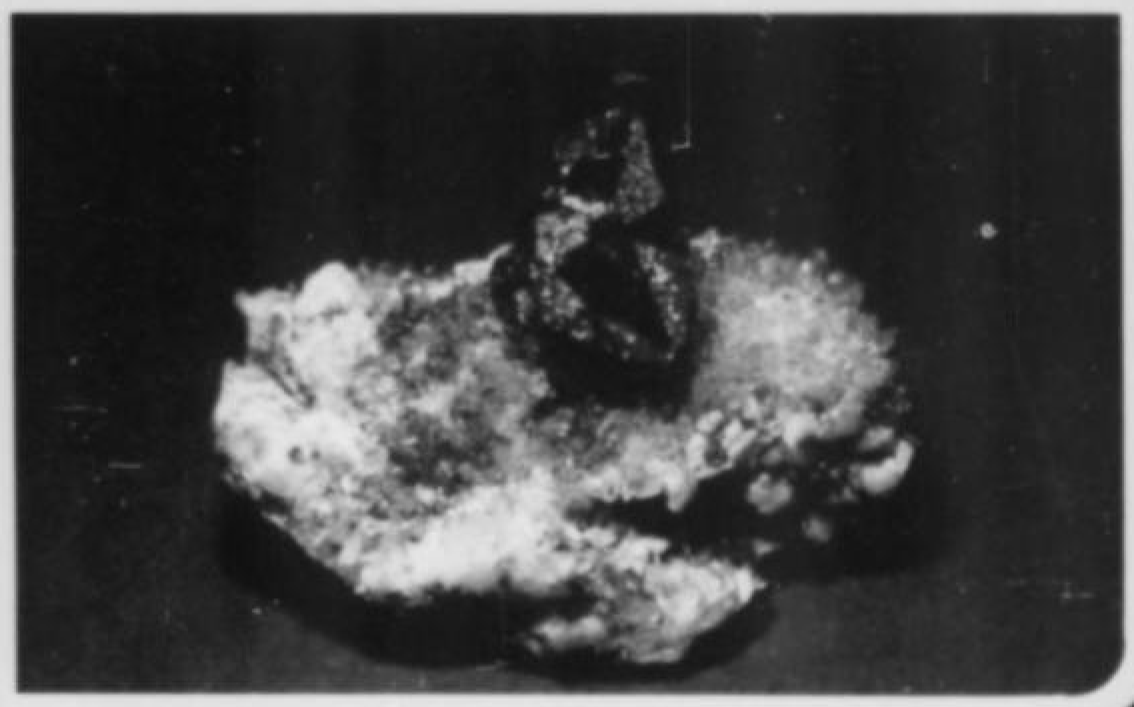
Phosphophyllite: Potosi, Bolivia; 5.5 cm tall (green).

Proustite: Marienberg, Germany; 6 cm wide (red).

Pyromorphite: Braubach, Germany; 6.7 cm wide (pale brown).



Hessite: Botes, Romania; 2.9 cm wide.



Cinnabar: Hunan Province, China; 2.4 cm tall (red).

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THE SECONDARY MERCURY MINERALS OF TERLINGUA, TEXAS

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The Terlingua mercury deposits in the Big Bend geological province of Texas are well known for their variety of rare secondary mercury minerals. Most notable among these are the mercury chlorides, oxides, and oxychlorides calomel, montroydite, eglestonite, and terlinguaite. A great deal of work has been done on these deposits, first for their economic importance, and second for their rare mineral assemblage.

The Terlingua district, Brewster County, Texas, lies immediately west of Big Bend National Park (Figure 1). The region extends for approximately 20 miles both north and south of the park and has an east-west extent of nearly 30 miles. Exposed are over 2000 feet of thick bedded upper and lower Cretaceous limestones and shales which have been cross-cut by igneous plugs and dikes of phonolitic, andesitic, and diabasic composition. Invariably the major mercury deposits lie close to one of these igneous intrusions.

Mercury was discovered in the region in 1894, though relic Spanish mercury retorts of unknown age can be found throughout the district. Active mining lasted over sixty years with many tons of mercury ore produced. The Chisos mine alone produced nearly 12 million dollars worth of refined mercury. Today however, Terlingua is a ghost town* and tourist center with most of the major mines long since abandoned.

The most striking feature of the Terlingua deposits is their control by anticlinal structures. The deposits are well developed within the Lower Cretaceous Edwards and Georgetown limestones where mineralization occurs in brecciated zones, resulting in the formation of fissure veins. Relatively impervious interbedded clays, shales, and marls or intrusive igneous dikes and sheets kept the mercury solutions (or gases) confined within the anticlinal structures and directed the mercury carriers in an ascending direction. The mineralized fissures were then filled by secondary calcite or a clay-rich caliche material known locally as *jaboncillo*. Associated with the calcite replacement are gypsum, iron and manganese oxides, and aragonite; the latter is occasionally locally abundant. Major ore minerals are cinnabar and native mercury. Deep red cinnabar crystals, some as large as ¾ inch, have been found. The most common occurrence of cinnabar is, however, as thin red powdery stains, though large masses of pure cinnabar, some weighing as much as several hundred pounds, were found as cavity fillings during the early days of mining. A few cave-size cavities were found to contain cinnabar-coated stalactites and small vugs which were often entirely filled with native mercury. One such vug containing over 20 pounds of pure liquid mercury was found in 1903. Though locally abundant, native mercury is far more commonly found as small disseminated blebs in masses of cinnabar, calomel, and montroydite.

The Upper Cretaceous deposits lie mainly within the Eagle Ford shales. These deposits are not associated with calcite-filled fissures as is so characteristic of the deposits of the Lower Cretaceous. Deposition is again fissure-controlled but gangue mineralization includes pyrite, iron oxides, psilomelane, pyrolusite, gypsum, and jaboncillo. Pyrite is very abundant and locally provides extensive iron staining near the deposits.

The areas near both the Upper and Lower Cretaceous type deposits show extensive structural deformation. The district is marked by its abundance of steep slopes and rugged terrain. It is believed that much of the mercury once deposited has been destroyed by erosion and renewed deformation of the host rocks (sellards and Baker, 1934). One placer deposit of cinnabar has been recorded but the lack of water in the region may have precluded extensive placer mineralization.

The following data on the crystal form and habits of the secondary mercury minerals is a combination of original work by the author and by previous researchers (Hill, 1903; Hillebrand, 1907; Rouse, 1975). The material used in the single crystal x-ray study was from the Terceiro shaft, Mariposa Mining Company, and from the Tres Cuevas mine. Collecting was done in both light protective containers and in normal glass vials.

Calomel $HgCl$

Tetragonal dipyramidal
4/m2/m2/m

Colomel, known as "horn quicksilver", is the most common of the mercury chlorides in the Terlingua district. It occurs as white to yellow prismatic crystals, often tabular to (001) (Figure 2). Crystals are usually small though some as large as 1.5 cm in length have been reported. Calomel turns gray to black with prolonged exposure to light. A deep red fluorescence can be observed in ultraviolet light.

Montroydite HgO

Orthorhombic dipyramidal 2/m2/m2/m

Montroydite occurs as brilliant orange-red needles which gradually change to gray upon continued exposure to light. Crystal size is often quite small, ranging from 0.3 to 1 mm size crystals. A well developed cleavage is seen along (010) (Figure 3). Montroydite is commonly associated with native mercury, the latter often filling in cavities and etch pits developed on the crystal surface.

Telinguaite Hg_2ClO

Monoclinic Prismatic 2/m

Terlinguaite is found as bright canary yellow, striated, prismatic 1 mm-sized crystals on native mercury, calomel, and cinnabar (Figure 4). They are easily distinguished by their translucent yellow color, though with exposure to light they change to a diagnostic olive green, then to black. Most crystals are large enough to be seen with the naked eye. This mineral, named for the district, is unique to this occurrence.

Eglestonite Hg_4Cl_2O

Isometric hexoctahedral $4/m\bar{3}2/m$

Eglestonite is the most photosensitive of the mercury oxychlorides. Occurring as small 0.5 to 1 mm-sized yellow crystals, it easily alters to yellow-brown to black with only minor exposure to light. It is found as a fragile crust which is easily crumbled, enabling single crystals to be easily separated. Dodecahedra are by far the most common form though octahedra have been reported (Figure 5). Single crystal work confirmed the space group as Ia3d as proposed by Rouse in 1975. The most extreme care must be taken in the collection, transportation, and observation of specimens of this mineral. Exposure to light, though changing the color, seemingly does not alter the crystal structure

---

*Terlingua comes alive at least once a year, however. Around the beginning of November over 10,000 Southwesterners descend on Terlingua for the annual **World Championship Chili Cookoff,** an Olympic festival of chili competition. Ed.

as space group determination was found to be identical on both altered and fresh specimens.

ACKNOWLEDGEMENTS

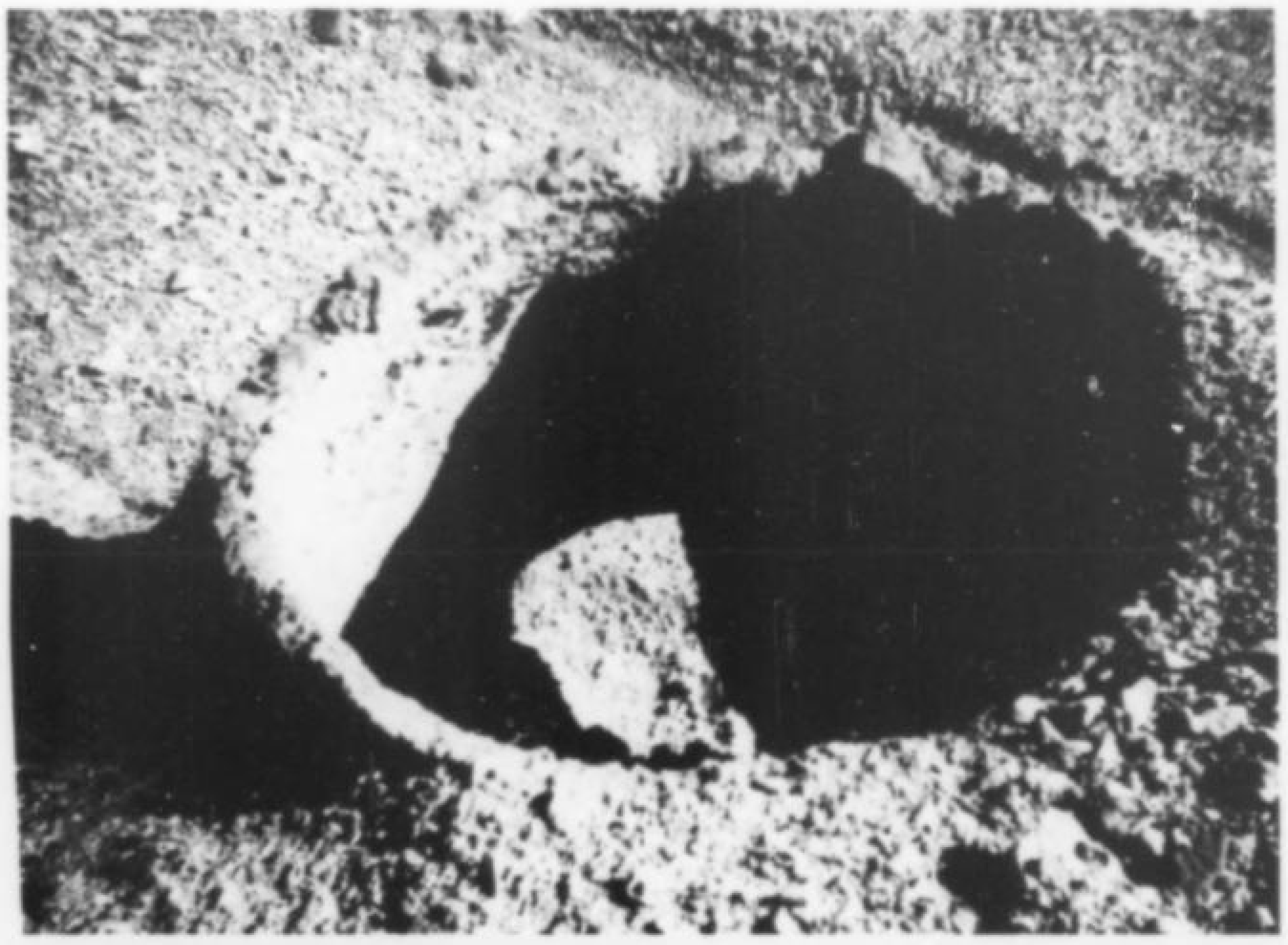
The writer is indebted to Southern Methodist University for specimens from the Terceiro shaft, Mariposa mine, and to Miss Angela Adams for assistance in collecting specimens of terlinguaite, eglestonite, and montroydite at the Tres Cuevas mine.

Figure 1. (top left) **Relic Spanish mercury retort.**

Figure 2. (lower left) **One of the many old mercury mines in the Terlingua area.**

Figure 3. (top right) **Mine dumps at Terlingua.**

Figure 4. (lower right) **Terlinguaite; yellow; 3 mm crystals; Smithsonian specimen 86645.**



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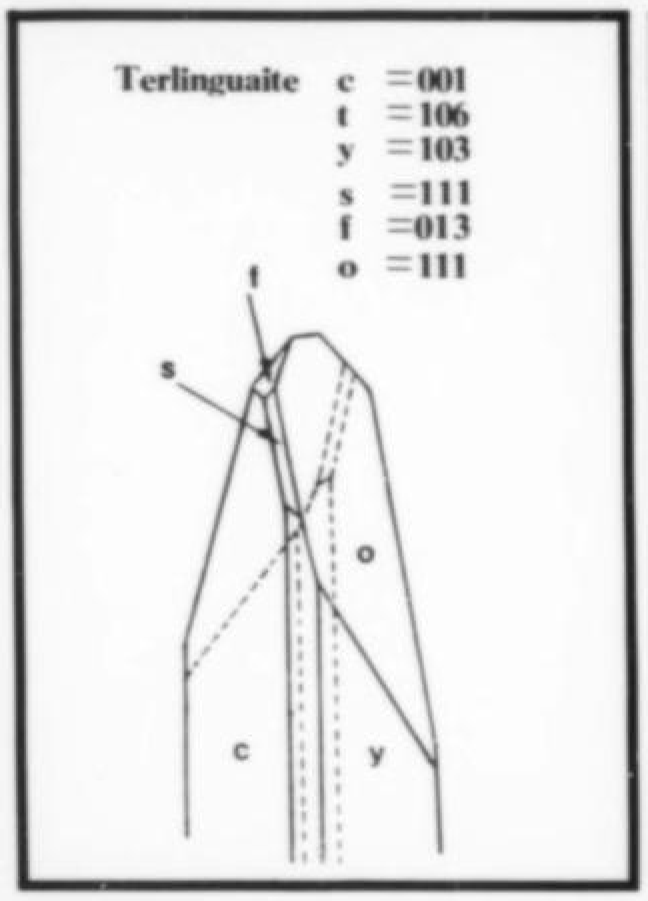

Figure 5.

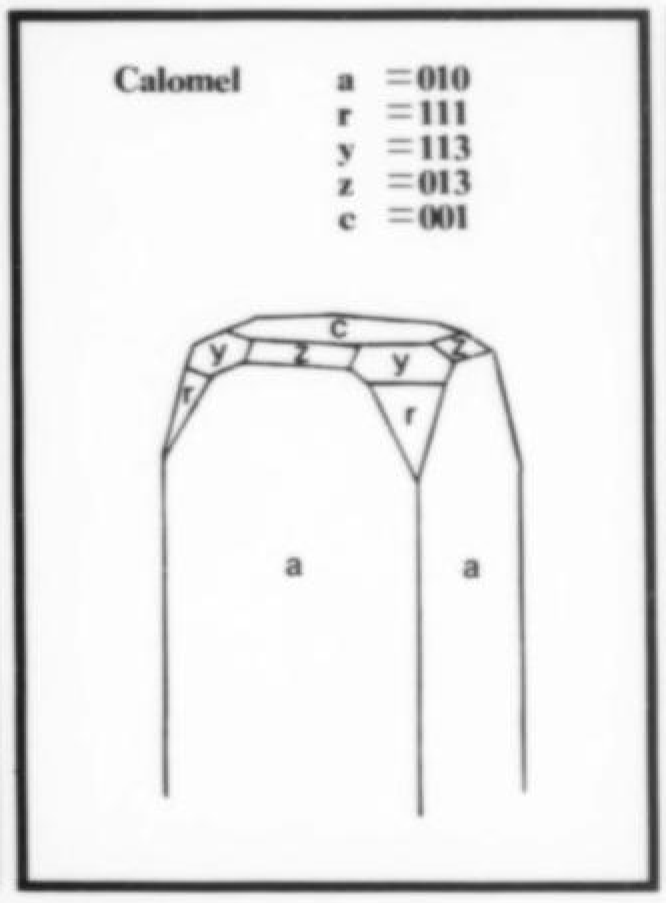

Figure 6.

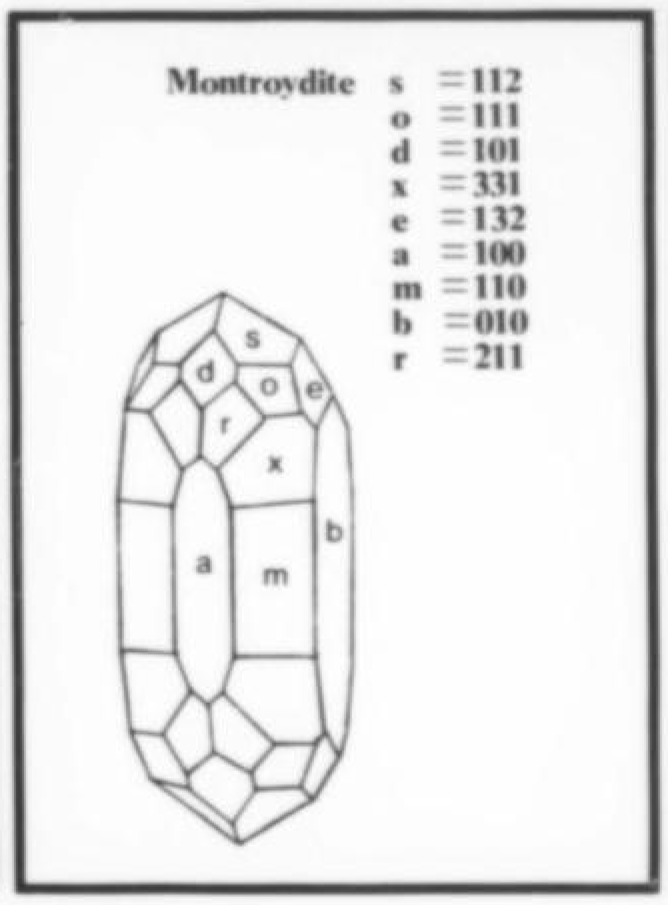

Figure 7.

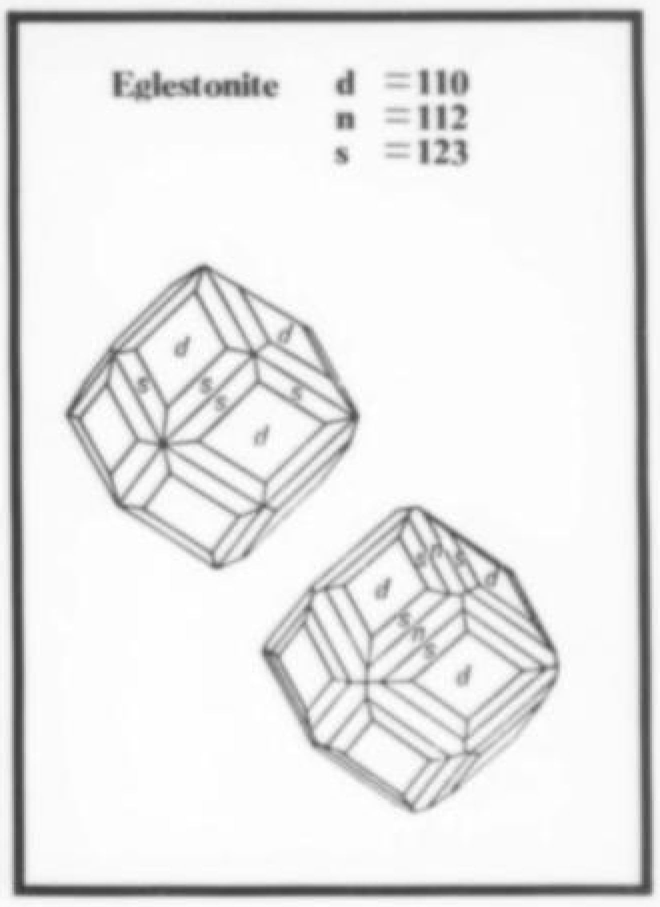

Figure 8. →

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Figure 9. (above left) Calomel; cavernous crystals; pale brown; 5 mm crystals; Smithsonian specimen 105039.

Figure 10. (above) Montroydite; sceptered crystal; dark red; type material; 1.5 mm in width; Smithsonian specimen 87483-24.

WEW

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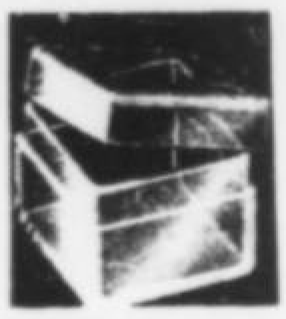

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CROCOITE

& Its Increasing Scarcity

By Keith Lancaster
14 Wilhelmina Ave., Launceston, Tasmania, Australia 7250

Crocoite, that rare hyacinth-red chromate of lead ($PbCrO_4$), has long been one of the most sought after crystal specimens. Its vivid clusters of bright acicular, often reticulated, masses of crystals form one of the most attractive creations in the mineral kingdom. Lucky indeed is he who possess one of these outstanding specimens, as choice material is becoming steadily more scarce at the major source of supply, the Australian island of Tasmania.

Crocoite is one of the many secondary minerals occuring in the silver-lead (galena) deposits which contain both lead and chromium. It forms in the upper oxidation zone amidst the ferrimanganian gossans and associated clays, often in company with other minerals of secondary origin. In the clays the crystals are frequently doubly terminated, but the structure of the clays is too soft to hold the crystal masses together after drying. Only crystal formations found in vugs in the harder gossans have a sound foundation on which to preserve their reticulated structure. A few specimens with crystals of 3 to 4 inches in length are still in existence from the Dundas field, but today specimens exceeding 1 inch in length are rarely unearthed.

Although crocoite has been found in several countries— Russia, Rumania, Brazil, the Phillipines, Western Australia, Rhodesia and the United States—it is from Tasmania that the world's choicest specimens have been supplied. It was first reported in 1895 (according to Records of the Tasmanian Mines Department) at the Heazlewood silver-lead mine as small acicular crystal groupings in clays, associated with cerussite and occasionally pyromorphite. This was during the silver-lead boom on Tasmania's West Coast when many silver-lead mines were operated in the Zeehan to Heazlewood area toward the close of the last century. Shortly afterward, the mineral was also discovered at the Whyte River and Washington Hay mines, a little farther northeast, and here the occurrence was more plentiful and consisted mainly of small doubly terminated crystals coating fractures in the gossan and country rock. These three mines had a short life, as ore reserves were meager, and they were closed around the turn of the century.

Figure 1. **Tasmania.**

The Magnet silver-lead mine, which operated from the 1890's to the 1920's a few miles south of Waratah and the Mt. Bischoff tin mine, also produced crocoite. Here reticulated bunches of fine prismatic crystals up to 2 inches long were found in vugs in gossan, occasionally with chromiferous cerussite. However, few samples from any or the above-mentioned mines exist today.

Silver-lead ore was discovered in the Dundas area in 1886 by prospectors fanning out from the newly established Zeehan field. By 1890 several silver-lead mines were in production there, although transport to this isolated West Coast sector hampered progress. The terrain was rugged and cloaked with dense forest vegetation. To gauge the disadvantage of this you need to consider that Tasmania's rain forests probably possess the most densely packed undergrowth in the world.

The rugged miners, intent upon winning as rich a reward as possible from their unenviable labors, paid little attention to the crocoite and associated secondary minerals, as they had little lead content, and trucked them away to the smelters to be used as flux. Crystals up to 1 foot in length were reported in the old days and one can imagine what a wealth of superb specimens must have been dumped unceremoniously into the smelters.

Unfortunatley, none of the silver-lead mines at Dundas had any substantial reserves of ore and by 1894 production was decreasing. Only a few mines were working at the close of the century; since then mining has been sporadic and negligible. Only one mine is being kept open today for the production of silver-lead and this is operating on only a small scale.

Although the initial discovery of crocoite in Tasmania is officially credited to the Heazlewood mine, in 1895, it is inconceivable to me that it could not have been recorded much earlier from the Dundas mines which were in full production and must have been sending crocoite to the Zeehan smelters for flux before that date. It is possible that a printing error occurred; the true date is more likely 1885.

Apart from the above-mentioned mining fields, the only other sighting of crocoite was in minute quantities in the Colonel North and Silver Queen mines in the Zeehan field. To gauge the possible future supply of crocoite and associated crystal specimens, let us examine the likely potential of these once abandoned mines.

The main shaft of the Magnet mine has been flooded, and the massive mine dumps recently carted away by the E.Z. Company to smelt for their zinc content; no indication of further early exploitation there exists, so there appears to be no future prospect of crocoite emanating from that source. The Heazlewood and Whyte River field has attracted no recent prospecting and, in any case, the specimens which came from there would be of little appeal to collectors. Thus there remains only the Dundas field to which we can look for further supplies of crocoite. Now let us see what has become of the various mines in the field.

MAESTRI'S MINE and THE COMET MINE were two of the earliest mines and simultaneously worked from opposite ends of the same lode. John Maestri pegged his claim in 1888 and his friend "Comet" Johnston pegged another alongside him. In 1895 the two claims were united and worked by the Comet Tribute Prospecting Syndicate, which railed sixty tons of ore per day to the smelters. This was one of the most productive mines on the field and finally closed during the First World War. Fine crocoite crystals were found there, along with superb specimens of "straw cerussite". The latter consisted of long reticulated masses of white crystals on a contrasting black gossan base. Today the shaft is flooded and a creek flows through the main adit.

The **ADELAIDE MINE** was another of the early ventures and occupies a hillside near the Dundas Rivulet. Mineral production was reasonably good and it continued intermittently up to the outbreak of the First World War. However, it was its secondary minerals that made the Adelaide worldfamous. In its early days, interlocking reticulate crystals of crocoite over 3 inches long were often unearthed in the upper part of the ore bodies. All but the best specimens went along with the ore to the smelters. Fifty years ago, hardly a home on the West Coast of Tasmania would be without a large specimen of much-handled crocoite carelessly resting on the mantleshelf.

It was not only crocoite that the Adelaide had to offer. Phoenicochroite, the deeper-hued form of lead chromate, was there in large hollow crystals, but is particularly scarce today. Dundasite, which takes its name from the place of its discovery, is a basic carbonate of lead and aluminium and occurred as creamy white encrustations on the gossan, generally with minute crocoite crystals. It is an extreme rarity today. Chromiferous cerussite also was found and sometimes in beautiful, trilled crystals, the bright yellow color being attributed to chromium. Gibbsite, an aluminium hydroxide, was present as white mamillary encrustations (sometimes stalactitic) on the gossan and often coating the crocoite crystals. Bindheimite, minium and phosgenite were other secondary minerals recorded; the primary mineral associated were galena, sphalerite, jamesonite and pyrite.

In recent years the Adelaide mine has been worked by various claimants for specimens only. At the moment it is held conjointly in lease with the **RED LEAD MINE**, which has a less impressive history, on the other side of the hill. Specimen mining has lately been focussed on the Red Lead mine with rewarding results. Unfortunately, the day of the superb specimen is nearing its close at all these old mines and any specimen with crystals exceeding ½ inch in length is regarded as very fine indeed. On rare occasions, a vug with 1 inch long crystals is discovered, but these occasions steadily become fewer.

The **WEST COMET MINE** was operated from 1890 onward, in 1896 by the Comet Mining Company and later by the West Comet Company. Much of its ferrimanganian gossan and crocoite was railed to the Zeehan smelters for flux. At least 500 tons of high grade ore were produced before its closure in 1910. Crystals of crocoite, cerussite and barite accompanied the primary lode, which consisted of galena, siderite, sphalerite and pyrite. In 1974 Rod Williams took out a claim on this mine to work it for mineral specimens. Apparently the venture was not very successful as the mine has been abandoned.

The **GREAT SOUTH COMET MINE** lies to the southeast of the field and was connected by a two-foot-gauge tramway to the rail system in the early days. Although not the richest of ore deposits, it has been worked over the longest period of years; recent work has been intermittent and on a small scale. The current leaseholder, Alan Smythe, still operates it for its silver-lead content. Crocoite was very sparse at this mine, but secondary minerals included cerussite, pyromorphite, pyrolusite and antimonial silver.

The **KOSMINSKY MINE** lies to the north of the South Comet on the southern slopes of Kosminsky Hill. Mining commenced in 1890 on a small scale but received greater attention after 1910 and, although ore there is somewhat similar to that at the South Comet, no current mining is in progress.

The **PLATT MINE** lies on the northern slopes of Kosminsky Hill and its silver-lead ore was mined in the 1890's via a shaft and three adits. After a long period of neglect it was reopened in April, 1976, by Michael Phelan and Joe Pringle, who are mining it solely for its specimen content, It possesses a fairly large amount of crocoite, but generally not in lengthy crystals. A rather attractive type of specimen, which comes only from the Platt mine, is a combination of crocoite and pyromorphite in which the crocoite crystals, though only about ½ inch in length, have

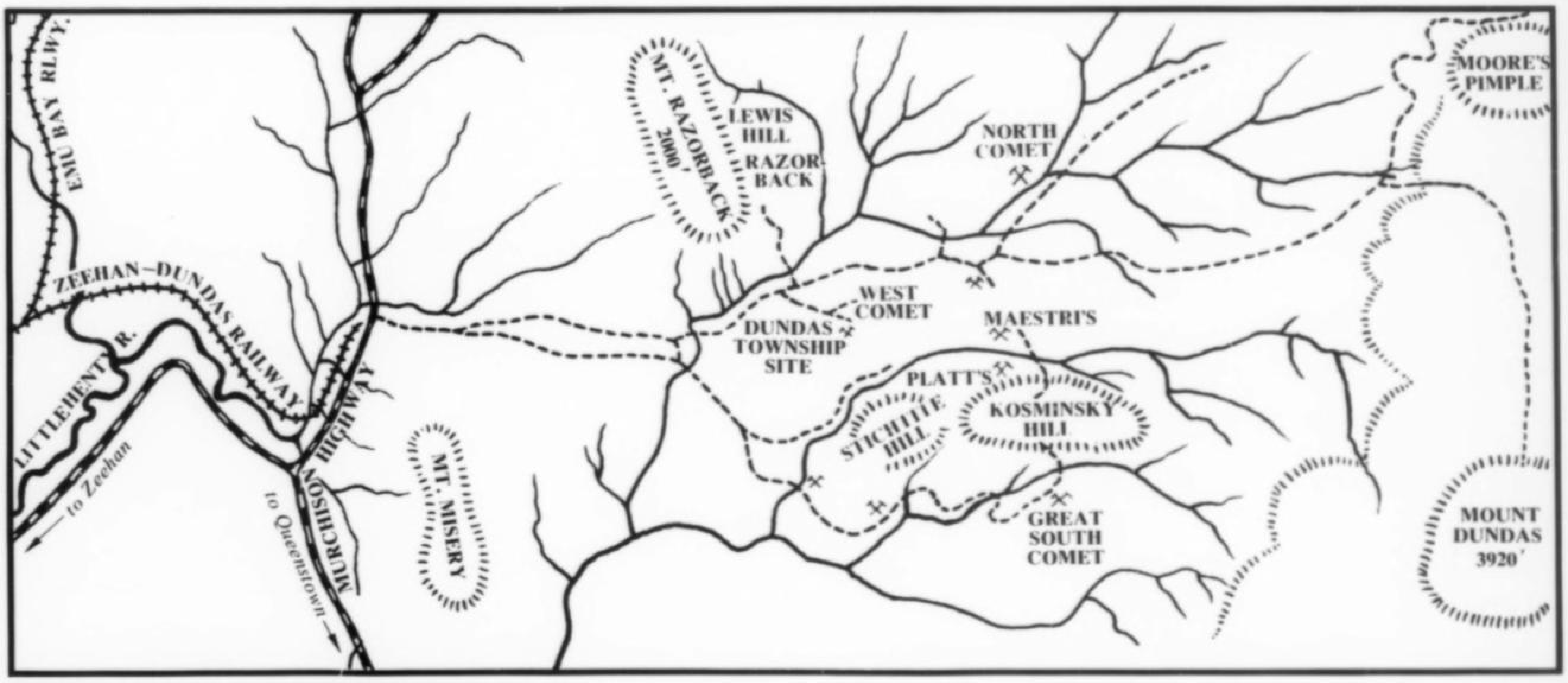
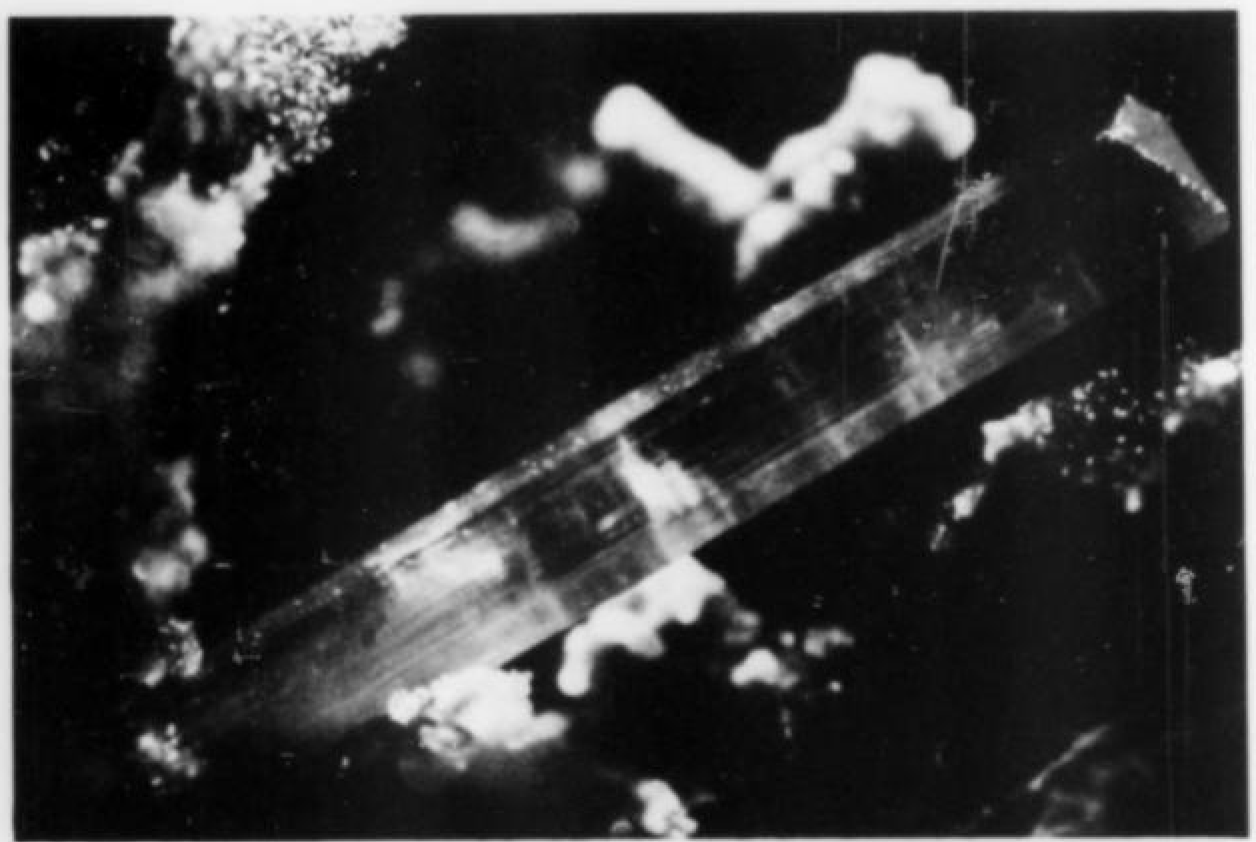


Figure 2. **Sketch map of the Dundas Field.**



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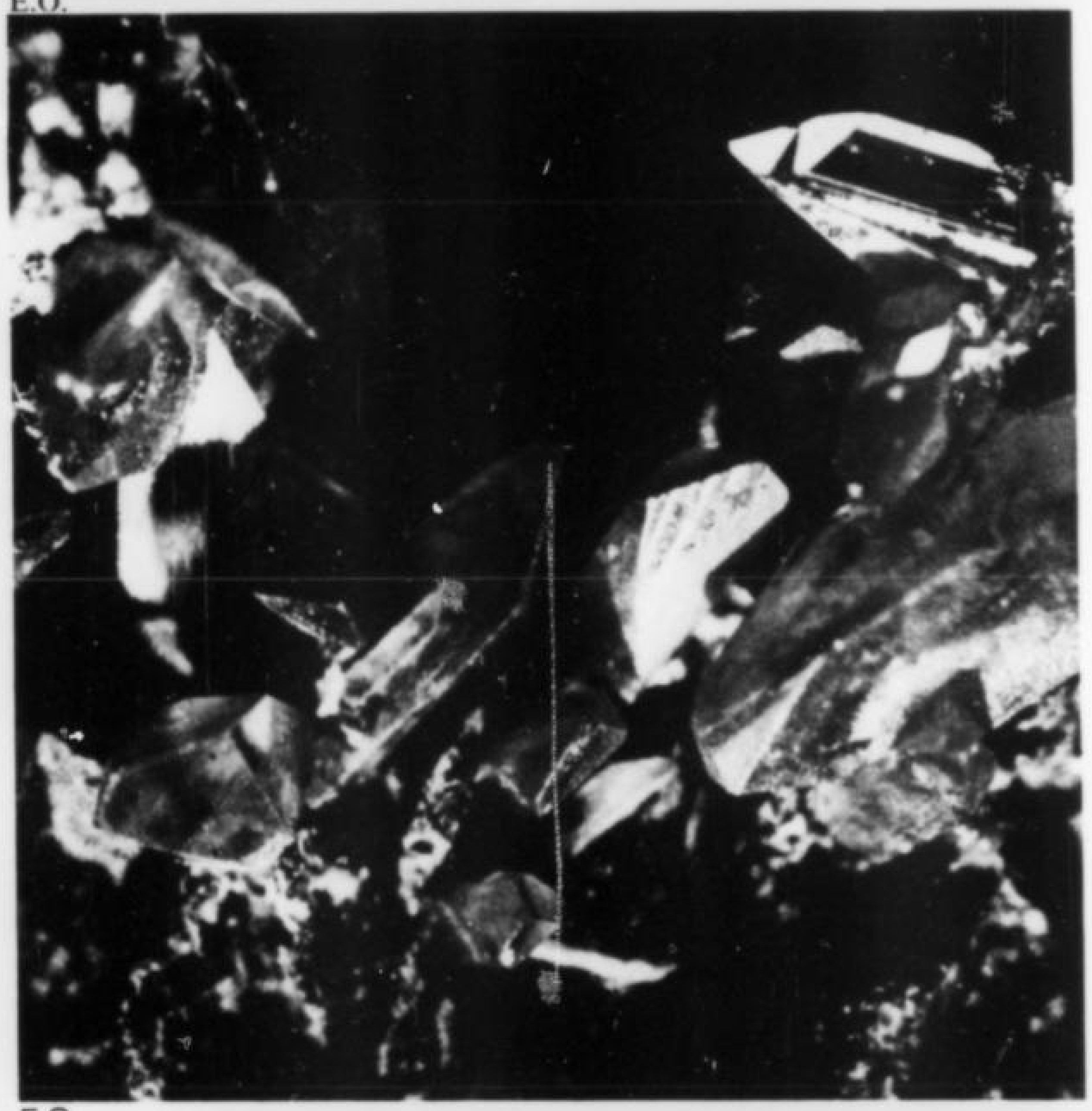

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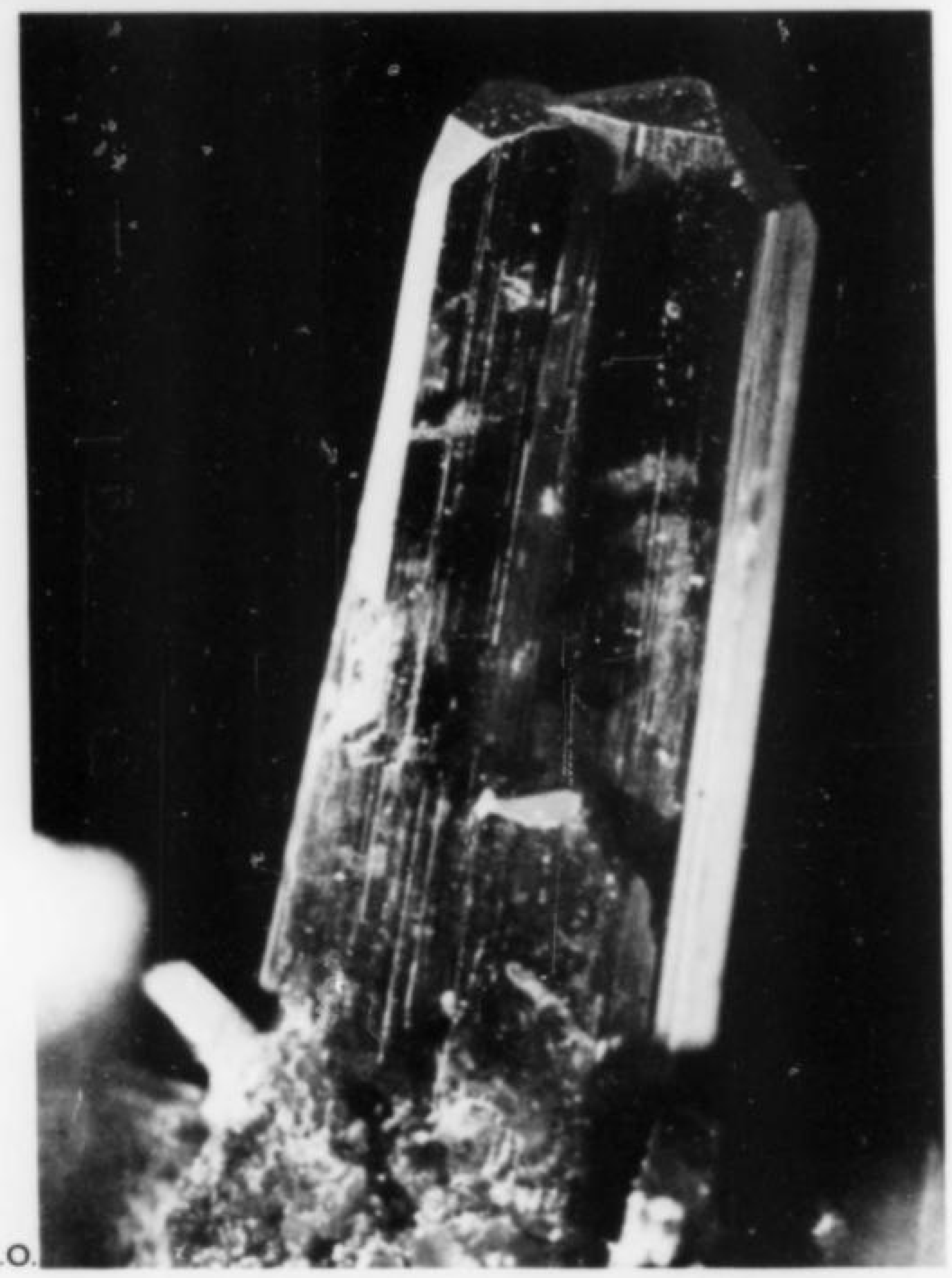


E.O.

very fine terminations uncommon to crocoite. In some instances, massicot (probably a decomposition product of pyromorphite) and clear cerussite also join the combination. Longer crystals of crocoite can be found but, alas, too often in clays too friable to hold the delicate crystals. Pyrolusite is also found in sections of the old mine. It is yet too early to fully gauge the future potential of this mine.

The **ANDERSON MINE** lies between the Adelaide and West Comet mines and is on the same hillside. Crocoite was originally found in abundance at a depth of fifty feet, but the lack of galena ore in the lower depths soon proved insufficient for profitable silver-lead extraction. At present it is held under lease for the purpose of extracting crocoite, but I suspect its potential will prove to be limited.

The **BONANZA MINE**, on the northern slopes of Stichtite Hill, contained a promisingly broad lode of silver-lead ore when originally mined, but it rapidly narrowed and soon pinched out. It contained crocoite and other secondary minerals in the gossan but, as a portion of the adit has collapsed, it appears that too much work would be involved in reopening it to obtain what would probably be a meager reward.

The **KAPI MINE** was the only mine on the North East Dundas field that contained crocoite. It is reached by another road from Melba Flats and lies on the hillside on the western side of Kapi Creek. Several short adits were driven into the hillside to exploit a galena-sphalerite lode. The upper adit was worked steadily for two years for crocoite and produced some valuable specimens. The crocoite, though of a brighter color than elsewhere, rarely occurred in long crystals, but made up for this by sometimes being associated with yellow crystals of phosgenite, usually suspended aloft by the crocoite crystals. Dundasite was another great rarity from this locality. Where larger crocoite crystals occurred, the gossans were often too soft and crumbly, making the specimens extremely fragile. Now the mine seems to have passed its zenith in specimen production, although Rod Williams is still making some headway there.

From the foregoing, it appears fairly certain that there will be progressively less good crocoite coming on the market despite the keen efforts of those engaged in its recovery. There is also the fact that the collecting of minerals has increased tremendously as a hobby in recent years throughout the world, so that even if production could be maintained at its present level, it would not satisfy the growing demand. Furthermore, the more the mineral specimen miners strive to keep up with the demand, the greater must be the inroads into the small remaining pockets that exist and this can only hasten depletion. It is all too obvious that higher prices and poorer specimens will prevail.

Despite the growing concern for the future of crocoite production, its fate appears much rosier than that of some of its secondary associates. Dundasite, chromiferous cerussite, gibbsite and phosgenite are already extremely rare in Tasmania and there seems little hope at the moment for the production of further supplies.

(The writer, who has been a frequent visitor to the various fields described, will be quite happy upon request to provide any reader with wider information on any matter raised here.)

Figure 3. (top) **Crocoite (orange), near Dundas, Tasmania. The crystal is about 3 mm long; specimen: Eric Offermann.**

Figure 4. (middle) **Crocoite (brilliant red) on pyromorphite (green), near Dundas, Tasmania. The crystals are 1-2 mm in size; specimen: G. Keller, Bettingen, Switzerland.**

Figure 5. (bottom) **Crocoite (brilliant red), near Dundas, Tasmania. The crystal is about 1 cm tall; specimen: G. Keller, Bettingen, Switzerland.**

THE HALL OF MINERALS AND GEMS AT THE AMERICAN MUSEUM

Peter B. Leavens, Associate Professor and Curator, Irenee duPont Mineral Collection, University of Delaware, Newark, Del. 19711

The American Museum of Natural History in New York City opened its new Hall of Minerals and Gems on May 21, after eight years of preparation and the expenditure of $1,500,000. It is undoubtedly the most dramatic mineral display hall in the world; overall it rivals the Smithsonian Institution's hall as the premier display in the country. A brochure handed out by the Museum states, "this beautiful new hall, one third of an acre in size, is filled with dazzling specimens of minerals, gems, and meteorites from the Museum's outstanding collections." It is indeed a dazzling display, although it is somewhat flawed by problems in organization and layout. It also includes a remarkable number of second rate pieces mingled with some of the finest mineral specimens in the world. More on this later.

Three people were heavily involved in designing the new hall and its displays. Vincent Manson was scientist in charge and developed the major concepts, as well as choosing most of the specimens displayed. Fred Bookhardt, of William F. Pedersen Architects, was largely responsible for the extraordinary treatment of space in the hall, and Christopher Schuberth, of the Museum's Department of Education, had much to do with the organization of the educational aspects of the hall. It is important to realize that the hall is designed largely as a teaching exhibit, and that from this point of view the audio tapes and written guides that go with the exhibits are an important part of them. It is possible to pick up a pretty good education in mineralogy by visiting the hall, and attendance should be compulsory for Grand Prix mineral collectors.

The Hall is actually a cluster of rooms housing meteorites, minerals, gems, a chamber on the interaction of minerals and energy, and a mini-auditorium. The meteorite display, still being completed, is attractive and conventional in character, with pedestal-mounted specimens and wall cases. Beyond the meteorite room is the mineral display hall, an unconventional and complex environment of multiple levels and spaces, dim lighting, and pervasive, earth-toned carpet—even some vertical surfaces are carpeted. The design suggests a particularly lush and intimate nightclub, and it is remarkably effective. The visitor can move by various paths through multiple levels with different themes, brightly lit specimens always at the center of attention. There are also places to sit and relax or listen to various taped presentations. I enjoyed this layout, but I am a bit worried at the hazards it may pose for small children and elderly people. The dim lights, lack of handrails, and complex levels make moving around complicated. Hopefully the carpet will cushion tumbles.

Most museum mineral displays are systematic, with cases for elements, sulfides, oxides, and so on, but here the systematic display, although large, occupies only two walls of the room. Within each anion group, the minerals are arranged according to the cations contained rather than by crystal chemistry. Thus, aragonite, cerussite, witherite, and strontianite, all in the carbonate group, are not arranged together, despite their similar structures. I found this a bit confusing, since I am familiar with the standard crystal-chemical classifications in Dana, Hey and Strunz.

The systematic cases are on one side of an aisle about six feet wide; the other side is a platform about four feet high, which separates the aisle from other areas. The wall of the platform, across the aisle from the systematic display, has small cases highlighting a single mineral or mineral group; I recall stibnite, pyrite, cuprite, hematite, gypsum, pyromorphite, apatite, wulfenite, feldspars, garnets, topaz, tourmalines, beryl. For children, who make up the largest group of visitors to the museum, these cases are perfect, but an adult must stoop or squat to examine them, and the aisle is narrow enough that a stooper tends to block traffic. It is too bad the cases could not be tilted back or otherwise arranged for adults as well as children, for many superb pieces are on display in them.

On the platforms are two hexagonal walk-around cases displaying exceptional small mineral specimens and carvings. Beyond the platforms, two amphitheaters take up most of the center of the room. These areas are devoted to cases illustrating the environments of mineral formation and the properties of minerals and crystalline substances. The cases on environments contain attractive, well-chosen specimens, and are accompanied by a taped lecture which goes from case to case, explaining in a simple but clear and informative fashion the conditions of formation of the minerals displayed in each case. Many different environments are represented, so that there are not just cases on sedimentary, igneous, and metamorphic minerals, but also on simple pegma-

Figure 1. **A large group of copper crystals from the Keweenaw Peninsula of Michigan. American Museum of Natural History specimen. (photo courtesy of AMNH)**

tites, complex pegmatites with replacement bodies and pockets, high, medium, and low temperature ore veins (a case for each), secondary enrichment of ore veins in the zone of oxidation and in the reducing zone below the water table, minerals from Franklin, N.J., evaporite, zeolites, minerals from the Keweenaw Peninsula copper district, Michigan, and probably a few more I have forgotten. This detailed display not only includes almost all environments that the mineral collector or specimen-oriented mineralogist is interested in, but also shows the public the complexity of chemical processes within the earth. This is the best educational display I have ever seen, and to me the most successful part of the mineral hall.

The area devoted to the properties of minerals and crystalline substances is not completed yet, but appears much less successful. What is completed seems sketchy and misleading in its explanations. Such elementary concepts as color, streak, and fusibility are overemphasized. There is little distinction between crystallography and crystal chemistry. Crystal twinning and polymorphism are not treated. A case on solid solution does not explain what it is and includes an error: it states that sphalerite is part of a solid solution series between sphalerite and wurtzite. In fact, the two minerals do not have different compositions, but different structures; they are polymorphs, not end-members. There is a good case showing that x-ray powder diffraction patterns of minerals of low-symmetry crystal systems, such as triclinic, are more complex than patterns from high-symmetry crystals, such as isometric. However, there is no case explaining what the crystal systems are in an understandable fashion. There will be an audio tape to go with the cases, and also a teaching guide to the hall which will complement the cases, explaining such phenomena as twinning and pseudomorphism and pointing out examples throughout the hall. Finally, docents or guides will give lectures with demonstrations for groups. These features should make the display more interesting and valuable, but it is deficient without them.

Figure 2. **Elbaite and quartz, from California. American Museum of Natural History specimen. (photo courtesy of AMNH)**

The centerpiece of the mineral environments ampitheater is a four and one-half ton block of azurite-malachite ore from Bisbee, Arizona, and all around the hall are large specimens of topaz, quartz, microcline, beryl, and other minerals, some sitting on the floor where they may be touched or fondled, others in special spotlit niches along one side of the room. This is a most attractive use of the large specimens that every museum seems to acquire, but some to the specimens in the niches are not worth the attention lavished on them. On the other hand, specimens which are to be handled shouldn't be too fine. As I was admiring a large, sharp topaz crystal, lit from within and displayed prominently, I overheard another viewer comment to his companion, "How would you like to knock off a piece of that?"

The chamber on the interaction of minerals and energy flanks the gem room and serves as a continuation of the area on the properties of minerals. Besides a display of fluorescent minerals, it has cases diagramming such phenomena as fluorescence, x-ray diffraction, and polarization. These cases use fiber optic techniques for animation, and the Museum is very proud of them. I will admit that I gave this chamber only a quick run-through, because I had only two hours and was most interested in looking at mineral specimens rather than discussions about mineral specimens. This chamber is another example of the hall's emphasis on teaching, and as such is entirely successful.

The mini-auditorium on the other side of the gem room will feature packaged slide and lecture presentations on minerals and earth resources. At present the show is entitled *Options*, and discusses the problems associated with the large-scale openpit mining of copper, contrasted with man's continuing need for the metal. The room also contains some small cases on the significance of minerals; these I could not see because people were sitting on the floor watching the slide show.

The gem room is much smaller than the fine gem hall at the Smithsonian. This was the most popular part of the whole hall when I was there, and was cramped with two dozen people in it. A couple of tour buses or busloads of grade-schoolers would jam it completely. The cases are crammed with gems, giving a feeling of opulent richness, like the treasure vault of an Eastern potentate. In the Smithsonian gem room, by contrast, pieces are spread out, and several occupy individual cases designed to emphasize their merits. Each style of display has advantages; each is effective.

There are some superb pieces on display, including a fabulous loan collection of large diamonds, some of which will be on display for an indeterminate length of time. The star stones were a disappointment. The Museum owns the Star of India, at 563 carats the largest fine star sapphire known, but it is displayed in unflattering floodlight, which damps the star and makes the ground color of the stone look washed out. The other star stones, including the 100 carat De long Ruby, are in the same case and fare no better. I understand that these stones will be rearranged and lighting improved after the loan exhibit of diamonds is finished.

One corner of the gem room contains a reconstructed gem pocket from Pala, California. It is a composite, for most of the display is made of material from several pockets from the Stewart mine, and the entrance, composed of impressive, log-like quartz crystals, is from the White Queen. Unfortunately, the brief text with the pocket does not explain this. The pocket is rather cleaner than ones I have seen, and it is as dramatic as Ali Baba's cave. The dim lighting and dark carpet already give the hall an underground atmosphere, which is reinforced by this pocket. It gave me a spooky and surreal but not unpleasant feeling. We are prepared for feelings like this at some art displays or at a carnival fun house; it was a surprise to encounter it here.

Another corner of the gem room contains a case of large carvings in semi-precious stones. The pieces are magnificent, and include some fine old Chinese jades, but they are so crowded and harshly lit that they suggest a police lineup. Clearly, it was decided to downplay these carvings, perhaps because they are objects made from minerals rather than mineral specimens, but it is a pity, for some of them are worth many thousands of dollars and are glorious. A museum which has material of this quality should treat it accordingly; the concept of the display should come in large part from the material available for display, rather than the material being subordinated to some independent concept. This is especially true when the material is of exceptional quality, as it is here. The Smithsonian has a separate room next to the gem room for its jade carvings, and the pieces are so displayed that one can get close to them and appreciate them individually.

The use of space in the hall is disturbing. The mini-auditorium gives presentations which educational TV could handle as well, and the mineral display hall devotes a wall to large but undistinguished pieces, but the great gem collection is in a small, cramped room, and the fine carvings in a single crowded case. Why?

In the mineral hall itself, much of what is displayed is not worthy of the room or is displayed poorly. First, many of the specimens are dusty, dirty, or tarnished. Others are bruised, poorly trimmed, covered with rust or other unnecessary stains: I understand that there was the usual last-minute rush to get the displays ready for the opening, but to remove, clean, and prepare the specimens as they should be would be a major undertaking—the kind that may not get done for a generation or so. Also, in most of the cases there are no shelves; rather, specimens are wired into place. This gives great freedom in arranging specimens, but makes it difficult to remove or change them.

In most of the cases, specimens are not labeled, but just numbered. The numbers refer to a large printed card at the bottom of the case, which has species and locality information. Thus, the viewer must do a lot of looking up and down to match the specimens with their identities. The advanced collector may enjoy guessing before looking at the answers, but except for this dubious advantage, it is a clumsy method of labelling. The hexagonal cases with small specimens are an exception. In them, each specimen is mounted on a plexiglas block, with mineral name and locality engraved on the base of the block, but since the letters are not blackened, they are almost illegible—hardly an improvement over the other method of labelling.

There are also mistakes in spelling and arrangement, which may be corrected by the time you read this. Volborthite in the systematic display is spelled volvrothite, and leucophoenicite in the Franklin case leucophenite. Calcite specimens from the Faraday mine in Canada and from England are reversed, as are opal

Figure 3. **Central view of the Hall of Minerals and Gems. The area is dominated by the largest specimen in the exhibit, a 4½-ton sample of azurite-malachite copper ore from the Copper Queen mine, Bisbee, Arizona. (Photo courtesy of AMNH)**

and labradorite in a case on color effects. A specimen from Franklin, N.J., is identified as pectolite, but recent work has shown that this material is wollastonite.

To me, most of the cases have just enough specimens to seem crowded, and would be better with one or two fewer pieces. However, since only 6000 out of the Museum's 70,000 minerals, gems, and other specimens are on display, a little crowding may be forgiven. The hexagonal cases are so jammed that they resemble Victorian knick-knack cabinets and are arranged with no discernable order and with great duplication. The quality of the small pieces in these cases is very high, however. In some of the other cases there are pieces which might, with some generosity, be called second-rate. This is especially true in the systematic display and in a large case of so-called "esthetic minerals". In the systematic cases in particular I remember a realgar badly photo-oxidized to orpiment, which was shedding fine yellow powder on the specimens below it, and a German bloedite which looked like a lump of ice; the species could have been handsomely represented by one of the well-formed crystals from Soda Lake, California.

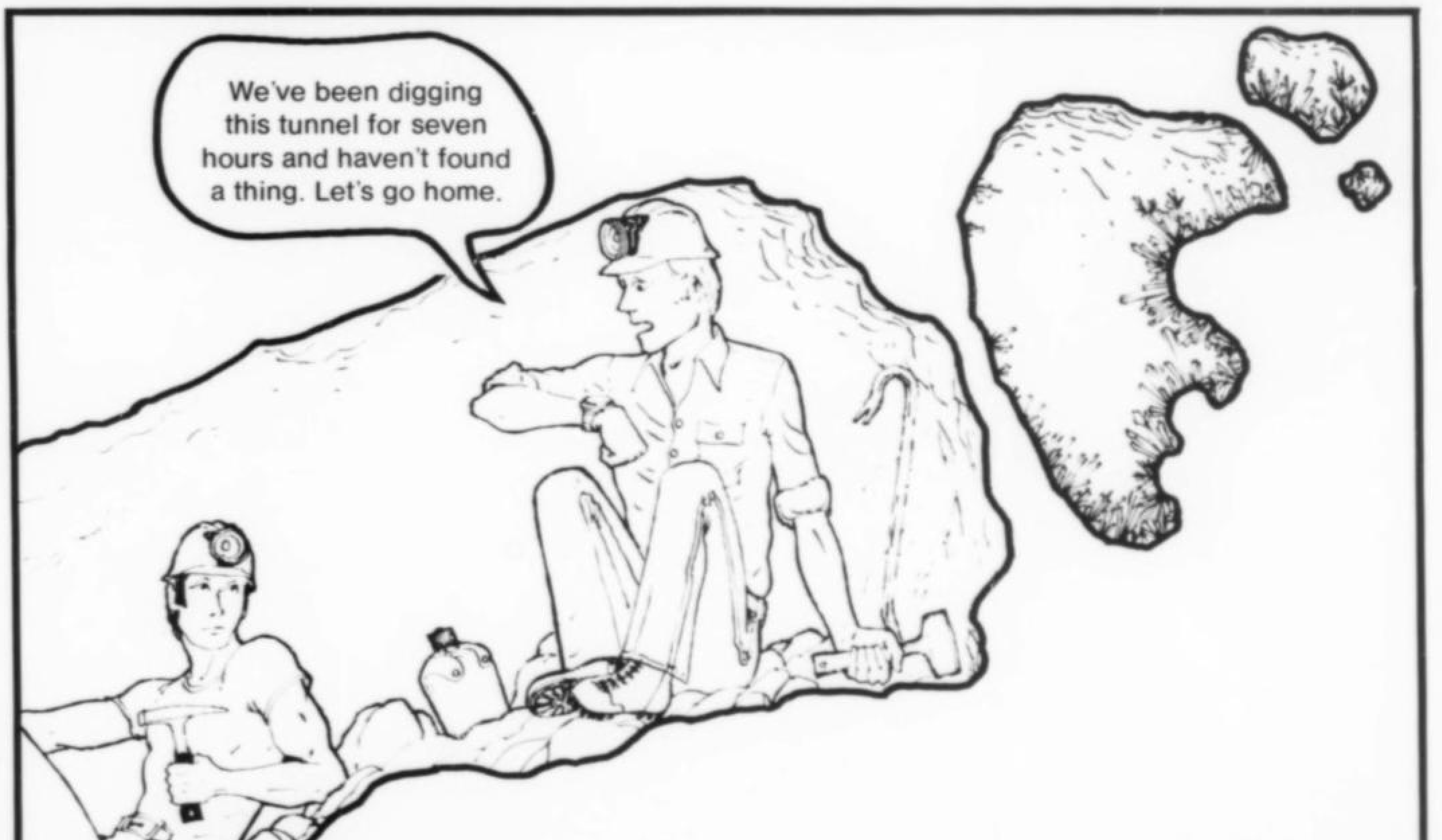
It might be argued that a systematic collection should show representative samples. Why? Does Thomas Hoving, director of the Metropolitan Museum of Art across Central Park from the American Museum, go to bed at night wondering if he has enough "representative" art objects? Does the Tucson Show give an award for Most Representative Display? More important, will the viewer learn more from a lump or from an outstanding example?

The case of large "esthetic" specimens also upset me. It was designed to wow the average viewer, and includes many pieces of the gaudy dog or coffee table variety. But "esthetic" means "of beauty" or "showing good taste", not "dramatic", and the distinction is an important one. This case does not show the finest and most beautiful mineral specimens. It does contain the great kunzite crystal, illustrated in Kunz's book on gemstones of California, and presented to the Museum by J.P. Morgan about 1900. Near it is a lump of prehnite from West Paterson suitable for a doorstop, and a large Japanese stibnite which looks like it was used for one and is now suitable for a boat anchor. A group of large erythrite crystals from Morocco might be fine if two-thirds of it were trimmed off. A large Kongsberg silver is so deeply tarnished and corroded that it looks like a specimen of arborescent coal. In a way, this is the worst case of all, for it betrays the uninformed viewers who will look at such pieces and, trusting the Museum, think they are looking at great mineral specimens. I understand it is a very popular case.

There are great pieces, truly esthectic ones, to be seen, howeve.. There are superb California tourmalines, magnificant, large, flawless Brazilian aquarmarine crystals, fine large Japanese stibnites in the systematic mineral case and in the stibnite case. I am running out of superlatives, but let me list a few more memorable pieces: a large silver with copper in the Michigan copper case, matrix emerald crystals in the gem room (although one met its matrix some time after it was collected), a small Swiss anhydrite crystal like a purple gem, a pair of intergrown four-inch rhodochrosite crystals from Colorado. To the dedicated great-specimen buff, one problem or perhaps challenge of the collection is its varied arrangement. Many species are displayed in three or four different places, and discovering outstanding pieces is a bit like a treasure hunt, with disappointments as well as rewards. I don't know whether there is no fine English bournonite, or whether I just missed it.

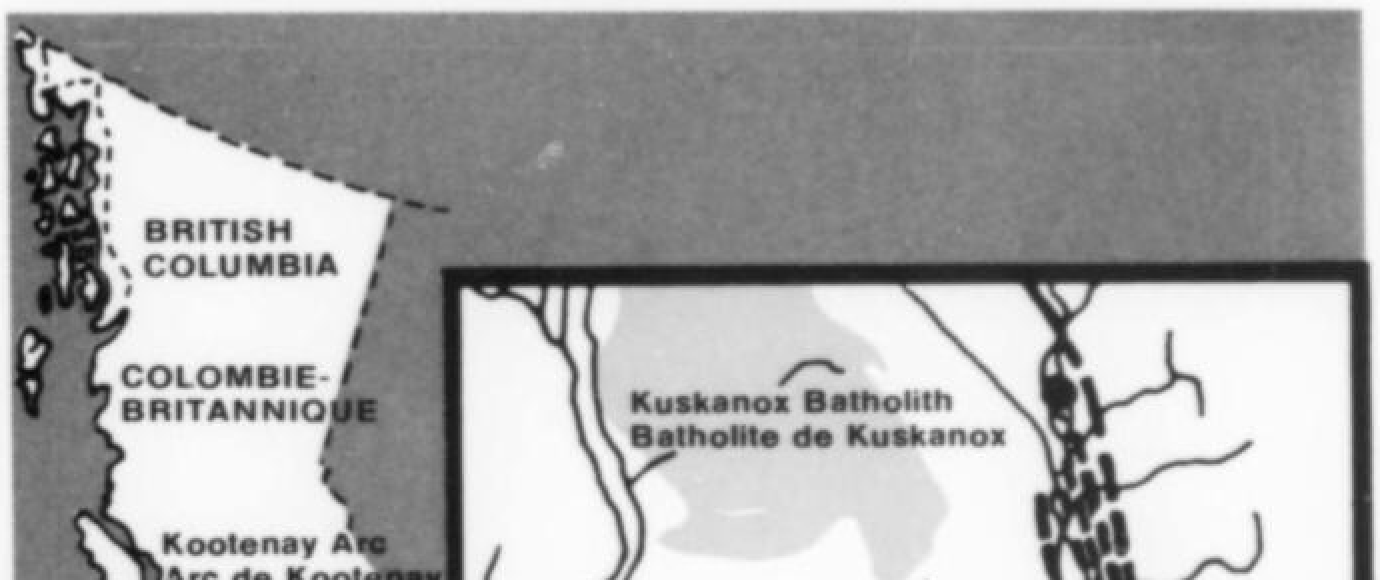
Finally, there does not seem to be provision for showing new acquisitions. Perhaps the Museum is not planning to acquire any more.

Overall, I grade the display somewhere between and A and a D, some of each, in fact, but more A. The room is remarkable, and will give prestige to mineral collecting. Parts of it are very well done and informative. The problems and shortcomings had me collaring innocent viewers to lecture to; some, I am sure, are bewildered by the madman who was in the museum that day. If the Museum does not take the attitude that the display is finished and frozen, much improvement can be made; as it is, the hall contains, along with the cramped gem room and the mistakes and the "representative" pieces, one of the world's great mineral collections. It is a must-see if you are near New York.



THE BLUEBELL MINE

RIONDEL, BRITISH COLUMBIA, CANADA



by J.D. Grice and R.A. Gault   Photographs by J.G. Runnells
National Museums of Canada, National Museum of National Sciences, Mineral Sciences Division, Ottawa, KIA OM8.

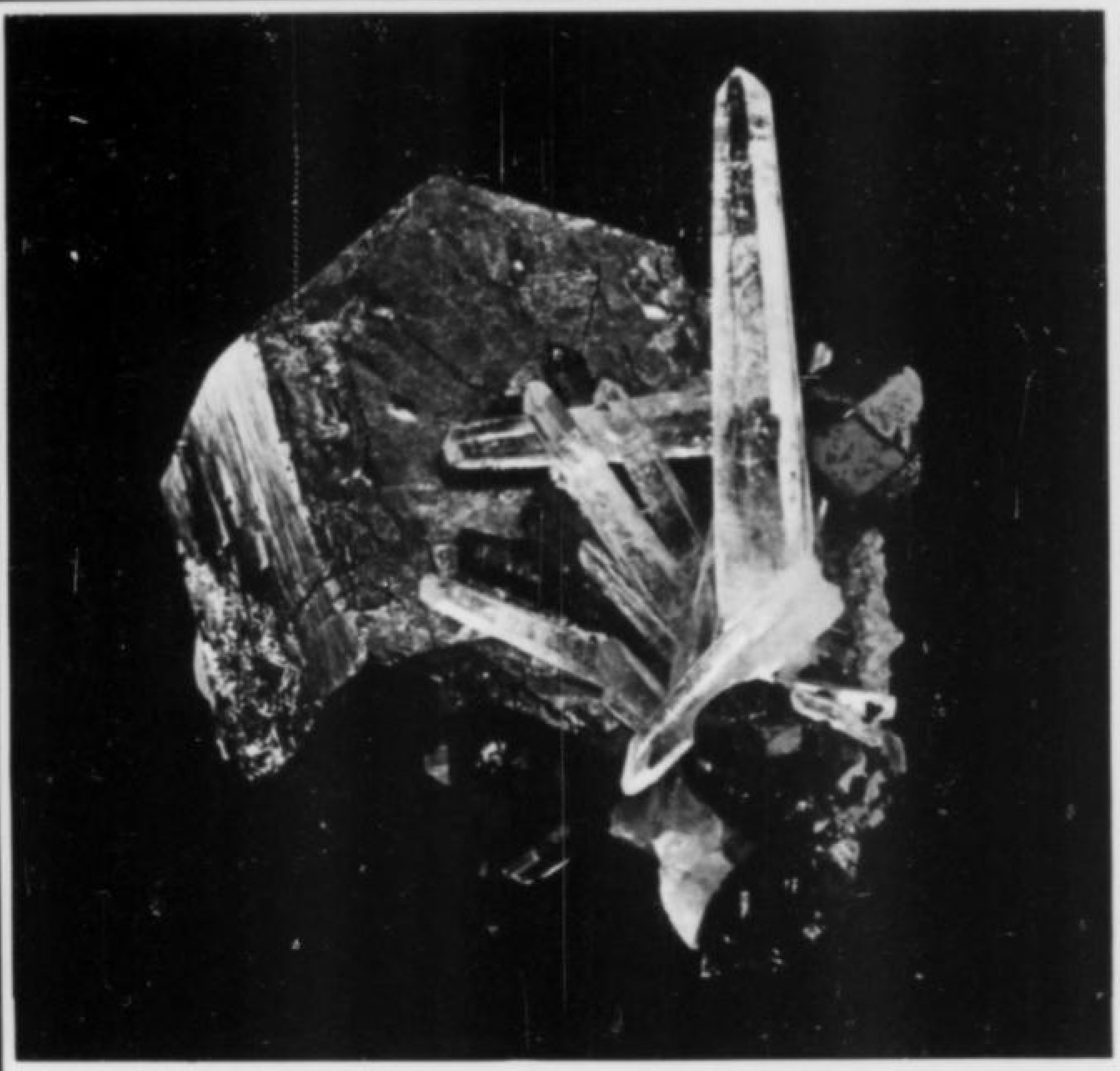


Figure 2. **Pyrrhotite with quartz and sphalerite (specimen no. 30111). Width of specimen as viewed is 3 cm.**

Figure 3. **Calcite with pyrite dusting (specimen no. 31199). Width of specimen as viewed is 18 cm.**

The Bluebell mine prior to its closure in 1971 was one of the major lead-zinc deposits in the province of British Columbia. It is also one of the oldest mines in the province and its early history was described by Walker and Gunning (1928). They reported that the deposit was known to explorers in the early 1800's who taught the Indians the art of making bullets from the lead ore. Old workings on this site are credited to the Hudson's Bay Company but the staking of the property was not completed until 1882 by Robert Evan Sproule. Production of the lead-zinc ore began in 1895 and proceeded intermittently under various owners until 1927 (Irvine, 1957).

Cominco Limited, owners of the mine since 1927, fortunately had the foresight to organize a mineral specimen salvage operation before allowing the underground operations to flood upon closure in 1971. Several Canadian museums and universities were invited to participate in this operation. Through the efforts of Louis Moyd, the National Museums of Canada acquired a large number of specimens. The museums of Canada are indebted to Cominco Limited for this opportunity and we hope that the success of this operation will encourage other mining companies to help preserve similar beautiful and important specimens, not only from mines which are scheduled to close, but also from those still operating.

Several of the photographed specimens will be incorporated into a travelling exhibit on the Bluebell mine which will be shown at a number of the major mineral shows in Canada and the United States beginning with the Greater Detroit Gem and Mineral Show in October, 1976. It is hoped that this brief article will provide readers with information on a little known but interesting mineral locality and will encourage collectors to watch for the exhibit.

General Geology

The Bluebell mine is located on the east shore of Kootenay Lake in southeastern British Columbia (Fig. 1). It was one of several lead-zinc deposits in the Kootenay Arc Formation which extends from Revelstoke, British Columbia, into Washington, Idaho and Montana for a distance of 260 km. The Kootenay Arc consists of a thick series of sedimentary and volcanic rocks of early Cambrian to late Mesozoic age. The most pronounced marker in this sequence (Fig. 1) is the Badshot Limestone in the Lardeau and Kootenay areas and the equivalent Reeves Limestone south of Nelson near Salmo (Fyles, 1970). The Bluebell mine ore occurs as a replacement of this limestone.

Mineralogy

The minerals reported from the Bluebell mine are sphalerite, pyrrhotite, pyrite, arsenopyrite, chalcopyrite, magnetite, calcite, aragonite, rhodochrosite, kutnahorite, siderite, ankerite, gypsum, quartz, manganoan fayalite ("knebelite"), minnesotaite, chlorite, dickite and muscovite. The following mineral descriptions are based on the specimens in the National Collection and therefore do not include all of the above species.

Sphalerite is the principal zinc mineral at the Bluebell mine and occurs in the massive ore with galena. Ohmoto and Rye (1970) reported that the sphalerite contains between 20 and 29 mole percent FeS which makes it very dark in color. It ranges in size from anhedral grains of a few millimetres up to euhedral, bright, stepped crystals of 2 cm. The commonest forms present on the crystals are the positive and negative tetrahedra modified by the cube. The common mineral associations of sphalerite are quartz, calcite, galena, arsenopyrite and pyrrhotite.

Galena, the other major ore mineral, has a large grain size distribution ranging in size from fine grains of a few millimetres up to euhedral crystals and cleavable masses of several centimetres. The better crystals are bright, sharp cubo-octahedra. The cube is the dominant form and these faces are often stepped.

Figure 4. **Quartz group (specimen no. 30232). Width of specimen as viewed is 4 cm.**

Figure 5. **Arsenopyrite rimmed with calcite on galena (specimen no. 31216). Width of larger arsenopyrite is 1 cm.**

Pyrrhotite is the most common sulfide in this deposit. The Bluebell is famous for fine pyrrhotite crystals, specimens of which may be seen in many collections throughout the world. Crystals have been found up to 10 cm in diameter and they are usually bright and lustrous. The dominant forms are the pseudo-hexagonal prism and pinacoid. The monoclinic variety is evident due to its ferromagnetism but without polished sections it is not known whether or not the hexagonal polytype is also present. Associated with brilliant, clear quartz crystals and milky-white calcite, the pyrrhotite is spectacular as one can see in Figure 2. The specimen quality rivals other well-known localities such as Santa Eulalia, Mexico and Trěpca, Yugoslavia.

Pyrite occurs as pseudomorphs after pyrrhotite as well as small cubic crystals of primary origin coexisting with pyrrhotite. Shannon (1970) described the pyrite pseudomorphs as follows: "The sequence of oxidation (of the ore body) appears to be: first pyrrhotite shows tiny fractures coated with a spongy-appearing pyrite. The pyrite gradually encroaches on the pyrrhotite until the pyrrhotite has been converted to lacy or spongy pyrite, which may be associated with unaltered galena, marmatite (sphalerite), arsenopyrite, knebelite (manganoan fayalite) or quartz". The examples in the collection fit this description and consist of hexagonal prisms replaced by "spongy" pyrite. The pseudomorphs may be up to 8 cm in diameter. Also of interest is the fine dusting of pyrite on preferred rhombohedral faces of calcite (Fig. 3.) and small stalactitic coatings on quartz.

Arsenopyrite crystals from the Bluebell mine are exceptional. They resemble the Mexican specimens in form and quality with bright, short prismatic crystals that are deeply striated (Fig. 5). The better crystals are commonly associated with galena, sphalerite and quartz.

Calcite is the most common gangue mineral, and occurs as crystals lining the vugs within the ore body. Only varying habits of the rhombohedral form appear in the National Museum specimens. Sharp, well-formed, rhombohedra to 13 cm were collected (Fig. 3 & 6) but cleavage fragments of much larger crystals were also found. Several clusters of rhombs recovered show a selective overgrowth of tiny bright pyrite cubes and these make particularly handsome specimens (Fig. 3). The flattened rhombohedral habit is more common and the individual rhombs are sometimes stacked vertically, forming unusual stepped aggregates. Some specimens show an oriented overgrowth of flattened rhombohedra on normal rhombohedra giving a somewhat etched appearance to the specimen. The most unusual calcites are the curved composite crystals with habits ranging from saddle-shaped to spheroidal. One particularly exaggerated habit is shown in Figure 7. The most common associated mineral is quartz with which it often combines in exquisite groups. Bluebell mine calcite is translucent white with some manganoan varieties being pale pink.

Rhodochrosite occurs sparingly as microscopic, curved, composite crystals, forming individual, flesh-colored spheres to 8 mm. Bluebell mine rhodochrosite is the ferroan variety (Ohmoto *et al.*, 1970).

Siderite is uncommon and occurs as compact aggregates of microscopic, light brown crystals forming individual spheres to 3 mm. Bluebell mine siderite is manganese rich (Ohmoto *et al.*, 1970).

Aragonite was precipitated during mining operations from hot springs rich in CO_2 occurring in the mine. It crystallized quickly, forming stalactites and large globular masses. Two-centimetre spheres of aragonite (so-called cave pearls) which crystallized about particles of sand were recovered from the floors of the mine drifts. They had been kept in constant motion and thus separated from one another by the continuous vibration of the mining operations.

Gypsum crystals are well-formed but very cloudy due to inclusions. Two habits are present; the most common is the typical tabular habit which occurs as euhedral crystals to 13 cm. Elongated, prismatic crystals with swallow-tail twins to 11 cm also occur.

Quartz, one of the commonest minerals in the Bluebell mine, normally occurs as groups of free-standing crystals and less often as small, doubly-terminated 'floaters'. The large, stubby crystals are often milky but generally the longer, prismatic crystals are clear and brilliant. They form aesthetic, radiating groups (Fig. 4) often in combination with well-formed pyrrhotite, arsenopyrite, sphalerite and calcite crystals. The commonest forms of quartz are present: prism, positive and negative rhombohedra. Crystal size ranges from less than a centimetre to magnificent cabinet specimens with crystals to 30 cm long.

Manganoan fayalite ("knebelite") occurs as dark brown, radiating, tabular crystals in calcite matrix. Blocks of ore-bearing, crystallized limestone containing up to 25% fayalite were recovered.

Paragenesis

Ohmoto *et al*, (1970) divided the mineralogical paragenetic sequence into three periods: Period I, knebelite formation; Period II, deposition of coarse-grained, massive, sulfide-quartz-carbonate ore; Period III, continued crystallization of the Period II minerals in vugs but with quartz and calcite more abundant than pyrrhotite, sphalerite and galena. Ohmoto *et al.* (1970) estimated that vugs occupy about 10% of the ore zone.

The ore is localized along fracture zones as a hydrothermal replacement of limestone. Ohmoto's (1971) study of fluid inclusions and isotopic ratios led him to conclude that the water in the hydrothermal fluid was of meteoric origin and the sulfur and metal were probably derived from sedimentary rocks present above the limestone during Tertiary time. The depth at the time of ore deposition was approximately 6 km and the initial temperature of formation greater than 450°C.

Acknowledgements

The authors would like to thank R.I. Gait of the Royal Ontario Museum, Toronto, for his suggestion of this article and for his critical review of the manuscript. We gratefully acknowledge N. Takeuchi of the National Museums of Canada, Ottawa, for the art work and design of the travelling exhibit of which Figure 1 is a part. Financial assistance was provided by the National Museums of Canada for the color reproduction in this article.

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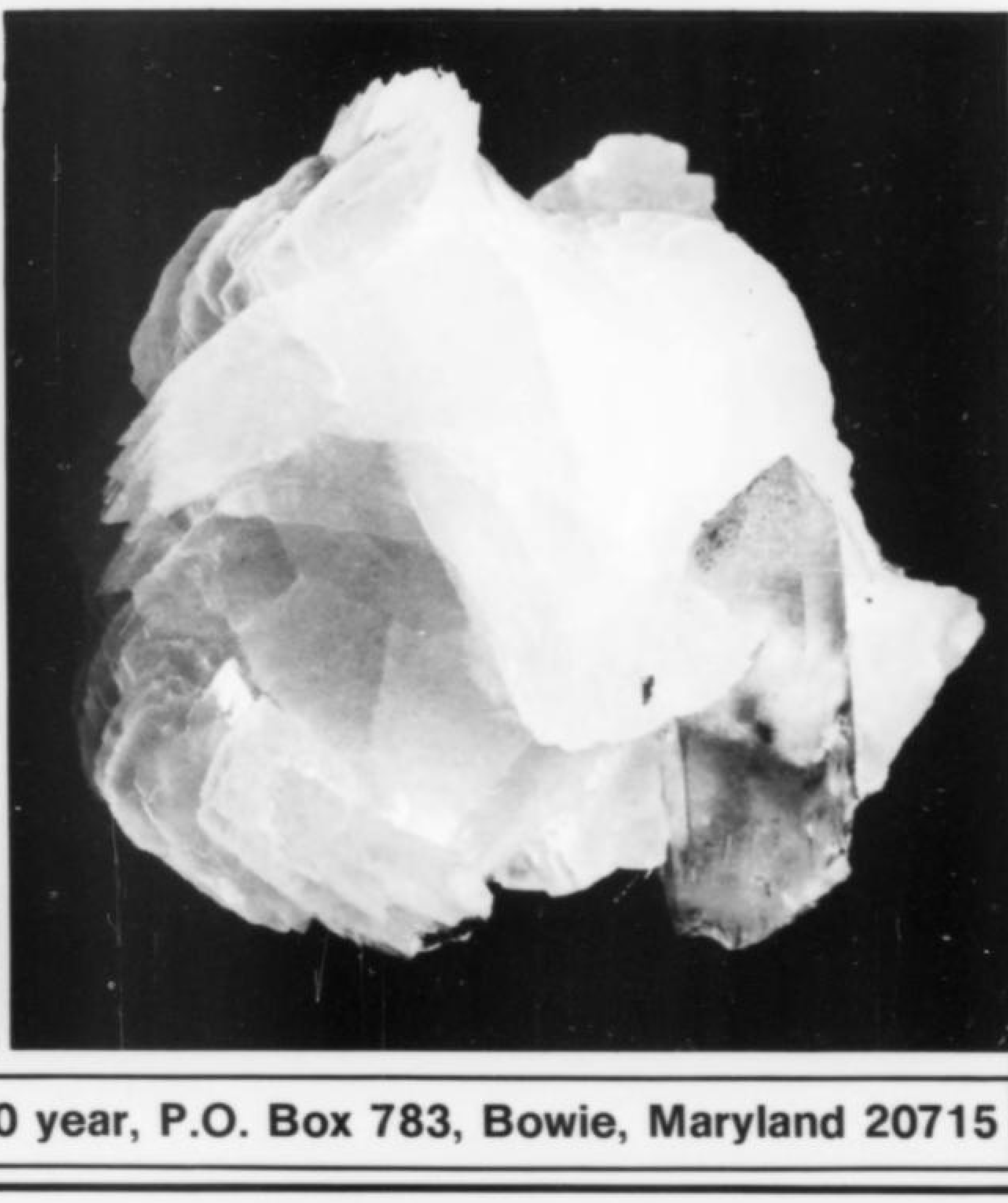
Figure 6. **Cream-colored calcite with colorless quartz (specimen no. 30174). Width of specimen as viewed is 10 cm.**

Figure 7. **Pale pink calcite (specimen no. 31200). Width of specimen as viewed is 6 cm.**



AN EXPERIMENT IN SPECIMEN APPRAISAL

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Dept. of Mineral Sciences
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Photos
By W.E.W.

PART 1

One would think, on an intuitive basis, that if a group of experienced and knowledgeable curators, collectors and dealers independently appraised each specimen in a collection they would arrive at remarkably similar figures. We thought the same thing, and decided to test this hypothesis. The results, we thought, were a foregone conclusion, but the statistical proof would be new and interesting.

The following experiment was devised to test the hypothesis that experienced value judges will consistently and closely agree. Ten specimens from the collections of the National Museum of Natural History (Smithsonian Institution) were placed on display at mineral shows and in the Smithsonian offices where guests could view them. Selected people were asked to independently assign dollar values to these pieces. All of these people were either collectors, dealers or curators. An attempt was made to include a large proportion of highly experienced, qualified appraisers, but we purposely included some inexperienced people as well. Naturally we "knew" that those in the former category would be remarkably consistent, and those in the latter category remarkably erratic. Imagine our shock when the resulting data annihilated all of our premises!

Before discussing the data, we would like to invite readers to test their own expertise in the appraisal of mineral specimens. The ten specimens are pictured here; write down your estimate of a reasonable retail value for each of the ten pieces shown (or simply make a wild guess) just as if you were thinking of buying or selling the specimens yourself. Then compare your appraisals with those of this article on page 48.

This survey was conducted over three years ago, and repeated recently, so perhaps you will wish to make two estimates for each specimen: one for its 1976 value and one for its 1972 value.

The specimens were chosen to provide a spectrum of values and types, from an exquisite California gold to a relatively common Vera Cruz amethyst. The selection includes species often found on the current market, and items almost never seen for sale.

Carefully consider the sizes and colors indicated when making your appraisals. **Then read Part II beginning on page 47.**

Figure 1. Quartz, **variety amethyst, from Las Vigas, Vera Cruz, Mexico. The crystals have purple tips of good color and the large crystal is doubly terminated. Specimen height: 9.3 cm.**

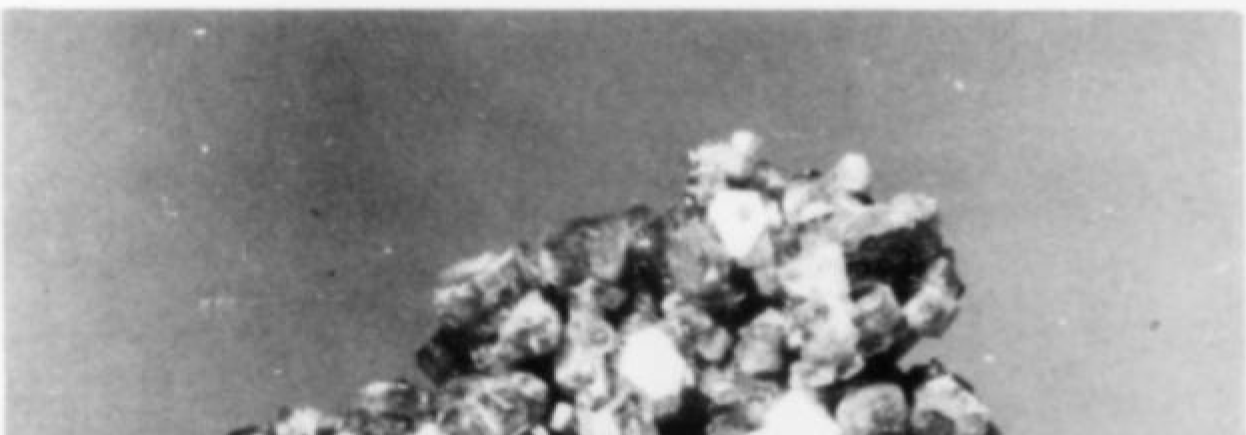

Figure 2. Vanadinite**, from the Old Yuma mine, Pima County, Arizona. Rich orange red. Specimen height: 7.0 cm.**

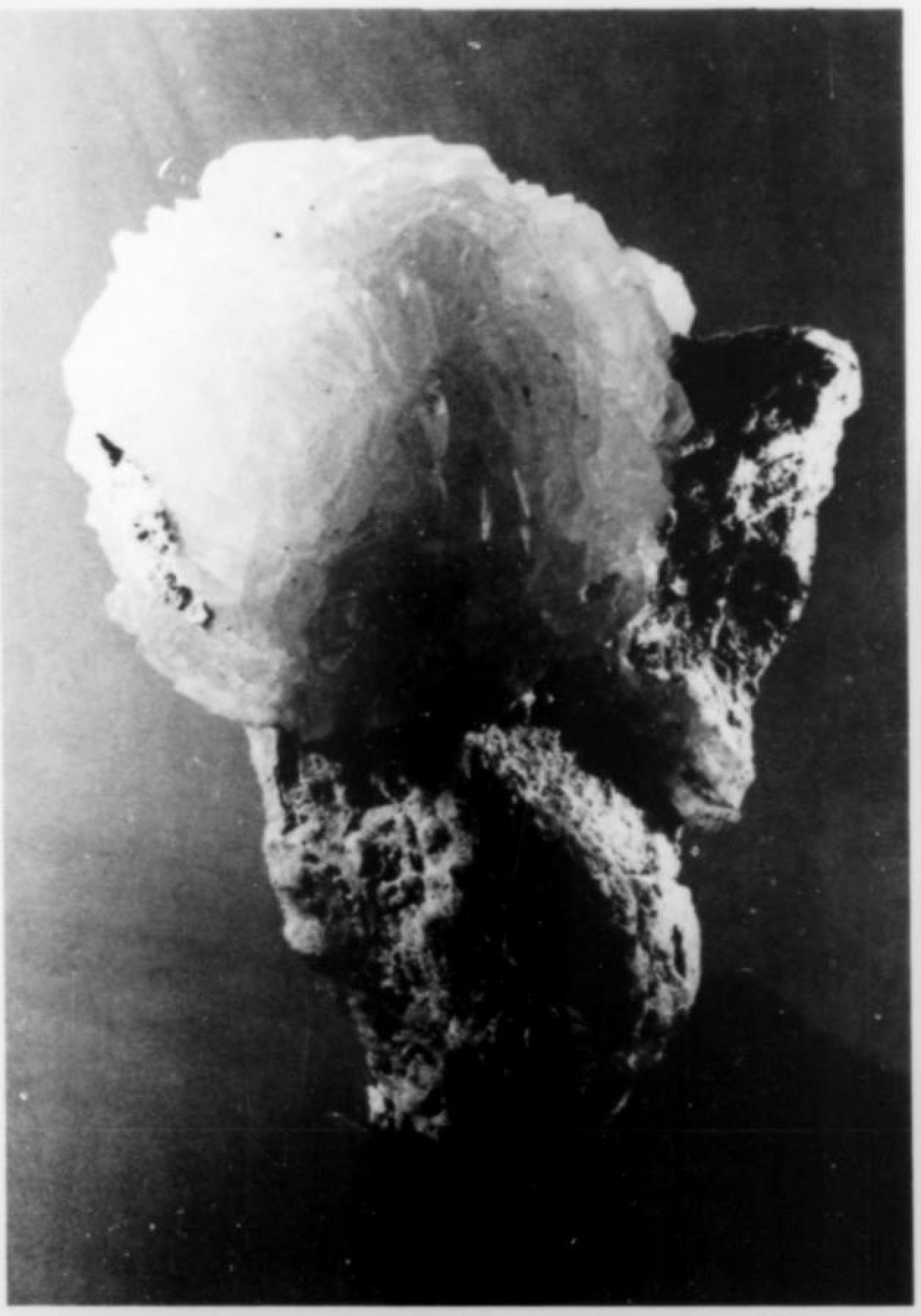

Figure 3. (left) Brucite, from Wood's Chrome mine, Lancaster County, Texas. Very pale green color. Specimen height: 7.3 cm.
Figure 4. (below) Apophyllite, from Poona, India. Medium lime-green; not as darkly colored as the darkest pieces from India, but still an attractive green. Specimen height: 4.5 cm.

Figure 5, (above) Fluorapatite with quartz, from Panasqueira. Portugal. Pale green. Specimen height: 6.0 cm.
Figure 6. (right) Epidote from Knappenwand, Untersulzbachtal, near Salzberg, Austria. Greenish black. Specimen height: 6.7 cm.

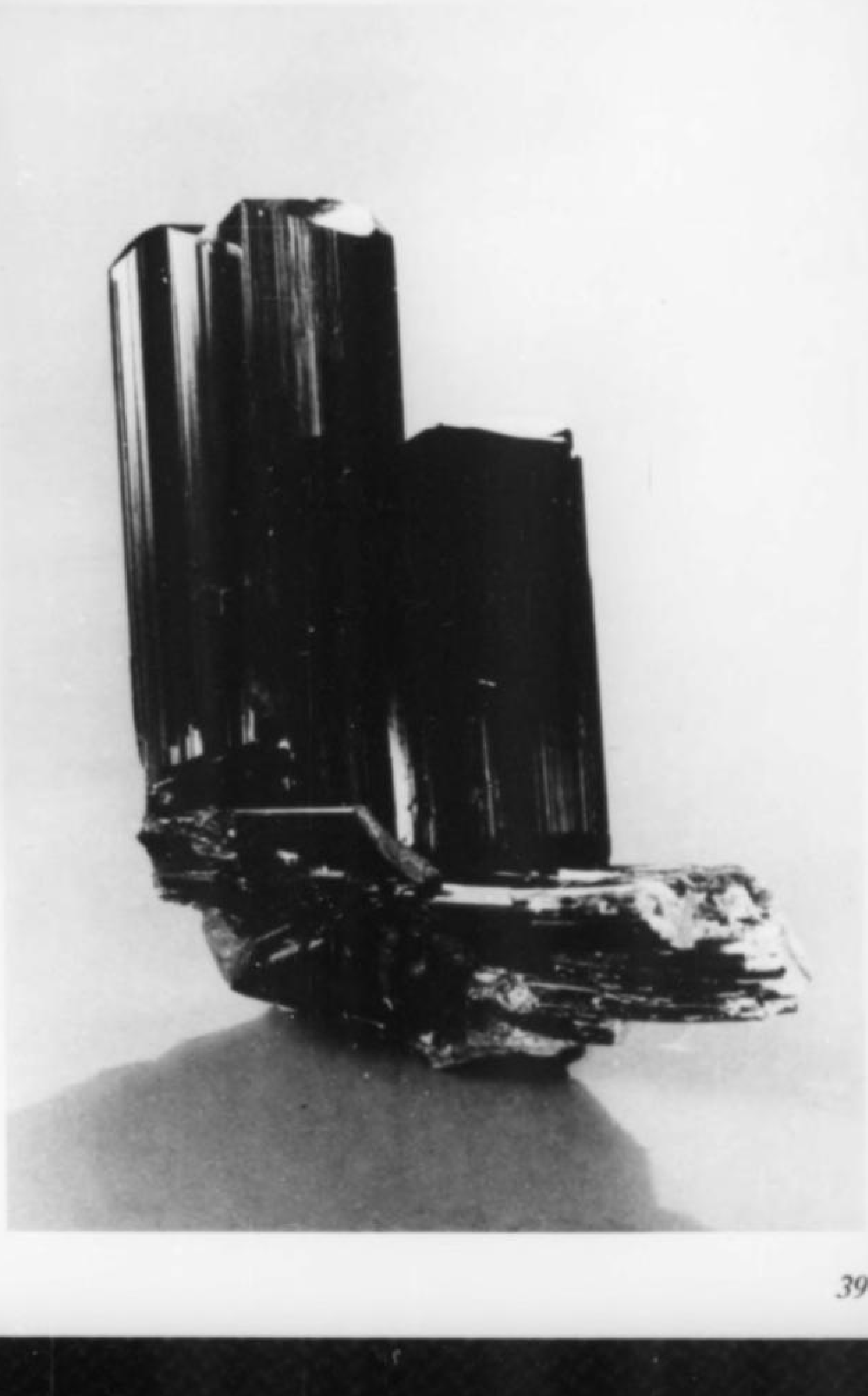

Figure 7. (below) Mimetite, from Tsumeb, Southwest Africa. Very pale yellow. Specimen height: 5.7 cm.

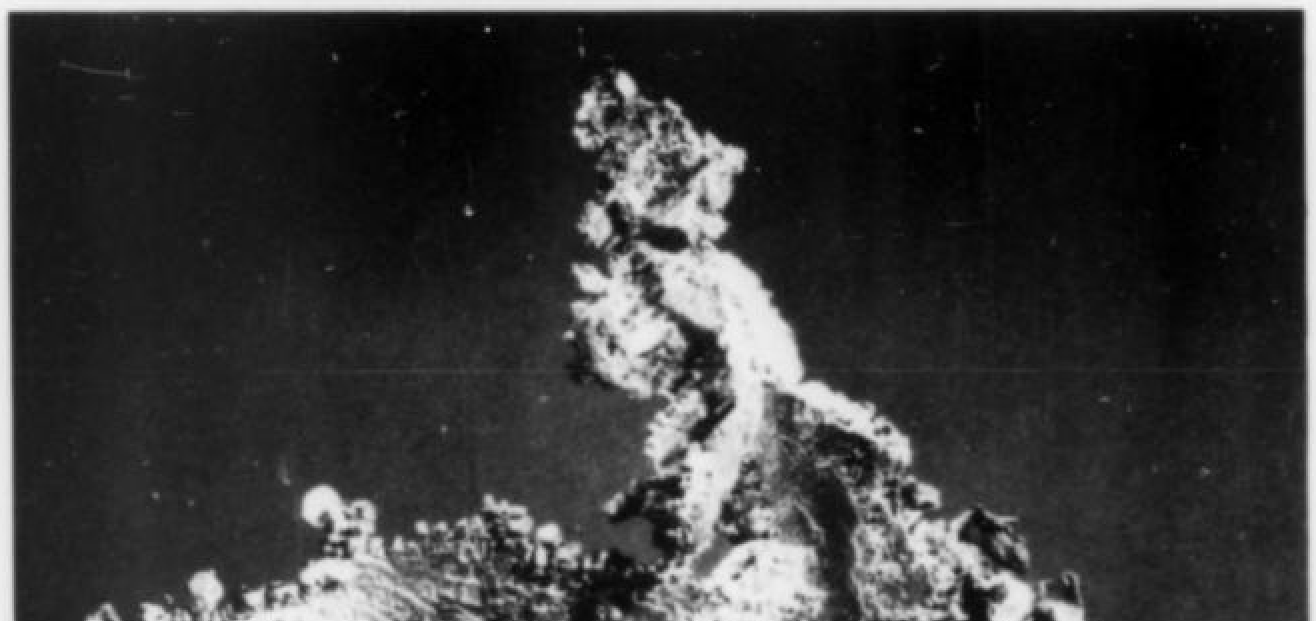

Figure 8. (top right) Bournonite, from Horhausen, Westerwald, Germany. Repaired, but a good job. Specimen height: 5.5 cm.
Figure 9. (left) Azurite, from Tsumeb, Southwest Africa. Black with blue internal reflections. Specimen height: 8.5 cm.
Figure 10. (above) Gold, from Grass Valley, California. Rich yellow. Specimen width: 8.0 cm.

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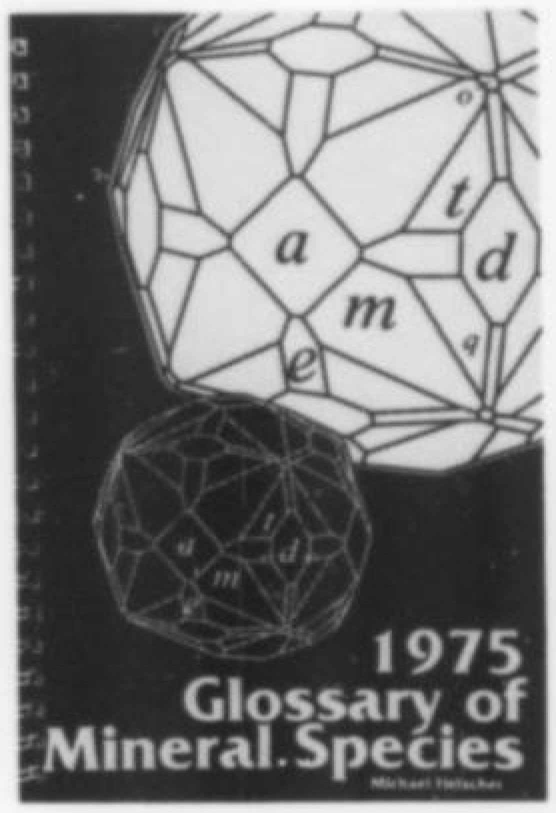

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Mining Claims for the Mineral Collector

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

Figure 1. **A mining claim corner post, typical of thousands throughout the western United States**

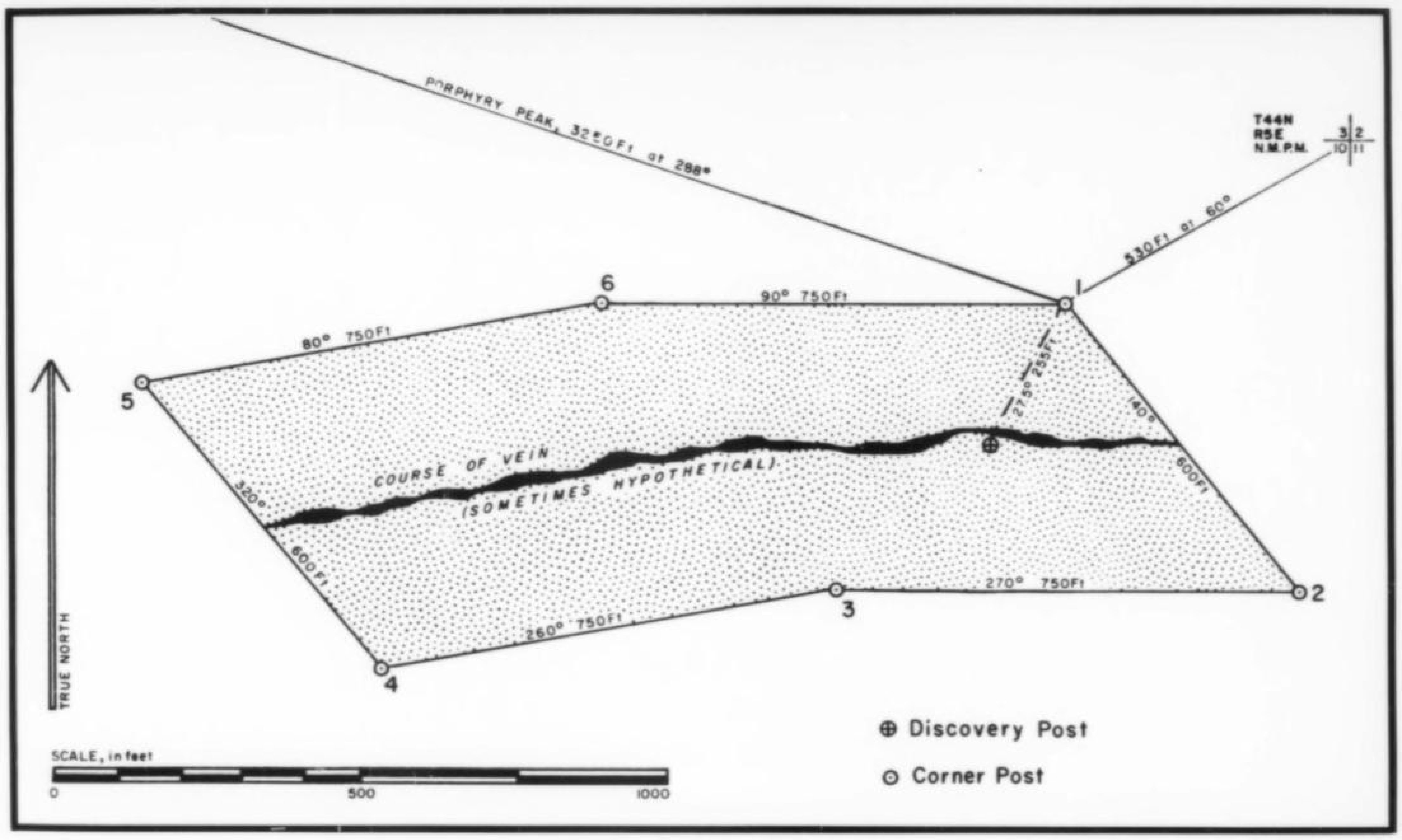
The Mining Law of 1872 rose out of the mists of primate territoriality. Early prospectors on the Mother Lode country of California found gold, but whose gold was it? Usually the gold went to the person who could possess the land on which it was found. But possession became a complicated and sometimes dangerous task for men who were mainly interested in mining. Eventually, the Federal Government of the United States gained control of lands in the West. With the land came the minerals and the Federal Government was then in a position to grant mineral rights to individuals. The Mining Law of 1872 provided the procedure.

At the present time, the lands on which an individual may claim minerals are known as public domain lands and are administered primarily by the Bureau of Land Management and the National Forest Service. The Law of 1872 does not allow people to claim minerals on privately owned land and on Federal lands which have been excluded from mineral location (National Parks, National Monuments, Indian Reservations, Military Reservations, most reclamation projects, scientific test areas, and some wildlife protection areas). The administrations of the Bureau of Land Management (BLM) and the Forest Service withdraw additional public lands from mineral location from time to time.

The Mining Law of 1872 is simple in theory, but has become rather complex in application. Originally intended as "an Act to promote the development of mining resources of the United States", it was expansionist in philosophy and granted many liberties to the individual. Since its passing, it has been limited by other legislation. Oil and gas, oil shale, potash, sodium, native asphalt, solid and semi-solid bitumen, bituminous rock, phosphate, coal, and sulfur in Louisiana and New Mexico, as well as all minerals in certain other lands, cannot be claimed and must be leased from the Federal Government under the terms of the Leasing Act of 1920. The Materials Sale Act of 1947 prevented the location of mining claims for sand, stone, gravel, pumice, pumicite, cinders, clay, petrified wood, and, I suspect, agate and jasper. These materials are to be purchased at fair market value from the Federal Government. In the Act of July 23, 1955, the Federal Government distinguished between surface and subsurface rights, took control of the management of surface rights such as timber and soil, and to a large degree regulated how mining could be done. Finally, the Wilderness Act of 1964 closed Wilderness areas to mineral location after 1983 and prevented the use of motorized equipment in Wilderness areas.

The idea of a mining claim for mineral specimens would probably get a snicker from a hard-rock miner, but if the sale of the specimens brings in more money than the cost of operating the "mine", it is a mining claim that even the mythical "prudent man" would find valuable. The basic problem for the authorities is that they must, from lack of experience, treat the novel idea of a specimen claim as they have treated claims in the past — with estimates of value in terms of tons of ore at a certain grade. But who has been able to estimate the value of specimens in a deposit? Who has tried?

Contests to a claim's validity will come from three quarters: the Federal Government, other mining companies, and mineral collectors. The Federal Government may be answered by the "prudent man" argument (see Thomssen, 1971) and the fact that the claims are for minerals, not for a summer homesite or other prohibited use. Mining companies interested in the area covered by a specimen claim will be interested in more than the specimens, which would indicate the claims are valuable for more than the specimens. And other collectors, when confronted with a claim on a mineral locality, must recognize that the person who staked the claim has more right to the minerals than *they* have.



The Claim

There are four types of mining claims: lode claims, placer claims, mill-site claims, and tunnel-site claims. The lode claim is the most common mining claim and will be discussed in detail below. The placer claim is used on alluvial deposits, particularly placer gold deposits, and grants no rights to minerals below the soil. The mill-site claim is a plot of ground with no mineral value which is appropriated for use in the erection of a mill for the processing of ore. The tunnel-site claim is a variation on the lode claim and can be used to reserve mineral rights on a 3000-foot by 3000-foot area, but its application is rather sophisticated.

A valid mining claim can only be made by a citizen of the United States, or by someone who has declared his intention to become a citizen, on ground that is unowned and unclaimed. The best place to determine the ownership of a particular portion of ground is to check with the BLM or Forest Service. If the maps on file show that the land is unowned, you may then check if it is unclaimed. The best place to check this is on the ground; walk around checking for claim posts (figure 1) or discovery monuments (figure 4). *If no posts or monuments can be found, there is no valid claim*, and you may proceed to stake your own claim. If there are posts, you should be able to find a discovery monument or a notice of location, and from these you can determine either the name of the claim or the name of the locator. Armed with this bit of information, you can go to the county clerk and recorders' office and, by checking the records, determine if the claim is still valid. If the claim is good, you may still be able to negotiate with the owner for specimen rights. If the claim is not valid, you may "jump" the claim by staking your own.

Your lode mining claim gives you the exclusive rights to the minerals within the boundaries of your claim (figure 2). The Law of 1872 also gives you the right to follow a well-defined vein *outside* the side-lines of your claim, provided that the vein apexes (surfaces) within your claim boundaries. The claim dimensions are a maximum of 1500-feet by 600-feet and contain an area of 20 acres. An individual may stake an unlimited number of lode claims, though overdoing it may result in close scrutiny of your work. Groups of tens of claims are not uncommon, though someone recently aroused Federal ire when he staked thousands of claims in several western states.

Filed for record the ___ day of ___ A. D. 19__ at ___ o'clock __ M. ___ RECORDER
Reception No. ___ By ___ DEPUTY

STATE OF COLORADO,
County of Saguache } ss. **Know all Men by these Presents,**

That Edwin R. Collector

the undersigned, has, this 15th day of April, 1976, located and claimed, and by these presents does locate and claim, by right of discovery and location, in compliance with the Mining Acts of Congress, approved May 10, 1872, and all subsequent acts, and with local customs, laws and regulations, 1500 linear feet and horizontal measurement on the SPECIMEN Lode, vein, ledge or deposit, along the vein thereof, with all its dips, angles and variations, as allowed by law, together with 300 feet on the North side, and 300 feet on the South side of the middle of said vein, at the surface, so far as can be determined from present developments; and all veins, lodes, ledges or deposits and surface ground within the lines of said claim, 300 feet running East from position of discovery post and 1200 feet running West from position of discovery post; said discovery post being situate upon said lode, vein, ledge or deposit, and within the lines of said claim, in Cochetopa Mining District, County of Saguache and State of Colorado, described by metes and bounds as follows, to-wit:

Beginning at corner No. 1, which is the northeast corner, and is located 225 feet at a bearing of 27.5° from the location of the discovery post; thence 600 feet at a bearing of 140° to corner number 2; thence 750 feet at a bearing of 270° to corner number 3; thence 750 feet at a bearing of 260° to corner number 4; thence 600 feet at a bearing of 320° to corner number 5; thence 750 feet at a bearing of 80° to corner number 6; thence 750 feet at a bearing of 90° to corner number 1, which is the point of origin.

From corner number 1, it is 530 feet at a bearing of 60° to the common corner of sections 2,3,10,and 11, Township 44 North, Range 5 East, New Mexico Principal Meridian; and 3250 feet at a bearing of 288° to the summit of Porphyry Peak.

Said lode was discovered on the 14th day of April, A. D. 1976
Date of location 15th April A. D. 1976
Date of Certificate 15th April A. D. 1976

Edwin R. Collector [SEAL]
Edwin R. Collector
[SEAL]
[SEAL]
[SEAL]
[SEAL]
[SEAL]

152 LOCATION CERTIFICATE LODE CLAIM

Figure 2. (top) **A map of the SPECIMEN Lode Mining Claim**

Figure 3. **The Location Certificate describing the SPECIMEN Lode Mining Claim**

The Paperwork

A valid mining claim must be described by a location certificate. The certificate, when properly completed, provides the following information:

1. The date of location of the claim
2. The name of the locator or locators
3. The name of the claim
4. The distance claimed along the vein and on each side of the vein
5. Some tie of the discovery monument or a corner to legal land survey (township) corners or to prominent landmarks
6. A description of the boundaries of the claim by metes and bounds

Any paper which gives this information is adequate, but convenient location certificate and location notice forms are usually available at county clerk and recorders' offices. Figure 3 is an example of a completed location certificate for a claim in Colorado. The information on a location *notice* is essentially the same as that on the location *certificate*.

Figure 4. **Placing the Location Certificate in a can on the Discovery Post or Monument**

The Ground Work

The most important feature of a lode mining claim is the discovery monument; it is required in all states. The term *monument* is rather grandiose—a post with an attached tin-can is the usual form that the monument takes (see figure 4). The purpose of the monument is to mark the site of the mineral discovery and to provide a description of the claim for anyone who is interested. While the law generally requires a mineral discovery for each claim, modern expedience has made this unnecessary. This is particularly evident in the case of large blocks of claims located in anticipation of finding a huge disseminated orebody. Surface indications of mineralization are sometimes absent, but the claims must be staked in order to protect a future discovery. The second function of the monument, that of an information center, is very important. Location certificates are placed at the monument, in tobacco cans, plastic vials, jars, tin-cans, or occasionally, devious traps designed to lacerate the fingers of the curious. The location certificate shown in figure 3 could have been found in the discovery monument of the claim illustrated in figure 2.

Once the discovery monument is in place and the location certificate is recorded, the claim has been made. It then remains to post the notice of location, and to mark the corners of the claim with posts or stone cairns. The number and placement of the corners, as well as the deadline for marking corners varies with the state in which the claim is located. The marking requirements and deadlines are summarized in figure 5; the information therein has been provided by the Owens Surveying Outfit.

If only one claim is being staked, the locations of the corners need not be exact—a compass-and-pace survey is adequate. If more than one claim is being located, a more accurate survey is needed to prevent "fractions" of unclaimed ground from appearing between the claims when later, more accurate, surveys are made. In any case, it is generally wise to stake undersized claims to allow for minor errors.

The amount of work, in addition to the above, required to validate a claim varies from state to state, from nothing to several hundred dollars' worth. The formerly required discovery pit is now becoming unnecessary. In some cases substitute work has been required; in others, the need for "discovery" work has been dropped.

Keeping The Claim

Once a claim has been staked, annual labor must be done to hold the claim and to protect it from claim jumpers. A claim owner is required to do $100 worth of work each year on each claim he owns. This can simply be work involved in extracting minerals, or it can be geologic, geophysical or geochemical surveys of the property, road construction, or any number of things. The owner must go to the county courthouse each year and sign an affadivit that he has, in fact, done this amount of work on his claim. It is interesting to note that, in these inflationary times, less work is needed each year to hold a claim.

A procedure which was commonly used in the past, but which is becoming difficult now, is to "**patent**" a claim. This involves doing the equivalent of five-years' annual labor, having a survey made, and paying an additional $500 for title to the surface and minerals on the claim. This land could then be bought and sold like a piece of real estate. Even now the mineral rights (but not the surface rights) of an unpatented lode mining claim can be bought, sold and inherited.

At a few places in the United States, mining claims are subject to taxation. This has its advantages and disadvantages, but these are beyond the scope of this article. But it is worth noting that if the taxes are based on the acreage of land claimed, it may be worthwhile to reduce the claim to a minimum size.

A final difficulty in keeping a claim is the possibility of an ad-

STATE	DISCOVERY	LOCATION WORK RECORDED	SET CORNERS	NO. OF CORNERS	END CTR. OR SIDE CTR.	RECORD CLAIMS	* FEE	REMARKS	ASSESSMENT RECORDED
ALASKA	None required	90 days	Immediately	4	N/A	90 days	$ 2.25	Post notice @ NE cor. Mark side lines	90 days after September 1
ARIZONA	Drilling**	120 days	90 days	6	end ctr.	90 days	$ 2.00		90 days after September 1.
CALIFORNIA	None required	None	90 days	6	end ctr	90 days	*		30 days after September 1.
COLORADO	Claim map, etc.	N/A	Before filing	6	side ctr.	90 days	$ 2.00		180 days after September 1.
IDAHO	None required	90 days	Immediately	4	N/A	90 days	$ 2.00		60 days after September 1.
MONTANA	None required	N/A	30 days	4	N/A	60 days	$ 2.00		90 days after September 1.
NEVADA	None required	N/A	20 days	6	side ctr.	90 days	$15.00	File claim map within 90 days	60 days after completion of work
NEW MEXICO	Drilling**	90 days	90 days	4	N/A	90 days	$ 2.00		60 days after September 1.
OREGON	None required	N/A	30 days	6	end ctr.	60 days	$ 3.50		within 30 days after annual record. date.
UTAH	None required	30 days	30 days	4	N/A	30 days	$ 2.00		30 days after September 1.
WASHINGTON	None required	N/A	90 days	4	N/A	90 days	$ 2.00		30 days after September 1.
WYOMING	Drilling**	60 days	60 days	6	side ctr.	60 days	$ 3.00		60 days after September 1.

NOTE: The number of days in respective columns for location work, set corners and record claims – refer to after the date of discovery.

*Varies in different counties. The above information was extracted from the respective State Land Offices.

**It must be demonstrated by *samples* that there are valuable minerals on the claim. Drilling *can* be used, but admissable samples can also be obtained from an outcrop, trench, or prospect pit.

Figure 5. **Requirements for Lode Mining Claims in various western states (Table courtesy ofThe Owens Surveying Outfit)**

verse claim – a claim on your ground by another individual. If you have properly staked the claim, done and recorded your annual labor, and paid any taxes on the claim, there should be no problem. There would be a problem, of course, if the other party can prove he was there before you by indicating the position of his discovery monument and claim corners on the ground, and his location certificate and affidavits of labor at the courthouse. It is always a good idea to go over the ground you are claiming to insure that someone else isn't there, and to check the courthouse records with care. In some rare cases, careful research can allow the acquisition of an abandoned mine for the nominal expense of staking a claim.

Summary of a Successful Claim

As a summary of the article, and a checklist for anyone who may be staking a claim, the following list is included. To stake a valid claim:

1. determine the general area of interest and check with the BLM or Forest Service to be sure the land is open to claiming.
2. check the ground for evidence of other claims, and if needed, follow this up with a check at the county clerk and recorders' office. While there pick up copies of blank location notices.
3. post your discovery monument.
4. record your location certificate.
5. post your notice of location and mark the boundaries of your claim.
6. do the required validation work, if any.
7. do and record your annual labor on the claim.

If this sounds impossibly complicated, it is well to remember that the Law of 1872 was designed to convey mineral rights to the prospectors of the late nineteenth century. By and large, these were not highly educated fellows, and problems you have in claim staking can generally be solved by removing the veneer of modern legal jargon. In fact, minor errors in staking may be ironed out by filing an amended location certificate, if necessary.

A mining claim is a realistic way to gain control of minerals on the public domain. I hope that the readers of this article use their power wisely, to gain *both* economic and scientific returns from a mineral deposit. In this way the use of mining claims can be compatible with the goals of locality preservation.

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AN EXPERIMENT IN SPECIMEN APPRAISAL PART 2

(Continued From Page 40)

The results of our two appraisal tests are given in Table 1. The first appraisal was concluded in October of 1972; the repeat was concluded, for the most part, in April of 1976. Although somewhat fewer appraisers were involved the second time (22 vs. 27 the first time), the relative proportion of dealers to collectors and curators was about the same. Many, though not all, of the people in the first test were involved in the second test, but none were told the test would be repeated; it is fairly safe to assume that they could not remember or be influenced by their own 1972 estimates when they repeated the appraisal in 1976.

One may well ask whether this data has any meaning at all. Specifically, what *is* the *true* price of a specimen? In reality, a successful selling price is a function of time; a low price (relative to what most people would expect for a particular specimen) results in a quick sale whereas a higher price for the same piece can result in a long, difficult sale. Remember that $1000 may seem a "low" price for certain fine specimens whereas $10 might seem too high for lesser pieces. The higher a particular specimen is priced, the fewer people there will be who would be willing to pay that price for that specimen. The fewer the potential buyers, the longer it takes to find one of them. So we must define a "reasonable retail price" as the price at which the specimen would sell in a reasonable period of time, or after exposure to a reasonable number of people (see editorial, v. 7, n. 6). We feel the average of all the appraisals for a given piece probably best approximates a reasonable retail price, and therefore *is* meaningful; one should bear in mind, however, that it might be quite possible for a piece to sell at a higher price if the seller has more than average patience.

While not what we expected, the data are nevertheless very interesting. The first column (A) lists the averages of all of the appraisals for each specimen during each of the two appraisal periods. These are the figures with which you will want to compare your own estimates. But if you are not too close to these figures, don't feel bad. The second and third columns list the averages of the highest and lowest appraisals. For example, for the 27 appraisers in the first test we averaged the lowest seven appraisals (column B) and the highest seven appraisals (column C). The range was far wider than we expected, indicating that even experts cannot closely agree. The next column gives the actual highest and lowest appraisals for each piece.

We separated the curators and collectors (buyers) from the dealers (sellers) to see if their appraisals differed significantly; they did. In general each group seems to have been influenced by some wishful thinking. The dealers' estimates of the "selling prices" were higher than the collectors' and curators' estimates of the "buying prices," probably similar in concept to the "bid" and "asked" prices of the stock market. There were some exceptions, but in general the dealers' appraisals were higher. However, different criteria may be in use by the two groups; perhaps the dealers have special customers already willing to pay a premium for such specimens that collectors and curators would normally be unwilling to pay. For example, at the *Mineralogical Record* mineral auction every year, dealers routinely outbid the collectors present!

In one statistical test on the first appraisal the experts were divided into two groups: those with more than twenty years of experience and those with less. Neither group showed a clear-cut superiority. In fact, one appraiser had virtually no experience in the buying or selling of fine specimens and yet his appraisals were excellent. Apparently accuracy of judgement requires considerably less than twenty years to acquire, if indeed it ever *can* be acquired.

Some specimens were more difficult for the appraisers to evaluate than others, and their appraisals, in general, have become significantly more erratic since the 1972 test. The column labelled C-B/A might be illustrated by a simple case. Suppose only four appraisers are involved; C is the highest appraisal of the four, and B is the lowest. These two extremes are compared to the average of all four appraisals (A). It appears that in 1972 the highest and lowest estimates of only four people were likely to differ by an amount about equal to the full average value of the specimen! For example, if the average value were $200, the estimates were likely to range from $100 to $300...a sizeable spread. But by 1976 the situation had become even worse; the difference between the highest and lowest of four estimates was liable to be nearly *twice* the "actual" value of the piece! If the value were $200, the estimates might run from $50 to $400.

In a similar test we rated each appraisal according to the ratio of the appraisal to the average of all appraisals for the specimen, dividing the lower value into the higher. For example, a guess of $50 compared to the actual average of $100 would be considered off by a factor of two. A guess of $200 on the same $100 piece would also be considered off by a factor of two. Summing the ratios for the ten appraisals given by each person, we obtained a measure of each person's accuracy relative to the grand average. Richard Bideaux was the winner in 1972, and Victor Yount was the winner in the recent test. Vic's average appraisal was off by a factor of only 1.4 (1.0 would be a perfect score). The 22 appraisers in the recent test, as a whole, were off by an average factor of 2.05. You may compare your own estimates to these scores obtained by the experts. The most inaccurate appraiser was off by a factor of 3.01.

Using the same ratios as above, we summed the ratios for each of the 22 appraisals for each specimen to obtain a measure of the trouble appraisers had with each piece. The average values are listed under the column labelled "difficulty". The most difficult pieces to assess were the apatite and brucite; the easiest were the amethyst, vanadinite and bournonite.

Values have definitely tended to increase significantly, even though they are poorly defined. Only the Old Yuma vanadinite lost value, probably due to the influx of fine Moroccan vanadinite. The others performed extremely well, from an investment standpoint; on the other hand, people who dread the increase in mineral prices might not be as pleased as the investor. It is clearly one of those situations to which you can either point with pride or view with alarm. The last columns indicate the *yearly* appreciation (or "interest rate") for each specimen and the total appreciation over the entire 3.4 year period. Even though this is an exceptionally fine selection of specimens, we think the near tripling of the total value during only 3.4 years is phenomenal, and may be the most significant finding of this experiment.

Perhaps other inferences may be drawn from the data, but we will leave them to readers. Only three conclusions seem relatively safe: (1) experts are in poor agreement on the value of specimens, (2) they are getting poorer, and (3) mineral values for specimens like these are definitely rising at a significant rate. One should not view mineral prices as absolutes; they will be debatable at least within a range of from one half to twice the price listed on the label or suggested by a buyer or seller.

ACKNOWLEDGMENTS

Our thanks to all of the people who took part in this study. We hope to repeat the appraisal of the ten Smithsonian specimens at 3-year intervals in the future, thereby providing a unique look at the long-range trend of mineral prices.

Table 1. Appraisal statistics

SPECIMEN	APPRAISAL DATE*	(A) AVG. OF ALL APPRAISALS	(B) AVG. OF LOWEST 1/4 of APPRAISALS	(C) AVG. OF HIGHEST 1/4 of APPRAISALS	ACTUAL RANGE	AVG. OF CURATORS AD COLLECTORS APPRAISALS	AVG. OF DEALER APPRAISALS	DIFFICULTY	(C-B)/A	APPROXIMATE AVG. **YEARLY** APPRECIATION, 1972 TO 1976, **	3½-YEAR APPRECIATION
AMETHYST	1972	$104	$ 90	$175	$35-225	$107	$100	1.77	0.82	29%	**114%**
	1976	223	91	413	75-700	202	240		1.44		
VANADINITE	1972	127	110	130	40-325	127	130	1.77	0.16	-1%	**-4%**
	1976	122	59	225	30-400	120	124		1.36		
APATITE	1972	425	310	530	125-1100	452	395	2.46	0.52	14%	**59%**
	1976	675	171	1475	125-2500	545	783		1.93		
BRUCITE	1972	325	170	500	50-1000	242	400	2.41	1.02	16%	**66%**
	1976	541	158	1142	50-1250	370	683		1.82		
APOPHYLLITE	1972	370	190	530	50-1200	222	510	2.03	0.92	17%	**73%**
	1976	640	242	1292	125-1800	698	629		1.62		
EPIDOTE	1972	795	470	1420	200-1750	629	945	2.38	1.19	31%	**149%**
	1976	1977	583	4167	250-4000	2090	1883		1.81		
MIMETITE	1972	805	390	1400	150-2500	666	935	2.38	1.25	48%	**298%**
	1976	3204	917	6917	500-10000	3035	3346		1.87		
BOURNONITE	1972	835	500	1150	100-2500	632	1020	1.73	0.78	21%	**89%**
	1976	1582	667	2700	450-3000	1525	1629		1.29		
AZURITE	1972	1735	1020	2635	750-5000	1281	2160	1.83	0.93	42%	**235%**
	1976	5809	2600	9917	750-12000	5775	5838		1.26		
GOLD	1972	2340	1105	3815	425-6000	1748	2885	1.78	1.16	40%	**219%**
	1976	7457	3008	12667	1550-15000	7555	7375		1.30		
TOTALS	1972	7560					MEANS:	2.05		37%	**194%**
	1976	22230									

*The 1972 appraisers included 14 dealers, 9 collectors and 4 curators; the 1976 appraisers included 12 dealers, 5 collectors and 5 curators.

**For example, if a specimen doubled in value in 3.4 years, it would have appreciated at a rate of about 22% *per year*. Over the *entire period* it would have appreciated by 100%.

Letters

INFORMATION EXCHANGE

Dear sir,

Would an "information exchange" column be useful or of general interest? Everyone has his or her own ideas about mounting, labelling, storing, cataloging, or arranging minerals for display. **Not** everyone wants to follow the cut-and-dried Federation rules, and there are certainly some interesting and original ideas among our readers which could be shared in this way. There are also probably many ingenious but unpublished aids to identification, such as homemade spectroscopes or polariscopes made from commonly available materials.

Mrs. Steven W. Cares
Sudbury, Mass.

Our letters column is already available for this type of material. Readers need not restrict themselves to commenting only on previously published items.

Ed.

EXCHANGES

Dear sir,

I have fine Spanish specimens, 2 X 2 to 5 X 5 inches, that I will exchange for fine worldwide minerals. Good quality only.

Manuel Borrás
Royo, 21
Zaragoza – 6, Spain

Dear sir,

I have good cabinet specimens to trade for micromount material, expecially from European locations. A detailed list of available material can be supplied to interested parties, together with photographs of rarer specimens.

M. Hollands
88 Weldrick Rd.
Richmond Hill
Ontario L4C-3T8 Canada

Dear sir,

I do not understand why it is easier to get trading partners with overseas collectors than with people here. I have some pieces of museum quality celestine available to exchange for similar quality material. Any U.S. collectors interested in trading via mail are welcome to contact me. I am willing to trade "locally."

Henry H. Fisher
4636 Dundee Ave.
Columbus, Ohio 43227

COORDINATED COVERS?

Dear sir,

How come the photos on the covers of your issues have nothing to do with the text inside?

Chris Korpi
Cypress, CA

The reason is that the plates (color separations) for covers must be made four-at-a-time to save money. When we have a small backlog of articles we often have no idea of what kinds of articles will be in issues six or eight months off. Even when articles are promised, we do not wish to put authors on the spot by giving such an inflexible deadline as would be required when covers are made before articles are finished. However, we currently have a rather large backlog of excellent articles, and this has enabled us to coordinate four out of the next five covers with articles inside the issues. We will attempt to do this as much as possible in the future.

Ed.

AN ANTIQUE COLLECTION?

Dear sir,

Recently I acquired an old, boxed mineral collection. The wooden box is 7½ inches deep, has a sliding wooden top and compartments for 25 specimens. The label on the box reads:

MINERALOGY set No 203
for young people
Collection No II
2nd Grade
Prepared by
G. Guttenberg
Teacher of Natural Sciences
Erie High School, Erie, Pa.

Can any of your readers determine the date of this set or any background information on Guttenberg?

Donald C. Fish
Frederick, Maryland

COMMENTS ON THE SEPTEMBER – OCTOBER ISSUE

Dear sir,

Congratulations on the September-October issue. My mouth is still hanging open even though I have thumbed through it several times already today. For some reason the particular articles in this issue were quite relaxing to read and seemed to be very worthwhile with respect to the information contained.

Robert B. Cook, Jr.
Auburn, Alabama

Dear sir,

Too many pictures of "man holding rock" but otherwise a beautiful issue; Dick Gaines' article on beryl was especially interesting.

Pete Dunn
Lanham, Maryland

Rather than reprint the large number of letters we received on this issue, I can summarize by saying that we have received about 25-30 very positive replies and three somewhat negative replies. On the negative side, two of the three said the overall technical level was too light, two of the three said there was too much of a commercial emphasis. In general, however, the response by mail and from the people I spoke with at the Detroit Show was overwhelmingly positive. More responses, positive or negative, to anything we publish will be welcomed.

Ed.

ROCK'S ROCKS

Dear sir,

Rock Currier's article on Indian zeolites was not only interesting and informative; it was, for me, a trip down memory lane for it was I who sold Rock the stilbite "bow-tie" pictured in figure 10 of his article (v. 7, n. 5, p. 254).

This specimen was part of a small lot of zeolites I purchased around 1972 and, contrary to Rock's statement, it was not the best one. The best specimen, in my opinion, is in my collection and it was once photographed by Rock; it beats me as to how he could forget it so quickly.

Joe Polityka
Brooklyn, New York

Rock said in the caption that he had not been able to find a better one ***in India****; I'm sure he remembered yours.*

Ed.

THE PALA AD

Dear sir,

The Collector (Pala Properties) ad in v. 7, n. 5, is proof positive that quality advertising in full color can add to the quality and attractiveness of its vehicle (*M.R.*) and also be effective. It does justice to beautiful minerals.

Dan Libeg
Pocatello, Idaho

According to Pala Properties, the ad has indeed been effective. Even here at ***M.R.*** *we have received almost as many compliments on that ad as we have for the rest of that issue: much of the credit must go to Harold Van Pelt, Los Angeles, for superb photographs.*

Ed.

FAN MAIL

Dear sir,

I received my first issue of the Record (Sept.-Oct.) recently. I want to tell you that it is the best magazine associated with minerals; I can't understand you being in financial trouble.

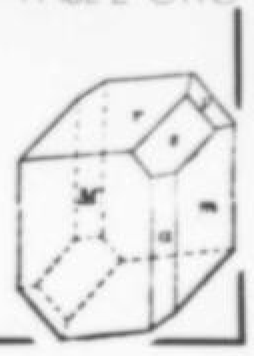
Louis Curinka
Melrose Park, Illinois

Dear Sir,

Just thought I would drop you a note of appreciation and renew my subscription. I am a professional geologist and have been a mineral collector for 15 years. I find most of the technical publications for mineralogy very dull. My father is an amateur lapidary and gets a few of the more popular lapidary magazines. I find the mineral articles in them to be more on the order of "*look look see the rock*". The *Record* fills a large gulf between the two and I hope it continues. Another thing I like is that all of your advertisements are placed so as not to interfere with the articles. So many of the lapidary magazines stick them everywhere so that neatly copying a good article (should one come along) is impossible.

Keep up the good work.

John W. Hopkins
Knoxville, Tennessee



MORPHOLOGY AND OCCURRENCE OF BOLIVIAN CASSITERITE

by Robert B. Cook, Department of Geology
Auburn University, Auburn, Alabama 36830

INTRODUCTION

Cassiterite is one of the few select mineral species that both brings fire to the eyes of collectors and causes crystallographers to lose sleep. Very few relatively common ore minerals can compare with cassiterite's beauty and crystal perfection, romance and intrigue of occurrence, and difficulty of specimen acquisition. As an economic geologist and mineralogist, I have often wondered why good specimens of this mineral were so difficult to acquire, particularly in view of the high annual world tin production and the desirability of cassiterite to collectors and researchers. The purpose of this article is to present a comprehensive overview of the relationships between the paragenesis and crystallography of cassiterite as well as descriptions and locations for Bolivia's most interesting tin occurrences.

The extensive Bolivian tin belt encompasses a generally north-south, 800 kilometre-long zone occupying the western part of the country from the Peruvian border immediately east of Lake Titicaca south to Argentina. Most of the more than 600 known tin deposits are generally confined to the eastern arm of the Andean Cordillera. Deposits in the northern part of the tin belt are veins and pegmatites generally related to major batholithic plutons while those in the central and southern portions are more complex vein systems related to major tectonic features (Ahlfeld, 1954). Intensity of mineralization seems to reach a maximum between Oruro and Potosi, gradually diminishing both to the north and south.

The major mining centers of Oruro, Viloco, Caracoles, Huanuni, Llallagua*, and Potosi are of relatively easy access from LaPaz by medium-duty paved and dirt roads. Routes to the mines at Viloco and Caracoles offer the visitor some of the most spectacular mountainous and glacial scenery in the western hemisphere. All major mines operated by COMIBOL, the national mining group, require identification and statement of purpose at guard houses along all roads entering the camps.

The geology and mineralogy of Bolivian cassiterite deposits suggest a wide range in chemical, pressure, and temperature conditions, and possibly depth of formation. Ahlfeld (1954) has ably described the various characteristics of Bolivian cassiterite occurrences in terms of mineralogy, physical characteristics, and relationships of deposits to enclosing host rocks, and has classified these deposits within the classical framework presented by Lindgren (1913). Occurrences vary throughout the paragenetic spectrum, from pegmatitic cassiterite deposits emplaced at very high pressure and temperature to xenothermal deposits formed at very shallow depth under moderate to low temperature and moderate to atmospheric pressure.

In his many years studying the Bolivian tin deposits, Ahlfeld noted an apparent change in cassiterite morphology relative to the apparent conditions of ore deposition as indicated by various geologic and mineralogic criteria. Five specific cassiterite morphological types were identified, ranging from simple bipyramidal crystals associated with pegmatites, to highly twinned forms in pneumatolitic and high temperature veins, through prismatic varieties characteristic of moderate to low temperature and pressure environments, and finally cryptocrystalline and colloidal cassiterite produced either by primary or supergene processes (Table 1). This apparent paragenetically dictated trend forms the basis and format for the following sections.

MORPHOLOGY AND OCCURRENCE

Type-1 Cassiterite

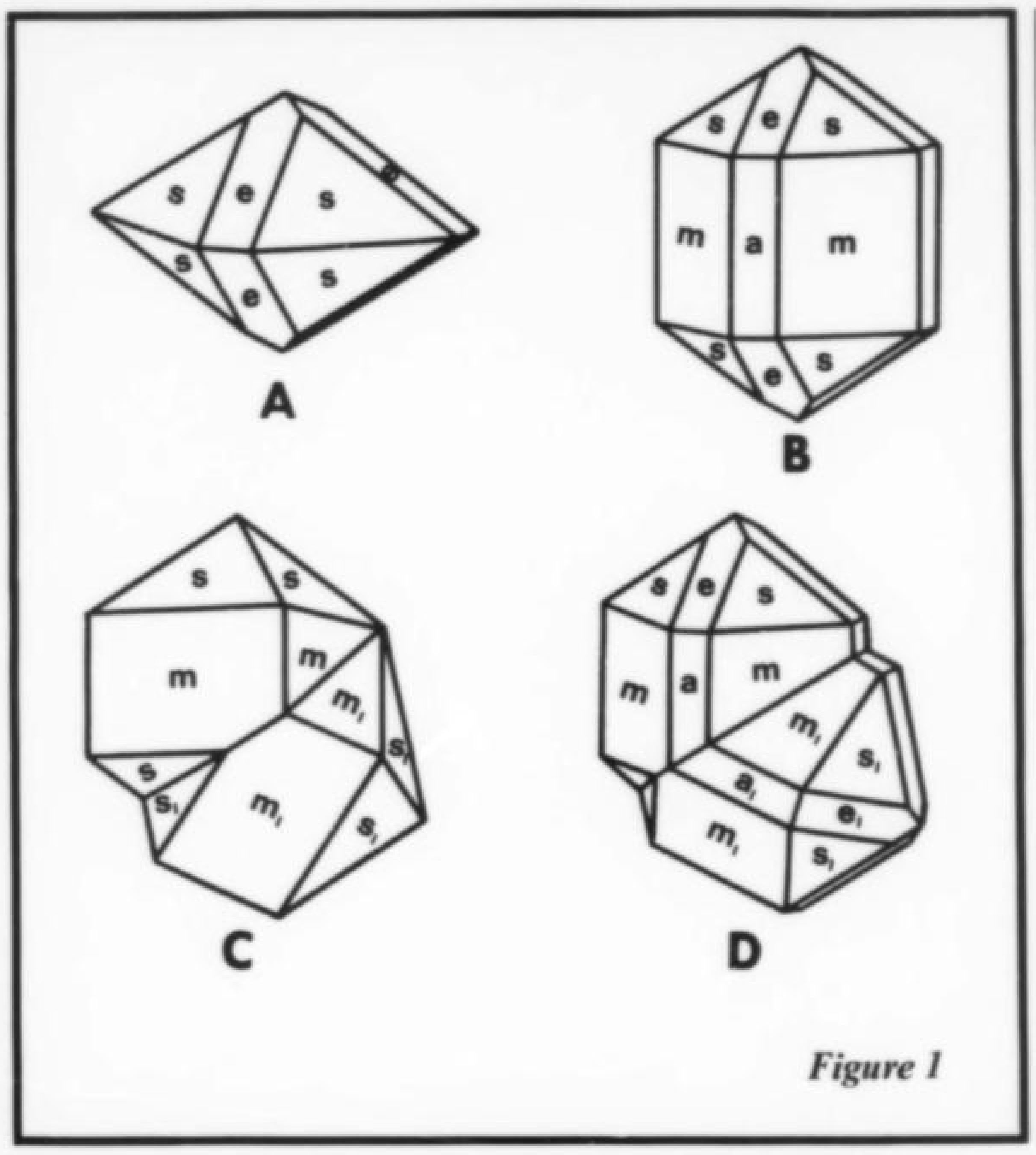
Type-1 cassiterite, exhibiting predominantly bipyramidal forms (Figure 1A), is restricted in Bolivia, as elsewhere, to pegmatites. Cassiterite of pegmatitic origin contributes only a very small percentage of Bolivia's total tin output. Perhaps the largest and best known pegmatitic cassiterite occurrence is that developed in the Fabulosa mine on the eastern flanks of the Cordillera Real in Larecaga Province, Department of LaPaz. The deposit is adjacent to the margin of the Sorata Batholith near the southeastern end of the central portion of the pluton, on the headwaters of the Challana River. Bipyramidal cassiterite crystals exhibiting both first and second order pyramids occur in, and adjacent to, the quartz core. Crystals are typically rather poorly developed, reddish to dark brown in color, and locally coated with muscovite and molybdenite. Quite large zoned crystals reaching 15 cm in diameter are locally abundant (Ahlfeld, 1954). Associated minerals are triphylite, triplite, lazulite, vivianite, molybdenite, chalcopyrite, pyrrhotite, arsenopyrite, pyrite, black sphalerite, and stannite.

Similar pegmatitic cassiterite has been exploited from time to time at the Fortaleza and Fenomenal prospects, approximately 15 kilometres to the southeast of the Fabulosa mine, near the headwaters of the Coscapa River.

Type-2 Cassiterite

With respect to the sheer volume of exquisite, multiply twinned, type-2 cassiterite crystals, no location in the world can compare with the famous mines originally known as Araca. This name generally refers to veins formerly exploited by La Empresa Minera de Araca, in what is now the Viloco district, originally a part of the Patiño group. The Viloco district occupies an area of approximately 5 square kilometres situated along the western margin of the Quimsa Cruz Batholith, approximately 7 hours by road south of LaPaz. While the district is of relatively easy access, a very good map or guide is necessary to arrive at the desired location. Scenery is beautifully rugged with the numerous mines and prospects draped along the flanks of steep glacial valleys and within cirques in terrain where road elevations locally exceed 5,100 km (17,000 feet). The mining camp itself is somewhat primitive with no accomodations except those occasionally furnished by COMIBOL. Specimens are infrequently encountered in the currently operating portions of the deposits, although they can be obtained periodically from various company personnel. Officials in this district are exceptionally courteous to those having specific reasons for being there. Expect discomfort from lack of oxygen, particularly during the

* Readers unfamiliar with Spanish should note that the double-l (**ll**) is always pronounced like a **y**,e.g. "ya-ya-gua" for Llallagua. Ed.



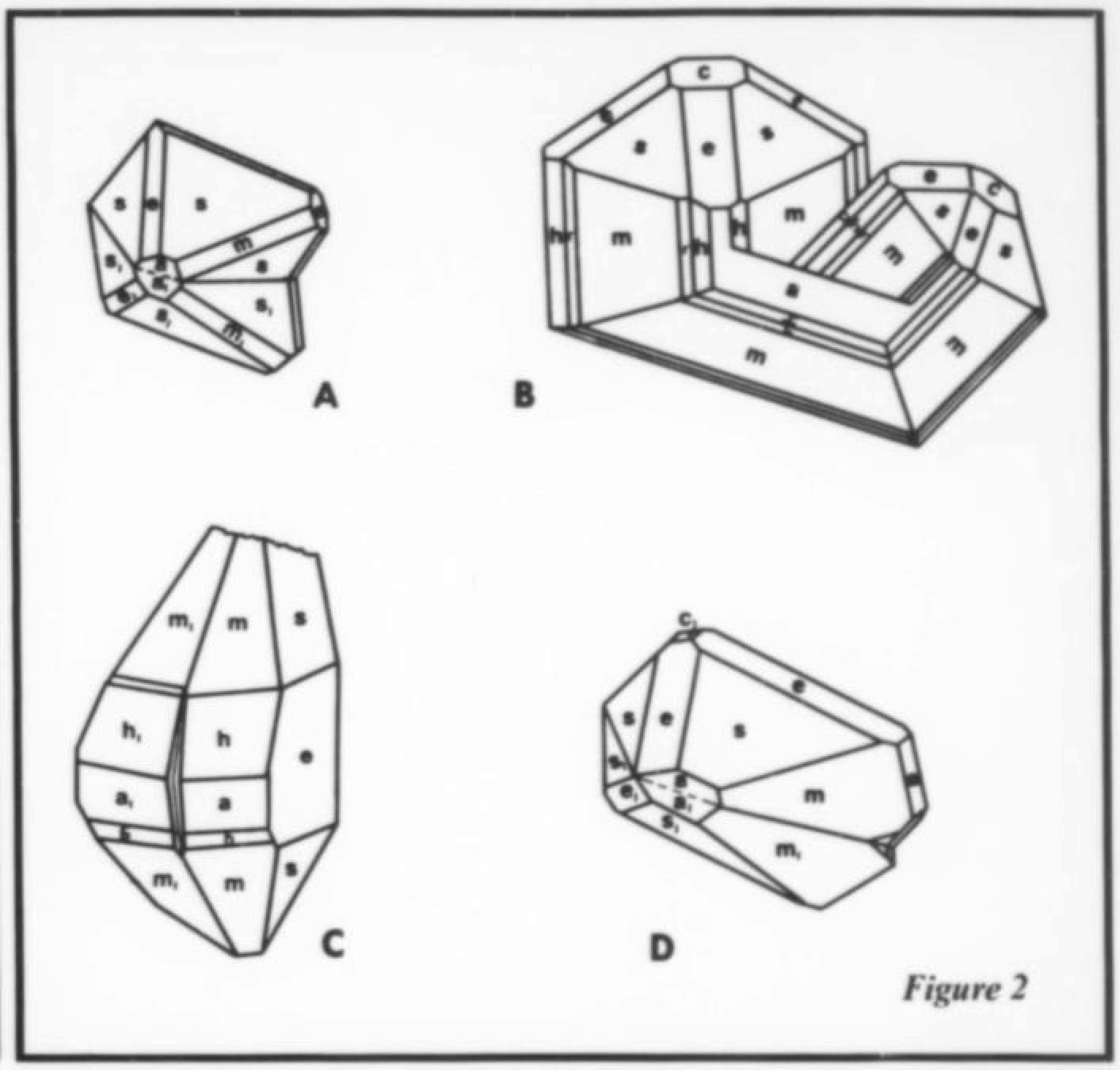


Figure 1. ***A.*** **Simple type-1 bipyramidal cassiterite crystal exhibiting s{111} and e{011} forms [from Dana (1892)].** ***B.*** **Simple prismatic crystal exhibiting 1st and 2nd order pyramids and prisms [from Brauns (1912)].** ***C.*** **Simple twin on e(011) exhibiting only first order prisms (m) and pyramids (s) [from Brauns (1912)].** ***D.*** **Simple twin on e(011) exhibiting both first and second order prisms (m and a) and pyramids (s and e) [from Dana (1892)].**

Figure 2. **Type-2 twinned cassiterite characteristic of Viloco.** ***A.*** **Twin on e(011) with extreme development of s{111} faces [from Dana (1892)].** ***B.*** **Complex cyclical twin exhibiting dominant development of 1st order prisms and pyramids modified by h{210} and r{320} prisms, and c{001} pinacoid [from Gordon (1924)].** ***C.*** **Simple twin on e(011) exhibiting unusual development of h{210} [from Hielmeier (1930)].** ***D.*** **Simple twin on e(011) exhibiting approximately equal development of the 1st order prism and pyramid [from Gordon (1924)].**

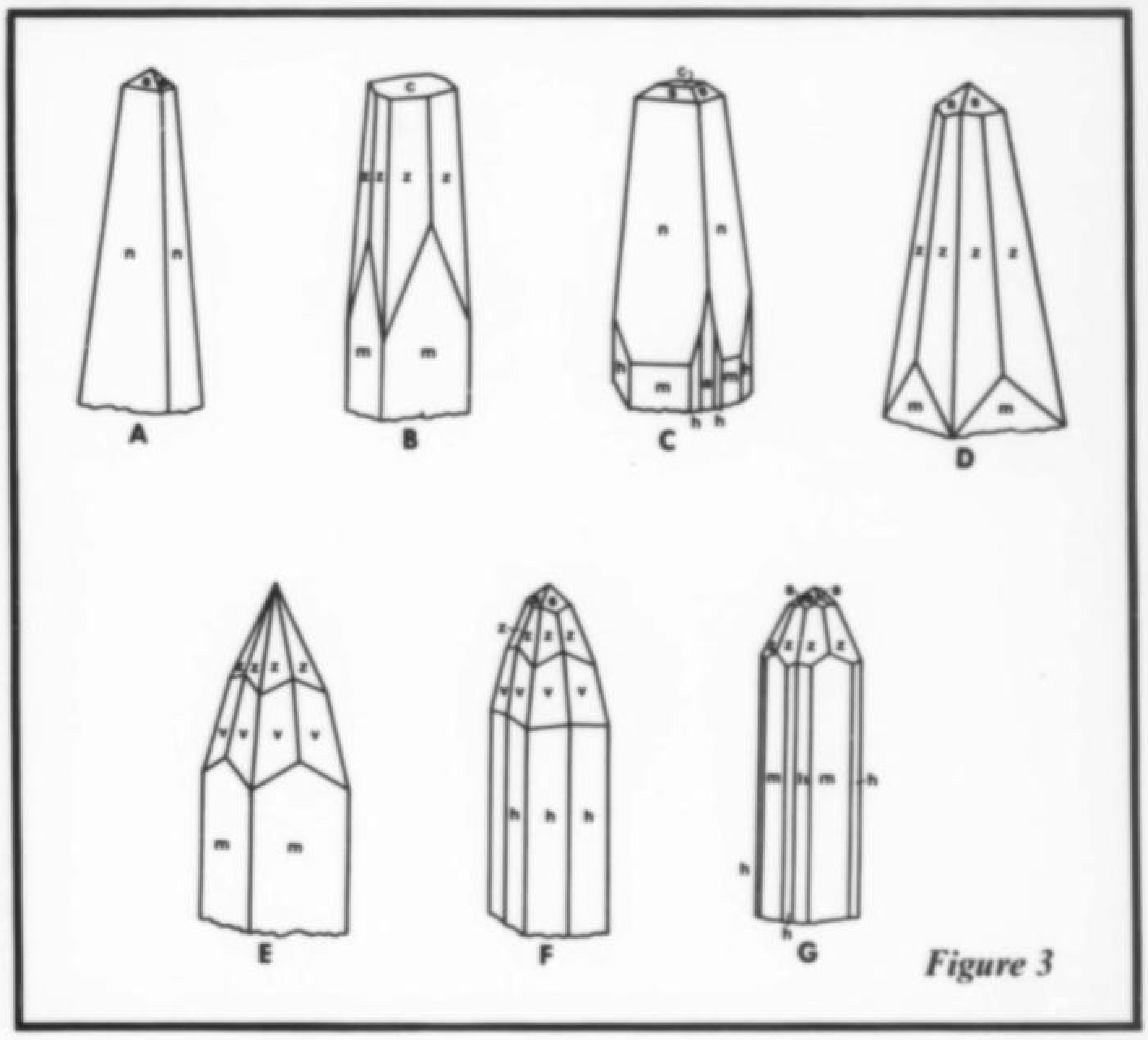


Figure 3. **Type-3 prismatic cassiterite.** ***A.*** **Prismatic crystal typical of both Huanuni and Monserrat (needle tin); identification of n{771} is tentative [modified from Ahlfeld and Muños Reyes (1943)].** ***B and D.*** **Prism from the Victoria Mine; identification of z{321} is tentative [modified from Ahlfeld and Himmel (1932)].** ***C.*** **Prismatic crystal from Viloco; identification of n{771} is tentative [modified from Ahlfeld and Himmel (1932)].** ***E and F.*** **Prismatic cassiterite from Monte Blanco; identification of v{752} is tentative [from Ahlfeld and Himmel (1932)].** ***G.*** **Typical, Cornish type-3 cassiterite [from Dana (1892)].**

trip into the district. Vehicles with modified carburetors, particularly Toyotas, are strongly recommended.

The vein deposits of the Viloco district have been studied in detail by Turneaure and Welter (1947) and have been shown to exhibit both lithologic and structural control as well as mineralogic zonation with respect to the batholithic margins. Most of the superb cassiterite specimens in older collections were found in the upper levels of the "veta principal", or principle vein, where large cavities contained spectacular twinned cassiterite crystals with quartz and secondary goethite. Today, similar though less spectacular specimens are occasionally produced from the San Antonio mine, approximately 2 kilometres to the west.

→

The luster, color, perfection, and size of Viloco crystals are remarkable. Twinned crystals up to 5 cm in diameter are not uncommon, and crystals reaching 8 cm have been reported. Crystal groups weighing up to 100 kg grace some of the world's finest museums. The color is typically dark brown, although crystals exhibiting phantoms and other color zonation are quite common. Colorless, transparent crystals of relatively small size have been reported. An unusual characteristic of color zoning in Viloco cassiterite is exhibited in crystals partially coated with siderite. When the siderite coating is removed, the underlying portion of the cassiterite crystals is commonly colorless to light yellow as opposed to dark brown for the uncoated portion.

The complex crystallographic features of Viloco cassiterite have been described several times in the literature (Gordon, 1924; Heilmeir, 1930; and Ahlfeld and Muños Reyes, 1943). Unfortunately, these publications are difficult to acquire and, with the exception of the brief work by Gordon, are in languages other than English.

The perfection of twins and abundance of crystal forms exhibited by Viloco cassiterite are almost overwhelming. The dominant crystal forms are m{110}, s{111}, e{101}, a{100}, h{210}, r{320}, t{313}, c{001}, j{310}, and v{752}. The (100) and (001) faces are typically bright and smooth while (110) faces are usually wavy due to vicinal faces, or may show fine striations (Figure 5). Other prism faces are typically quite smooth (Gordon, 1924).

Twinning is almost invariably with e(011) as the composition plane (Figure 2). Although both contact and penetration twins occur here, casual observation suggests that contact twinning is the predominant type. The most common habit of twinned crystals consists of two individuals symmetrically developed with respect to e(101) (Figure 2A, D). Such crystals may exhibit a dominant development of adjacent (111) faces at the expense of (110) faces (Figure 2A) or the opposite case where the m(110) prism dominates over the s(111) pyramid as suggested in figure 3D. Repeated or multiple twins resulting in trillings or sixlings occur but are not common.

Simply twinned, light yellow to grey, type-2 cassiterite crystals up to 2 cm in diameter are occasionally found in massive pyrrhotite. Specimens containing euhedral pyrrhotite and quartz have been found in the San Antonio mine in recent years.

Matrix samples containing type-2 cassiterite are occasionally available at the famous Siglo XX or Twentieth Century mine at Llallagua. This mine, the world's largest underground tin mine and the only block caving tin operation, is situated in Bustillos Province in the Department of Potosi. The deposit is located near the towns of Catavi and Uncia, approximately 4 hours by road southeast of the major mining center of Oruro.

Mountain sides surrounding the mine are covered with numerous old dumps from which rather mediocre specimens containing vugs lined with quartz and small (2-3 mm) type-2 cassiterite crystals may be collected. A thorough search of these dumps did not yield a single worthwhile sample of the famous Llallagua phosphates, although weathered wavellite is locally abundant. Good specimens can only be acquired by dealing with the miners very patiently. Unfortunately, they feel that only quartz and pyrite are of sufficient beauty to remove from the mine. Occasionally, however, such quartz clusters contain excellent type-2 cassiterite and rarely late overgrowths of wavellite, apatite, paravauxite, and vivianite.

Llallagua cassiterite is typically very dark brown to black and occurs in generally small (less than 1 cm) crystals on slender transparent quartz crystals. Matrix samples containing small wolframite crystals with cassiterite are relatively common.

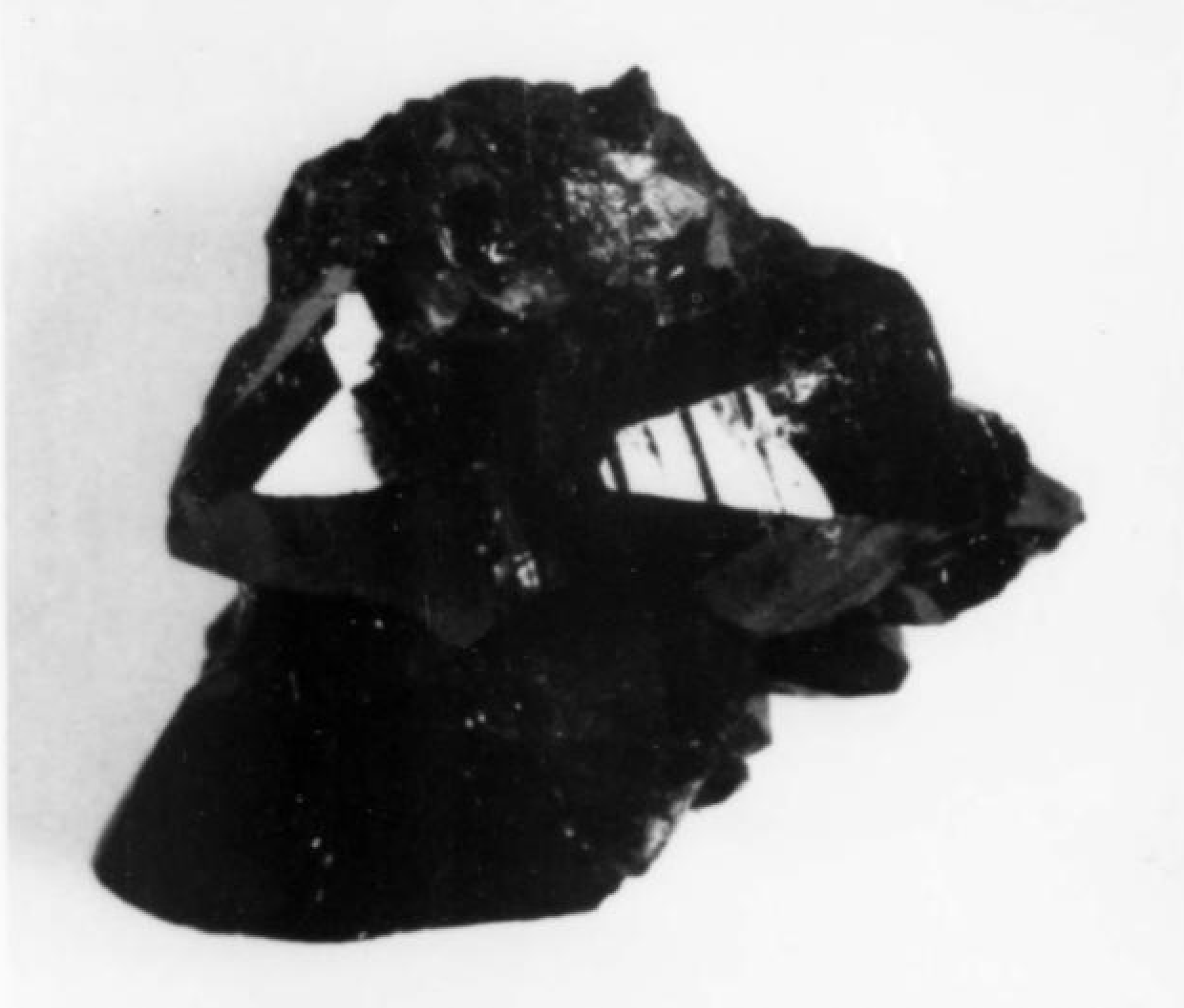


Figure 4. (top) **Cluster of twinned cassiterite typical of material currently available at Viloco. Sample is 4.5 x 3.0 cm.**
Figure 5. (middle) **Viloco cassiterite twins exhibiting striated prisms and vicinal modification of pyramids. Crystals average 2.5 cm in diameter.**
Figure 6. (bottom) **Twinned Viloco cassiterite of the size rarely available today. Crystals are 3.5 x 4.5 and 4.2 x 4.8 cm.**

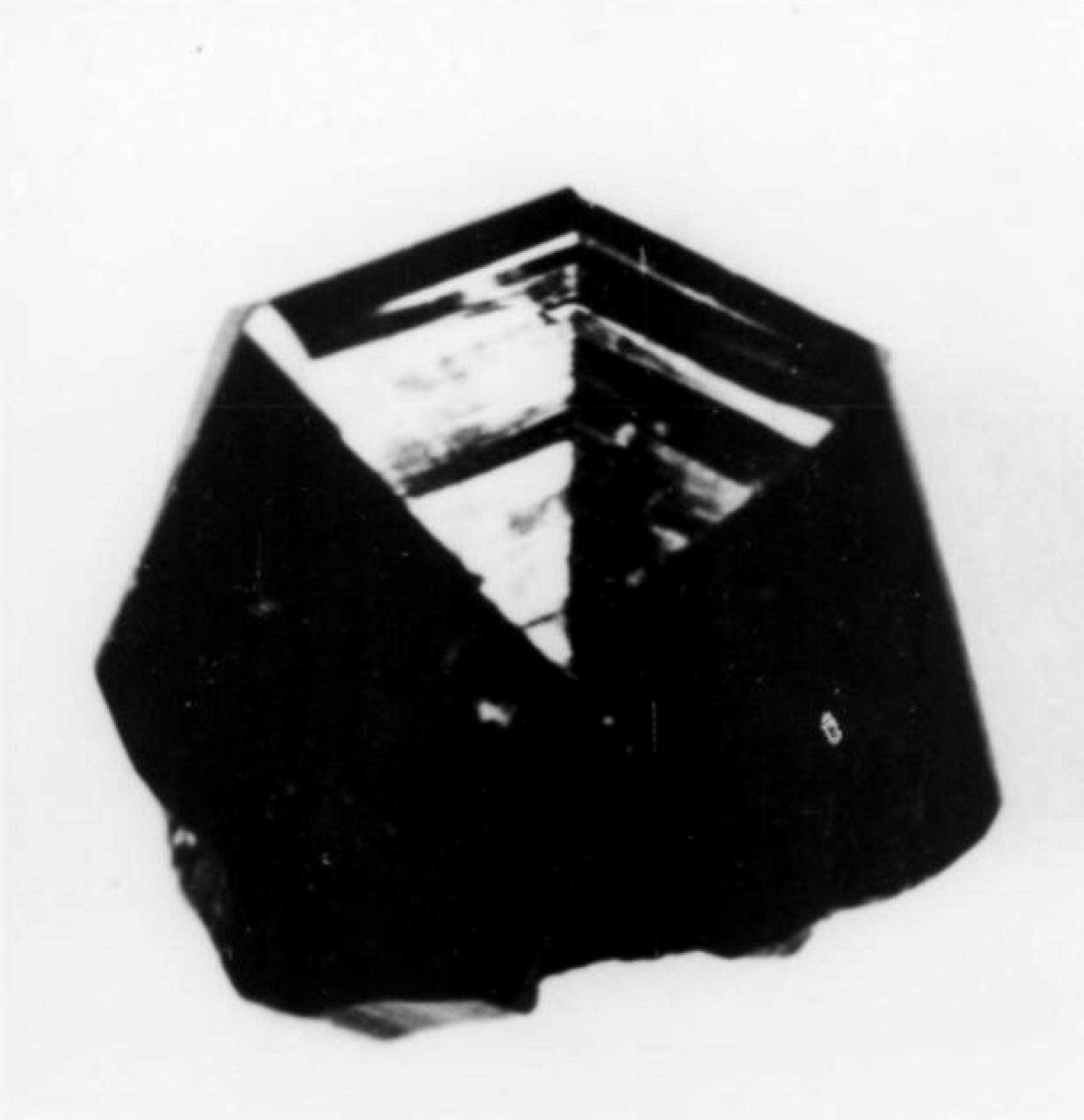


Figure 7. (top) **An unusual Viloco specimen exhibiting the uncommon association of type-2 cassiterite on crystalline arsenopyrite. Sample is 4.5 x 3.0 cm.**
Figure 8. (middle) **Brilliant black penetration twin from Viloco. Sample is 1.5 cm in diameter.**
Figure 9. (bottom) **Type-4 prismatic black cassiterite currently produced at Huanuni. Single crystal and group are 3.0 x 1.5 cm and 4.0 x 3.0 cm respectively.**

Llallagua cassiterite is almost invariably twinned on e(011) and exhibits the forms m{110} and s{111}.

Type-2 cassiterite similar to that of Llallagua occurs in the Huanuni and Avicaya districts, approximately midway between Llallagua and Oruro. Excellent type-2 cassiterite crystals were also once common in the hypothermal quartz vein exploited in the Alaska mine near Pongo in the LaPaz Yungas. These crystals exhibit simple twinning as well as cyclical twins typical of rutile. The crystals range from yellow to dark brown. Small though well developed type-2 cassiterite crystals were described from the Tanapaca mine north of Viloco and in numerous other veins associated with the margins of the Quimsa Cruz Batholith (Ahlfeld, 1954). Other such deposits include those at the Laracota and Carolina (Caracoles) mines.

Attractive type-2 cassiterite in crystals reaching 3 cm in diameter is currently produced from the fault-controlled quartz veins of the Chojlla mine in the Yanacachi tungsten district, Sud Yungas Province, Department of LaPaz. The crystals are light buff-brown, opaque and, while they do not exhibit the luster of Viloco cassiterite, are interesting due to the development of a wide array of prism facies and twins similar to that illustrated in figure 2C.

Large, rich-brown cassiterite crystals simply twinned on e(011) were at times found in one of the veins exploited in the El Barco mine in the Yanacachi district. Cassiterite at this location occurs intimately intergrown with felspar crystals in a locally pegmatitic quartz vein. This deposit has produced outstanding museum specimens of cassiterite.

Bipyramidal, pseudohexagonal cassiterite twins have been described by Spencer and Prior (1907) from the Chacaltaya mine near LaPaz. These twins are unusual sixlings exhibiting only m(110) faces.

Ahlfeld and Munos Reyes (1943) pointed out that there are several apparent pneumatolitic or hypothermal vein deposits that contain type-1 rather than type-2 cassiterite. An important example is the Consolidated mine north of Illampu in which excellent simple crystals up to 1 cm in diameter have been found (Figure 2B). These crystals are typically dark brown, semi-opaque, and occur with quartz and pyrite, or in crystal-lined vugs in quartz veins. Similar, transparent yellow crystals exhibiting the same forms have been found in hypothermal quartz veins at Tiquinani in the Zongo region.

Type-3 Cassiterite

Type-3 cassiterite, the type apparently typical of mesothermal deposits, was first observed years ago in Cornish tin mines. The crystals are elongated parallel to prismatic zones, generally small and delicate, and are almost never twinned. The Bolivian occurrence of type-3 cassiterite was originally described by Ahlfeld and Himmel (1932) from ore samples collected in the Victoria and Kala Uya mines in Chalcataya Mountain, north of LaPaz. Crystals of the Victoria mine are characterized by m{110} prisms terminated by various bipyramidal faces (Figure 3B, D).

Small type-3 cassiterite crystals quite similar to Cornish material occur in cavities in tourmalinized quartzite at the Monte Blanco mine in the rugged Quimsa Cruz Cordillera, approximately 5 hours south of LaPaz. Crystals exhibit complex terminations by various bipyramidal faces (Figure 3E, F). Larger simple crystals exhibiting {100} and {110} prisms and {101}, {335} and {111} pyramids are also found in this mine (Ahlfeld and Himmel, 1932).

Superb examples of simple prismatic cassiterite are currently produced in very limited amounts from the COMIBOL mine at Huanuni, approximately 1 hour southeast of Oruro. While these crystals, at first glance, appear to be simple {110} prisms terminated by the {111} pyramid, with local modification by complex and unidentified pyramidal faces, it has been shown by Ahlfeld and Muños Reyes (1943) through thin section examination that these crystals are in fact pseudoprismatic twins formed by the interpenetration of four individual prismatic crystals. Specimens from this occurrence are particularly desirable due to an intense black color and unusually brilliant luster (Figure 9). Crystals larger than 1.5 cm in length are uncommon. The most attractive specimens are those consisting of divergent cassiterite groups or single crystals on plates of crystalline quartz with pyrite and alunite. Specimen acquisition is extremely difficult in this district.

Prismatic cassiterite of the type-3 variety, perched on typical type-2, multiply twinned cassiterite and apparently representing a second generation of cassiterite, occurred in the uppermost portions of the "veta principal" at Viloco.

Additional localities where cassiterite exhibiting type-3 morphology has been identified are the Rotschild vein in the Milluni mine, the Isolina vein in the Cerro Grande mine at Colcha, and at Colquiri where prismatic brown crystals are found with quartz, fluorite, and siderite.

Type-4 Cassiterite

Type-4 cassiterite, "needle tin", is very common in the xenothermal and epithermal deposits in the central part of the Bolivian tin belt. These simple crystals generally exhibit the prismatic forms m{110} and a{100}, and are typically terminated by the {111} pyramid. Crystals vary in size from microscopic to approximately 8 mm in length, and in color from dark brownish black to transparent yellow or almost colorless.

Perhaps the most outstanding occurrence of "needle tin", with respect to volume and overall beauty of specimens produced, is the Ichucollo mine at Monserrat, Poopo district, approximately 1.5 hours by road south of Oruro. "Needle tin" of this occurrence is found as zones within wurtzite or as well developed crystals in cavities associated with euhedral wurtzite, teallite, franckeite, pyrite, galena, and quartz. Individual "needle tin" crystals range from 1 to 5 mm in length and are typically a lustrous yellow. Occasionally the crystals are transparent and almost colorless. Paragenetic studies have shown that type-4 cassiterite is of later formation than the associated sulfides and sulfosalts. While samples of Ichucollo mine "needle tin" are not readily available on the collector market, they may be easily recognized by associated, abundant matrix galena exhibiting an unusual blue tarnish.

Similar though small crystals of "needle tin" were locally abundant in the upper portions of various vein deposits in and around the city of Oruro. Crystals are usually in radial aggregates with individuals reaching 1 or 2 mm in length. Most samples contain cassiterite in cavities in pyrite associated with zinkenite, jamesonite, andorite, plagionite, pyrite and quartz. Twinned acicular crystals occur locally in this district. Samples can occasionally be found by diligent work on both the Itos and San Jose mine dumps.

Small, dark brown, acicular cassiterite crystals with unusually brilliant luster have been found in cavities in massive cassiterite and in galena and siderite in the Descubridora and Transvaal veins at Colquechaca. Spheroidal cassiterite aggregates containing radial structure and locally exhibiting acicular cassiterite at the periphery of the aggregates have been mentioned by Ahlfeld and Munos Reyes (1943) at several locations. Chief among these are the Natividad vein at Chorolque, Tasna, the Animas mine at Potosi, and Vila Apacheta.

Type-5 Cassiterite

It has long been suggested by various authors that the xenothermal cassiterite deposits of the central and southern part of the Bolivian tin belt have formed to a degree from colloidal solutions. This concept has been discussed and greatly expanded by Ahlfeld (1954). Cassiterite originating in this way is typically botryoidal, extremely fine-grained or cryptocrystalline, and generally exhibits preserved colloidal structures. Morphologically identical cassiterite has also been shown to form by supergene processes involving the decomposition of tin-bearing sulfosalts. Cassiterite of either origin is generally of the sort referred to as "wood tin".

Apparently primary deposits of colloidally deposited cassiterite have been described in the Colorado vein at Oruro, in the deposits exploited by various mines at Morococala and Santa Fe where at times the cassiterite is white, in the upper levels at Potosi, in the Colorado vein at Chocaya where "wood tin" is associated with pyrite, stannite, quartz and chalcedony in cockade textures (Jaskolski, 1935), and in the Bolivia vein of the Animas mine at Chocaya where thin section study has shown the cassiterite to be in part isotropic or pseudo-isotropic (Jaskolski, 1935).

Of particular mineralogical interest are impregnations and small veinlets of "wood tin" in dacitic lavas exposed on Condor Iquina Mountain, approximately 20 kilometres south of Macha. This occurrence represents one of the few known examples of "wood tin" of apparently unquestionable primary origin. Cassiterite at this location is intimately intergrown with chalcedony as red to brown, botryoidal and stalactitic masses in sericitized dacite. Associated opal and adularia replace altered rock along small fissures. The "wood tin" exhibits typical fine-banded textures similar to agate.

While cassiterite is practically insoluble under surface or near surface conditions, many Bolivian deposits were formally noted for apparent zones of tin enrichment in and near vein outcrops. An interesting example of this enrichment was very profitably exploited at the famous occurrence at Llallagua where magnificent concretionary masses of type-5 cassiterite were once found. This apparent tin enrichment by the production of type-5 cassiterite has been accomplished by the oxidation of tin-bearing sulfosalts and redeposition of tin as botryoidal cassiterite. Such cassiterite has been shown to form by the oxidation of sulfosalts at depth at Carguaicolla where type-5 cassiterite has been found intimately associated with cassiterite pseudomorphs after teallite, and at Vila Apacheta where cassiterite has been shown to form by oxidation of franckeite and cylindrite (Moritz, 1933).

Superb examples of "wood tin" have been found in numerous alluvial or placer accumulations in the vicinity of known vein deposits. Exceptional occurrences are at Negro Pabellon, Morococala, Huanuni, Llallagua, Antequera, Carguaicollo, Potosi, and Chorolque. Unusually large masses of "wood tin" have been found in several locations, particularly within the drainage of the Huanuni River where masses weighing up to 1000 kg have been reported.

CONCLUSION

Genetic data for most Bolivian tin occurrences are available to fully determine the prevailing conditions at the time of their formation; most evidence tends to support Ahlfeld's original hypothesis that there is a general trend in cassiterite morphology from dominantly pyramidal under high temperatures and pressures to dominantly prismatic under moderate to low temperature and pressure. The lack of precise paragenetic data for these deposits is due primarily to the fundamental and practical nature of the Bolivian mining industry, whose primary objective is the exploration and development of ore rather than the more academic aspects of ore genesis. The mineralogy of cassiterite, when coupled with detailed paragenetic data, offers a wide range

Table 1. Occurrence and Morphology of Bolivian Cassiterite

Deposit Type	Depositional Characteristics	Cassiterite Type	Cassiterite Morphology	Dominant Forms
Pegmatite	High to moderate temperatures; high pressure.	1	Simple bipyramids; prisms absent or poorly developed; twinning uncommon.	s{111}; e{101} common. a{100}; m{110} rare.
Hypothermal	High (300°-500° C) temperature and pressure. Deposition usually at great depth.	2	Highly modified multiple twins on e{101} with variable development of 1st and 2nd order pyramidal and prismatic faces.	s{111}; e{101}; m{110}; a{100}; c{001} common. h{210}; r{320}; t{313}; j{310} and v{752} less common but not rare.
Mesothermal	Moderate (200°-300° C) temperature, relatively high pressure; usually at moderate depth.	3	Prismatic crystals terminated by simple pyramid and {100} pinacoid or complex array of pyramidal faces. Penetrations twins on C axis common at certain locations.	a{100}; m{110}; s{111}; c{001} common. z{321} and other poorly defined pyramidal forms less common.
Epithermal and xenothermal	Deposition at shallow depths; moderate to low (50°-200° C) temperature (xenothermal higher); moderate to atmospheric pressure; usually shallow depth.	4	"Needle tin"; fine- to medium-grained prismatic aggregates.	m{110}; a{100}; s{111}; and complex pyramidal faces such as (3·1·12) common.
Primary colloidal or supergene	Deposition at very shallow depths by primary colloidal or supergene processes.	5	"Wood tin:" cryptocrystalline and colloidal textures characteristic; botryoidal masses.	Surfaces rarely bounded by small crystal faces typical of "needle tin".

of research potential, particularly with respect to changes in crystallography, optical characteristics, and elemental substitution with conditions of vein formation.

Little encouragement can be given to the collector of fine mineral specimens with regard to the future availability of Bolivian cassiterite. Although the mines at Viloco, Huanuni, and Llallagua will undoubtedly be in production for years to come, each district suffers from particular deterrents to the preservation of fine specimens. Perhaps the worst problem is that there is virtually no incentive to save specimen material from the mill. With the exception of perhaps two or three private collectors in LaPaz and Oruro, no concerted effort is ever made to secure such specimens or to enlighten miners and mine personnel of the potential research or commercial value of such material. In each camp one can always find a few people with specimens but in almost every instance the owner has been given some erroneous concept of the true worth of the sample. Interestingly enough, manufactured goods demand a very high premium in the mining camps and most of the author's material was obtained by simple barter of such things as boots, rock hammers, books, and in one instance a calculator. Miners and company personnel at Llallagua appear to be the most enlightened with respect to the significance of unusual specimens but, unfortunately, most ore is now produced by block caving techniques which render the stopes inaccessible.

The collector or visiting professional can expect to be treated well in the mining camps of the Bolivian Andes and should fair well as long as he remembers that even the best the camps have to offer may not be quite what he is used to at home. COMIBOL maintains an excellent public relations office in LaPaz, the personnel of which are always eager to accommodate the serious visitor. Arrangements should be made through this office prior to any visit to the mines of the interior.

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What's New in Minerals?

DETROIT SHOW 1976

The Greater Detroit Gem and Mineral Show was held this past year, as usual, during the second week in October. New discoveries were not obviously in abundance, but could be seen by careful scrutiny of the dealers' stocks. Before discussing what's new it should be pointed out that an abundance of fine, reasonably priced specimens from older localities was available. Attractive, well-formed, undamaged specimens of many species could easily be obtained for less than $50, and often less than $35. Examples include Vera Cruz (Mexico) amethyst, "Herkimer diamond" quartz crystals, fine calcite specimens from central Missouri (the specimen on the cover of this issue was puchased not long ago for $15), tourmaline from Brazil, fluorite from Illinois, a variety of Tsumeb minerals, many zeolite species from India, and a large number of other minerals. If one is not intent upon competing in the Master's category, it is a simple matter these days to build a fine collection on a limited budget. This wealth of low-priced material is no doubt a by-product of the frenzied search in recent years for museum quality, very expensive specimens to satisfy the extremely high demand for "investment" or "competition" pieces. The average collector can take advantage of the many low-priced pieces that always accompany the few top specimens.

San Francisco mine wulfenite:

The only North American locality currently producing significant quantities of wulfenite is the San Francisco mine near Magdalena, Sonora, Mexico. Though not strictly a "new" discovery, the mine had lain dormant for a period of time until it was leased by the Van Scrivers early last year. One of the largest pockets ever found there was entered recently, and a large quantity of very fine, yellow wulfenite (Fig. 1) in crystals up to 2 inches on an edge is temporarily available at very reasonable prices. Orange mimetite is sometimes associated. Curt Van Scriver, who has been overseeing the mining, has been careful not to allow any of the Mexican miners to remove specimens once pockets are encountered; therefore the pieces have been collected with a maximum of skill and a minimum of damage. It is interesting to note that the Van Scriver family includes three generations of mineral dealers represented by four separate dealerships, all in business simultaneously. Beth Gordon, a dealer in Saugus, California, is Brad Van Scriver's mother, as well as the mother of Patty Owens, a Washington dealer. Brad is the father of Curt, and both of them operate their businesses in Arizona.

More Tsumeb minerals:

A major collection of Tsumeb minerals was brought to Detroit from Tsumeb by the Zweibels; these were collected and accumulated by a Tsumeb miner about two years ago, and because of the tense situation in Southwest Africa the miner decided it was time to sell his hoard and pull up stakes. Many very fine dioptase specimens were included, along with some fine cerussite, wulfenite (one crystal lemon-yellow!) calcite, dolomite, etc.

Chrysocolla pseudomorphs from Ray:

In September an occurrence of chrysocolla (x-ray identified) pseudomorphs after an unknown mineral was discovered at the 2220 level in the Silica Ore Body at the Ray open pit mine, Ray, Arizona. About 100 relatively complete specimens, thumbnail to cabinet size, were collected from two interconnected pockets by Gary Fleck, Andy Clark and Wayne Thompson (all of Southwestern Mineral Associates, Phoenix, which has a specimen recovery contract with Kennecott Corporation, the owner of the Ray mines). Suggestions for the original mineral include azurite and gypsum, although the pseudomorphs look distinctly orthorhombic. The largest crystal found is 1 x 3 inches: most specimens were thumbnails or small miniatures, but a few spectacular cabinet specimens to 3 x 4 inches were also recovered. The two largest pieces each contained 30 to 40 crystals, most of them in the 1 to 1½-inch range. Nearly all of the groups had to be repaired; some have as many as ten crystals reattached, but their appearance is not seriously altered, and since this find may constitute a unique occurrence, their repair is immaterial. The color of the pseudomorphs ranges from a light sky-blue to a rich blue-green; they are internally banded with layers of varying intensity of color.

The specimens are colorful and showy, and have been selling briskly in Arizona (and at the Detroit Show) for moderately high prices (over $1000 for the cabinet specimens, down to around $20 for thumbnails). These specimens were saved only through the foresight of conservation-minded officials at Kennecott Corporation; they are to be highly commended. Specimens have been jointly donated by Kennecott and S.W.M.A. to the Smithsonian Institution (Fig. 2, 3).

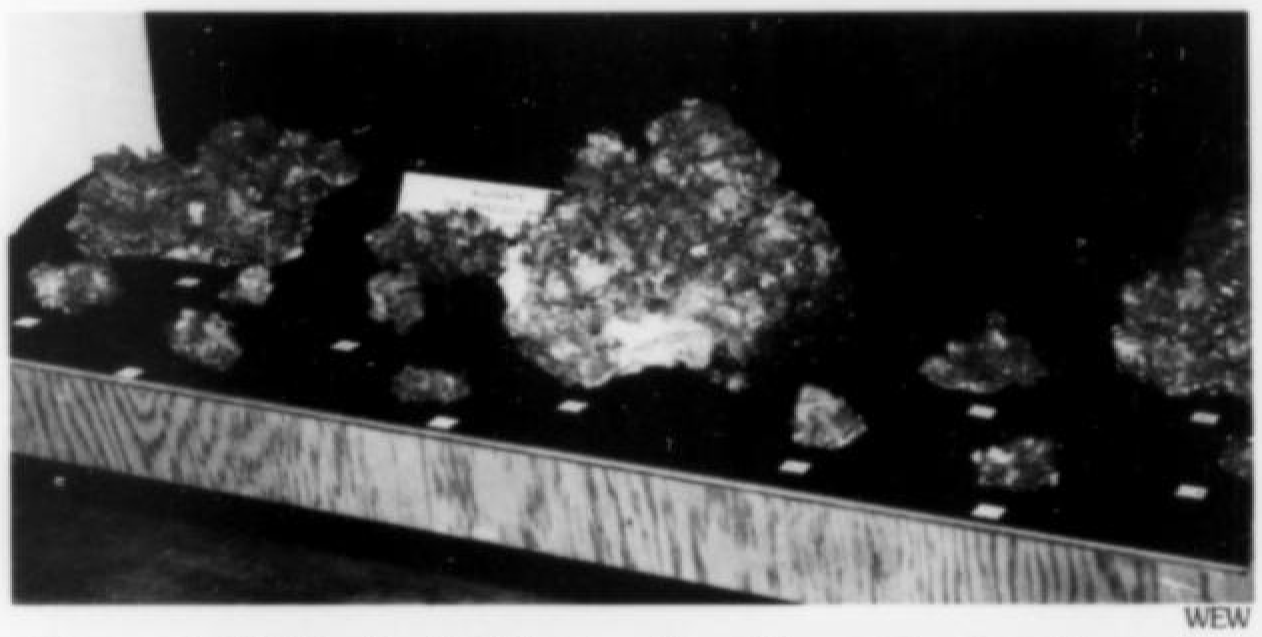

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Figure 1. **Wulfenite (brilliant yellow) from the San Francisco mine, Sonora, Mexico, in the Van Scriver's case. The small white squares are about 2 cm in size.**

Jeffrey quarry quartz:

A remarkable specimen of quartz from the Jeffrey quarry, North Little Rock, Arkansas is pictured in figure 5. There is no twinning or systematic alignment of one set of crystals to the next, but each set consists of a "stack" of thin crystals, their *c* axes parallel. Other sets, at random angles to each other, could be seen on the reverse side of the specimen.

Smoky Japan-law quartz twins:

Dick Jones, a wholesaler from Casa Grande, Arizona, had some specimens from a new find in New Mexico (Mina Tiro Estrella, El Capitan Mountains, Lincoln Co.). The most interesting of various species from this mine is smoky quartz in Japan-law twins, on a matrix of white feldspar (Fig. 6). The smoky color is believably natural because many crystals of radioactive allanite were found in the same pockets with the smoky twins. Relatively few were available, as the locality is just being opened by Gary Novak, Dick, and his son Roy. Other minerals they have found there thus far include titanite, microlite, actinolite and hematite "roses". Dick is somewhat reluctant to allow other col-

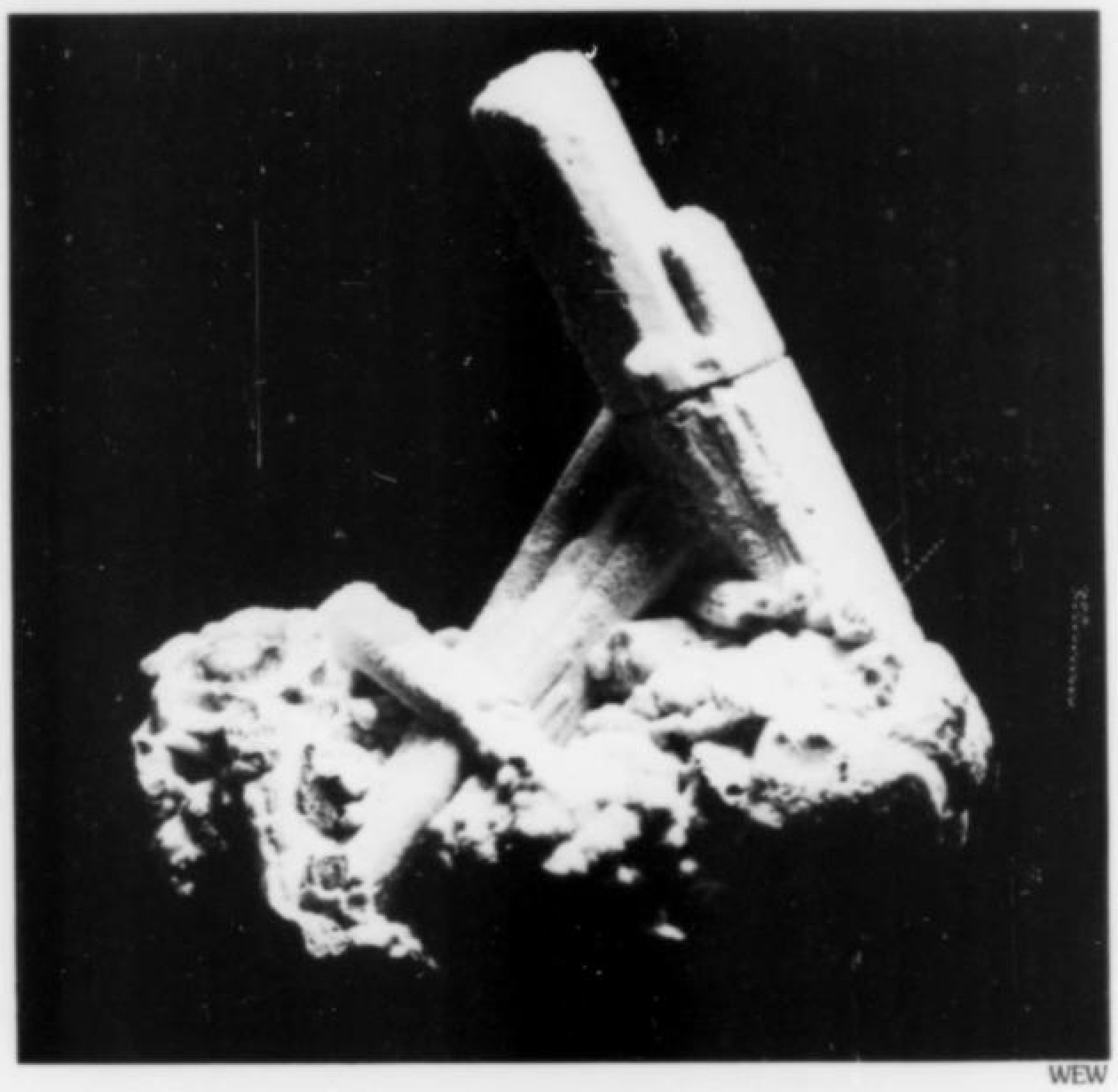

Figure 2. **Chrysocolla pseudomorph (greenish blue), about 5 cm tall, from Ray, Arizona. Smithsonian specimen, donated by Kennecott Corporation and Southwestern Mineral Associates.**

lectors on the locality at this time. (I believe his words were "Any varmint I catch in there will have his tail shot off.")

More danburite:

An enormous lot of danburite specimens (2000 pieces) was acquired by Flying Pan minerals, Littleton, Colorado, and they have been selling them since the Tucson Show last year. Single crystals of 3 inches each, in groups on matrix, are not uncommon in this lot, and there are many cabinet pieces from 10 inches to over a foot in size; some have quartz crystals perched on the ends of the danburite crystals.

Italian sulfur and Swiss gwindels:

Herb Obodda had several new items. While in Europe he came across a group of 50 sulfur specimens on matrix from Perticara, Romagna, Italy. He bought the best ones in the lot, which were superb crystals, clear, sharp, brilliantly faced, on matrix with asphalt. The sulfur crystals are about 1 inch in maximum dimension. Herb also had several smoky quartz gwindels from a recent discovery in Pez Ault, Graubunden, Switzerland; these averaged about 1½ inches.

Blue jeremejevite:

Attractive, blue crystals of jeremejevite have recently been discovered near mile 72, north of Swakopmund, Southwest Africa, and several were available from Prosper Williams. The crystals were about ⅛ X ⅛ X 1 inch, but one was 1½ inches long.

Etcetera

Other items of interest at the show included what will probably be the final display of David Wilber's Tourmaline Queen collection, and John Barlow's newly acquired (from Pala Properties) purple herderite, the finest in the world, from Virgem da Lapa, Brazil. The crystal is deeply colored, undamaged, on matrix, and about 6 inches long (Fig. 7).

A few new wrinkles were added to the history of mineral labels at the Detroit Show. Oceanside Imports was using a very convenient label (Fig. 8a): all one needs to do for most Brazilian minerals, is to check the boxes for species and locality. Probably over 90% of the specimens coming from Brazil could be described through this label. At the opposite end of the versatility spectrum are labels being used by Rock Currier for Indian zeolites. Each label contains a full paragraph describing the species, its location, and details of proper care and cleaning (Fig. 8b).

I asked many of the dealers how the show had been for them this year, and they were all smiles. Other shows this past summer have verged on financial disaster, but collectors were clearly in an enthusiastic mood for the Detroit Show this year and business was good. Lower priced specimens seem to be coming back into vogue; perhaps the obsession with competition quality minerals is fading, and all types of specimens will again be appreciated for what they are, rather than what they're worth. This would be a very healthy development for mineral collecting.

The Detroit Show each year has what is undoubtedly the East's finest array of displays. Competitive and non-competitive displays, museum displays, club displays, and educational displays give even the casual observer much to marvel at. This year the Smithsonian Institution's display consisted of only a single specimen which did not even have visible crystals. Nevertheless this piece, the Ontonagan copper boulder (see *M.R.* **7**, 207-210) has created more excitement and comment than any exhibit the Smithsonian has ever brought to Detroit. The boulder was even interviewed on local television (Paul Desautels of the Smithsonian answered for it) and thousands of reprints of the *M.R.* article on the boulder were handed out to visitors by the Michigan Mineralogical Society.

One sour note continues to emanate from the show committee. Some members still feel that it is somehow wrong of mineral dealers to set up a "satellite show" at the Holiday Inn, in conjunction with the Detroit Show. Dealer space is always filled at the Detroit Show, and many dealers who would buy official space cannot; other dealers operate on a small basis and have neither sufficient funds nor sufficient stock to sell from a booth at the show. Still, according to one member, the committee may discriminate against their applications for show space in the future if they advertise their presence at the satellite show now! Hopefully the show committee will one day realize that the satellite show actually draws more people to Detroit for the Detroit Show, adds to the festive atmosphere of the weekend, and helps to make the Detroit Show what it is today: No. 2 in the nation. It seems plainly unfair of the committee to discriminate against small businessmen doing business in the only way open to them.

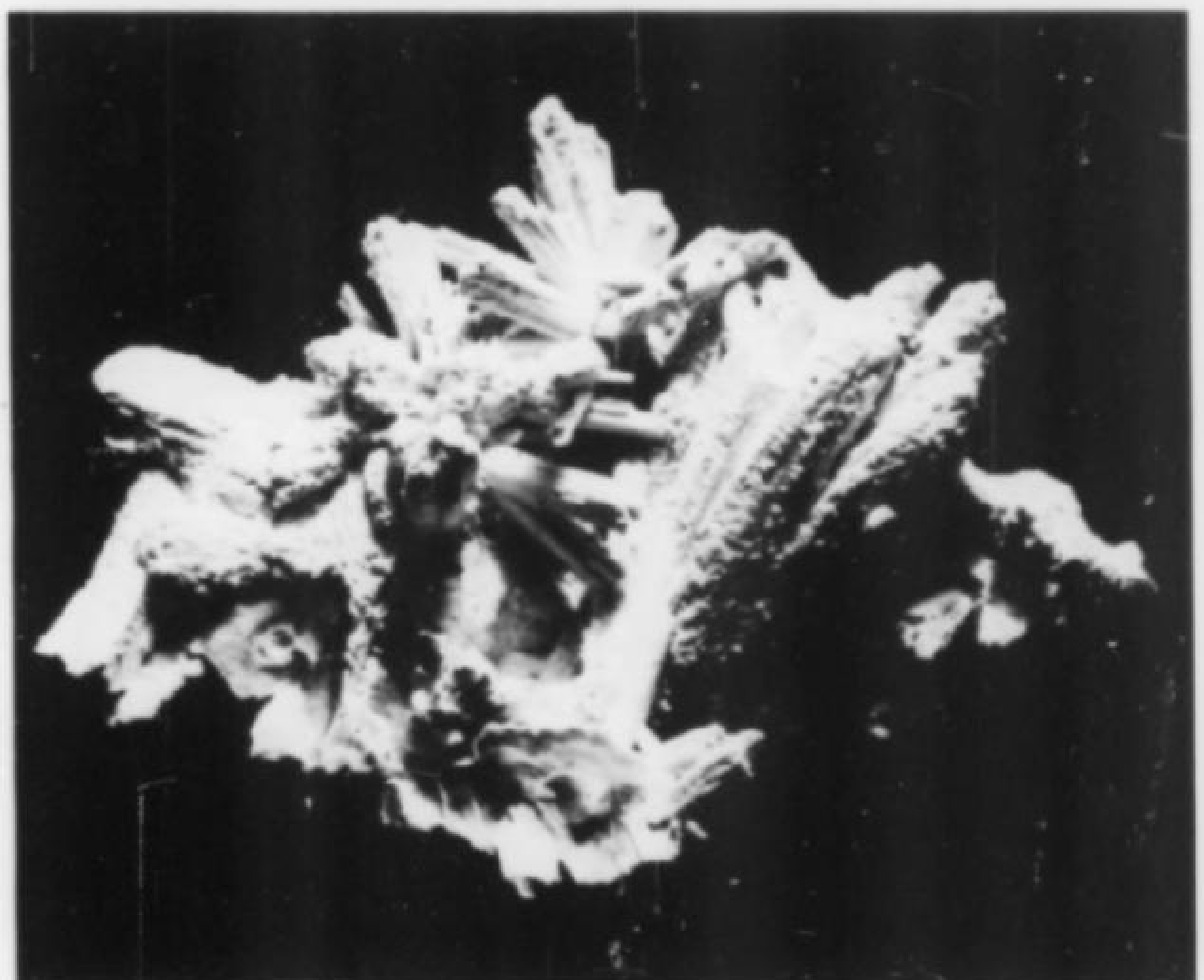

Figure 3. **Chrysocolla pseudomorph group (pale sky blue), about 4.5 cm wide, from Ray, Arizona. Smithsonian specimen, donated by Kennecott Corporation and Southwestern Mineral Associates.**

Not all members of the committee feel discriminatory, and hopefully they will soon vote to declare amnesty for the satellite show dealers. A show of the size of the Detroit Show can afford to be gracious.

W.E.W.

AIKINITE

Aikinite is generally thought of as a relatively rare mineral but it does occur in a number of places under a variety of circumstances. Most of these occurrences are related to commercial mineral deposits.

Aikinite has just been identified from a new locality, one that appears to represent a new *type* of occurrence as well: prehnite/

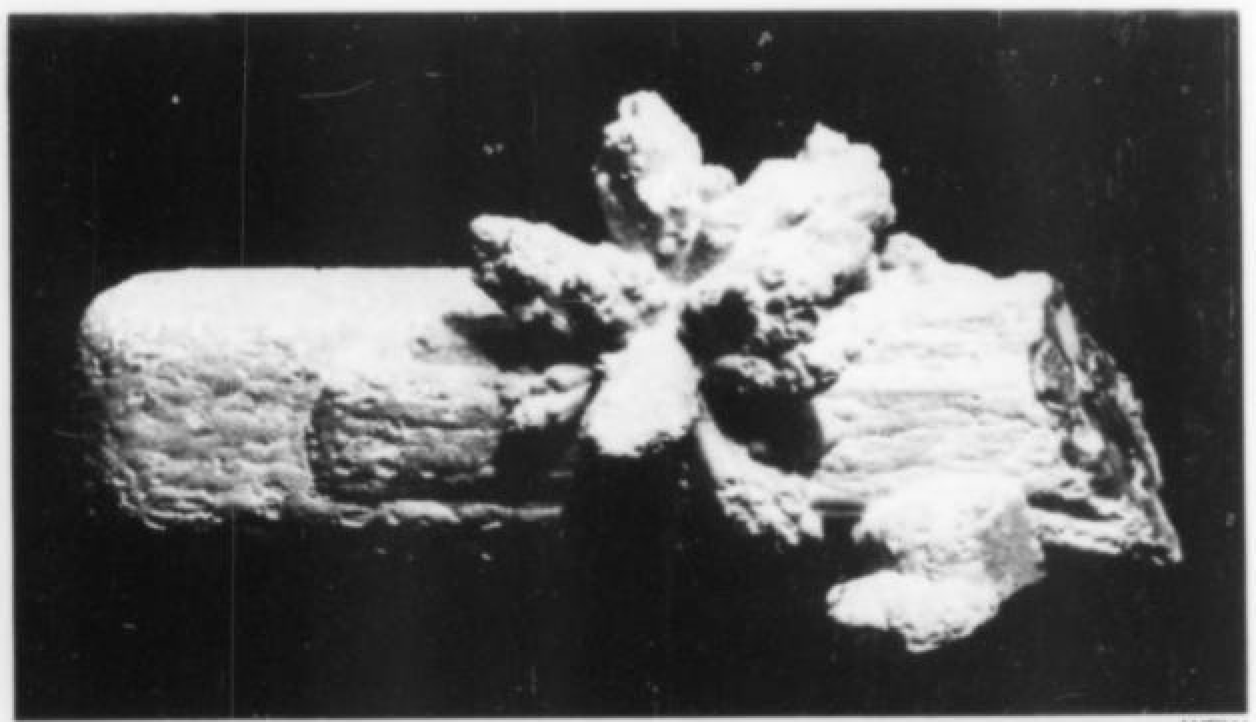

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Figure 4. (top) **Chrysocolla pseudomorph, (pale sky blue), about 4.5 cm long. John Tetrick collection.**

Figure 5. (above) **Quartz (colorless), about 5 cm tall, from the Jeffrey quarry, North Little Rock, Arkansas. Marshall Sussman collection.**

WEW

Figure 6. **Quartz (smoky gray) Japan-law twin with oligoclase, from Mina Tiro Estrella, El Capitan Mountains, Lincoln Co., New Mexico. About 4 cm wide. Dick Jones specimen.**

apopyllite seams in the Triassic diabase (trap-rock) of northern Virginia. It was found in 1976 by Norman Martin of Fairfax, Virginia at the Chantilly quarry, near Arcola, Loudoun County. Martin very graciously donated all that he collected to the Smithsonian Institution, a total of about six micromount-sized specimens.

Preliminary identification was made by x-ray diffraction at the Smithsonian and a microprobe analysis was performed by T.T. Chen, Canada Centre for Mineral and Energy Technology (Ottawa). The results, not published elsewhere, are given here with Chen's approval: Pb **33.9**, S **17.1**, Bi **40.0**, Cu **10.4**, total **101.4**. The appearance of aikinite at the Chantilly quarry is not altogether a surprise since other copper and bismuth sulfides (wittichenite and cuprobismutite) have been found at nearby Centreville in prehnite/apophyllite seams. Lead is present in the northern Virginia trap-rock quarries as evidenced by the frequent appearance of galena.

The most exciting aspect of the Chantilly akinite is the perfection of the crystals which are found mostly as highly lustrous, acicular, black, free-standing clusters in pockety, pale-green prehnite. The photographs (Fig. 10) illustrate the typical appearance of the crystal groups. The largest group that was found is nearly 3 mm in length.

J.S.W.

CALCITE ON CELESTINE

Calcite and celestine have been intermittently coming out of the locality known as Clay Center, Ottawa County, Ohio for at least 43 years, judging from a cursory scan of the literature. The locality could very well be much older. (*Published information on mineral localities in Ohio is difficult to find. Does anyone know of a good reference? Ed.)*

Just recently an area in the limestone quarry was encountered that provided some lovely specimens of calcite and celestine. Fig. 10 illustrates the most exciting product of the discovery: choice, miniature-sized single crystals of white celestine, each capped with a single, curved, rhombohedral crystal of yellowish calcite. They are indeed very aesthetic specimens. Notable also are the large (up to 12 x 7 x 3 inches) plates of celestine crystals, some are as long as 3 inches.

The find was made by Joe Kielbaso of Tipp City, Ohio.

J.S.W.

WEW

Figure 7. (above) **Herderite (purple/blue), about 15 cm tall, from Virgem da Lapa, Minas Gerais, Brazil. John Barlow collection**

Figure 9. (below) a and b. **Aikinite (black), about 3 mm wide, from the Chantilly quarry, near Arcola, Loudoun County, Virginia. Smithsonian specimens.**

Figure 8. (above) **Two new labels; (a) from Oceanside Imports, (b) from Jewel Tunnel Imports.**

Figure 10. (below) **Yellow calcite crystal perched on white celestine crystal (1 cm wide), from Clay Center, Ottawa County, Ohio. Smithsonian Specimen.**

Julius Weber

CAVANSITE FROM THE POONA DISTRICT, INDIA

The following note is from Bill Birch

Curator of Minerals
National Museum of Victoria
285-321 Russell Street
MELBOURNE. Vic. 3000. Australia

During late 1974, examination of a shipment of zeolite specimens imported by a local mineral dealer from the Poona area, near Bombay, India revealed several specimens of large stilbite crystals on white heulandite, accompanied by an unfamiliar blue mineral.

The unknown mineral was in the form of isolated sky-blue rosettes of fibrous, radially-arranged crystals up to 3 mm long (See Fig. 11).

Subsequent chemical work using a scanning electron microscope equipped with EDAX, revealed that calcium, vanadium and silicon were the major constituents present. X-ray diffraction on the powdered sample confirmed the mineral as cavansite, **$Ca(VO)(Si_4O_{10})4H_2O$**, by comparison with the data of Staples et al. (1973).

Cavansite (named for its constituents) was first described by Staples et al (1968, 1973) and its crystal structure was elucidated by Evans (1973). The type locality was a road cut near Owyhee Dam, Malheur County, Oregon. A further locality exists in a near Gable, Columbia County, Oregon. In both localities, cavansite is associated with other zeolites, including stilbite and heulandite, in cavities in basalts or tuffs.

As the local dealer bought the shipment in bulk while in India, he was unable to trace the precise origin of individual pieces, and thus the exact locality of the Indian cavansite could not be ascertained. To the author's knowledge, it has not been recorded from any locality outside Oregon.

A prominent mineral in the Poona zeolite assemblages is apophyllite, which occasionally forms attractive, clear, greenish crystals. Rossman (1974) has found that the green color is due to the presence of vanadium in amounts up to 1600 ppm. Thus although no green apophyllite is associated with the cavansite specimens, there is evidently a source of vanadium in the Poona basalts.

Three specimens are held in the collection of the National Museum of Victoria and at least one (and the best) specimen is in a local private collection.

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ROSSMAN, G.R. (1974) Optical spectroscopy of green vanadium apophyllite from Poona, India. *Amer. Mineral.,* **59**, 621-622.

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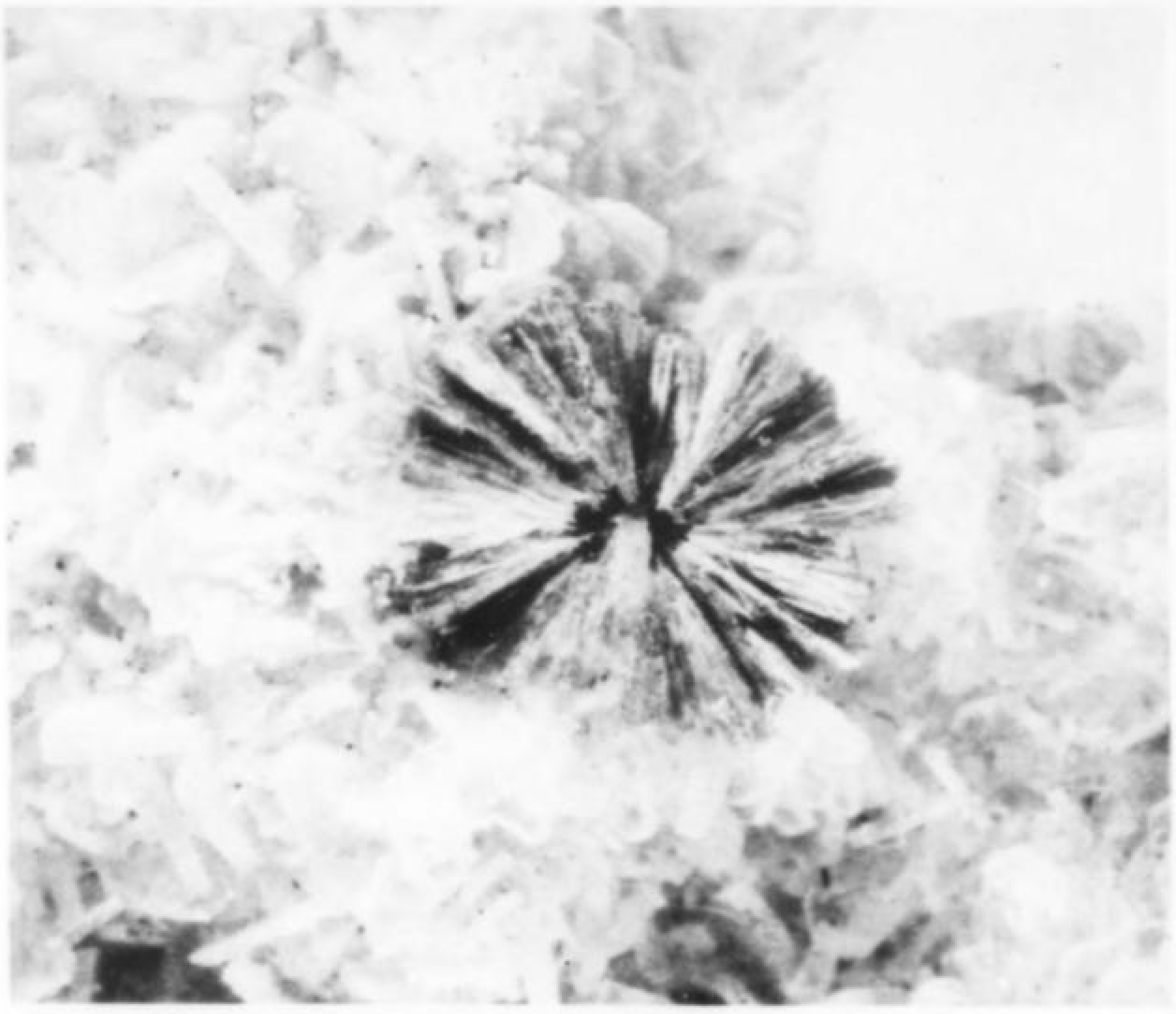

Figure 11. **Cavansite from Poona, India**

CRESTMORE QUARRY REOPENED TO COLLECTORS

The Riverside Cement Company, a division of Amcord Corporation, has invited the Jurupa Mountains Cultural Center to conduct collecting trips for minerals. Collecting at the Crestmore quarry has been suspended during the past four years and although the active mining is still being done at this quarry, collectors will now be able to register for participation by contacting Jurupa Center at 7621 Granite Hill Drive, Riverside, Ca. 92509.

Jurupa Center and the Crestmore Quarries are both located in the Jurupa Mountains Range and the tours will be conducted with a definite program so that the participants will understand the genesis of this mineralogist's delight where over 150 different minerals have been found. Unusual minerals such as ludwigite, scawtite, wilkeite, nekoite, ettringite, and even the newly described stringhamite, can be found in the contact metamorphic zones where collectors may explore. The beautiful sky-blue calcite is world-famous.

A collecting trip to Crestmore in the Jurupa Mountains is interesting also because the entrance of the quarry enters through the plant, one of the largest and most modern cement manufacturing plants in California. Immense kilns are now using coal as their fuel; the sulfur from the coal is consumed in the lime and there is no pollution. Another benefit is the saving of natural gas sufficient to heat 135,000 homes in an area where natural gas is in short supply. The Riverside Cement Co. plant is totally controlled from a central computer system.

A complete program has been developed by the Jurupa Center for monthly collecting trips into the Crestmore Quarry, providing basic information about contact metamorphic minerals; in fact, the program and trip may be taken for University Extension credit if desired.

Participants will have an opportunity to examine a large collection of Crestmore minerals before and after the collecting trip at the Jurupa Center Museum. The large displays illustrate the zones where these specimens are found in the quarry. An identification period will follow a delicious dinner of Crestmore metamorphic stew, Feldspar slabs (garlic bread), monticellite cookies (carob), and miners brew. All collectors have been enthusiastic about this program.

A $5.00 fee covers the program, dinner and safety equipment that is necessary for the tour. There is presently a waiting list and requests are taken in the order received.

Jurupa Center is fortunate to be the recipient of one of the largest Crestmore mineral collections made during the past 60 years and the staff mineralogists have been sorting and selecting specimens for the new museum. Duplicates of some specimens are available for purchase to benefit the museum building fund.

Ruth A. Kirkby
Executive Director
Jarupa Mountains Cultural Center
7621 Granite Hill Drive,
Riverside, CA 92509
TEL.: (714) 685-5818
(714) 685-5025

Specimen Requests

The Instituto di Mineralogia e Petrologia,
Universita di Modena,
via S. Eufemia 19,
41100 Modena, Italy.

needs samples of MESOLITE, THOMSONITE, GONNARDITE, SCOLECITE, EDINGTONITE

After a preliminary X-ray or IR-test to confirm the identification, a chemical analysis will be done on each sample, and the result will be sent to the donor.

yedlin on micromounting

accompanying photograph shows 4 of his collecting tags. Broadwell was a collector, printer, photographer, and had compiled a list (together with Charles Hoadley) of the Franklin, New Jersey minerals, put out in a 4-page pamphlet, today a collector's item. He was a member of the New York Mineralogical Club and a charter member of the Newark, New Jersey Mineral Society.

Now here are some further details of the Broadwell micromount collection. Some specimens had green, thin labels, "fluorescent", affixed to them. Printed localities (see photograph) were pasted to those specimens of which he had a plethora—Franklin, Paterson, Great Notch, Upper Montclair, Griggstown (all in New Jersey), Bedford, Tilly Foster (in New York), Bisbee. (Arizona), Broken Hill (New South Wales), and many others. As a printer he had the facilities, though it is not easily explained why all his micromount labels were not imprinted with his name.

Last June we acquired an old micromount collection. The details may be of interest. Got a note from someone who explained that he had a collection of small minerals in boxes and was disposing of them. Asked if we could advise him of the most advantageous method of doing this, as they belonged to his father who was no longer able to enjoy them. A very brief description—about 2500 or so specimens, in small paper boxes. "Square or oblong?" was our immediate question. "Square, about an inch in size," was the response. So the Assemblage represented a period of collecting in the 1930's and prior, but not as early as 1912 or so. when oblong paper boxes were in vogue. "Whose?", next question; "Don't know, but my father bought them all from a dealer in New York City." So we went to Yonkers to view them and found the following:

1. 2500 to 3000 specimens.
2. Square cardboard boxes, labeled top and bottom.
3. No name affixed, either of the original collector or the final owner.
4. Originally cemented by dropping a blob of hot wax into the container bottom, pressing the specimen into it until the wax hardened.
5. In the course of 35 years or so just about every blob of wax became loosened from the box or specimen; thus the minerals were detached.
6. The collection was housed in 2 cabinets of wood, one of 10 drawers and the other of 20, the whole capable of holding 5000 micromounts. The front, sides and rear of every drawer were notched to hold partitions, indicating square sections holding printer's type.
7. A printed number was cemented to the upper right corner of every box, and was keyed to...
8. ...numbered file cards, in a separate six-drawer cabinet, each card containing the identical data as the label on the micromount box, plus, in some cases, the name of the person from whom the specimen had been obtained.
9. The file cards were in various colors—yellow, green, purple, pink and white, perhaps a key or clue to some arrangement. The cards were filed by number, consecutively, to correspond to the numbers on the mounts in the collection: a journal-type arrangement.
10. A very few (perhaps 25) oblong paper containers were in the collection, obviously acquired from another collector, although there were no names indicating that fact.
11. One of the drawers contained some packs of mineral labels of William H. Broadwell, Newark, New Jersey. A few scattered micromounts had his printed label, too, and the

The quality of the specimens varied; there were some fine local specimens, other United States locality samples, and some from Brazil, Europe, Africa and Australia. But in general the assemblage was not a first class one. Broadwell visited every quarry, mine, road cut, and building excavation within miles of his home. He attended all field trips of his societies, collecting profusely. And he mounted just as prolifically, duplicating many, many species, and trying to represent in his collection as many localities as possible. This had the result of downgrading the collection in some areas, but provided a good cross section of available minerals.

There were, too, some minerals of New York City, obtained from construction blasting, subway excavations and the like. These, because we lived here for a great portion of our life, we retained *en toto*. Mostly they were zeolites and associated minerals, garnets, apatite, monazite, ilmenite and rutile. Good enough!

Broadwell mounted non-crystals in some cases. Where the material was rare and unusual and he could not obtain specimens exhibiting external morphology, he settled for material showing other characteristics—cleavage or fracture, color, luster, or some other feature—and mounted it. Thus there appeared small masses of gadolinite, euxenite, fergusonite and the like in the collection. A great many were labeled with varietal names, obsolete and improvised ones, and even a Franklin specimen marked *jerseyite*, for which we can find no reference. Errors were evident, as is the case in most collections today (for what is so rare as a day in which we can find no mistakes?).

The history of the collection is most interesting. At Broadwell's passing it was acquired by Maurice Hammoneau, a New York dealer who had been in charge of the sales shop at the American Museum of Natural History in New York, during and prior to World War II. He left the museum, opened his own establishment, and purveyed minerals, shells, books, natural history items and the like. At this point Desautels, Perloff and we went through some of the mounted specimens and acquired a few of the better ones before Hammoneau decided to rearrange things and reevaluate their potentialities. Shortly thereafter he died and his widow disposed of the micromounts after several mail bids. It was out of sight until last June, when it was offerred to us and we acquired it.

Apparently the collection had not been studied much since that time, for there was a heavy coating of dust throughout. A

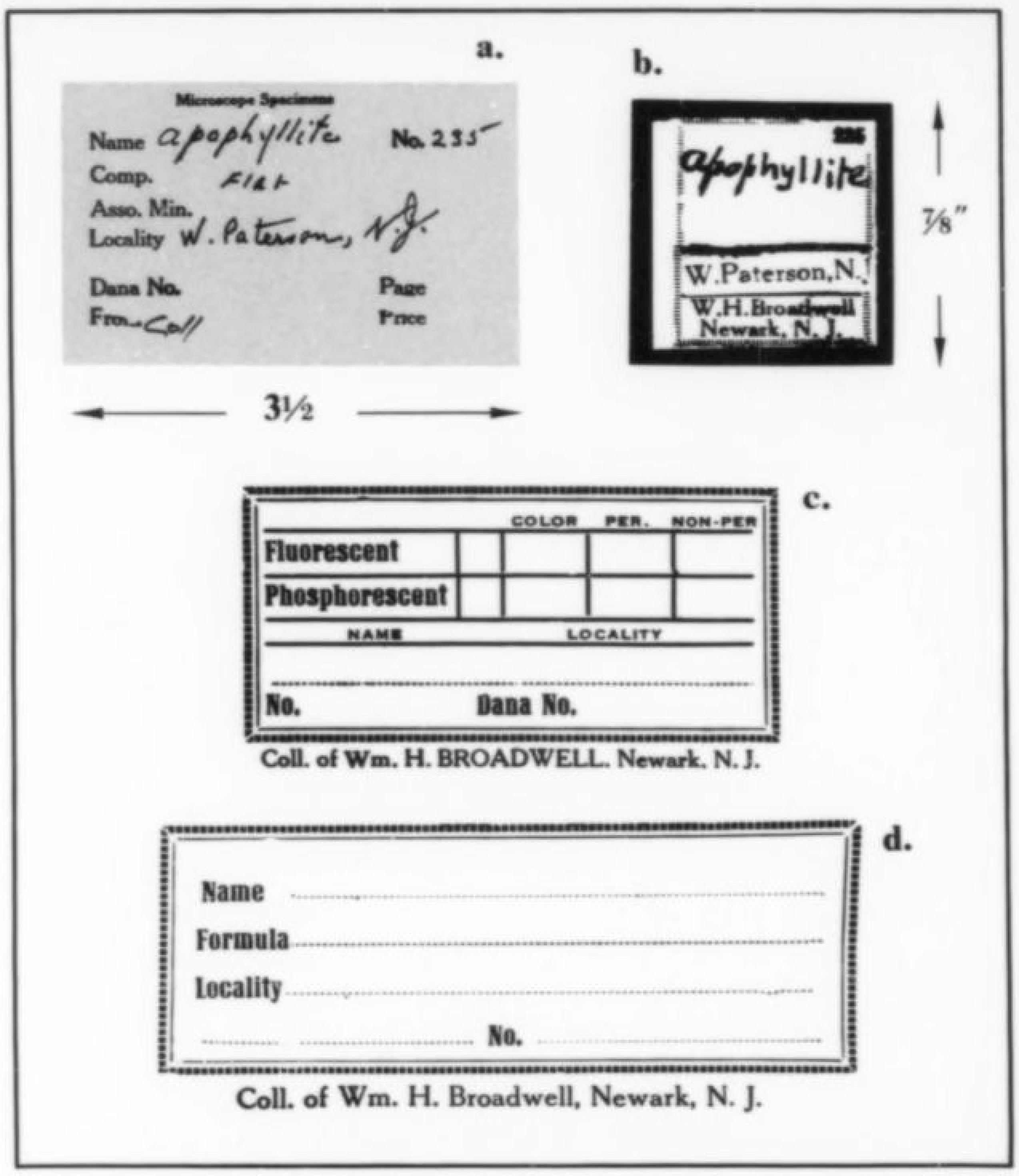

Figure 1. **Some of William H. Broadwell's labels. No. a:- File card (green), corresponding to the m/m label No. b. Note the printed locality on the small box top. No. c:- Label for his fluorescent minerals, of cabinet size (red lettering). No. d:- A standard cabinet label (green lettering). With the exception of those for micromounts, all of Broadwell's tags were done in various colors of ink.**

vacuum cleaner, a dry cloth and a damp sponge were used in succession to clean the mess, with partial success. The process brought out some contradictions in our previous opinions. We'd always advised using the best paper obtainable for labels, preferably linen or material with rag content. Old mineral tags of such paper have withstood the passage of time, and in our label collection we have some over 100 years of age that are crisp, firm, and in remarkable condition. Some of Broadwell's boxes had such material. A great many did not, but had cheap, glossy paper, obviously the type which we'd warned against. After attempted cleaning this was what we'd discovered:

1. That the fine linen stock was minutely porous, and retained ingrained dust and grime. That this type of label could not be cleaned completely without wearing down the inked writing.
2. That the slick glossy papers were completely cleansed and whitened with but a single wipe of a damp sponge.
3. That is you plan to leave a collection untouched for many years, gathering dust, then use slick, glossy material for labels.

Of the entire collection of some 3000 mounts we were able to add but 200 to our own collection. About 1000 additional were rather good, were recemented in place, and were disposed of. The balance, perhaps 2000 or so, were discarded as being worthless as micromount specimens. The resulting empty square paper boxes are in the process of being rehabilitated with new outside white tops and bottoms, and black interior bases, and will be used to house duplicates. We had a lot of fun, learned a good deal, acquired a couple of cabinets which we needed, have a vast supply of square paper boxes, and pretty well know the collecting habits of William H. Broadwell.

Oh yes, the key to the colored index cards came to light. No key at all. Broadwell as a printer had acquired a batch of miscellaneous, thin, colored stock, which he cut to size and printed, and then used quite indiscriminately. Want samples of the cards? Send us a stamped, addressed envelope, with a slip with "Broadwell" on it and you've got 'em, with our compliments.

We've just picked up a fascinating book: Alan Holden's *Space, Shapes and Symmetry,* Columbia University Press, New York, 1971. Paperback, 6½" X 9¼", 200 pages, 202 black and white photographs of crystals forms made from models constructed by the author. Price $4.95. There are normal crystals here as mineral collectors know them, and additional mathematical variations of crystal solids and their extensions, developing 3 dimensional conceptions of solids and crystal morphology. The photographs provide excellent visual media, enhanced by simple text explanations. The book is a departure from the usual mineralogical crystallographic treatise but will abet an understanding of 3-dimensional space and form. The crystal photographs are beautiful. This you should have in your library.

Al Falster, 510 Bernard Street, Wausau, Wisconsin 54401, has been working on a new phenakite locality in Marathon County, Wisconsin. The crystals we received from him were clear shallow rhombs, with narrow prisms, partially embedded in iron stained microcline. He has collected, too, long prismatic crystals, twinned, in micro size and larger. Falster is an avid trader and welcomes inquiries; says he has a good deal of the material. He collects general species from all world localities.

A joint venture of the Micro Mineral Group, the New Jersey Mineralogical Society, and the Bergen County Mineralogical Society at West Paterson, New Jersey on October 23, 1976, resulted in the first "Micro Mineral Swap and Workshop." It was a successful first for the group. About 100 devotees attended, with microscopes and mineral material. Exchanges of micromounts, ideas, and suggestions were in order, and an area for demonstrations, identifications and know-how was set up, manned by Tom Peters, Alice Kraissl, Walt Zabisky and Don Peck. Russ DeRoo and his cohorts. These ardent collectors have conducted micromount conclaves for the past several years, and anticipate future affairs. These are stimulating events.

Received a long missive from Juliet Reed of Bryn Mawr College in Pennsylvania, who tells of her fabulous summer collecting throughout Colorado, New Mexico, Illinois and Wyoming, gathering specimens, studying old mines, working ore dumps, and photographing everything for course lectures and talks at mineral clubs. Her affiliation and loyalty to the Mineral Society of Pennsylvania and the Friends of Mineralogy have been of great worth to her and to the organizations, for it is due to such ardent mineralogists that these groups execute their basic functions so well. She sent to us a copy of the publication *Annotated Bibliography of Pennsylvania Minerals. 1965 to 1974.* You should have this for your library, and if you are a member of the Society it is yours for fifty cents in postage; otherwise it is obtainable at a postpaid price of $3.25. Address: Dr. Davis Gardner, Green Hill Road, R.D. 1, Collegeville, Pennsylvania 19426.

We attended a session of the group at West Chester in 1975 and had a wonderful time, mineralogically, geologically, socially and "collectively", for a field trip was on the agenda. These annual affairs are notable and merit everyone's attendance.

The 20th annual symposium of the Baltimore Mineral Society took place last September, and, as usual, it was great. Visitors from as far away as California, Arizona and Canada were there. Nostalgia was rife. The speakers were four members who had attended the first meeting — Desautels, Seel, Perloff and Yedlin, each of whom related his talk to an era of the hobby, in order: Early History, The Middle years, Photographs of Minerals Seen Only by Micromounters, and Current Activities. The club established a micromounters Hall of Fame in honor of the occasion and to perpetuate those who had done so much for the art. As a beginning, G.G. Rakestraw and G.W. Fiss, first to develop this each having made lasting contributions. Every year and "old timer" and a "modernaire" will be elected by the Baltimore Society, and their names inscribed on a fitting plaque.

The Baltimore Micromount Symposium is important for its original and dominant place in the mineralogical milieu. Besides the "gathering of the clan", the demonstrations, the new equipment, and the reports of new finds, there are always available recent and superb minerals for micromounts, old and rare books, fine tools and supplies. The members of Society are to be congratulated for this annual undertaking. John Jedlika, club member, and principal of the Stemmers Run Junior High School, where the event has taken place for many years, must be thanked for providing facilities and staff.

Meanwhile buy and use a good mineral book: those listed above, and John Sinkankas' *Gemstones of North America, Volume II*. 1976. Sure it's about clear mineral masses and decorative materials, but in many cases the listed localities provide minute gem crystals. A 2661 item biblography is included, more than worth the price of the book, $30.00. We compute this as about 3 good dinners, but the book is more lasting and digestible.

Neal Yedlin
129 Englewood Drive
New Haven, Connecticut 06515

The Record Bookshelf

***Die alpinen Kluftmineralien der osterreichischen Ostalpen*, by Heinz Weninger, published by the Vereinigung der Freunde der Mineralogie und Geologie (VFMG), Heiderlberg, 1974, Special Publication 25 of the journal *Der Aufschluss*, editor: Dr. Rudolf Metz, 75 Karlsruhe 41 (Durlach), Schlesierstrasse 48, W. Germany, 168 pages (in German).**

The book (the Alpine fissure minerals of the Austrian East Alps) is the kind of book that brings joy to serious collectors and museum curators who constantly must struggle with a very frustrating tangle of obscure locality designations when dealing with specimens from the Alps. Weninger's book is as valuable in providing useful information about the prolific Austrian Alps as Weibel's book on the minerals of Switzerland has been. Unfortunately, for many of its potential users, the text is in German, but this does not entirely negate its utility since the format is such that fluency in German is not required.

Following several short introductory sections, including a discussion of Alpine fissures, the book is an alphabetical listing of the minerals found. The mineral name, composition and crystal system are given, then one or more paragraphs of descriptive text in which paragenesis and crystal habits are emphasized. Finally, there is a list of the various localities from which the species have been reported. Under each locality is a very brief comment about some characteristic of the occurrence; such as crystal size or associated minerals, each referenced to a published description listed in the extensive bibliography at the end of the book. Under adularia are given 55 different localities, 60 for apatite, a huge number for quartz, and 49 for rutile - to name just some.

At the end of this section there is an alphabetical listing of major localities in the area, with the minerals that are found at each of them. The last section of the book includes a chapter devoted to the *strahlers* and it even contains a list of them (and collectors who are not strahlers) complete with addresses! A section of color plates (16) precedes the bibliography, and it should be mentioned that some 62 black and white photographs of average quality are dispersed throughout the book. The final touch is a marvelous set of 10 maps of the different segments of the Austrian East Alps, a tremendous aid in pinpointing localities.

I heartily endorse this book for anyone who is interested in locality references. It appears to be very carefully and meticulously prepared.

John Sampson White

***How to Invest in Gems: Everyone's Guide to Buying Rubies, Sapphires, Emeralds, and Diamonds*, by Benjamin Zucker, Quadrangle/The New York Times Book Co., New York, 1976 ($12.50).**

Here is a book that we just can't take too lightly, since it really does not impart much useful information about investing in gems. Rather, it is a strange mixture of promotion of the author's own company, extolment of his family, and much dubious or downright faulty information about gems, their origins and characteristics. It appears to have been hastily slapped together with little planning or research, and obviously there was no critical reading of the manuscript by someone knowledgeable in the field of gemology.

Zucker's thesis is that people with lots of surplus money can purchase very fine gems at full retail prices (or more, if they agree to pay an extra "advisory fee") from the nation's most expensive retail establishments and that these gems will eventually multiply many times in value, netting vast profits upon resale even though they must be sold for only their *wholesale* value (less whatever is spent for appraisals which, according to Zucker, cannot even be trusted). The evidence offered to support his contention that the values of superior quality rubies, sapphires, emeralds and diamonds have increased severalfold in a relatively short period of time is not awesome. He offers a table "History of Diamond Prices" showing how they have changed from 1968 to 1976 for various sizes, but the numbers in the table have come out of Mr. Zucker's head and are not supported by any published data, even though such data are available from rather reliable sources. He then cites a small number of isolated examples where certain stones were purchased for certain prices in one year and sold for many times those prices some years later. This proves nothing, as a shrewd dealer can duplicate some of these examples within a matter of days from purchase to resale.

In the introduction Zucker claims the book will show "how to evaluate their (gems) quality and worth; the mechanics of buying them, including how to talk knowledgeably to a gem retailer and help him to help you; when to resell." These things the book does not do; no secrets are revealed, no great revelations are made, no bargains are suggested. How can the reader learn to "talk knowledeably" from an author who cannot write knowledgeably?

Of the mere 107 pages of text, thirteen are devoted to buying rubies, six to sapphires, seven to emeralds and only three to diamonds. Twenty percent of the book (21 pages) is a disjointed discussion of the DeBeers diamond operations, except for about three pages unaccountably given over to the personal history of Zucker's family.

Technical errors, omissions, and other serious defects abound. A few examples follow:

p. 20 "The material (ruby) has been subjected to so much pressure that the crystal has actually spun around on its axis repeatedly while growing."

p. 35 "The chromium within the emerald crystal is composed of aluminum oxide and accounts for the depth of color."

p. 37 "Synthetic emeralds are made by mixing aluminum oxide with traces of

chromium under high heat and large amounts of pressure."
p. 75 "Fine quality specimen crystal groups with a mounting stand can be purchased from the following materials...rose quartz from Arkansas."

Even the bibliography has all the earmarks of an afterthought, and is a poor representation of what exists in the literature of gemology. New editions (both 1975) of the two leading gemology texts are not listed, and the only published catalog, in book form, of gem prices is not even mentioned.

I will close this review with the best advice found in the book "I advise you to purchase your gems from a fine retail establishment." We needed this book to learn this?

John Sampson White

***An Introduction To The Chemistry of Rocks and Minerals* by Max B. Perrin, Halstead Press division of John Wiley & Sons, 1975 ($5.95)**

This small volume (93 pages) is part of a series (No. 9 of Studies in Chemistry) edited by Bryan J. Stokes and Anthony J. Malpas, and is designed as a 6th form textbook; roughly equivalent to the American senior high school year. It is surprising that the effort of author, editors, and a publisher long associated with outstanding scientific publications should have resulted in such a poor product. The attempt to deal with this very broad and complex subject in so few pages may have been well intentioned, but it has resulted in an extremely superficial treatment of the material. This unfortunate circumstance is aggravated by the inexcusably high incidence of both factual and typographical errors. One quickly comes to the realization that the author is not really familiar with the material, and that the editors were either no better equipped or simply failed to do their job.

A few brief examples from the six chapters will serve to illustrate the shortcomings of the text. In chapter 1 the table of crustal abundances of the elements makes no mention of aluminum! In chapter 2 (Rocks and Minerals) the terms crystal class and crystal system are treated as equivalent, and X-ray diffraction is discussed solely by the following remarkable sentence: "X-ray diffraction has been of great help in the determination of crystal structures in the past, and is now used to establish the relationship of the colloidal-sized particles in clay minerals, and is the only method available which could cope with this task." In chapter 3 (The Structure of Minerals) we learn that clay minerals are *fragments of silicates*. A number of mineral formulas are in error, i.e. $Ca_2Si_2O_6$ for enstatite, and potash feldspars are stated to be monoclinic as opposed to triclinic because of the larger size of the potassium ion relative to calcium or sodium ion. Apparently the author is not familiar with the existance of microcline. Chapter 4 is presumptuously titled "Application of Chemical Principles to Geologic Problems." One might have hoped, this being a chemistry series, to find greater strength here, but it was not to be. Phase diagrams are very poorly if not inaccurately discussed, and one finds the antiquated view of *six distinct* (feldspar) *minerals* being *recognized* in the plagioclase series extended to the olivine group where *six distinct minerals are recognized*! We are also told that crystal, opal, agate, and chalcedony are polymorphs of quartz, and that gypsum and selenite are polymorphs of hydrated calcium sulfate. The chemist fares no better in chapter 5 (The Geochemical Cycle) where goethite is stated to contain iron in the ferrous state even though the accompanying formula clearly indicates that it is in the ferric state. Chapter six (Suggestions for Experimental Work) fares a little better—there are fewer errors, perhaps because there are fewer facts presented. Even here we find such an outlandish statement as "Very often several minerals are found together as a mixture. This is particularly true of the famous Sudbury ores, the mineral pyrrhotite being a mixed sulfide of iron, nickel and some cobalt." To top it all off we find on page 72 the word minerology (*sic*).

One can only hope that teachers will shun this text, and that students will be protected from exposure to it.

Abraham Rosenzweig

***Inventaire Minéralogique de la France: No. 3*, 29-Finistère (1973) (117 pages); *No. 4*, 06-Alpes Maritimes (1974) (167 pages); *No. 5*, 22-Côtes du Nord (1975) (210 pages); *No. 6*, 81-Tarn (1976) (147 pages). In French. They may be obtained from B.R.G.M., Departement Promotion et Vente, B.P. 6009, 45018 Orleans Cedex, France (35F each).**

The first two volumes of this topographical series were reviewed in *M.R.*, **6**, (1975), p. 43. The four volumes here listed continue the excellent work of the B.R.G.M. toward a complete description of the mineralogy of France. Each volume describes the mineralogy of a particular Department (equivalent to an American state or an English county) and bearing in mind that France is made up of over 90 Departments, it will take a long time to complete the series.

The format remains the same as in the first two volumes: a sketch map for each locality or group of localities, a note on how to find the locality and a list of the species recorded. However, improvements were introduced in the Finistère volume and continued in the subsequent ones. The general geology of the Department is outlined briefly at the beginning with a geological sketch map, the locality maps show some of the geology as well and there is a brief note on the geology of each deposit—all welcome inovations, especially to the foreigner who does not have access to the necessary geological maps.

The mineral lists are becoming more comprehensive. Having recently tried No. 1 in the series (15-Cantal) it appears that the lists were compiled from samples examined in polished section and rarely from hand specimens; the lists are dominated by the ore minerals and very few of the gangue or supergene species are mentioned. However, in the later volumes, the gangue minerals are described in some detail, often with crystallographic notes, and the lists of supergenes become quite lengthy—a trend which I favor.

Those familiar with the geography of France will note the selectivity of the areas so far covered. Finistère and Côtes du Nord are in the heavily mineralized Hercynian province of Brittany. Tarn is in the Massif Central and Alpes Maritimes speak for themselves. Cantal is also in the Massif Central and Hautes Aples covers the main French part of the Alpine Massif. There are still a lot of heavily mineralized Departments to cover in these three areas, not to mention the Vosges, the Ardennes and the Pyrenees. However, when it comes to such soft rock areas as Gironde and Pas de Calais, the volumes will, I think, be rather slim.

I would congratulate the B.R.G.M. on their achievement thus far and I look forward to the continuation of the series. My remarks in the previous review concerning worry at the publication of localities and their consequent depletion still hold. I hope my worries are unfounded.

Roger S. Harker

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