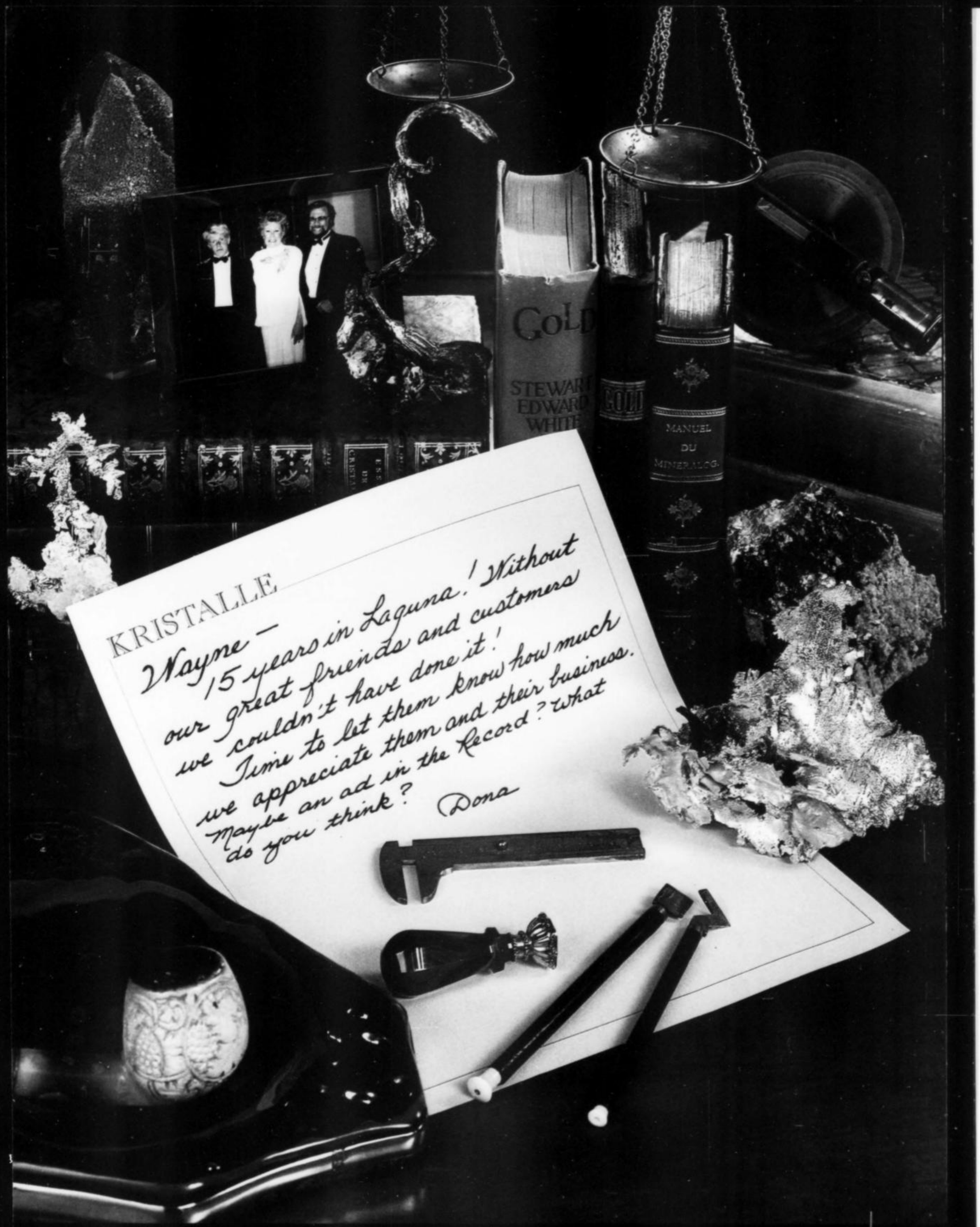
the Mineralogical Record Volume Seventeen, Number Five September-October 1986 $7.50



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The Mineralogical Record Inc. is a non-profit organization
The Mineralogical Record magazine (USPS-887-700) is published by the Mineralogical Record Inc., 7413 N. Mowry Place Tucson, Arizona 85741
Subscriptions
$27 per year, $52 for two years, $600 lifetime, domestic and foreign. Payment in U.S. dollars.

Mailing addresses & phone nos.:

Circulation, back issues, reprints
The Mineralogical Record
P.O. Box 35565
Tucson, Arizona 85740
602-297-6709

Editing, advertising
Wendell E. Wilson
Mineralogical Record
4631 Paseo Tubutama
Tucson, AZ 85715
602-299-5274

Special second class postage
Paid at Tucson, Arizona, and additional offices. POSTMASTER: send address changes to:
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the Mineralogical Record®

Volume 17, number 5, September-October 1986

Articles

Departments

COVER: AZURITE, 7.3 cm tall, from Tsumeb, Namibia. Houston Museum of Natural Science Collection. For more information on this collection see pages 293–295 of this issue. Photo by Harold and Erica Van Pelt.

EDITORIAL

What's Happening to Rockhounding?

Most readers of the *Mineralogical Record* tend to bristle when referred to as "rockhounds." They prefer to be called mineral collectors. In fact, they seem to prefer that term to "amateur mineralogist," which has something of a bush league sound to it. Better to be a full-fledged mineral collector than an amateur anything, so the reasoning seems to go.

Mineral collecting involves (at its fullest development) an encyclopedic knowledge of mineral localities worldwide, and a highly trained eye for making visual hand-specimen and microcrystal identifications. A firm background in the basics of mineral chemistry and crystallography are valuable to have, along with an eye for esthetics. Modern professional mineralogists, on the other hand, build their work around the use of expensive and sophisticated instrumentation which extracts detailed numerical data from tiny samples. Physics and esoteric crystallochemistry dominate their work and their thinking. And so it must be if they are to push back the frontiers of knowledge. But almost no one today is an amateur at such activities . . . you either learn it as a profession or you don't do it. Consequently, the gap between mineral collectors and professional mineralogists is clearly developed.

Fortunately, the gap is not hopelessly wide. Mineralogists, for example, can enjoy the *Mineralogical Record* for its overview articles on mineral localities (a category too general for pure research journals), descriptive mineralogy, and its emphasis on the study of habits and assemblages. Mineral collectors still refer to journals such as the *American Mineralogist* for descriptions and abstracts of new species. The point is, however, that a person's personal identity as mineral collector or professional mineralogist (or both) is based on a distinct set of characteristics developed over the last century or so.

What, then, of the "rockhound"? And how might he be defined? I would say that the average rockhound is a dabbler in many fields but a master of none. His interest is not in the accumulation of specialized knowledge, but in pleasant and relaxing activity, especially above-ground field collecting and craft work. His clubs and societies are primarily social organizations. He may well engage in lapidary work, but is not a professional jeweler or a gemologist. He may enjoy fossils, but has no intense interest in real paleontology. He may even have crystal specimens or rocks, but he does not relate to mineralogy, petrology, or geology in a focused manner. In short, he is a handicraft hobbyist and a "curio" collector, an unspecialized putterer with a barely awakened curiosity about the details of natural science. Is it any wonder that mineral collectors, with their insatiable curiosity, intense specialization and scientific bent, prefer not to be grouped with the rockhounds?

What amazes mineral collectors is the incredible *number* of people who have chosen to be rockhounds. Ten times our own ranks, perhaps? Or twenty? We assume we will always be vastly outnumbered. But in fact there is a major change taking place in the United States. It began to be felt ten or fifteen years ago, and in another ten or twenty years it will probably have resolved itself into a situation quite different from what we have become used to. The fact is, rockhounding appears to be dying.

The early warnings signs have been editorialized about and commented on privately for years. Remember when you could drive across the U.S. and visit dozens upon dozens of "rock shops." There seem to be fewer now. And what about the many gem and mineral clubs across the country? Most of them still exist, but most of their *members* are into retirement age now. Membership in the Midwest Federation, for example, has in recent years been declining at an annual rate of about 5%. Perhaps the most clear and startling evidence is the steady decline in the circulation of rockhound-oriented magazines such as *Lapidary Journal, Gems and Minerals,* and *Rock and Gem.* For the last decade their readership has been falling by about 6% per year, on the average, and they have now lost roughly *half* their total circulation . . . nearly 90,000 subscriptions lost! (See Fig. 1.)

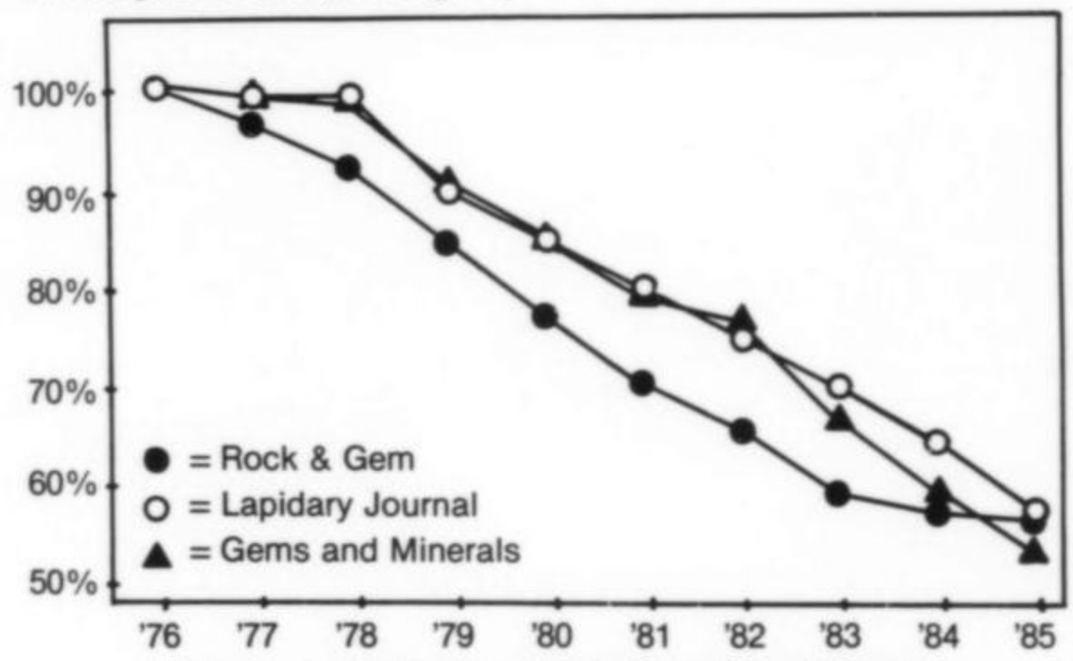

Figure 1. **Decline in circulation of rockhound publications, 1976–1985.** ***Lapidary Journal*** **peak circulation 66,200 in 1976; 37,400 in 1985.** ***Gems and Minerals*** **peak circulation 38,300 in 1977; 20,600 in 1985.** ***Rock & Gem*** **peak circulation 96,200 in 1976; 54,400 in 1985. For this graph, the peak circulations during the 1976–1985 period are set at 100% and the other years calculated relative to it. All data are from published Statement of Ownership reports for each publication. Note that if the trend continues unabated, all three journals will have zero circulation by 1995 or so.**

Of course there are still a great many rockhounds around. The three leading rockhound journals boast a combined circulation well in excess of 100,000, and we must assume that not every rockhound subscribes. I wouldn't be surprised if the total U.S. rockhound population was several times that subscription figure even now.

But it would appear that rockhounding has nevertheless failed to attract new recruits, and that this failure has persisted for decades before becoming noticeable. It is a suggestive fact that the number of people in their 60s or older who die or become otherwise unable to read magazines each year amounts to about 6% * . . . the same

* Information courtesy of the United States Census Bureau and the National Center for Health Statistics, Washington, D.C.

as the rate of circulation decline mentioned above.

Some people have pointed to this trend with alarm and asked what can be done to reverse it. A better question would be: is it too late?

I suspect that in trying to revive rockhounding, we'd be flogging a dead horse. If this phenomenon of few new recruits took hold 30 or 40 years ago, the hobby was already doomed then. Complex changes in society have taken place since the 1940s and 1950s, and the decline of rockhounding must be one effect. The odds against reversing it at this late date seem essentially insurmountable.

The important questions now are: (1) Is there a new pattern whereby people get into the earth sciences today? And (2) where do we go from here?

I think the number of people who begin with a general interest which then develops into a chosen specialty (mineral collecting, mineralogy, paleontology, geology, jewelry making, gemology, etc.) has not really declined, and may actually have increased. However, most people interested in activities more physical and social than intellectual now go directly into other types of hobbies instead, of which there are a great many available. Most of these activities require a little more money than toeing up agates in the desert, but people have more disposable income now than they did in the 1940s, especially with the great increase in two-income families.

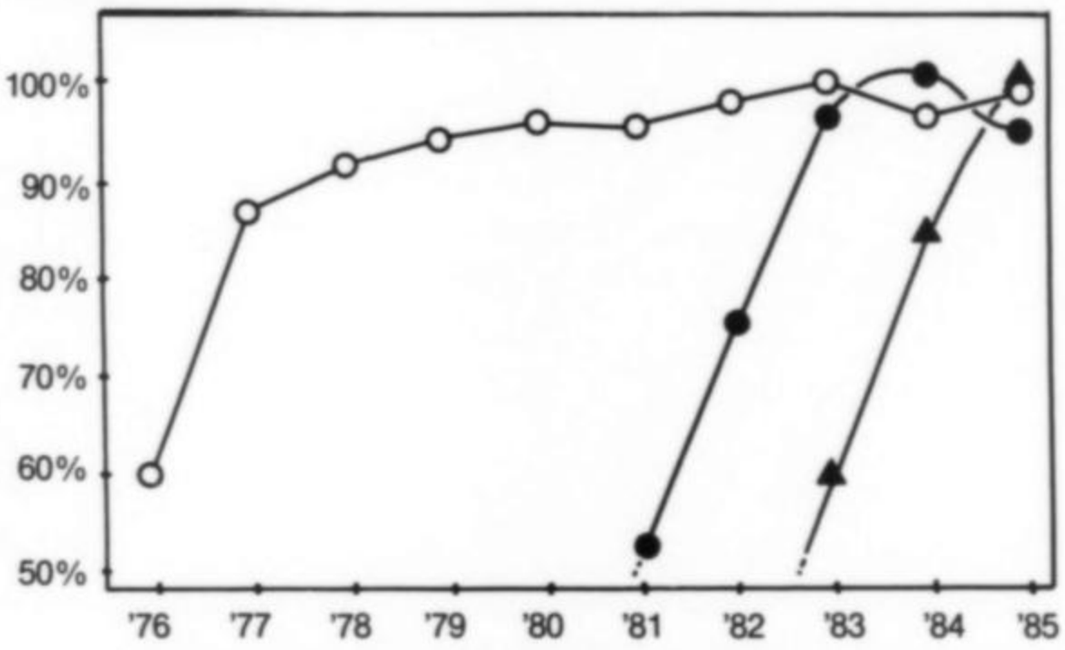

***Figure 2.* Growth of specialty publications, 1976–1985. Circles = *Mineralogical Record* (1985 = 6,466). Dots = *Gems and Gemology* (1985 = 9,500). Solid triangles = *Fossils Quarterly* (1985 = 1600). (Peak year for each magazine set at 100%.)**

People today are moving more rapidly from general interest into specialties, and there are fine specialty publications in most areas: *Gems and Gemology* for the gem specialist, *Fossils Quarterly* for the fossil collector, not to mention the *Mineralogical Record* for you-know-who. The trend has not gone unnoticed by the rockhound publications. *Lapidary Journal,* for instance, has just recently come under new ownership and has been completely revamped to attract a more specialized gemologist audience. *Rocks and Minerals* has been working to find an editorial mix more acceptable to mineral collectors, and their circulation slide has shown a corresponding up-turn.

Where do we go from here? The first thing we must do is identify potential losses to mineral collectors due to the decline of rockhounding. For example, a great reduction in the number of gem and mineral clubs across the country is probably on the way. *Some of these clubs sponsor mineral shows which we would not want to see closed!* Therefore, mineral collectors will have to become more involved in the production of these shows.

Another conclusion is that there is going to be a shake-out in the publishing industry. Books and magazines of the type which are supported, to a significant extent, by rockhounds will probably cease to be published. However, *collections* of these which have been built up over the years by rockhounds will probably come on the market during the next ten years. So a temporary opportunity to build one's library will be coupled with a challenge to support publication of as many worthwhile books and magazines as we can save.

And what about new recruits for mineral collecting? I would imagine that many long-time mineral collectors got their start, years ago, under the kindly guidance of a rockhound. The rockhounding approach is friendly, low-key, and unintimidating to the novice. From that gentle beginning, the courage to grow and learn and specialize can come forth in its own time, so that eventually the novice far surpasses his mentor. What we are facing here is a *major loss of mentors* for fledgling mineral collectors.

Many people today do not begin their interest in mineralogy as children, but in their 20s or 30s. They do not utilize clubs or societies, save in a few fortunate regions having active mineral collector-dominated clubs; instead they are initiated by a few friends who are already in the hobby. Some may not have their first exposure until college courses touch on the earth sciences, or until they come across interesting museum exhibits or visit a large mineral show on a whim. How do these people compare in number to those who got their start with the help of rockhounds? I don't know, but perhaps we should work to guarantee that mineral collecting does not suffer a major recruiting crisis when most of the rockhounds are gone.

I think the best conclusion to draw is that we, as mineral collectors, should work to put our own house in order. We may soon be coming out from under the shadow of half a million rockhounds. We'll be left to manage our own shows, support our own publications, safeguard the classic localities, and break in the beginners. Let's be sure we do it right. In fact, let's do it with style.

W.E.W.

NOTE ADDED IN PROOF:

As this issue was being typeset, *Gems and Minerals* magazine announced it would cease publication with the June 1986 issue.

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notes from the EDITOR

SKULLDUGGERY

Breathes there a mineralogist with soul so dead, who never to himself hath said, "Fossils are actually kind of interesting too"? Especially if they're decorator quality, for enhancing the office, den or collection room! Unfortunately, the *serious* fossil collectors have driven the price up so unconscionably on top-quality pieces that the casual shopper is in danger of life-threatening sticker shock. (Thank goodness such a thing could never happen in the mineral world.)

So, is there any hope for those of us who might like to have, for example, a nicely mounted saber-tooth tiger skull smiling at us from the mantle? There certainly is, provided we're willing to ac-

cept an extremely detailed and minutely well crafted full-size replica.

A company called Skullduggery (P.O. Box 1021, Brea, CA 92621) has these available, in a realistically hand-rubbed antique finish, for $88.75 postpaid (add $1 for Tar Pit finish, 6% tax for California residents). I've seen their work and it is excellent. The jaw is loose and fully articulating, the fangs are 6½ inches long. The Skullduggery catalog also features human, African lion, gorilla, chimpanzee, orangutan and grizzly bear skulls.

VARIETAL NAMES

In a way, varietal names are the curse of modern mineralogy. On the one hand, they are temptingly convenient to use. But they can also be scientifically awkward, imprecise, ambiguous, misleading, unnecessary or just plain wrong. They are also a source of inconsistency, and editors are always involved in a death-struggle against inconsistency. Yes, I remember what Emerson said ("Consistency is the hobgobblin of little minds"), but he undoubtedly meant to exclude editors, and just forgot to say so.

In any case, the time has come to formalize the *Mineralogical Record*'s stand on the use of varietal names (authors and *advertisers* take note):

1. Most varietal terms are of no practical use and will simply be omitted, e.g., selenite.

2. Some varietal terms commonly found on old labels or worth noting for historical reasons will be indicated in parentheses and quotation marks following the correct term, e.g., hematite ("martite"), acicular cuprite ("chalcotrichite").

3. A few varietal terms which are extremely convenient to use throughout a discussion will be identified the first time they appear in each article but not thereafter, e.g., melanite (= black titanian andradite), limonite (= a mixture of hydrous iron oxides).

4. Certain ancient names of gem varieties, universally understood, will be used without explanation. The list will be limited to the following: amethyst, aquamarine, emerald, ruby and sapphire.

OPPORTUNITY TO GET PUBLISHED

The long-awaited second edition of *Encyclopedia of Minerals* is currently in the final stages of preparation. The book will contain a great many mineral photos, most of which have already been selected. However, the publisher, Van Nostrand Reinhold, finds that it has space remaining for *up to 120 more mineral photos* in the color layout. No fee can be paid to photographers for these additional photos, but it is an opportunity to contribute to a major work and to see one's photos in print with full credit given.

Photographers interested in submitting photos for consideration should send them to: Encyclopedia Photos, c/o Mineralogical Record, 4631 Paseo Tubutama, Tucson, AZ 85715.

All photos will be returned following publication. Deadline for entries is November 1, 1986. Photos should be clear and sharp 35-mm transparencies accompanied by photographer's name, specimen owner's name, species, locality and size, plus a signed note granting Van Nostrand Reinhold permission for one-time use at no charge. Right is reserved to reject any or all photos submitted.

There is one further stipulation: In order to maximize photo coverage, only photos of species *not* already on file will be considered. Since most of the common species are already on file, entries should be limited more or less to the rare species.

MINERAL MUSEUMS OF EUROPE

The article in this issue by Ulrich Burchard on the Kremsmünster museum in Austria was taken largely from his recent book, *Mineral Museums of Europe*. Several illustrations are included here for which space was lacking in the book, and with a little prodding Uli can probably be persuaded to favor us with a few more expanded chapters from time to time. I should mention, however, that the Kremsmünster chapter in the book is unusual in not having any actual specimen photos; the rest of the volume is filled with them.

Incidentally, if anyone reading this would like a *German-language* edition of the book, copies may be obtained directly from Ulrich Burchard (Haindlfing, D-8051 Freising, West Germany), for 78 DM plus 5 DM postage on European orders and 20 DM postage on orders from North America.

BANCROFT LEATHER EDITION TO END

Peter Bancroft has announced that no more leatherbound copies of his book *Gem & Crystal Treasures* will be produced. As of May 19, fifteen copies were still in stock. People who had been procrastinating up to now but would still like a copy should contact our book department immediately; the price is still $230 postpaid (foreign orders add $25).

RARE JOURNAL to be REPRINTED

A wealth of interesting reading appeared in early American mineral collecting journals, but it is a sad fact that these journals are in grave danger of becoming "lost works." Their high-acid paper is crumbling and their rarity is therefore increasing. Press runs were small to begin with, and no library in the country, as far as I know, maintains a set. Even the Library of Congress lacks copies now (their set was sent out for binding a few years ago and was stolen or accidently discarded somewhere along the way).

The journals I am referring to are primarily those published by Arthur Chamberlain from 1885 to 1909. The titles and dates are as follows:

Exchanger's Monthly (1885–1890)
Mineralogist's Monthly (1890–1893)
Minerals monthly (1892–1893) (published by W. M. Goldthwaite)
The Mineral Collector (1894–1909)

The journals that followed these (*American Mineralogist* in 1916 and *Rocks and Minerals* in 1926) are still widely available, and *American Mineralogist* has been reprinted for the early volumes.

A complete set of *the Mineral Collector* today would be extremely expensive if it could be found. The Mineralogical Record has long thought of reprinting it as a literature reclamation project, but in all these years we've never found a set for sale, nor have we found anyone with even a partial set who was willing to sacrifice it to unbinding and certain, severe damage to the brittle paper as a result of handling during the reprinting process.

Now the good news: Lawrence Conklin (62 St. John Place, New Canaan, CT 06840) has located a complete set of *the Mineral Collector,* over 6000 pages in 15 volumes, and has decided to reprint a limited number of sets for collectors and libraries. The set will sell for $350 postpaid (softbound, with sewn bindings), and is, I think, well worth it considering the high unit cost of low-run printing. I particularly want to urge professional mineralogists to *demand* that their institution librarian order a set. This journal deserves to be preserved and made available to library users. And the reprint will be far superior to an original set in terms of durability.

If this reprint is well received, Larry plans to reprint the earlier three titles as well. Let's help him do it by supporting the project. Printing of *the Mineral Collector* is scheduled to be completed in October, so place your order now.

Incidentally, copies of Larry's book on George F. Kunz are still available at $150 postpaid for the regular edition and around $750 for the leather edition containing an original Kunz letter. (See vol. 16, p. 328–329 or write for brochure.)

People, Happenings And so forth

We are pleased to begin here a new column devoted to people and events of interest to mineral collectors. I hesitate to call it a "social" column . . . we intend for it to have more depth than that. But the tone will be kept informal, and the scope of subjects will be wide. The column is open to contributions from readers.

Ed.

HOUSTON MUSEUM EXHIBIT OPENS

The Houston Museum of Natural Science recently held a gala grand opening party for their new mineral exhibit of specimens from the Perkins and Ann Sams collection. Over 600 extraordinary specimens (about half the total collection) and several hundred gemstones were unveiled in the 6000-square-foot Lillie and Roy Cullen Gallery of Earth Sciences and the Exxon Hall of Fluorescent Minerals.

The black-tie affair, at $100/ticket and up, drew an enthusiastic crowd of Houston's philanthropic elite, prominent mineral dealers and collectors. One would never have guessed that mineral collectors could look so elegant!

The center of attention, of course, was the exquisite mineral collection, built at a cost of more than $6 million over a period of only four years by Perkins and Ann Sams. Consultant on nearly all of the acquisitions was Paul E. Desautels, former Smithsonian curator and *Mineralogical Record* associate editor.

Although of major scientific importance, the overriding theme of the collection is world-class esthetics. Many of the pieces are the finest known for their species. The displays are designed to have maximum esthetic impact, even on viewers unfamiliar with minerals. The specimens are treated with the care and reverence normally reserved for fine sculpture and rare objets d'art. The effect is astounding.

Upon entering the gallery from the second floor one first comes upon the "Crystal Pocket," a recreation of a pocket in the Elmwood mine near Carthage, Tennessee. A space of several cubic meters is lined with large, purple fluorite crystals, golden yellow calcites, lustrous sphalerites and white barite clusters.

In the following succession of adjoining display rooms all is dark save for the glowing, recessed exhibit cases set into curving walls. Dark forest-green cloth lines the cases and risers; labels are partially hidden from view so as not to distract from the specimens.

Mineral collectors will recognize many "old friends" in these cases . . . specimens that have become famous over the years. The great Alma (Colorado) rhodochrosite once owned by David Wilber is there, and also the "Seahorse" gold nugget.

The secret which allowed such an amazing collection to be built in such a short time was two-fold. First, Sams obtained the guidance of Desautels, who is considered by many to have the most refined and discriminating eye for esthetics of anyone in the mineral world. Second, Sams purchased not only single specimens but entire collections meticulously accumulated over many years by top collectors and dealers such as Edward Swoboda, Dave Wilber, Rustam Kothavala and Miriam and Julius Zweibel. In doing so he telescoped the collecting process by absorbing already sophisticated collections. The result was brought into the public sector when, through a series of major grants and donations, the Houston Museum of Natural Science was enabled to purchase the entire collection.

Figure 1. (From left to right:) **Ernest H. Cockrell (President, Museum Board of Directors) and wife Janet, Ann and Perkins Sams, mineral dealers Jeannie and Bill Larson, and Norma and Paul Desautels. Photo by Kaye Marvins.**

Figure 2. **Mimetite, 3.2 x 3.2 cm, from Tsumeb, Namibia. Sams collection; Van Pelt photo.**

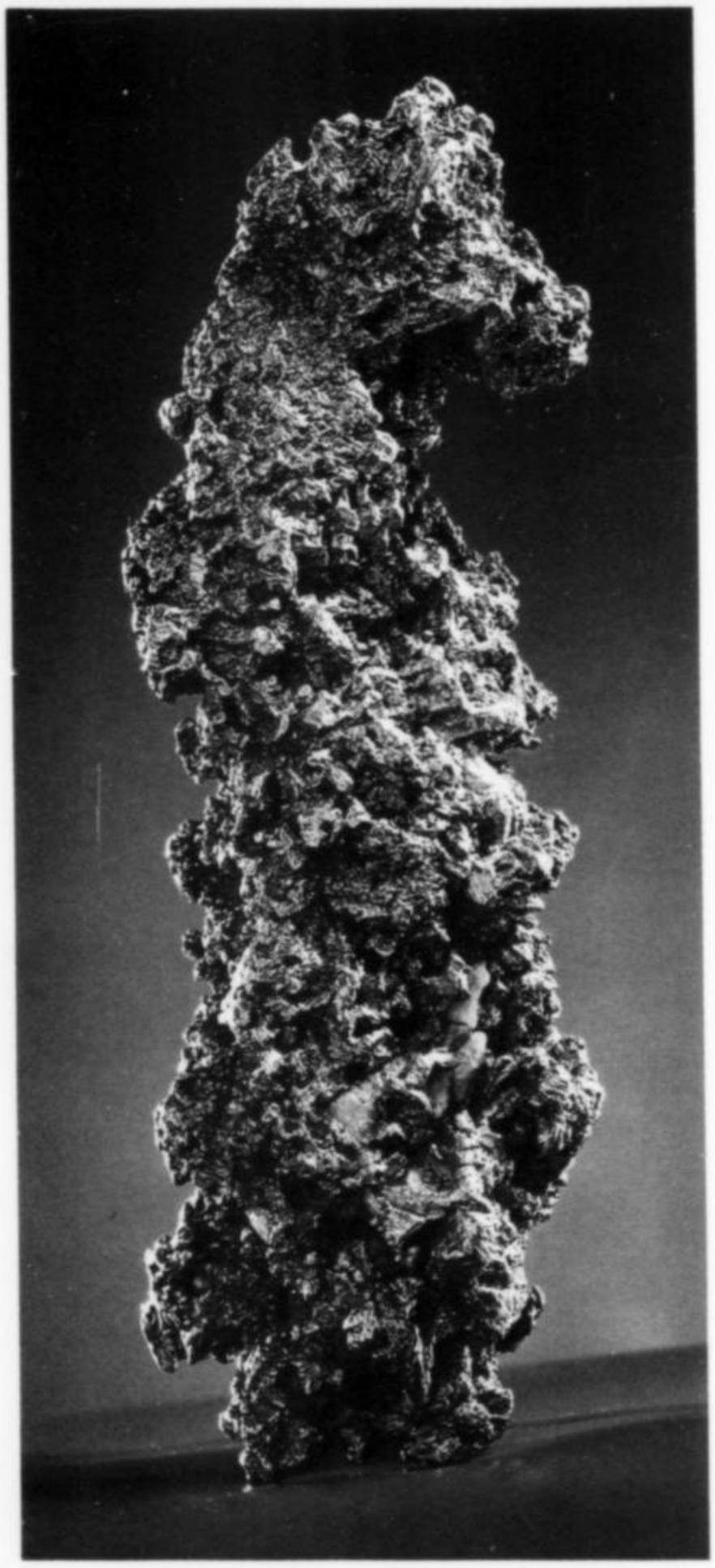
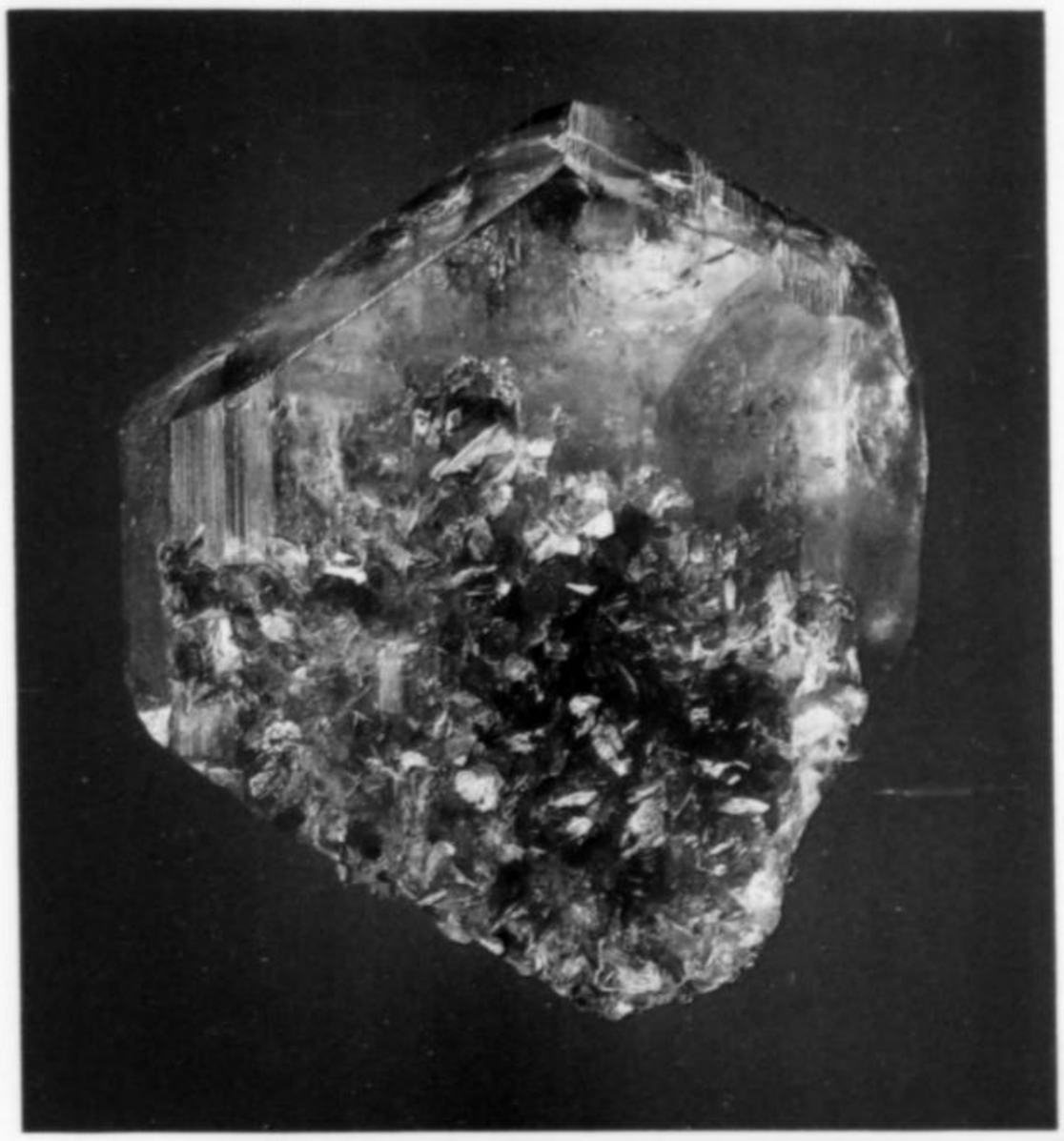


Figure 3. **The "Sea Horse" gold nugget, 17 cm tall, from California. Sams collection; Van Pelt photo.**

Figure 4. **Scorodite crystals to 1.3 cm, from Zacatecas, Mexico. Sams collection; Van Pelt photo.**

Figure 5. **Cerussite twins, 7.6 cm, from Touissit, Morocco. Sams collection; Van Pelt photo.**



The grand opening party, in true Texas style, boasted a great deal more than mere exhibits, however. Food, wine and champagne were abundant in every room on both floors. "Dinosaur ribs" (ribs are *big* in Texas), spinach crepes, roast duck, fried clams, raw oysters on the half shell, strawberries dipped in chocolate . . . it was a weighty experience. For those who could still move and who could break themselves away from the exhibits, there was dancing. In all, about 1000 people were on hand to celebrate the opening.

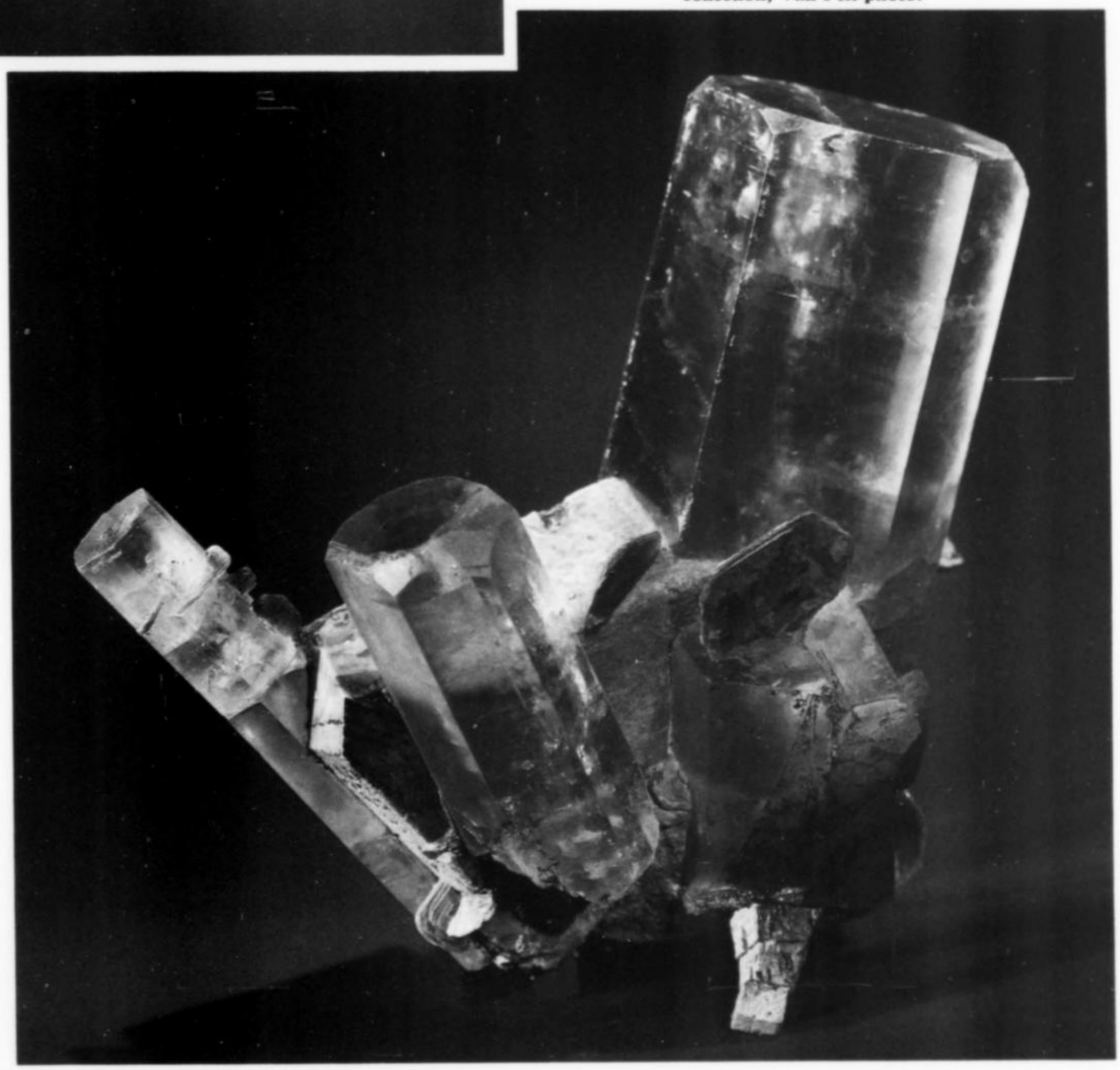
Paul Desautels basked in unalloyed praise for the impressive results of his efforts. And the museum officials are so pleased that they are considering applying his approach to other collections and exhibits of natural history objects in the museum.

The Houston Museum of Natural Science is located at 1 Hermann Cricle Drive (713-526-4273). Museum hours are 9-5 Tuesday-Saturday and 12-5 Sunday and Monday.

Gale and Richard Thomssen

Figure 6. **Brazilianite crystal, 8 cm, with muscovite from Corrego Frio, Minas Gerais, Brazil. Sams collection; Van Pelt photo.**

Figure 7. **Aquamarine crystals to 14 cm, from Virgem da Lapa, Minas Gerais, Brazil. Sams collection; Van Pelt photo.**



EXHIBITION!

"This is New England"

DEALERS:

Apple Valley Minerals Ltd.
Smithfield, RI

The Best of Canning
Burlington, MA

Blakeslee's Minerals
Wallingford, CT

John Bradshaw, Gemologist
Somerville, MA

DalinHa Designs
La Mesa, CA

D & F Enterprises
Pawtucket, RI

Facet Tool Co.
Oceanside, NY

Trafford Flynn
Norfolk, MA

The Gemmery
Sussex, NJ

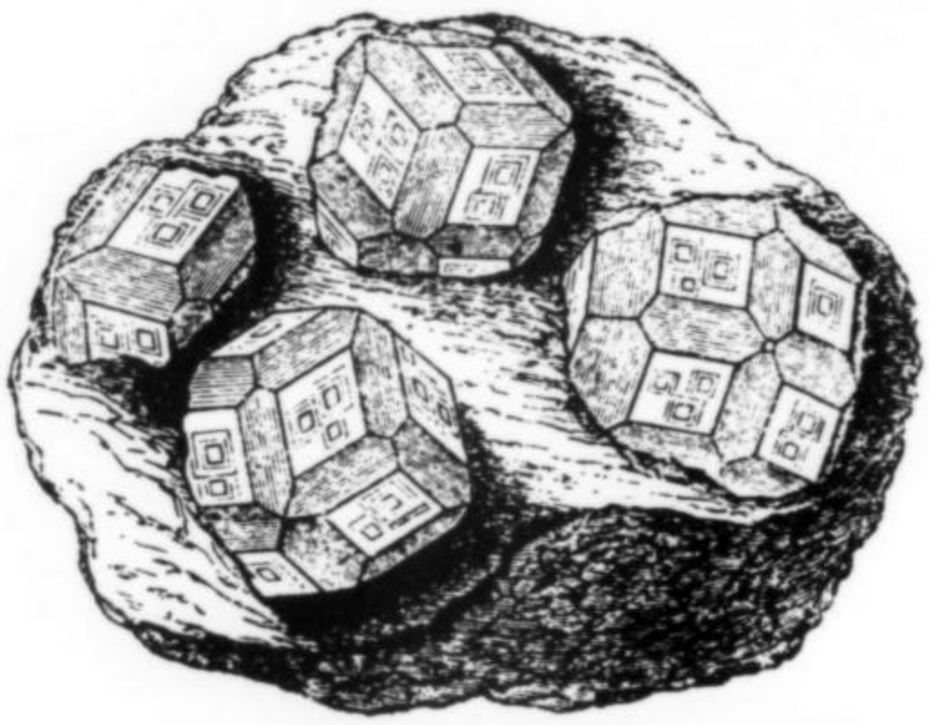
K & K International
Laurel, MD

The Lloyd's
N. Brookfield, MA

M. Phantom Minerals
Columbus, OH

Martin Minerals
Millersburg, PA

Mineral & Needle Craft Creations, Inc.
Oceanside, NY



Minerals America
Orlando, FL

The Museum Piece
E. Boston, MA

Nature's Nook
Lindenhurst, NY

Nutmeg Minerals
Durham, CT

Quality Minerals & Fossils
Boylston, MA

Quarry Enterprises
Northvale, NJ

Raytech Industries
Stafford Springs, CT

The Rocksmiths
Tombstone, AZ

STD Mineral Co.
Hyde Park, MD

Sea/Land Minerals
Peekskill, NY

The Showcase
Minoa, NY

Surf & Turf
Lake View, NY

Williams Minerals
Idaho Springs, CO

Willis Earth Treasures
Stewartsville, NJ

Gem & Mineral Show
October 25-26, 1986

Sponsored by:
Rhode Island Mineral Hunters
At: Community College of Rh. Is.
Knight Campus (Mall Exit I-95)
Warwick, Rhode Island

Show Chairman:
Marilyn F. Dodge
72 Woodbury St.
Providence, R.I. 02906
Tel: 401-751-5217

We are hosting the Eastern Federation Mineralogical and Lapidary Societies Convention & Show

Type Locality Minerals of the

BLACK HILLS, SOUTH DAKOTA

Kurt L. Triscori and **Thomas J. Campbell**
Museum of Geology
South Dakota School of Mines and Technology
Rapid City, South Dakota 57701

INTRODUCTION

The Black Hills of western South Dakota are a great storehouse of mineral wealth, and a great variety of mineral deposits are known to occur there. These range from Precambrian gold veins and pegmatites to Tertiary vein and replacement deposits. In this geographic area, measuring roughly 160 km long and 88 km across, over 300 mineral species have been found; of these, 22 minerals new to science have been described. The majority of these 22 were found in pegmatites, of which there are over 20,000 distributed largely within the central and southern Black Hills. Particularly prolific is the Tip Top pegmatite, the type locality for eight species (see Campbell and Roberts, 1986). In addition, 21 of the 22 are phosphates and 20 of the 22 have been described within the last 12 years, largely through the persevering work of Willard "Bill" Roberts at the Museum of Geology, South Dakota School of Mines and Technology, and Paul Moore at the University of Chicago. Two other minerals have been described from the Black Hills but are presently considered invalid species. All of the valid and invalid species are discussed herein, and all but one of the type localities are located on the map in Figure 1.

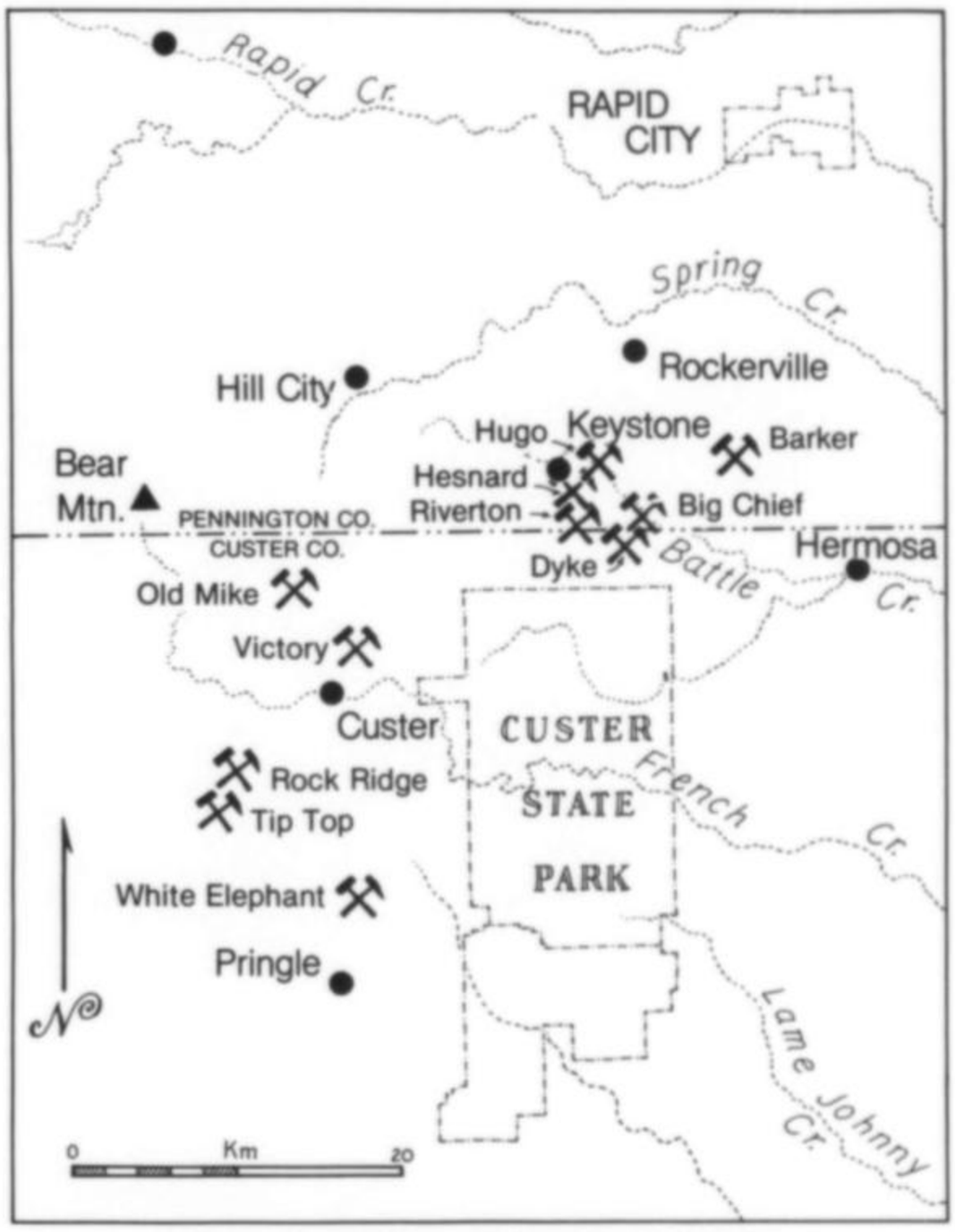


Figure 1. **Map of the southern Black Hills showing locations of eleven type localities.**

MINERALS

Ćernỳite Cu_2CdSnS_4

Ćernỳite was first discovered at the Hugo pegmatite, near Keystone in 1947 but was tentatively identified as stannite. In 1969, ćernỳite was found at the Tanco pegmatite, Bernic Lake, Manitoba. Ćernỳite from both occurrences was subsequently described by Kissin *et al.* (1978). At the Hugo mine the mineral occurs as irregular grains in the form of ćernỳite-kesterite intergrowths that range in size from under 1 mm up to 12 cm and are disseminated in quartz. Kissin *et al.* (1978) suggest that the intergrowths are crystallographically controlled and may represent an exsolution texture. Ćernỳite grains free of kesterite rarely exceed 200 μm in maximum dimension and to this date no crystal forms or cleavages have been observed. In hand specimen ćernỳite is steel-gray with a metallic luster; however, weathered surfaces are dull greenish gray to iron-black. Ćernỳite has a Mohs hardness of 4. Due to their similarity, ćernỳite and kesterite cannot be distinguished in hand sample. In reflected light in oil ćernỳite is anisotropic and is bireflectant from creamy gray with a yellow tint to pale gray (Kissin

et al., 1978). The mineral was named in honor of Dr. Petr Ćerný of the University of Manitoba, Canada.

Cuprocassiterite (discredited species)

Massive green to brown vitreous material found at the Etta pegmatite near Keystone was described as a new tin mineral by Ulke (1893) and named cuprocassiterite. In the same year, William P. Headden described the material as a mixture of alteration products formed by the breakdown of stannite. Subsequently in 1914, Victor Ziegler determined pseudomalachite ($Cu_5(PO_4)_2(OH)_4 \cdot H_2O$) to be the predominant mineral in the mixture.

Ehrleite $Ca_4Be_3Zn_2(PO_4)_6 \cdot 9H_2O$

This new species was described by Grice and Robinson (1984) from the Tip Top pegmatite near Custer, and only two matrix specimens are known. Ehrleite occurs as colorless, tabular, triclinic, 0.2-mm bladed crystals associated with roscherite, parascholzite, mitridatite and crandallite. The mineral was named in honor of Howard (Bud) Ehrle.

Ferrowyllieite $(Na,Ca,Mn)(Fe^{+2},Mn)(Fe^{+2},Fe^{+3},Mg)Al(PO_4)_3$

This mineral was described from the Victory pegmatite near Custer by Moore and Ito (1979) and is the iron analog of wyllieite. Ferrowyllieite, however, was originally described as wyllieite by Moore and Ito in their 1973 paper but later investigations of a wyllieite-like mineral from the Old Mike mine near Custer proved to be iron-deficient. The mineral described from the Victory pegmatite was shown to have more iron and wyllieite was then resubmitted as ferrowyllieite and the iron-poor material from the Old Mike mine was named wyllieite by Moore and Ito (1979). Ferrowyllieite is triclinic and occurs as euhedral to subhedral crystals but is more commonly found as large masses of interlocking crystals weighing up to approximately 20 kg (45 pounds). It is deep blue-green to deep oily green, gray-green and green-black, and has a vitreous to submetallic luster. Ferrowyllieite is associated with scorzalite, muscovite, schorl, albite, perthitic microcline and quartz.

Fransoletite $H_2Ca_3Be_2(PO_4)_4 \cdot 4H_2O$

Fransoletite, named in honor of Dr. André-Mathieu Fransolet of the University of Liege, Belgium, was described by Peacor *et al.* (1983) from the Tip Top pegmatite near Custer; it has thus far been found nowhere else. The mineral occurs as subvitreous, milky to white, arrowhead-shaped crystal aggregates up to 3 mm in maximum dimension. These aggregates are composed of thousands of thin platy microcrystals in subparallel growth. Peacor *et al.* (1983) found the dominant forms of the composite crystals to be {100}, {011}, and {010}. The mineral has a Mohs hardness of 3 and a white streak. Fransoletite is found in association with tiptopite, roscherite, hurlbutite and montgomeryite, all of which commonly occur in fractures within beryl and quartz (Peacor *et al.*, 1983; Campbell, 1984). Fransoletite is often found perched on or intimately intergrown with tiptopite. According to Peacor *et al.* (1983), fransoletite may be related to the herderite-väyrynenite group.

Griphite $Na_4Ca_6(Mn,Fe^{+2},Mg)_{19}Li_2Al_8(PO_4)_{24}(F,OH)_8$

Griphite, the first new mineral species described from the Black Hills (Headden, 1891), is found as dark brown to brownish black masses at the Riverton Lode (Everly mine) near Keystone. Masses up to about 23 kg have been recovered. Griphite is generally translucent with a resinous to vitreous luster and exhibits no cleavage but has an uneven to conchoidal fracture. Unaltered nodules of griphite up to 2 meters across have since been found at the Sitting Bull mine northwest of Keystone (Roberts and Rapp, 1965).

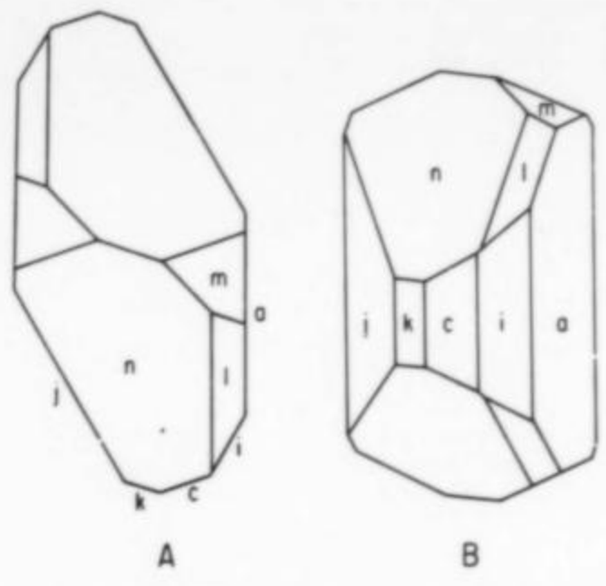


Figure 2. **Crystal drawings of jahnsite; A. Plan. B. Clinographic (Moore, 1974).**

Jahnsite $CaMn(Mg,Fe^{+2})_2Fe_2^{+3}(PO_4)_4(OH)_2 \cdot 8H_2O$

Jahnsite was originally described from the Tip Top pegmatite near Custer (Moore, 1974), where it occurs as well developed, short prismatic crystals commonly striated parallel to [010]. Dominant forms are {001}, {100}, {$\bar{2}$01}, {201}, and {$\bar{1}$11} (Moore, 1974). Crystals are typically 0.1 to 1 mm in length; however, crystals to 1 cm have been found (Campbell, 1984). The mineral is nut-brown to green-brown, yellow-orange and greenish yellow, and is transparent to translucent with a vitreous to sub-adamantine luster. Jahnsite is found with leucophosphite, hureaulite, vivianite and other secondary phosphate minerals in altered triphylite masses. Jahnsite was named for the late Dr. Richard Jahns of Stanford University.

Kehoeite $(Zn,Ca)Al_2(PO_4)_2(OH)_2 \cdot 5H_2O$
(Approximate formula)

Kehoeite was first discovered by Henry Kehoe at the Merritt lead-silver mine near Galena; it was subsequently described by William P. Headden in 1893 and named after the discoverer. The species is considered doubtful; neither original nor additional material can be found to verify the occurrence. Kehoeite was described as white, chalky, amorphous masses occurring as seams and bunches in argentiferous galena-pyrite-sphalerite ore (Roberts and Rapp, 1965).

Maghagendorfite $NaMn(Mg,Fe^{+2},Fe^{+3})_3(PO_4)_3$

Maghagendorfite was first discovered in the Dyke Lode near Keystone, as a result of an extensive study of Black Hills phosphates conducted by Paul Moore of the University of Chicago. It is the magnesium analog of hagendorfite (Moore and Ito, 1979).

Metavivianite $Fe_{3-x}^{+2}Fe_x^{+3}(PO_4)_2(OH)_x \cdot (8-X)H_2O$

Ritz *et al.* (1974) described metavivianite from the Big Chief mine near Keystone. Metavivianite is isostructural with symplesite; however, it is not isostructural with vivianite (Dormann and Poullen, 1980). Metavivianite is found as green, flat prismatic, opaque to translucent, «1-mm crystals in solution cavities in triphylite intergrown with dark red kryzhanovskite. Metavivianite crystals are elongated parallel to [001] with {110} as the dominant form (Ritz *et al.*, 1974).

Olmsteadite $KFe_2^{+2}(Nb,Ta)(PO_4)_2O_2 \cdot 2H_2O$

Olmsteadite was first discovered at the Hesnard mine near Keystone, and just a few months later it was found at the Big Chief pegmatite near Keystone. At the Hesnard mine, olmsteadite occurs as deep brown to black, transparent to translucent, thick, crystals tabular parallel to (100), and is associated with red-brown, botryoidal rockbridgeite. Crystals found at the Big Chief pegmatite are deep brown, red-brown to black, tabular parallel to (001), elongated on [010], and are associated with granular siderite and

Figure 3. **Olmsteadite crystal, 1 mm, from the White Cap mine. Julius Weber photo.**

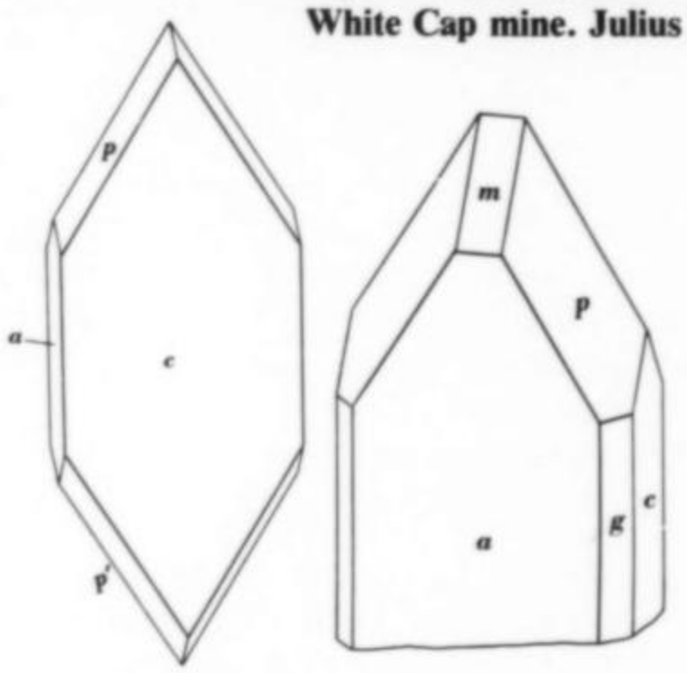


Figure 4. **Crystal drawings of olmsteadite. Left: Big Chief pegmatite. Right: Hesnard pegmatite (Moore *et al.*, 1976).**

quartz. Olmsteadite from the Big Chief pegmatite is commonly Ta-deficient compared to specimens from the Hesnard mine (Moore *et al.*, 1976). The mineral is a product of hydrothermal alteration of triphylite-lithiophilite and columbite-tantalite. Olmsteadite was described in 1976 by Moore and others and was named in honor of Milo Olmstead of Rapid City, South Dakota.

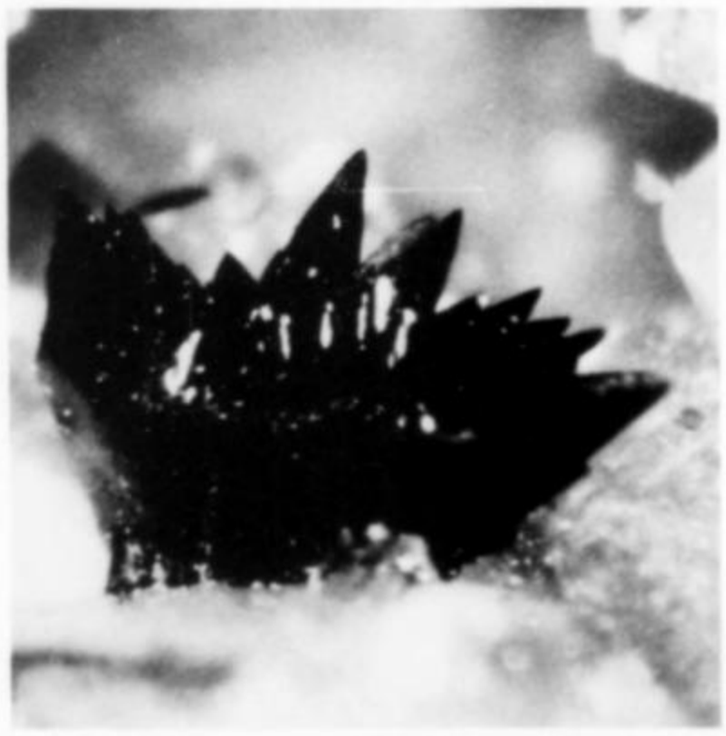


Figure 5. **Spray of perloffite crystals, 1.5 mm, from the Big Chief mine. Julius Weber photo.**

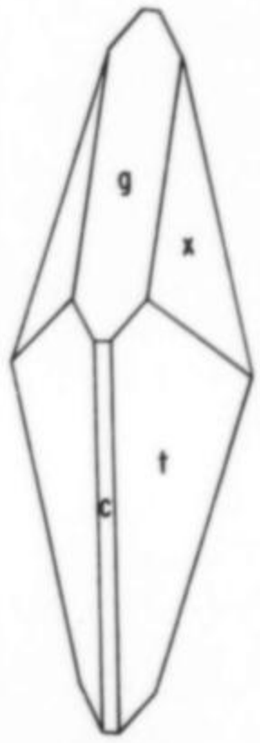


Figure 6. **Crystal drawing of perloffite (Kampf, 1977).**

Perloffite $Ba(Mn,Fe^{+2})_2Fe_2^{+3}(PO_4)_3(OH)_3$

Perloffite, the iron analog of bjarebyite, was discovered at the Big Chief pegmatite and was subsequently described by Kampf (1977). It was named for Louis Perloff of Tryon, North Carolina. Perloffite occurs as dark brown to almost black, spear-shaped crystals that are commonly 0.1 mm in maximum dimension and rarely reach 1 mm in length. It occurs with ludlamite, hureaulite, vivianite, messelite, beraunite, rockbridgeite, whitmoreite and siderite.

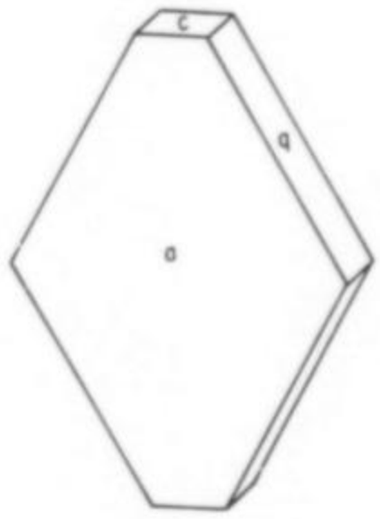


Figure 7. **Crystal drawing of robertsite (Moore *et al.*, 1974).**

Robertsite $Ca_3Mn_4^{+3}(PO_4)_4(OH)_6 \cdot 3H_2O$

Robertsite was described by Moore *et al.* (1974) from the Tip Top mine near Custer and was named for Willard L. Roberts of Rapid City, South Dakota. Robertsite, the manganese analog of mitridatite, occurs as vitreous to adamantine, deep red to black, translucent, tabular to barrel-shaped crystals up to 5 mm in maximum dimension. It is also found as stalactitic and dendritic aggregates, and as botryoids up to about 2 cm across that exhibit a radial-fibrous to platy internal structure. Robertsite is most commonly associated with messelite, collinsite, jahnsite and leucophosphite. Robertsite assemblages are found in pockets of altered triphylite masses and along fractures cutting quartz.

Rosemaryite $(Na,Ca,Mn^{+2})(Mn^{+2},Fe^{+2})(Fe^{+3},Fe^{+2},Mg)Al(PO_4)_3$

Rosemaryite was described by Moore and Ito (1979) from the Rock Ridge pegmatite near Custer. This was one of four new mineral species found as part of Moore's extensive study of the wyllieite group. Rosemaryite is named in honor of Mrs. F. Rosemary Wyllie.

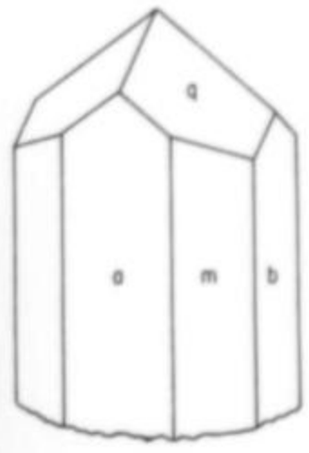


Figure 8. **Crystal drawing of segelerite (Moore, 1974).**

Figure 9. **Segelerite crystals, 1 mm, on robertsite from the Tip Top mine. Lou Perloff photo.**

Segelerite $CaMgFe^{+3}(PO_4)_2OH \cdot 4H_2O$

Segelerite was described by Moore *et al.* (1974) from the Tip Top mine and was named for Curt G. Segeler of Brooklyn, New York. Segelerite occurs as elongated, prismatic, orthorhombic prisms

which are commonly vertically striated and are roughly square in cross-section. Common forms consist of {100}, {010}, {110}, and {121}. Segelerite typically occurs as vitreous, pale yellow-green to chartreuse, transparent to translucent crystals up to 1 mm in length. It is found with collinsite, robertsite and hydroxylapatite in altered triphylite nodules.

Figure 10. **Colorless sinkankasite crystals to 2 mm with strengite, from the Barker mine. Julius Weber photo.**

Sinkankasite $H_2MnAl(PO_4)_2(OH)\cdot 6H_2O$

Sinkankasite was described by Peacor *et al.* (1984) from the Barker pegmatite near Keystone. It was initially discovered over twenty years earlier by Bill Roberts, and was long thought to be gatumbaite by everyone but Bill. It was named in honor of John Sinkankas of San Diego, California. The mineral occurs as vitreous to dull, elongate, bladed, prismatic crystals ranging from 0.2 to 4 mm in length. Crystals invariably exhibit polysynthetic twinning parallel to (100) (Peacor *et al.,* 1984). Crystals are colorless and often occur as divergent, radial clusters and as spheroidal aggregates. Sinkankasite occurs in solution cavities within altered triphylite crystals and also along fractures in quartz, microcline, albite and muscovite. It is sometimes found completely replacing subhedral to euhedral triphylite crystals (Peacor *et al.,* 1984). Associated minerals include vivianite, hureaulite, carbonate-apatite, strengite, barbosalite and fluellite.

Soda-Triphylite (discredited name)

In 1914, Victor Ziegler described material from the Nickel Plate pegmatite near Keystone as a new mineral species. He described the material as dark green, vitreous to greasy masses, and named it soda-triphylite. Unaware of the work done by Ziegler, Percy Quensel described the same material in 1937 and named it headdenite, after William P. Headden who first collected and analyzed the material in 1891. Several years later, in 1942, a mineral was found in Brazil having the composition $((Na_2)(Fe^{+2},Mn^{+2})_5(PO_4)_4$. Unaware of the work by either Ziegler or Quensel on material of the same composition, Djalma Guimaraes described it as a new species and named it arrojadite. Since then, the names soda-triphylite and headdenite have been discredited and arrojadite accepted as described by Guimaraes.

Tinsleyite $KAl_2(PO_4)_2(OH)\cdot 2H_2O$

This mineral was described from the Tip Top pegmatite near Custer by Dunn *et al.* (1984). Tinsleyite occurs as thin (‹ 0.1 mm), vitreous, magenta-red to dark purple, morphologically continuous overgrowths on leucophosphite; a well developed parting surface occurs between the two species (Dunn *et al.,* 1984). Crystals are exceedingly rare, but are identical in habit to leucophosphite and are rarely more than 1 mm in maximum dimension. Tinsleyite occurs in highly altered triphylite masses associated with tavorite, leucophosphite, frondelite/rockbridgeite, carbonate-apatite, robertsite, laueite and jahnsite. Tinsleyite was named for Frank C. Tinsley of Rapid City, South Dakota.

Tiptopite $(Li,K,Na,Ca,\square)_8Be_6(PO_4)_6(OH_4)$

Tiptopite (Grice *et al.,* 1985) was named for the Tip Top pegmatite near Custer. It occurs as radial aggregates composed of colorless, vitreous, elongate, hexagonal prisms terminated by the pinacoid and ranging from ‹ 1 mm to 5 mm in length and up to 0.1 mm in width. Tiptopite is one of several phosphate species comprising a suite of minerals with a very complex paragenesis (Campbell and Roberts, 1986). Some associated minerals include roscherite, fransoletite, montgomeryite, hurlbutite and englishite. Tiptopite occurs primarily along fractures in beryl and quartz.

Walentaite $H_4(Ca,Mn,Fe)_4Fe^{+3}_{12}(AsO_4)_{10}(PO_4)_6\cdot 28H_2O$

This mineral was discovered at the White Elephant pegmatite near Pringle. Walentaite (Dunn *et al.,* 1984) was named in honor of Dr. Curt Walenta of the University of Stuttgart, Germany. It occurs as bright yellow to pale brown crystals having a vitreous luster. As noted by Dunn *et al.* (1984), walentaite crystals are bladed and reach only 20 μm in width, 60 μm in length and 1–2 μm in thickness; crystals are flattened on (010) and elongate on [001]. Walentaite occurs in four assemblages; however, the most common consists of thin crusts and druses of walentaite coating loellingite, quartz, frondelite/rockbridgeite and muscovite in severely altered triphylite nodules. Walentaite is the result of extensive hydrothermal alteration of triphylite and loellingite (Dunn *et al.,* 1984).

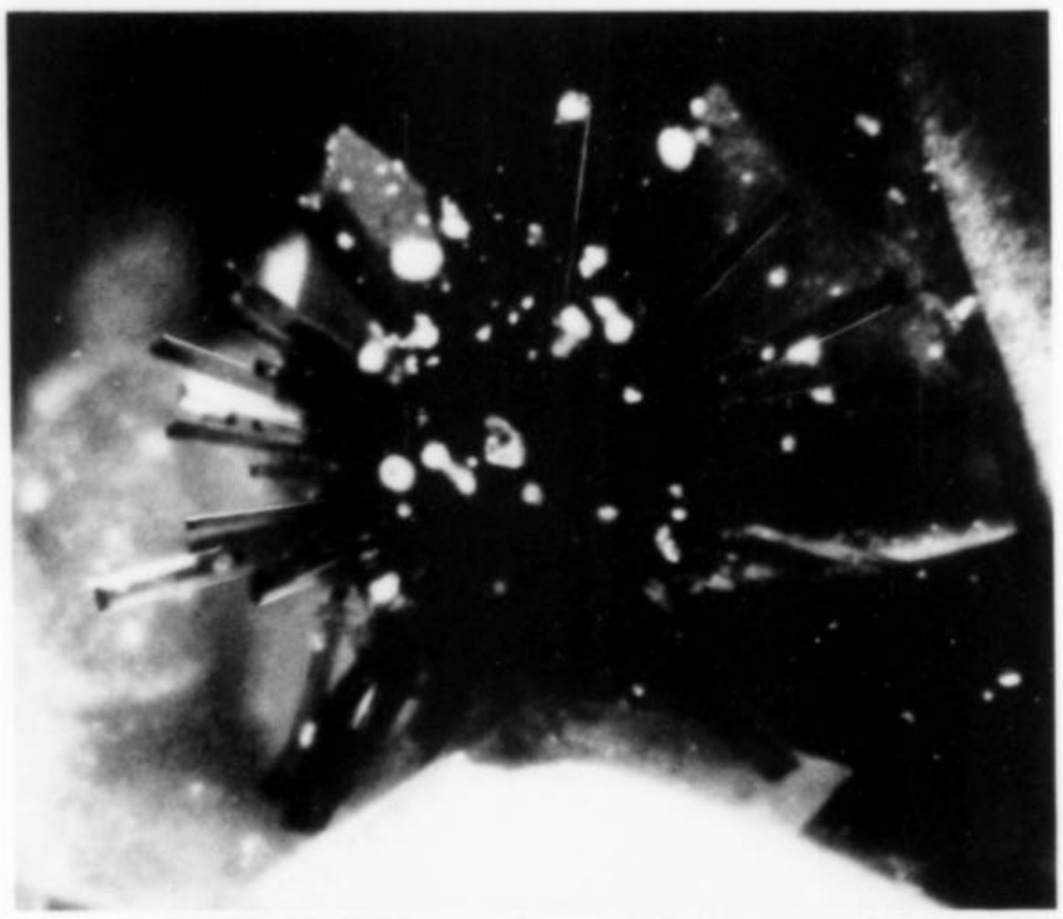


Figure 11. **Whitemoreite crystal aggregate, 1.5 mm from the Big Chief mine. Julius Weber photo.**

Whitmoreite $Fe^{+2}Fe^{+3}_2(PO_4)_2(OH)_2\cdot 4H_2O$

In the early 1960s specimens of a new mineral were collected from the Big Chief pegmatite near Keystone. Shortly thereafter, specimens of the same species were culled from the Fitzgibbon pegmatite, East Alstead, New Hampshire, and in 1973, specimens of the same species were found at the Palermo No. 1 pegmatite in North Groton, New Hampshire. The mineral was subsequently described by Moore *et al.* in 1974, and named whitmoreite in honor of Robert Whitmore of Weare, New Hampshire. The Big Chief pegmatite, credited for the first discovery, is considered the type

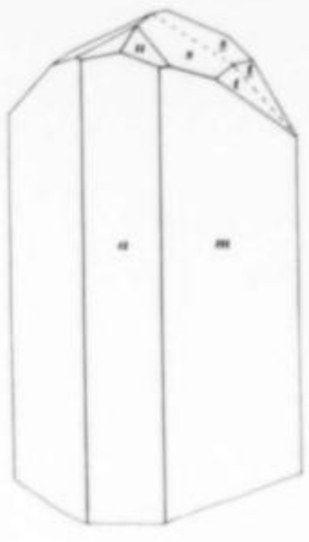


Figure 12. **Crystal drawing of whitemoreite (Moore *et al.*, 1974).**

locality. Whitmoreite occurs as fan-like aggregates or clusters resembling floating naval mines consisting of thin acicular crystals that range from 0.1 to 2 mm in length and 0.05 to 0.3 mm in width. Single crystals are prismatic with a rhombohedral cross-section and have chisel-shaped terminations. Whitmoreite is vitreous to subadamantine in luster and is pale tan to deep brown and greenish brown in color. It is often perched upon ludlamite, siderite or quartz and is associated with later formed minerals such as strunzite, laueite, beraunite and mitridatite.

Wyllieite $(Na,Ca,Mn^{+2})(Mn^{+2},Fe^{+2})(Fe^{+2},Fe^{+3},Mg)Al(PO_4)_3$

Wyllieite was described from the Old Mike pegmatite near Custer by Moore and Ito (1979). Physical properties are the same as those discussed under ferrowyllieite.

Unnamed Phosphate

This new species was found at the Tip Top mine in 1982, as part of an extensive study by Campbell (1984), and is presently being characterized. It is very rare and only a few specimens are known. It is restricted to olive-green roscherite-bearing assemblages (Campbell, 1984) and is found as glassy, colorless to pale pink or pale yellow-green, isometric crystals that are less than 1 mm in diameter. Associations include roscherite, tiptopite and englishite.

Unnamed Wicksite-like Mineral

$(Mn,Fe^{+3},Fe^{+2},Na,Ca)_7Ca_2(PO_4)_6(OH,H_2O)_4$

This mineral is the possible manganese analog of wicksite and occurs as dark green to pale green, compact lamellar aggregates in pyrite and as medium green crusts composed of ‹ 0.01-mm platy crystals in vugs in barbosalite (Peacor *et al.*, 1985). The luster is pearly on cleaved surfaces; however, unfractured surfaces appear dull. It occurs in masses of barbosalite up to 1 meter in diameter and is associated with pyrite, strengite, phosphosiderite and gypsum at the Bull Moose pegmatite, Custer County.

AVAILABILITY

Over half of the species discussed above can still be found on mine dumps or in old mine workings, though some of the species are more abundant than others. It is very unlikely that species such as ehrleite, fransoletite and tiptopite will ever be encountered again at the Tip Top mine; they were found in an area of the pegmatite which has been mined out. Very little of the material hosting these minerals is left on the dump because they were chiefly associated with beryl which was mined and shipped for ore.

The availability of other minerals such as metavivianite, perloffite, walentaite and whitmoreite is very limited, though it may improve if there is renewed mining activity at the type localities. Species such as cernyite, maghagendorfite, olmsteadite, rosemaryite and wyllieite may be found on the dumps of their respective mines if the collector is willing to work hard and put in some long hours. Ferrowylieite, griphite, segelerite, sinkankasite, tinsleyite and the unnamed wicksite-like mineral are not common but are somewhat more easily obtained. Any visitors to the Tip Top mine should easily find at least one specimen of jahnsite and robertsite by examining triphylite in the dump material. In addition, a day's work on the dumps of the Barker mine should produce at least one specimen of sinkankasite.

CONCLUSION

Not including the species discussed in this article, the authors have been notified that at least four new species are presently being characterized from the Black Hills. Through the continuing efforts of the amateur mineralogist, whether it be the novice weekend collector, the serious species collector or the pegmatite specialist, the Black Hills should continue to produce mineral species new to science.

ACKNOWLEDGMENTS

The authors would like to extend their sincere thanks to W. L. Roberts for many helpful discussions and use of photographs. Thanks are also extended to Debbie Bakeberg for typing the manuscript.

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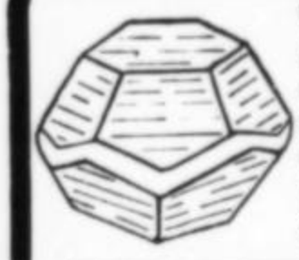

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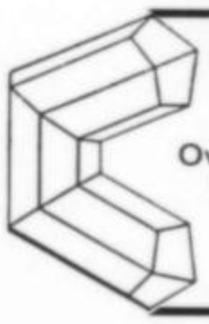

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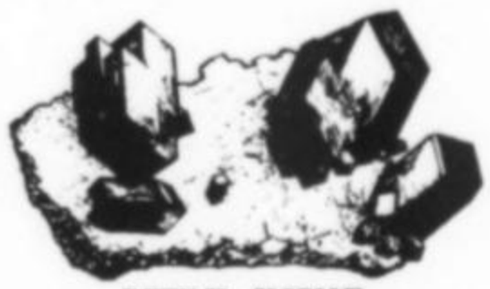

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Minas Gerais, Brazil

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The Urucum pegmatite first became famous over 13 years ago when major quantities of large, gemmy beryl and spodumene crystals were found. Rarer species including karibibite and schneiderhoehnite have been collected in recent years.

INTRODUCTION

The Córrego do Urucum pegmatite, also known as the Lavra (= mine) do Tim, is situated east of the town of Galiléia and about 50 km east-southeast of Governador Valadares. This is near the Rio Doce Valley in far eastern Minas Gerais. Map coordinates are x = 241.4, y = 7894.8, on the Conselheiro Pena 1:100,000 quadrangle (SE-24-Y-C-11).

Access from Governador Valadares is by a good but unpaved road leading toward Mantena until it reaches São Vitor. From there a road toward Conselheiro Pena forks to the right and continues on to Galiléia. From Galiléia a narrow mine road passes upstream along the Córrego (= creek) São Tome and then along the Urucum valley for about 11 km to the mine property entrance, fording the creek five times along the way. A 1-km trail leads to the mine buildings at an elevation of about 300 meters.

The region is dissected into gently undulating grass-covered hills dominated by barren or spottily forested granite inselbergs and sugarloafs. The population, scattered throughout the valleys, lives by farming.

Rocks in the area belong to the Paraiba group, lower Precambrian in age (1980 m.y.). Mica-staurolite schists of the São Tome formation have been intruded by granites and pegmatites (Moura *et al.*, 1978). Granitic rocks near Galiléia have been dated at 550 to 600 m.y. (Barbosa *et al.*, 1966). Many local pegmatites have been mined, mainly for beryl, tourmaline, spodumene, mica and feldspar.

DESCRIPTION OF THE DEPOSIT

The pegmatite consists of a large, lenticular body running east-southeast and having a steep westerly dip. The adjoining wall rock is a fine-grained biotite granite with large potassium feldspar phenocrysts lacking any preferred orientation. A clear zonation characterizes the pegmatite body. A thin, schorl-rich zone in sharp contact with the granite wall rock is followed by a coarser granitic zone (thickest between the 320 and 335 levels). Inward from there is the zone of giant crystals, with replacement bodies and large pockets. More than 10 tons of feldspar crystals, spodumene laths up to 2 meters in length, schorl crystals near a meter, large muscovite books and fine beryl crystals have been removed from this zone. At the 335 level irregular masses of smoky quartz were found associated with bodies of uraninite and loellingite. The core zone of the pegmatite, visible on the 335 level, consists of milky quartz in crystals up to 1 meter.

The thickness of the pegmatite body exceeds 20 meters near the central portion and appears to thicken with depth. Schist xenoliths, surrounded by large schorl crystals, are common. Pegmatitic apophyses puncture the surrounding granite country rock at many places.

HISTORY

For more than 20 years the Urucum pegmatite was worked for industrial muscovite, lepidolite, beryl and feldspar. Large stopes were developed and were connected by several adits (see mine

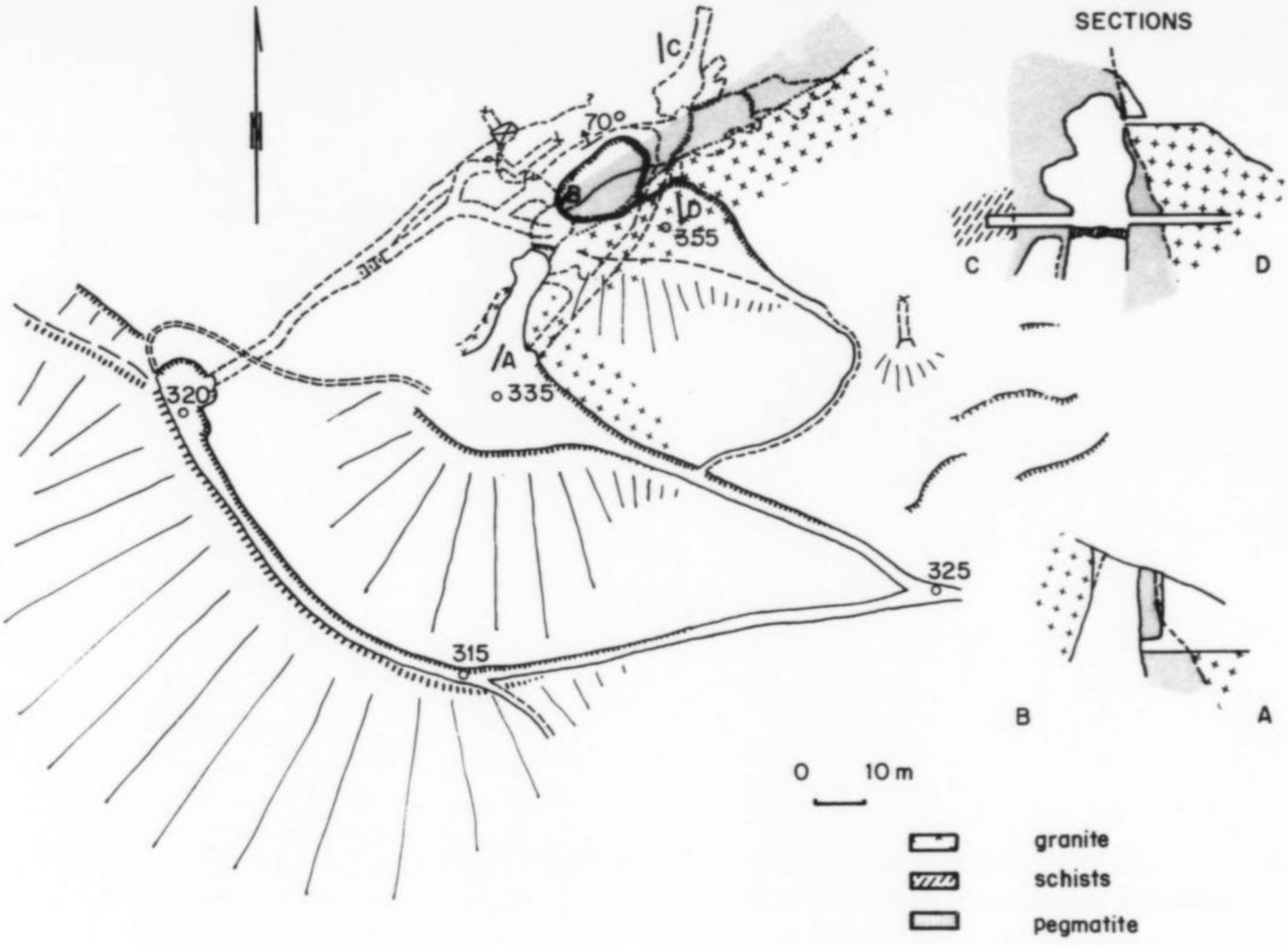

Figure 1. **Mine map of the Corrego do Urucum pegmatite.**

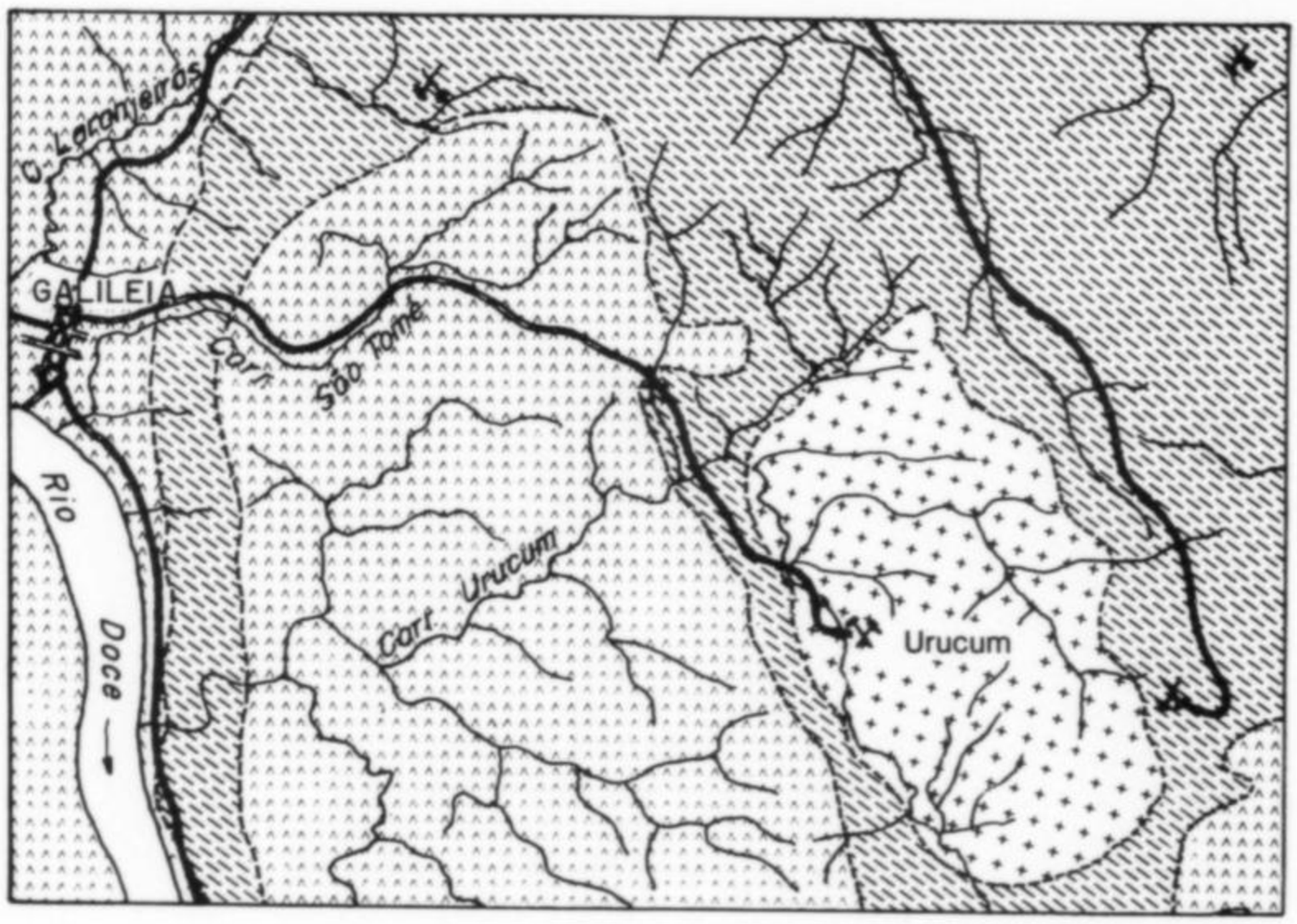

Figure 2. **Regional geology east of Galiléia (after Moura *et al.*, 1978).**

map). The 335 short adit opens into a large stope on the 335 level; from there an adit runs 20 meters through the giant crystal zone and a few meters into schist (which may be country rock or just a very large xenolith).

The 320 shaft (now partially flooded) was sunk near the contact between the giant crystal zone and the granitic zone.

In 1968 a zone rich in kunzite (= lavender spodumene) was discovered. The crystals, many of them broken, occurred abundantly in disrupted masses measuring about 1.5 meters across and suspended in clay. Mining of this kunzite-rich zone left a stope 20 meters high and 10 x 15 meters across. Roughly 3000 kg (6600 pounds!) of gem spodumene were produced, of which 500 kg rated as very fine, gem-quality kunzite plus a few green and yellow crystals. The largest single crystals weighed just under 2 kg.

In 1973 another crystal pocket was discovered within 2.5 meters of the kunzite stope. This one was vertically cylindrical in shape, about 2 meters in diameter and 10 meters tall. The sides were lined with cleavelandite (= white platy albite). A total of 300 kg of fine morganite crystals (= pink beryl) were removed, some crystals enclosing dark green tourmaline needles and measuring up to 25 cm across. Schorl and crushed quartz were abundant in the clay pocket filling. No spodumene was found in association, but hollow molds of feldspar appear to have formed around spodumene crystals now gone.

The 320 adit level was opened in order to explore the possible downward extension of the morganite pocket.

MINERALS

Albite $NaAlSi_3O_8$

Albite occurs as large white masses and as thick coatings of platy crystals ("cleavelandite"). Molds, apparently after spodumene, show a rectangular cross-section in the void. Boxworks of such rectangular voids in albite are common and are probably a leaching phenomenon related to the final phase of pegmatite formation. The voids reach up to 40 cm in length.

Figure 3. **Beryl ("morganite") crystal, 3.2 cm tall, consisting predominantly of the form {3141}. R. Gaines specimen.**

Beryl $Be_3Al_2Si_6O_{18}$

Large masses of pale blue, cracked and opaque, industrial-grade beryl have been encountered. A few rare, gemmy blue crystals have also been found. But the beryl for which the deposit has become famous is morganite, in large, partially gemmy crystals. These crystals are typically six-sided and flattened on the *c* axis, leaving a large and lustrous *c* face. Rare, predominantly bipyramidal crystals are also known. Many of the crystals are zoned, with a salmon-pink core and lighter rim. Crystals are typically large, some reaching 25 cm across. Associations include blackish green tourmaline needles and pencils, and also white albite.

Biotite $K(Mg,Fe^{+2})_3(Al,Fe^{+3})Si_3O_{10}(OH,F)_2$

Biotite is found scattered through the granitic zone as small, elongated flakes, commonly weathered.

Bismuth Bi

Native bismuth has been found rarely as irregular patches in loellingite. Generally it is only identifiable in polished section.

Cassiterite SnO_2

Cassiterite occurs as small, scattered grains in feldspar.

Cookeite $LiAl_4(Si_3Al)O_{10}(OH)_8$

Coatings of small, gray-green cookeite crystals enveloping tourmaline needles on cleavelandite are common and make attractive micromounts. Silky to fine-grained, pale pink to lavender cookeite masses occur as a replacement of spodumene.

Dickite $Al_2Si_2O_5(OH)_4$

Irregular patches of dickite mixed with pharmacosiderite have been identified by X-ray diffraction.

Elbaite $Na(Li,Al)_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$

Tourmaline is plentiful at Urucum, generally as blackish green needles in milky quartz and on cleavelandite, as blackish brown needles and clusters with loellingite, and more frequently as black prisms (probably schorl) up to 1 meter in length. The cores of these large crystals commonly contain colorless to blue or apple-green tourmaline (probably elbaite) perhaps representing a different growth stage. Fine, gemmy, equant crystals having bluish green color and steep terminations are also known. Felted masses of dark green, acicular crystals are sometimes found between cleavelandite blades. Some tourmaline crystals show chatoyancy.

Fluorapatite $Ca_5(PO_4)_3F$

Crystals of fluorapatite to a centimeter or so and masses up to several tens of centimeters have been found. The crystals are a waxy gray-green with a spongy, corroded exterior.

Hematite Fe_2O_3

Hematite occurs primarily in association with uraninite, and is identifiable in polished section as rhombohedral plates.

Hoernesite $Mg_3(AsO_4)_2 \cdot 8H_2O$

Hoernesite occurs very rarely as thin, very pale to water-green coatings scattered along fissures in loellingite.

Karibibite $Fe_2^{+3}As_4^{+3}(O,OH)_9$

Massive to finely banded karibibite occurs along fissures in loellingite, and as typical, golden, reticulated coatings around broken remnants of loellingite. It is also found in boxworks as thin coatings, clusters and spherically radiating groups of needles to 1 mm in length. Color varies from pale to brownish orange; the streak is bright yellow. Unlike Namibian karibibite, the Urucum material does not fluoresce.

Karibibite is easily soluble in dilute acids, is slightly pleochroic, and has refractive indices over 1.90. The powder diffraction pattern for Urucum material closely resembles that of the type material (Cassedanne and Cassedanne, in press).

A wet chemical analysis of Urucum karibibite yielded: As_2O_3 = 71.14%, Fe_2O_3 = 28.69%, H_2O_{total} = 0.28%, or, on the basis of

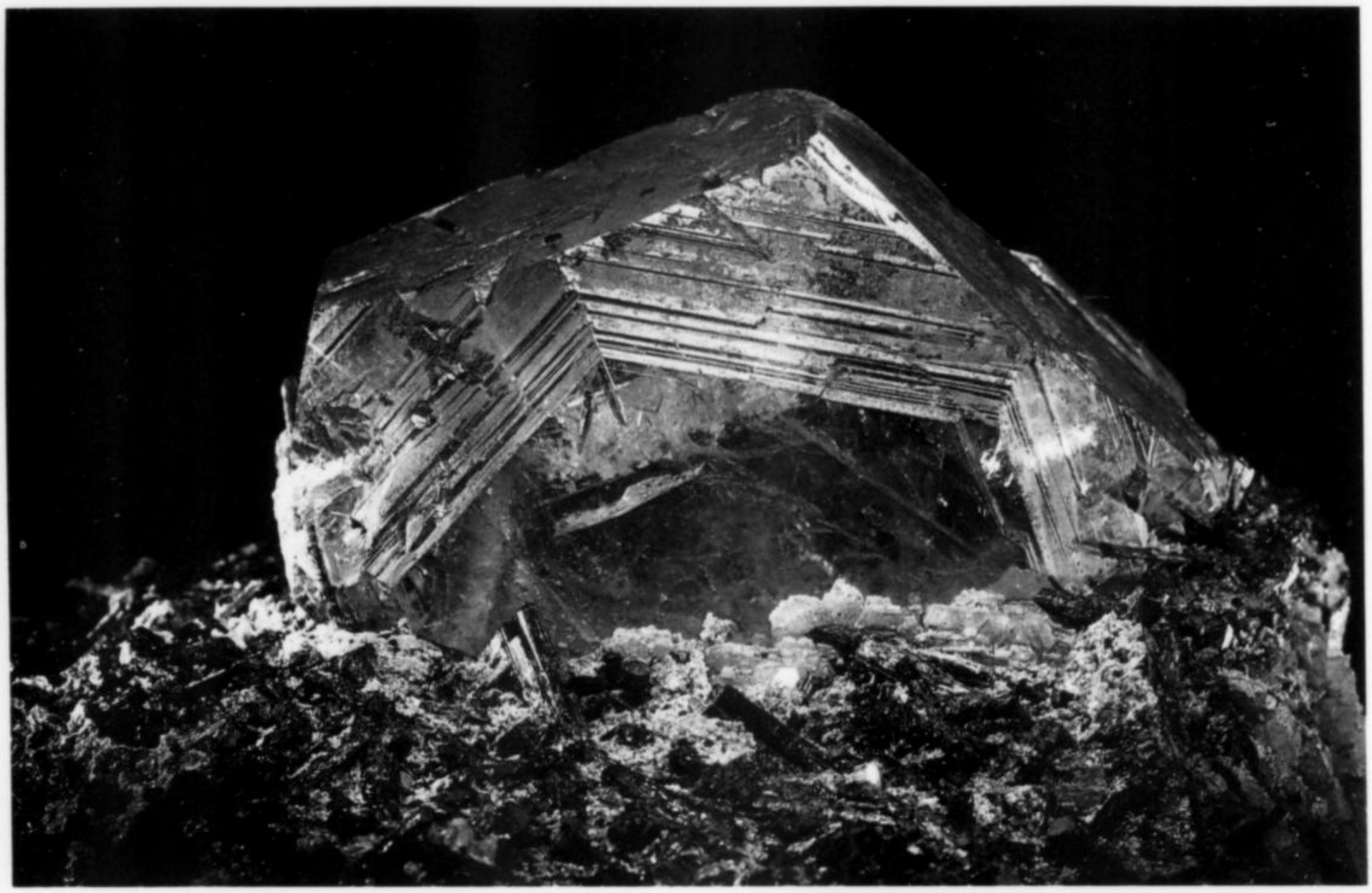

Figure 4. **Beryl ("morganite") crystal, 7 cm, with tourmaline and albite. Olaf Medenbach photo.**

9 oxygens, an ideal formula of $As_4Fe_2O_9$ or $(AsO_3)_3(Fe_2As)$ as Knorring, *et al.* (1973) suggested.

The Urucum pegmatite is the second Brazilian occurrence of karibibite (with the Mulundu pegmatite; Cassedanne and Cassedanne, 1980), and the fourth reported in the world. Of the four, the Urucum is certainly the richest presently known; fine and abundant specimens, from micromount to cabinet size, may be collected on the dumps.

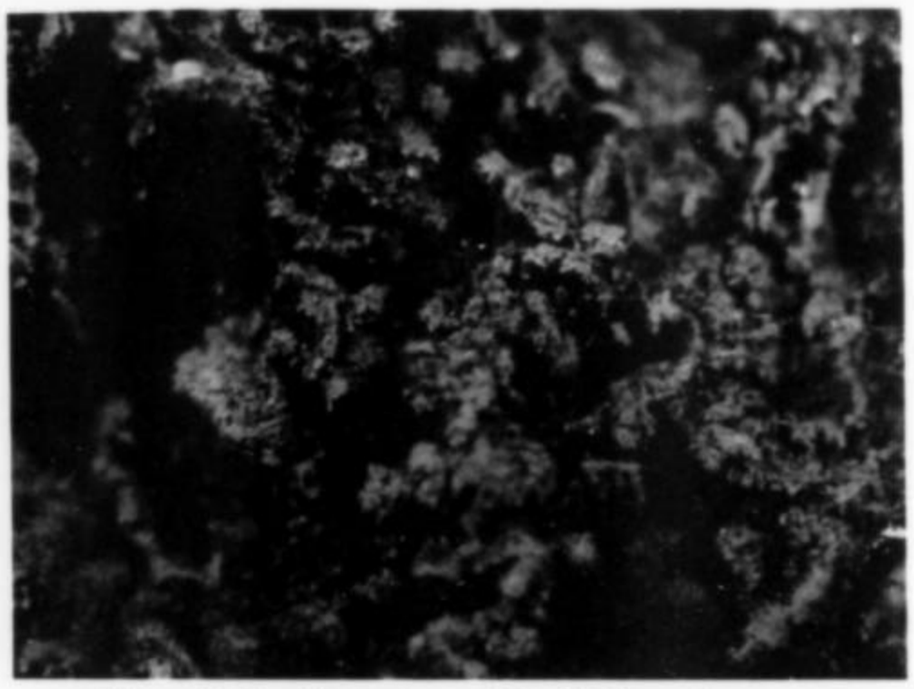

Figure 6. **Small clusters of karibibite microcrystals; the view is 3.5 cm across. Author's specimen and photo.**

Loellingite $FeAs_2$

Loellingite occurs as masses several tens of centimeters in size, enclosed in feldspar. Due to intensive shearing, the masses part into slabs coated by scorodite, karibibite and schneiderhoehnite as alteration products. Small tourmaline needles and specks of

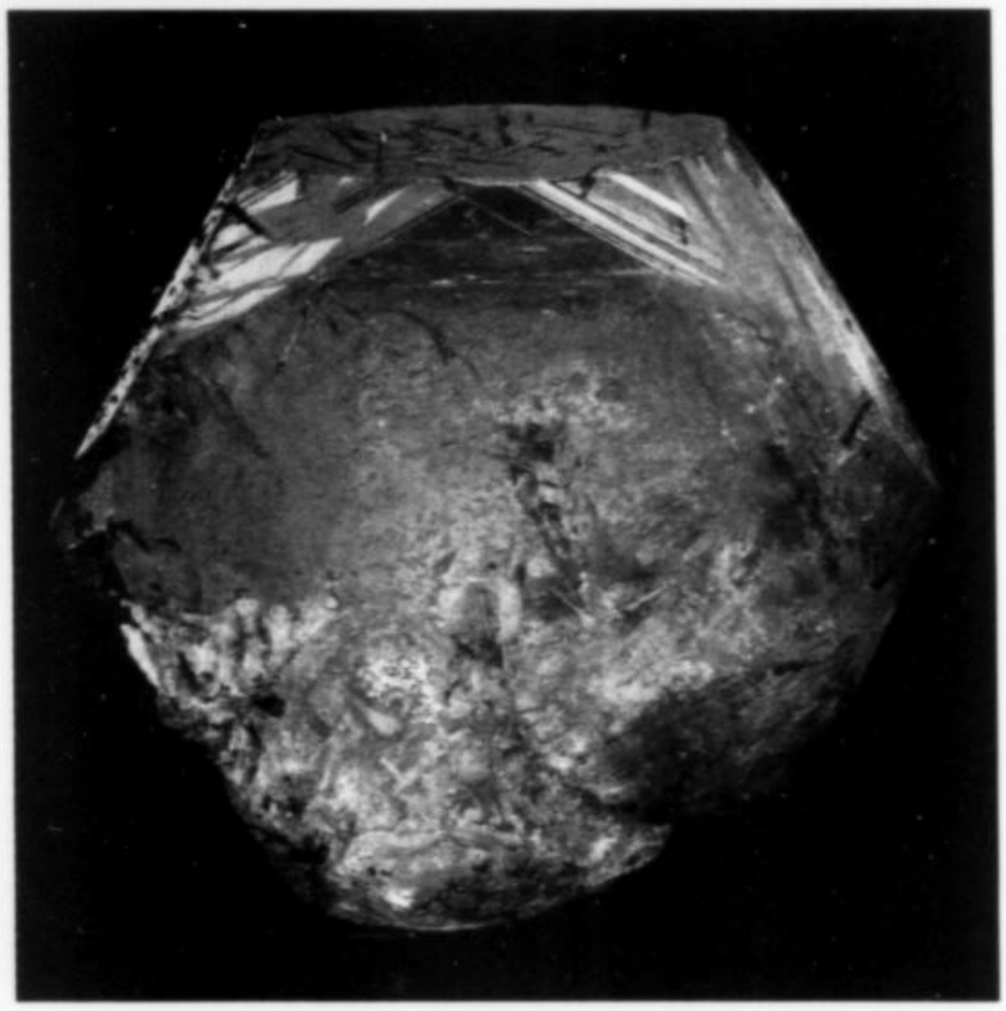

Figure 5. **Beryl ("morganite") crystal, 12 cm across. Keith Proctor specimen; Van Pelt photo.**

bismuth form scattered inclusions. Small euhedral crystals may be found at the contact between orange garnet crystals and tourmaline needles. But loellingite is never found in association with uraninite.

A wet chemical analysis yielded: As = 77.93%, Fe_2O_3 = 21.68%, H_2O_{total} = 0.38%.

Microcline $KAlSi_3O_8$

Masses of microcline weighing up to 10 metric tons are common near the pegmatite core. Microcline also forms long, white to beige or pale pink prisms, commonly twinned on the Baveno law.

Figure 7. **Spessartine crystal, 6.3 cm, with cut stones. R. Gaines specimens.**

Figure 8. **Microcline crystal (Baveno twin), 14.7 cm tall. R. Gaines specimen.**

Microlite $(Na,Ca)_2Ta_2O_6(O,OH,F)$

Small (to several mm), tan to yellowish tan crystals of microlite occur sparsely scattered through feldspar.

Montmorillonite $(Na,Ca)_{0.33}(Al,Mg)_2Si_4O_{10}(OH)_2 \cdot nH_2O$

Montmorillonite clay is found as porous, pale pink to pale orange masses filling boxworks after spodumene.

Muscovite $KAl_2(Si_3Al)O_{10}(OH,F)_2$

Muscovite books are abundant, sometimes twinned, and measure up to 25 cm across.

Nontronite $Na_{0.33}Fe^{+3}_2(Si,Al)_4O_{10}(OH)_2 \cdot nH_2O$

Nontronite occurs as yellowish green to spinach-green masses and fissure coatings in feldspar. Good samples are easily collected.

Opal $SiO_2 \cdot nH_2O$

Opal ("hyalite") occurs as thin, transparent, mamillary crusts lining fissures. It is sporadically fluorescent a bright green.

Pharmacosiderite $KFe^{+3}_4(AsO_4)_3(OH)_4 \cdot 6\text{–}7H_2O$

Apple-green, transparent to translucent pharmacosiderite is found infrequently as euhedral, modified cubes to 0.5 mm in size. The crystals occur as coatings on iron oxides and on crystals of schneiderhoehnite.

Phosphosiderite $Fe^{+3}PO_4 \cdot 2H_2O$

Phosphosiderite occurs with karibibite as pale blue to lavender microcrystals.

Phosphuranylite $Ca(UO_2)_3(PO_4)_2(OH)_2 \cdot 6H_2O$

Phosphuranylite has been found as thin, cryptocrystalline coatings of a golden yellow color in quartz and feldspar cavities. In rare cases it has replaced uraninite.

Quartz SiO_2

Milky, anhedral quart is very abundant at Urucum. Intergrowths with feldspar have resulted in curious herringbone patterns. Small,

doubly terminated crystals in parallel growths are locally common in the replacement bodies. Smoky quartz in masses measuring several tens of centimeters is also frequently encountered, especially near uraninite and loellingite bodies, but crystals are rare. Fragments of translucent, heavily fractured rose quartz have been found on the dumps.

Saleeite $Mg(UO_2)_2(PO_4)_2 \cdot 10H_2O$

Bright yellow crystals of saleeite to a millimeter or so occur as flattened tablets scattered in scorodite cavities, on milky quartz, smoky quartz and loellingite. Large, thin coatings of cryptocrystalline saleeite are found lining fractures in smoky quartz. Saleeite is the most common secondary uranium mineral at Urucum. It is highly fluorescent and, according to a partial wet chemical analysis, calcium free. Identification was confirmed by X-ray diffraction.

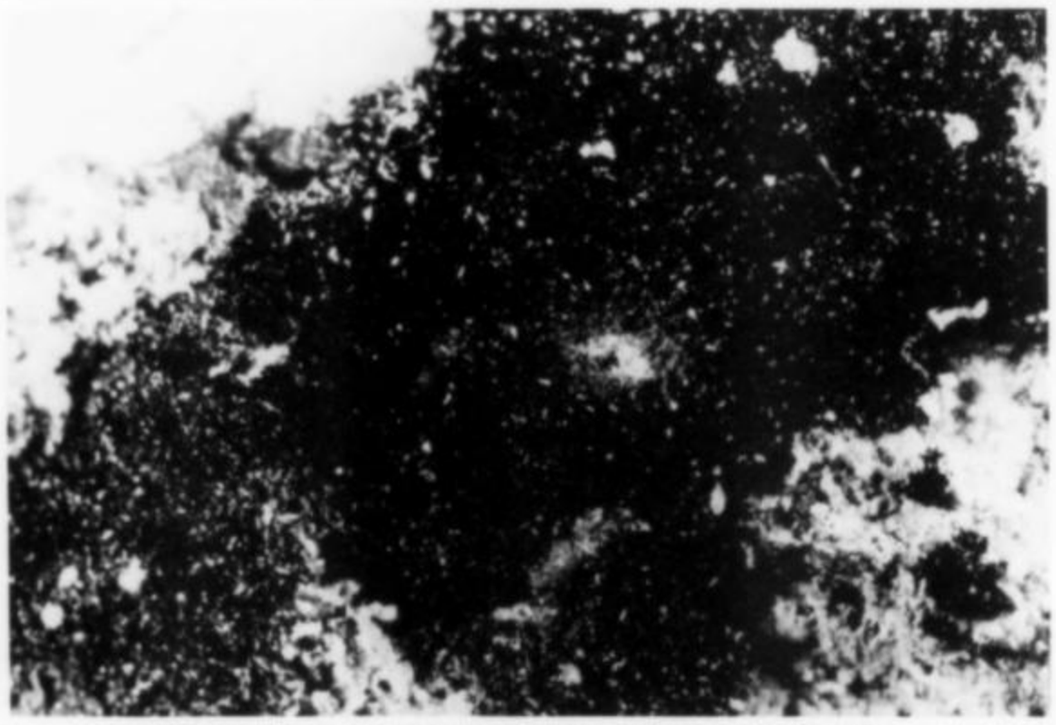

Figure 9. **Schneiderhoehnite microcrystals; the view is 3 cm across. Author's specimen and photo.**

Schneiderhoehnite $Fe^{+2}_{8}As^{+3}_{10}O_{23}$

Soft, dark brown, very fine-grained schneiderhoehnite forms thin, branching veinlets in loellingite and feldspar. Scorodite and karibibite are sometimes associated. Thick crusts of schneiderhoehnite surrounding loellingite pods have also been found.

Elongated to lozenge-shaped, lustrous, black crystals commonly form coatings and clusters in veinlet cavities and on quartz, feldspar and phosphuranylite. Locally schneiderhoehnite is found coated by sericite (= fine-grained mica), scorodite or very rarely by sulfur.

X-ray diffraction data for Urucum schneiderhoehnite matches well with that for type material from Namibia (Otteman *et al.*, 1973). A wet chemical analysis yielded: $FeO = 35.90\%$, $As_2O_3 = 63.64\%$, $H_2O_{total} = 0.15\%$, indicating an ideal formula of $Fe_8As_{10}O_{23}$. The Urucum pegmatite is only the second known schneiderhoehnite occurrence in the world. Excellent specimens can be easily collected on the sorted dumps, but crystal crusts and clusters rarely exceed a few square centimeters in size.

Scorodite $Fe^{+3}AsO_4 \cdot 2H_2O$

Scorodite is a common alteration product forming banded, mamillary veinlets, crusts and coatings on and after loellingite, karibibite and schneiderhoehnite. The veinlets tend to be darker near the center. Color is variable, ranging from pale green to brown, orange, tan, white and pale sky-blue. At least three generations of growth can be seen: (1) bright, greenish brown to pale orange crystals to 1 mm, in clusters and rosettes on loellingite and karibibite, (2) banded coatings and small globules on first-generation scorodite, and (3) small crystals with saleeite on first and second generation scorodite.

A wet chemical analysis shows this scorodite to be relatively low in aluminum: $Al_2O_3 = 1.35\%$, $Fe_2O_3 = 32.80\%$, $As_2O_5 = 50.20\%$, $H_2O_{total} = 15.21\%$, indicating a formula of $(Fe^{+}_{0.94}Al_{0.06})AsO_4 \cdot 2H_2O$.

Spessartine $Mn_3Al_2(SiO_4)_3$

Spessartine occurs as gemmy crystals to several centimeters which show severe surficial resorption. Cracked masses occur embedded in cleavelandite, sometimes with blackish green tourmaline needles. The color ranges from pale pink-orange to deep orange-red and brown.

Figure 10. **Weathered spodumene crystals up to 2 meters in length. Photo by the author.**

Figure 11. **Gemmy, pale pink crystal of spodumene ("kunzite") recovered in 1968. It measures 14 cm and weighs 860 grams (nearly 2 pounds). Author's specimen and photo.**

Spodumene $LiAlSi_2O_6$

Spodumene formed in two stages at Urucum. The first stage consists of white to cream-colored, elongated, heavily corroded crystals to several meters in length, most prominently seen on the 335 level. The second stage consists mostly of kunzite. The kunzite crystals are long and prismatic with square or rectangular cross-sections and striated faces; some crystals have curved, irregular faces and resorbed, "shredded" terminations. Triangular growth figures are common on the larger faces. Thin tubular voids cross obliquely through the crystals. Color varies from pale to deep pink and bluish purple. Some crystals are bicolored, from colorless to yellow or very pale pink on one end, passing gradually into more intense coloration on the other end.

Density is 3.18 ± 0.01. Fluorescence is variable, ranging from absent to pink or orange, and appearing only faintly in shortwave ultraviolet light but more strongly under longwave. Color fades with long exposure to sunlight. See Cassedanne and Cassedanne (in press) for gem properties.

Figure 12. **A group of stokesite nodules, tan color, 4.1 cm across. R. Gaines specimen.**

Stokesite $CaSnSi_3O_9 \cdot 2H_2O$

Stokesite nodules were first reported from Urucum by White (1973). The spherical clusters measure up to 3 cm in diameter and have a rough surface. Color varies from pinkish tan to pale brown. Stokesite is associated with the large beryl crystals in the morganite pocket, and therefore also with cleavelandite and, in some cases, with small crystals of titanite and microlite. Only about ten of the stokesite nodules were recovered.

Sulfur S

Sulfur is very rare, occurring as thin, pale yellow coatings on schneiderhoehnite and in a few cavities in loellingite.

Titanite $CaTiSiO_5$

Titanite occurs very rarely as millimeter-size, tan to slightly pink spheres associated with stokesite.

Uraninite UO_2

Uraninite, always found near loellingite, occurs as complex, euhedral crystals up to 1 cm in size, scattered through feldspar and in coralloid groups. It has commonly been replaced by gummite (= yellow, earthy mixture of secondary uranium minerals, including saleeite). Careful crushing of selected specimens has freed excellent microcrystals including some six-sided habits reminiscent of rutile twins.

Figure 13. **Black uraninite crystals to 1 cm in feldspar. Author's specimen and photo.**

Vivianite $Fe_3^{+2}(PO_4)_2 \cdot 8H_2O$

Vivanite is rare at Urucum, occurring primarily as pale water-green clusters and thin coatings measuring around 1 mm and lining fissures in loellingite.

Woelsendorfite $(Pb,Ca)U_2O_7 \cdot 2H_2O$

A single microcrystalline specimen of woelsendorfite measuring about 1 cm has been found on the dumps. It is associated with quartz and has a reddish orange color.

Other Minerals

Limonitic material resulting from the last stage of loellingite alteration occurs as ochre to brown cavernous masses and pale brown to reddish or purplish brown coatings. X-ray diffraction shows goethite to be the main component. Other secondary iron and manganese oxides are abundant as coatings and stains.

A waxy coating varying in color from yellow to blue and pale greenish gray proved amorphous but semiquantitative X-ray fluorescence analysis indicates that it contains only Fe and As with traces of Cu.

Small, black crystals of a mineral belonging to the columbite-tantalite group have been found scattered through feldspar.

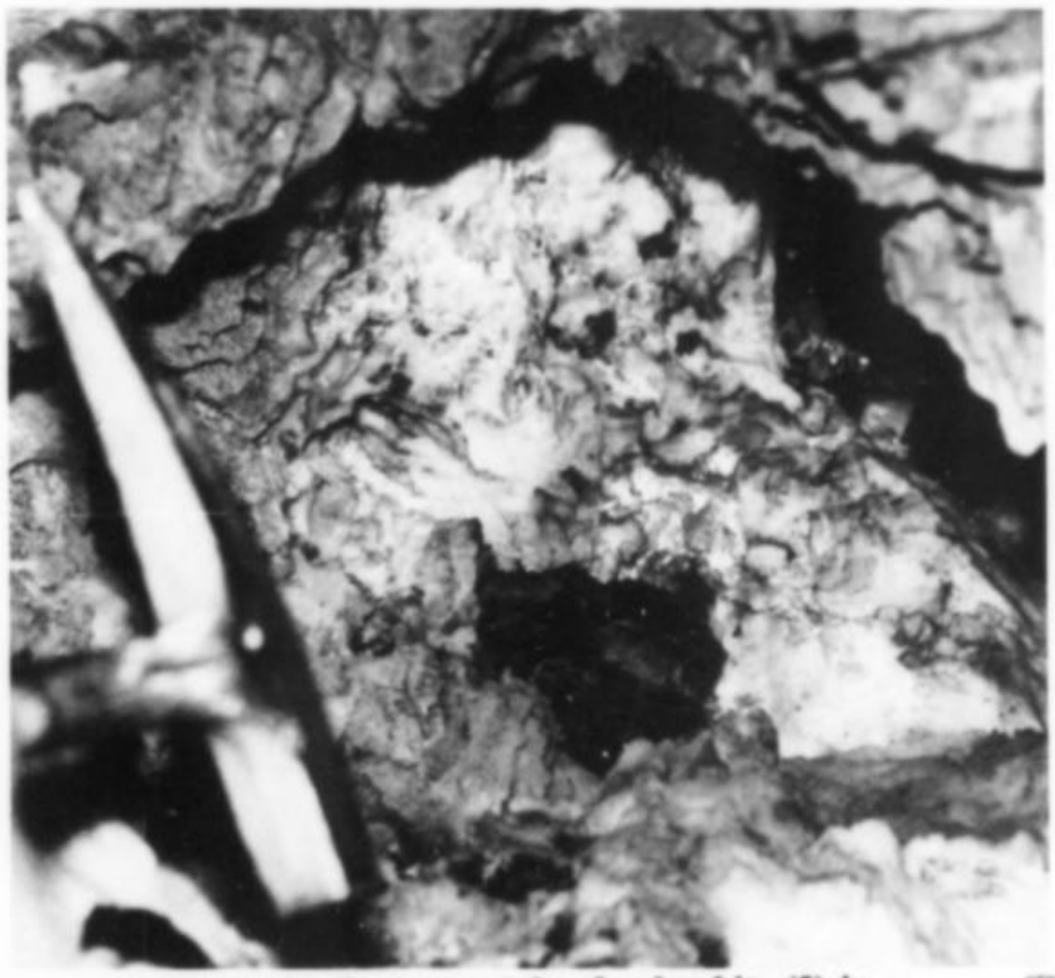

Figure 14. **Large crystals of columbite (?) in a vug in feldspar.**

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Mineralogy of the

• KALKAR QUARRY •

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The Kalkar quarry produced commercial limestone for nearly a century. It has also yielded 76 minerals, including several rare sulfosalts and silicates, and is the type locality for pabstite, the tin analog of benitoite. The mineralogy of this quarry is unique in the region, but unfortunately the locality is now essentially extinct.

INTRODUCTION

The Pacific Limestone Products Company quarry, locally known as the Kalkar quarry, is located in the coastal town of Santa Cruz, about 96 km south of San Francisco in the southwest quarter of Sec. 11, T11S, R2W, M.D.M. The company property is surrounded on the north by the University of California Santa Cruz campus, on the east by Spring Street, and on the south and west by private residences.

Limestone has been mined at the deposit since before 1884 (Hanks, 1884). The property was sold in 1922 to the Pacific Limestone Products Company. From this time until the mid 1960s, when the property was sold for real estate development, the company produced a variety of limestone products, the most common being livestock feed supplements and decorative stone.

The deposit has been developed by two quarries about 200 meters apart at an elevation of 100 meters above sea level. The larger and more recently active of the two quarries explored a massive recrystallized limestone and calc-silicate rock assemblage which has been faulted and broken. Solution cavities, although small, are common throughout the limestone body where calc-silicate rocks are absent. Underground water was a constant problem during quarry operations, and both channels and pumps have been used for drainage.

Mineralization is confined to the larger quarry and consists of a number of silicates related to contact metamorphism, followed by sulfide and sulfosalt replacement of the recrystallized limestone. Weathering of the sulfide-sulfosalt minerals has produced a large number of secondary minerals. Minerals identified from the quarry include native elements, sulfides, arsenides, sulfosalts, oxides, hydroxides, carbonates, sulfates, arsenates, phosphates, molybdates and silicates.

HISTORY

Quarry Operation

The earliest records of limestone quarrying operations date back to before 1884 (Hanks, 1884). The operations have been summarized by Hubbard (1943) for the years 1922 to 1943. The operations continued essentially unchanged from 1943 until the quarry ceased operation in the mid 1960s.

Basic quarry operations consisted of drilling charge holes in the massive limestone blocks and breaking them up with explosives. Air from a portable Schramm compressor operated several dry jackhammers using detachable bits. Pieces larger than 1 meter were plug shot and subsequently broken with 7 kg rock hammers to sizes less than 30 cm. Because of magnesium and silica impurities, all rock was hand-picked to insure uniform quality. The resulting rock was hand-loaded into special steel skips fitted with removable aprons operated from the truck driver's seat. These skips held about 1 to 1.5 metric tons of rock and had a lug in each side to fit hoisting hooks on the company's ingenious patented trucks, which were built on a Model A Ford chassis with a friction-drive cable

Figure 1. **Panoramic view of the Kalkar quarry 1965. The mineralized western section is at left, the fault area is at center.**

hoist employing a worm-drive rear axle assembly. The loaded skips containing limestone were transported to the nearby mill for processing. The impure material remaining was sold for building and decorative stone.

The processed limestone was sold for various applications including terrazo, stucco dash, chicken grit, roofing grit, commercial filler, mortar sand, cattle calcium, poultry calcium, fertilizer and macadam. The most important product, however, was a complex mineral mix for livestock and cattle.

Mineral Collecting

Fitch (1931) noted occurrences of a number of minerals in the irregular beds of limestone; these included quartz, diopside, forsterite, phlogophite, titanite, tourmaline, chlorite, arsenopyrite and pyrite. Later in the 1930s, Fred W. Johnson, owner of the quarry, called to the attention of the late Magnus Vonsen, (a skilled amateur mineralogist of the Bay area) the rare and interesting minerals which were being found during quarrying operations. Among the first rare minerals to be identified by Vonsen were meneghinite and franckeite (Gross *et al.,* 1967).

During the 1940s, Charles W. Chesterman, geologist for the California Division of Mines and Geology, and Charles Milton of the U.S.G.S. collected a small suite of minerals from the quarry which included meneghinite, franckeite, pyrrhotite, stannite, native bismuth, arsenopyrite and fluorapatite. In the following years the quarry was visited by a number of local mineral collectors who collected fine specimens of many different minerals.

In 1958 the authors became interested in the minerals that had been reported from the Kalkar quarry; during the next 12 years the quarry was visited regularly on weekends. On each visit a systematic examination of the quarry area was made for any new exposures of minerals. These occurrences were recorded along with data such as rock type, location, mineral content and associations. Since the quarry was actively being worked, both the overall quarry dimensions and the exposed mineralogy were constantly changing. To aid in mineral location within the quarry, a large plane table map of the quarry was constructed with a location grid system; each mineral find was recorded on the map with the date. The quarry was eventually divided into nine general collecting areas labeled A through I. These areas are located on the quarry map and the minerals occurring at each location are listed in Table 1. Locations A through E are located in an area which was not being worked for limestone. Locations F through I are located in the north portion of the quarry where blasting was constantly exposing new rock.

Since blasting was usually performed on Friday afternoons, Saturday collecting was usually profitable because new rocks were exposed and the larger ones had been reduced to a manageable size. Quarry collecting usually consisted of examining the surfaces of each rock for exposed metallics and cavities which might contain minerals. Often the quarry was visited at night with a shortwave ultraviolet light.

The largest exposure of sulfide-bearing calc-silicate rocks was in the western part of the quarry and included locations A through D. Here the calc-silicate rocks are interstratified with beds of coarse-grained limestone. Within these rocks, masses of sulfides and sulfosalts were regularly found associated with quartz, tremolite and actinolite. The high silica and heavy metal content of this rock made it unusable for commercial feed application or decorative stone because of its general lack of compactness and its weathering characteristics. Early quarry operations extracted only small quantities of limestone from this area, and in later years it was used as a dump for waste rock. During the early years abundant franckeite and meneghinite associated with pyrite and pyrrhotite were common in this area. Much of the quarry floor, however, is now covered with waste rock, trees, brush and water.

Locality A is a small sulfide-rich quartz vein near the processing plant. The exposed vein measures about 1 meter high and 50 cm wide, and dips slightly to the east. Relic pods and seams of pyrite, arsenopyrite, sphalerite and galena are found here. Surface weathering has oxidized much of the sulfide minerals, leaving a dark brown goethite stain on the quartz.

Secondary minerals of interest include adamite, zincian symplesite, scorodite, rozenite, copiapite, kornelite, melanterite, woodruffite and gypsum.

Location B represents a small area in a fine-grained limestone which caps the calc-silicate rocks at the western boundary of the quarry. A single small mass of tetrahedrite was discovered here. Except for isolated pods, most of the tetrahedrite has weathered into a mixture of azurite, malachite and stibiconite. The limestone also hosts small weathered specks of chalcopyrite containing covellite.

Figure 2. **A view of the Kalkar quarry facing west, showing the fault. May 1960.**

Below this zone a large boulder of silica-rich rock was exposed which contained meneghinite veins measuring from 1 to 3 cm in thickness.

Location C was considered to be the most productive mineralized zone of the quarry. This area was a constant source of meneghinite, jamesonite and boulangerite. A silica-rich bench exists here which contains abundant arsenopyrite in crystals associated with deep red kermesite. The kermesite has originated from thin films of stibnite along the fracture surfaces of the silica-rich rock. In addition to a number of common minerals, isolated finds of dravite in fine, brown, striated crystals and green sprays were recovered. In the pure masses of quartz, which contained the brown dravite, small prismatic crystals of stibnite were common. The meneghinite at this location rarely contained clear to light yellow grains of cassiterite. Also at this area a single crystal of allanite was recovered in a quartz-rich calc-silicate rock (this was the only occurrence of a rare-earth-bearing mineral in the quarry). Small masses of cobaltian loellingite with arsenopyrite were also found in this area.

Locality D represents the probable location of the large masses of franckeite with native bismuth and stannite found during collecting in the 1940s and earlier. Also from this area masses of pyrrhotite containing anhedral grains of fluorapatite were found. It is most probable that the single sample of graphitic limestone containing minute grains of stannite, tetrahedrite and uraninite came from this area. Most of the rock now filling this area is waste rock from other portions of the quarry.

Location E is the general area where the two faults intersect. Although now covered with fill, some very unusual rocks were encountered during early operations. Communications with Fred Johnson revealed that some of the rock quarried here had been dumped in a pile a short distance from the fault intersection. This dump area, which measured no more than 5 by 10 meters, contained a number of old boulders probably quarried during the 1930s. They were discovered partially buried among several willow trees and were generally composed of calc-silicates with veins of quartz and tremolite. During night exploration of this area, using a shortwave ultraviolet light, abundant red fluorescent calcite was found together with a blue-white fluorescent mineral which later proved to be the new mineral pabstite, the tin analog of benitoite (Gross *et al.,* 1965). Small crystals of celsian, galena and massive witherite were also discovered with the pabstite. The rock containing the pabstite also contained large cleavage sections of a dark-brown mineral admixed with tremolite fibers. X-ray methods proved this mineral to be titantaramellite (Alfors and Pabst, 1984). This locality so far has produced the largest specimens of titantaramellite ever found.

One of the most interesting finds was made in the fault zone of the northwest-trending fault at location F. Here, major quantities of high-temperature rocks containing forsterite and diopside with titanite and sulfides occurred. A large mass of rock, broken by blasing, contained fractures coated with a green mineral. This coating was found to be bright apple-green crystals of magnesian annabergite, the first mineral containing nickel to be found in the quarry. Also present were minute, clear, glassy crystals of hoernesite attached to secondary calcite crystals. The matrix rock was later found to contain narrow veins of a bright silvery mineral together with a blue-black mineral that resembled graphite. Abundant black sphalerite was also present which contained very thin yellow-orange coatings of greenockite. The silvery mineral and the blue-black mineral were later identified as gersdorffite and molyb-

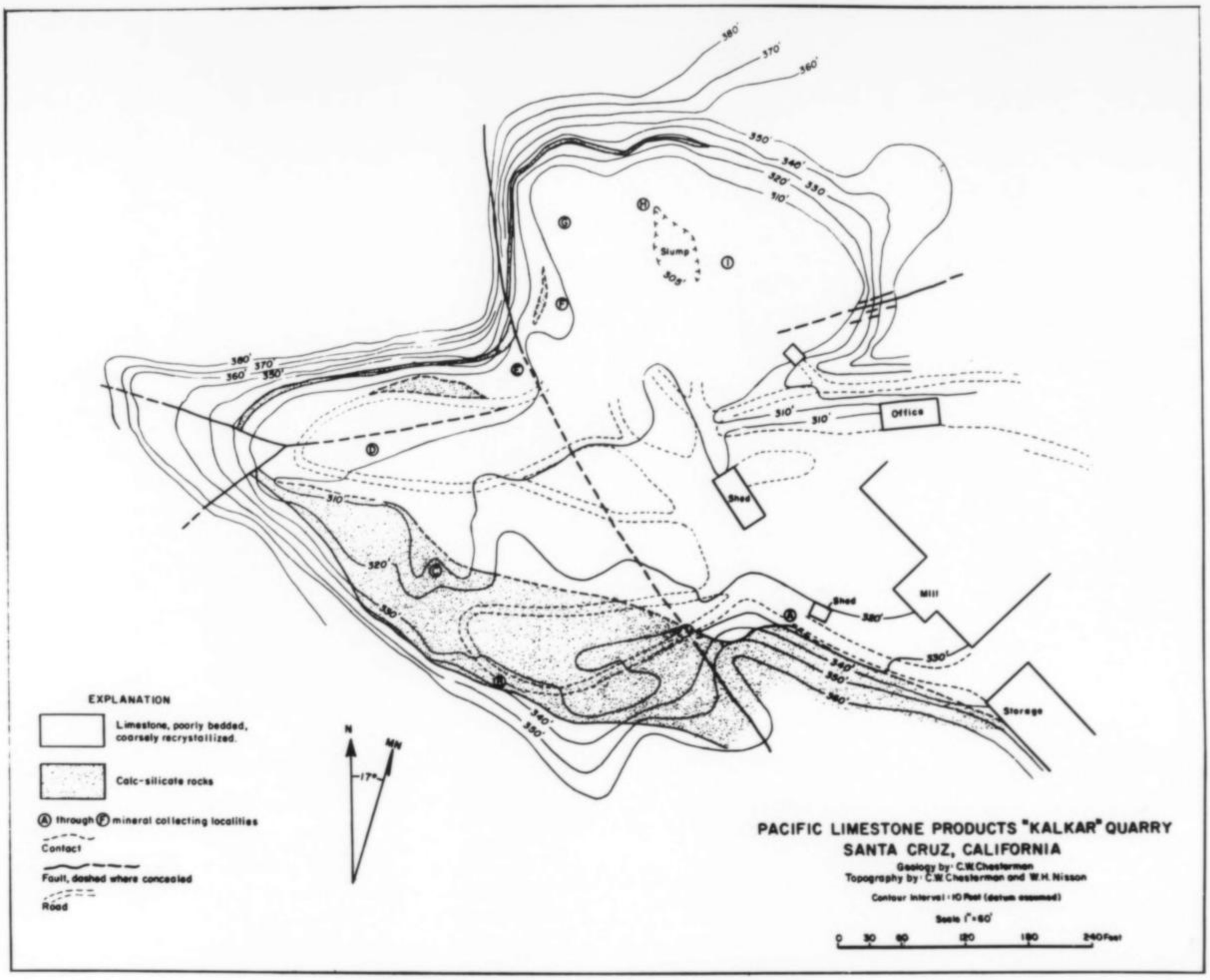

Figure 3. **Map of the Kalkar quarry (from Gross *et al.*, 1967).**

denite respectively. At this same locality a small cavity was found which contained small but well-developed crystals of amethyst covered by small secondary calcite crystals.

The sulfide-bearing diopside-forsterite rock had been fractured, followed by carbonate cementing. When freshly broken, these seams contain small cavities containing a number of secondary minerals including arseniosiderite, aragonite, calcite, huntite, powellite and wulfenite. The powellite occurs as minute "roses" covering secondary calcite. Anhedral grains of wulfenite were found embedded in massive calcite associated with amesite.

Location G was composed mainly of large blocks of limestone. The zones between these blocks frequently contained pulverulent masses of calcite, goethite, quartz, pyrolusite and the uncommon mineral coronadite.

Locations H and I contained mostly calcite crystals, talc containing pyrite crystals, antigorite, tremolite and amesite.

A visit to the Kalkar quarry in 1978 found the area overgrown with small willow trees and brush, and the quarry floor covered in many areas by water. The quarry bench at location C was located and several specimens of meneghinite, arsenopyrite and kermesite were collected. Also a few samples of galena were discovered in float boulders which later were found to contain pabstite. The small pyrite-arsenopyrite-sphalerite vein at location A was also found but it was occupied by a swarm of very angry bees.

In 1983 construction began on a series of private residences which currently cover most of the quarry floor in addition to the surrounding cliffs. The site is now on private land and collecting is not possible. It is regrettable that this most interesting quarry will never produce minerals again.

Had it not been for the keen interest and cooperation of the owner, the late Fred W. Johnson, very few of the rare and unusual minerals would have been found and preserved. Because of his interest in the quarry and its mineral content, two nearly complete collections of Kalkar minerals exist today in the authors' personal collections.

GEOLOGY

The regional geology of the Santa Cruz quadrangle has been described by Branner *et al.* (1909) and Taliaferro (1943). Hubbard (1943) has briefly summarized their work. More recently, Leo (1967) has examined the plutonic and metamorphic rocks of Ben Lomond Mountain, which is located just to the north of Santa Cruz.

The region consists primarily of Tertiary (Miocene) marine sand-

Table 1. **Mineral assemblages at nine locations within the Kalkar quarry (see map).**

A	B	C	D	E	F	G
Adamite	Azurite	Actinolite	Bismuth	Boulangerite	Annabergite	Calcite
Arsenopyrite	Bindheimite	Allanite	Chalcopyrite	Calcite	Aragonite	Coronadite
Copiopite	Chalcopyrite	Andradite	Fluorapatite	Celsian	Arseniosiderite	Diopside
Galena	Covellite	Arsenopyrite	Franckeite	Epsomite	Barite	Epsomite
Goethite	Malachite	Bindheimite	Graphite	Galena	Bindheimite	Forsterite
Greenockite	Meneghinite	Biotite	Malachite	Gypsum	Brucite	Pyrolusite
Gypsum	Sphalerite	Boulangerite	Meneghinite	Muscovite	Calcite	Pyrite
Kornelite	Stibiconite	Cassiterite	Pyrite	Pabstite	Clinochlore	Sphalerite
Melanterite	Tetrahedrite	Cerussite	Pyrrhotite	Pyrite	Diopside	Tremolite
Meneghinite		Chalcopyrite	Sphalerite	Sphalerite	Forsterite	Talc
Pyrite		Covellite	Stannite	Titantaramellite	Galena	**H**
Pyrolusite		Dravite	Tetrahedrite	Witherite	Gersdorffite	
Rozenite		Franckeite	Uraninite		Greenockite	Amesite
Scorodite		Galena			Hoernesite	Antigorite
Sphalerite		Graphite			Huntite	Calcite
Symplesite		Jamesonite			Jamesonite	Pyrite
Woodruffite		Kermesite			Meneghinite	Sphalerite
		Loellingite			Molybdenite	Talc
		Malachite			Pabstite	Tremolite
		Meneghinite			Phlogophite	**I**
		Pyrite			Powellite	
		Pyrrhotite			Pyrrhotite	Amesite
		Stibiconite			Quartz	Antigorite
		Stibnite			Sphalerite	Calcite
		Talc			Titanite	Pyrite
					Tremolite	Talc
					Wulfenite	Tremolite

stones and diatomaceous shales. Quaternary sands, gravels and clays predominate along the southern part of the quadrangle. To the north of Santa Cruz, Ben Lomond Mountain, at an elevation of 600 meters, presents a steep escarpment to the northeast and a long gentle slope on the southwest to the ocean. This mountain is an upward-tilted granite block with a quartz diorite core. Relatively small volumes of metamorphic schist, marble and limestone have been identified in this block.

The sedimentary formations of the region have been heavily folded, crushed and broken, with abundant faulting including the effects of the famous San Andreas fault. Rocks of the Jurassic Franciscan complex predominate in the eastern part of the quadrangle.

Locally, the Kalkar quarry explores a poorly bedded recrystallized limestone containing lens-like strata of calc-silicate rocks which probably belong to the Sur Series (?) of pre-Cretaceous age (Fitch, 1931). These strata range in thickness from less than a meter to about 10 meters. They are generally white in color, but zones of light to dark gray limestone and siltstone are common.

Lenticular, interbedded layers of calc-silicate rock are most conspicuous in the southwestern part of the quarry where their thickness ranges from about 2 meters to 10 meters. One such body, though faulted, is exposed also in the northern wall of the quarry where it gradually pinches out towards the east.

The fine-grained, greenish gray to gray calc-silicate rock is moderately dense, and shows an indistinct foliation. The more massive, medium-green siliceous layers show an abrupt textural change with the fine-grained calc-silicate rocks. These siliceous beds are less conspicuous in the quarry because their dull gray to white color resembles that of the recrystallized limestone beds. The siliceous rock types consist principally of calcite and quartz with lesser amounts of tremolite, actinolite and diopside. The fine-grained schistose rocks are composed mainly of phlogophite mica, calcite and other silicates and show banding and minor foliation. The size of calcite crystals in the recrystallized limestone ranges from several mm to about 3 cm. Hydrogen sulfide is common in the limestone and is characterized by a fetid odor when the rock is freshly broken.

No granitic rocks were observed in the main quarry, but in the smaller quarry, about 200 meters to the south, a narrow dike of altered, coarse-grained quartz diorite occurs in fault contact with coarse-grained, white, recrystallized limestone. No evidence of contact metamorphism was observed there. Crawford (1894) records a glaucophane schist interstratified with limestone in this quarry but at present it is covered by quarry rubble.

Faulting is apparent in the limestone body exposed in the northern quarry. Visible fault surfaces and shear zones are exposed along the massive blocks of limestone. No other local deformation has occurred. The limestone body has a very gentle dip to the east and a low strike. Two fault zones, aligned northwest and northeast respectively, have shear zones from 1 to 4 meters wide and prominent vertical fault surfaces. Field evidence indicates that these faults controlled the mineralization in the quarry.

MINERALOGY

The mineral assemblage at the Kalkar quarry is composed of silicate gangue minerals related to contact metamorphism of the limestone and siliceous beds, and a group of sulfides, arsenides and sulfosalts which are the result of metasomatism of the recrystallized limestone. Near-surface weathering of these sulfides, arsenides and sulfosalts has resulted in a suite of secondary minerals which include oxides, carbonates, sulfates, arsenates and molybdates.

Native Elements

Bismuth Bi

Samples of a fine-grained graphitic limestone from the western section of the quarry in the general vicinity of area D (collected by Charles Milton during the 1940s) contained native bismuth associated with meneghinite, pyrite, and rare crystals of stannite (Gross *et al.,* 1967). No further samples containing native bismuth have been found since that time.

Graphite C

Graphite is widespread throughout the recrystallized limestone beds as either parallel layers composed of minute flakes or as foliated masses several cm in size. The minute graphite flakes show a typical hexagonal outline.

Sulfides and Arsenides

The ten sulfides and arsenides comprise the largest metallic mineral assemblage in the quarry. Although many of the sulfides found in the quarry are considered common in nature, several are quite rare. The weathering of this mineral group has resulted in a number of secondary minerals.

Figure 4. **Arsenopyrite crystal, 5 mm, in quartz. G. Dunning specimen and photo.**

Arsenopyrite FeAsS

Arsenopyrite, like pyrite, is a major constituent of the recrystallized limestone and of the calc-silicate rocks in the western part of the quarry. Crystals up to 5 cm in length have been found in pale-colored limestone, but smaller crystals are more common. These crystals are often intergrown and have a brilliant silver color.

Chalcopyrite $CuFeS_2$
Covellite CuS

Copper minerals are rare at Kalkar. Chalcopyrite has been found only as small grains and seams associated with pyrite in white recrystallized limestone and massive quartz near location C. It is commonly altered to a mixture of azurite, malachite and goethite. Covellite is very rare and occurs as thin coatings on fracture surfaces in chalcopyrite from which it was derived. It was identified in polished sections of chalcopyrite (Gross *et al.,* 1967).

Galena PbS

Coarsely crystalline masses of galena occur in fine-grained, weathered, calc-silicate rocks removed during early quarry operations and deposited in the western part of the quarry. Galena is commonly associated with tremolite, quartz, titanian pabstite, celsian and titantaramellite. It has been found to be a good field indicator of rocks containing pabstite. Galena has also been identified in place at location A, associated with quartz, pyrite, sphalerite, arsenopyrite and greenockite.

Loellingite $(Fe,Co)As_2$

Rare masses of cobaltian loellingite, closely associated with coarsely crystalline arsenopyrite, occur in the calc-silicate rocks along a bench face in the western part of the quarry near location C (Gross *et al.,* 1967). The mineral is indistinguishable from arsenopyrite except by X-ray or chemical analysis.

Molybdenite MoS_2
Gersdorffite (Ni,Fe,Co)AsS

Both molybdenite and gersdorffite occur intimately associated with sphalerite in a dense calc-silicate rock along the shear zone of the northwest-trending fault at location F. The molybdenite occurs as minute flakes and masses composing parallel bands in the complex rock. It resembles graphite but is somewhat bluer in color.

Anhedral grains of gersdorffite associated with molybdenite compose veins in the complex calc-silicate rock. Subsequent alteration along fracture surfaces has resulted in coatings and crystals of magnesian annabergite and hoernesite.

Pyrite FeS_2

Pyrite, one of the commonest sulfide minerals in the quarry, is found in all the rock types. Well-formed crystals showing cubic, octahedral, and pyritohedral forms have been found in the recrystallized white limestone and in masses of pure white talc. Also, vein-like masses of pyrite occur traversing siliceous rock types associated with the sulfosalt minerals.

Pyrrhotite $Fe_{1-x}S$

Pyrrhotite, although not as common as pyrite or arsenopyrite, occurs mainly in the calc-silicate rocks in small masses associated with pyrite and sphalerite. Some of the larger masses, measuring up to 5 cm, contain pale yellow anhedral grains of fluorapatite, identified by X-ray powder diffraction and spectrographic methods (Gross *et al.,* 1967).

Sphalerite ZnS
Greenockite CdS

Dark brown to black vein fillings of massive sphalerite occur in the fine-grained dark limestone, and also as small, discrete crystals associated with pyrite and arsenopyrite in coarse-grained white limestone. Spectrographic analysis of the brown sphalerite indicates a trace of cadmium and iron, whereas analysis of the black sphalerite shows a greater amount of cadmium (up to 1%) and a percent or more of iron.

The black massive sphalerite occurring just north of the fault intersection at locality F contains rare yellow-orange coatings of greenockite. Greenockite has also been identified at locality A in massive quartz containing pyrite, arsenopyrite, galena and sphalerite.

Stannite $CuFeSnS_4$

Rare crystals of stannite embedded in pyrite and associated with meneghinite and native bismuth were collected during the 1940s by Charles Milton of the U.S.G.S. in the rich metallic zone of the western section. This is the only recorded find of this rare mineral (Gross *et al.,* 1967). A specimen provided the authors by the late Fred W. Johnson, owner of the quarry, was examined by scanning electron microscopy (SEM) and found to contain massive pyrite, stannite, chalcopyrite, galena and tetrahedrite in a graphitic seam in dark gray limestone.

Stibnite Sb_2S_3
Kermesite Sb_2S_2O

Poorly formed prismatic crystals, minute grains and films of stibnite occur in quartz-rich rocks in the western part of the quarry associated with meneghinite and arsenopyrite. Stibnite is nowhere

abundant at Kalkar. Partial alteration of stibnite has resulted in thin films of reddish kermesite along fractures in the quartz. Further alteration to stibiconite is rare and occurs generally as pale yellow to white halos at the ends of the kermesite films.

Sulfosalts

Only five sulfosalts have been identified in the limestone beds of the quarry. Of these five, the rare sulfosalts franckeite and meneghinite were found to be the most abundant whereas tetrahedrite is quite rare.

Boulangerite $Pb_5Sb_4S_{11}$

Boulangerite is difficult to recognize in the field because of its close resemblance to meneghinite. It usually has a more fibrous habit when not found associated with either meneghinite or jamesonite. Positive identification requires X-ray analysis.

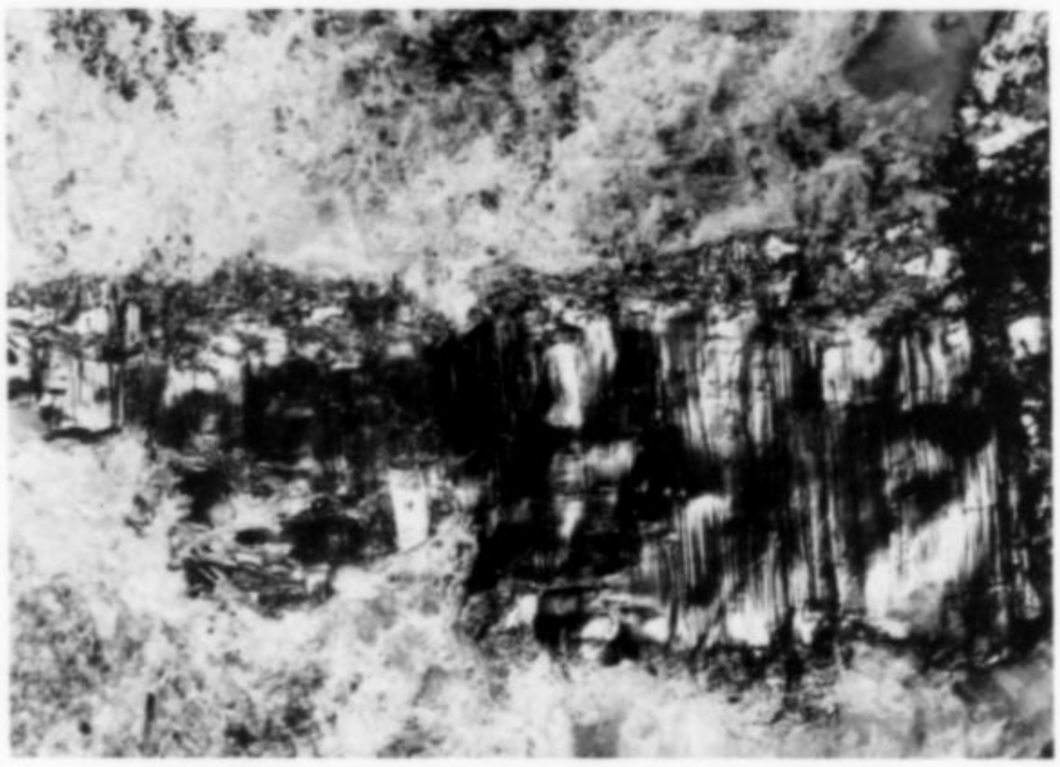

Figure 5. **Franckeite in limestone, 5 cm across, showing platy habit and fine twinning. G. Dunning specimen and photo.**

Franckeite $Pb_5Sn_3Sb_2S_{14}$

Although now very difficult to find, franckeite was quite common in the western part of the quarry during early quarry operations. Excellent samples of crystals showing the typical, thin, warped and striated habit were recovered from graphitic limestone associated with pyrite. Euhedral, tabular crystals commonly measure up to 6 cm in size. In recent years small amounts of franckeite have been found in a medium gray limestone on a bench in the southwest part of the quarry at location C.

Jamesonite $Pb_4FeSb_6S_{14}$

Jamesonite is common in the mineralized zones as fresh and partially altered coarsely crystalline masses. Where partially altered it has a distinctive yellow coating of bindheimite and occasional small crystals of cerussite. Close association with both meneghinite and boulangerite is common.

Meneghinite $CuPb_{13}Sb_7S_{23}$

Meneghinite, admixed with boulangerite and jamesonite, is the most abundant sulfosalt at Kalkar. It occurs as coarsely crystalline to semi-fibrous masses and isolated pods filling fractures in the calc-silicate rocks in the western part of the quarry, especially at location C. These masses often show polysynthetic twinning resulting in a banded effect. Surface oxidation of meneghinite usually produces a bluish color along cleavage planes.

Tetrahedrite $(Cu,Fe)_{12}Sb_4S_{13}$

Tetrahedrite is quite rare in the limestone of the quarry. One small mass, which measured about 4 cm in maximum size, was discovered at location B in the western part of the quarry. It occurred in calc-silicate rock associated with a quartz seam and was partially altered to azurite, malachite and stibiconite. A few minute grains of tetrahedrite were also identified in an old specimen from the western section associated with stannite, pyrite, chalcopyrite and galena.

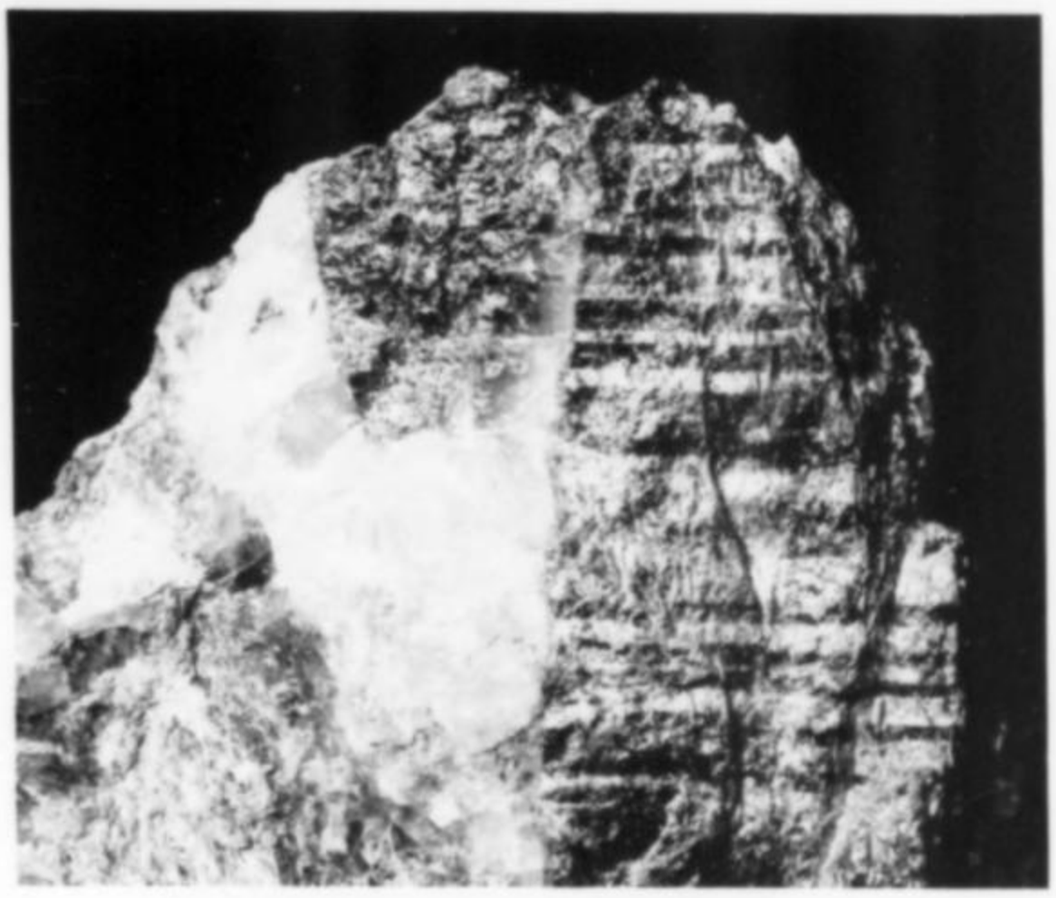

Figure 6. **Meneghinite vein, 4 cm, showing twinning. G. Dunning specimen and photo.**

Oxides and Hydroxides

The oxides and hydroxides identified at Kalkar represent an interesting assemblage. The majority of oxide minerals have resulted from oxidation of either sulfides or sulfosalts. A few are the result of metasomatic action during mineralization.

Bindheimite $Pb_2Sb_2O_6(O,OH)$

Bindheimite occurs as the principal oxidation product of jamesonite, boulangerite and meneghinite. It is generally pale yellow in color and is found coating fracture surfaces and masses of the lead-bearing sulfosalts.

Brucite $Mg(OH)_2$

Brucite is a minor constituent along with diopside and forsterite in a thin layer of recrystallized limestone between more massive layers of calc-silicate rocks. It is white and occurs in rounded anhedral grains which are visible only under the petrographic microscope (Gross *et al.*, 1967).

Cassiterite SnO_2

A few very small, honey-yellow, anhedral grains of cassiterite were found embedded in a mass of meneghinite at Location C. The identity was confirmed by X-ray powder diffraction. Cassiterite has also been found associated with titantaramellite and titanian pabstite in siliceous limestone removed from the fault zone many years ago.

Coronadite $Pb(Mn^{+4},Mn^{+2})_8O_{16}$

A dark brown, pulverulent material collected from between large blocks of limestone near locality G was examined in the SEM using energy dispersive spectrometry. A black botryoidal material containing both lead and manganese was identified along with a manganese oxide and quartz. A subsequent X-ray powder pattern gave diagnostic lines for both coronadite and pyrolusite. Abundant goethite comprised the remainder of the material.

Goethite α-FeO(OH)

Hydrated iron oxides, which have resulted from the weathering of pyrite and arsenopyrite, have generally been referred to as goethite. It is very abundant at location A and occurs commonly as shiny, dark brown botryoidal coatings.

Pyrolusite MnO_2

Pyrolusite has been identified as dendritic growths on fracture surfaces in limestone throughout the quarry. It is nowhere abundant in any quantity. Powder diffraction patterns of several black managese oxides collected from the quarry gave strong lines for pyrolusite.

Stibiconite $Sb^{+3}Sb_2^{+5}O_6(OH)$

Stibiconite was identified by powder methods as pale yellow to white coatings in fractured quartz, where it occurs as the latest-formed oxidation product of stibnite (formed following kermesite). The pale yellow massive material surrounding a single tetrahedrite sample from location B has been identified as stibiconite.

Uraninite UO

Minute dodecahedrons of uraninite were identified as a constituent of a thin graphite seam in limestone associated with pyrite, stannite, galena, chalcopyrite and tetrahedrite. Insufficient material was available for an X-ray powder pattern. An energy dispersive spectrum gave a value for uranium very near that for uraninite.

Woodruffite $(Zn,Mn^{+2})Mn_3^{+4}O_7 \cdot 1\text{-}2H_2O$

An initial SEM examination (by energy dispersive spectrometry) of a brilliant, black, botryoidal mineral coating scorodite crystals revealed the presence of both zinc and manganese. Values of 13.5 % ZnO and 72.0 % MnO were calculated from the EDS spectrum using zinc and manganese oxide standards. A subsequent X-ray powder pattern resembling that of todorokite was obtained.

Carbonates

Aside from calcite and aragonite, the carbonates constitute a small fraction of the minerals in the quarry. The abundant groundwater and the humid weather at the quarry (in close proximity to the ocean) have resulted in conditions unfavorable to secondary carbonate formation.

Aragonite $CaCO_3$

Radiating crystals of aragonite occur along fracture surfaces in limestone in the western part of the quarry. This aragonite fluoresces a bright green under shortwave ultraviolet light. At locality F aragonite occurs with minute crystals of hoernesite along a thin fracture surface.

Azurite $Cu_3(CO_3)_2(OH)_2$
Malachite $Cu_2(CO_3)(OH)_2$

Deep azure-blue crystals of azurite associated with green coatings of malachite occur in the western part of the quarry at location B; they formed as a result of the oxidation of tetrahedrite and chalcopyrite. The crystals are small, less than 2 mm long, and are confined to cavities in oxidized tetrahedrite.

Calcite $CaCO_3$

In addition to massive calcite, which is the main constituent of the recrystallized limestone, good crystals of secondary calcite occur closely associated with the rocks along the fault zones. The rhombohedral form predominates in the western part of the quarry in a small solution cave. In the eastern area of the quarry the scaleohedron form occurs in solution cavities and fractures in the blocky limestone. Pseudocubic rhombohedral forms are abundant along the shear wall of the northwest-trending fault. Fine "nailhead spar" crystals were collected along the northeast-trending fault zone

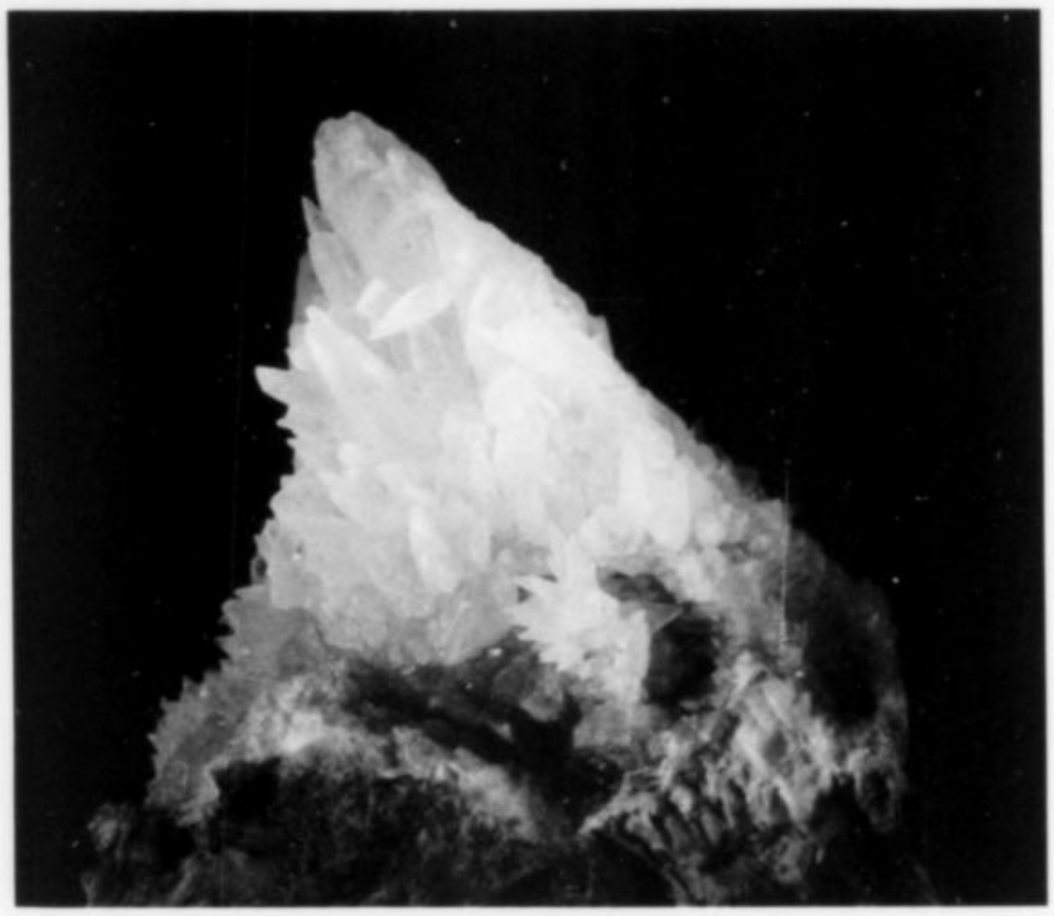

Figure 7. **Calcite scalenohedron group on limestone, 9 cm. J. F. Cooper specimen, G. Dunning photo.**

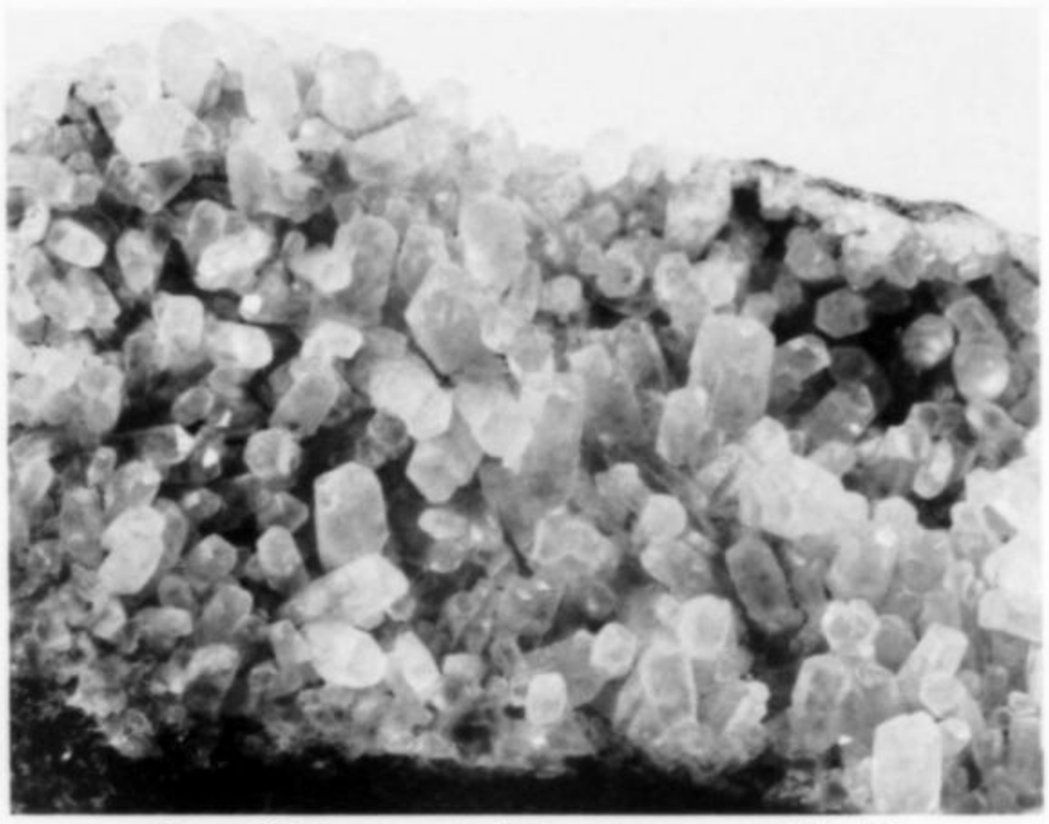

Figure 8. **Hexagonal calcite prisms on matrix, 10 cm. J. F. Cooper specimen, G. Dunning photo.**

in association with amethyst crystals. These "nailhead spar" crystals are typical hexagonal prisms with rhombohedral terminations. Calcite, showing a vivid red fluorescence, occurs associated with veins of brown sphalerite.

Cerussite $PbCO_3$

Brilliant, glassy crystals of cerussite associated with bindheimite have been found in cavities in galena and jamesonite at location C.

Huntite $CaMg_3(CO_3)_4$

Small white spheroids composed of minute, acicular crystals of huntite occur coating secondary calcite and barite associated with aragonite and magnesian annabergite at locality F. The huntite was identified by X-ray powder diffraction.

Witherite $BaCO_3$

Witherite is exceedingly rare at Kalkar and was found very closely associated with titanian pabstite, tremolite, quartz and galena (Gross *et al.*, 1967) with a medium-grained siliceous limestone.

Figure 9. **Cerussite crystals to 1 mm with bindheimite in jamesonite vug. G. Dunning specimen and photo.**

Sulfates

Like the carbonates, the sulfates constitute only a small fraction of the mineral content of the quarry. Only during periods of extreme dryness do sulfates others than gypsum and barite form.

Barite $BaSO_4$

Minute crystals of barite occur sparingly along fracture surfaces at location F, associated with secondary calcite, aragonite, magnesian annabergite and huntite. Abundant sepiolite also occurs along these fractures.

Epsomite $MgSO_4 \cdot 7H_2O$

Epsomite is found sparingly, and only during periods of extreme dryness, as light encrustations on fractures in magnesium-rich rocks.

Gypsum $CaSO_4 \cdot 2H_2O$

Gypsum is very common throughout the quarry and occurs along fractures in the pyrite-bearing calc-silicate rocks. It is especially abundant at location A.

Melanterite $FeSO_4 \cdot 7H_2O$
Kornelite $Fe_2(SO_4)_3 \cdot 7H_2O$
Copiapite $Fe^{+2}Fe_4^{+3}(SO_4)_6(OH)_2 \cdot 20H_2O$

These three iron sulfates occur as efflorescences on fracture surfaces of pyrite-arsenopyrite-sphalerite veins at location A. They only occur during periods of extreme dryness.

Rozenite $FeSO_4 \cdot 4H_2O$

This rare sulfate occurs as a white powder (which is quite delicate) on fractures in broken and sheared siliceous rocks at location A. It was identified by X-ray diffraction and is the second occurrence reported for this mineral in California (Gross *et al.*, 1967).

Phosphates, Arsenates and Molybdates

Except for fluorapatite, the members of these groups have resulted from the oxidation of sulfides of iron, zinc, molybdenium or nickel. Their occurrence is limited to those mineralized areas rich in corresponding sulfides and arsenides.

Adamite $Zn_2(AsO_4)(OH)$

Adamite, associated with scorodite and goethite, occurs as colorless, transparent bow-tie groups of rounded crystals filling alteration cavities that host a number of secondary minerals at location A. These adamite groups are weakly fluorescent pale green under shortwave ultraviolet light.

Figure 10. **Magnesian annabergite crystals to 0.15 mm. G. Dunning specimen and SEM photo.**

Annabergite $(Ni,Mg)_3(AsO_4)_2 \cdot H_2O$

Small, pale apple-green crystals of magnesian annabergite coat fracture surfaces in the gersdorffite-molybdenite-sphalerite vein of calc-silicate rocks at location F. The monoclinic crystals are acicular [001] and flattened on {010}. Crystals form spheroidal groups with the crystal terminations forming the outer surface of the spheroid. Identification was confirmed by X-ray diffraction and spectrographic analysis. Secondary calcite has been found covering many of the magnesian annabergite groups.

Arseniosiderite $Ca_3Fe_4(AsO_4)_4(OH)_6 \cdot 3H_2O$

Reddish-brown botryoidal coatings of arseniosiderite occur as an oxidation product of arsenopyrite along fracture surfaces at location F. Only two small samples have been recovered from the locality. The mineral occurs closely associated with minute acicular aragonite crystals and zincian nepouite. Identification was made by X-ray diffraction and energy dispersive spectrometry.

Fluorapatite $Ca_5(PO_4)_3F$

Fluorapatite is the only phosphate mineral identified in the limestone body at Kalkar. It is quite rare and only a few specimens are known. The only preserved specimens are composed of pale yellow anhedral grains forming small masses in massive pyrrhotite. Its identification was established by X-ray diffraction and chemical analysis (Gross *et al.*, 1967).

Hoernesite $Mg_3(AsO_4) \cdot 8H_2O$

Minute, clear prismatic crystals of hoernesite associated with aragonite occur as fracture fillings at location F. The crystals show sharp monoclinic terminations and are usually found as small groups of divergent crystals. The mineral was identified by X-ray diffraction and spectrographic analysis.

Powellite $CaMoO_4$

Minute, dull white crystal aggregates of powellite occur on corroded faces of secondary calcite associated with magnesian annabergite at location F. The individual crystals show a creamy yellow to golden yellow fluorescence under shortwave ultraviolet light. The mineral is very rare and has resulted from the oxidation of

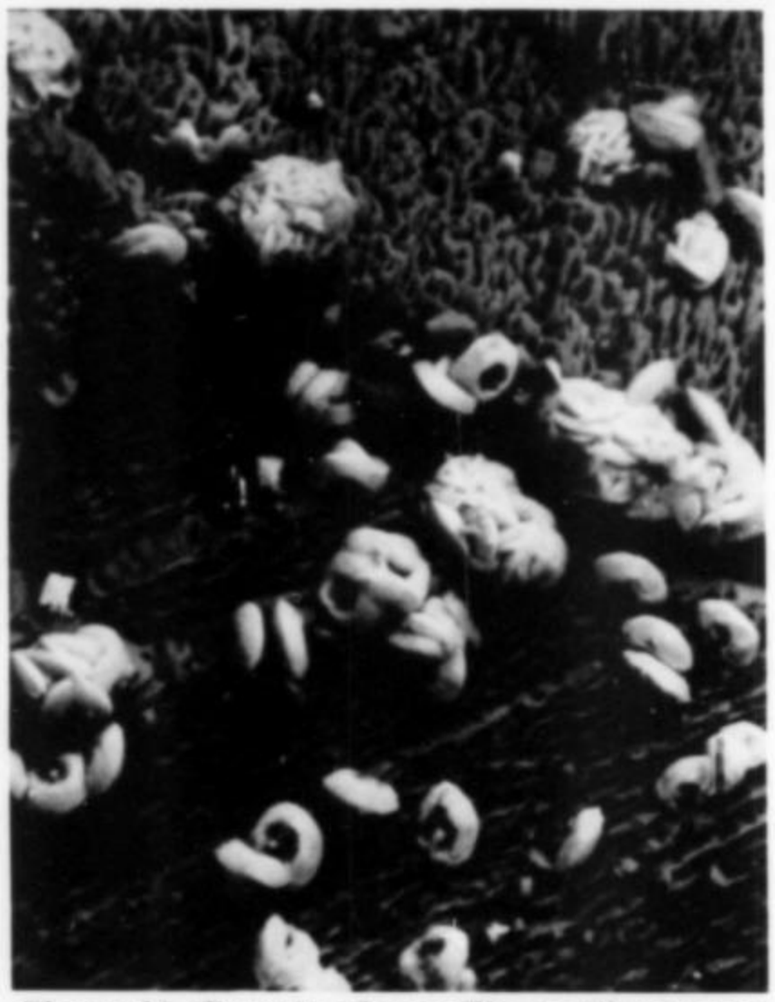

Figure 11. **Crystals of powellite to 12 microns on calcite. G. Dunning specimen and SEM photo.**

minute molybdenite flakes in the hard calc-silicate rock. Identification was made by energy dispersive spectrometry.

Scorodite $Fe(AsO_4)\cdot 2H_2O$

Scorodite occurs as one of the alteration products of the pyrite-arsenopyrite-sphalerite veins at location A. It generally forms minute pyramidal orthorhombic crystals with a light green color, coating fracture surfaces and cavities of the oxidized sulfide-quartz vein.

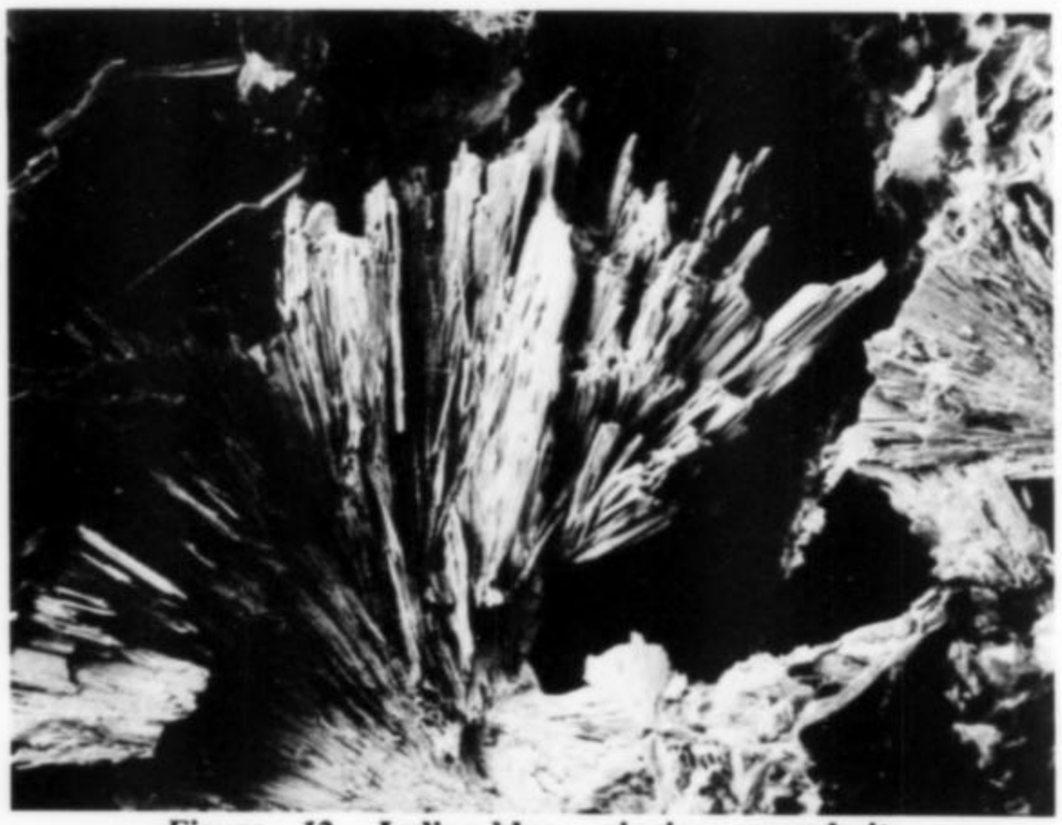

Figure 12. **Indigo-blue, zincian symplesite spray, 1 mm. G. Dunning specimen and SEM photo.**

Symplesite $(Fe,Zn)_3(AsO_4)_2\cdot 8H_2O$

Deep indigo-blue crystals and coatings of zincian symplesite, showing a coarsely fibrous radial habit, occur in the highly oxidized portion of the sphalerite-arsenopyrite-pyrite vein at location A. It is closely associated with gypsum, scorodite and goethite along fractures in the vein rock. The mineral was identified by X-ray diffraction and energy dispersive spectrometry.

Wulfenite $PbMoO_4$

Minute, yellow-orange, anhedral crystals of wulfenite occur embedded in silica and calcite along fracture surfaces at location F. The source of the lead is believed to have been galena, although none has been identified at this locality. The identification of the wulfenite was made by energy dispersive spectrometry.

Silicates

The silicates constitute the largest group of minerals found at Kalkar. They are generally the product of contact metamorphism of silica beds associated with limestone, and of metasomatic action along the fault system of the quarry.

Actinolite $Ca_2(Mg,Fe)_5Si_8O_{22}(OH)_2$

Dark green elongated crystals and masses of actinolite, associated with tremolite, occur in the quartz-rich sulfide-bearing veins of the west quarry contact area. It is the main silicate of the boulangerite-meneghinite-jamesonite sulfosalt assemblage.

Allanite $(Ca,Ce,Al)_2(Fe^{+2},Mg)(Al,Fe^{+3})_2O\cdot(Si_2O_7)(SiO_4)(OH)$

Allanite is very rare in the calc-silicate rocks at Kalkar. A single dark brown crystal, showing four faces, was found at location C. It was identified by X-ray diffraction; energy dispersive spectrometry indicates equal amounts of Ce and La in the crystal.

Amesite $Mg_2Al(Si,Al)O_5(OH)_4$

Pale green crystals of amesite occur embedded in talc in the north part of the quarry at location H.

Andradite $Ca_3Fe_2(SiO_4)_3$

Several small andradite crystals, less than 2 mm in size, were recovered from the contact metamorphic zone at location C. They were embedded in a fine-grained limestone. They are dark brown in color and show the dodecahedral form.

Antigorite $(Mg,Fe)_3Si_2O_5(OH)_4$

Pale greenish antigorite forms part of the alteration of forsterite in the calc-silicate rocks at location F.

Biotite $K(Mg,Fe)_3(Al,Fe)Si_3O_{10}(OH,F)_2$

A few rare flakes of biotite were found in the calc-silicate rocks that contained an abundance of arsenopyrite and pyrite. Biotite also was observed with feldspar in the quartz diorite block of the small quarry to the south.

Celsian $BaAl_2Si_2O_8$

Celsian is very rare at Kalkar. Small crystals less than 3 mm in length occur in tremolite with titantaramellite and titanian pabstite. It also occurs as vein fillings in phlogopite schist and can be recognized by its cleavage and pale gray color. It was identified by X-ray powder diffraction.

Chondrodite $(Mg,Fe)_5(SiO_4)_2(F,OH)_2$

Small anhedral crystals of chondrodite occur sparingly in the recrystallized limestone near the quarry faults. Its color is usually dark golden brown (Leo, 1967).

Clinochlore $(Mg,Fe)_5Al(Si_3Al)O_{10}(OH)_8$

A chlorite mica near clinochlore in composition occurs as pale green foliated masses associated with phlogopite and pyrite in the calc-silicate rocks in the western quarry section.

Diopside $CaMgSi_2O_6$
Forsterite $(Mg,Fe)_2SiO_4$

Both diopside and forsterite occur as colorless, xenoblastic grains in the recrystallized limestone. The forsterite is altered in part to pale greenish antigorite and white to pale green talc (Gross *et al.*, 1967).

Dravite $NaMg_3Al_6(BO_3)_3Si_6O_{18}(OH)_4$

Rare prismatic crystals of green dravite were found in the western part of the quarry embedded in a graphitic limestone. The crystals show a radiating habit parallel to the graphite seam. In the same general area several small prismatic brown crystals of dravite were found in quartz-limestone rock associated with stibnite. Both samples were identified by X-ray powder diffraction and energy dispersive spectrometry.

Meionite $3CaAl_2Si_2O_8 \cdot CaCO_3$

Meionite has been observed sparingly in the impure marble, associated with diopside (Leo, 1967).

Muscovite $KAl_2(Si_3Al)O_{19}(OH,F)_2$

Muscovite occurs rarely in the calc-silicate rocks. It was observed associated with boulangerite in the western part of the quarry.

Nepouite $(Ni,Zn)_3Si_2O_5(OH)$

Nepouite rich in zinc occurs as yellowish green spheroidal coatings covering aragonite and calcite along fracture surfaces at location F. It is closely associated with arseniosiderite. The mineral was identified by X-ray diffraction and energy dispersive spectrometry.

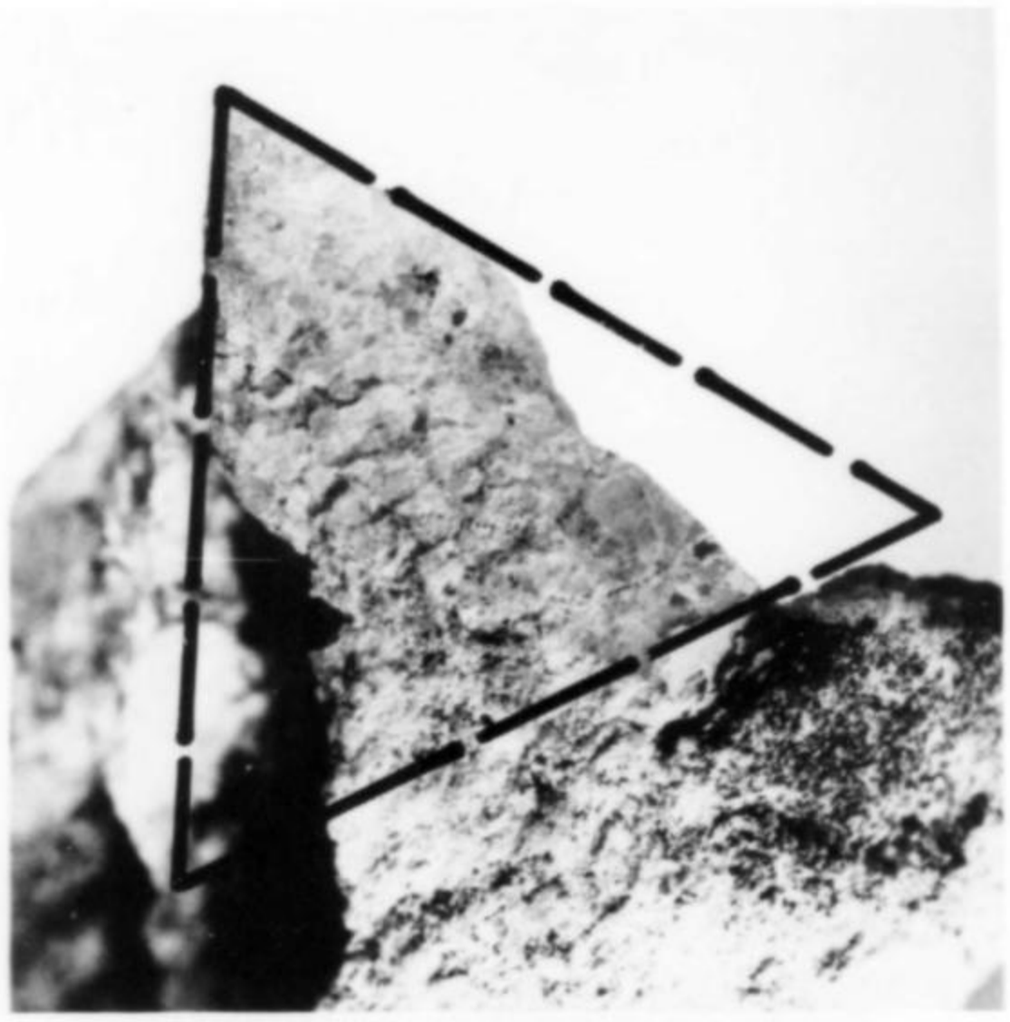

Figure 13. **Pale pink, partial crystal of titanian pabstite, 3.5 cm, showing trigonal symmetry. J. F. Cooper specimen, G. Dunning photo.**

Pabstite $Ba(Sn,Ti)Si_3O_9$

The new mineral pabstite was discovered in 1963 (by the authors) in recrystallized siliceous limestone, and subsequently described by Gross *et al.* in 1965. Pabstite occurs as anhedral grains and masses which are colorless to white with a pink tinge when freshly broken. It is also found very rarely in partial crystals with a trigonal outline. Field identification is very difficult except when searching with a shortwave ultraviolet light which reveals a bluish white fluorescence.

Pabstite is found in close association with titantaramellite, witherite, galena, cassiterite and sphalerite. Both galena and sphalerite, when found together, are good field indicators for pabstite.

Phlogopite $KMg_3AlSi_3O_{10}(OH,F)_2$

Abundant phlogopite mica occurs as pale pinkish brown to colorless plates in the calc-silicate rocks which are interbedded in limestone. This mica is the major component of the mica schists exposed throughout the quarry.

Quartz SiO_2

Massive quartz occurs abundantly throughout the western part of the quarry as a constituent of the calc-silicate rocks. Fine-grained quartz, resembling porcelain, is usually found with tremolite cutting the recrystallized limestone. Amethyst was found at location F as small, pale purple crystals in a fracture in siliceous limestone. Secondary calcite rhombohedrons cover most of the amethyst crystals.

Sepiolite $Mg_4Si_6O_{15}(OH)_2 \cdot 6H_2O$

Sepiolite occurs throughout the recrystallized limestone as thin coatings along fracture surfaces (Leo, 1967).

Talc $Mg_3Si_4O_{10}(OH)_2$

Talc occurs as small masses of foliated flakes in the calc-silicate-free limestone of the northern section of the quarry. The talc often contains pyrite cubes up to 1 cm on an edge.

Titanite $CaTiOSiO_4$

Titanite, in xenoblastic, brown grains less than 1 mm in size, is abundant in the calc-silicate rocks of the quarry (Gross *et al.*, 1967).

Figure 14. **Anhedral titantaramellite crystal, 10 cm. G. Dunning specimen and photo.**

Titantaramellite $Ba_4(Ti,Fe,V,Mg)_4(B_2Si_8O_{27})O_2Cl_x$

Large, dark brown to black, anhedral crystals of titantaramellite up to 10 cm in size occur in float material removed during quarry operations many years ago. This mineral occurred locally in the contact metamorphic limestone near the fault zones and is usually intergrown with tremolite. Associated minerals include celsian, titanian pabstite, galena, cassiterite and quartz. The titantaramellite from Kalkar contains the highest concentration of vanadium (3.2% V_2O_3) of all the titantaramellites analyzed (Alfors and Pabst, 1984). The titantaramellite crystals from this locality are among the largest in the world.

Tremolite $Ca_2Mg_5Si_8O_{22}(OH)_2$

Tremolite is one of the most abundant silicate minerals in the quarry. It is most common in the areas adjacent to the faults where it forms slickenside surfaces up to several cm in thickness. Its texture ranges from massive granular to coarse elongated crystals. The variety "mountain leather" is found coating surfaces between fault blocks in the limestone in the northern section of the quarry.

PARAGENESIS

Only a few of the sulfides found at the Kalkar quarry show sequential relationships. Arsenopyrite has been found included in massive sphalerite which in turn contains small veinlets of chalcopyrite and pyrite. Sulfosalts border the iron sulfides and may fill fractures in non-metallic minerals. A paragenetic sequence for the Kalkar sulfide-sulfosalt mineralization was difficult to formulate because of the spotty nature of the sulfide-sulfosalt occurrences throughout the quarry.

Gross *et al.* (1967) have concluded, based on limited evidence from polished sections and field relationships, that an overlapping sequence of sulfide formation occurred with molybdenite, cobaltian loellingite and gersdorffite forming earliest at temperatures possible above 600° C. Later, arsenopyrite, chalcopyrite, pyrrhotite, pyrite, and sphalerite formed, perhaps below 555° C. The sulfosalts formed last at temperatures below 400° C.

DISCUSSION

The Kalkar quarry differs from other limestone quarries in the Santa Cruz vicinity in the amount and type of impurities in the original sediments and in the degree of metasomatic action that occurred along the transverse faults. These Sur Series (?) limestones generally contain large amounts of silica and iron. Metamorphism by a nearby plutonic body is believed to have formed the forsterite-diopside-phlogopite assemblage and the tremolite-actinolite facies. It is probable that some of the elements were in the existing sediments, most notably Ba, Fe Zn and Ti, while others, such as Sn, Pb, Sb, As, Mo, Co and Ni, were probably introduced during metasomatic alteration.

Although mineralization at the Kalkar quarry is of limited extent, it is nevertheless unique in mineral content in an area which is dominated by non-mineralized marine deposits. Pabstite, the tin analog of benitoite, has not been discovered at any other locality. In addition to pabstite the quarry has produced some of the largest specimens of franckeite, meneghinite and titantaramellite known in North America.

ACKNOWLEDGMENT

The authors wish to acknowledge the interest and cooperation of the late Fred W. Johnson, owner of the Pacific Limestone Products quarry. Through his observations and recollection the authors were able to reconstruct the probable location of many early mineral occurrences; and he generously presented us with several superb samples of franckeite, calcite, malachite and azurite which were preserved from early mining operations.

This paper is dedicated to the late Fred W. Johnson in recognition of his keen interest in quarry mineralogy and specimen preservation.

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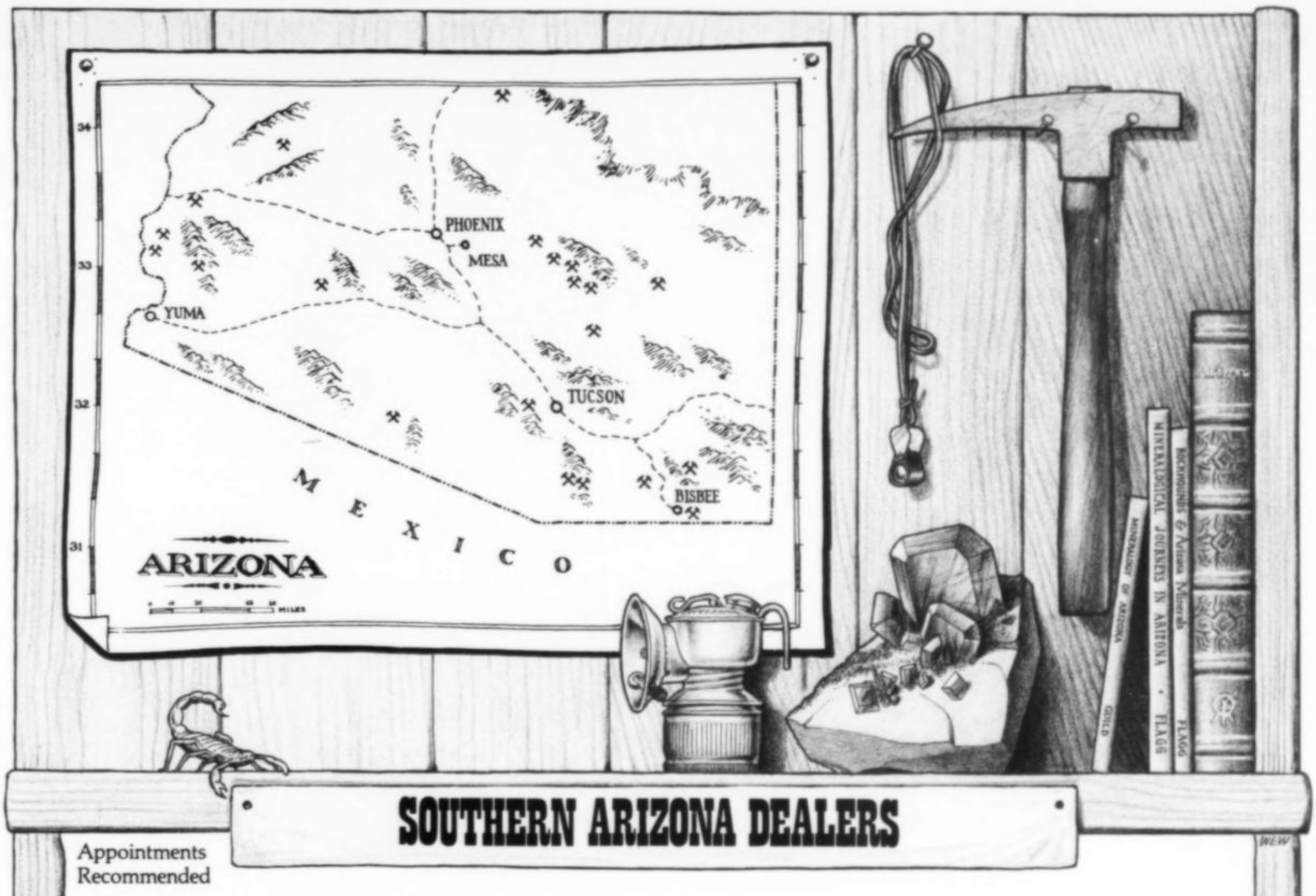

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The Mineralogical Cabinet of the Observatory of Kremsmünster Austria

Ulrich Burchard*
Zueding 5
D-8351 Lalling, West Germany

One of the most beautiful and least known mineral cabinets in Europe is housed in the observatory of the Kremsmünster monastery in Austria. Set amid charming alpine scenery, the museum is furnished with Baroque and Empire glass cases. Most of the mineral inventory dates back to the year 1780.

INTRODUCTION

The small town of Kremsmünster in Northern Austria is situated approximately 30 km south of the provincial capital of Linz. It can best be reached by using the freeway connecting the cities of Salzburg and Vienna. The church and the extensive monastery were built on the hills bordering the valley of the river Krems, a tributary of the Danube.

The "official" name of the museum is the Mineralogisches Kabinett in der Sternwarte (mailing address: Stift, A-4550 Kremsmünster, Austria; telephone 07583-275), curated by Professor P. J. Krinzinger. Admission (adults 25 schillings; children 10 schillings) is by guided tour only, between Easter and November 1. Special guided tours can be arranged.

HISTORY

The monastery was founded in the year 777 by Duke Tassilo III of Bavaria. The architecture of the buildings of the Benedictine Abbey shows many features from the Baroque period. The twin towers of the collegiate church, and the 50 m height of the observatory building, look down over this impressive setting.

The boldly assertive observatory, a tower-like palace, was completed in 1759 and is considered to be a landmark of the town. This tower, actually the first "skyscraper" in Europe, was designed from the beginning for use as an observatory and general museum. In 1850, however, the art collection and the paintings were moved elsewhere.

The mineral collection was begun in 1782, with the acquisition of the comprehensive rock and mineral collection of R. von Rutershausen, a counsellor of justice. From 1803, these specimens were housed in the observatory tower. The catalogue of minerals of the Rutershausen collection still exists; it lists many "curiosities" such as shark teeth, amber, limonite concretions, and so on.

Under the curatorship of Father Sigmund Felloecker (1816–1887) the mineral collection was steadily augmented and a set of wooden crystal models was acquired.

In 1977, on the occasion of the twelfth centenary of the monastery, the natural history collections were refurbished. Great care was taken to preserve the original ambiance of the old exhibits.

The mineral section contains about 12,000 specimens, mainly from extinct localities in the former Austro-Hungarian empire. During the last few years, the display collection has been systematically improved.

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*This article is taken, with minor modifications, from the recently published book *Mineral Museums of Europe* by Ulrich Burchard and Rainer Bode.

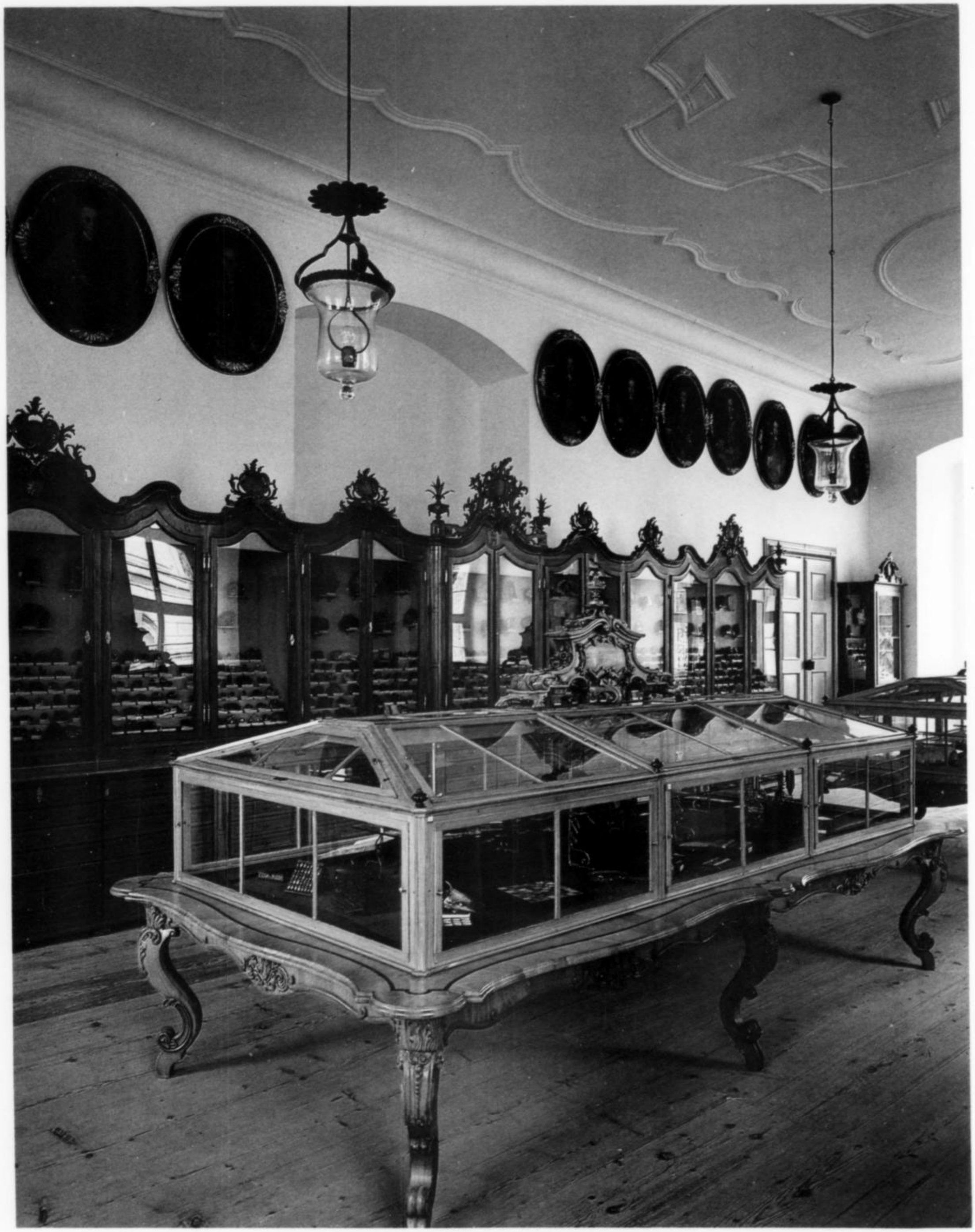

Figure 1. **The minerals are displayed in hand-carved, richly decorated, eighteenth-century style glass cabinets. Photo courtesy of the Kremsmünster monastery.**


CATALOGUS
Systematicus & Synopticus
Musaei
Rogerii de Rutershausen
S.C.R.A.M.C.A.S.C.
Nach dem System
des
Herrn Professor Baumer
in der
Naturgeschichte
des
Mineral-Reiches
1780.

Figure 2. **Title page of the mineral inventory catalog of R. v.Rutershausen, dated 1780.**

Figure 3. **The collegiate church of the Kremsmünster monastery overlooking the Krems valley and parts of the Alps. Photo by E. Mejchar, Vienna.**

Figure 4. **The high-rise observatory tower which houses the natural history cabinets. Photo by E. Mejchar, Vienna.**

BEST SPECIMENS

	Very Good
Pyrolusite	Ilfeld, Harz, GDR
Diopside, Grossular	Val d'Ala, Piemonte, Italy
	Good
Gold	Rosia Montana, Romania
Bournonite	Baia Sprie, Romania
Proustite	Joachimsthal, Czechoslovakia
Mimetite (var. Campylite)	Alston, Cumberland, GB
Vivianite	Capnik, Romania
Zircon	Miask, Urals, USSR
Clinochlore	Hocharn, Rauris, Salzburg, Austria
Gonnardite	Klöch, Styria, Austria

EXHIBITS

The exhibits at the observatory are predominantly oriented toward natural history. Geology-palaeontology is on the first floor, mineralogy on the second. On the third floor is a fascinating display of antique scientific instruments. The zoological collection on the fourth floor includes, among other things, a very large section devoted to birds and a collection of wood samples. The fifth floor is occupied by ethnology and subjects related to cultural history. The former observatory, on the sixth floor, is now a museum of astronomy: there are sundials, telescopes, models of the earth and planets, and surveying instruments.

The mineral collection occupies a room of barely 100 square meters, furnished in late eighteenth century style with old furniture brought from the abbey. The sixteen curved baroque cabinets, and the two straight-lined Empire cases with decorative carving, provide a unique atmosphere and period setting for the mineral display.

The 1200 or so specimens in the exhibits (representing about 300 species) are presented systematically and synoptically. Labeling is good, and the lighting appropriate. Historical aspects of the subject are illustrated by an inventory register of 1780, a Wollaston goniometer, a microscope dated 1850, and other objects in one of the two center cases.

OTHER POINTS OF INTEREST

A visit to the Baroque Abbey, the Imperial Hall, the Treasury, the Art Gallery and Armoury of the monastery, and to the collection of paintings and library of the Kremsmünster foundation, is highly recommended.

Stereo Optics for Mineralogy

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INTRODUCTION

Let's say that old Aunt Esmerelda just died and left you a million dollars. Obviously, your first act is to rush out and buy a brand new stereo microscope. The question is: which one to buy?

Most of us would solve that problem by walking into the local dealer's, throwing him an armful of money (good stereo microscopes are expensive), and saying: "Give me the best you've got." That would be the easy solution, but it might not be the best one. You could wind up with a beautiful piece of equipment that won't do exactly what you want.

In fact, the first thing you have to do is ask yourself two simple questions: (1) What do I want to do with this microscope? And (2) how good is my color vision?

The answers to the first question are normally (A) I want to look at things; or (B) I want to photograph things; or (C) I want to look at things, and photograph things.

These answers are not as simple as they may seem. It is not just a case of saying: "If I want to photograph things, I buy a microscope with a photo attachment." Some microscopes fitted with photo attachments are not optically suited for photography! This does not arise because of some manufacturer's whim: it stems from the basic laws of optics, and the fact that there are two types of stereo microscope.

The answer to the second question is also deceiving. The *better* your color vision, the greater your difficulty in obtaining a suitable microscope. Again, the laws of optics narrow the choice.

A QUICK REVIEW

Since those of us who took it probably struggled through second year optics with the greatest of difficulty, and promptly forgot the whole messy subject right after final exams, it might be best to review a few basic facts:

ONE: Light travels at different speeds in different media. Because of this, light traveling in one medium (say, air), hitting the surface of another medium (say, glass), at any angle other than the perpendicular will be bent away from its original direction of travel as it enters the second medium (see Fig. 1). (Some of it will be reflected away, and will not enter the second medium at all – but we do not have to worry about that.) We can make convenient use of this property to shape a piece of glass so that it will make incoming light form an image. This is a simple lens (Fig. 2).

TWO: Light of different wavelengths is bent at different angles. Shorter wavelengths are bent more than longer wavelengths (Fig. 3). This causes a bit of a problem for our simple lens, because it

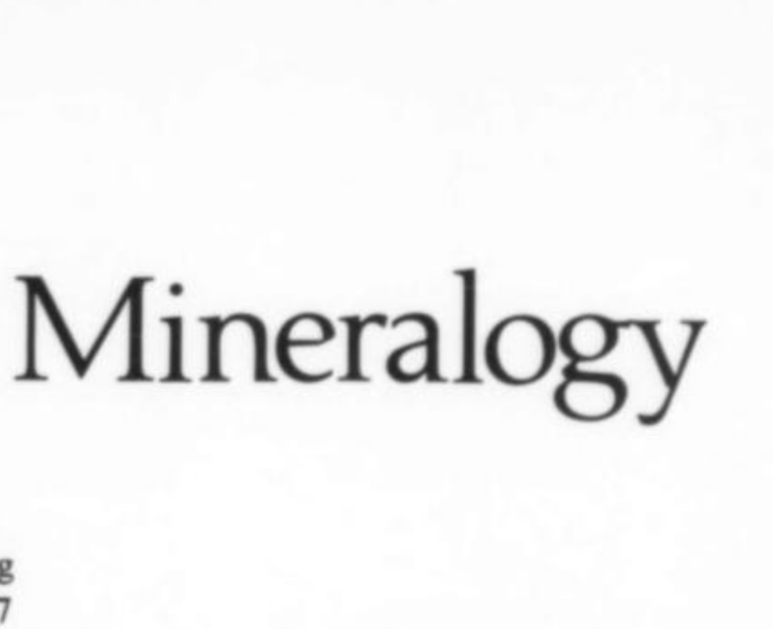

Figure 1. **Simple refraction.**

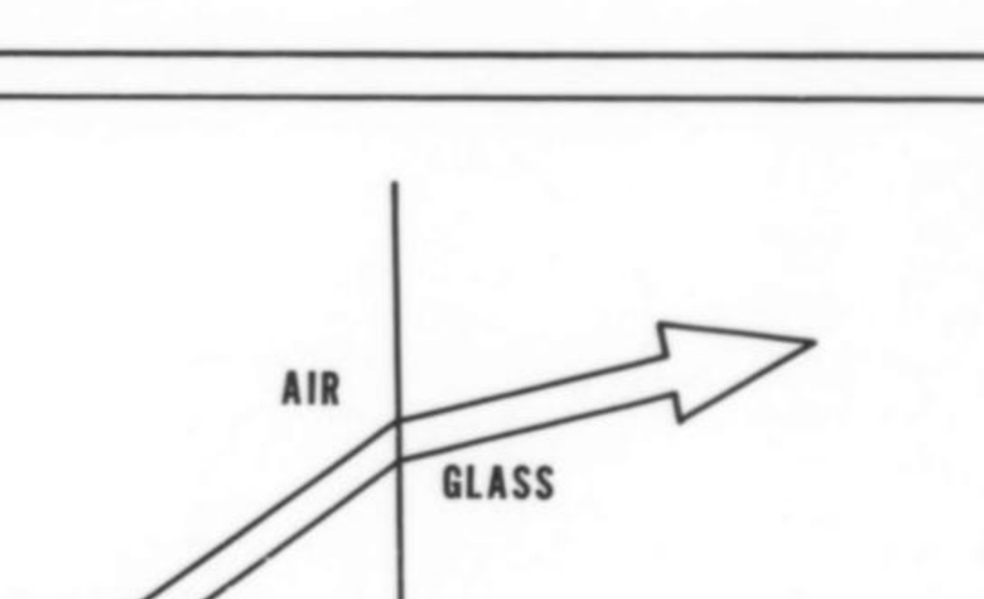

Figure 2. **Simple lens.**

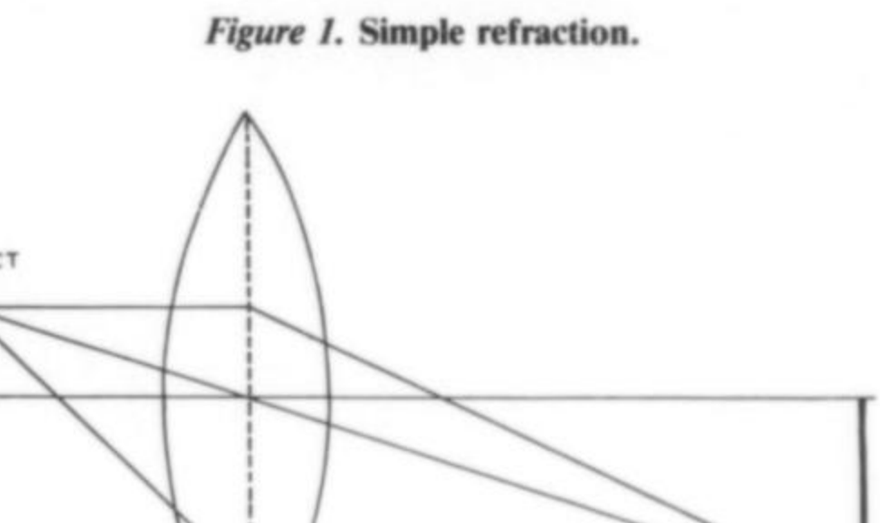

Figure 3. **Variation in refraction with wavelength.**

means that there is a different focal point for each wavelength of light (Figs. 4 and 5).

Note also that there are two displacements of the focal point: one along the axis of the lens (longitudinal chromatic aberration), and one in the size of the image (lateral chromatic aberration).

THREE: Because each side of our simple lens is a section of a sphere (that's how they are made), light falling on the surface of the lens at different heights above the axis is bent at different angles, and arrives at the axis at different points (Fig. 6). This is known as spherical aberration. When it combines with chromatic aberration it gives the simple lens some very fuzzy and colorful effects (Fig. 7).

FOUR: The effects of these aberrations (and of several others I haven't mentioned) get larger as the incoming light rays get further from the axis of the lens, or approach the surface of the lens in a direction not parallel to the axis. That is because off-axis rays result in greater lateral errors, and the human eye can detect lateral errors much more easily than longitudinal ones.

OPTICS OF THE EYE

The human eye is a masterpiece of electronic engineering, adept at receiving information, decoding it and integrating it to a recognizable image in the brain. Because the eye is so good at its function, it can take small variations in focus into account and still produce an acceptably sharp image. This is because of a factor known as the "circle of confusion." Once an image falls below a certain size on the retina, it is seen simply as a point—indistinguishable from all other points. For the average human eye, this happens when an object is at a distance of roughly three thousand times its own diameter. In other words, the average eye cannot distinguish between the images of a 1-cm pea thirty meters away, and a ten-cm grapefruit three hundred meters away. Obviously, other clues such as distance will allow the brain to conclude that there is a difference between the objects, but the eye has reached its limit as far as the image on the retina is concerned.

Look now, at Figure 8. As the light forming the image of a point arrives at the focus, it appears as a cone of rays which diminish to a point of exact focus, and expand again as they pass through.

If we take successive slices through the cone perpendicular to the axis, we obtain a series of circles which diminish in size to the focal point, then expand again. At some point, A, along the axis, the diameter of the circles will fall below that of the circle of confusion for the eye. Similarly, as the circles expand after passing focus, they will reach a point, A^1, at which their diameter is once again greater than that of the circle of confusion. Since the eye cannot tell the difference between images smaller than the circle of confusion, all images which fall between these two points, A and A^1, will seem to be in focus, or at least as sharp as we are capable of seeing them.

Note the angle of intersection of the refracted light rays with the optic axis in Figure 9. For those rays closest to the axis (paraxial rays), the angle is much smaller than for those further away (marginal rays). This means that the cone slices of the paraxial rays will be smaller than the circle of confusion of the eye for a greater distance along the axis ($A\text{-}A^1$), than will those of the marginal ones ($B\text{-}B^1$). In other words, a slight movement of the eye along the axis in the "A" region will make little difference to the image on the retina, but a slight movement of the eye in the "B" region will make a great deal of difference. Furthermore, the rays which have already passed through focus at B will give a fuzzy halo around the image at A. This halo, and certain other adverse effects, can be eliminated by cutting out the marginal rays and concentrating on the paraxial rays alone. That is part of the usefulness of the diaphragm in a camera lens—it cuts off unwanted off-axis rays as it is stopped down (Fig. 10).

The distance $A\text{-}A^1$ of Figure 9 is known as the depth of focus of

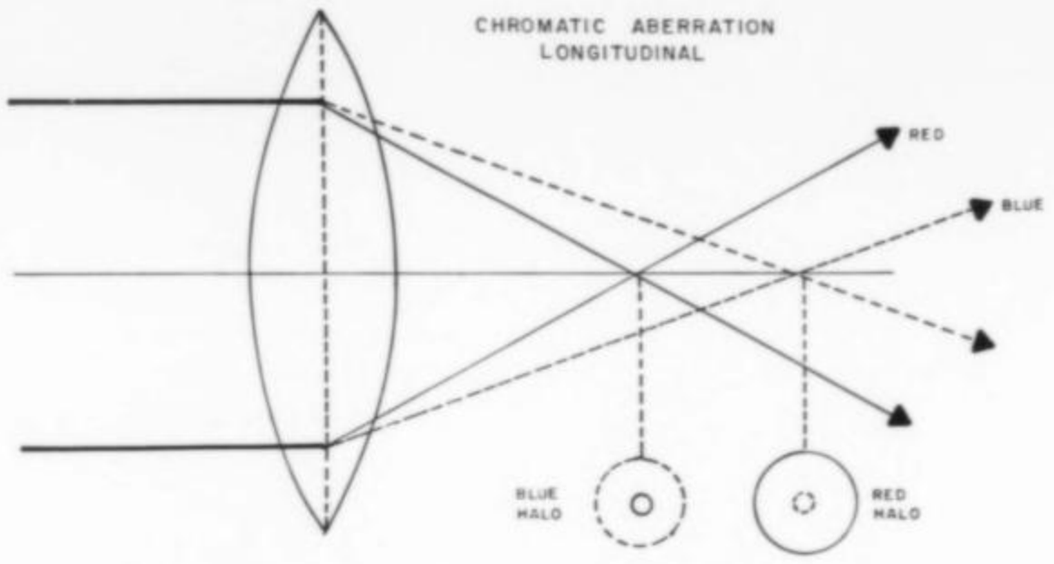

Figure 4. **Variation in focal point with wavelength.**

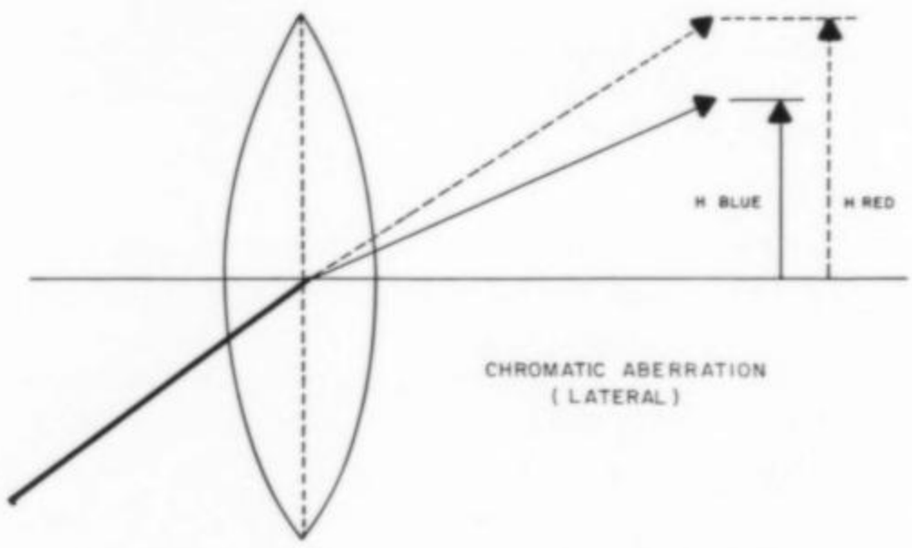

Figure 5. **Variation in image height with wavelength.**

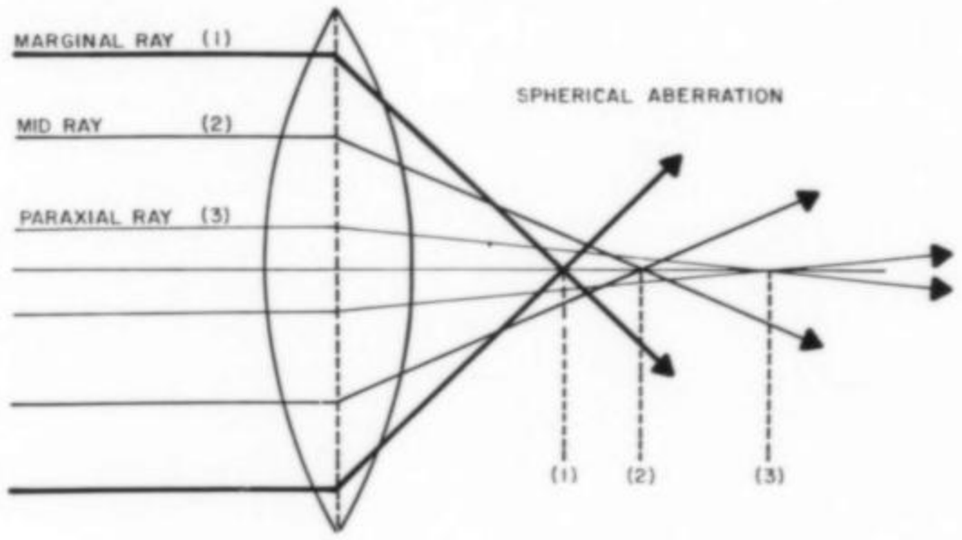

Figure 6. **Variation in focal point with distance from optic axis.**

Figure 7. **Combination of lens faults.**

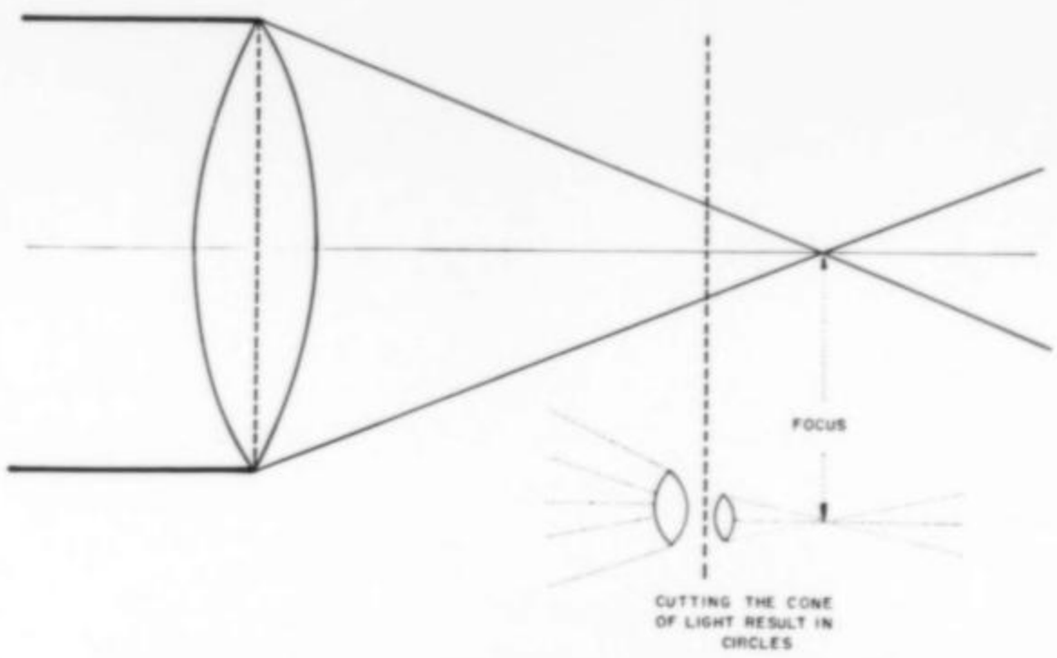

Figure 8. **Image of a point formed by a cone of rays.**

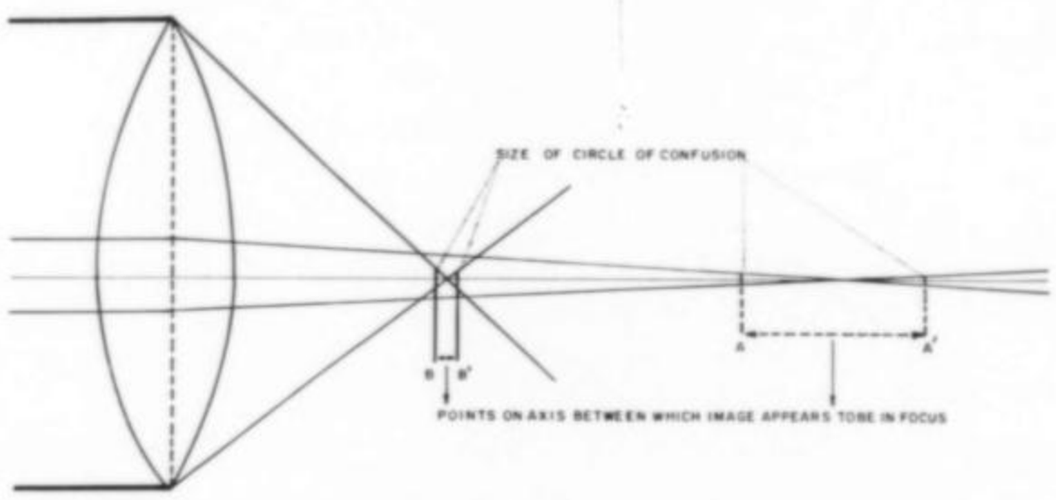

Figure 9. **Variation in depth of focus with ray distance from optic axis.**

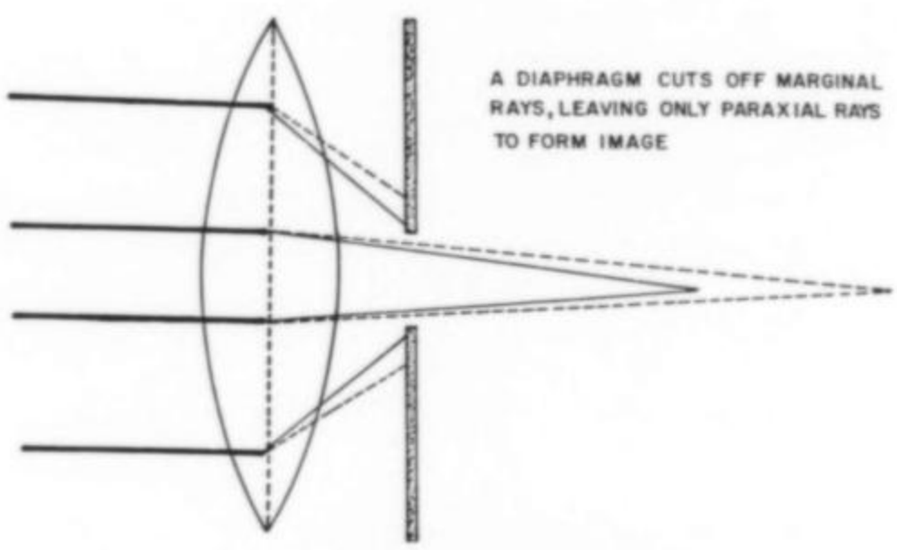

Figure 10. **Diaphragm blocking marginal rays, admitting paraxial rays.**

the lens. Mathematically, the depth of focus is proportional to the inverse of the relative aperture of the lens. As the relative aperture increases, the depth of focus decreases. This is shown clearly in camera lenses, in which a decrease in relative aperture (closing down the diaphragm) results in greater depth of focus, and sharper image.

As microscopists and photographers, we are, of course, interested in depth of field rather than depth of focus. Depth of field relates to the object side of the lens rather than the image side. Unfortunately, the depth of field is equal to the depth of focus divided by the square of the magnification. In other words, a big, bright lens with its larger relative aperture is going to give us less resolution and less depth of field as we go to higher magnification.

MICROSCOPES

By this time, of course, everyone will be saying: "That's all very well, but what does it have to do with me and my microscope? I know that most aberrations can be eliminated or reduced by the use of aspheric lenses, fluorite elements, and mixtures of glasses of different refractive index." Indeed they can: but nothing has yet been devised that will make an off-axis ray as effective as a paraxial ray in forming an image—and that takes us right into the design of microscopes.

The simplest compound microscope has two lenses: an objective, and an eyepiece. It works by using the eyepiece lens to provide a large virtual image of the real image produced by the objective, as shown in Figure 11.

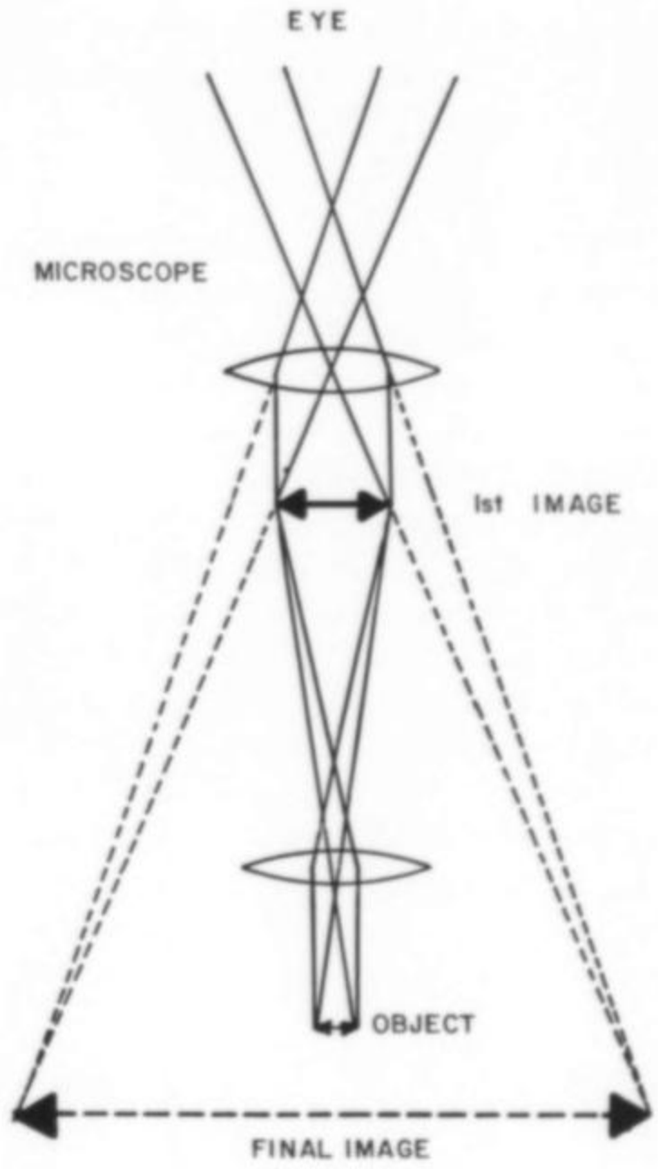

Figure 11. **Arrangement of the basic compound microscope.**

Our problem of course, arises from the fact that we have stereoscopic vision, and we like to see things in three dimensions—hence the stereo microscope. The simplest way to make a stereo microscope is to use two ordinary microscopes side-by-side, with appropriate separation and angle of viewing. This is known as the Greenough principle of construction. Essentially, as we can see in Figure 12, it has all of the standard features of an ordinary monocular microscope. Its great advantage is that light from the object enters the microscope for the most part as paraxial rays, so that we get the benefit of high resolution with relatively few distortions.

At the same time, it has some disadvantages which should be taken into account. Note that the two objective lenses are very close together. In fact, in some microscopes they are so close together that we must cut pieces off of the lenses to help them fit. That means that the lenses have to be small as a matter of necessity—and small lenses simply do not admit a great deal of light. Because the microscopes are tilted with respect to the vertical, the objective lenses are also tilted. This means that if we are looking at an object which is flat, one side of the lens is closer to it than the other, so the edge focus suffers (Fig. 13). Furthermore, because the smaller

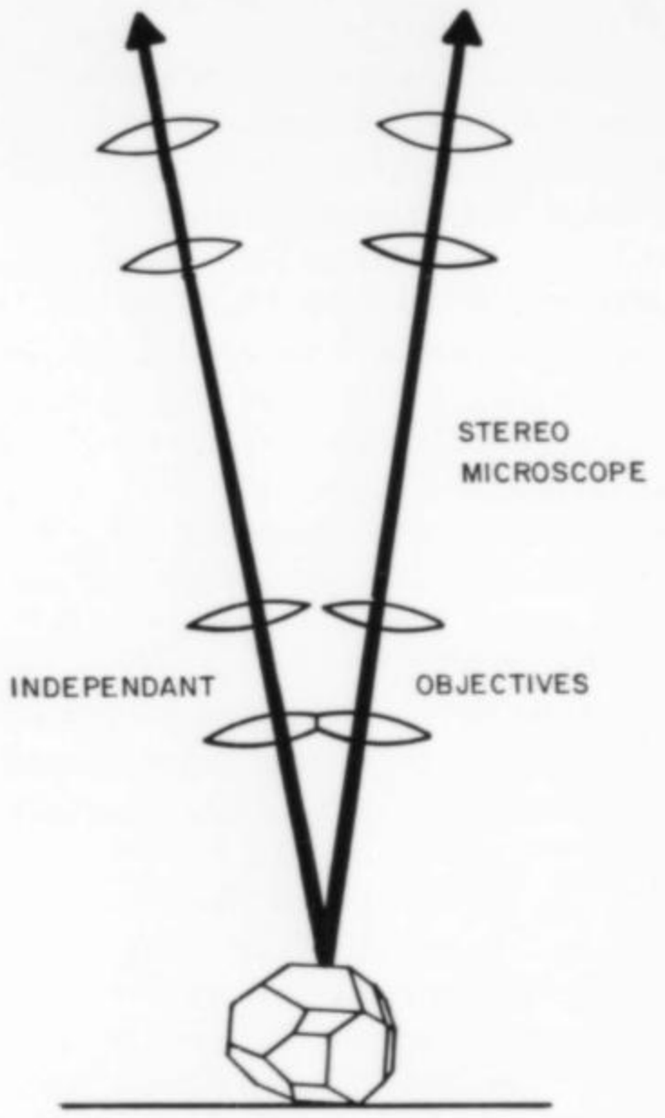

Figure 12. **Arrangement of the Greenough principle stereo microscope.**

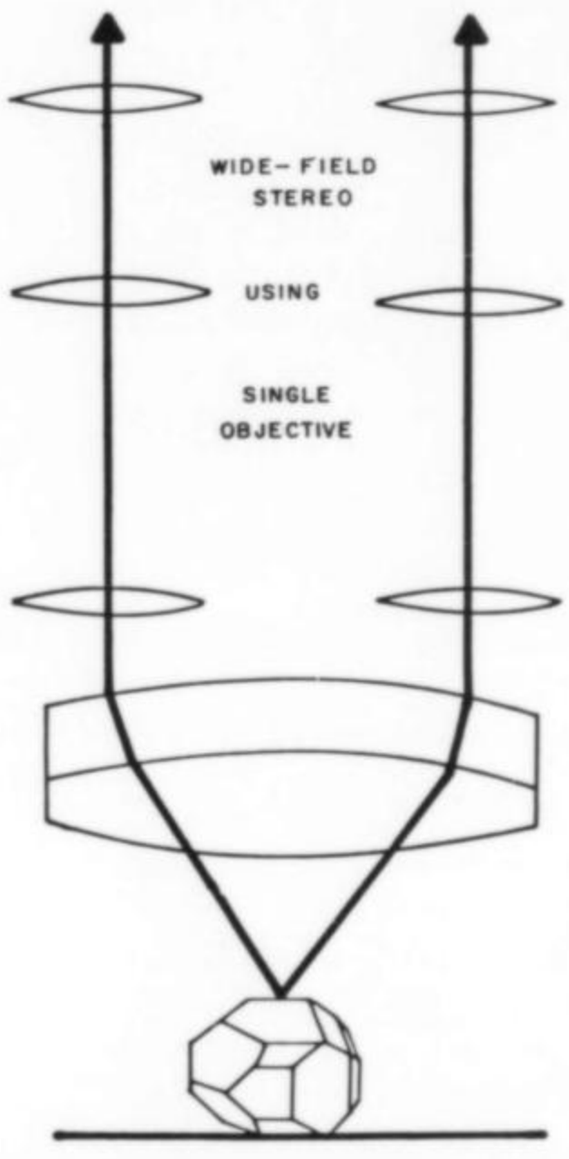

Figure 14. **Arrangement of the wide field stereo microscope.**

lenses are cut from small radius spheres, we tend to run into curvature-of-field effects which again give us distortion of the edges.

To alleviate some of these problems, there is a second type of stereo microscope illustrated in Figure 14. In this design, known simply as "wide field," the two small objective lenses have been replaced by one large lens. The optical path is then adjusted for

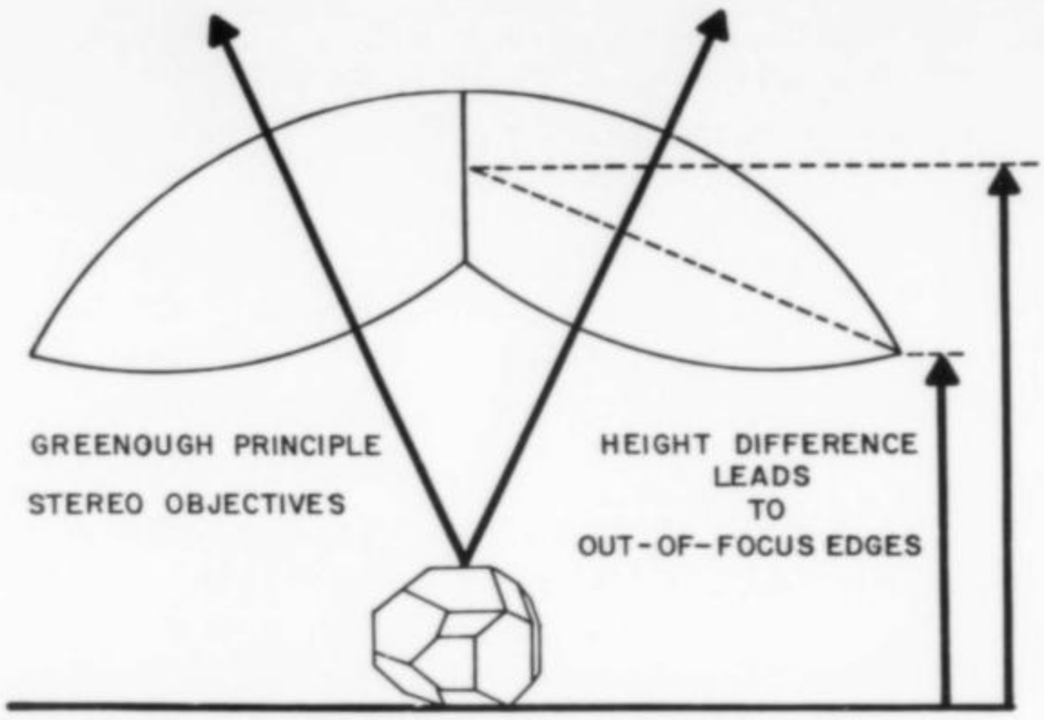

Figure 13. **Tilted lens of the Greenough system causes out-of-focus edges.**

stereo further inside the body of the microscope.

The main advantage of this design is immediately obvious – one can get a great deal more light through a lens the size of a jam-jar bottom than through a lens the size of a dime. The wide field microscope offers a larger, brighter field of view. In addition, because the bottom lens is so big, its radius of curvature is larger, and the curved field effect is markedly reduced. The view through such a microscope is therefore brighter and flatter than through a Greenough design.

The improvements of the wide field design, however, are not obtained without cost. Note the path of the light indicated in Figure 15. No matter how we set it up, we cannot obtain the stereo effect unless the light passes through the objective lens in an off-axis direction. That means that the optical aberrations associated with marginal or off-axis rays cannot be corrected as easily by the usual methods. This is particularly true of lateral chromatic aberrations. Because the eyepiece magnifies the image formed by the objective lens, it magnifies these chromatic aberrations also. That is why one has to ask questions about color vision. People with sensitive color vision will see a disconcerting aura of colors surrounding the object at high magnification, particularly when viewing white or colorless crystals. These colors will also show up on film, so part of the light-

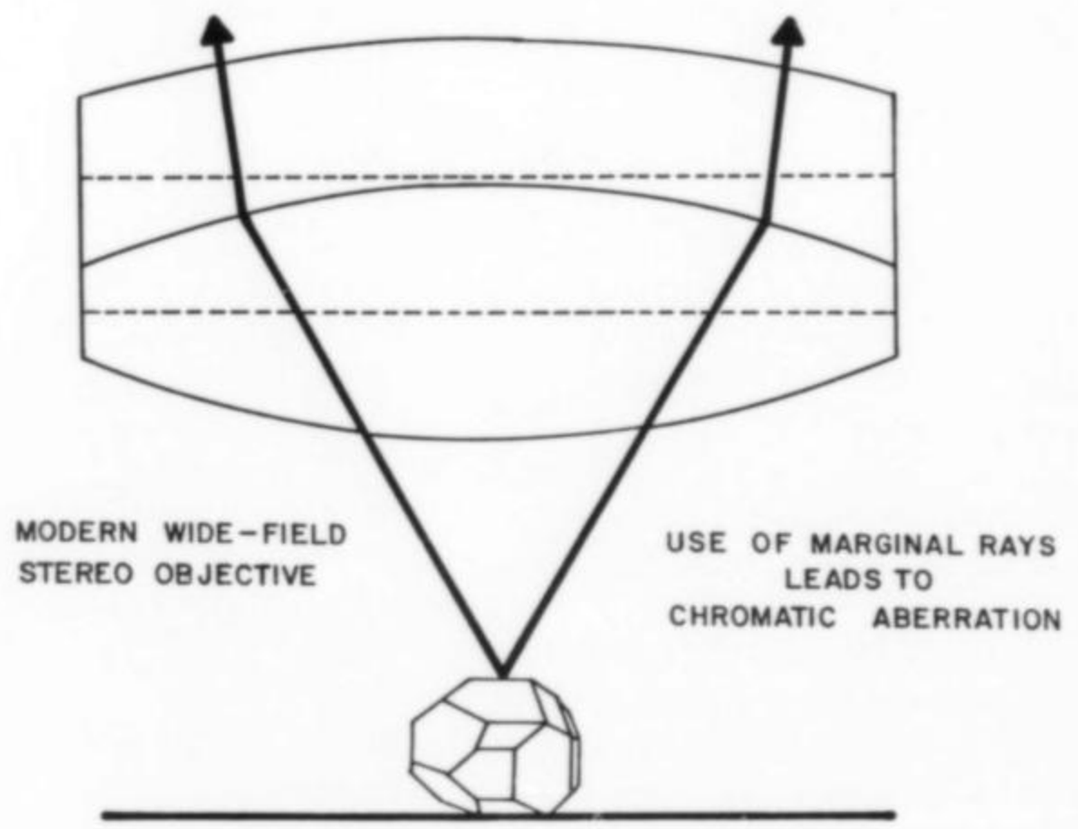

Figure 15. **Use of marginal rays in the wide field system causes chromatic aberration.**

gathering advantage of the large lens is negated for photography by the necessity of using low magnification to avoid the color fringes. It is possible to counteract part of this chromatic aberration by using special (hence, very expensive) eyepieces, but the law of diminishing returns applies, and the correction is minimal at best.

Where does that leave us? Essentially, it means that we have a choice between fairly dim, but high resolution viewing, and bright, flatter, but lower resolution viewing with some color problems. For photography, we have much the same choice, with the added factor that photographs with color fringes are unacceptable for most formal uses, such as publication.

Having said all that, I must point out that both types of microscope cover the major portion of the micromounter's needs very well. If you only want to look, and are content to remain below 45X, then the wide field microscope will be easier on the eyes. If, on the other hand, you wish to have higher magnification, particularly for photography, you would be better off to accept the dimmer field and edge focus problems to get the higher resolution and color correction of the Greenough style.

There are three tests which will help in making the choice. First, send off to a scientific supply house and buy a resolution slide. These are 35mm slides made up to test the lenses of projectors. They consist of a series of clear lines against a black background. The lines are grouped in threes, and get progressively shorter and narrower. We need the slide because the edges between the clear and black portions are very sharp. Illuminate the slide from beneath (with transmitted light). You may have to use a right-angled flashlight if you don't have a clear stage plate. Now, focus on the smallest clear line which fits comfortably into the field of view. Go to the highest magnification. Is the edge still black on one side and clear on the other? Are there two contrasting color fringes instead? If the color capabilities of the microscope are low, you may see blue on one side of the edge and yellow on the other, or green on one side and red on the other. Again, zoom up and down. If the color fringes are present, at what magnification do they disappear? Is that magnification high enough that it will not interfere with your normal viewing range?

Next, get some clean, sharply-lined graph paper, and focus on it, keeping it as flat as possible. Now, slide it sideways, watching the lines at the end of the field of view. Do they curve as they reach the edge? Is the effect enough to bother you during normal viewing of crystals? If you are using a zoom microscope, repeat the test throughout the entire range of magnification.

Finally, find a nice white or clear crystal with a sharp edge. Focus on the edge and zoom up and down. Do the color fringes appear? Are they obtrusive enough to be irritating? Change the position of the light to make certain that you are not being fooled by refraction through the edge of a clear crystal. Chromatic aberration is usually most noticeable outside the image.

It is obvious that most of this discussion has referred to zoom microscopes. Remember that zoom microscopes have a built-in problem with resolution. They have internal moving parts, which means that it is very difficult to keep the optical elements in the precise alignment needed for the highest resolution. Fixed magnification microscopes of equivalent quality normally have better optical performance, although they lack the great convenience of the zoom feature.

After running these tests on a few different microscopes, you will have a better idea of the one you like the best. Once you know which optics you prefer, you can concentrate on the fancy bells and whistles. After all, there isn't much point in buying a microscope which will trim rock, do a microprobe analysis, and make tea, if you can't see the specimen through it. Look and think before you buy.

Now, about the rest of that million – have I got a deal for you!

ACKNOWLEDGMENTS

The author wishes to express his gratitude for critical reading and comment to the following people who aided him greatly in producing this article: George Robinson, National Museum of Natural Sciences; Lieutenant Colonel M. A. Underhill, Canadian Forces, Major D. W. Lyon, Canadian Forces, and Willow Wight, National Museum of Natural Sciences. He is also indebted to J. VanVelthuizen, National Museum of Natural Sciences, for redrafting the drawings from the author's original.

What's New in Minerals?

ROCHESTER ACADEMY OF SCIENCE
THIRTEENTH ANNUAL
MINERALOGICAL SYMPOSIUM HIGHLIGHTS:

WHAT'S NEW IN MINERALS? PANEL DISCUSSION

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The following* has been compiled through the cooperative effort of many individuals, without whose help this list would have been impossible to generate. Therefore, I would like to take this opportunity to thank all the panel members, speakers, collectors and dealers who have so generously made their specimens, slides, and information accessible to me on such short notice. In addition, I would like to extend special thanks to Wendell E. Wilson and the *Mineralogical Record,* William Pinch, Carl Francis and William Metropolis from Harvard University, Rod Lee, Patrick Collins, John Biczoc and William Panczner for their much appreciated help.

AUSTRIA

Due to favorable weather conditions last year, collecting in the Alps proved to be more rewarding than in previous years. Good alpine minerals from Salzburg were evident at the Munich show, including not only the more common minerals such as quartz, orthoclase and clinochlore, but also the more sought-after twinned titanite and good epidote and augite from Krimml. The Natural History Museum of Vienna continued to work the famous epidote mine at Knappenwand in the Untersulzbachtal, and some very fine specimens were found, including a 6-inch epidote crystal only weeks before the show in Munich. The red almandine crystals in schist from the Zillertal were also particularly abundant.

BOLIVIA

There were no more of the superb vivianites from Morococala this year, although a few of the unsold ones from last year's find were still available in Tucson. There were also a few phosphophyllite specimens from Potosi, but it is assumed they were old specimens being recycled.

BRAZIL

Some of the most spectacular new finds this year have been made in Brazil, particularly in the pegmatite region of Minas Gerais. Superb elbaites from several localities (including Santa Rosa, the Genipapo mine in the Aracuai district, Lavra da Natinho near Goverador Valaderes, the Itinga and Taquaral areas, and the well-known Cruziero mine) were recovered. Excellent aquamarine from Lavra de Invreja, Marambainha, and golden-yellow topaz crystals up to 3 kg from Mimosa, Esprito Santo, continue the list. The new blue anatase crystals on quartz from Minas Novas are mind-boggling, to say the least. Interestingly twinned monazites also showed up, but the locality is uncertain (conflicting reports have given both Serra Espinosa and the Joaquin Felicio mine near Buenopolis as localities). There were also some interesting blue quartz crystals available from several dealers in Tucson. These are colored by fine inclusions of a clay-like mineral, and come from Buenopolis, in Minas Gerais. There were also a number of good magnetite crystals (octahedrons to 2 cm) in chlorite schist available from Itabira; these somewhat resemble the old Chester, Vermont, material; a few appear to be at least partially replaced by hematite.

From elsewhere in Brazil, the huge amethyst geodes from Rio Grande do Sul continue to come out in an incredible array of sizes, shapes and colors.

CANADA

There is much to report from Canada. The Poudrette quarry at Mont St-Hilaire continued to operate all last year, and many fine specimens were recovered, largely through the efforts of hard-working Montreal collector Gilles Haineault. Species found include catapleiite rosettes up to 10 cm across, a 13-cm terminated and lustrous arfvedsonite crystal, a 2.5-cm monteregianite crystal, excellent lemoynite, eudidymite "stars" to nearly 2.5 cm, large Baveno-twin microclines, water-clear terminated natrolites 10 cm in length, light pink sodalite crystals over 2.5 cm across, large pockets of siderite twins reminiscent of those found in the late 1960s, large rhombs of pink rhodochrosite, some with leifite crystals, and the normal amounts of good serandite, acmite, pectolite, etc.

The nearby Francon quarry in St. Michel has officially closed and is being used as a landfill site. However, good specimens were still being produced, even in its last days. Some of these included an 11-cm weloganite collected by Don Doell, several good cryolites up to 1.3 cm, good dresserite and strontianite, and some unusual dolomite pseudomorphs after an unknown mineral.

Activity at the Jeffrey mine in Asbestos, Quebec, continued to slow down, as a result of the worldwide lack of demand for asbestos. Only one small find of grossular was made, but the crystals are particularly noteworthy, as they are completely different from any that have been previously encountered; they occur as opaque, white dodecahedrons averaging about 6 mm on green to brown diopside. The lot was relatively small, and is being handled by Rod Tyson (*Tyson's Minerals* in Edmonton). A few collectors were able to unearth some reasonably good honey-brown prehnite from the collector's dump outside the main gates, in spite of no new material being dumped there in a long time.

From Ontario, good crystals of glassy, green diopside were collected all summer long from a new roadcut north of Wilberforce. These are coated with a clay-like substance that fluoresces bright green, and was as a result being called autunite by local collectors. While the cause of the fluorescence is still uncertain, the material gives an X-ray pattern for stevensite.

From much further north, there is a new barite locality at Rock River in the Richardson Mountains of the Yukon Territory. The crystals form groups of tabular prisms up to 45 kg (100 lbs.) associated with pale yellow calcite. The crystals are reportedly gray when collected, but turn *blue* upon exposure to sunlight. The best

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*Ed. Note: Each year at the Rochester Symposium in April a morning is devoted to a panel discussion of new mineral discoveries made during the preceding year. Panel Chairman George Robinson prepared a handout for the audience and was kind enough to permit reprinting of extracts here. Most sections which simply refer to write-ups in previous issues of the *Mineralogical Record* have been deleted.

are quite nearly as good as the more famous English material. Specimens are available from *Tyson's Minerals* and John Biczok (Box 2656, Thunder Bay, Ontario).

Perhaps one of the most exciting new finds in Canada has been the wealth of pyrite specimens that are starting to emerge from the Nanisivik mine, Nanisivik (northwest Baffin Island), Northwest Territories. The crystals occur in more habits and associations than can possibly be described here. The locality promises to become more important; Rod Tyson has successfully negotiated a contract with the mining company to mine and market specimens. Associated species include very nice combinations of calcite, dolomite, sphalerite, quartz and pyrite pseudomorphs after marcasite.

There were a number of interesting Canadian finds of rare species and microminerals. First, Mont St-Hilaire, Quebec, provided excellent monteregianite, lemoynite, gaidonnayite, nenadkevichite, sabinaite and milarite micros (yes, the sabinaite was in visible crystals!). In addition, a number of other species were confirmed present and added to the ever-growing list: beryl, franconite, hochelagaite (the new Ca-analog of franconite), nahpoite, dorfmanite, thalcusite, natrophosphate, lovozerite, and doyleite (a new aluminum hydroxide polymorph described in *Canadian Mineralogist,* vol. 23, p. 21–28) to mention a few.

Also from Quebec, a quantity of armenite was found at a roadcut near the village of Remigny, Temiscaminque County, and a new mineral was named from the Evans Lou pegmatite near Poltimore, north of Ottawa-Hull. The new species was named moydite in honor of Curator Emeritus Louis Moyd at the National Museum of Natural Sciences in Ottawa. It is a yttrium carbonate-borate, and forms tiny, platy, yellow crystals in altered hellandite. Also noted from the Evans Lou, but not with the moydite, was the rare species namibite – the second world occurrence?

Rapidcreekite, a new Ca sulfate-carbonate-hydrate from the Rapid Creek, Yukon area, was available from *Upper Canada Minerals* and Forrest Cureton. Rod Tyson also had a number of good, rich gorceixite specimens available from Rapid Creek, but they were old pieces new to the market, and not recently collected.

Also of interest from northern Canada is an occurrence of mpororoite and anthoinite from Kalzas Lake in the Yukon; russellite from the Nug-4 claim in the Nahani River area of the Northwest Territories; a new Be-REE pegmatite near Thor Lake, N.W.T., where over 70 species have already been identified; and a barium skarn deposit at the Gunn claim in the Itsy Mountains near Macmillan Pass, Yukon, where superb, rich, red gillespite occurs with pellyite, sanbornite, taramellite, fresnoite, muirite and other species, including some tapered, blue barite crystals up to 13 cm long.

As if all that were not enough, Don Harris at the Geological Survey of Canada has already identified over 80 species from the new Hemlo Gold deposit on the north shore of Lake Superior. Among the list of species are aktashite, aurostibite, parapierrotite, routhierite, chalcostibite, melonite, galkhaite, cafarsite and tvalchrelidzeite.

CHINA

Despite an apparent lack of some of the other species to have come to market in recent years, very fine cinnabar crystals from Kweichow Province continue to be seen.

CZECHOSLOVAKIA

A number of good kermesite specimens from Pezinok, in Slovakia, have been available over the last year.

Micromount dealer Rod Lee (*Simkev Minerals*) has just obtained new lots of good micro specimens from Czechoslovakia. Among the items being offered are whewellite from Kladno, krupkaite from Krupka, gold with tetradymite from Jilove, pyrostilpnite and aurostibite from Kutna Hora, slavikite from Skrivan, barytocalcite from Stribro, and nice blue spinels from Imramov.

FRANCE

Hawthorneden (Eldorado, Ontario) had some very nice green fluorite crystals (some with white barite) from the Avellan mine in the masif de L'Esterel, at the Munich show, but they quickly disappeared. Good marcasite specimens from the Cap Blanc Nez area in Pas-de-Calais were also to be seen at Munich, and Alain Carion had some unusual satin spar-like blue halite from Mulhouse, Department du Haut-Rhin. Also new from France are ludlamite and cronstedtite crystals from the Salsigue gold mine in Auge.

GREECE

More good ilvaite crystals from the celebrated locality on the island of Seriphos were collected last year, as were some very lustrous andradite garnets and green quartz crystals, reportedly from a locality nearby.

ICELAND

As a result of the Harvard Mineralogical Museum Association's field trip last summer, there are three new localities to report from Iceland. They are all situated about 32 km north of Reykjavik along Route 1, near the Hvalstod Hvalfjordur. Specimens collected include yugawaralite crystals up to 6 mm with calcite crystals, small crystals of ilvaite and long, white needles of erionite. In addition to these specimens, participants in the trip were also able to obtain good specimens of stilbite, epistilbite, heulandite and natrolite from the Teigarhorn area and nice calcite from the famous Helgustadur calcite mine, for which the variety Iceland spar was named. See *Rocks and Minerals* (vol. 61, pp. 63–69) for details.

INDIA

More very fine zeolites from Maharashtra Province continue to come out, and include new goosecreekite crystals, large chabazite, yuguwaralite, stellerite, large, distorted quartz crystals and calcites in many unusual habits, laumontite and gyrolite, in addition to the more common stilbite, okenite, apophyllite, etc. Some of the better specimens were available from Miriam and Julius Zweibel (*Mineral Kingdom*) and from *Mountain Minerals International* of Louisville, Colorado.

ITALY

New stibnite specimens from Tuscany were available from some of the Italian dealers at Munich last fall. Some of the groups formed rather spectacular black sprays of elongate, prismatic crystals almost 30 cm across. However, nearly all are obtained by leaching away calcite; some appeared to have been dulled by the acid and later sprayed with lacquer to enhance their luster. The absence of any more of the fine epidotes from Val di Viu and vesuvianite from Bellecombe was particularly evident.

MADAGASCAR

Euxenite, betafite and spinel were available from the Betafo and Ambafatosy regions, but generally in only average quality. A notable exception was a single specimen of intergrown zircon and xenotime from Ambatofotsy.

MEXICO

Regarding what's new from Mexico, no particular dealer seemed to have more than a single item to report, yet the sum total when seen all together would suggest that there was indeed much new from Mexico over the last year. There were a few more creedites

from the Potosi mine in the Santa Eulalia District, but the color and size was greatly inferior to last year's find. Perhaps the rumors concerning the thousand flats of fine crystals that had supposedly been collected and set aside were just that. The mine did produce a few good pyrrhotites, however, and some pink manganocalcites, some with doubly terminated quartz crystals. There was a major find (a mere 6 tonnes) of aragonite at the Santa Rita mine, with individual crystals up to 15 cm.

Elsewhere there were other finds. Dave Garske had quite nice cleavage rhombs of optical-grade calcite from a new occurrence in the Challenger Cave System, south of Monterrey, Nuevo Leon. According to Dave, the "rough" from which the rhombs are cleaved occurs as huge crystals up to 1.5 meters long, with various color zones in pink, green, blue and yellow hues in addition to the more common colorless variety. There were more superb acanthites, pyrargyrites, stephanites and polybasites from the Reyes mine in Guanajuato. One of the acanthites found last July is nearly 7 cm on edge and is now in the collection of Miguel Romero. Good barites (especially by Mexican standards) have appeared from two new localities: Tasco, Guerrero, and Angangueo, Michoacan.

William Panczner reports that a few more purple adamites were very recently collected at Mina Ojuela, in Mapimi, Durango, due to a receding water level. If the water continues to go down we may expect more adamite and possibly more legrandite in the next few months.

MOROCCO

Victor Yount had some new and very unusual anglesites from Touissit, and reports additional new finds including water-clear gypsum crystals to 7.6 cm on a matrix of smithsonite (?), malachite and rosasite on pink dolomite (some covered by clear gypsum crystals), and sharp, terminated brochantite crystals up to 6 mm intergrown with malachite.

NAMIBIA

The famous Tsumeb mine is still producing new and beautiful specimens. Last year saw two major finds of azurite crystals on the 35th and 7 levels, glowing green cuprian adamite crystals up to 2.5 cm, superb beudantite crystals from the 36th level, small, transparent, gemmy yellow mimetite crystals, and good specimens of ludlockite, native copper, duftite, leiteite, mottramite and calcite. In addition, there were some attractive new boltwoodites from Arandis, near Swakapmund, and some new stellerites from Rossing.

William Pinch reports that there are some interesting species coming out of the Kombat mine in Namibia's Otavi Mountains. Besides nambulite there is a new sahlinite-like mineral, a lorettoite-like mineral, a new Mn-borate, and a number of other species.

NORWAY

More of the large, red zircons have been collected from the Seiland Island locality in the Alta fjord in northern Norway. The new specimens are as good as the older ones and perhaps not quite as expensive.

PERU

About two years ago there were many good hutchinsonites from Quiruvilca on the market. On some pieces, especially those associated with drusy orpiment and fine barite blades, there appeared an unknown that formed felted masses of maroon-colored needles, most of which were so tiny that they looked like a purplish powder. Recent work by Don Harris at the Geological Survey of Canada and myself suggests that the mineral is most likely baumhauerite. The identification is based largely on microprobe and X-ray powder data, as the crystals are too small to permit measurement of additional properties.

SWITZERLAND

Like Austria, the favored collecting sites in the Swiss Alps were producing fine specimens due to last year's good weather. Some very nice smoky quartz from Cavardiras, Graubunden, and Val Giuv, Grisons, and good orthoclase from Piz Beverin were among the finds.

SRI LANKA

Best known for its gem-bearing gravels, Sri Lanka has recently produced some astounding sapphires, first seen at Tucson in 1985. A few more showed up again this year but were not as large or as good as the previous lot. The locality is being given as Balangoda, near Ratnapura. Also new, and certainly worth mention, are the gemmy, terminated crystals of sillimanite and colorless enstatite from Embilipidya.

USSR

Specimens of numerous species from Russia were once again available at both Tucson and Munich last year, but overall the quality was largely of reference grade. Of exception, however, were some 3-cm red-brown zircons from Lovozero, Kola Peninsula, and some dark green, leafy vivianite from Kerch, Crimea. Brian Cowger (Rochester, NY) has also recently obtained a new lot of diamond crystals in matrix from the Mir pipe in Yakutsk, Siberia.

ZAIRE

There were more malachite crystals and some well-crystallized metatyuyamunite from Mashamba, West Shaba Province. Also new from West Shaba are some brilliant, clear red, gemmy cuprite crystals up to a centimeter. Some are associated with green malachite and make striking specimens. The locality is near Dikuluwe.

ZIMBABWE

About two flats of dark blue euclase crystals from the Last Hope mine, Karoi District, were seen at Tucson. The crystals are similar in size and quality to earlier material.

U.S.A. (by State)

Arizona

The Total Wreck mine produced a few nice yellow-orange wulfenites up to 1.9 cm. Tucson collector Stan Esbenshade recently collected some colorful, blue azurite stalactites at Morenci, and several local collectors continue to find good specimens of Japan-law twinned quartz crystals from Washington Camp, near Patagonia.

California

A remarkable tourmaline discovery was made at the Fano mine, Little Cahuilla Mountain, Riverside County, by Ken Gochenour. The crystals form opaque, black prisms several inches in length, and the few matrix specimens that were available are quite spectacular. Fred Stevens (*Back Country Gems*) had some good twinned crystals of helvite up to 1.3 cm from San Diego County.

Colorado

Keith Williams had a good lot of iron-cross twinned pyrite crystals from the Wyoming mine, near Red Cliff, Eagle County; and Don Knowles (*Golden Minerals*) is currently digging some new golden barites from an old mine near Gilman. He reports that they are very similar to the familiar Eagle mine specimens.

Connecticut

Manchester collector Larry Cross has collected large, tapered crystals of beryl from the Case quarry near Portland.

Idaho

Patrick Collins (*Upper Canada Minerals*) and Mike Menzies of Calgary, spent their summer holidays in the Sawtooth Range of central Idaho. Besides being rewarded with super scenery and a good time, their collecting provided them with several pockets of very fine smoky quartz, microcline, topaz and bertrandite crystals. Some of the smoky quartz is of gem quality and a 200-carat stone has been faceted from one piece of rough. The minerals occur in miarolitic cavities in granite.

Maine

In August of last year an important find of purple fluorapatite was made by James Mann and Priscilla Chavarie at the Mt. Rubellite Pegmatite near Hebron, in Oxford County. The crystals were probably the best to have come out of Maine since Terry Szenics' discovery at the Pulsifer quarry in the 1960s.

Massachusetts

Carl Francis reports that local collectors have had reasonably good luck obtaining small but good crystals of babingtonite from the Grove Street quarry in Roxbury, which proves that, with persistence, many of the older localities may still produce good specimens.

Montana

More specimens of veszelyite have been brought out of the Black Pine mine in Phillipsburg by Duane Johnson. Among other Black Pine minerals, Duane had some nice groups of quartz crystals that were new, and also some specimens of the rare, new mineral phillipsburgite.

Nevada

A large pocket containing white crystals of calcite over 30 cm long was recently excavated by Harvey Gordon and Steve Rose (*Sierra Nevada Minerals*) in Pershing County. Hundreds of clusters and single crystals were recovered, some showing good fishtail twins.

New Hampshire

More interesting specimens continue to be found in the miarolitic cavities associated with the Conway Granite in northern New Hampshire. Good Baveno-twin microcline crystals were collected at Moat Mountain by Frank Lavoie, and Mike Undercolferr has found good specimens of cassiterite and helvite in the area to the north. A rather strange looking "topaz" recently acquired by Bob Whitmore (owner of the famous Palermo mine in North Groton) has been shown to be phenakite. The locality was given only as being in the Sugarloaf Mountain area, and the recognition for what it was, one of the best phenakites known from a North American locality, has spurred renewed interest in the area. Other finds include molybdenite as 1.3-cm crystals in matrix from the Dartmouth ski area, 2.5-cm crystals of triploidite from the Chandler pegmatite found by Robert Janules (see pertinent articles in *Rocks and Minerals,* vol. 60, pp. 262–273), and Dana Jewel's discovery of wolfeite at the Keyes mine.

New Mexico

Japan-law twinned quartz crystals were collected from the San Pedro mine, and small yellow scheelites from the Ortiz mine, both in Santa Fe County. Nicholas Theis (1602 Mayflower Drive, Carrollton, TX 75007) had thumbnails available at Tucson.

New York

With lots of hard work, superb specimens of quartz ("Herkimer diamonds") can still be collected at Middleville. In Tucson, Ken and Meredith Silvy had a room full of some of the best crystals I've seen in a long time. Ken also obtained some interesting golden brown calcite from Middleville with clear areas that have furnished small gems similar to the material from Baja California.

The release of C. Ervin Brown's U.S.G.S. Professional Paper 1279 has spurred a renewed interest in the Beaver Creek area of St. Lawrence County among local collectors. Good crystals of calcite, tremolite and uvite-dravite have been found at a number of the localities described and new discoveries have been made nearby. Elsewhere in the North Country some long, prismatic amphibole crystals, unlike others previously found there, were collected at the Powers farm uvite occurrence in Pierrepont.

South Dakota

Both Sharon Cisneros (*Mineralogical Research Co.*) and Dave Garske are offering the new Ca-Fe arsenate-phosphate, walentaite, for sale. The locality is the White Elephant mine, Pringle, South Dakota. Also Bud Ehrle, *Black Hills Institute of Geological Research,* and others had tiptopite, montgomeryite, roscherite and other associated minerals from the Tip Top pegmatite near Custer.

G.W.R.

Figure 1. **Durangite, Thomas Mountains, Utah. Right: 2 cm tall. Joe Pfeifer specimens.**

DURANGITE FROM UTAH

Joe Pfeifer (*Xtal,* Box 253, Sandy, UT 84091) has recently been involved in the discovery of a localized zone of complex mineralogy in the Thomas Range, Utah. Most notable is the occurrence of the rare species durangite, $NaAlF(AsO_4)$, in excellent crystals from micro-size to more than 1 cm. The crystals are tabular on {010} to equant, opaque to nearly gemmy, frosty to very lustrous, and orange-brown to deep red, bearing a passing resemblance to vanadinite except for the monoclinic symmetry.

Associated minerals include cassiterite in brown nodules and microcrystals; hematite in masses, microcrystals and flattened crystals to more than 1 cm; colorless topaz as nests and druses of small (to a few mm) acicular crystals; and also ilmenite, wickmanite, tridymite, tantalite and others.

Though durangite has been known as a species since 1869, a cursory check of the literature suggests that this may be only the third known occurrence. The other two are a pegmatite near Lake Ramsay, Nova Scotia (with cassiterite) and the type locality, the Barranca tin mine, Durango, mexico (with cassiterite, topaz and hematite).

W.E.W.

Italian miner. *Harper's*

Letters

DISSATISFIED MINERAL CUSTOMER

About five or six years ago I complained to you that, in effect, Mr. _____ stole one of my specimens. I enquired about trading one of my specimens to him and he said by letter to send or mail the specimen to him. I sent him a specimen of two red, transparent zircons about 1 inch high, in matrix, worth about $50 at least, because clear red zircons are hard to find now in Ontario. I wrote him two or three times [after that] and he never returned my letters. You said the *Record* was about to cancel his ad anyway, for nonpayment. Good! Now I find to my horror that he is back as an advertiser. (I haven't seen the *Record* for quite a while and don't know when you allowed him to come back.)

I am angry! And he still owes me that specimen I mailed to him in 1978 or 1979. How do I go about charging Mr. _____ for theft and non-return of a specimen? How do I sue him? This is a disgrace. A big-time mineral dealer taking advantage of a small-time well-meaning collector who entrusted the big guy with one of his most valued specimens. Is there no justice when the big guy cheats the little guy?

If he ever turns up at a mineral show near [where I live], I am tempted to get the help of the police force to arrest Mr. _____ on theft.

I am writing this in hope you can do something about this injustice. I am still quite upset, and want a reasonable solution to this crime!

[Name withheld by the editor]

I can understand how irate you are with this dealer (I have withheld the names for legal reasons). Unfortunately, justice in such cases is hard to come by. It turns out that this dealer did eventually pay his overdue ad bill in full, and now pays in advance like everyone else. Also, yours is the only complaint against him we've ever received, and we don't drop advertisers over one complaint. It could easily be some kind of misunderstanding.

As to suing him or arresting him, I'm no lawyer but I suspect this would cause you a lot more than $50-worth of trouble and expense.

The mineral market is a pretty free-wheeling place. Specimens change hands and deals are made involving thousands of dollars, but hardly anyone bothers with rigorous paperwork. People soon learn who they can trust and who they can't. In the process, when they lose a few bucks, they usually write it off to experience and refrain from doing business with that person again. I can only think of one similar court case off hand (over a several-thousand-dollar specimen)

My advice would be to discuss it in person with the dealer next time you see him. Perhaps he will be feeling cooperative or will have some explanation. Did you send the specimen by registered, insured or certified mail so you can prove he even received it? If not, perhaps he never got it. Who knows? Mail service is not always good.

Your letter should also serve as a caution to dealers in general. Unhappy customers have long memories and can spread a great deal of negative publicity, justified or not. Neglecting to answer their letters only infuriates them more. Ed.

FOLDED COPIES

When loading your magazine and address sheet into the plastic bag, I suggest you put the sheet over the *front* cover instead of the back cover. If the Post Office folds it, they always do so with the address sheet out; this way the back cover will get creased instead of the front. Try it, you may like it.

Louis A. Fischer
Monroe, Michigan

We'll do it (with apologies to Bill Larson, whose ad is on the back cover). Ed.

MORE ON MISLABELING

The article on "Mineral Specimen Mislabeling" raises many important issues with broader implications to serious mineral collectors. When a specimen changes hands all of its old labels should go with it. Collecting of old labels without the corresponding specimens should therefore be discouraged. Historical data (such as the date when the specimen was found, bought, catalogued, etc.) can occasionally supplement or clarify the locality data, since mines don't last forever.

I believe all serious collectors should be encouraged to *catalog* their collections. By moving much of the data to a separate (larger) card, there is less pressure to abbreviate localities or to trust anything to memory. A set of preprinted index cards is inexpensive, convenient, and truly indispensable for a collection of any size. Remember that the resale value of an advanced reference or research-grade collection will depend

"This one just says *Fold*."

on the credibility of its documentation.

Dealers should be encouraged to avail themselves of analytical services if they have the slightest doubt about the identity of their material. Often a quick analysis can be obtained in exchange for one or two specimens of the material in question, by finding an interested professor or graduate student. Analysis increases the value of the specimens; dealers and their customers should be willing to pay for it. Conversely, when a particular dealer makes a habit of selling misidentified specimens, word will eventually get around.

Robert J. Lauf
Oak Ridge, TN

I received the March-April issue of the *Mineralogical Record* a few days ago; the article on mineral specimen labeling, a subject of particular and long-standing interest to me, prompts a letter to the editor. I fully agree with the article and it is high time that such a warning note should be written!

As a beginner, and even in the more advanced stages of collecting, it is often very difficult to tell whether a specimen has been mislabeled. It takes a lot of mineralogical experience, a good memory, some knowledge of geography, and in the case of foreign countries, of their history, to be able to recognize errors. With experience also comes the knowledge of dealers (when purchasing specimens) so that one gets to realize that some dealers' labels are more reliable than others. There are some who go to real lengths to assure accuracy, and who are actually grateful when one points out mistakes—and then there are those who just shrug their shoulders. Even when self-collecting, one has to be sure that the material found, if on a dump, or even in the open field, hasn't been "dumped." Only those specimens actually self-collected in a vein, by oneself or a serious collector friend, can be truly and properly relied on.

As geography and history, particularly those of Central Europe, have always been hobbies of mine, and mineralogy (in a serious manner) since the early fifties, it seems that the historical aspect of mineralogy became a very fascinating specialty, sort of by accident. For many, many years, dealers have known me going around at the shows, pointing out misspellings—or erroneous locations that were obvious—and correcting the former, and suggesting a more likely locality when I was fairly positive. I have learned to be a "doubting Thomas" when I buy a specimen, when I am not sure that the information is adequate or correct. If I have such doubts, I have made notations on my file labels. Although I do not have special labels for this, as pointed out in the article, I do make notations on my regular labels. I may mark them: "Original label says" . . . This is a warning, a red flag. If I have a notion of another location, I will say "Label says . . . but may be . . . (check)." Or, "Label says . . . but probably wrong." If, after having researched the item in question, and I have developed a fairly firm opinion of the locality, I will mark on my label: "Label says . . . but probably . . . (see . . .)" and I give the reference. If it is a locality that I am unfamiliar with, I hit the books. Luckily, I am fluent in Italian, German and French; this means that I can go to literature in all these languages, and do not have to rely on Dana's *System,* which has innumerable errors and obsolete usages.

A label such as the one in the article on page 101 poses no problem to me at this stage. It is easy to read because it is in Latin script. But how many Americans could find it on a map, or even know where to look? This is where history comes in: in the nineteenth century, the Reussische Voigtland was one of the innumerable, tiny principalities of the German Empire. "Voigtland" is now Vogtland, and this particular area is in the southernmost part of Saxony near the border of Thuringia and northernmost Bavaria. But you won't find it on a modern map!

Geography being my hobby, I have a pretty good collection of large-scale maps of mineralized areas of Central Europe. My "secret weapon," though, is a huge German atlas of 1904, with about every hamlet in the old Austro-Hungarian and German Empires. If I find an old label with an unknown locality, I first look these up, then, by following physical points (rivers, mountains, etc.), I find the same place on a post-war map. Either the old or the new name are clues, which can be followed up in mineral books. I do have atlases from the twenties, and up-to-date ones, as well, but the best are my large-scale maps. In this manner, I can find the mineralized area and the "new" name: after the thorough carving up of these old Empires, the new name can be in Romanian, Czech, Polish, Hungarian or Yugoslavian. Some of the old mining areas had even then two or more names, particularly in Hungary and Transylvania, where they spoke both German and some local language. Once in a while, I am stymied, but it doesn't happen too often. I find it a great challenge. Also, there are great aids in books, most of them of the nineteenth century, or early part of the twentieth. Many of these, such as the 1843 Gustav Leonhardt, or the standard work by Hintze (which I have complete in photocopy) not only list all the localites known for a particular mineral at the time of publication, but also its color, crystal form and matrix for a particular mine. The Germans have a number of books on regions which are equally descriptive; the French have the huge six-volume Lacroix, which not only describes every mineral and every locality in France and its old colonies, but even shows the crystal forms of a mineral at that particular locality!

The research is great fun for me, and I love doing it. Besides, I have 3000–4000 specimens from Germany (i.e., the German Empire before 1914, when it included Silesia, Alsace and large parts that are now Poland). This large, specialized collection is arranged not only by regions but by mining districts so that, when looking at a group, one gets an immediate feeling for the mineralization of an area. I do not trim my specimens for show, but want to keep matrix and associations, paragenesis, etc. It is a very important clue and helps in the recognition of mislabeled or lost localities.

Another source of errors is the fact that many Europeans assume that you know enough geography to recognize a well-known locality, without putting the entire details on the label. For instance: "Seiser Alm, Tyrol." Every collector in Europe knows where this is; but how many Americans would know that it is not in Austria, but in Italy, in the Southern Tyrol which was ceded by the Treaty of Versailles? (The Italian name is "Alpe di Siusi.") I once bought a 50¢, nondescript specimen, just to get its labels: one, the original one from a French collection, with "Bishopton, Écosse." The dealer's label read: "Bishopton, Écosse, France." "Écosse" is the French word for "Scotland"! Not that Bishopton is such a French name . . . the dealer should have known.

There are specimens that are so typical for a particular mine, both in crystal form and association, that one can be fairly sure that the attribution is correct, but it should nevertheless be marked on the label. In some very rare instances there are two localities with highly similar-looking minerals, including their association, even though they come from different parts of the world. I have two such items, and I make very sure that they do not get mixed up: one of them is a very old vesuvianite from an old European collection, in blue calcite, from the well-known locality of Monzoni, Fassa Valley, Southern Tyrol, which is the "spitting image" of another from Crestmore, California, found in the forties. In a case such as this, it would be easy for a Californian to doubt the earlier attribution, which is a classic one! It is important to realize that such similarities occur, and not jump to conclusions.

When the original labels are gone, and an error in translation has been made, it is almost impossible to re-establish an absolutely correct location (cf. your "Clay Center" label), but there are times when a lot of detective work and some luck can help.

The most frequent errors in translating old labels occur when the original label is not only in a foreign language, but in old German script: there are few people in this country who can read the old German script, and even Germans do not learn it any more. Luckily, I learned to write that way as a child (at the same time as Latin script; in those days one didn't waste time learning to print first!). I can tell you some weird and wonderful stories, caused by such mis-readings! I have found that, many times, just writing out the "transcription" in German script can provide a clue. In German script, the capital "B" and "L" are almost alike, the "c" and the "i," the "n" and the "u," are the same except for dots or hooks over them; the "m" and "w," the "e," "r" and "v," are groups that can very easily be misread if one doesn't know the language. There are three different forms of "s," depending where they are used, and the long "s" in the middle of a word looks almost impossibly close to an "f."

After so many years of specializing in just this area and building a reference collection together with maps and locality books, I love to be able to help others, and welcome being asked. As I have not had any science education nor advanced math in school (my training is almost exclusively in the humanities) I am unable to do any technical work in mineralogy; but by concentrating on the areas where I do have knowledge, I have had a lot of fun, and can perhaps fill a niche where there is little competition and where I can be of help, even to professionals.

Kay Robertson
10334 Ilona Avenue
Los Angeles, CA 90064

WHITE TOURMALINE

In the article on the history of tourmaline in the Tourmaline Issue (vol. 16, no. 5, p. 335) there is an illustration from Sowerby's *British Mineralogy* (1811). It is labeled "Achroite or colorless tourmaline with quartz crystals from St. Just, Cornwall." However, in 1964 Arthur Kingsbury wrote that the mineral illustrated is most likely phenakite, a species not described until 1833. Phenakite has been found in modern times at Stamps, Jowl Zwan and Wheal Edward (all in the St. Just area). Although the Stamps and Jowl Zwan specimens are unlike Sowerby's in form and association, the Wheal Edward crystals are identical to the small single crystal figured at lower right in the Sowerby plate.

Incidentally, every issue of the *Mineralogical Record* since the introduction of the clear plastic envelopes has arrived here in near-mint condition, compared to the torn and bent state of former mailings. Perhaps the transparent wrappers enable the mail carriers to see the obvious quality of the contents and therefore heed the printed request not to bend or fold them!

Lewis R. Barton
Camborne School of Mines
Redruth, Cornwall, England

I hope you are right about the mail carriers! As to the "tourmaline" illustration, the authors are blameless for any possible error; the editor provided the illustration. (A perfect example of the "outdated identification" type of labeling error discussed in the article on mineral specimen mislabeling.

Ed.

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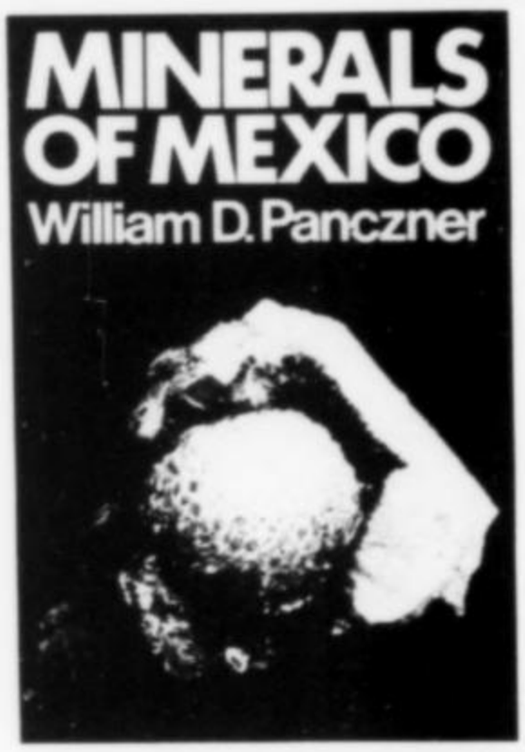

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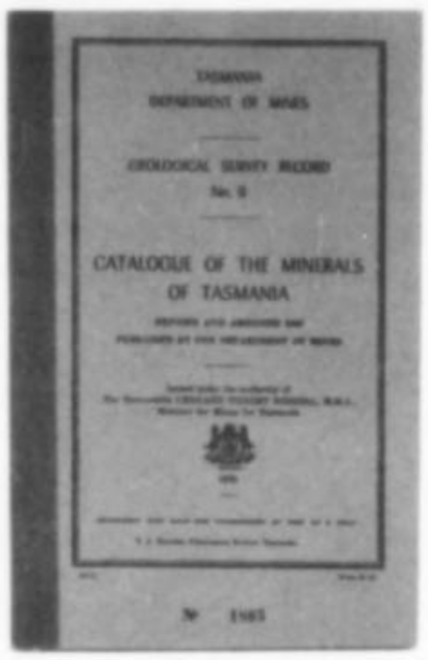

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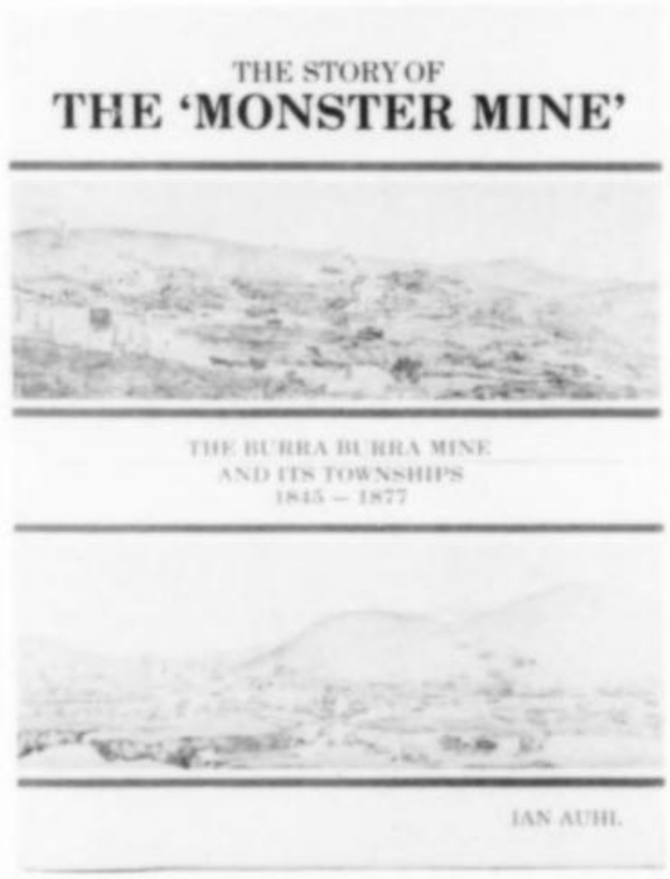

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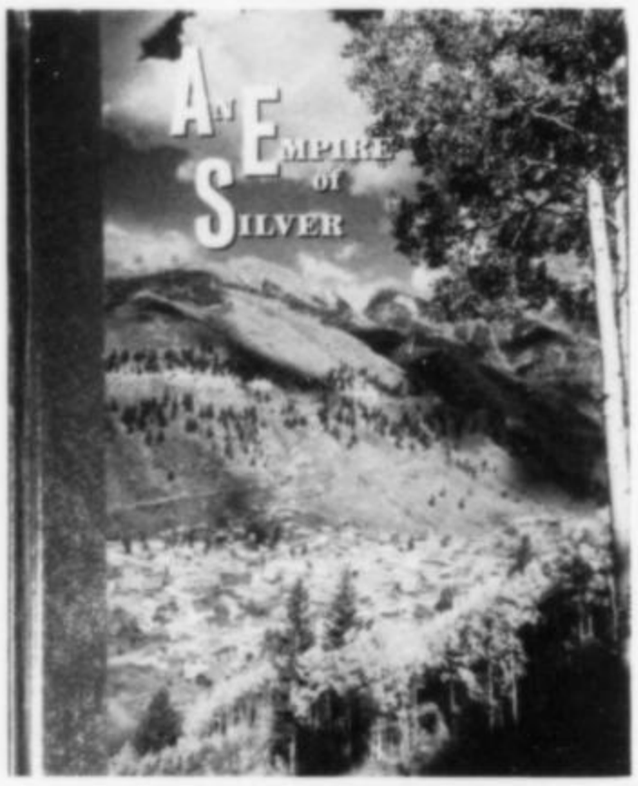

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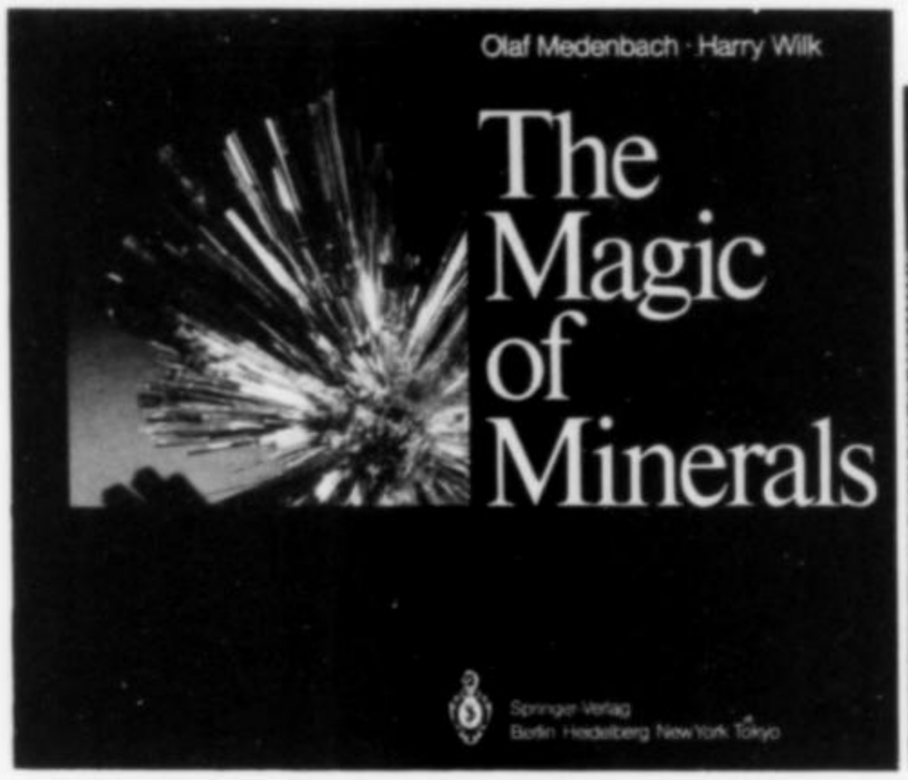

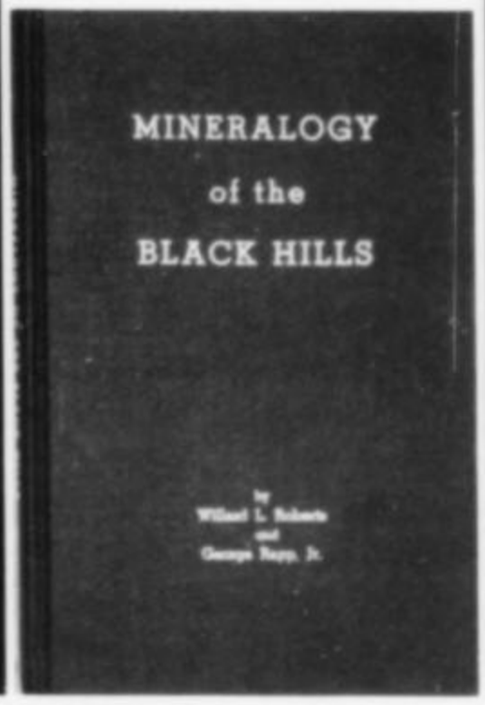

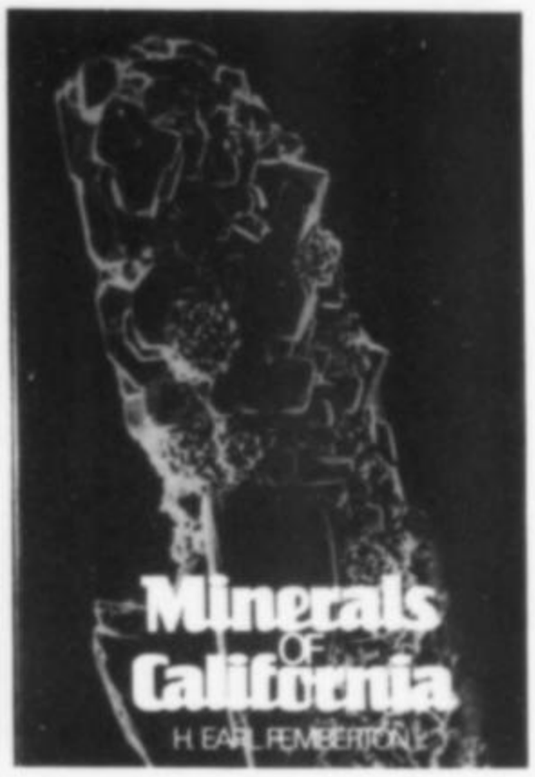

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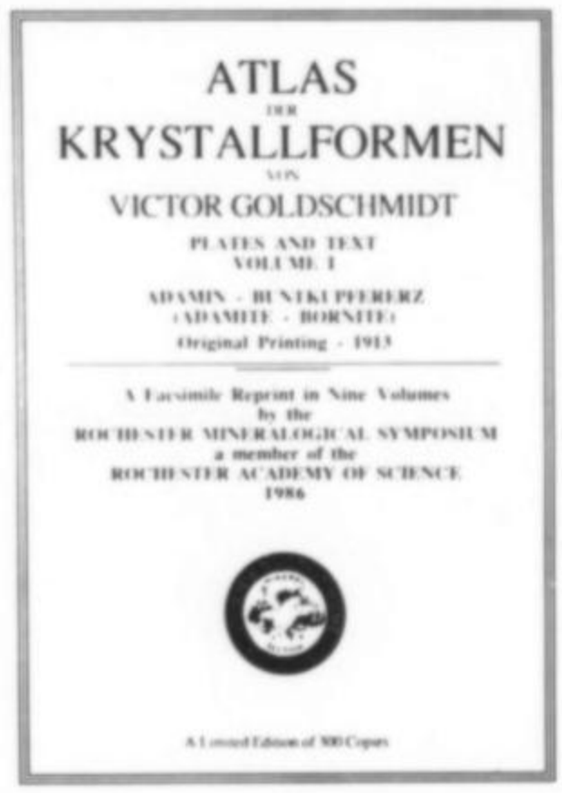

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